WSM

WORKSHOP MANUAL
KUBOTA EXCAVATOR

KX057-4

Kubota

CONTENTS

TO THE READER
TO THE READER

I INFORMATION
CONTENTS
INFORMATION
1. SAFETY FIRST I-1
2. SAFETY DECALS I-4

G GENERAL
CONTENTS
GENERAL
1. CHECKING EXCAVATOR IDENTIFICATION G-1
2. ENGINE IDENTIFICATION G-2
3. GENERAL PRECAUTIONS.....G-4
4. HANDLING PRECAUTIONS FOR ELECTRICAL PARTS AND WIRING.....G-8
5. TIGHTENING TORQUES.....G-12
6. NEW PRODUCT FEATURE (EUROPEAN VERSION).....G-17
7. NEW FEATURES OUTLINE.....G-20
8. QUALITY SPECIFICATIONS G-22
9. WATER AND OIL QUANTITY G-32
10. DESCRIPTION OF PARTS G-33
11. CYLINDER DIMENSIONS.....G-41
12. MAINTENANCE CHECK LIST G-42

1 MACHINE BODY
CONTENTS
SERVICING
1. SWIVEL FRAME..... 1-S1
2. TRACK FRAME 1-S22

2 ENGINE
CONTENTS
GENERAL
1. ENGINE 2-G1
2. SPECIAL TOOLS 2-G4
MECHANISM
1. FEATURE 2-M1
2. ENGINE BODY..... 2-M2
3. LUBRICATING SYSTEM..... 2-M7
4. COOLING SYSTEM 2-M8
5. FUEL SYSTEM..... 2-M10
SERVICING
1. TROUBLESHOOTING.....2-S1
2. SERVICING SPECIFICATIONS 2-S4
3. TIGHTENING TORQUES.....2-S10
4. CHECKING, DISASSEMBLING AND SERVICING 2-S13

3 HYDRAULIC SYSTEM
CONTENTS
MECHANISM
1. DIAGRAM OF HYDRAULIC CIRCUIT (KX057-4EU, U55-4 AUX1, AUX2 TYPE). 3-M1
2. HYDRAULIC DEVICE LAYOUT 3-M2
3. FEATURES..... 3-M3
4. PUMP..... 3-M7
5. CONTROL VALVE..... 3-M20
6. SWIVEL MOTOR..... 3-M30
7. TRAVEL MOTOR..... 3-M36
8. HYDRAULIC CYLINDER..... 3-M47
9. PILOT VALVE..... 3-M54
10. UNLOAD VALVE 3-M65
11. HOLDING VALVE..... 3-M69
12. SERVICE PORT 3-M73
SERVICING
1. PUMP.....3-S1
2. CONTROL VALVE.....3-S23
3. SWIVEL MOTOR.....3-S41
4. SWIVEL JOINT 3-S55
5. TRAVEL MOTOR.....3-S57
6. HYDRAULIC CYLINDER.....3-S89
7. PILOT VALVE (CONTROL).....3-S102
8. PILOT VALVE (TRAVEL).....3-S112
9. PILOT VALVE (BLADE, SWING).....3-S123
10. UNLOAD VALVE 3-S133
11. THIRD LINE VALVE ASSEMBLY 3-S138
12. ROUTING OF HYDRAULIC HOSES 3-S140
13. BOOM HOLDING VALVE 3-S160
14. MEASURING HYDRAULIC DEVICE PERFORMANCE 3-S168
15. TROUBLESHOOTING.....3-S187

4 ELECTRICAL SYSTEM
CONTENTS
SERVICING
1. ELECTRONIC DEVICE LAYOUT 4-S1
2. WIRING CIRCUIT 4-S2
3. TROUBLESHOOTING (START-UP EQUIPMENT VERSION) 4-S13
4. INSPECTIONS.....4-S15
5. INSTRUMENT PANEL OPERATING GUIDE 4-S22
6. TROUBLESHOOTING (METER PANEL EDITION) 4-S88

5 CABIN

CONTENTS

MECHANISM

1. AIR CONDITIONING SYSTEM..... 5-M1
2. WIPER 5-M20

SERVICING

1. TROUBLESHOOTING.....5-S1
2. MAINTENANCE AND SERVICE RELATED SPECIFICATIONS...5-S4
3. TORQUE.....5-S5
4. PRECAUTIONS WHEN REPAIRING THE REFRIGERANT SYSTEM 5-S6
5. INSPECTING AND CHARGING THE REFRIGERANT SYSTEM 5-S12
6. INSPECTION AND DISASSEMBLY 5-S21
7. CABIN REMOVAL AND MOUNTING 5-S39
8. WINDOW WASHER 5-S41
9. LIGHTING DEVICES (CAB WORK LIGHT, INTERIOR LIGHT).....5-S44
10. REMOVAL AND INSTALLATION OF GLASS 5-S47
11. FRONT WINDOW.....5-S52

TO THE READER

This Workshop Manual provides service personnel with information about the mechanisms, service and maintenance of the construction machinery. This Workshop Manual is divided into 3 sections, General, Mechanisms and Service.

■ **General**

This section contains information such as engine and equipment ID numbers, general precautions, maintenance schedules, inspections and maintenance items and special tools.

■ **Mechanisms**

This section describes the structure of mechanisms and explains their functions.Be sure that you fully understand this Mechanisms section prior to performing any service work, such as troubleshooting or when performing any disassembly or assembly work.

■ **Service**

This section contains information and procedures for performing maintenance on the backhoe, such as troubleshooting, service specification tables, torque specifications, items to be inspected and adjusted, disassembly and assembly procedures, as well as precautions, maintenance standard values and usage limits.

All of the illustrations, specifications and other information in this manual were created based on the latest model at the time of publication.

Please be aware that changes to the content may be made without prior notice.

■ **NOTE**

- **Corresponding model list**

Machine Model		Engine Model
KX057-4	For European Union	V2607-DI-E3-BH

March, 2010

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Record of Revisions

Last digit of the Code No.	Date	Main Revised Point and Corrective Measures
1	2010.02.05	• Add TO THE READER • Add MACHINE BODY CONTENTS • Add ENGINE CONTENTS • Add CABIN CONTENTS • Correct the mistake of GENERAL CONTENTS • Correct the mistake of ELECTRICAL SYSTEM CONTENTS
2	2010.03.31	• G-14 [Correct Torque] • G-35 [Add the content.] • G-42 [Unite terms. (chassis → track frame)] • 1-S16 [Add the illustration.] • 1-S23 to S24 [Add WARNING] • 3-M21 [Add Mark] • 3-M26 to M28 [Unite terms.] • 3-S24, S56 [Correct and add Torque] • 3-S111 [Add the content. (U-joint Tightening Tool)] • 3-S123 [Correct and delete the content.] • 3-S140 to S159 [Add the content. (Routing of hydraulic hoses)] • 3-S160 to S165 [Add the content. (Boom holding valve)] • 3-S175 to S176 [Add the content. (Method of measuring overload)] • 3-S179 [Add the content. (LS Control Pressure)] • 3-S180 [Correct the error in writing. (mode → motor)] • 4-S57 to S58 [Add the content. (Overload warning)] • 4-S59 to S60 [Correct the content. (Model Setting)] • 5-S8 [Correct the illustration.] • 5-S19, S27, S29 to S31, S47 [Correct the content.] • Correct Electrical Wiring Diagram and Circuit Diagram
3	2011.09.30	• Page G-22, 25, 27, 28 [Machine weight, drain amount of travel motor and swivel motor, allowable limits of cylinder oil sealing capacity are added.] • Page G-36 [Steel crawler allowable limits are added.] • Page G-43 [Contents are corrected.] • Page 1-S7 [Pump cross-section is corrected.] • Page 2-M10 [Contents are corrected.] • Page 2-S12,S46 [Connecting rod screws are changed.] • Page 3-M1,M3 [Contents are corrected.] • Page 3-M8 [Standby flow rates and Remarks are added.] • Page 3-M43 [Contents are added.] • Page 3-S20 [A torque value is corrected.] • Page 3-S146 [High-pressure Hydraulic Hose Routing (Front) is added.] • Page 3-S165,S166 [Valve Assy Components and Assembling are added.] • Page 3-S170,S181 [Contents are corrected.] • Page 3-S173 [Actual AUX PQ Value Measurement is added.] • Page 4-S19 [Relay capacity and their circuits are corrected.] • Page 4-S34 [MAX pressure of AUX2 port is corrected.] • Page 4-S36 [Contents is corrected.] • Page 4-S42 [List of failure is added.] • Page 4-S46 to S57 [AUX Setting is corrected.] • Page 4-S70 to S78 [Multipurpose Function is added.] • Page 4-S153 to S160 [Fuel Supply Pump is added.] • Page 5-M14,S31 [Contents are corrected.] • Page 5-S49 to 51 [How to Replace the Glass of the Right-side Window is added.]

I INFORMATION

INFORMATION

CONTENTS

1. SAFETY FIRST I-1
2. SAFETY DECALS I-4

1. SAFETY FIRST

⚠ SAFETY FIRST

- **This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels on the machine itself to warn of the possibility of personal injury. Read these instructions carefully.**
- **It is essential that you read the instructions and safety regulations before you attempt to repair or use this unit.**

⚠ DANGER
- **Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.**

⚠ WARNING
- **Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.**

⚠ CAUTION
- **Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.**

■ IMPORTANT
- **Indicates that equipment or property damage could result if instructions are not followed.**

■ NOTE
- **Gives helpful information.**

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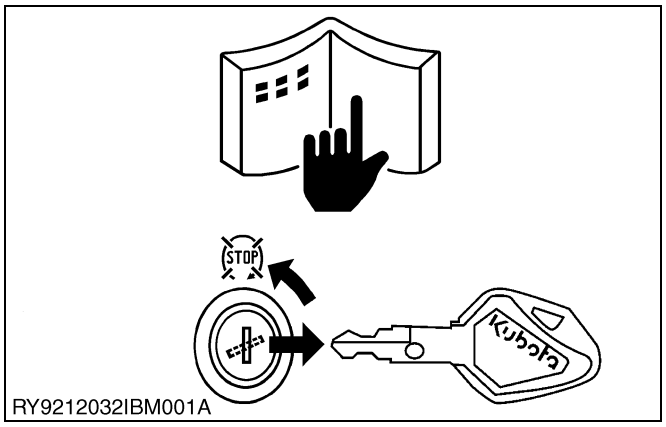

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BEFORE SERVICING AND REPAIRING

- Read all instructions and safety instructions in this manual and on your engine safety decals.
- Clean the work area and engine.
- Park the machine on a stable and level ground.
- Let the temperature of the engine decrease before you start a job.
- Stop the engine, then remove the key.
- Disconnect the battery negative cable.
- Hang a **"DO NOT OPERATE"** tag in the operator station.

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SAFETY STARTING

- Do not do the procedures below when you start the engine.
  - short across starter terminals
  - bypass the safety start switch
- Do not make unauthorized modifications to the engine. This can cause damage and decrease the engine life.

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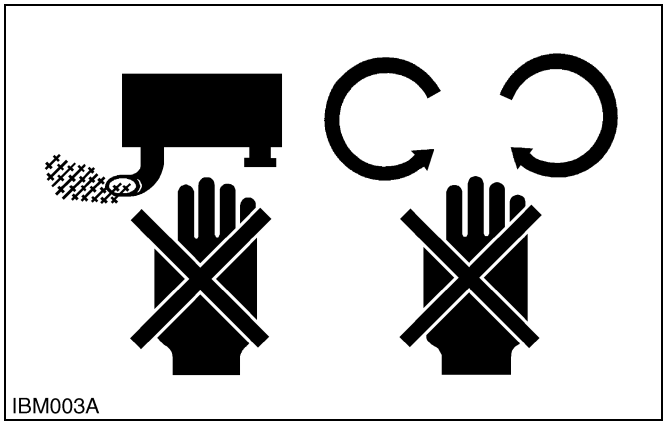
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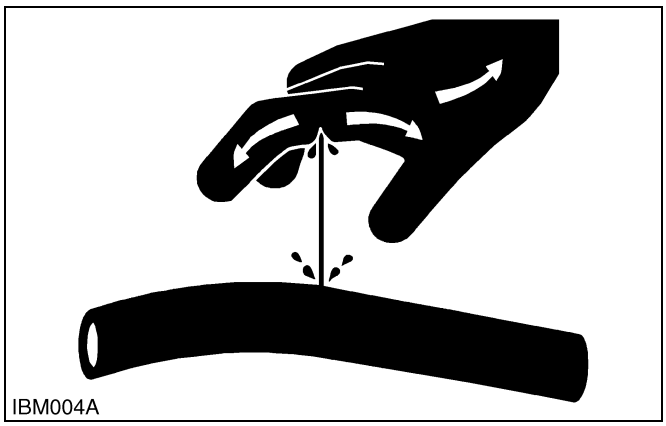
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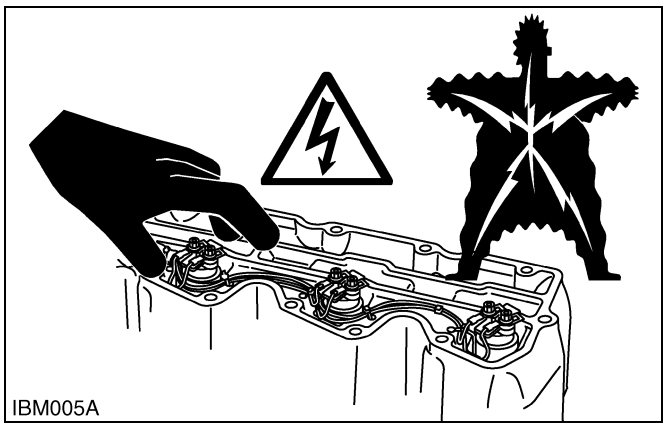
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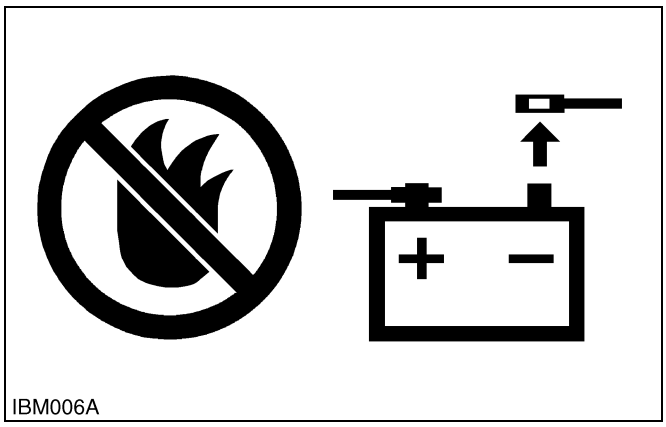
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SAFETY WORKING

- Do not use the machine after you consume alcohol or medication or when you are tired.
- Put on applicable clothing and safety equipment.
- Use applicable tools only. Do not use alternative tools or parts.
- When 2 or more persons do servicing, make sure that you do it safely.
- Do not touch the hot parts or parts that turn when the engine operates.
- Do not remove the radiator cap when the engine operates, or immediately after it stops. If not, hot water can spout out from the radiator. Only remove the radiator cap when it is at a sufficiently low temperature to touch with bare hands. Slowly loosen the cap to release the pressure before you remove it fully.
- Released fluid (fuel or hydraulic oil) under pressure can cause damage to the skin and cause serious injury. Release the pressure before you disconnect hydraulic or fuel lines. Tighten all connections before you apply the pressure.
- Do not open a fuel system under high pressure. The fluid under high pressure that stays in fuel lines can cause serious injury. Do not disconnect or repair the fuel lines, sensors, or any other components between the fuel pump and injectors on engines with a common rail fuel system under high pressure.
- Put on an applicable ear protective device (earmuffs or earplugs) to prevent injury against loud noises.
- Be careful about electric shock. The engine generates a high voltage of more than DC100 V in the ECU and is applied to the injector.

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AVOID FIRES

- Fuel is very flammable and explosive under some conditions. Do not smoke or let flames or sparks in your work area.
- To prevent sparks from an accidental short circuit, always disconnect the battery negative cable first and connect it last.
- The battery gas can cause an explosion. Keep the sparks and open flame away from the top of battery, especially when you charge the battery.
- Make sure that you do not spill fuel on the engine.

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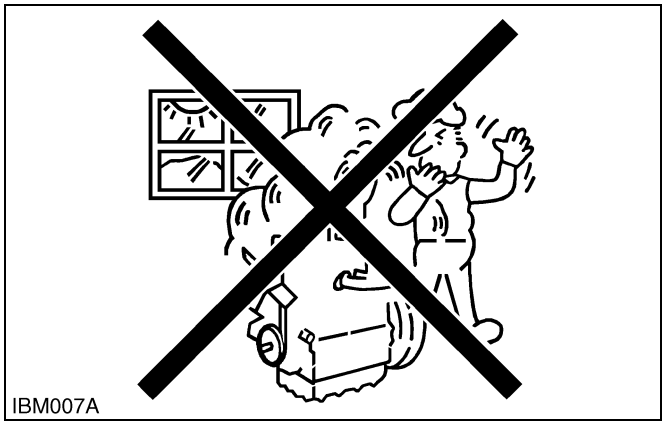
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KEEP A GOOD AIRFLOW IN THE WORK AREA

- If the engine is in operation, make sure that the area has good airflow. Do not operate the engine in a closed area. The exhaust gas contains poisonous carbon monoxide.

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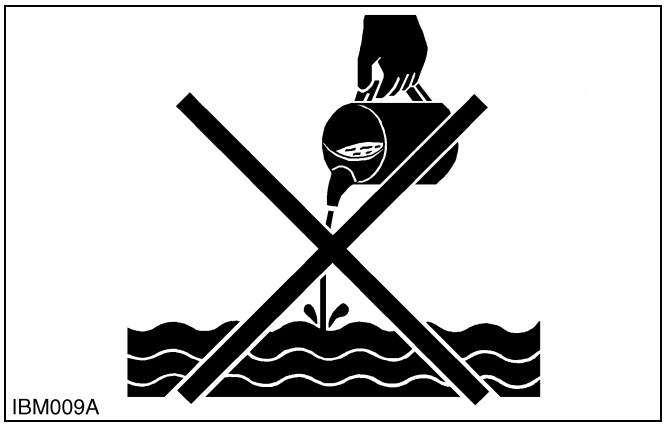
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DISPOSE OF FLUIDS CORRECTLY

- Do not discard fluids on the ground, down the drain, into a stream, pond, or lake. Obey related environmental protection regulations when you discard oil, fuel, coolant, electrolyte and other dangerous waste.

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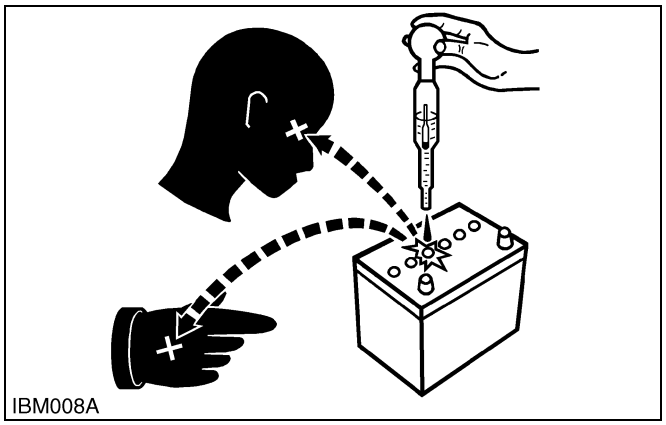
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PREVENT ACID BURNS

- Keep electrolyte away from your eyes, hands and clothing. Sulfuric acid in battery electrolyte is poisonous and it can burn your skin and clothing and cause blindness. If you spill electrolyte on yourself, clean yourself with water, and get medical aid immediately.

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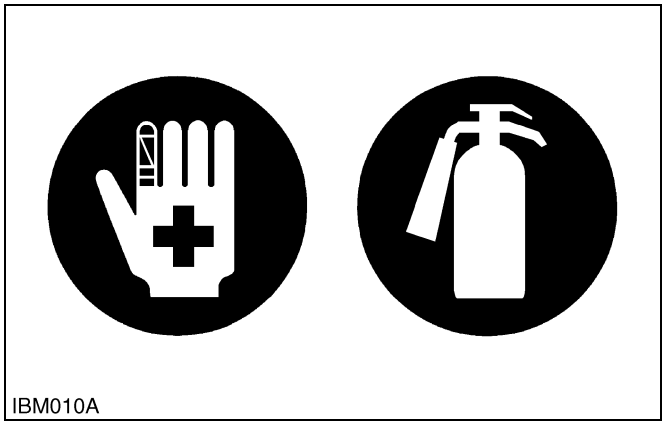
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PREPARE FOR EMERGENCIES

- Keep a first aid kit and fire extinguisher ready at all times.
- Keep emergency numbers for doctors, ambulance service, hospital and fire department near your telephone at all times.

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2. SAFETY DECALS

The following safety decals are installed on the machine.
If a decal becomes damaged, illegible or is not on the machine, replace it. The decal part number is listed in the parts list.

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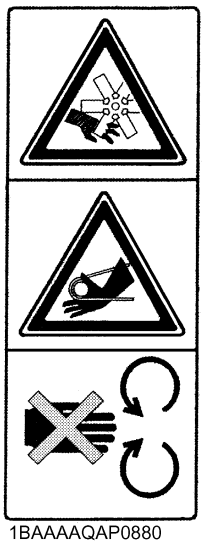
DANGER, WARNING AND CAUTION LABELS

(1)

1BAAGACAP0280

(2)



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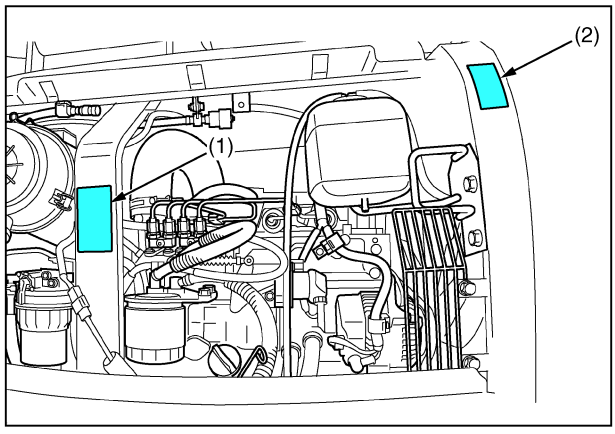

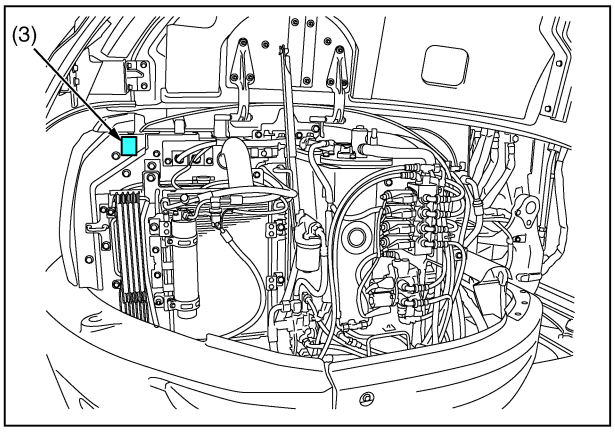

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(1) Part No. TA040-49580 - Do not touch hot parts such as exhaust etc.
(2) Part No. RC418-57370 - Keep away from fan and fan belt.
(3) Part No. RA028-57240 - Attention to the danger of burning.

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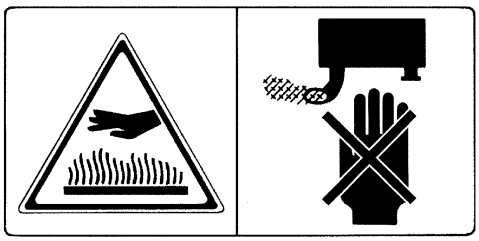
(1)



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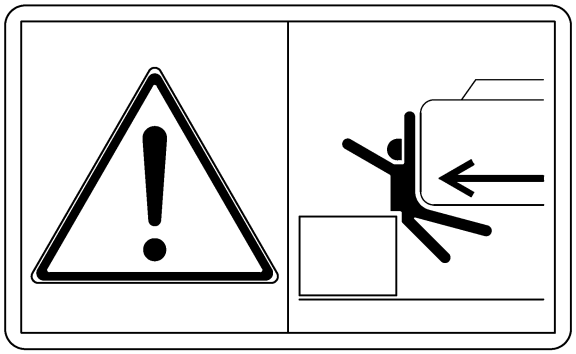

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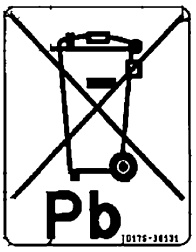

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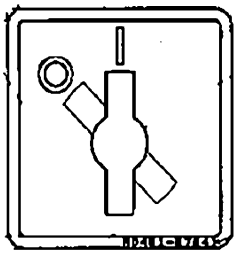

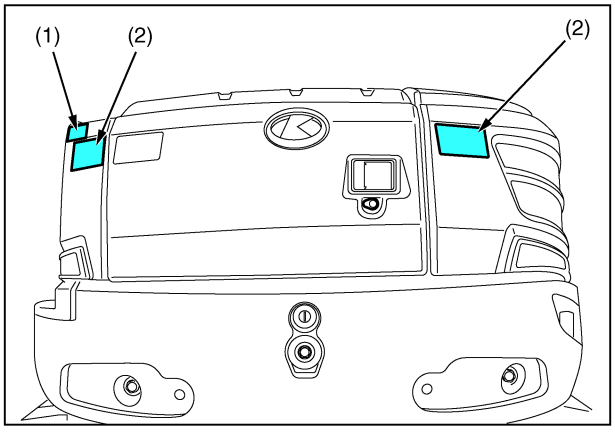

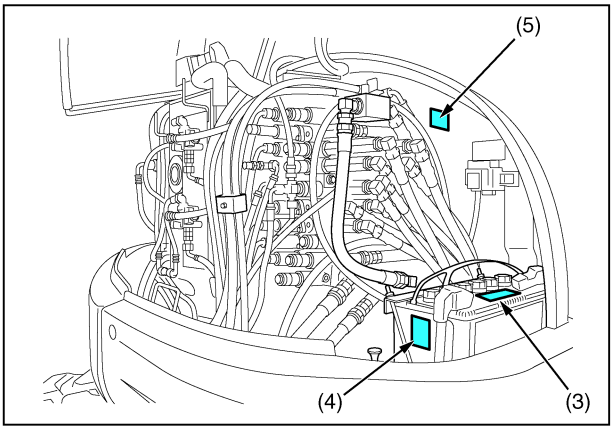

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(1) Part No. RD809-57450 - Do not touch hot parts such as exhaust etc.
(2) Part No. RD809-57250 - Do not allow any persons within the working range.
(3) Part No. T1060-30090 - Keep sparks, flame, cigarettes away.
(4) Part No. TD179-30130 - Battery recycle label
(5) Part No. RD359-57840 - Battery cut switch label

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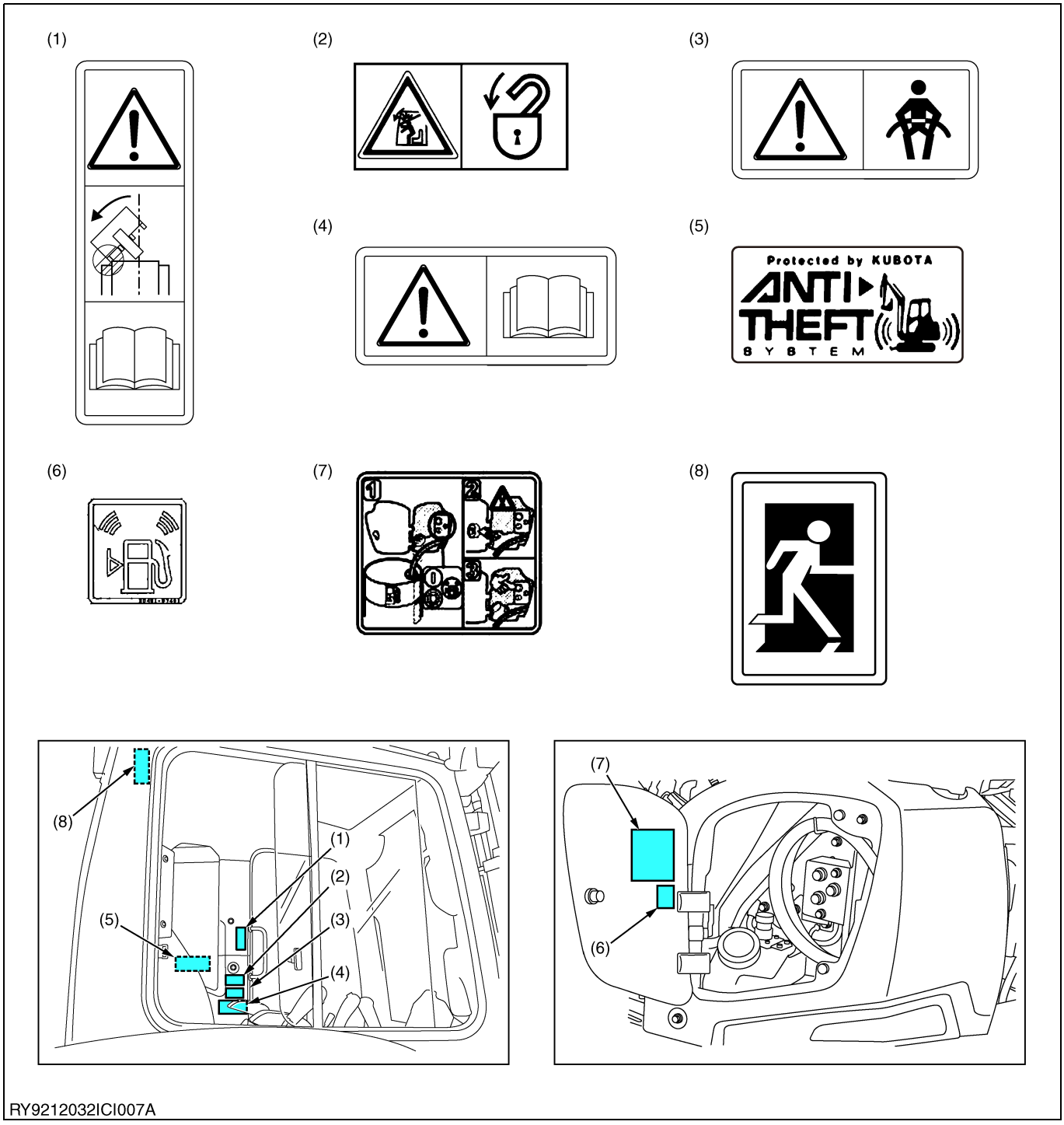

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(1) Part No. RD809-57390 - When using a wider or deeper bucket, take good care when swinging or pulling in the front attachments to make sure that the bucket does not hit the cab.
(2) Part No. RB419-57930 - Label front door lock
(3) Part No. RD809-57430 - Fasten the seatbelt.
(4) Part No. 69198-57840 - Label manual
(5) Part No. RA228-93380 - Anti-theft system
(6) Part No. RD359-57260 - Fuel supply label
(7) Part No. RB238-57360 - Fuel supply label (Fuel pump equipped)
(8) Part No. RD809-57140 - Emergency exit

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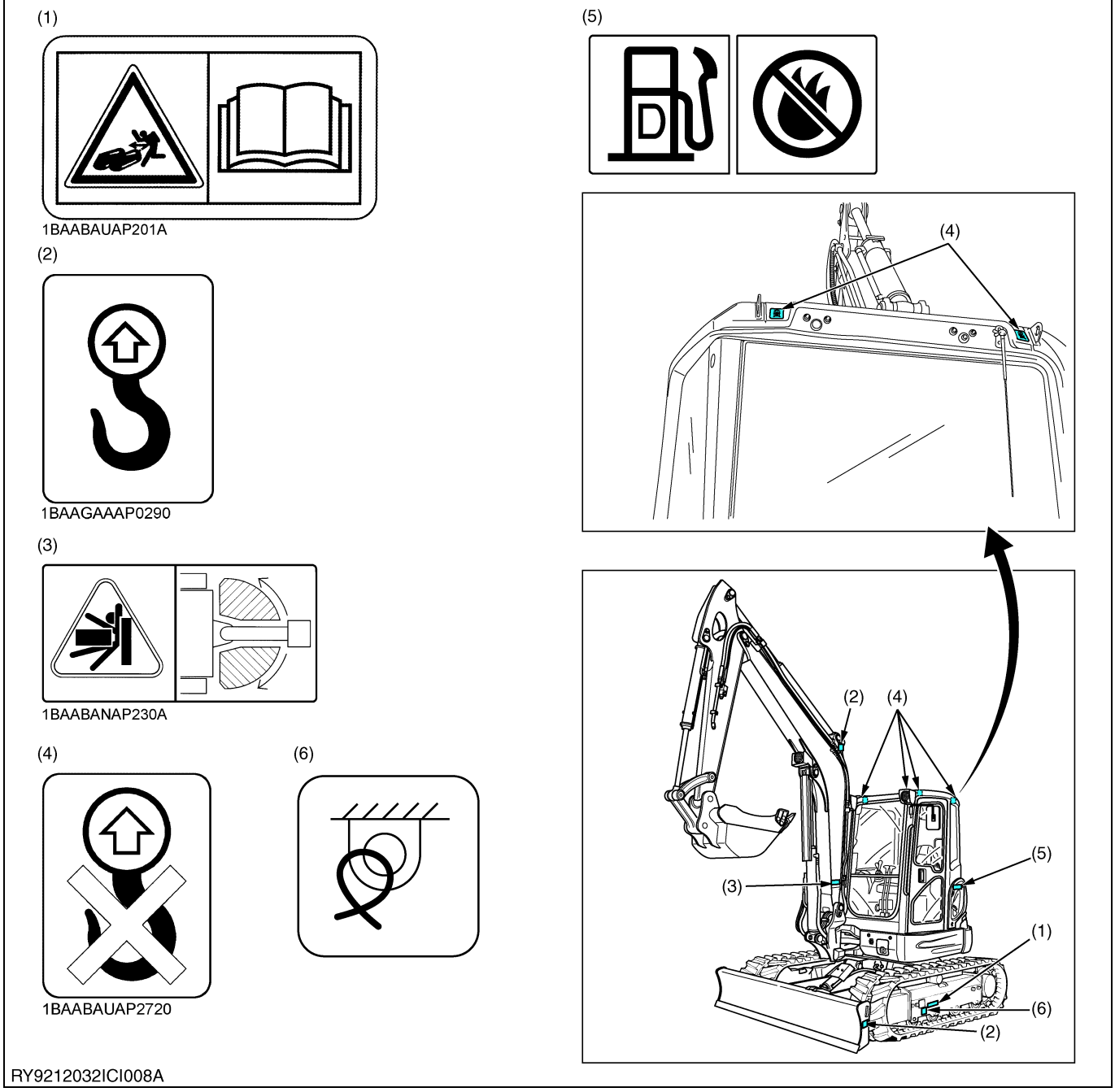

(1) Part No. RD809-57950 - For information about loosening the crawler, consult the operating instructions.
(2) Part No. RC108-57960 - Attachment point for lifting gear.
(3) Part No. RD809-57250 - Do not enter the manoeuvring area.
(4) Part No. RB419-57960 - Not an attachment point for lifting gear!
(5) Part No. RD451-57480 - Diesel fuel only, no open fire.
(6) Part No. RA809-57330 - Use the attachment point only for clamping the excavator securely to a transport vehicle.

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CARE OF DANGER, WARNING AND CAUTION LABELS

1. Keep danger, warning and caution labels clean and free from obstructing material.
2. Clean danger, warning and caution labels with soap and water, dry with a soft cloth.
3. Replace damaged or missing danger, warning and caution labels with new labels from your KUBOTA dealer.
4. If a component with danger, warning and caution label(s) affixed is replace with new part, make sure new label(s) is (are) attached in the same locations(s) as the replace component.
5. Mount new danger, warning and caution labels by applying on a clean dry surface and pressure any bubbles to outside edge.

RY9212007INI0015US0

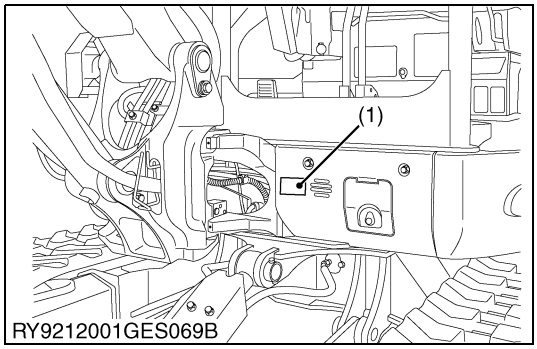
G GENERAL

GENERAL

CONTENTS

1. CHECKING EXCAVATOR IDENTIFICATION G-1
2. ENGINE IDENTIFICATION G-2
   [1] MODEL NAME AND SERIAL NUMBER G-2
   [2] E3B ENGINE G-3
   [3] CYLINDER NUMBER G-3
3. GENERAL PRECAUTIONS G-4
4. HANDLING PRECAUTIONS FOR ELECTRICAL PARTS AND WIRING G-8
   [1] WIRING G-8
   [2] FUSES G-10
   [3] CONNECTOR G-10
   [4] WASHING THE MACHINE WITH A HIGH-PRESSURE WASHER G-11
5. TIGHTENING TORQUES G-12
   [1] GENERAL USE SCREWS, BOLTS AND NUTS G-12
   [2] STUD BOLTS G-12
   [3] TORQUE FOR HYDRAULIC HOSE FITTINGS G-13
      (1) Torque for Hydraulic Hose Fittings G-13
      (2) Torques of Lock-Nuts for Elbows with Male Seats and Adaptors with O-rings (Straight Threads) G-14
      (3) Torque for Tapering Adaptors G-14
   [4] HOSE CLAMP SCREW TORQUE G-15
6. NEW PRODUCT FEATURE (EUROPEAN VERSION) G-17
7. NEW FEATURES OUTLINE G-20
8. QUALITY SPECIFICATIONS G-22
9. WATER AND OIL QUANTITY G-32
10. DESCRIPTION OF PARTS G-33
   [1] FRONT PINS G-33
   [2] BUCKET G-34
      (1) Bucket dimensions G-34
      (2) Bucket installation relevant dimensions G-35
   [3] RUBBER CRAWLER (EU VERSION) G-35
   [4] STEEL CRAWLER G-36
   [5] TRUCK ROLLER, IDLER, SPROCKET G-37
   [6] BLADE G-38
   [7] PARTS WEIGHT (EU VERSION) G-39
11. CYLINDER DIMENSIONS G-41
12. MAINTENANCE CHECK LIST G-42

1. CHECKING EXCAVATOR IDENTIFICATION



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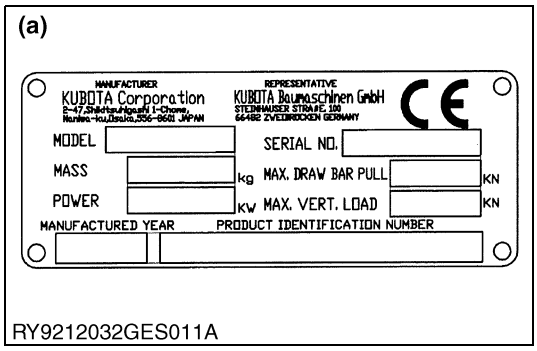

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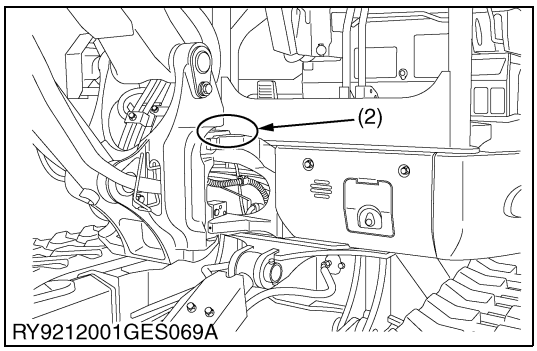

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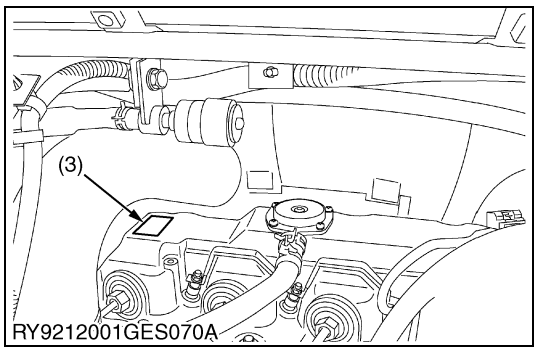


RY9212001GES070A

When consulting with your local KUBOTA dealer about this mini-excavator, please provide the model of the mini-excavator, its frame and engine numbers and the number of hours on the hour meter.

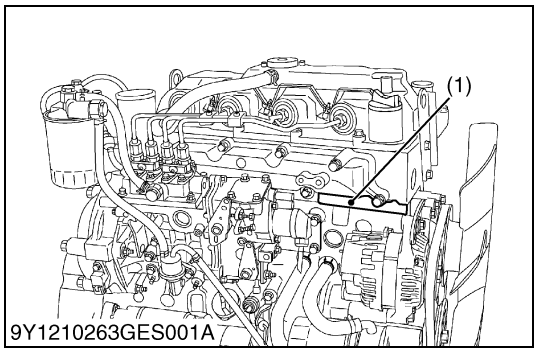
(1) Mini-excavator Nameplate (Model, frame number, engine number)
(2) Frame Number
(3) Engine Number

(a) Model Nameplate

RY9212032GEG0003US0

2. ENGINE IDENTIFICATION

[1] MODEL NAME AND SERIAL NUMBER



Be sure to check the engine nameplate and serial number when you wish to consult about the engine.

The model and serial number of the engine need to be checked prior to servicing the engine or replacing any of its parts.

■ **Engine Serial No.**

The engine serial number is the numerical ID of the engine and is printed after the engine's model number.

The year and month of manufacture are indicated as follows.

Year Manufactured

Letter or Number	Year	Letter or Number	Year
1	2001	F	2015
2	2002	G	2016
3	2003	H	2017
4	2004	J	2018
5	2005	K	2019
6	2006	L	2020
7	2007	M	2021
8	2008	N	2022
9	2009	P	2023
A	2010	R	2024
B	2011	S	2025
C	2012	T	2026
D	2013	V	2027
E	2014		

*The letters **I**, **O**, **Q**, **U** and **Z** are not used.

Month Manufactured

Month	Lot Number	
January	A0001 to A9999	B0001 to BZ999
February	C0001 to C9999	D0001 to DZ999
March	E0001 to E9999	F0001 to FZ999
April	G0001 to G9999	H0001 to HZ999
May	J0001 to J9999	K0001 to KZ999
June	L0001 to L9999	M0001 to MZ999
July	N0001 to N9999	P0001 to PZ999
August	Q0001 to Q9999	R0001 to RZ999
September	S0001 to S9999	T0001 to TZ999
October	U0001 to U9999	V0001 to VZ999
November	W0001 to W9999	X0001 to XZ999
December	Y0001 to Y9999	Z0001 to ZZ999

*The letter **I** and **O** are not used.

(a) (b)(c) (d)
e.g. V2607 - 8 HA001

(a) Engine Model : **V2607-DI**
(b) Year Manufactured : The **8** indicates **2008**.
(c) Month : April is indicated by either **G** or **H**.
(d) Lot Number : (Either **0001 to 9999** or **A001 to Z999**)

(1) Engine Model and Serial Number

RY9212001END0009US0

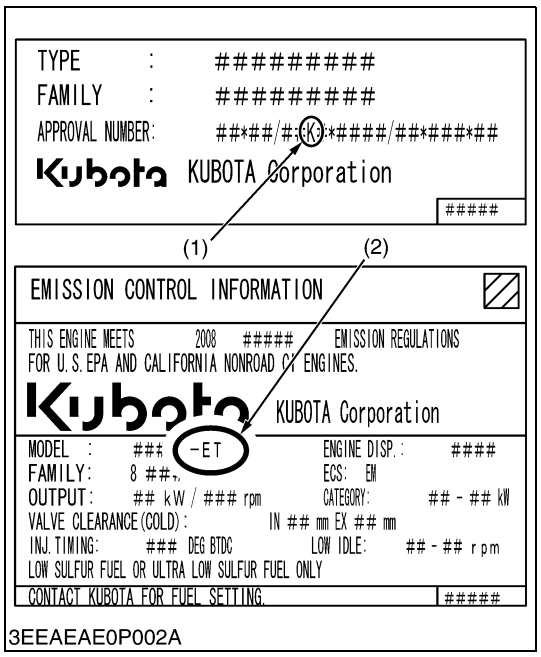
[2] E3B ENGINE

[Ex. : Engine Model V2607-DI-E3B-XXXX]

While the exhaust emissions regulations in each country that have been implemented to date to prevent air pollution are constantly changing, regulations governing off-road exhaust emissions are expected to be implemented more quickly. The date that specific off-road exhaust emissions regulations will take effect depends on the output category of the engine.

For some years now KUBOTA has been supplying regulation-compliant diesel engines in countries where off-road exhaust emission regulations have been introduced. KUBOTA's E3B series of engines meet the next phase of exhaust emission regulations. (See the table below.)

Whenever repairs or service is performed on a ###-E3B series engine, E3B engine replacements parts, which are in the applicable E3B KUBOTA Parts List, must be used and the KUBOTA Operator's Manual and E3B Workshop Manual must be used for maintenance. Use of incorrect replacement parts or replacement parts from other emission level engines (for example : E2B engines), may result in emission levels out of compliance with the original E3B design, EPA and/or other applicable regulations. Check the output category and emissions data on the emissions label on the header cover of the engine. E3B engines have the suffix ET after the model name on the EPA label. E3B is not marked on the engine.



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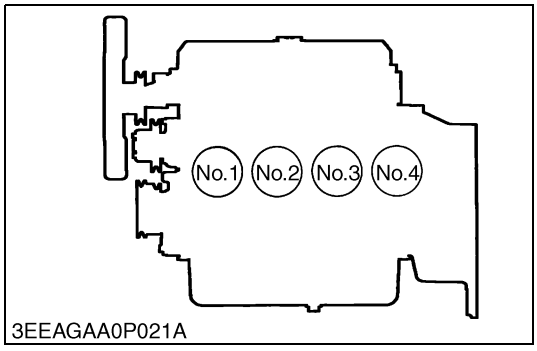
Class (1)	Engine Output Category	EU Regulation
K	19 to/not including 37 kW	STAGE IIIA
J	37 to/not including 75 kW	STAGE IIIA
I	75 to/not including 130 kW	STAGE IIIA

Class (2)	Engine Output Category	EPA Regulation
ET	Less than 19 kW	Tier 4
	19 to/not including 56 kW	Interim Tier 4
	56 to/not including 75 kW	Tier 3
	75 to/not including 130 kW	Tier 3

(1) EU Regulation engine output classification
(2) "E3B engines" have the suffix ET after the model name on the EPA label. "E3B" models meet Tier 3, Interim Tier4 or Tier4 regulations, depending on the engine output category.

RY9212001END0010US0

[3] CYLINDER NUMBER



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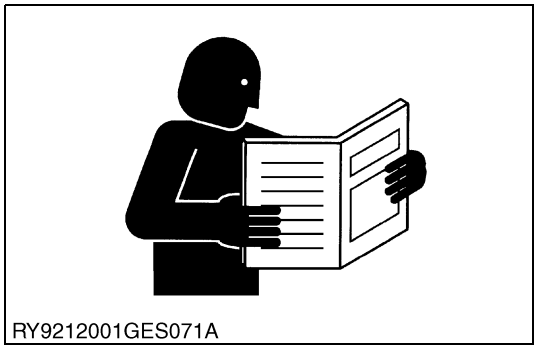
KUBOTA diesel engines are numbered as indicated in the figure.

Cylinders are numbered from the front cover (fan side) in the order 1, 2, 3 and 4.

RY9212001END0011US0

3. GENERAL PRECAUTIONS


RY9212001GES071A

Whenever performing maintenance on the machine, always read the Safety Precautions in this manual and the Operator's Manual carefully, become familiar with them and perform the work safely.

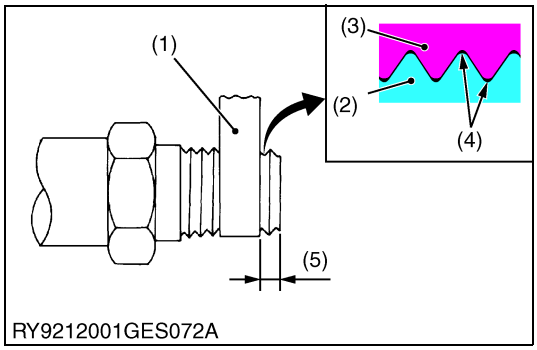
Before performing any maintenance on the machine, make sure it is sufficiently clean and choose a sufficiently clean location to perform any disassembly.

Before performing maintenance on the machine, always disconnect the negative battery cable first.

Whenever a special tool is required, use the special tool that KUBOTA recommends. Make any special tools that are not used very frequently according to the diagrams in this manual.

Always use genuine KUBOTA parts to maintain the performance and safety characteristics of the machine.

RY9212001GEG0011US0



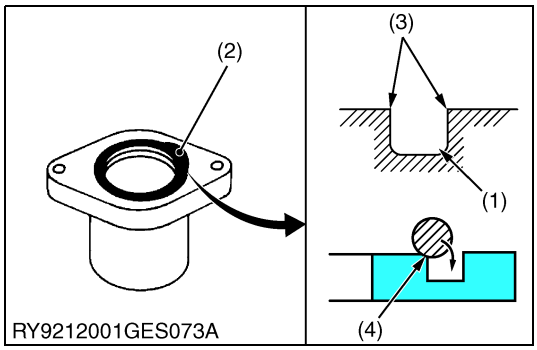
RY9212001GES072A

Plumber's Tape

- Wrap plumber's tape on the threads before tightening taper couplings. After wrapping (2 wraps) the plumber's tape, tighten to the specified torque. Once the coupling is tightened, do not loosen it as this will cause an oil leak.

(1) Plumber's Tape
(2) External Thread
(3) Internal Thread
(4) Gap
(5) Leave 1 to 2 threads

RY9212001GEG0012US0



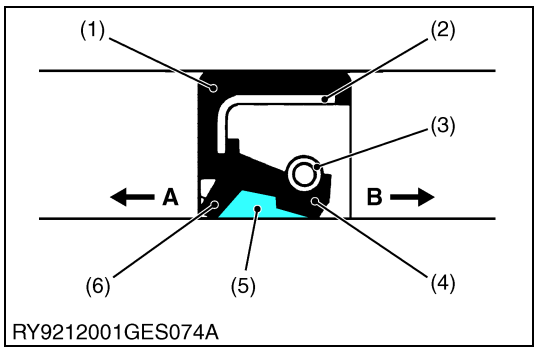
RY9212001GES073A

O-Ring

- Clean the groove the O-ring goes in and remove any burrs. Apply grease on the O-ring when inserting it in the groove. (Except floating seals)
- When putting the O-ring in the groove, be careful as it is easy at the very end to twist the O-ring against the inside of the groove. If it gets twisted, roll it gently with your fingertip to untwist it.

(1) O-ring Groove
(2) O-ring
(3) Check for burrs
(4) If the ring touches this corner, it will twist

RY9212001GEG0013US0



RY9212001GES074A

Oil Seal

- Do not face the lip of the oil seal in the wrong direction. Face the main lip toward the material to be sealed.
- After oil seals are replaced, apply grease to the moving parts around the lip to prevent the dry surfaces from wearing against each other when the engine is started. If the seal has a dust lip, fill the gap between the lips with grease.
- As a general rule, use a press to insert the oil seal in place. If that is not possible, use an appropriate tool to gently and evenly tap it into place, taking care that it does not go in at a slant. Press the seal all the way so it seats in the boss.

(1) Gasket
(2) Metal Ring
(3) Spring
(4) Main Lip
(5) Grease
(6) Dust Lip

A : Air (outside)
B : Hydraulic chamber (inside)

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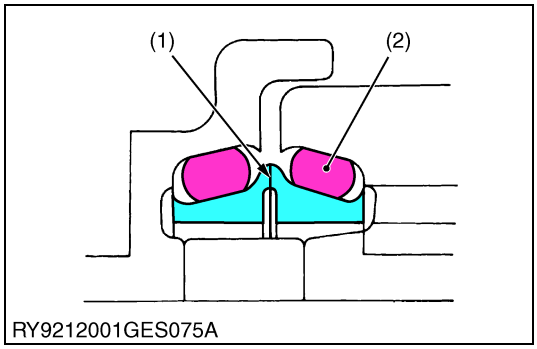

RY9212001GES075A

Floating Seal

- Be sure to wipe off any oil from the O-ring or surfaces that touch the O-ring. (For wheel motors, apply a light film)
- When putting an O-ring into a floating seal, make sure the O-ring does not twist.
- Apply a light film of oil to surrounding surfaces when working to get the floating seal with O-ring in place; take care that the surrounding surfaces, O-ring and housing are parallel with each other.
- After getting the seal in place, turn the engine over 2 or 3 revolutions, to both create a film of oil on surrounding surfaces and to properly seat the face of the seal.

(1) Surrounding Surfaces (2) O-ring

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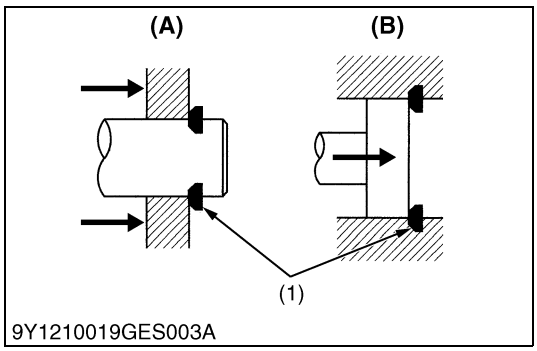


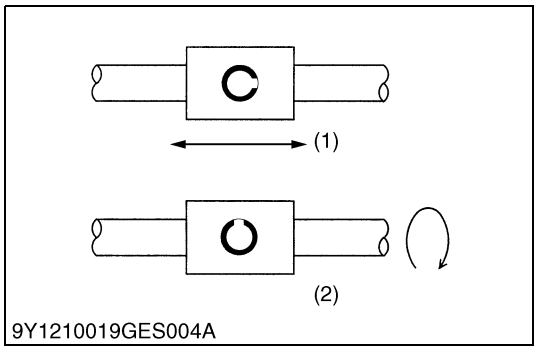
9Y1210019GES003A

Snap Ring Related

- When installing external or internal snap rings, orient them as shown in the diagram so the angled side faces the direction of force.

(1) Position so the angled part receives the force
(A) External
(B) Internal

RY9212001GEG0016US0



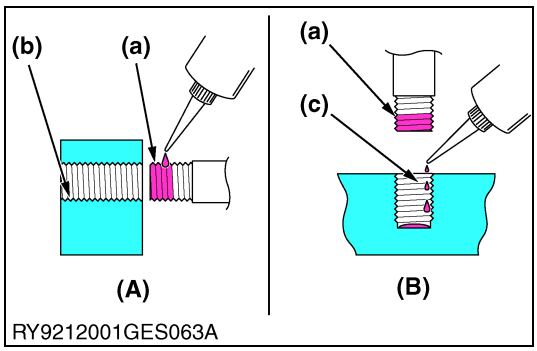
9Y1210019GES004A

Spring Pins

- When driving a spring pin, face the split in the direction that receives the force, as shown in the diagram.

(1) With lateral movement (2) With rotational movement

RY9212001GEG0017US0



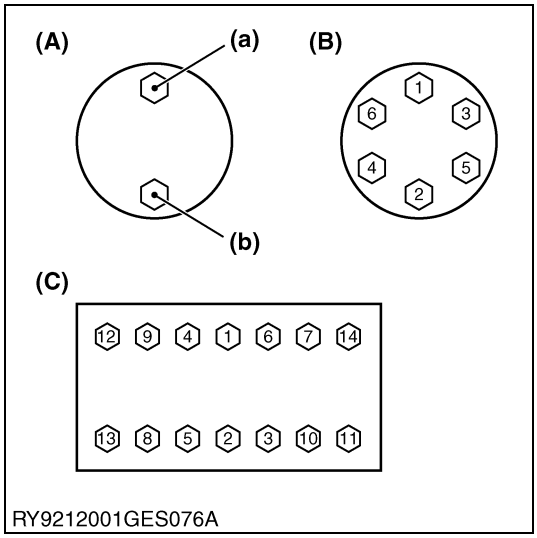
RY9212001GES063A

Adhesive

- Clean and dry the area where adhesive will be applied with a solvent so it is free of moisture, oil and dirt.
- Apply adhesive all around the threads of the bolt except the first set of threads at the tip and fill the grooves between the threads. If the threads or the grooves are large, adjust the amount of adhesive accordingly and apply it all around the bolt hole as well.

(A) Bolt Through-hole (nut)
(B) Pocket Bolt Hold (capsule shape, etc.)
(a) Apply here
(b) Do not apply
(c) Drip on

RY9212001GEG0018US0



RY9212001GES076A

Tightening Bolts and Nuts

- Tighten bolts and nuts to their specified torque.
- Tighten nuts and bolts alternately top/bottom **(a) (b)**, left/right so the torque is distributed evenly.

(A) Top/bottom alternately
(B) Across diagonally
(C) Diagonally across the center

RY9212001GEG0019US0

Assembling Hydraulic Hoses

- Tighten to their specified torque.
- Before assembling, wipe the inside of metal fittings clean of any dirt.
- After assembly, put the fitting under normal pressure and check that it does not leak.

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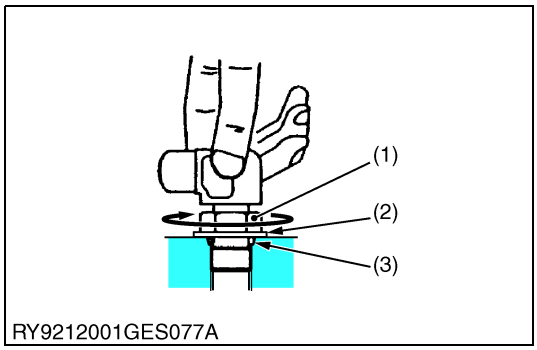
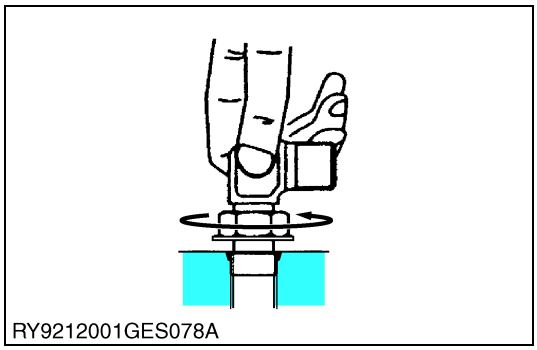


RY9212001GES077A

Elbow with Male Seat Assembly Procedure

When assembling an elbow with male seat, adhere to the following procedures to prevent deformation of O-rings and leaks.

1. Connecting to Valves
   - Clean the blow with male seat and the surface of the seal opposite and mount with the lock-nut on top.
   - Finger tighten till it touches the washer.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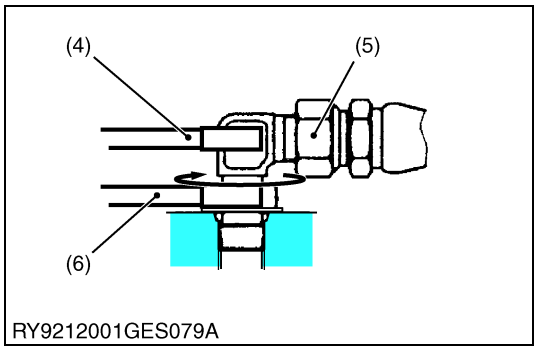
2. Positioning
   - Turn the mouth of the elbow back so it faces the right direction. (not back over 1 turn)

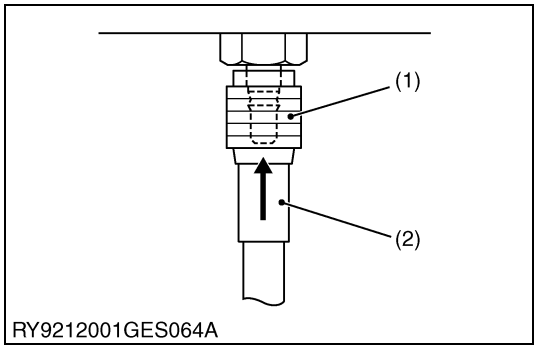


RY9212001GES079A

3. Fasten
   - Tighten the lock-nut to the specified torque with a wrench.

(1) Lock-nut
(2) Washer
(3) Seal (O-ring)
(4) Wrench for holding
(5) Hose
(6) Torque wrench for tightening

RY9212001GEG0021US0



RY9212001GES064A

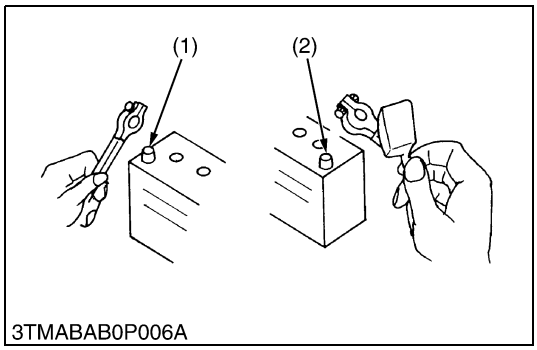
Installing and Removing Quick Couplings

- To remove a quick hose coupling, push the fitting (2) in the direction of the arrow and pull on the plastic part (1) in the opposite direction.
- To attach a quick coupler, push it in firmly in the direction of the arrow. Then check that it will not pull off.

(1) Plastic part (2) Fitting

RY9212001GEG0022US0

4. HANDLING PRECAUTIONS FOR ELECTRICAL PARTS AND WIRING



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Follow the precautions below for handling electrical parts and wiring to ensure safety and prevent damage to the machine and nearby equipment.

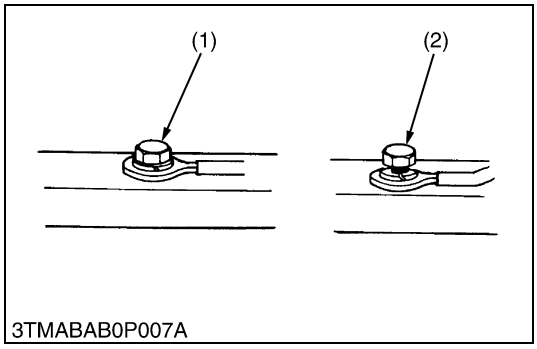
■ **IMPORTANT**

- **Inspect electrical wiring for damage and/or loose connections.**
- **Do not alter or rewire any electrical parts or wiring.**
- **Always remove the negative battery cable first when disconnecting the battery and attach the positive cable first when connecting it.**

(1) Battery Cable (-) Side (2) Battery Cable (+) Side

RY9212001GEG0023US0

[1] WIRING



3TMABAB0P007A

- Tighten wiring terminals securely.

(1) Correct (Tightened securely) (2) Incorrect (Poor contact if loose)

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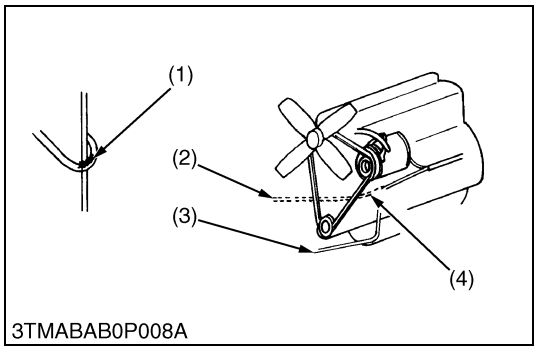
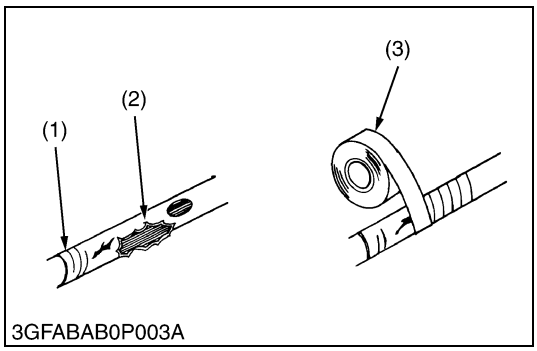


3TMABAB0P008A

- Keep wiring away from hazards.

(1) Hazardous Positioning
(2) Wiring Position (wrong)
(3) Wiring Position (right)
(4) Hazardous Position

RY9212001GEG0025US0



3GFABAB0P003A

- Immediately repair or replace old or damaged wiring.

(1) Damaged
(2) Torn
(3) Electrical Tape

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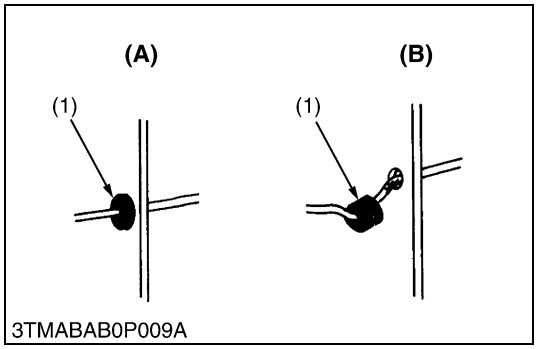

3TMABAB0P009A

- Insert grommet securely.

(1) Grommet
(A) Correct
(B) Incorrect

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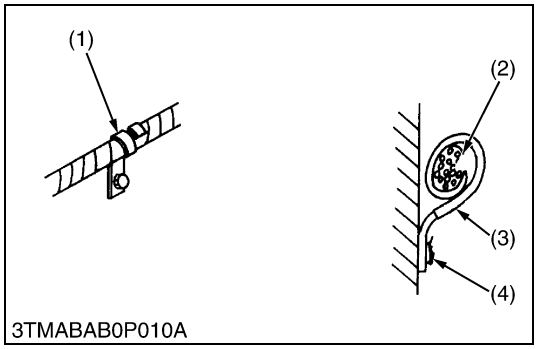

3TMABAB0P010A

- Clamp wiring securely but do not damage wires with the clamp.

(1) Clamp (Spiral clamp around wire)
(2) Wire
(3) Clamp
(4) Welding Mark

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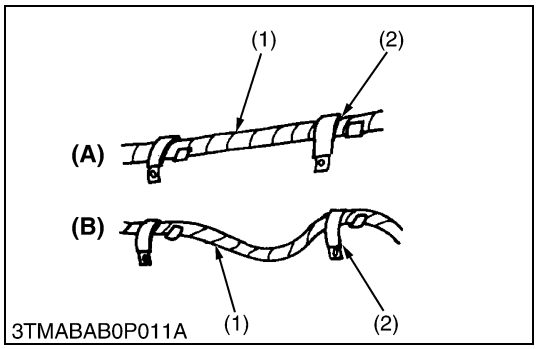
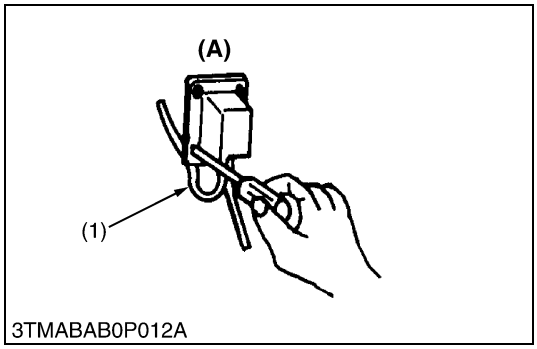


3TMABAB0P011A

- Clamp wiring so it is not twisted, pulled too tight or sag too much. However, moving parts may require play in the wiring.

(1) Wire
(2) Clamp
(A) Correct
(B) Incorrect

RY9212001GEG0029US0



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- Do not pinch or bind wiring when installing parts.

(1) Wire
(A) Incorrect

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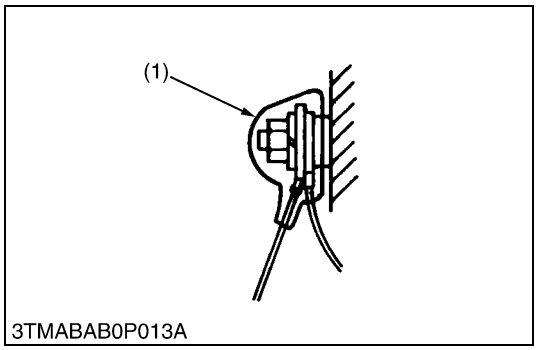

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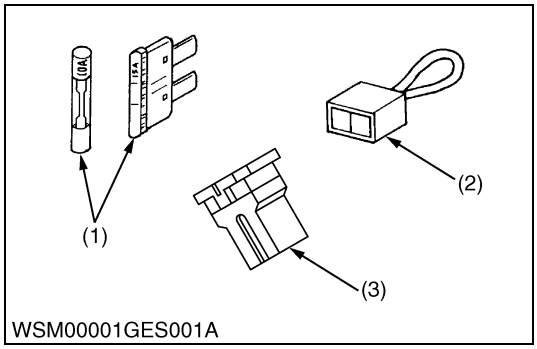
- After wiring, double-check terminal protectors and clamps before connecting battery cables.

(1) Cover (Install covers securely)

RY9212001GEG0031US0

[2] FUSES



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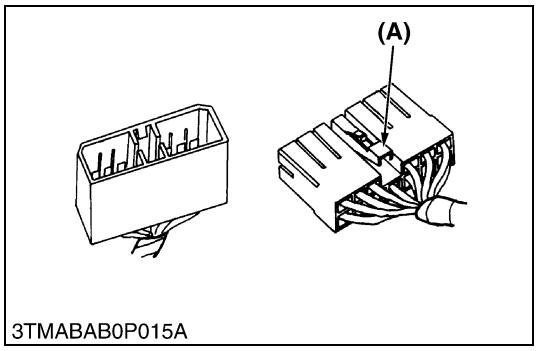
- Always use fuses of the specified capacity.
  Never use over or undersized fuses.
- Never use copper or steel wire in place of a fuse.
- Do not install accessories such as work lights, radios, etc., if your machine does not have an auxiliary circuit.
- Do not install accessories as they will exceed the capacity of fuses.

(1) Fuse
(2) Fusible Link
(3) Slow-blow Fuse

RY9212001GEG0032US0

[3] CONNECTOR

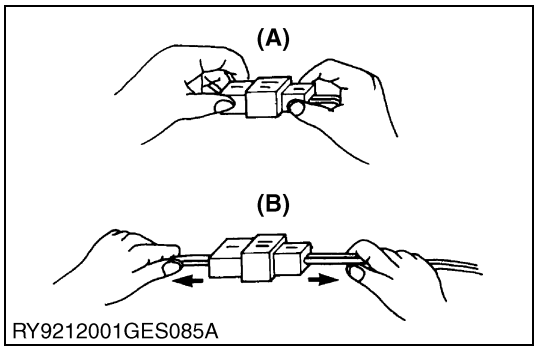


3TMABAB0P015A

- Press the lock to disconnect locking connectors.

(A) Push

RY9212001GEG0033US0

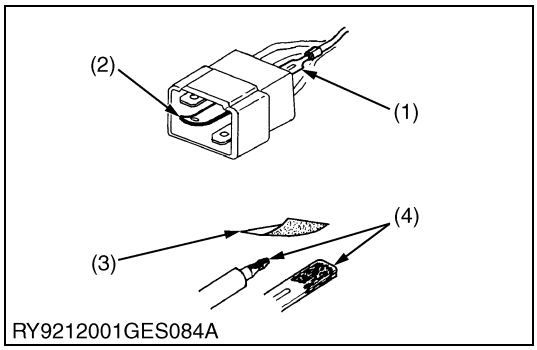


RY9212001GES085A

- Hold the connectors when separating them.
- Do not pull on the wire harness to separate the connectors.

(A) Correct **(B) Incorrect**

RY9212001GEG0034US0

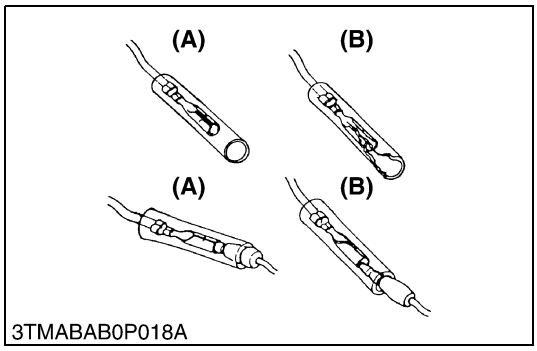


RY9212001GES084A

- Straighten bent prongs and make sure none are sticking out or missing.
- Remove corrosion from terminals with sandpaper.

(1) Missing terminal
(2) Bent Prong
(3) Sandpaper
(4) Corrosion

RY9212001GEG0035US0

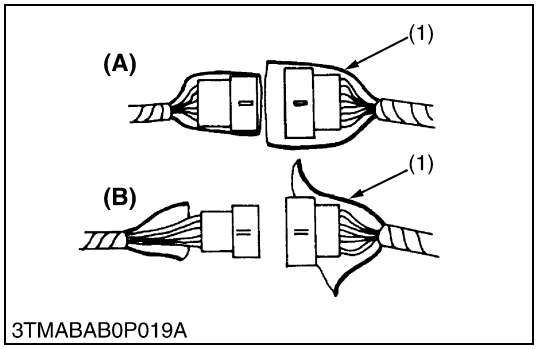


3TMABAB0P018A

- Female connectors must not be spread too far open

(A) Correct **(B) Incorrect**

RY9212001GEG0036US0



3TMABAB0P019A

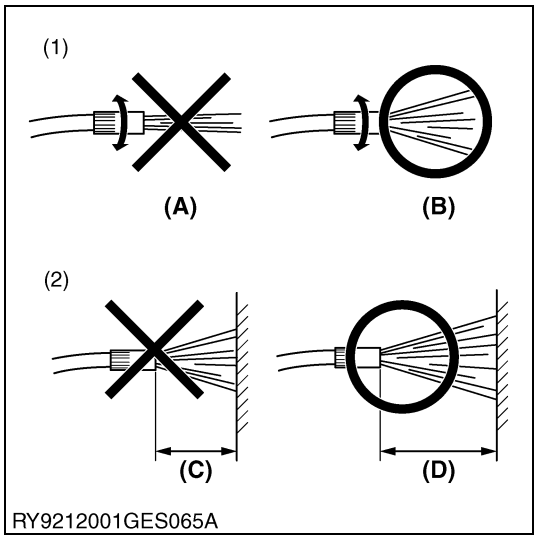
- The plastic covers of connectors must cover them completely.

(1) Cover

(A) Correct
(B) Incorrect

RY9212001GEG0037US0

[4] WASHING THE MACHINE WITH A HIGH-PRESSURE WASHER



RY9212001GES065A

Using a high-pressure washer incorrectly can lead to personal injury and/or damage, break or cause parts of the machine to fail, so use the power washer properly according to its operator's manual and labels.

CAUTION

- **Stand at least 2 meters from the machine and adjust the nozzle for a wide spray so it does not cause any damage. If you blast the machine with water or wash it from too close a distance,**

1. It may cause a fire due to damaged or cuts in the insulation of electrical wiring.
2. An injury may result if hydraulic oil gushes out under high pressure, due to damaged hydraulic hoses.
3. It may damage, break or cause parts of the machine to fail.
(Ex.)
(1) Stickers or labels may come off
(2) Electrical parts or the engine may fail due to water in them.
(3) Damage glass, resins, etc. or the rubber of oil seals.
(4) Tear off paint or the film from plating

(1) Do not blast with water
(2) Never wash from too close

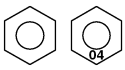
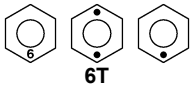
(A) Blasting
(B) Wide Spray
(C) Less than 2 m (80 in.)
(D) Over 2 m (80 in.)

RY9212001GEG0038US0

5. TIGHTENING TORQUES

[1] GENERAL USE SCREWS, BOLTS AND NUTS

Screws, bolts and nuts whose tightening torques are not specified in this Workshop Manual should be tightened according to the table below.

Indication on top of bolt	No-grade or 4T						7T						9T		
Indication on top of nut	 No-grade or 4T												 6T		
Material of opponent part	Ordinariness			Aluminum			Ordinariness			Aluminum			Ordinariness		
Unit	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.8	7.9 to 8.8	0.80 to 0.90	5.8 to 6.5	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31	7.9 to 8.8	0.80 to 0.90	5.8 to 6.5	12.3 to 14.2	1.25 to 1.45	9.05 to 10.4
M8	18 to 20	1.8 to 2.1	13 to 15	17 to 19	1.7 to 2.0	13 to 14	24 to 27	2.4 to 2.8	18 to 20	18 to 20	1.8 to 2.1	13 to 15	30 to 34	3.0 to 3.5	22 to 25
M10	40 to 45	4.0 to 4.6	29 to 33	32 to 34	3.2 to 3.5	24 to 25	48 to 55	4.9 to 5.7	36 to 41	40 to 44	4.0 to 4.5	29 to 32	61 to 70	6.2 to 7.2	45 to 52
M12	63 to 72	6.4 to 7.4	47 to 53	–	–	–	78 to 90	7.9 to 9.2	58 to 66	63 to 72	6.4 to 7.4	47 to 53	103 to 117	10.5 to 12.0	76.0 to 86.7
M14	108 to 125	11.0 to 12.8	79.6 to 92.5	–	–	–	124 to 147	12.6 to 15.0	91.2 to 108	–	–	–	167 to 196	17.0 to 20.0	123 to 144
M16	167 to 191	17.0 to 19.5	123 to 141	–	–	–	197 to 225	20.0 to 23.0	145 to 166	–	–	–	260 to 304	26.5 to 31.0	192 to 224
M18	246 to 284	25.0 to 29.0	181 to 209	–	–	–	275 to 318	28.0 to 32.5	203 to 235	–	–	–	344 to 402	35.0 to 41.0	254 to 296
M20	334 to 392	34.0 to 40.0	246 to 289	–	–	–	368 to 431	37.5 to 44.0	272 to 318	–	–	–	491 to 568	50.0 to 58.0	362 to 419

RY9212032GEG0001US0

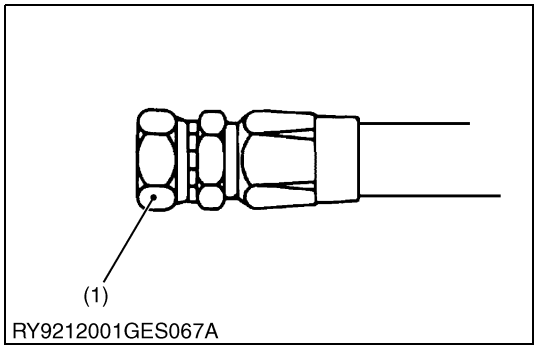
[2] STUD BOLTS

Material of opponent part	Ordinariness			Aluminum		
Unit	N·m	kgf·m	lbf·ft	N·m	kgf·m	lbf·ft
M8	12 to 15	1.2 to 1.6	8.7 to 11	8.9 to 11	0.90 to 1.2	6.5 to 8.6
M10	25 to 31	2.5 to 3.2	18 to 23	20 to 25	2.0 to 2.6	15 to 18
M12	30 to 49	3.0 to 5.0	22 to 36	31	3.2	23
M14	62 to 73	6.3 to 7.5	46 to 54	–	–	–
M16	98.1 to 112	10.0 to 11.5	72.4 to 83.1	–	–	–
M18	172 to 201	17.5 to 20.5	127 to 148	–	–	–

RY9212032GEG0002US0

[3] TORQUE FOR HYDRAULIC HOSE FITTINGS

(1) Torque for Hydraulic Hose Fittings



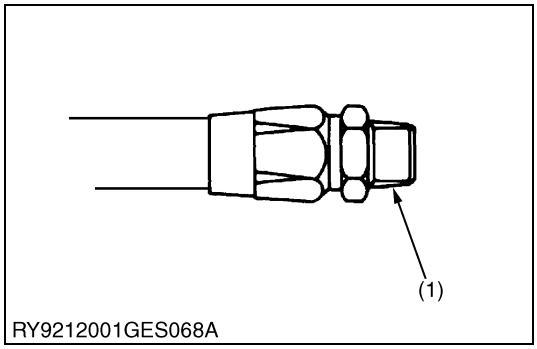
RY9212001GES067A

Union Nuts

Tightening torque	1/8	7.8 to 11.8 N·m 0.8 to 1.2 kgf·m 5.7 to 8.7 lbf·ft
	1/4	24.5 to 29.2 N·m 2.5 to 3.0 kgf·m 18.1 to 21.7 lbf·ft
	3/8	37.2 to 42.1 N·m 3.8 to 4.3 kgf·m 27.5 to 31.1 lbf·ft
	1/2	58.8 to 63.7 N·m 6.0 to 6.5 kgf·m 43.4 to 47.0 lbf·ft
	3/4	117.6 to 127.4 N·m 12.0 to 13.0 kgf·m 86.8 to 94.0 lbf·ft
	1	181.3 to 191.1 N·m 18.5 to 19.5 kgf·m 133.8 to 141.0 lbf·ft
	1-1/4	210.7 to 220.5 N·m 21.5 to 22.5 kgf·m 162.7 to 168.0 lbf·ft

(1) Union Nuts

RY9212001GEG0041US0



RY9212001GES068A

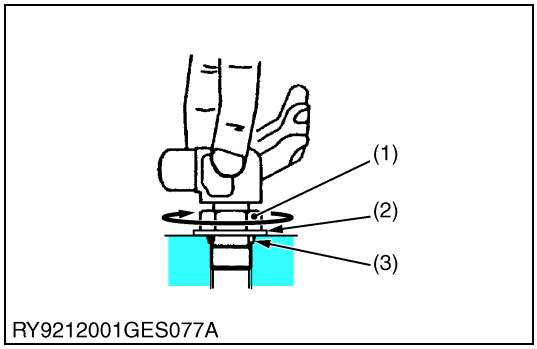
Tapered Nuts

Tightening torque	1/8	19.6 to 29.4 N·m 2.0 to 3.0 kgf·m 14.5 to 21.7 lbf·ft
	1/4	36.6 to 44.1 N·m 3.7 to 4.5 kgf·m 26.8 to 32.5 lbf·ft
	3/8	68.6 to 73.5 N·m 7.0 to 7.5 kgf·m 50.6 to 54.2 lbf·ft
	1/2	83.4 to 88.3 N·m 8.5 to 9.0 kgf·m 61.5 to 65.1 lbf·ft
	3/4	166.6 to 181.3 N·m 17.0 to 18.5 kgf·m 123.0 to 133.8 lbf·ft

(1) Taper

RY9212001GEG0042US0

(2) Torques of Lock-Nuts for Elbows with Male Seats and Adaptors with O-rings (Straight Threads)



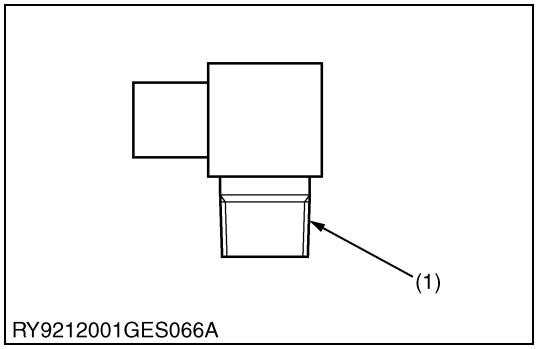
RY9212001GES077A

Tightening torque	1/8	15.0 to 16.5 N·m 1.5 to 1.7 kgf·m 11.1 to 12.2 lbf·ft
	1/4	24.5 to 29.4 N·m 2.5 to 3.0 kgf·m 18.1 to 21.7 lbf·ft
	3/8	49.0 to 53.9 N·m 5.0 to 5.5 kgf·m 36.1 to 39.8 lbf·ft
	1/2	58.8 to 63.7 N·m 6.0 to 6.5 kgf·m 43.4 to 47.0 lbf·ft
	3/4, 1	117.6 to 127.4 N·m 12.0 to 13.0 kgf·m 86.8 to 94.0 lbf·ft
	1-1/4	220.5 to 230.3 N·m 22.5 to 23.5 kgf·m 162.8 to 170.0 lbf·ft

(1) Lock-nut
(2) Washer
(3) Seal (O-ring)

RY9212001GEG0043US0

(3) Torque for Tapering Adaptors



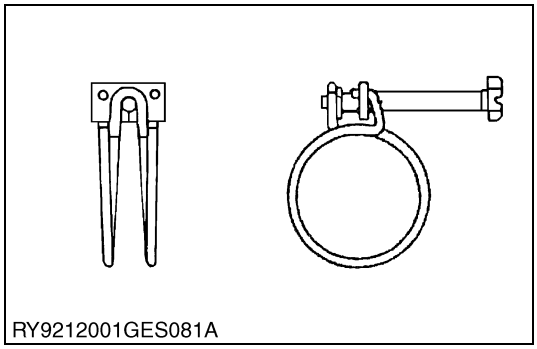
RY9212001GES066A

Tightening torque	1/8	19.6 to 29.4 N·m 2.0 to 3.0 kgf·m 14.5 to 21.7 lbf·ft
	1/4	36.6 to 44.1 N·m 3.7 to 4.5 kgf·m 26.8 to 32.5 lbf·ft
	3/8	68.6 to 73.5 N·m 7.0 to 7.5 kgf·m 50.6 to 54.2 lbf·ft
	1/2	83.4 to 88.3 N·m 8.5 to 9.0 kgf·m 61.5 to 65.1 lbf·ft
	3/4	166.6 to 181.3 N·m 17.0 to 18.5 kgf·m 123.0 to 133.8 lbf·ft

(1) Taper

RY9212001GEG0044US0

[4] HOSE CLAMP SCREW TORQUE

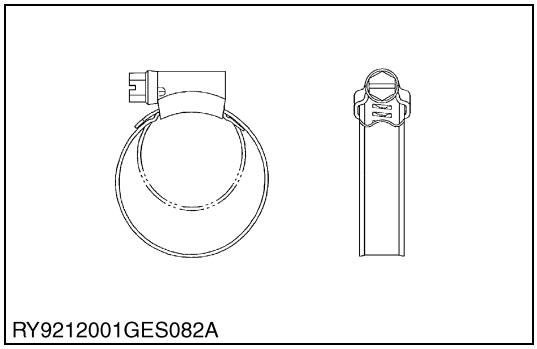


RY9212001GES081A

Type 1

Tightening torque	φ10-φ14	6C040-58721	2.5 to 3.4 N·m 25 to 35 kgf·cm 1.8 to 2.5 lbf·ft
	φ12-φ16	09318-89016	2.5 to 3.4 N·m 25 to 35 kgf·cm 1.8 to 2.5 lbf·ft
	φ19-φ25	09318-89024	2.5 to 3.4 N·m 25 to 35 kgf·cm 1.8 to 2.5 lbf·ft
	φ31-φ40	09318-89039	2.5 to 3.4 N·m 25 to 35 kgf·cm 1.8 to 2.5 lbf·ft
	φ36-φ46	09318-89045	2.5 to 3.4 N·m 25 to 35 kgf·cm 1.8 to 2.5 lbf·ft
	φ44-φ53	09318-89052	3.9 to 4.9 N·m 40 to 50 kgf·cm 2.9 to 3.6 lbf·ft
	φ51-φ59	09318-89058	3.9 to 4.9 N·m 40 to 50 kgf·cm 2.9 to 3.6 lbf·ft
	φ86-φ96	RD809-42241	2.5 to 3.4 N·m 25 to 35 kgf·cm 1.8 to 2.5 lbf·ft

RY9212001GEG0045US0


RY9212001GES082A

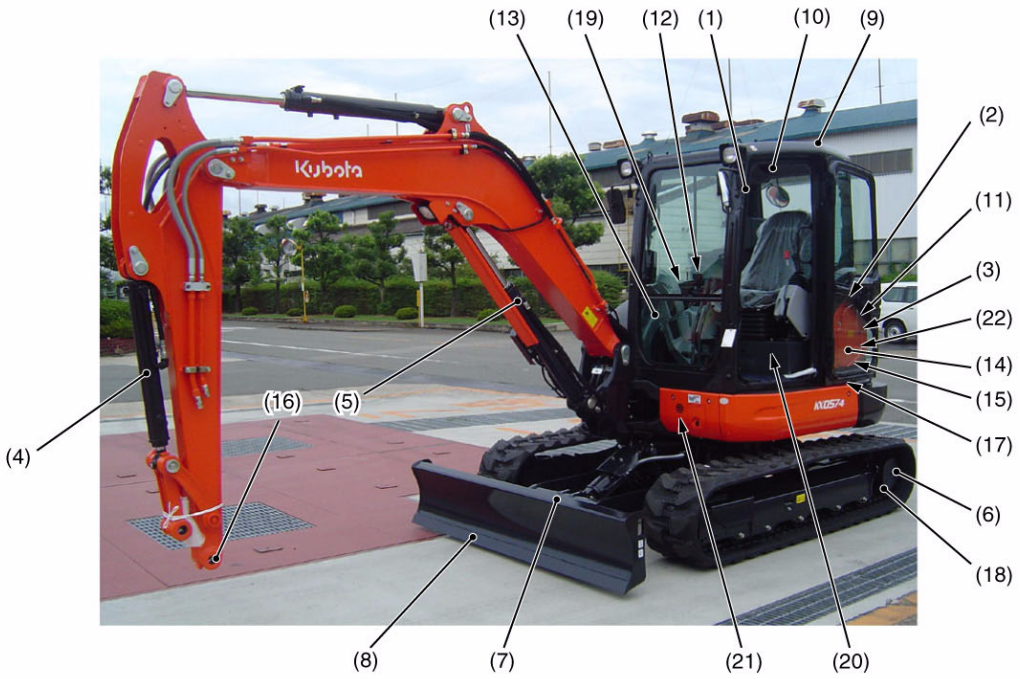
Type 2

Tightening torque	ϕ13-ϕ20	RB101-63631	2.5 to 3.4 N·m 25 to 35 kgf·cm 1.8 to 2.5 lbf·ft
	ϕ15-ϕ25	RC101-64581	4.9 to 5.9 N·m 50 to 60 kgf·cm 3.6 to 4.3 lbf·ft
	ϕ19-ϕ28	R1401-63211	4.9 to 5.9 N·m 50 to 60 kgf·cm 3.6 to 4.3 lbf·ft
	ϕ22-ϕ32	R1401-63151	4.9 to 5.9 N·m 50 to 60 kgf·cm 3.6 to 4.3 lbf·ft
	ϕ26-ϕ38	68311-72821	4.9 to 5.9 N·m 50 to 60 kgf·cm 3.6 to 4.3 lbf·ft
	ϕ32-ϕ44	RD411-63821	4.9 to 5.9 N·m 50 to 60 kgf·cm 3.6 to 4.3 lbf·ft
	ϕ44-ϕ56	35820-15181	4.9 to 5.9 N·m 50 to 60 kgf·cm 3.6 to 4.3 lbf·ft
	ϕ50-ϕ65	RC401-63191	4.9 to 5.9 N·m 50 to 60 kgf·cm 3.6 to 4.3 lbf·ft
	ϕ58-ϕ75	36919-04591	4.9 to 5.9 N·m 50 to 60 kgf·cm 3.6 to 4.3 lbf·ft
	ϕ60-ϕ80	RD809-63101	4.9 to 5.9 N·m 50 to 60 kgf·cm 3.6 to 4.3 lbf·ft
	ϕ68-ϕ85	RD809-63061	4.9 to 5.9 N·m 50 to 60 kgf·cm 3.6 to 4.3 lbf·ft
	ϕ77-ϕ95	69284-63171	4.9 to 5.9 N·m 50 to 60 kgf·cm 3.6 to 4.3 lbf·ft

RY9212001GEG0046US0

6. NEW PRODUCT FEATURE (EUROPEAN VERSION)

Quick chart - Machine type classification should be defined (L type)



RY9212032GES001A

Basic specification		Operation	
(1)	Robust Machine Weight (Machine class upgraded to 5.5 ton)	(13)	Pilot hydraulic remote-control system for all actuators
(2)	V2607 New DI Engine	Serviceability	
(3)	Advanced Three Pump Load Sensing System *	(14)	Sheet-metal processed covers
(4)	Strong bucket breakout force	(15)	One side engine maintenance
Performance		(16)	Bush with flange at arm tip end
(5)	Bigger Lifting Capacity	(17)	Prolonged return filter life 500 hours → 1000 hours
(6)	Dual Speed with Auto-shift as standard (Bigger travel force)	Safety	
(7)	Higher Blade	(18)	Travel parking brake as standard
(8)	Shortened distance between blade and bucket teeth	Others	
Operator comfort		(19)	KUBOTA original digital panel at the Front *
(9)	Spacious and comfort cabin	(20)	Leading-edge Anti-theft system for greater security
(10)	Powerful Air conditioning	(21)	Battery Isolator *
Versatility		(22)	Refueling pump
(11)	AUX1" and "AUX2" with proportional control on joystick is adopted. *		
(12)	The maximum oil flow of both AUX lines can be adjusted by digital panel. *		

* : New Feature

RY9212007GEG0001US0

Standard Equipment

Safety system
- Engine start safety system on the left console
- Travel motor with disc brake
- Overload warning buzzer
- KUBOTA original anti-theft system
- Anti-drop valve on the boom (ISO8643)
- All hydraulic control system

Working equipment
- Auxiliary hydraulic circuits (SP1 and SP2*) piping to the arm end *for Types L and M.
- 2 working lights on cabin and 1 light on the boom
- 1820 mm arm length

Cabin
- ROPS (Roll-over Protective Structure, ISO3471)
- OPG (Operating Protective Guard) Level1
- Wight-adjustable full suspension seat
- Seatbelt
- Hydraulic pilot control levers with wrist rests
- Travel levers with foot pedals
- Air conditioning (Type L)
- Cabin heater for defrosting and demising
- Emergency exit hammer
- Front window power assisted with gas damper
- 12 V power source
- 2 speakers and radio aerial
- Location for radio
- Back mirror (left, right and rear)
- Cup holder

Engine / Fuel system
- Double-element air filter
- Electric fuel injection pump system
- Auto idling system
- Tank electric refueling pump (type L and M)

Undercarriage
- 400 mm rubber track
- 1 x upper track roller
- 5 double-flange track rollers on each track
- 2-speed travel switch on blade lever
- Two-speed travel with auto-shift
- Water separator with drain cock

Hydraulic system
- Pressure accumulator
- Hydraulic pressure checking ports
- Straight travel circuit
- Third line hydraulic return
- Load-sensing hydraulic system
- Adjustable maximum oil flow on auxiliary circuits (SP1 and SP2) *For (Type L and M)
- Double auxiliary circuit accessories
- Auxiliary switch (SP1) on right control lever
- Auxiliary switch (SP2) on left control lever (Type L and M)

RY9212007GEG0002US0

Optional Equipment

Undercarriage
- 400 mm steel track (+ 100 kg)
- 550 mm steel track (+ 300 kg)

Safety system
- Anti-drop valve unit (arm and blade)
- Bracket and harness for beacon light

Others
- Special paint upon request

RY9212007GEG0003US0

Standard Equipment For Each Type

Type	Air conditioning	SP SP1 / SP2	Refueling pump
L	●	● / ●	●
M	–	● / ●	●
S	–	● / –	–

RY9212007GEG0004US0

7. NEW FEATURES OUTLINE

New Design Digital Meter Panel

Features :

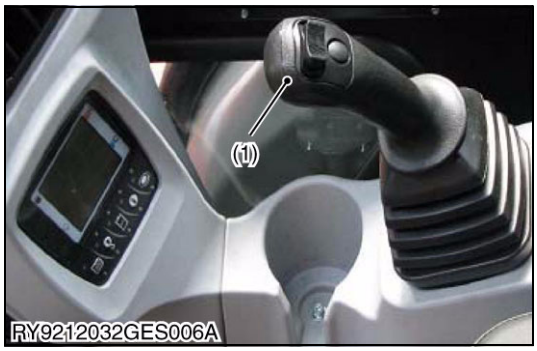
1. Large LCD display
2. Display and anti-theft controllers are unified into 1 ECU.
3. Main display and ECU are independent items connected by CAN (Controller Area Network) technology.

(1) GENERAL
*CONTROL ECU
*AUTO IDLE
*ANTI-THEFT
*AUTO SHIFT TRAVELING SPEED

(2) MAIN DISPLAY METER PANAL

(a) CAN

RY9212007GEG0005US0



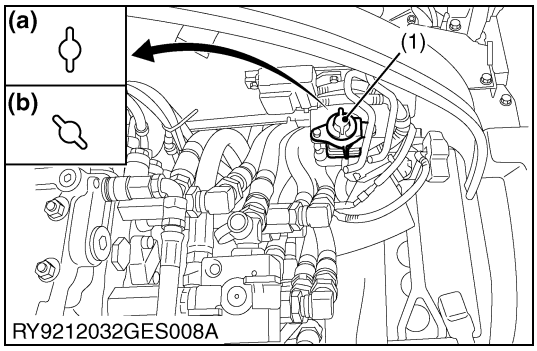
AUX 1 and 2 Operation Control

Hard-control system

The hydraulic control grip has proportional Flow Control built in. Signals from this sensor activate the proportional solenoid valve to control the flow rate at the hydraulic service port.

(1) Control knob (Auxiliary circuit)

RY9212007GEG0006US0



Battery Isolator

(1) Battery cut switch

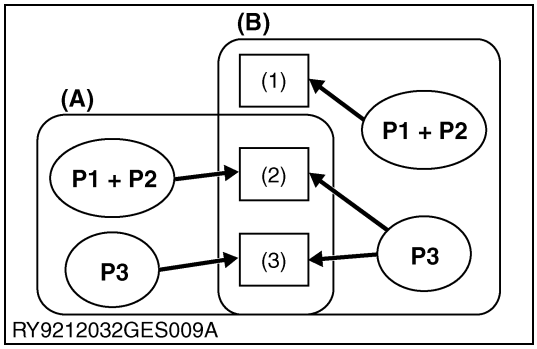
(a) "ON"
(b) "OFF"

RY9212007GEG0007US0

Three pump Load Sensing System

Hydraulic operation for all actuators

All actuators are hydraulically locked when the unlock lever is raised.
(travel, swing, blade and SP are also hydraulically controlled.)
It realizes smoother movement with fine inching control.
KX057-4 is designed as "standard" machine in order to keep the good machine stability.



3-pump load sensing system

- KX057-4 adopts the same 3-pump load sensing system as KX080-3.
- 1st and 2nd pumps that normally supply the oil to front attachments change the oil flow to travel actuator when travelling in order to realize the strong travel performance.
- The travel slow down while operating front attachments is minimized by adopting 3-pump load sensing system (ex. when blading and travelling.

(1) Travel (R), Travel (L)
(2) Boom, Arm, Bucket, AUX1, Swivel
(3) AUX2, Blade, Swing

(A) When not travelling
(B) When travelling

RY9212007GEG0008US0

8. QUALITY SPECIFICATIONS

Machine specification: Auxiliary port1 and 2, Wrist rest, STD-arm for EU, Cab, Japan STD-bucket (135 kg with pins)

Item		Factory Specification	Remarks
Machine size			
• Total length (Transport)		5520 ± 110 mm 217.3 ± 4.3 in.	
• Total width		1960 ± 20 mm 77.2 ± 0.8 in.	
• Total height		2550 ± 25 mm 100.4 ± 1.0 in.	
Weight			
• Machine weight		5470 ± 274 kg 12150 ± 603 lbs	with 135 kg (298 lbs) standard bucket and fully served
• Operating weight		5545 ± 274 kg 12225 ± 603 lbs	with 75 kg (170 lbs) operator, 135 kg (298 lbs) standard bucket and fully served
Performance			
• Swivel speed	L	9.3 ± 0.9 rpm	Front horizontal bucket crowd with no load Engine Max. speed, Oil temp.: 50 ±5 °C (122 ± 9 °F)
	R	9.3 ± 0.9 rpm	
• Travel speed	Rubber F1	2.8 ± 0.3 km/h 1.74 ± 0.2 mph	Traveling stance: Engine Max.speed, Oil temp.: 50 ±5 °C (122 ± 9 °F)
	Rubber F2	4.9 ± 0.5 km/h 3.04 ± 0.3 mph	
	Steel F1	2.6 ± 0.3 km/h 1.62 ± 0.2 mph	
	Steel F2	4.6 ± 0.5 km/h 2.86 ± 0.3 mph	
• Gradeability	F1	30 ° <	Hill-climbing stance, E/G Max speed
Rear end min. turning radius		1276 ± 26 mm 50.2 ± 1.0 in.	
Swivel frame rear ground clearance		629 ± 12.6 mm 24.8 ± 0.5 in.	
Tumbler center distance		1990 ± 60.0 mm 78.3 ± 2.4 in.	
Crawler total length		2500 ± 75 mm 98.4 ± 3.0 in.	

Item		Factory Specification	Remarks
Crawler total width		1960 ± 39 mm 77.2 ± 1.5 in.	
Min. ground clearance		310 ± 9 mm 12.2 ± 0.4 in.	Including bottom plate
Front attachment			
• Bucket heaped capacity	SAE, JIS	0.16 ± 0.006 m^3 0.2 ± 0.008 yd^3	Slope angle: 1 x 1
• Bucket struck capacity		0.12 ± 0.005 m^3 0.2 ± 0.006 yd^3	
• Bucket width		600 ± 12 mm 23.6 ± 0.5 in.	Without side cutter
• Swing angle	L	71 ± 2 °	
	R	54 ± 2 °	
• Max. digging radius		6260 ± 94 mm 246.5 ± 4 in.	0 ° swing
• Ground level Max. digging radius		6130 ± 92 mm 241.3 ± 4 in.	0 ° swing
• Ground level Min. finish radius		1800 ± 36 mm 70.9 ± 1 in.	0 ° swing Bucket bottom horizontal
• Max. digging depth		3890 ± 78 mm 153.1 ± 3 in.	
• Max. vertical digging depth		3100 ± 93 mm 122.0 ± 4 in.	
• Max. digging height		5820 ± 116 mm 229.1 ± 5 in.	
• Max. dump height		4160 ± 83 mm 163.8 ± 3 in.	
• Max. dump height (Arm vertical)		1590 ± 48 mm 62.6 ± 2 in.	
• Mini. turning radius		2435 ± 73 mm 95.9 ± 3 in.	
• Mini. turning radius (Left swing)		2060 ± 62 mm 81.1 ± 2 in.	

Item		Factory Specification	Remarks
Blade • Width • Height • Max. lift above GL • Max. below GL		 1960 ± 5 mm 77.2 ± 0.2 in. 408 ± 10 mm 16.1 ± 0.4 in. 440 ± 50 mm 17.3 ± 2 in. 410 ± 50 mm 16.1 ± 2 in.	
Bucket tooth sluggish		73 mm > 2.87 in. >	Without shockless F=30 kgf (66 lbf)
Front boom lateral declination		10 mm > 0.39 in. >	
Blade's lateral declination		10 mm > 0.39 in. >	
Clearance between bucket crow and boom cylinder cover		100 ± 19 mm 3.94 ± 0.7 in.	Boom max. height, Arm crowd
Approach angle		30 ± 3 °	
Crawler height		523 ± 10 mm 20.59 ± 0.4 in.	Include grouser height of the crawler
Max. crawler height		555 ± 11 mm 21.85 ± 0.4 in.	
Max, engine rpm • no load • 2 pump relief (Variable displacement pump) • Blade+2 pump relief (Variable displacement pump)		 2400 rpm > 1980 rpm < 1980 rpm <	 Arm and bucket Slow operation to relief, Oil temp.: 50 ± 5 °C (122 ± 9 °F) Blade relief, Arm and bucket Slow operation to relief, Oil temp.: 50 ± 5 °C (122 ± 9 °F)
Idling RPM	Cabin	1125 ± 75 rpm	
Travel motor block performance	L R	0 mm 0 in. 0 mm 0 in.	20 deg. slope, 10 min, Engine stop Oil temp.: 50 ± 5 °C (122 ± 9 °F) With parking brake

Item		Factory Specification	Remarks
Max, Traction force	F1	4140 kgf < 40.6 N < 9127 lbf <	Slip 70% theoretical torque Travel stance, Oil temp.: 50 ± 5 °C (122 ± 9 °F)
	F2	–	Data N/A, traveling speed reduce to low range.
Travel straightness	F1	600 mm > 23.62 in. >	Travel stance, 10 m distance Engine Max. speed, Oil temp.: 50 ± 5 °C (122 ± 9 °F) Travel stance, Blade up and down 10 m (390 in.) distance Engine Max. speed, Oil temp.: 50 ± 5 °C (122 ± 9 °F)
	F2	600 mm > 23.62 in. >	
	Blade F1	600 mm > 23.62 in. >	
	Blade R1	600 mm > 23.62 in. >	
Travel motor drain amount	During rotation	0.5 / 0.75 L/min 30.5 / 45.8 cu.in.	1F / 2F
	When blocked	4.0 L/min 244 cu.in.	
Track shoe sag distance	Steel	80 to 85 mm 3.15 to 3.35 in.	
	Rubber	10 to 15 mm 0.39 to 0.59 in.	
Arm digging force		2376 kgf < 23.3 kN < 5238 lbf <	Bucket tooth root (Arm cylinder length: 1403 mm (55.24 in.))
Bucket digging force		4099 kgf > 40.2 kN < 9037 lbf <	Bucket tooth root (Bucket cylinder length:1098 mm (43.23 in.))
Blade force	Down	3753 kgf < 36.8 kN < 8273 lbf <	Cutting edge down force at ground level
Boom speed	Up (Ground to max.up)	2.7 ± 0.3 sec.	Arm extend. bucket dump with no load. Oil temp.: 50 ± 5 °C (122 ± 9 °F) exclude cushioning
	Up (max.down to max.up)	4.5 ± 0.3 sec.	
	Down (max.up to Ground)	3.4 ± 0.3 sec.	
	Down (max.up to max.down)	4.9 ± 0.3 sec.	

Item		Factory Specification	Remarks
Arm speed	Crowd Dump	3.2 ± 0.3 sec. 2.8 ± 0.3 sec.	Cylinder full stroke Oil temp.: 50 ± 5 °C (122 ± 9 °F)
Bucket speed	Crowd Dump	3.0 ± 0.3 sec. 2.1 ± 0.3 sec.	Cylinder full stroke Oil temp.: 50 ± 5 °C (122 ± 9 °F)
Blade speed	Up (Ground to max.up) Up (max.down to max.up) Down (max.up to Ground) Down (max.up to max.down)	1.1 ± 0.3 sec. 2.2 ± 0.3 sec. 1.5 ± 0.3 sec. 2.9 ± 0.3 sec.	Cylinder full stroke Oil temp.: 50 ± 5 °C (122 ± 9 °F)
Arm cylinder cavitation		5 mm > 0.2 in. >	Oil temp.: 95 ± 5 °C (203 ± 9 °F) Engine speed: 1300 rpm Bucket loaded at heaped (420 kg (926 lbs): including bucket).
Max. digging height radius		3543 ± 354 mm 139.5 ± 13.9 in.	
Max. dump height radius		3297 ± 198 mm 129.8 ± 7.8 in.	at bucket pin
Bucket bottom height at arm vertical		1590 ± 48 mm 62.6 ± 1.9 in.	Bucket horizontal Boom max. height, Arm dump max.
Bucket wrist angle		185.0 ± 3.0	
Swivel torque	L R	1237 kgf.m < 12.1 kN.m < 8947 ft.lbf < 1237 kgf.m < 12.1 kN.m < 8947 ft.lbf <	Arm extend, Quick operation Engine Max. speed Oil temp.: 50 ± 5 °C (122 ± 9 °F)
Swivel capable slope angle	L R	19 ° < 19 ° <	Front horizontal, Bucket load heaped (420 kg (926 lbs): including bucket), Engine Max. speed, Oil temp.: 50 ± 5 °C (122 ± 9 °F)

Item		Factory Specification	Remarks
Swivel block performance (with negative break) • engine stop	L	5 ° >	Bucket load heaped (420 kg (926 lbs): including bucket), Slope angle at 20 degrees for 1 min. Engine stop. Oil temp.: 50 ± 5 °C (122 ± 9 °F)
	R	5 ° >	
• engine idling	L	30 ° >	
	R	30 ° >	
Swivel start-up speed	L	2.8 ± 0.3 sec.	Front horizontal, 90 °swivel Bucket load heaped (420 kg: including bucket). Engine Max. Speed Oil temp.: 50 ± 5 °C (122 ± 9 °F)
	R	2.8 ± 0.3 sec.	
Swivel motor drain amount	During rotation	0.5 L/min 30.5 cu.in.	1F / 2F
	When blocked	4.0 L/min 244 cu.in.	
Swing speed	L	6.5 ± 0.5 sec.	Front horizontal, bucket crowd with no load. Engine Max. speed Oil temp.: 50 ± 5 °C (122 ± 9 °F)
	R	7.9 ± 0.5 sec.	
Swing Lock	Swivel R and L	10 mm> 0.39 in.>	90 °swivel, 100 times actual Bucket load heaped (420 kg: including bucket). Oil temp.: 50 ± 5 °C (122 ± 9 °F)
Relief pressure setting	P1 (aTR)	280 ± 5 kgf/cm^2 27.0 ± 0.5 MPa 275 ± 5.0 bar 3900 ± 70 psi	Engine Max. speed with back pressure. Oil temp.: 50 ± 5 °C (122 ± 9 °F)
	P2 (aTL)	280 ± 5 kgf/cm^2 27.0 ± 0.5 MPa 275 ± 5.0 bar 3900 ± 70 psi	
	P3 (aP3)	198 ± 5 kgf/cm^2 19.4 ± 0.5 MPa 194 ± 5.0 bar 2810 ± 70 psi	
	P4 (aPP)	43 ± 2 kgf/cm^2 4.2 ± 0.2 MPa 42.0 ± 2.0 bar 610 ± 30 psi	

Item		Factory Specification	Remarks
Cylinder oil sealing capacity • Boom	50 ± 5 °C (122 ± 9 °F) 95 ± 5 °C (203 ± 9 °F) [Allowable limit]	20 mm > 0.79 in. > 20 mm > 0.79 in. > 100 mm (3.94 in.) >	Arm extend. Bucket crowd for 10 min. Bucket load heaped (420 kg (926 lbs): including bucket).
• Arm	50 ± 5 °C (122 ± 9 °F) [Allowable limit]	20 mm > 0.79 in. > 100 mm (3.94 in.) >	
• Bucket	50 ± 5 °C (203 ± 9 °F) [Allowable limit]	10 mm > 0.39 in. > 50 mm (1.97 in.) >	
• Blade	50 ± 5 °C (203 ± 9 °F) [Allowable limit]	20 mm > 0.79 in. > 85 mm (3.34 in.) >	Arm vertical. blade cylinder extended for 10 min. engine stop.
Boom cushioning performance	30 °C (86 °F) 50 °C (122 °F) 80 °C (176 °F)	3 sec. > 0.4 to 1.3 sec. 0.3 sec. <	Arm extended, bucket crowd with no load. Engine Max. speed.
Boom lever operating force	Up Down	1.2 ± 0.5 kgf 12 ± 5 N 2.7 ± 1.1 lbf 1.43 ± 0.5 kgf 14 ± 5 N 3.1 ± 1.1 lbf	Measuring point: 20 mm (0.79 in.) lower from the lever top. Pilot lever with engine Max. speed.
Arm lever	Crowd Dump	1.2 ± 0.5 kgf 12 ± 5 N 2.7 ± 1.1 lbf 1.43 ± 0.5 kgf 14 ± 5 N 3.1 ± 1.1 lbf	
Bucket lever	Crowd Dump	1.0 ± 0.5 kgf 10 ± 5 N 2.2 ± 1.1 lbf 1.0 ± 0.5 kgf 10 ± 5 N 2.2 ± 1.1 lbf	

Item		Factory Specification	Remarks
Swivel lever	R	1.0 ± 0.5 kgf 10 ± 5 N 2.2 ± 1.1 lbf	Measuring point: 20 mm (0.79 in.) lower from the lever top. Pilot lever with engine Max. speed.
	L	1.0 ± 0.5 kgf 10 ± 5 N 2.2 ± 1.1 lbf	
Blade lever	Up	1.6 ± 0.5 kgf 16 ± 5 N 3.6 ± 1.1 lbf	Up and down Measuring point: 15 mm (0.59 in.) lower from the lever top
	Down	1.6 ± 0.5 kgf 16 ± 5 N 3.6 ± 1.1 lbf	
Travel lever L	Forward	1.97 ± 0.5 kgf 19 ± 5 N 4.3 ± 1.1 lbf	Measuring point: 20 mm (0.79 in.) lower from the lever top.
	Back	1.97 ± 0.5 kgf 19 ± 5 N 4.3 ± 1.1 lbf	
Travel lever R	Forward	1.97 ± 0.5 kgf 19 ± 5 N 4.3 ± 1.1 lbf	
	Back	1.97 ± 0.5 kgf 19 ± 5 N 4.3 ± 1.1 lbf	
Swing pedal	R	10.0 ± 1.0 kgf 59 ± 10 N 13.3 ± 2.2 lbf	Pedal edge. 45 ° inward
	L	10.0 ± 1.0 kgf 59 ± 10 N 13.3 ± 2.2 lbf	
Safety lock lever L	Up	2.75 ± 1.0 kgf 27 ± 10 N 6.1 ± 2.2 lbf	
	Down	7.49 ± 1.0 kgf 69 ± 10 N 15.5 ± 2.2 lbf	
Travel Hi-Lo change		–	This machine has a switch.

Item		Factory Specification	Remarks
Boom lever stroke	Up	84 ± 10 mm 3.31 ± 0.4 in.	Measuring point: The lever top. Pilot lever with engine Max. speed.
	Down	84 ± 10 mm 3.31 ± 0.4 in.	
Arm lever stroke	Crowd	84 ± 10 mm 3.31 ± 0.4 in.	
	Dump	84 ± 10 mm 3.31 ± 0.4 in.	
Bucket lever stroke	Crowd	74 ± 10 mm 29.1 ± 0.4 in.	
	Dump	74 ± 10 mm 29.1 ± 0.4 in.	
Swivel lever stroke	R	74 ± 10 mm 29.1 ± 0.4 in.	
	L	74 ± 10 mm 29.1 ± 0.4 in.	
Blade lever stroke	Up	60 ± 10 mm 2.36 ± 0.4 in.	Measuring point: The lever top.
	Down	60 ± 10 mm 2.36 ± 0.4 in.	
Travel lever stroke L	Forward	100 ± 10 mm 3.94 ± 0.4 in.	
	Back	100 ± 10 mm 3.94 ± 0.4 in.	
Travel lever stroke R	Forward	100 ± 10 mm 3.94 ± 0.4 in.	
	Back	100 ± 10 mm 3.94 ± 0.4 in.	

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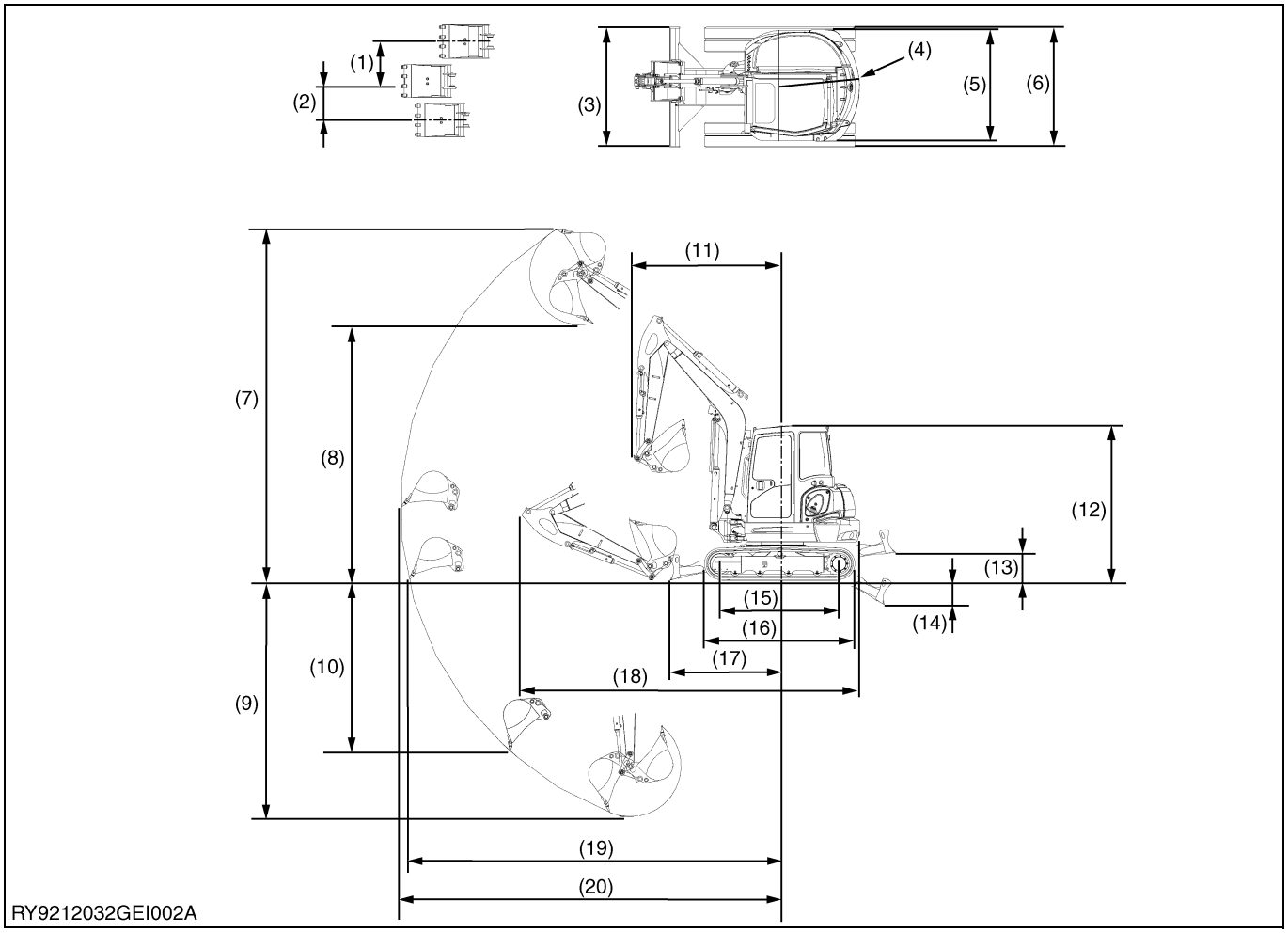
Main Dimension



	KX057-4		KX057-4		KX057-4		KX057-4
(1)	750 mm 29.5 in.	(6)	1960 mm 77.2 in.	(11)	2420 mm 95.3 in.	(16)	2500 mm 98.4 in.
(2)	550 mm 21.7 in.	(7)	5820 mm 229.1 in.	(12)	2550 mm 100.4 in.	(17)	1820 mm 71.7 in.
(3)	1960 mm 77.2 in.	(8)	4160 mm 163.8 in.	(13)	440 mm 17.3 in.	(18)	5520 mm 217.4 in.
(4)	1045 mm 41.1 in.	(9)	3890 mm 153.1 in.	(14)	410 mm 16.2 in.	(19)	6130 mm 241.3 in.
(5)	1830 mm 72.0 in.	(10)	3070 mm 120.9 in.	(15)	1990 mm 78.3 in.	(20)	6260 mm 246.5 in.

■ **NOTE**

- **Above dimensions are besed on the machine with KUBOTA original bucket.**
- **Above dimensions are besed on the machine with rubber track.**
- **Specifications subject to change without notice.**

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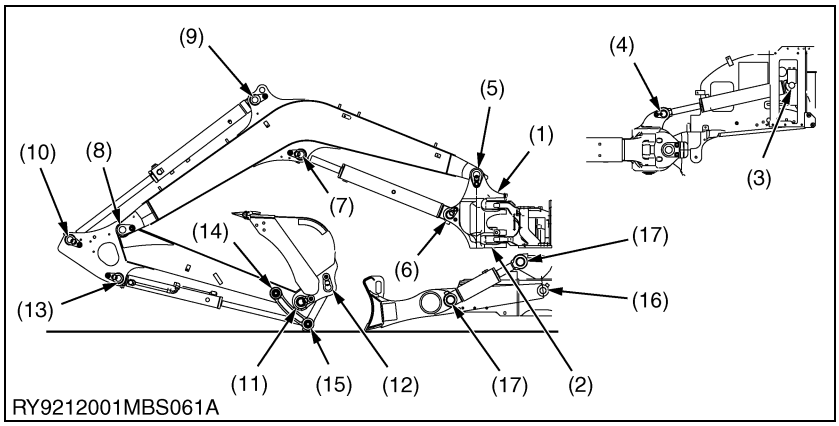
9. WATER AND OIL QUANTITY

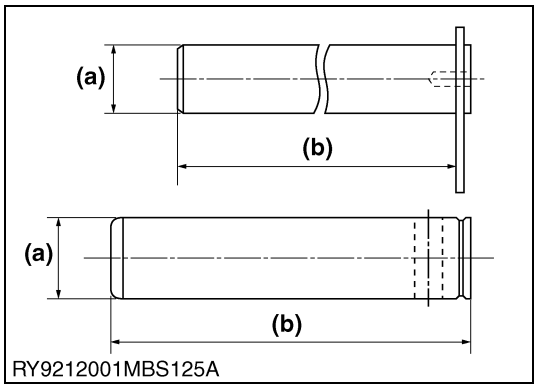
		KX057-4	Remarks
Radiator		7.0 L 1.85 U.S.gal	KUBOTA LLC-N-50F 50%
Reserve tank		1.1 L 0.29 U.S.gal	
Engine crank case		9.0 L 2.38 U.S.gal	SAE 10W-30 (CF or CI-4)
Hydraulic oil	Full	79 L 20.87 U.S.gal	ISO VG46
	Tank	45 L 11.89 U.S.gal	ISO VG46
Travel motor		0.9 L 0.24 U.S.gal	SAE90 (API GL-4)
Track roller		80 ml 4.88 cu.in	SAE30 (CD)
Carrier roller		60 ml 3.66 cu.in	SAE30 (CD)
Front idler		50 ml 3.05 cu.in	SAE30 (CD)
Fuel tank		75.0 L 19.8 U.S.gal	Diesel Fuel JIS #3 (Initial)

RY9212007GEG0011US0

10. DESCRIPTION OF PARTS

[1] FRONT PINS





		Unit	KX057-4
(1)	Pin diameter x length	mm in.	ϕ92 x 176 ϕ3.62 x 6.93
(2)	Pin diameter x length	mm in.	ϕ92 x 150 ϕ3.62 x 5.91
(3)	Pin diameter x length	mm in.	ϕ45 x 158 ϕ1.77 x 6.22
(4)	Pin diameter x length	mm in.	ϕ45 x 131 ϕ1.77 x 5.16
(5)	Pin diameter x length	mm in.	ϕ55 x 347 ϕ2.17 x 13.66
(6)	Pin diameter x length	mm in.	ϕ55 x 165 ϕ2.17 x 6.50
(7)	Pin diameter x length	mm in.	ϕ55 x 196 ϕ2.17 x 7.72
(8)	Pin diameter x length	mm in.	ϕ55 x 235 ϕ2.17 x 9.25
(9)	Pin diameter x length	mm in.	ϕ50 x 196 ϕ1.97 x 7.72
(10)	Pin diameter x length	mm in.	ϕ50 x 152 ϕ1.97 x 5.98
(11)	Pin diameter x length	mm in.	ϕ45 x 257 ϕ1.77 x 10.12
(12)	Pin diameter x length	mm in.	ϕ45 x 257 ϕ1.77 x 10.12
(13)	Pin diameter x length	mm in.	ϕ45 x 152 ϕ1.17 x 5.98
(14)	Pin diameter x length	mm in.	ϕ45 x 204 ϕ1.77 x 8.03
(15)	Pin diameter x length	mm in.	ϕ45 x 204 ϕ1.77 x 8.03
(16)	Pin diameter x length	mm in.	ϕ45 x 142 ϕ1.77 x 5.59
(17)	Pin diameter x length	mm in.	ϕ55 x 154 ϕ2.17 x 6.06

■ **NOTE**

- **Service limit of pin and bushing is 1.0 mm (0.04 in.) less and more than original diameter respectively.**

(a) Pin diameter **(b) Pin length**

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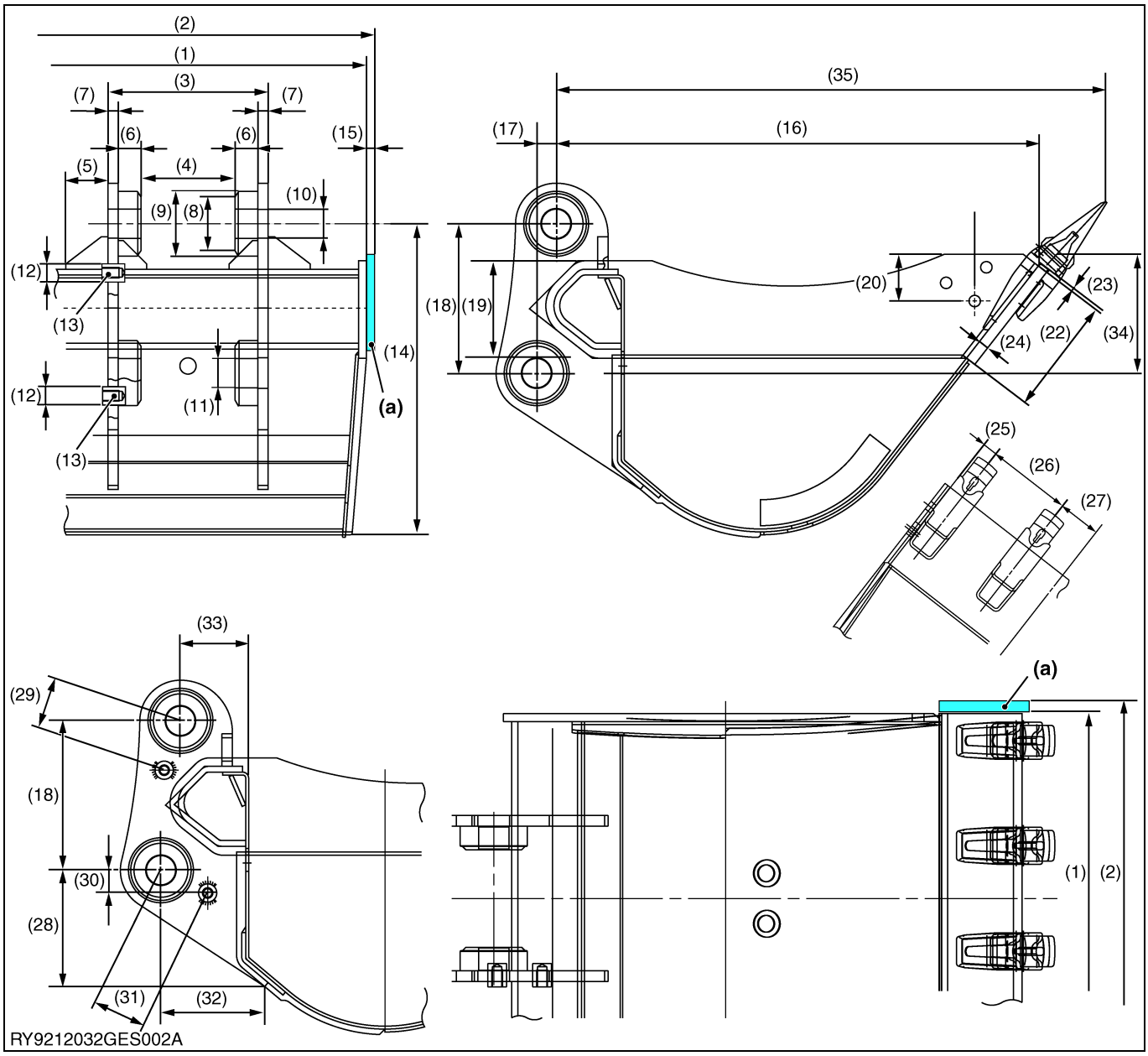
[2] BUCKET

(1) Bucket dimensions

NOTE : KUBOTA JAPAN BUCKET



No.	KX057-4	No.	KX057-4	No.	KX057-4	No.	KX057-4	No.	KX057-4
(1)	600 mm 23.62 in.	(8)	83 mm 3.27 in.	(15)	12 mm 0.47 in.	(22)	180 mm 7.09 in.	(29)	80 mm 3.15 in.
(2)	650 mm 25.59 in.	(9)	100 mm 39.4 in.	(16)	743 mm 29.25 in.	(23)	5 mm 0.20 in.	(30)	35 mm 1.38 in.
(3)	247 mm 9.72 in.	(10)	45 mm 1.77 in.	(17)	30 mm 1.18 in.	(24)	16 mm 0.63 in.	(31)	80 mm 3.15 in.
(4)	145 mm 5.71 in.	(11)	45 mm 1.77 in.	(18)	230 mm 9.06 in.	(25)	28.5 mm 1.12 in.	(32)	165 mm 6.50 in.
(5)	65 mm 2.56 in.	(12)	28 mm 1.10 in.	(19)	150 mm 5.91 in.	(26)	173 mm 6.81 in.	(33)	1.5 mm 0.06 in.
(6)	35 mm 1.38 in.	(13)	M16 x 1.5 x 2.5	(20)	72 mm 2.83 in.	(27)	87 mm 3.41 in.	(34)	165 mm 6.50 in.
(7)	16 mm 0.63 in.	(14)	483 mm 19.02 in.	(21)	98 mm 3.86 in.	(28)	173 mm 6.81 in.	(35)	849 mm 33.43 in.

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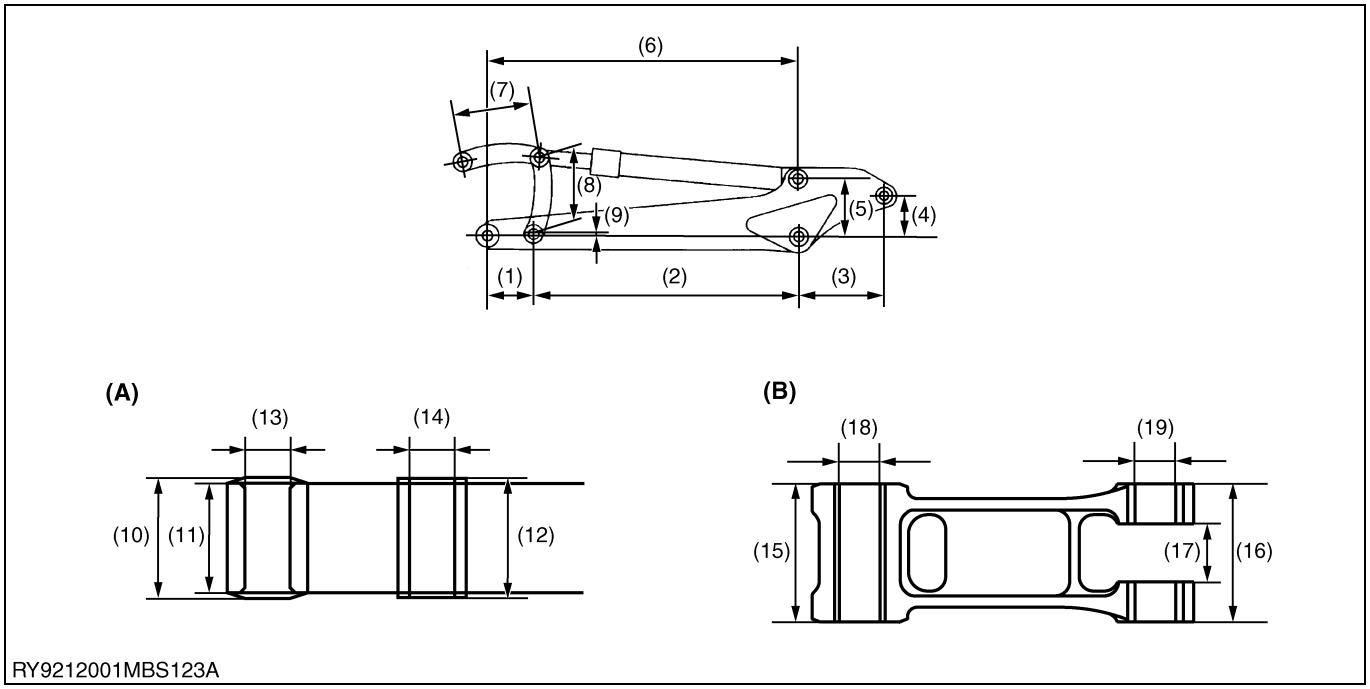
(2) Bucket installation relevant dimensions



RY9212001MBS123A

(A) Arm tip **(B) Bucket, link 1**

No.	KX057-4		No.	KX057-4	No.	KX057-4	No.	KX057-4	No.	KX057-4
(1)	200 mm 7.87 in.		(5)	335 mm 13.19 in.	(9)	10 mm 0.39 in.	(13)	45 mm 1.77 in.	(17)	61 mm 2.40 in.
(2)	1620 mm 63.78 in.	1370 mm 53.94 in.	(6)	1360 mm 53.54 in.	(10)	145 mm 5.71 in.	(14)	45 mm 1.77 in.	(18)	45 mm 1.77 in.
(3)	353 mm 13.90 in.		(7)	315 mm 12.40 in.	(11)	133 mm 5.24 in.	(15)	145 mm 5.71 in.	(19)	45 mm 1.77 in.
(4)	193 mm 7.60 in.		(8)	335 mm 13.19 in.	(12)	145 mm 5.71 in.	(16)	145 mm 5.71 in.		

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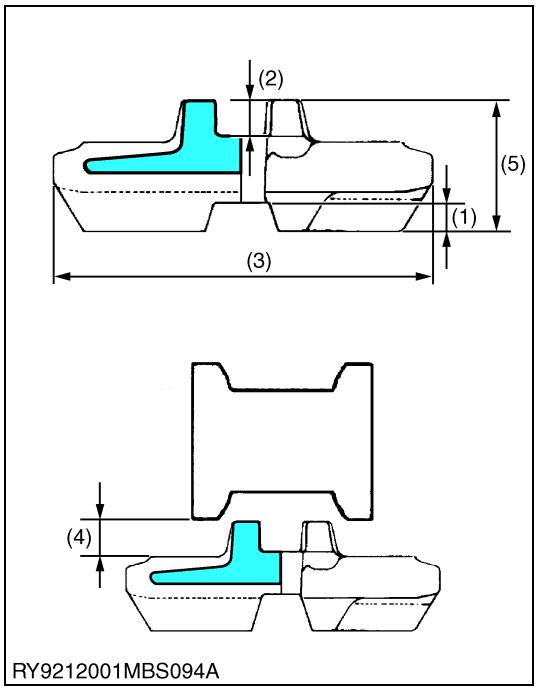
[3] RUBBER CRAWLER (EU VERSION)

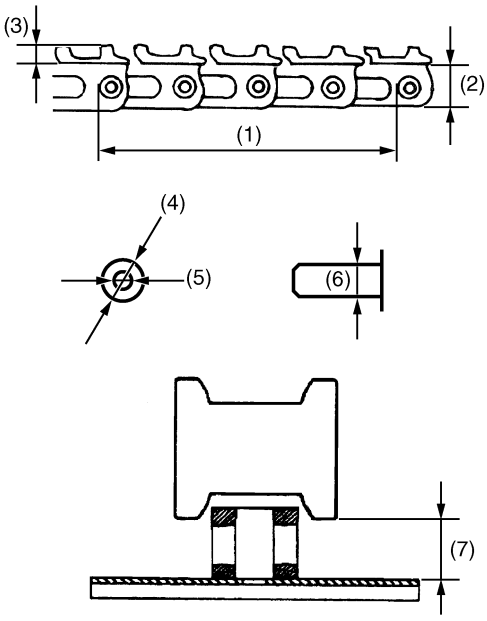


RY9212001MBS094A

	KX057-4	KX161-3α
Crawler assy code No.	RD551-2231-0	RD441-2231-0
Identification mark (Core metal lapping position)	∞	
(1) Lug height	19 mm 0.75 in.	23 mm 0.91 in.
(2) Link height	25 mm 0.96 in.	
(3) Crawler width	400 mm 15.75 in.	
(4) Crawler sag distance	10 to 15 mm 0.39 to 0.59 in.	
(5) Crawler height	91.0 mm 3.58 in.	92.0 mm 3.62 in.
Number of core metal	74	
Circumference	5365 mm 211.2 in.	
Core metal pitch	72.5 mm 2.85 in.	

RY9212007GEG0015US0

[4] STEEL CRAWLER



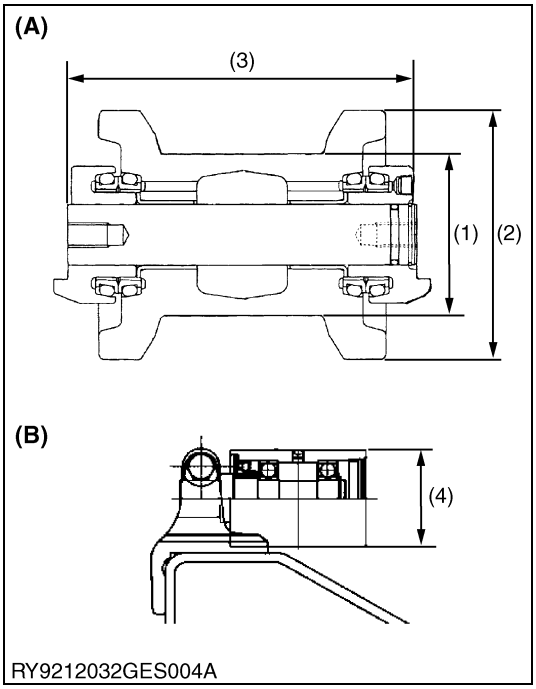
RY9212001MBS095A

	Unit	KX057-4 (STD)	KX057-4 (Wide)	KX161-3α (STD)	KX161-3α (Wide)
Crawler ass'y code No.		RD411-2220-0	RD519-2220-0	RD411-2220-0	RD519-2250-0
Crawler width	mm in.	400 15.75	550 21.65	400 15.75	550 21.65
(1) 4 links length (a)/(b)	mm in.	540 / 548 21.26 / 21.57			
(2) Height	mm in.	67.0 2.64			
(3) Grouser height	mm in.	20.0 0.79			
(4) Bushing O. D. (a)/(b)	mm in.	ϕ35.0 / 34.0 ϕ1.38 / 1.34			
(5) Bushing I. D. (a)/(b)	mm in.	ϕ22.5 / 23.5 ϕ0.89 / 0.93			
(6) Master pin O. D. (a)/(b)	mm in.	ϕ22.15 / 21.5 ϕ0.87 / 0.83			
(7) Crawler sag distance	mm in.	80 to 85 3.15 to 3.35			
Number of links		39			

(a) New machine reference value
(b) Allowable limit

RY9212007GEG0016US0

[5] TRUCK ROLLER, IDLER, SPROCKET



RY9212032GES004A

	Unit	KX057-4	Remarks
(1) Guide diameter	mm in.	ϕ85 ϕ3.35	
(2) Outer diameter	mm in.	ϕ135 ϕ5.31	
(3) Roller width	mm in.	200 7.87	
(4) Carrier roller diameter	mm in.	ϕ80 ϕ3.15	

(A) Truck roller **(B) Carrier roller**

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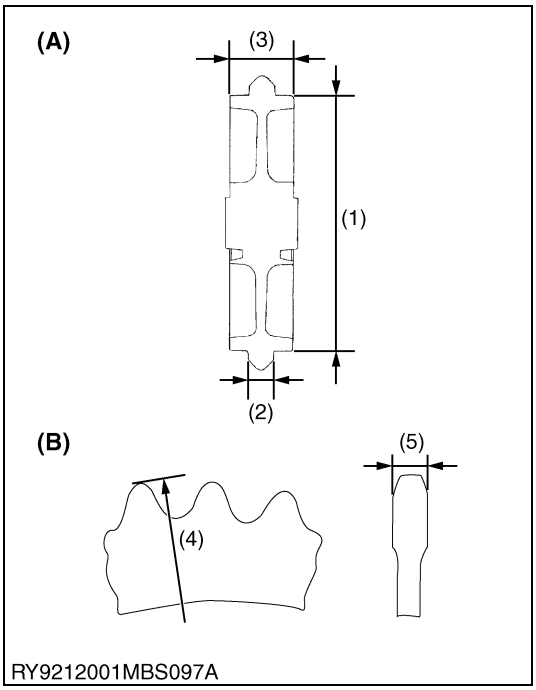

RY9212001MBS097A

	Unit	KX057-4	Remarks
(1) Idler O.D.	mm in.	ϕ300 ϕ12.99	
(2) Guide width	mm in.	ϕ52 ϕ2.05	
(3) Idler width	mm in.	93 3.66	
(4) Sprocket wheel O.D.	mm in.	ϕ429 ϕ16.89	
(5) Sprocket wheel width	mm in.	43 1.69	

(A) Idler **(B) Sprocket**

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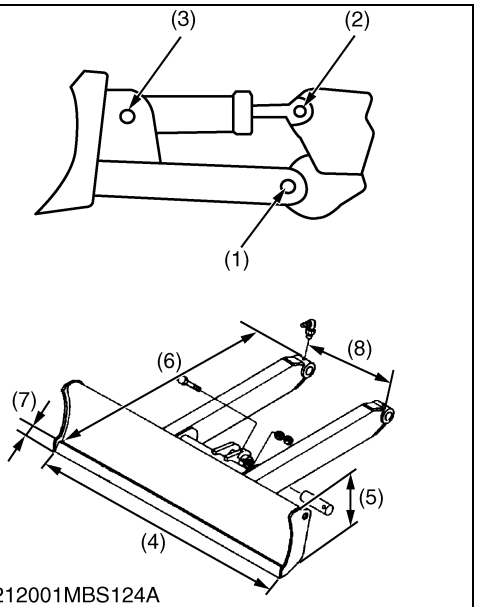
[6] BLADE



RY9212001MBS124A

	Unit	KX057-4	Remarks
(1) Pin diameter × length	mm in.	ϕ45 x 142 ϕ1.77 x 559	Blade arm – Track frame
(2) Pin diameter × length	mm in.	ϕ55 x 154 ϕ2.17 x 6.06	Blade cylinder – Track frame
(3) Pin diameter × length	mm in.	ϕ55 x 154 ϕ2.17 x 6.06	Blade cylinder – Blade
(4) Blade width	mm in.	1960 77.17	
(5) Blade height	mm in.	400.0 15.75	
(6) Blade length	mm in.	1365 53.74	
(7) Blade tip plate height × thickness	mm in.	65 x t12 2.56 x t0.47	
(8) Length between blade arms	mm in.	599 23.58	

RY9212007GEG0019US0

[7] PARTS WEIGHT (EU VERSION)

	Unit	KX057-4	Remarks
Track frame	kg lbs	615 1355.8	
Swivel frame	kg lbs	622.0 1371.3	
Swing bracket	kg lbs	121.0 266.8	
Boom	kg lbs	208.0 458.6	
Arm	kg lbs	123.0 271.2	
Bucket	kg lbs	110.0 244.7	Without teeth and side cutter
Blade	kg lbs	241.0 531.3	
Weight (rear)	kg lbs	692.0 1525.6	
Rubber crawler	kg lbs	240.0 529.1	
Steel crawler (STD.)	kg lbs	285.0 628.3	
Steel crawler (wide)	kg lbs	385.0 848.8	
Arch frame	kg lbs	51.0 112.4	
Engine	kg lbs	225.0 496.0	Dry weight
Hydraulic tank	kg lbs	38.0 83.8	With filter
Fuel tank	kg lbs	4.2 9.3	
Swivel bearing	kg lbs	68.6 151.2	
Battery	kg lbs	22.7 49.9	
Track roller	kg lbs	9.4 20.7	
Upper roller	kg lbs	3.3 7.2	
ROPS/FOPS cabin	kg lbs	235.0 518.1	
Hydraulic pump	kg lbs	42.0 92.6	
Traveling motor	kg lbs	58.0 127.9	
Swivel motor	kg lbs	50.0 110.2	
Sprocket	kg lbs	15.3 33.8	
Idler ass'y	kg lbs	46.4 102.3	
Control valve	kg lbs	59.5 131.2	Without adaptors
Boom cylinder	kg lbs	60.0 132.3	
Arm cylinder	kg lbs	56.0 123.5	

	Unit	KX057-4	Remarks
Bucket cylinder	kg lbs	32.0 70.5	
Swing cylinder	kg lbs	37.3 82.2	
Blade cylinder	kg lbs	36.5 80.5	
Rotary joint	kg lbs	27.7 61.1	

The above weight list is based on calculation and slightly different from actual ones.

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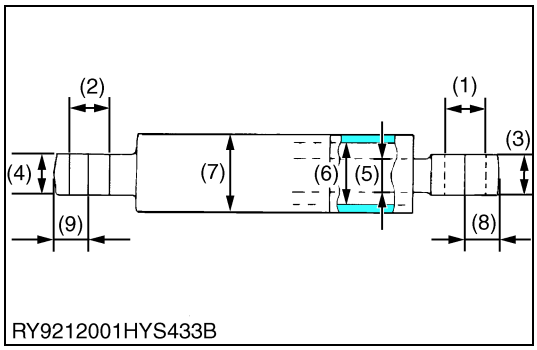
11. CYLINDER DIMENSIONS

KX057-4 Max. retraction length (stroke)



RY9212001HYS433B

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	Port screw size	
Boom	55 mm 2.17 in.	55 mm 2.17 in.	70 mm 2.76 in.	70 mm 2.76 in.	55 mm 2.17 in.	95 mm 3.74 in.	117 mm 4.61 in.	55 mm 2.17 in.	50 mm 1.97 in.	PF 1/2"	
Arm	50 mm 1.97 in.	50 mm 1.97 in.	70 mm 2.76 in.	70 mm 2.76 in.	55 mm 2.17 in.	85 mm 3.35 in.	105 mm 4.13 in.	55 mm 2.17 in.	50 mm 1.97 in.	PF 1/2"	
Bucket	45 mm 1.77 in.	45 mm 1.77 in.	60 mm 2.36 in.	60 mm 2.36 in.	45 mm 1.77 in.	75 mm 2.95 in.	91 mm 3.58 in.	40 mm 1.57 in.	40 mm 1.57 in.	PF 1/2"	
Swing	45 mm 1.77 in.	45 mm 1.77 in.	60 mm 2.36 in.	60 mm 2.36 in.	50 mm 1.97 in.	90 mm 3.54 in.	107 mm 4.21 in.	49 mm 1.03 in.	50 mm 1.97 in.	G 1/4"	
Blade	55 mm 2.17 in.	55 mm 2.17 in.	70 mm 2.76 in.	70 mm 2.76 in.	60 mm 2.36 in.	110 mm 4.33 in.	131 mm 5.16 in.	55 mm 2.17 in.	56 mm 2.20 in.	G 3/8"	

RY9212007GEG0023US0

12. MAINTENANCE CHECK LIST

Operator Service

	General Maintenance	Elapsed Operating Hours																			Interval	
		50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	
	Check the fuel level																				daily	
	Check the coolant level																				daily	
	Checking the engine oil level																				daily	
	Check the hydraulic oil level																				daily	
	Grease the bucket bolt and bucket linkage bolt																				daily	
	Check the V-belt																				daily	
	Check the fluid level of the washer system reservoir																				daily	
	Check the electric cables and connections																				daily	
	Clean the radiator and condenser																				daily	
	Lubricate the front-end attachments : Grease the swing bracket Other greasing points																				daily	
	Check the water separator	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	50 h	
	Drain water from the fuel tank	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	50 h	
	Check the battery electrolyte level	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	50 h	
	Crawlers and track frame: Clean, visually inspect and check tension	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	50 h	
	Grease the swivel gear	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	❍	50 h	
	Grease the pitch bearing				❍				❍				❍				❍				❍	200 h	
*1	Check and clean the interior air filter				❍				❍				❍				❍				❍	200 h	
*1	Check, clean the air filter				❍				❍				❍				❍				❍	200 h	
	Check the coolant hoses and hose clamps				❍				❍				❍				❍				❍	200 h	
	Check the fuel lines and air intake hoses				❍				❍				❍				❍				❍	200 h	
	Check the pipes and hoses of the air conditioner																					annually	

*1 : Under very dusty conditions, the air filter and the interior air filter must be cleaned more frequently or replaced.

Servicing by skilled personnel or KUBOTA dealer

	General Maintenance	Elapsed Operating Hours																				Interval	
		50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000		
	Check the coolant hoses and hose clamps					❍					❍					❍					❍	250 h	
	Replace the coolant hoses and hose clamps																					every 2 years	
	Replace the fuel lines and air intake hoses																					every 2 years	
	Check and adjust the V-belt					❍					❍					❍					❍	250 h	
	Change the engine oil and oil filter										❍										❍	500 h	*3
*4	Replace the drive unit oil	●									❍										❍	500 h	*3
	Replace the fuel filter										❍										❍	500 h	*3
	Replace the tank breather filter										❍										❍	500 h	*3
*2	Replace the return filter																				❍	1000 h	*3
	Replace the pilot circuit filter																				❍	1000 h	*3
*2	Change the hydraulic oil and replace the suction filter																				❍	1000 h	*3
*1	Replace the air filter elements																				❍	1000 h	*3
*1	Replace the interior air filter																				❍	1000 h	*3
	Change the oil of the idler and track roller																					2000 h	*3
	Check alternator and starter motor																					2000 h	
	Replace the pipes and hoses of the air conditioner																					every 2 years	
	Replace the coolant																					every 2 years	
	Change the hydraulic hoses																					every 6 years	
	Check the coolant content																					maintenance on demand	
*5	Safety inspection																					annually	

The servicing identified with ● must be carried after the specified hours of operation after initial operation have been reached.
*1 : Under very dusty conditions, the air filter and the interior air filter must be cleaned more frequently or replaced.
*2 : When using a hydraulic hammer over 20 % → every 800 h.
When using a hydraulic hammer over 40 % → every 400 h.
When using a hydraulic hammer over 60 % → every 300 h.
When using a hydraulic hammer over 80 % → every 200 h.
*3 : At 10 hours before the periodical check,the massages will be appeared on the display of the electronic console.
*4 : Earlier if necessary.
*5 : At least annually.

RY9212032GEG0005US0

1 MACHINE BODY

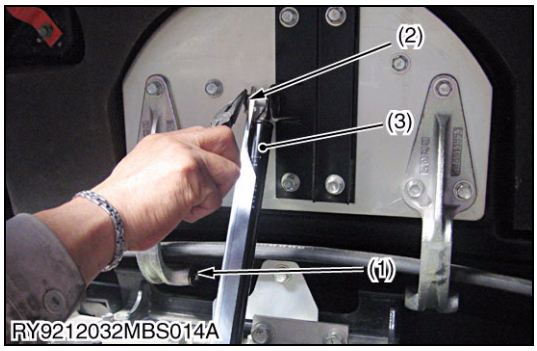
SERVICING

CONTENTS

1. SWIVEL FRAME 1-S1
   [1] WEIGHT DISASSEMBLY / ASSEMBLY 1-S1
   [2] FUEL TANK 1-S3
   [3] HYDRAULIC OIL TANK 1-S9
      (1) Hydraulic oil tank components 1-S9
      (2) Hydraulic oil return filter replacement procedure 1-S10
      (3) Filter (suction) replacement procedure 1-S11
      (4) Filter (breather) replacement procedure 1-S12
      (5) Assembly of anti vibration support for the hydraulic oil tank 1-S13
   [4] ENGINE 1-S14
      (1) Engine mount 1-S14
      (2) Muffler 1-S15
      (3) Arch, Air cleaner 1-S16
      (4) Radiator 1-S17
      (5) Oil cooler 1-S18
      (6) Accelerator cable 1-S19
   [5] ASSEMBLING OF OPERATING LEVERS 1-S20
      (1) Travel lever 1-S20
      (2) Blade lever 1-S21
2. TRACK FRAME 1-S22
   [1] ASSEMBLING OF SWIVEL BEARING 1-S22
   [2] TRACK 1-S24
      (1) Assembly / disassembly of rubber track 1-S24
      (2) Assembly / disassembly of iron tracks 1-S25
   [3] FRONT IDLER 1-S28
      (1) Assembly/disassembly of front idler 1-S28
      (2) Front idler structural components 1-S28
   [4] SPRING ASSY 1-S29
      (1) Assembly/disassembly of spring assy 1-S29
   [5] CYLINDER ASSEMBLY 1-S30
      (1) Assembly/disassembly of cylinder assy 1-S30
      (2) Cylinder assembly structural components 1-S30
   [6] TRACK ROLLER 1-S32
      (1) Assembly/disassembly of track roller 1-S32
      (2) Track roller structural components 1-S33
   [7] CARRIER ROLLER 1-S34
      (1) Assembly/disassembly of carrier roller 1-S34
      (2) Carrier roller structural components 1-S35

1. SWIVEL FRAME

[1] WEIGHT DISASSEMBLY / ASSEMBLY



Removing the bonnet (right)

1. Open the bonnet (right) (4), remove the two snap pins (1), (2), and separate the gas damper from the bonnet.

2. Slide the bonnet (right) (4) to the front of the body and remove it.

CAUTION

- **Have another person help you when removing/attaching the bonnet (right).**
- Bonnet (right) weight : 27 kg (60 lbs)

(1) Snap pin, flat washer
(2) Snap pin, flat washer
(3) Gas damper
(4) Bonnet (right)

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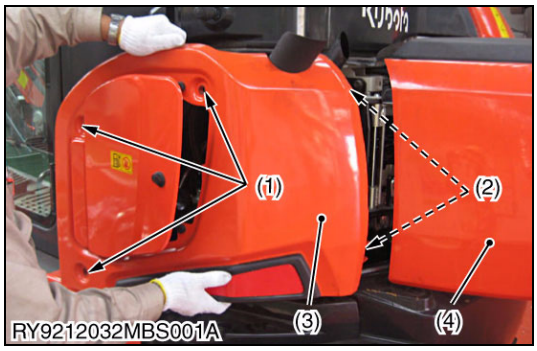

Removing the bonnet (left)

1. Remove five mounting bolts (1), (2) of the bonnet (left) (3) and remove the bonnet (left) (3).

(1) Bolt (M10 × 35)
(2) Bolt (M10 × 25)
(3) Bonnet (left)
(4) Bonnet (rear)

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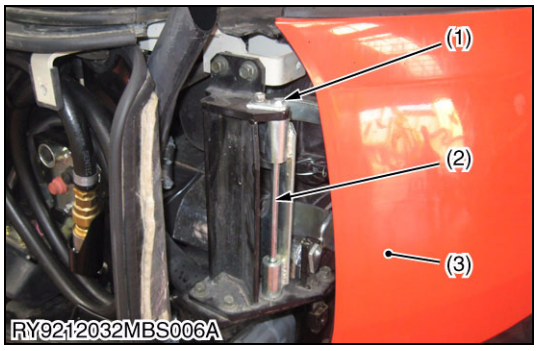
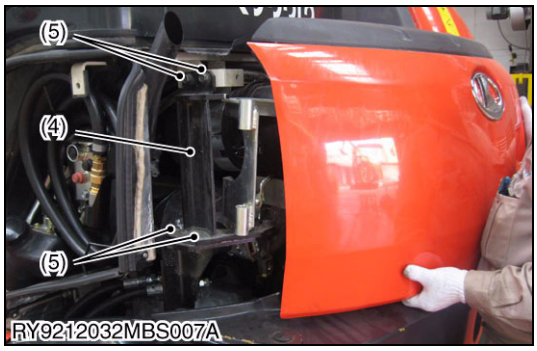


Removing the bonnet (rear)

1. Remove the bolt (1), pull out the pin (2), and remove the bonnet (rear) (3).



2. Remove the mounting bracket (4) and four mounting bolts (5) of the bonnet (rear) and remove the bracket (4).

(1) Bolt (M8 × 16)
(2) Pin
(3) Bonnet (rear)
(4) Bracket
(5) Bolt (M10 × 20)

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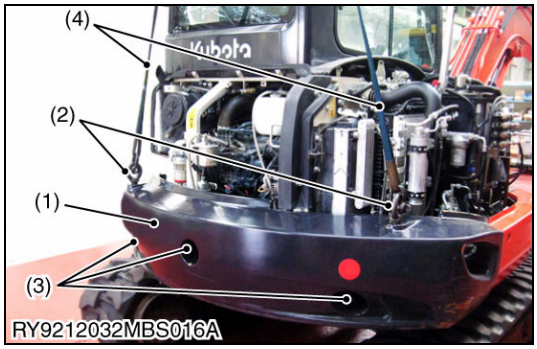

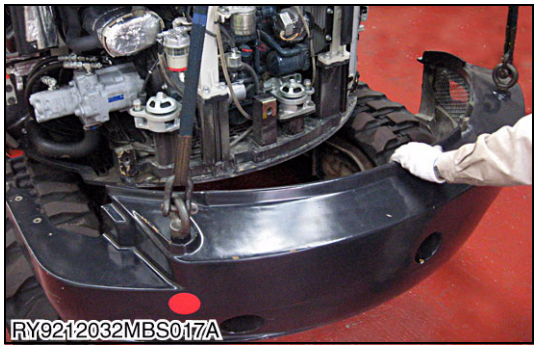

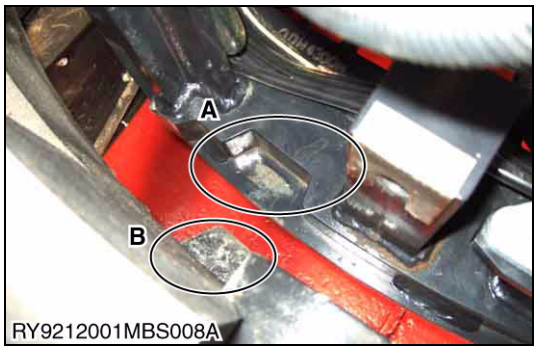

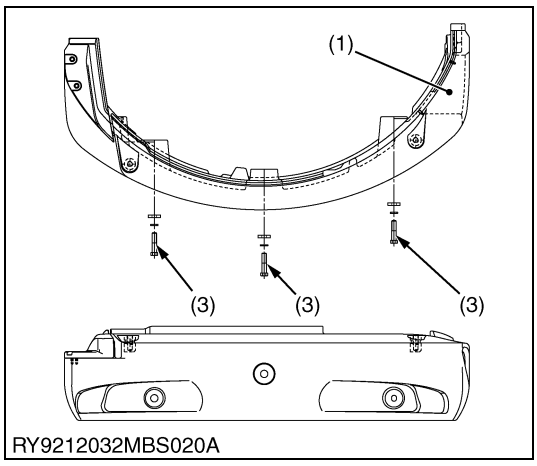

Removing the weight

1. Attach two eyebolts (2) to the weight (1), connect a nylon sling (4) to these and support the weight using a crane.

2. Remove the three mounting bolts (3) of the weight, lift slightly with the crane, slide the weight to the rear, lift the weight and remove it from the frame.

Tightening torque	Weight (1)	367.7 to 431.5 N·m 37.5 to 44.0 kgf·m 271.2 to 318.3 lbf·ft

Apply thread locking compound. (Loctite 271)

- Weight of the weight : approximately 680 kg (1500 lbs)

CAUTION

- **When assembling the weight, align the protruding part B of the weight with the indented part A in the frame and line up the mounting holes.**

(1) Weight
(2) Eyebolt (M24 × P3)
(3) Bolt (M20 × 90)
(4) Nylon sling

A : Indent part in frame
B : Protruding part of weight

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(1) Weight

(3) Bolt (M20 × 90)

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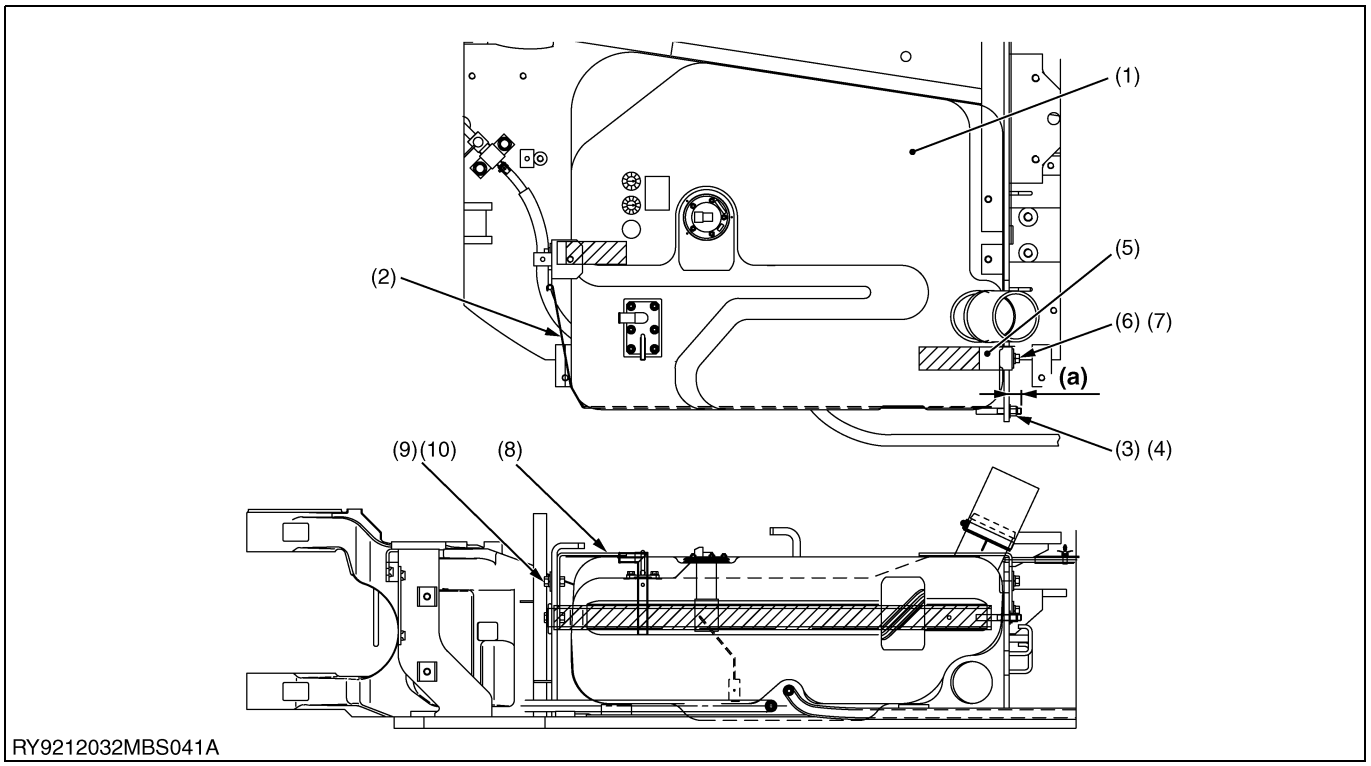
[2] FUEL TANK

Assembling the fuel tank



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(1) Fuel tank assembly
(2) Band, assy (fuel tank)
(3) Lock nut
(4) Flat metal washer
(5) Plate, assy (1, fuel tank support)
(6) Bolt (M10 × 20)
(7) Flat metal washer
(8) Plate, assy (2, fuel tank support)
(9) Bolt (M10 × 25)
(10) Flat metal washer
(a) Tolerance from the frame (swivel) partition plate to band screw part : 20 to 25 mm, 0.79 to 0.98 in.

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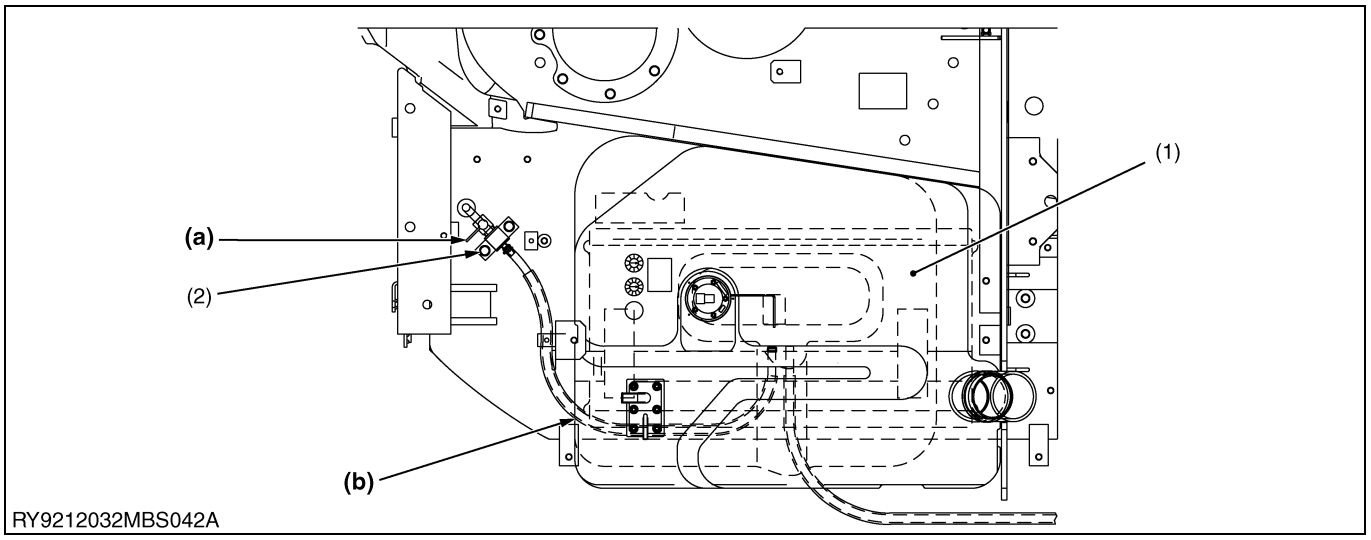
Assembling the fuel hose



RY9212032MBS042A

(1) Fuel tank assembly
(2) Bolt (M10 × 25)
(a) Cock closed position
(b) Be careful to make sure the hose does not get caught between the frame (swivel) and the fuel tank

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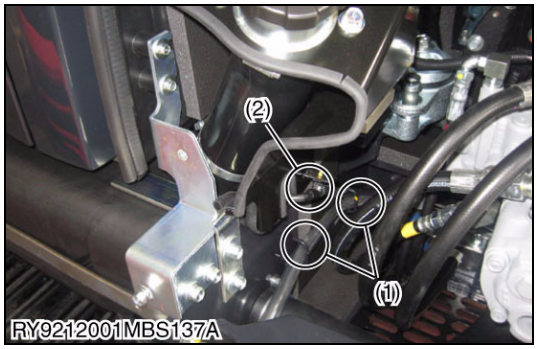
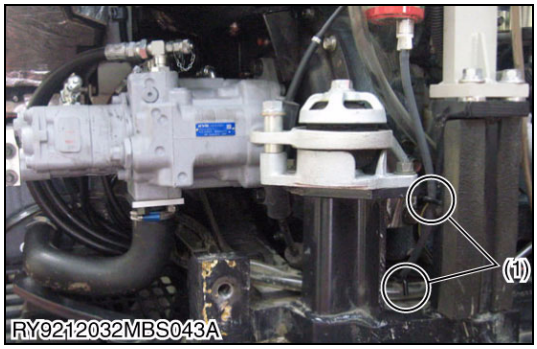
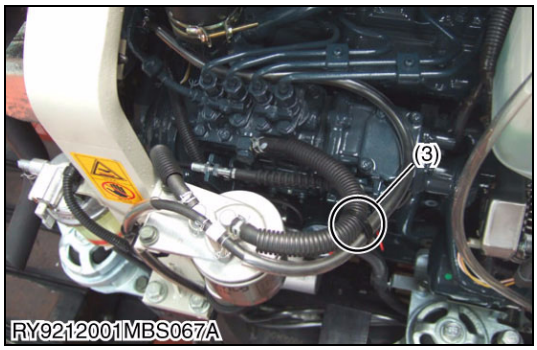
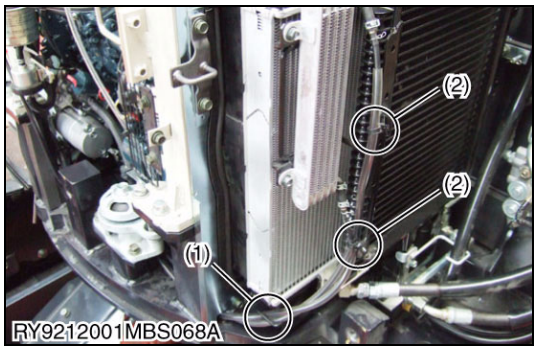
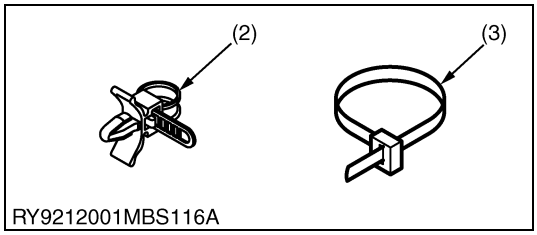








Fuel hose clamp, guide position



(1) Guide
(2) Clamp
(3) Clamp

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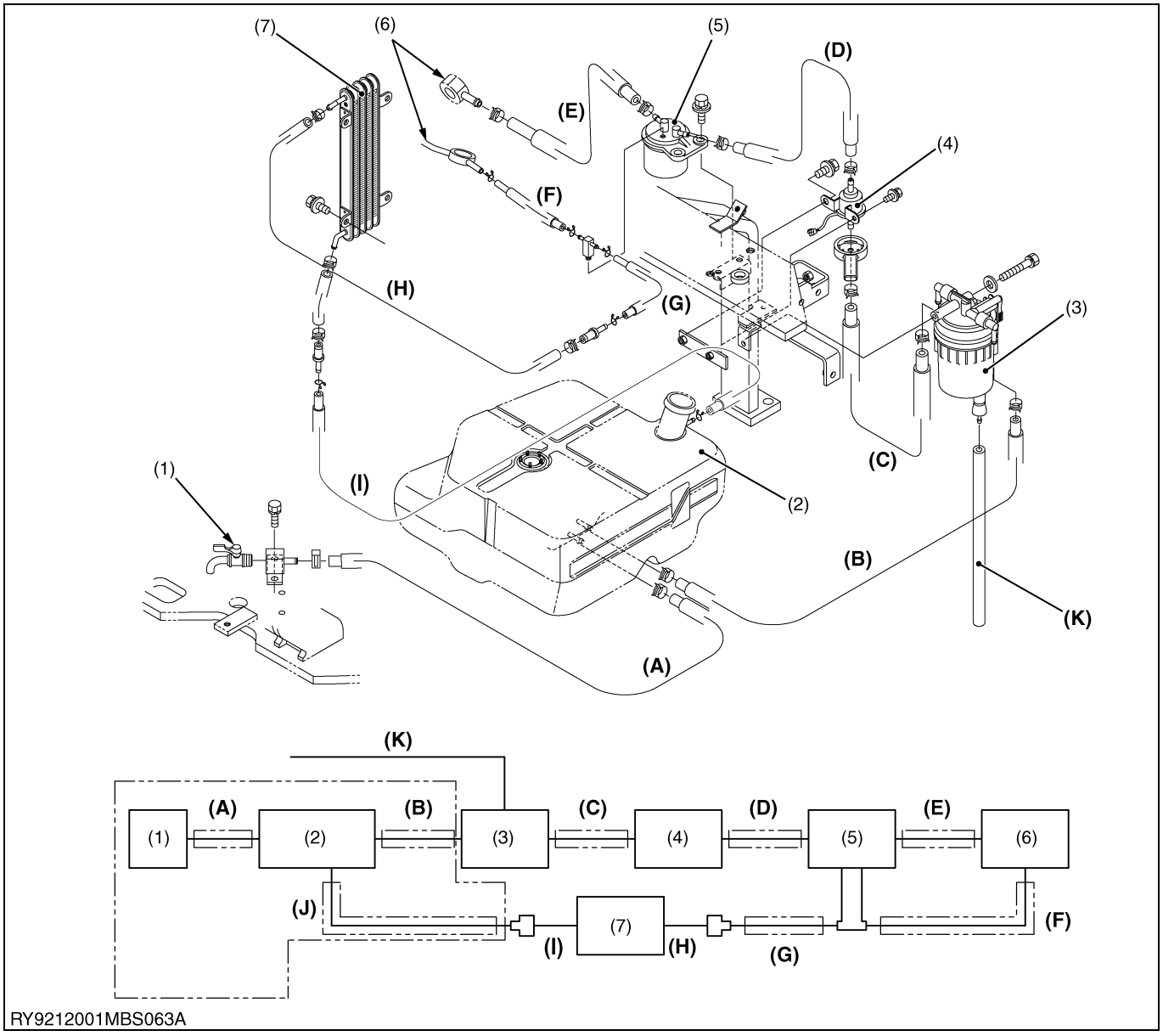
Fuel hose route



RY9212001MBS063A

(1) Drain cock
(2) Fuel tank
(3) Water separator
(4) Fuel pump
(5) Fuel filter
(6) Engine
(7) Fuel cooler

List of fuel hoses

	Fuel tube		Protection tube		Hose band
	Part	Length	Part	Length	In / Out side
(A)	RD358-51331	800 mm, 31.5 in.	RD451-51341	610 mm, 24 in.	09318-88130
(B)	09664-82100	2100 mm, 82.7 in.	RD301-51151	2000 mm, 78.7 in.	14911-42751
(C)	09664-80340	340 mm, 13.4 in.	RD451-51352	260 mm, 10.2 in.	14911-42751
(D)	09664-80260	260 mm, 10.2 in.	RD451-51382	200 mm, 7.9 in.	14911-42751
(E)	09664-80260	260 mm, 10.2 in.	RD451-51382	200 mm, 7.9 in.	14911-42751
(F)	09664-40500	500 mm, 19.7 in.	RC461-51641	450 mm, 17.7 in.	14971-42751
(G)	09664-41750	1750 mm, 68.9 in.	RD451-51392	1650 mm, 65 in.	14971-42751
(H)	09664-80040	40 mm, 1.6 in.	–	–	14911-42751
(I)	09664-80040	40 mm, 1.6 in.	–	–	14911-42751
(J)	09664-42100	2100 mm, 82.7 in.	RB441-51221	2000 mm, 78.7 in.	14971-42751
(K)	09664-60420	420 mm, 16.5 in.	–	–	–

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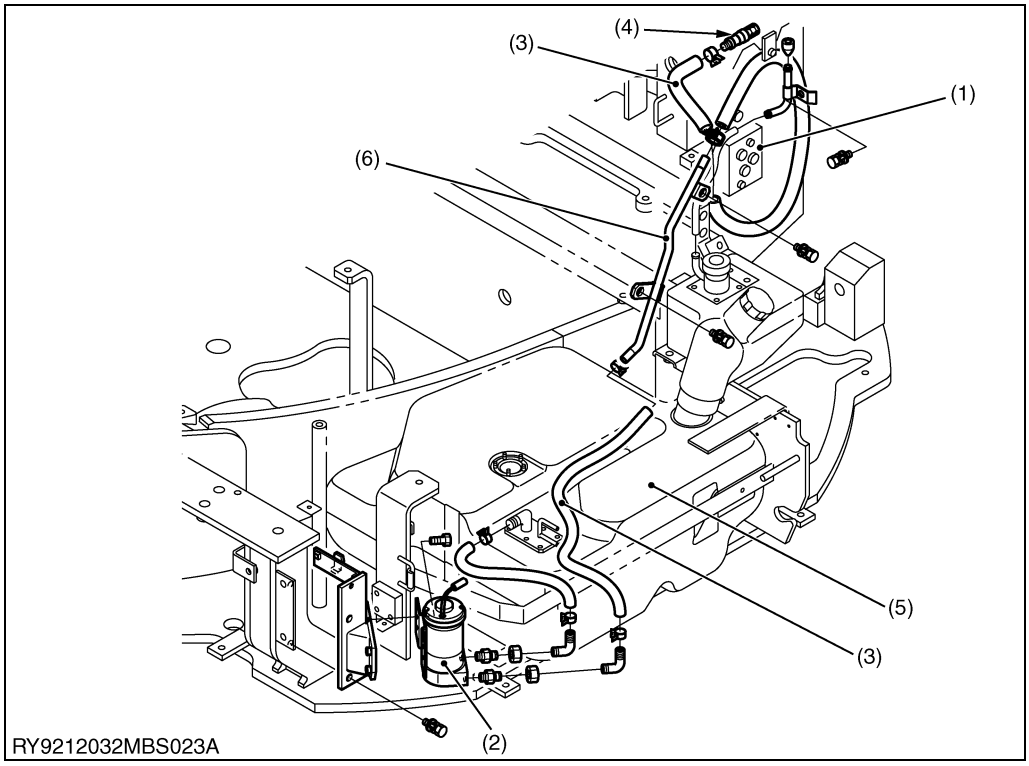
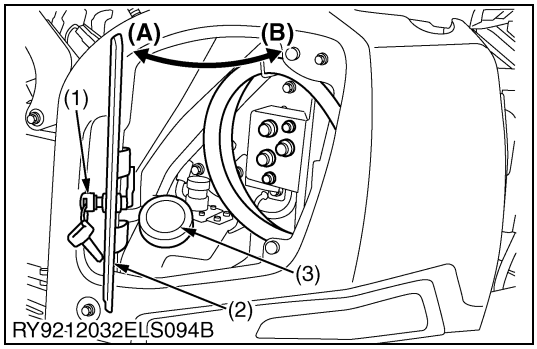
Primary components



RY9212032MBS023A

(1) Switch box
(2) Fuel supply pump
(3) Hose
(4) Filter (suction)
(5) Fuel Tank
(6) Pipe

RY9212032MBS0015US0



RY9212032ELS094B

Supply method

- After finishing work, fill the fuel tank until it is full and fully tighten the cap.
- Be sure to pass the fuel through the fuel tank strainer when filling with fuel.
- Be careful to prevent foreign contamination of water or filth in the fuel tank.
- Normally air does not enter the fuel lines unless the fuel tank is emptied completely but in the event it does, perform an air bleed.

(1) Key
(2) Tank cover
(3) Fuel tank cap

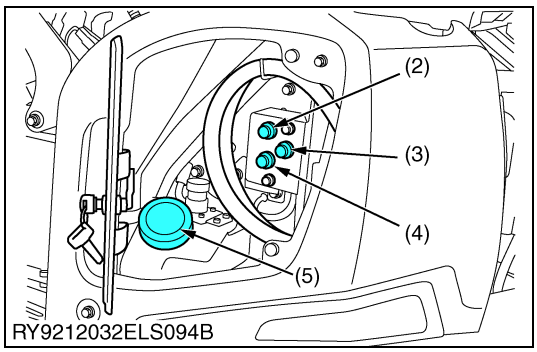
(A) Open
(B) Close

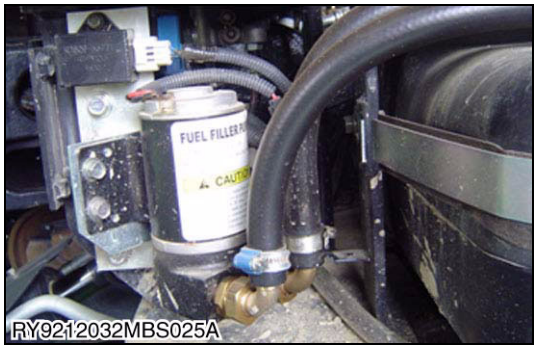
RY9212032MBS0016US0

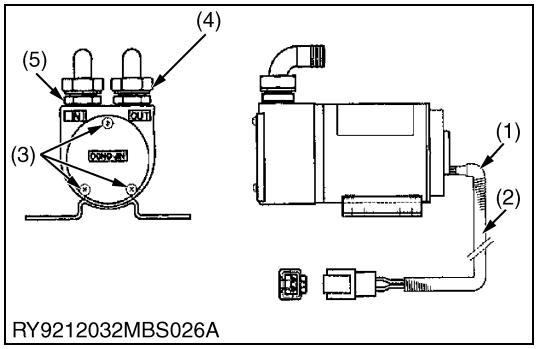
How to open the fuel tank cover

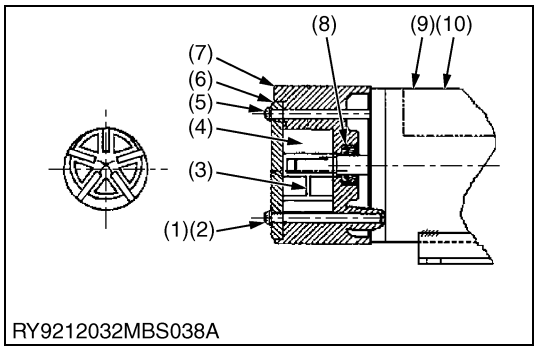
- Insert the key into the key hole located on the cover and turn it clockwise to unlock.
- To lock the cover, close the cover fully and turn the key in the counter clockwise direction.

RY9212032MBS0017US0









How to supply fuel

1. Attach the pump nozzle to the tank fuel supply side.
2. With key in the stop position, press the switch (2) and push the buzzer switch for notification when full.
3. While filling with fuel, listen for the buzzer notifying tank is full and continue to supply fuel until the buzzer stays on.
4. If fuel supply is stopped before the tank is full, push the buzzer switch for notifying tank is full to stop operation of the switch or wait for 10 minutes and the buzzer will stop.

(1) Pump nozzle
(2) Switch (black button)
(3) Buzzer switch for notifying tank is full
(4) Switch (red button)
(5) Fuel tank cap

RY9212032MBS0018US0

Fuel pump specifications

Tightening torque	Bolt (3)	2.0 to 2.5 N·m 0.2 to 0.26 kgf·m 1.4 to 1.87 lbf·ft
	Bolt (4)	20 to 25 N·m 2 to 2.6 kgf·m 14.4 to 18.7 lbf·ft

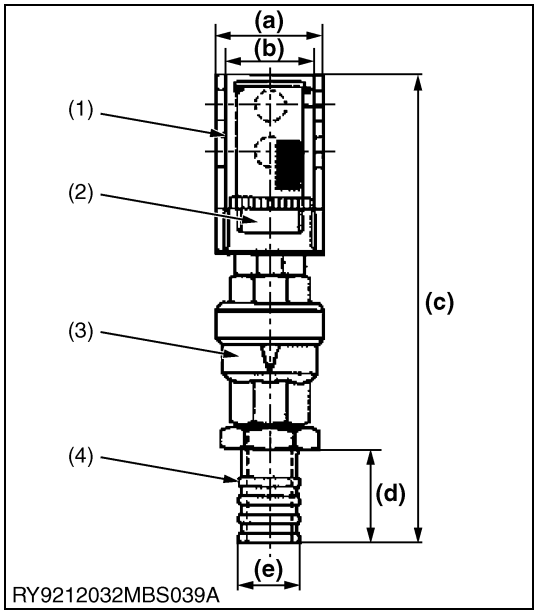
(1) Wire length (150 mm, 5.9 in.)
(2) Vinyl tube length (130 mm, 5.1 in.)
(3) Bolt
(4) Bolt
(5) Copper washer

RY9212032MBS0019US0

Pump cross-section

(1) Screw
(2) Washer-Spring
(3) Rotor
(4) Vane
(5) O-Ring
(6) End cover
(7) Body
(8) Seal
(9) Motor
(10) Label

RY9212032MBS0020US0



Fuel fill opening cross section

Item	Specifications
Voltage	DC12 V
Operating voltage limits	DC 9 to 15 V
Current requirements	18 A (suction height of 3 m, 100 in.)
Flow rate	35 L/min (DC voltage requirement 12V)
Suction height	6 m, 200 in. (Maximum total head)
Allowable limits	30 minutes with a surroundings temperature of 20 °C, 68 °F
	25 minutes with a surroundings temperature of 30 °C, 86 °F
	20 minutes with a surroundings temperature of 40 °C,104 °F
	The breaker will trip at 150 °C (302 °F). Can not be used while breaker is tripped.
Operating temperature range	–30 °C to +80 °C, –86 °F to +176 °F

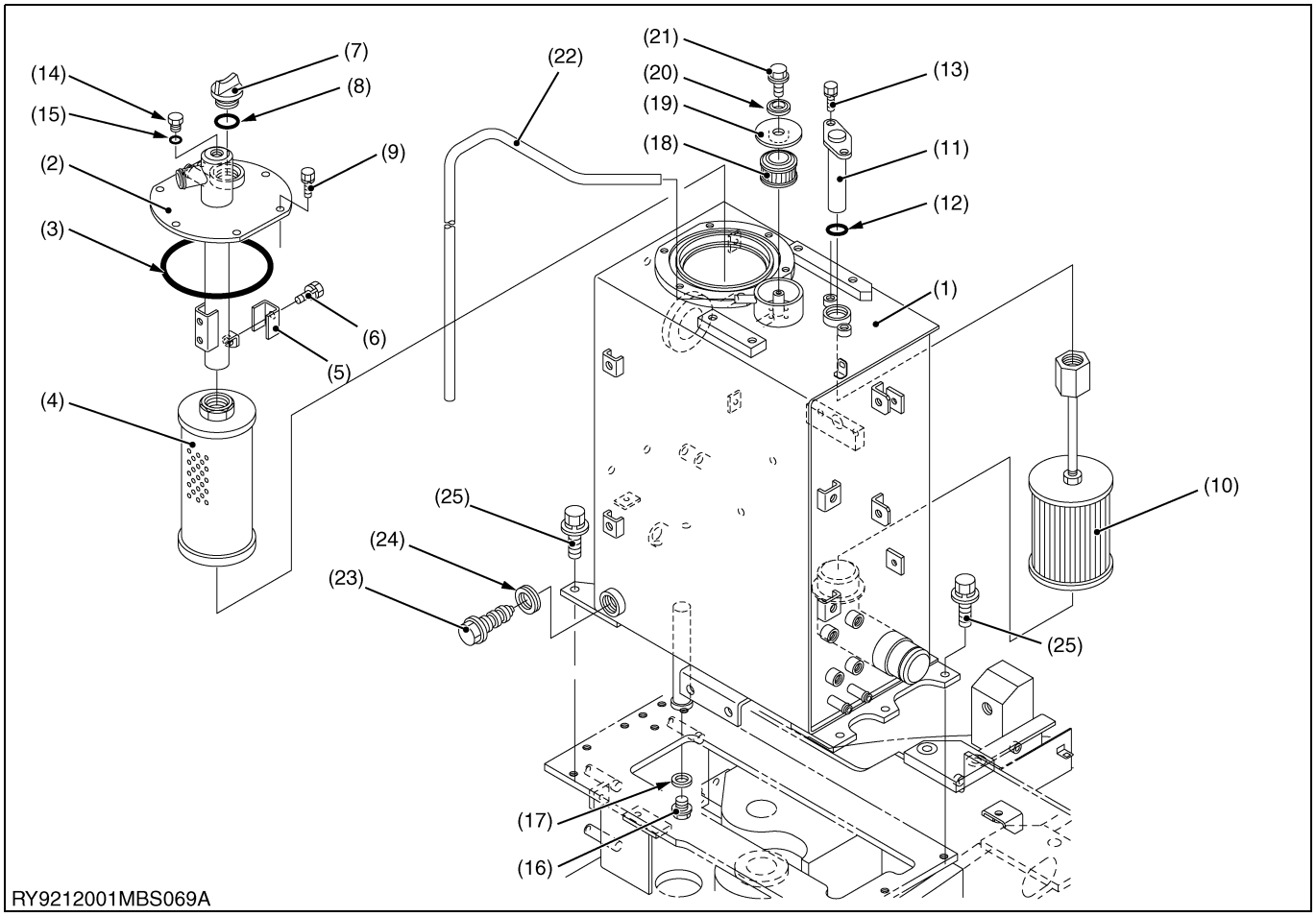
(1) Protector
(2) Strainer
(3) Check valve
(4) Hose adapter

(a) 34 mm, 1.3 in.
(b) 26 mm, 1.0 in.
(c) 155 mm, 6.1 in.
(d) 30 mm, 1.2 in.

RY9212032MBS0021US0

[3] HYDRAULIC OIL TANK

(1) Hydraulic oil tank components



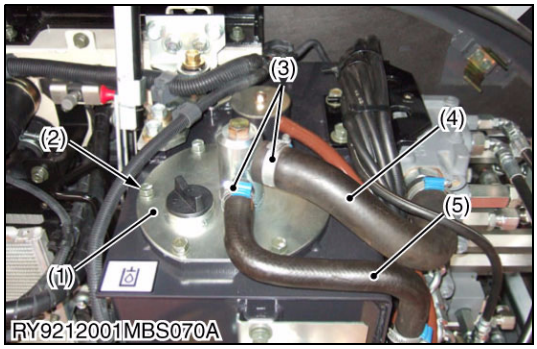
(1) Hydraulic oil tank
(2) Cover (tank)
(3) O-Ring
(4) Filter (return)
(5) Stopper (return filter)
(6) Bolt (M8 × 16)
(7) Plug (fill)
(8) O-Ring
(9) Bolt (M10 × 16)
(10) Filter, assy (suction)
(11) Pin (suction filter)
(12) O-Ring
(13) Bolt (M10 × 16)
(14) Plug (G1/4)
(15) O-Ring
(16) Plug
(17) Sealing washer
(18) Filter (blazer)
(19) Metal washer
(20) Sealing washer
(21) Flange holder
(22) Tube (blazer)
(23) Magnet plug
(24) Sealing washer
(25) Bolt (M12 × 30)

Tightening torque	Bolt (25)	77.5 to 90.2 N·m 7.9 to 9.2 kgf·m 57.2 to 66.5 lbf·ft

Apply thread locking compound (Loctite 271) to the bolt (25).

RY9212050MBS0030US0

(2) Hydraulic oil return filter replacement procedure

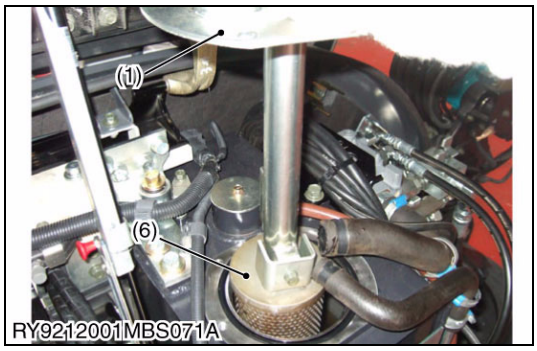


Removing the cover (tank)

1. Loosen the hose clamp (3), remove the hose (return) (4), hose (return, cooler) (5), from the cover (tank) (1) side.
2. Remove the cover (tank) (1) mounting bolt (2).

(1) Cover (tank)
(2) Bolt
(3) Hose clamp
(4) Hose (return)
(5) Hose (return, cooler)

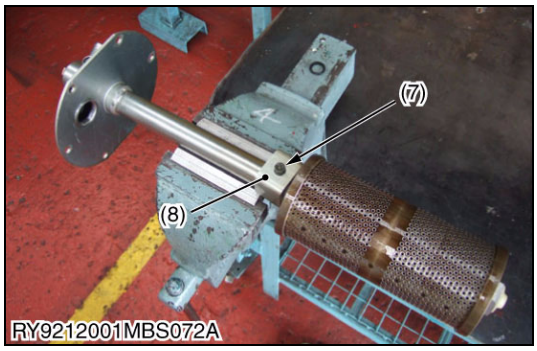
RY9212001MBS0052US0



3. Pull up the cover (tank) (1) and remove the filter (return) (6).

(1) Cover (tank)
(6) Filter (return)

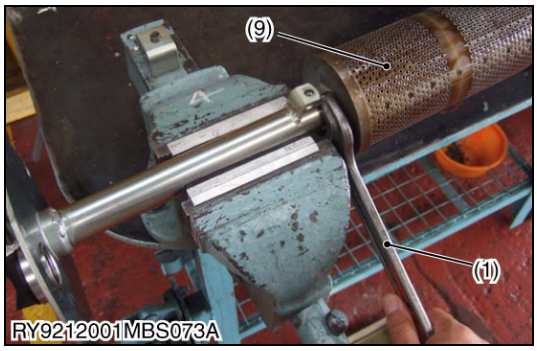
RY9212001MBS0053US0



4. Clamp in a vice, loosen the set bolt (7), and remove the stopper (8).

(7) Set bolt
(8) Stopper

RY9212001MBS0054US0

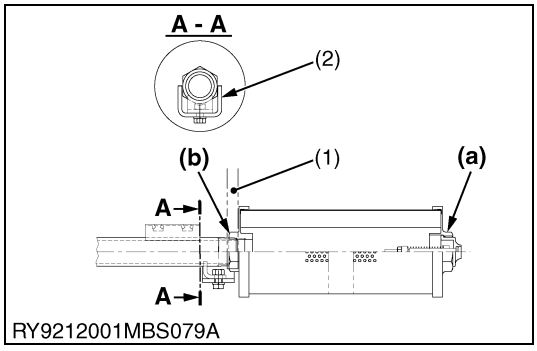


5. Remove the filter (return) (9) using a wrench (1).
   Wrench : 41 mm, 1.6 in. (two opposite faces)

Tightening torque	Filter (return) (9)	68.6 to 78.4 N·m 7.0 to 8.0 kgf·m 50.6 to 57.8 lbf·ft

CAUTION

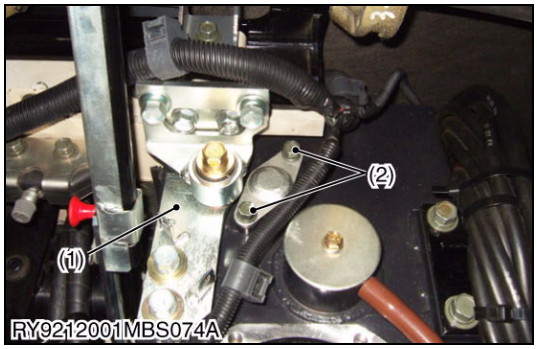
- **When tightening the filter (return), tighten with the wrench (1) on the nut (b) shown in the diagram to the left.**
  If the wrench (1) is placed on the nut on (a) side, the filter will break.
- **Assemble the filter so that opposite sides of the hexagonal part of the filter fully engages with the flat surfaces of the stopper (2).**



(1) Wrench
(2) Stopper
(9) Filter (return)

RY9212001MBS0055US0

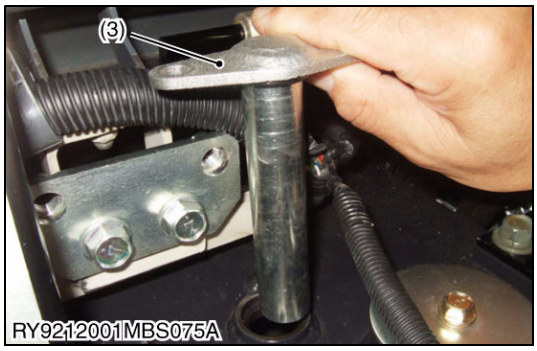
(3) Filter (suction) replacement procedure



1. Remove the filter (return) from the tank.
   (Refer to the chapter Filter (Return) Assembly/Disassembly.)
   Remove the bracket (1).

(1) Bracket (2) Bolt (M10 × 16)

RY9212001MBS0056US0



2. Remove the bolt and the suction filter mounting pin (3).

(3) Pin (suction)

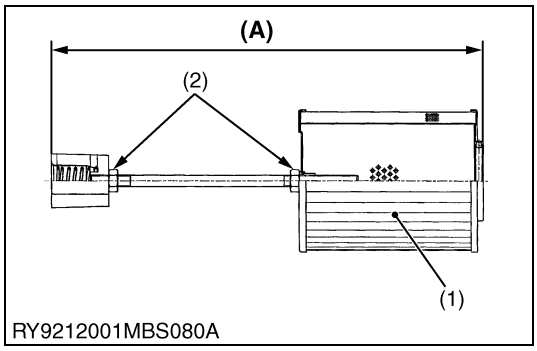
RY9212001MBS0057US0

3. Hold onto the upper part of the filter (support) and remove the filter (suction) (4) from the tank.

CAUTION

- **Remove only the strainer (1) and when replacing with a new part, set the overall length (A) to 380 mm (15 in.).**

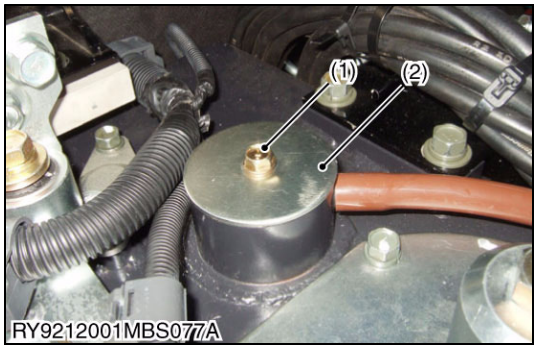
Tightening torque	Nut (2)	16 to 24 N·m 1.6 to 2.4 kgf·m 12 to 18 lbf·ft



(1) Strainer **(A) 380 mm, 15 in.**
(2) Nut
(4) Filter (suction)

RY9212050MBS0026US0

(4) Filter (breather) replacement procedure



1. Loosen the bolt (1), and remove the washer (2).

(1) Bolt (2) Metal washer

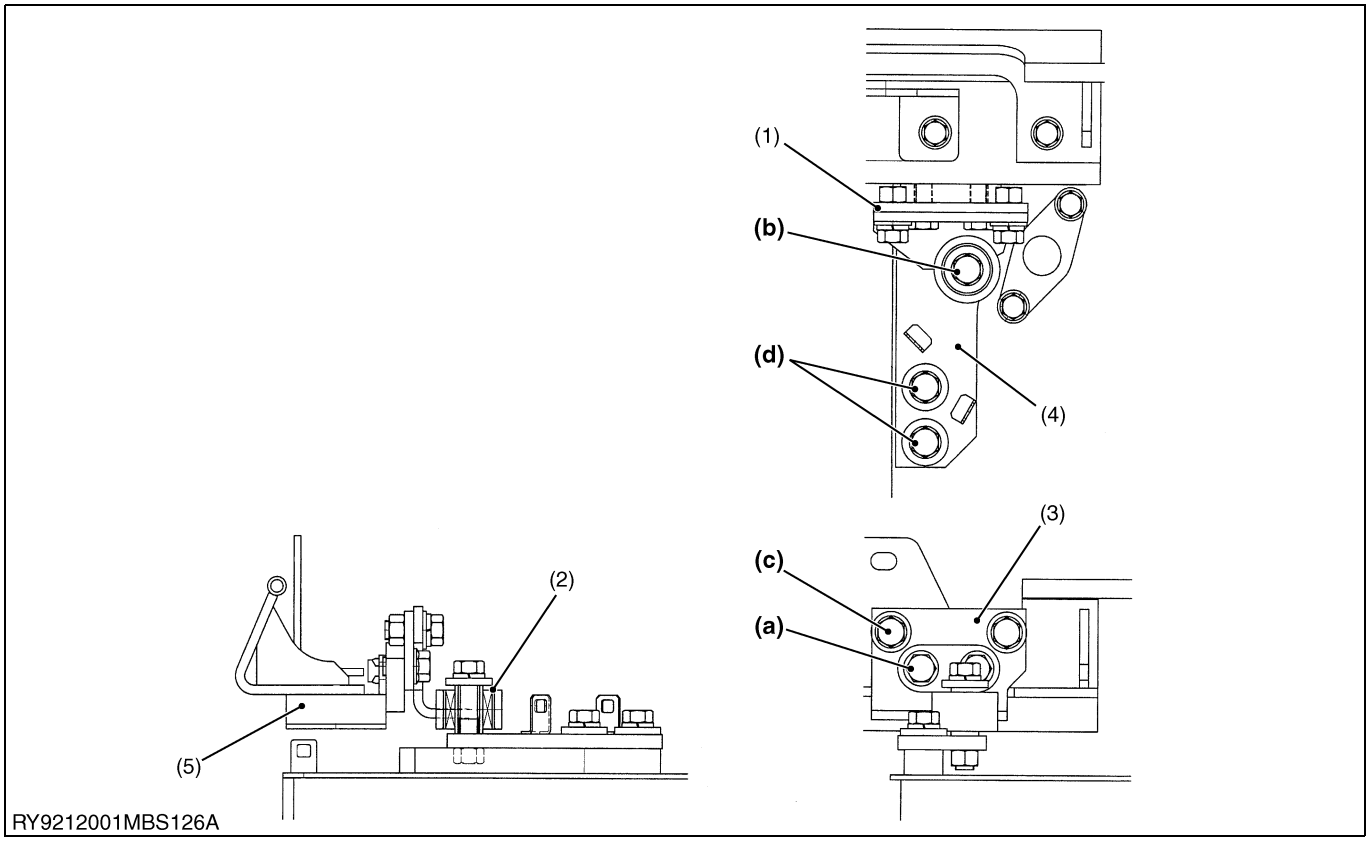
RY9212001MBS0059US0

2. Remove the filter (breather) (3) from the tank.

(3) Filter (breather)

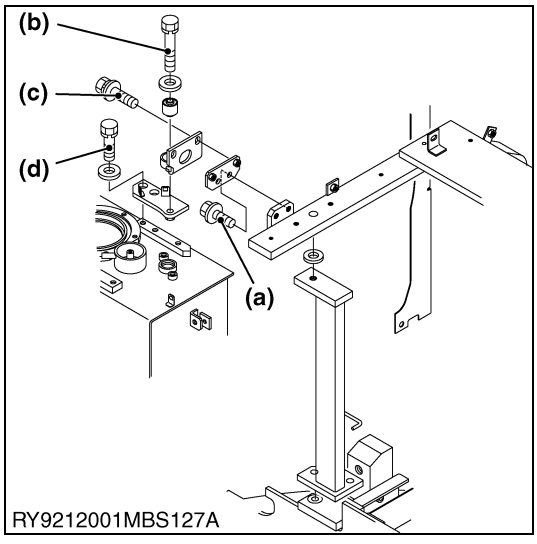
RY9212001MBS0060US0

(5) Assembly of anti vibration support for the hydraulic oil tank



(1) Plate (stay, oil tank)
(2) Anti-vibration rubber
(3) Stay (tank, anti-vibration)
(4) Base (tank, anti-vibration)
(5) Frame (arch)
(a) Flange bolt (M12 × 20)
(b) Bolt (M12 × 60)
(c) Bolt (M12 × 30)
(d) Bolt (M12 × 30)

RY9212001MBS0061US0



Tightening order for each bolt

The tightening order for each bolt is indicated using the letters **(a)** through **(d)** in the diagram to the left.

1. After assembly, fully tighten the **(a)** bolt to the arch.
2. Lightly tighten bolts **(b), (c), and (d)** together with the assembly of their associated components.
3. Tighten in the order of **(b)**→**(c)**→**(d)**.
4. Be sure the **(b)** bolt is assembled straight and not cross threaded.

Tightening torque	Bolts **(a) (b) (c) (d)**	77.5 to 90.2 N·m 7.9 to 9.2 kgf·m 57.2 to 66.5 lbf·ft

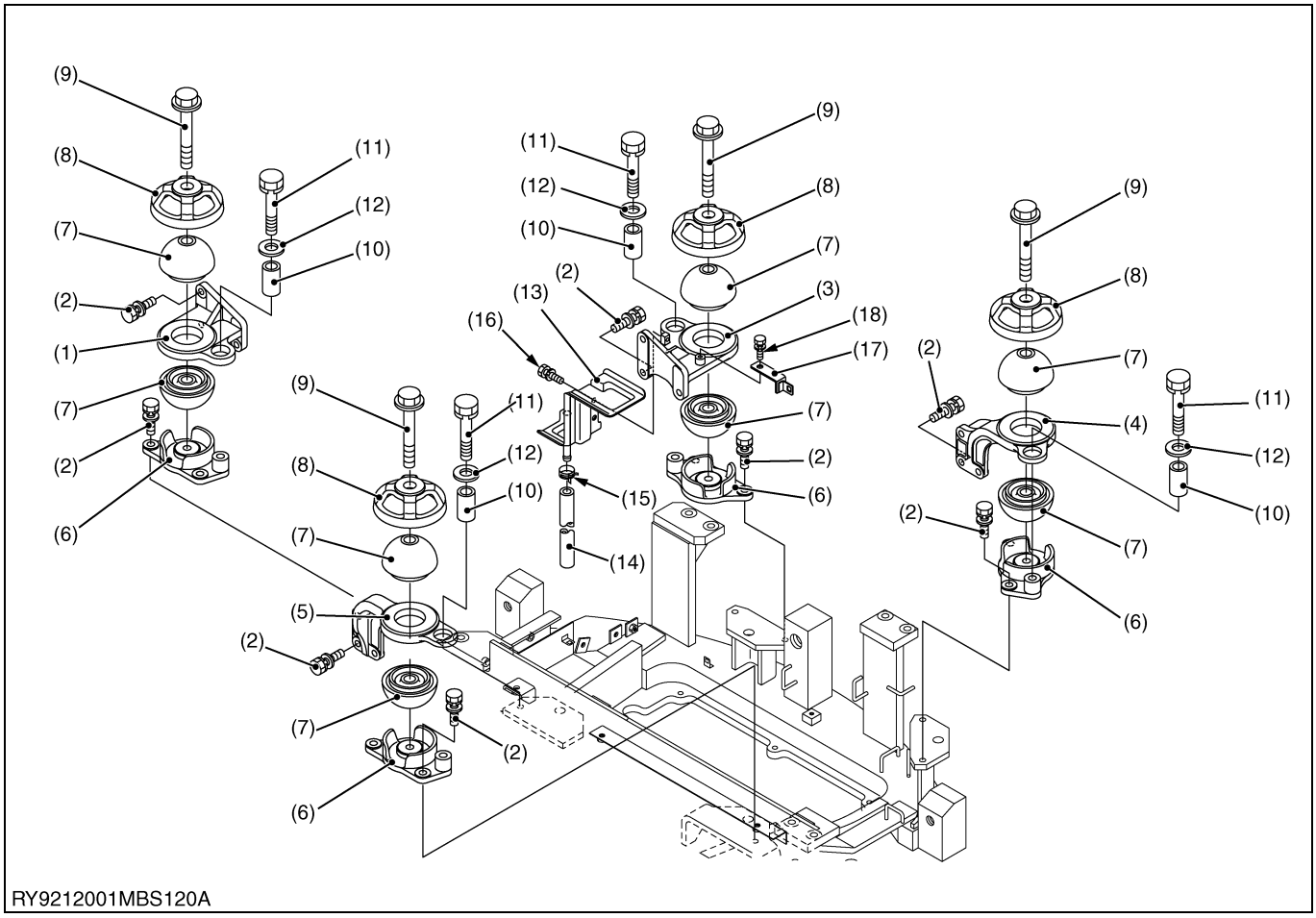
Apply thread locking compound (Loctite 271) to **(b)**.

RY9212001MBS0062US0

[4] ENGINE

(1) Engine mount

[A] Engine mount structural components



RY9212001MBS120A

(1) Bracket (1, engine)
(2) Bolt (M12 × 35)
(3) Bracket (2, engine)
(4) Bracket (3, engine)
(5) Bracket (4, engine)
(6) Support (engine)
(7) Anti-vibration rubber (450)
(8) Cap
(9) Bolt (M16 × 110)
(10) Collar
(11) Bolt (M16 × 70)
(12) Flat metal washer
(13) Tray (engine)
(14) Fuel tube
(15) Pipe clip
(16) Flat washer assembly bolt
(17) Stay (harness clamp)
(18) Flat washer assembly bolt

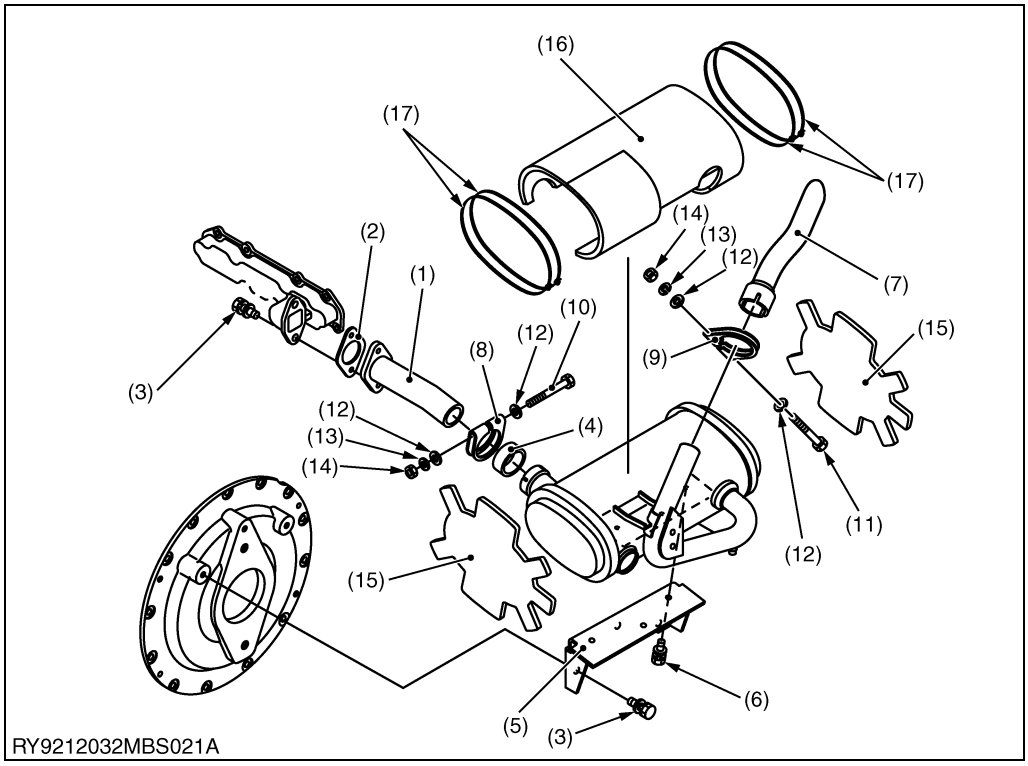
Tightening torque	Bolt (9)	196.1 to 225.6 N·m 20 to 23 kgf·m 144.7 to 166.3 lbf·ft

Apply thread locking compound (Loctite 271) onto part number (2), (9), (11) and (18).

RY9212050MBS0031US0

(2) Muffler

[A] Muffler structural components



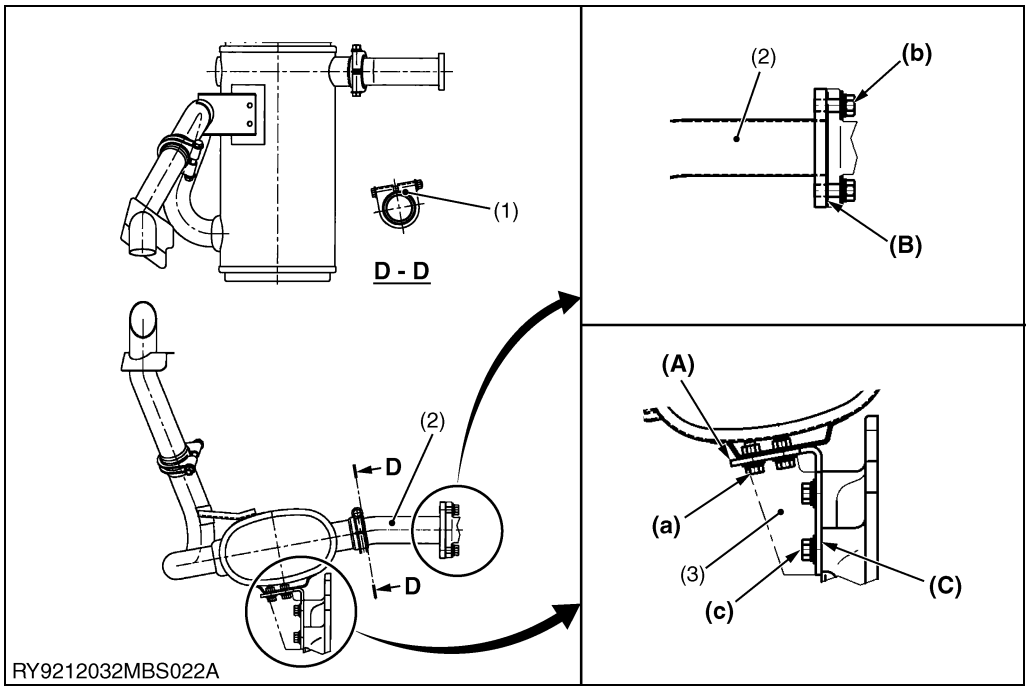
RY9212032MBS021A

(1) Flange (muffler)
(2) Gasket (muffler, NA)
(3) Bolt (M10 × 25)
(4) Gasket (muffler)
(5) Bracket (muffler)
(6) Bolt (M8 × 20)
(7) Pipe (muffler)
(8) Band (flange muffler)
(9) Band (muffler pipe)
(10) Bolt (M8 × 85)
(11) Bolt (M8 × 75)
(12) Flat metal washer
(13) Spring washer
(14) Nut
(15) Insulation (1, muffler)
(16) Insulation (2, muffler)
(17) Wire

RY9212032MBS0027US0

[B] Assembling of muffler

Assembling pipe (muffler) clamp



RY9212032MBS022A

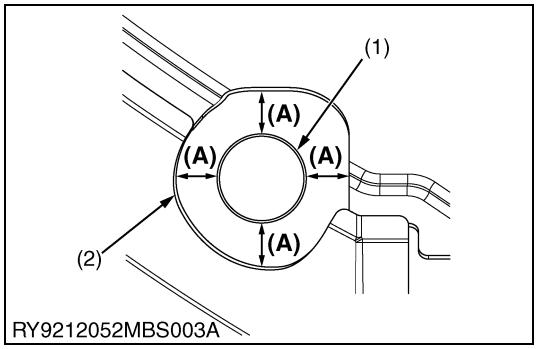
(1) Band (flange muffler)
(2) Flange (muffler)
(3) Bracket (muffler)

(a) Bolt
(b) Bolt
(c) Bolt
(A) X surface
(B) Y surface
(C) Z surface

Being careful not to dent or deform the tail pipe, tighten with the following torques.

Tightening torque	Band (flange muffler) (1)	3.9 to 5.9 N·m 0.4 to 0.6 kgf·m 2.9 to 4.3 lbf·ft

RY9212032MBS0028US0



RY9212052MBS003A

Assembly procedure for the muffler assy

1. Lightly tighten the bolts **(a)**, **(b)**, **(c)**.

CAUTION

- **Be sure there are not any gaps on the X surface, Y surface, or Z surface.**

2. Tighten the **(a)** bolt.
3. Tighten the **(b)** bolt.
4. Tighten the **(c)** bolt.

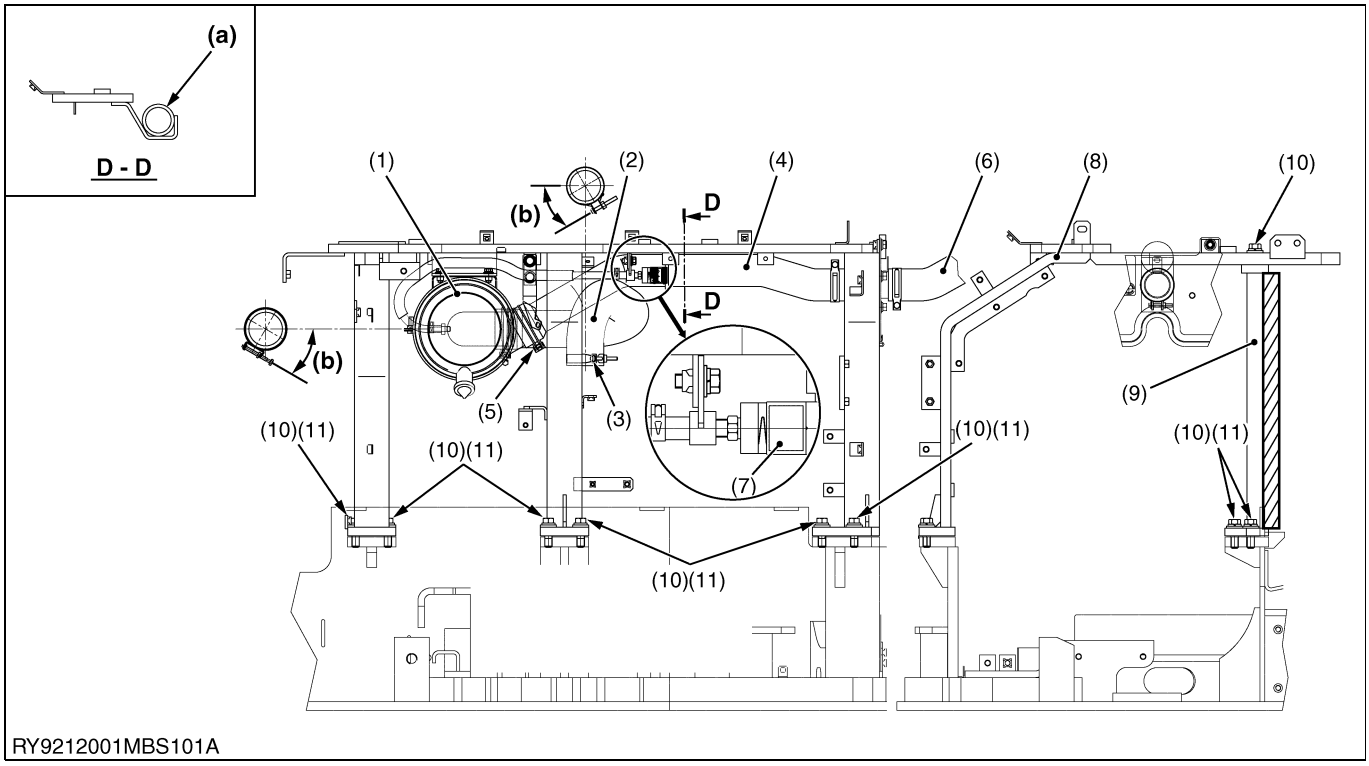
(1) Tail pipe
(2) Bonnet

(A) Clearance 15 mm, 0.59 in. ≤

RY9212052MBS0003US0

(3) Arch, Air cleaner

[A] Assembling the Arch and Air Cleaner

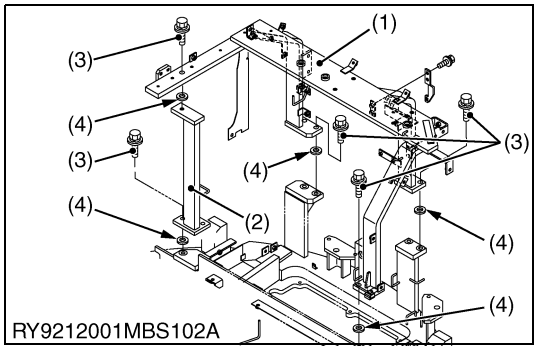


RY9212001MBS101A

(1) Air cleaner, assy
(2) Hose (inlet)
(3) Hose clamp (with screw)
(4) Hose (1, inlet)
(5) Pipe band
(6) Hose (3, inlet)
(7) Indicator
(8) Frame (arch)
(9) Frame (2, arch)
(10) Bolt (M14, arch)
(11) Collar (arch)

(a) Place in the frame (arch) guide
(b) 30 °

RY9212001MBS0082US0



RY9212001MBS102A

Assembling the Arch

There is a counter bore in the arch mounting area on the swivel frame and it has a structure where a collar (arch) (4) is inserted and joined with the arch.

Be careful not to lose the collar (arch) (4) when disassembling and reassembling and tighten using the following torque.

Tightening torque	Bolt (3)	123.6 to 147.1 N·m 12.6 to 15.0 kgf·m 91.17 to 108.4 lbf·ft

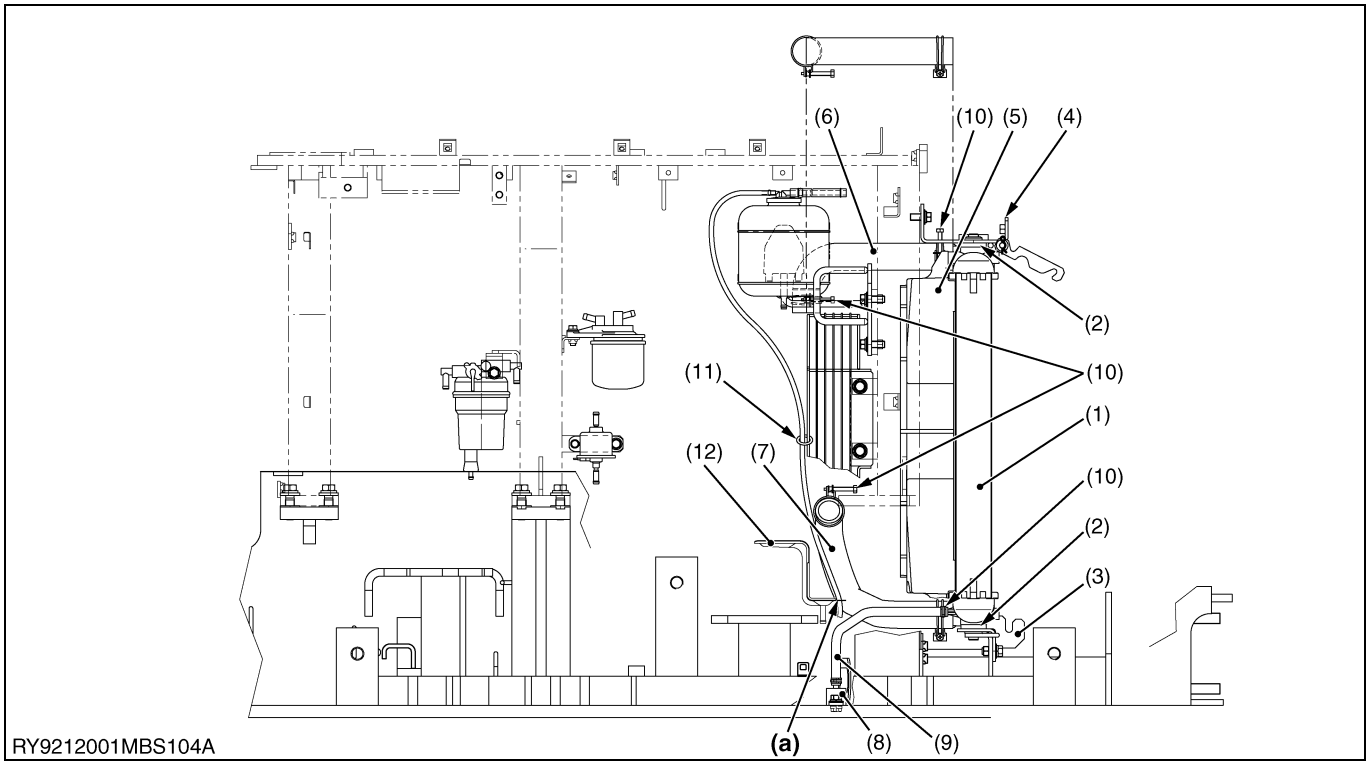
Apply thread lock compound (Loctite 271).

(1) Frame (arch)
(2) Frame (2, arch)
(3) Bolt (M14, arch)
(4) Collar (arch)

RY9212050MBS0027US0

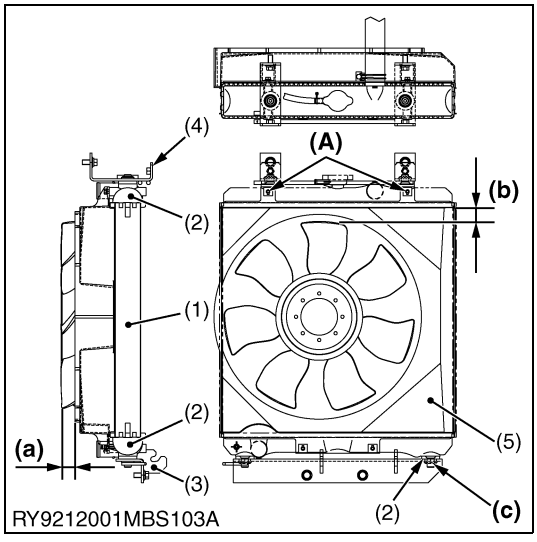
(4) Radiator

[A] Assembling of the Radiator



(1) Radiator, ASSY
(2) Rubber (radiator mount)
(3) Bracket (1, radiator)
(4) Bracket (2, radiator)
(5) Shroud (fan)
(6) Hose (upper, WP)
(7) Hose (lower, WP)
(8) Coupler (drain)
(9) Hose (drain)
(10) Clamp
(11) Cord band
(12) Tray (engine oil)
(a) Pass through hole

RY9212001MBS0084US0



Assembling the Shroud (fan)

Tightening torque	Bolt **(A)**	4.5 to 5.5 N·m 0.46 to 0.56 kgf·m 3.4 to 4.0 lbf·ft

(1) Radiator, ASSY
(2) Rubber (radiator mount)
(3) Bracket (1, radiator)
(4) Bracket (2, radiator)
(5) Shroud (fan)

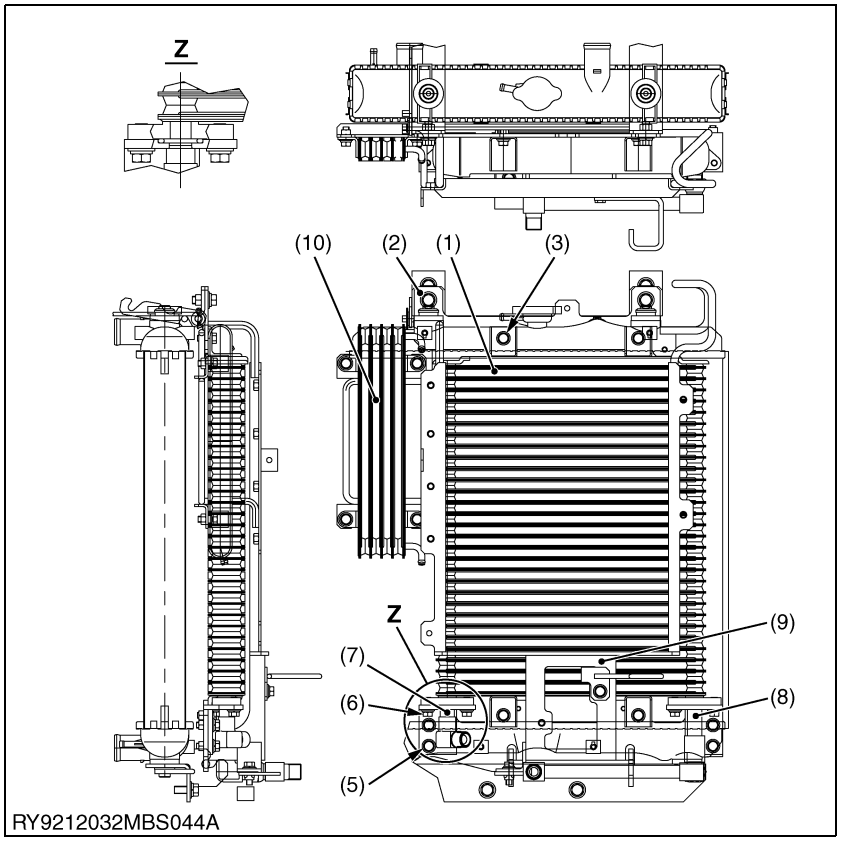
(A) Bolt (M6 × 16)

(a) Tolerance from shroud (fan) to fan : 30 ± 3 mm, 1.2 ± 0.1 in.
(b) Gap between fan and shroud (fan) at least 10 mm, 0.4 in.
(c) Be sure that the tab is fully inserted into the hole in the bracket.

RY9212001MBS0085US0

(5) Oil cooler

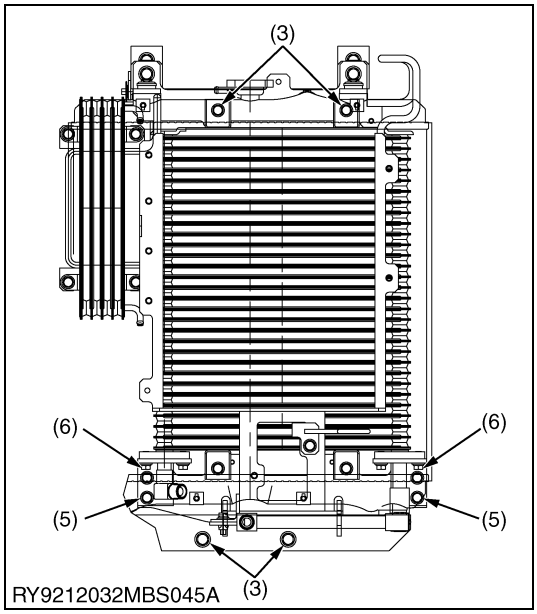
[A] Assembling of the Oil Cooler



RY9212032MBS044A

(1) Oil cooler
(2) Bracket (oil cooler)
(3) Bolt (M8 × 20)
(4) Flat metal washer
(5) Bolt (M8 × 25)
(6) Bolt (M8 × 20)
(7) Pipe joint (oil cooler, L)
(8) Pipe joint (oil cooler, R)
(9) Guide (hose, PP)
(10) Cooler (fuel)

RY9212032MBS0029US0



RY9212032MBS045A

Oil cooler assembly procedure

1. Lightly tighten bolts (3), (5), and (6).
2. Tighten bolt (6).

Tightening torque	Bolt (6)	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.1 to 15.1 lbf·ft

3. Tighten bolt (3).

Tightening torque	Bolt (3)	9.8 to 11.3 N·m 1.0 to 1.15 kgf·m 7.3 to 8.3 lbf·ft

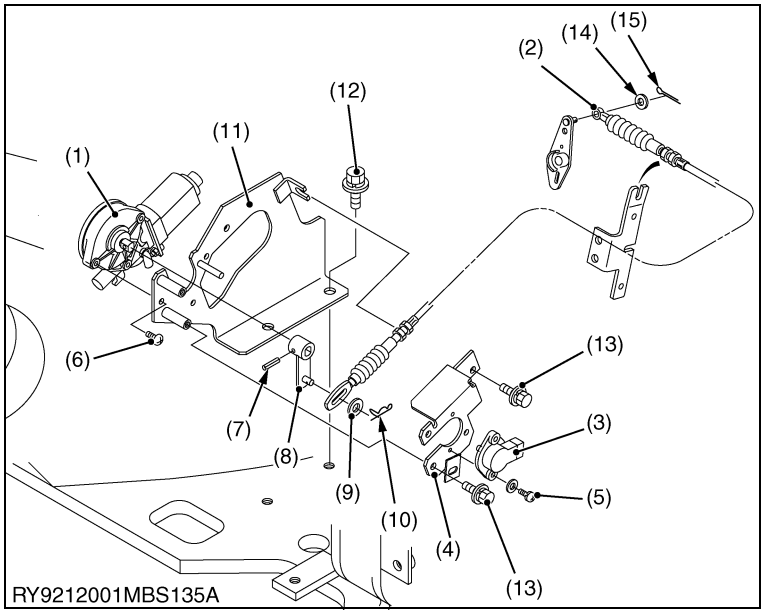
4. Tighten bolt (5).

Tightening torque	Bolt (5)	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.2 lbf·ft

(3) Bolt (M6 × 14)
(5) Bolt (M8 × 25)
(6) Bolt (M8 × 20)

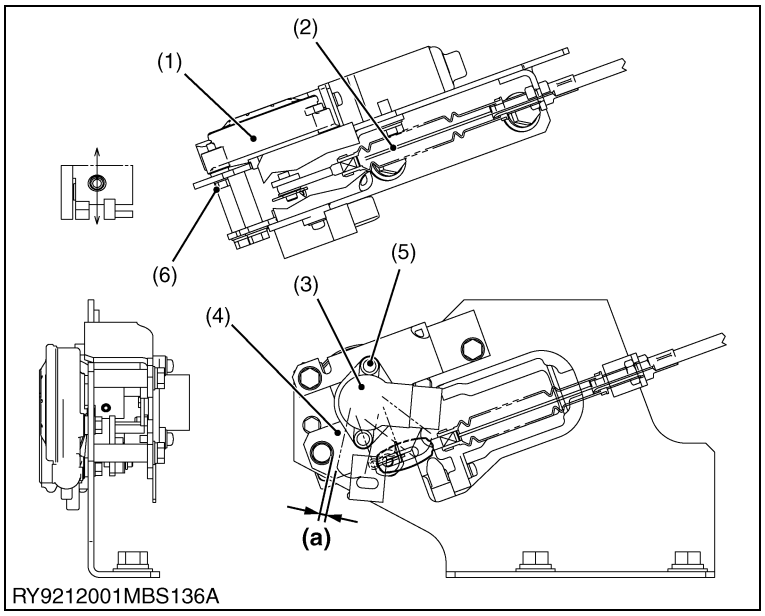
RY9212032MBS0030US0

(6) Accelerator cable



(1) Motor ASSY (AI)
(2) Cable (accelerator)
(3) Sensor (accelerator)
(4) Bracket (sensor, AI)
(5) Washer head machine screw
(6) Machine screw (taptite)
(7) Spring Pins
(8) Rod (AI motor)
(9) Flat metal washer
(10) Snap pin (6, with bleed prevention)
(11) Bracket (AI motor)
(12) Bolt (M10 × 20)
(13) Bolt (M6 × 16)
(14) Flat metal washer
(15) Cotter pin

RY9212001MBS0088US0



(1) Motor ASSY (AI)
(2) Cable (accelerator)
(3) Sensor (accelerator)
(4) Bracket (sensor, AI)
(5) Washer head machine screw
(6) Machine screw (taptite)

(a) Gap of at least 1 mm (0.04 in.) at max engine speed

RY9212001MBS0089US0

Motor, assy (AI) tightening torque

Tightening torque	Bolt (12)	2.45 to 3.92 N·m 0.25 to 0.40 kgf·m 1.81 to 2.89 lbf·ft

RY9212050MBS0028US0

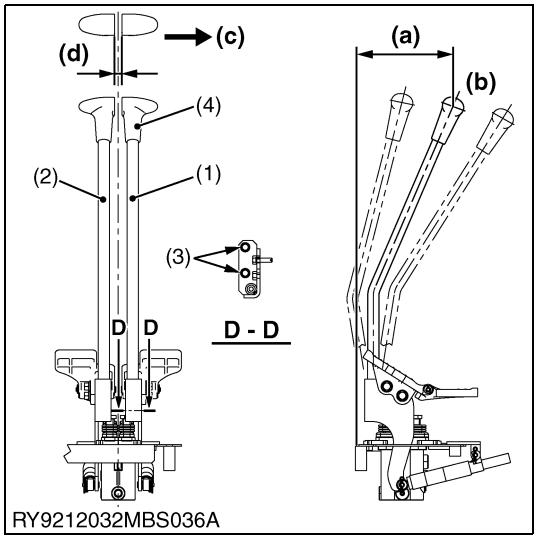
Sensor (accelerator) tightening torque

Tightening torque	Bolt (5)	1.47 to 1.96 N·m 0.15 to 0.20 kgf·m 1.09 to 1.94 lbf·ft

RY9212050MBS0029US0

[5] ASSEMBLING OF OPERATING LEVERS

(1) Travel lever

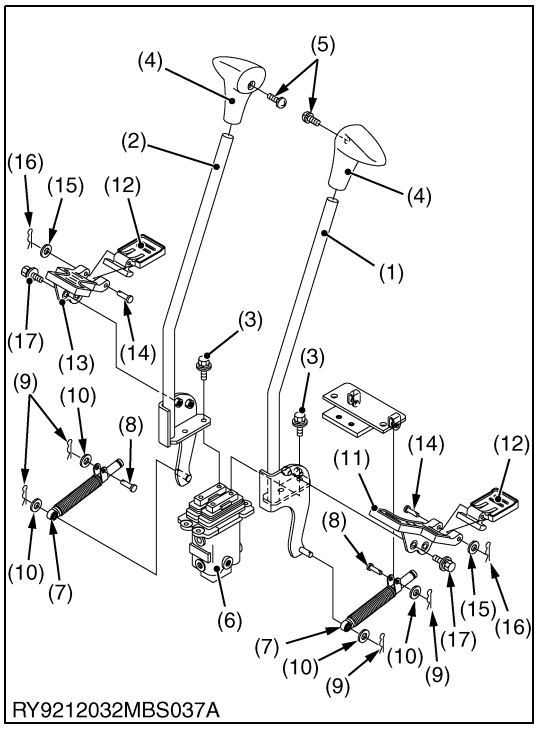


RY9212032MBS036A

(1) Lever (travel, left)
(2) Lever (travel, right)
(3) Bolt (M8 × 20)
(4) Grip (travel)

(a) 193 ± 5 mm, 7.6 ± 0.2 in.
(b) When in neutral
(c) To-and-fro difference between left and right levers should be within 2 mm, 0.08 in.
(d) Gap between left and right levers : 11 to 22 mm, 0.43 to 0.87 in.

RY9212032MBS0031US0



RY9212032MBS037A

Lever (travel, left), lever (travel, right) assembly

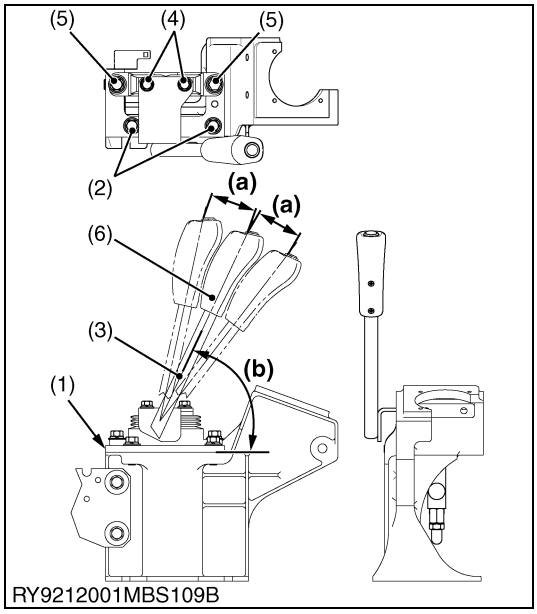
The pilot valve side is aluminum die cast so be careful not to over tighten; tighten to the torques indicated below.

Tightening torque	Bolt (3)	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.1 to 15.1 lbf·ft

(1) Lever (travel, left)
(2) Lever (travel, right)
(3) Bolt (M8 × 20)
(4) Grip (travel)
(5) Washer head bolt
(6) Valve, assy (PV, travel)
(7) Damper (HST)
(8) Headed pin
(9) Snap pin 8
(10) Flat metal washer
(11) Pedal assy (travel left)
(12) Pedal (travel 2)
(13) Pedal assy (travel right)
(14) Headed pin
(15) Flat metal washer
(16) Snap pin
(17) Bolt (M10 × 25)

RY9212032MBS0032US0

(2) Blade lever

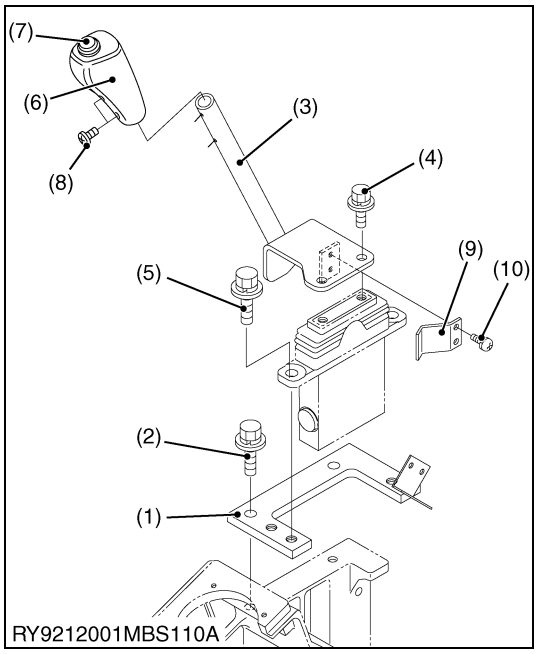


RY9212001MBS109B

(1) Plate (blade)
(2) Bolt (M10 × 30)
(3) Lever (blade)
(4) Bolt (M8 × 16)
(5) Bolt (M10 × 25)
(6) Grip (two gears)

(a) 60 mm, 2.4 in.
(b) 65 °

RY9212001MBS0094US0



RY9212001MBS110A

Assembling the lever (blade)

Tightening torque	Lever (blade) (3)	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.2 lbf·ft

(1) Plate (blade)
(2) Bolt (M10 × 30)
(3) Lever (blade)
(4) Bolt (M8 × 16)
(5) Bolt (M10 × 25)
(6) Grip (two gears)
(7) Button (switch, green)
(8) Pan head machine screw
(9) Plate spring (capacitor)
(10) Washer head machine screw

RY9212001MBS0095US0

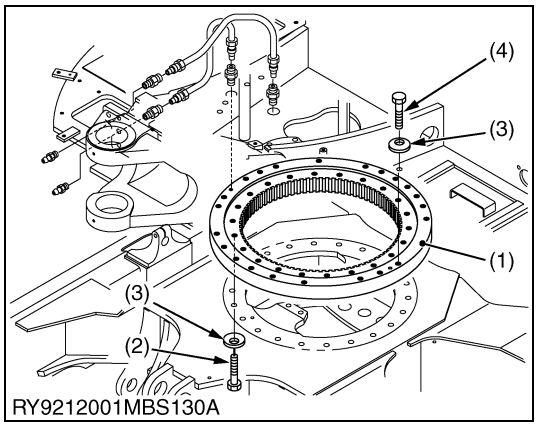
Assembling the plate (blade)

Tightening torque	Plate (blade) (1)	39.2 to 45.1 N·m 4.0 to 4.6 kgf·m 29.0 to 33.2 lbf·ft

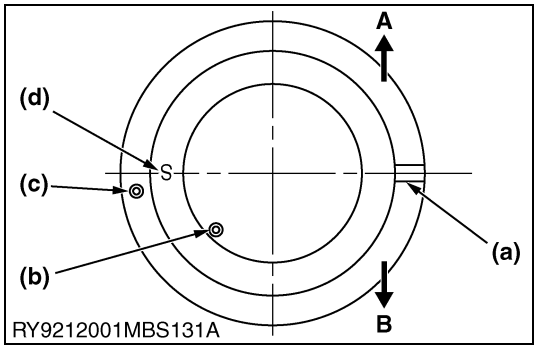
RY9212001MBS0096US0

2. TRACK FRAME

[1] ASSEMBLING OF SWIVEL BEARING



RY9212001MBS130A



RY9212001MBS131A

(1) Swivel bearing assembly procedure

1. Component names

No. in Figure	Component names	Q'ty
(1)	Bearing (swivel)	1
(2)	Bolt (M16 × 60)	24
(3)	Diaphragm spring	48
(4)	Bolt (M16 × 55)	24

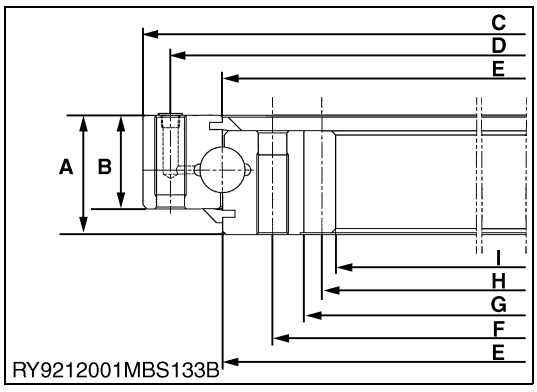
2. Assembly position
   Mount the inner tire soft zone ('S' mark) **(d)** on the right side of the body.
3. Swivel bearing tightening torque
   After lightly tightening, tighten to the torque indicated below from a diagonal angle.

Tightening torque	Swivel bearing (1)	259.9 to 304 N·m 26.5 to 31 kgf·m 191.7 to 224 lbf·ft

   Apply thread lock compound. (Loctite 271)
4. Apply grease to the tooth surfaces
   Apply grease so that it covers the entire bearing teeth surfaces.

(a) Ball insert groove (external tire soft zone)
(b) Tooth surface grease application zone
(c) Port for applying grease to the ball (mate with hole in swivel frame)
(d) 'S' Mark
A : Rear of vehicle
B : Front of vehicle

RY9212032MBS0003US0



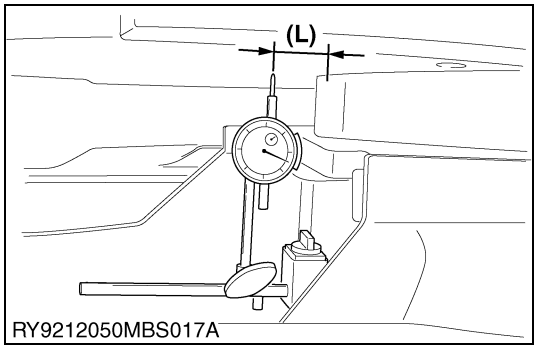
RY9212001MBS133B

(2) Swivel bearing external dimensions

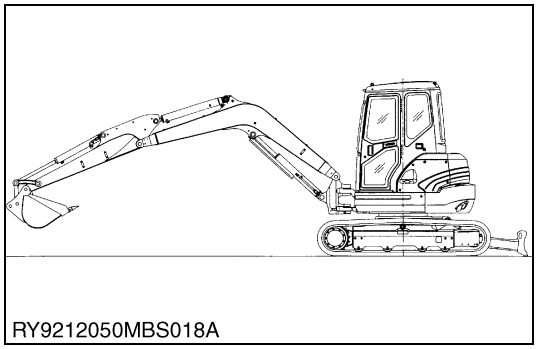
No. in Figure	Size
A	60 mm, 2.4 in.
B	47 mm, 1.8 in.
C	ϕ770 mm, ϕ30.3 in.
D	P.C.D. 742 mm, P.C.D. 29.2 in.
E	ϕ689 mm, ϕ27.1 in.
F	P.C.D. 638 mm, P.C.D. 25.1 in.
G	ϕ610 mm, ϕ24 in.
H	P.C.D. 588 mm P.C.D. 23.1 in.
I	ϕ574 mm, ϕ22.6 in.

RY9212032MBS0004US0

RY9212050MBS016A



RY9212050MBS017A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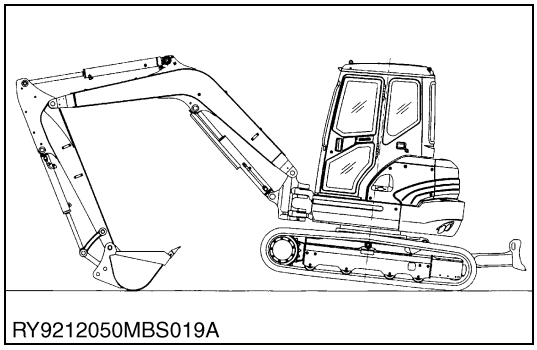

RY9212050MBS019A

(3) Measuring the swivel bearing play

1. Attach the dial gauge and the dial gauge fixture on the machine front. (Measurement position differs with the machine model.)
2. Fully stretch the arm and place the bucket in the crowded position. Set the dial gauge to the zero point.
3. Using the attachment, tilt up the machine body, and take the dial gauge reading. Make this measurement several times and take their average as the final measurement.

CAUTION

- **Perform the measurement three times, determine the average value, and take this as the measured value.**

(L) : 20 mm (0.79 in.) away from swivel race	Factory spec.	KX057-4	1.08 mm 0.04 in.
	Allowable limit	KX057-4	2.16 mm 0.09 in.

(L) Measurement position

RY9212032MBS0040US0

[2] TRACK

(1) Assembly / disassembly of rubber track

CAUTION

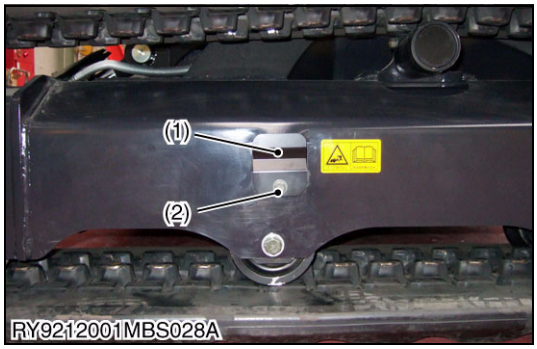
- **The pressure in the grease cylinder is high so if loosened quickly, the nipple may pop off and the highly pressurized grease in the cylinder may fly out so do not get your face near the nipple nor place your body in front of the nipple and loosen the nipple gradually.**

RY9212001MBS0008US0

WARNING

- **The excavator is equipped with an overload warning system.**
  When changing from rubber crawlers to steel crawlers or vice versa it is necessary to change the overload warning setting.
  Overload warning doesn't operate normally, and it could result in death or serious injury if Pre-set code is not correctly set.
  After setting, confirm overload warning operates normally based on Boom Overload Alarm Check Method. (Refer to "Overload Warning System" at "ELECTRICAL SYSTEM" Section.)

RY9212052MBS0013US0



Removing the grease nipple

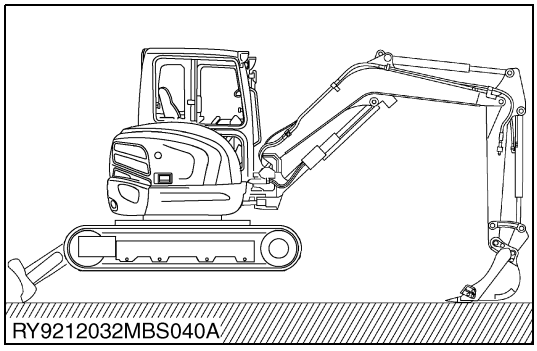
1. Remove one bolt (2) and then the cover (1).

2. Place a wrench (socket) at the base of the grease nipple and loosen slowly.
   If there is a rock etc. caught in the sprocket, remove the rock first.

Tightening torque	Grease nipple	98 to 107.8 N·m 10 to 11 kgf·m 73 to 79.5 lbf·ft

(1) Cover
(2) Bolt (M10)
(3) Grease nipple

RY9212001MBS0016US0



Loosen track

1. Jack up the body using the front end and blade, expel grease from inside the grease cylinder, and fully loosen up the track.
   When the track loosens up, attach the grease nipple.

RY9212032MBS0008US0

Removing the rubber tracks

1. Lift the body slightly and move the track in the forward direction **A**.
   Slide the track in the sideways direction at the front idler to remove it.
   Weight of rubber track : approximately 240 kg (529 lbs)

A : Forward direction **B : Slide direction**

RY9212032MBS0033US0

Assembling rubber tracks

1. Jack up the mini-excavator with the front-end and the blade and assemble the track starting at the sprocket.

CAUTION
- **Make sure to assemble the rubber track in the correct orientation.**

2. With the mini-excavator lifted slightly, hold the rubber track with your hand on the outside, slowly turn it in the forward direction, and set it on the stepped area of the front idler.

CAUTION
- **Watch carefully to prevent your hands and legs from getting caught.**
- **Lower the mini-excavator, drive it backwards to make sure the tracks are on securely.**

RY9212032MBS0034US0

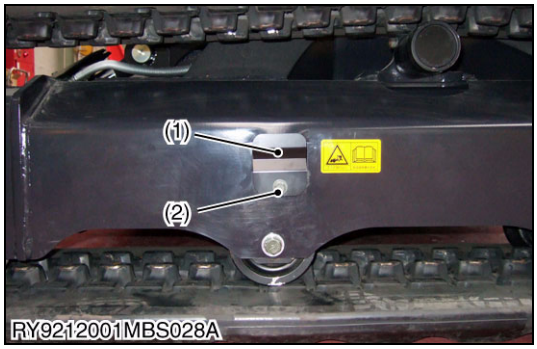
(2) Assembly / disassembly of iron tracks

CAUTION
- **The pressure in the grease cylinder is high so if loosened quickly, the nipple may pop off and the highly pressurized grease in the cylinder may fly out so do not get your face near the nipple nor place your body in front of the nipple and loosen the nipple gradually.**

RY9212001MBS0008US0

WARNING
- **The excavator is equipped with an overload warning system.**
  When changing from rubber crawlers to steel crawlers or vice versa it is necessary to change the overload warning setting.
  Overload warning doesn't operate normally, and it could result in death or serious injury if Pre-set code is not correctly set.
  After setting, confirm overload warning operates normally based on Boom Overload Alarm Check Method. (Refer to "Overload Warning System" at "ELECTRICAL SYSTEM" Section.)

RY9212052MBS0013US0



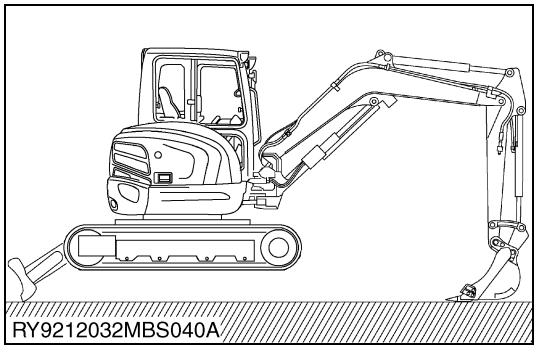
Removing the grease nipple

1. Remove one bolt (2) and then the cover (1).

2. Place a wrench (socket) at the base of the grease nipple and loosen slowly.
   If there is a rock etc. caught in the sprocket, remove the rock first.

(1) Cover
(2) Bolt (M10)
(3) Grease nipple

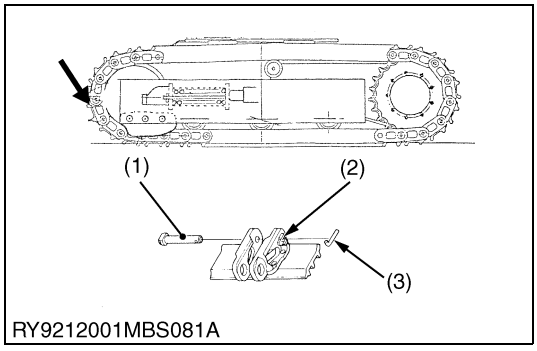
RY9212001MBS0009US0



Loosen track

1. Jack up the body using the front end and blade, expel grease from inside the grease cylinder, and fully loosen up the track. When the track loosens up, attach the grease nipple.

RY9212032MBS0008US0

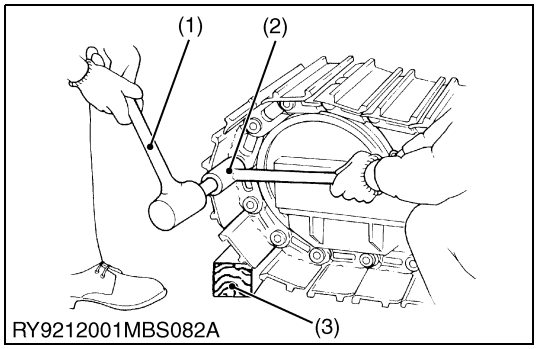


Removing the locking pin

1. Turn the track until the master pin (1) is in front of the front idler.
2. Remove the locking pin (3) from the master pin.

(1) Master pin
(2) Master link
(3) Locking pin

RY9212001MBS0103US0

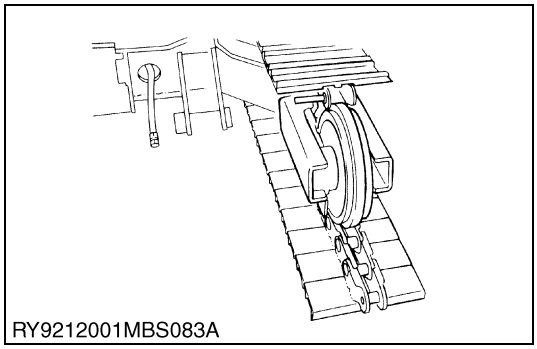


Removing the master pin

1. Place a jig on the master pin and tap it out with a hammer.
   Use a jig as shown in the diagram to the left for removing the pin.

(1) Hammer
(2) Jig
(3) Block

RY9212001MBS0104US0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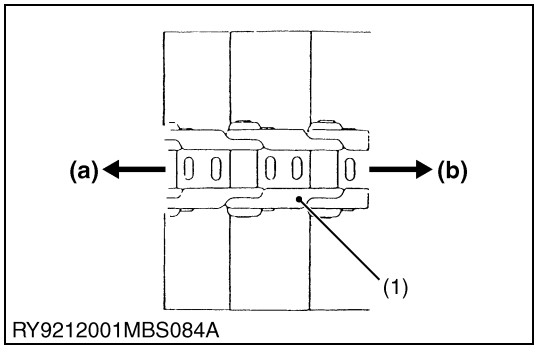

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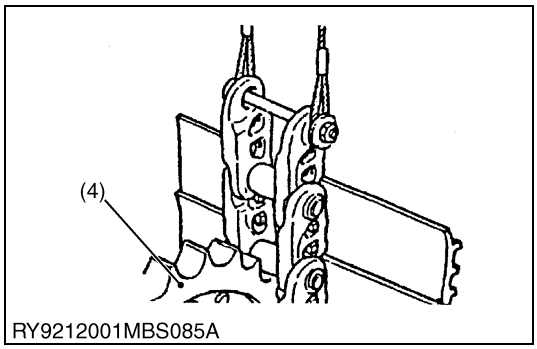

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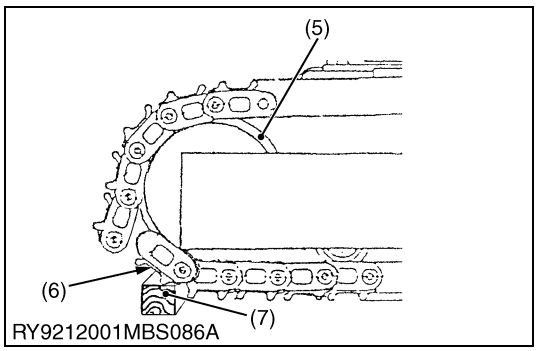


RY9212001MBS086A

Removing the shoe

1. Slowly move the travel lever to the backup position and back up the mini-excavator.
2. Jack up the mini excavator using the front end and blade and pull off the shoe.

DANGER
- **Do not place feet under the mini excavator.**
- Weight of iron track : approximately 285 kg (628 lbs)

RY9212001MBS0105US0

Mounting an iron track

1. Jack up the mini excavator using the front end and blade and place the track so that the end of the track meshes with the sprocket under the mini excavator.
   Make sure the track is placed in the correct orientation.

(1) Master link
(a) Sprocket side
(b) Front idler side

RY9212001MBS0106US0

2. Raise the track using a crane and mesh it with the sprocket teeth.

(4) Sprocket

RY9212001MBS0107US0

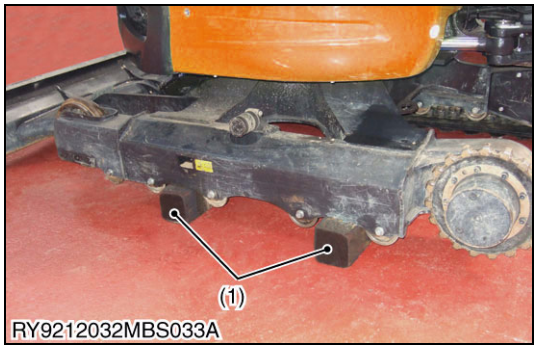
3. Slowly move the travel lever to the forward travel position to mesh the track with the shoe (6).
   When the track is sufficiently pulled on to where the track link joint is at the front idler, lower the mini-excavator, and place a block (7) under the shoe to support the shoe.
   Match up both ends of the shoe, insert the master pin from the outside of the body, insert the locking pin and bend the tip.

(5) Idler
(6) Shoe
(7) Block

RY9212001MBS0108US0

[3] FRONT IDLER

(1) Assembly/disassembly of front idler



Removing the idler

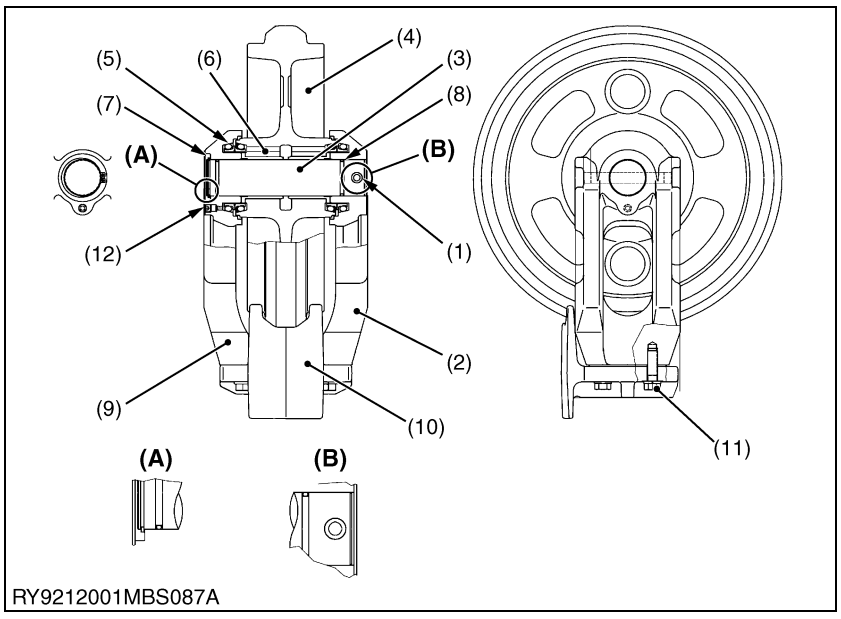
1. Remove the track.
   (Refer to the chapter "Track Assembly/Disassembly".)
   Jack up the mini-excavator with the front-end and the blade and place timbers etc. under the frame.

2. Using a bar, remove the front idler from the track frame along with the yoke.
   - Front idler assy weight : approximately 46 kg (100 lbs)

(1) Block

RY9212032MBS0035US0

(2) Front idler structural components



No.	Component names	Q'ty
(1)	Spring Pins	1
(2)	Bracket (R)	4
(3)	Shaft (idler)	1
(4)	Idler	1
(5)	Floating Seal	2
(6)	Bushing	1
(7)	External circlip	2
(8)	O-Ring	2
(9)	Bracket (L)	1
(10)	Plate (yoke)	1
(11)	Bolt	1
(12)	Plug (R1/8)	1

RY9212001MBS0112US0

[4] SPRING ASSY

(1) Assembly/disassembly of spring assy

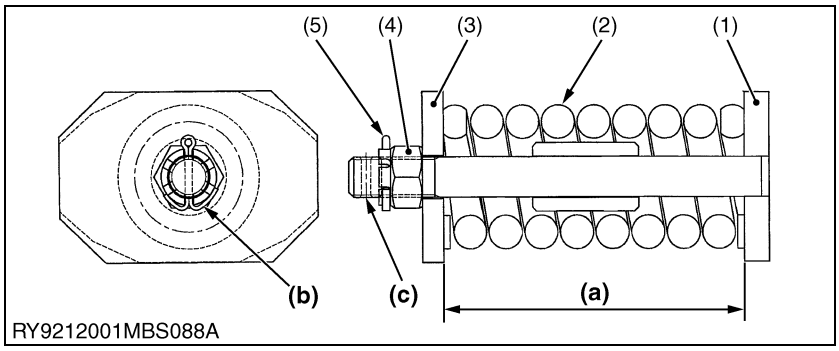
Removing the spring assy

1. Remove the track and the front idler.
   (Refer to the "Track and Front Idler" chapters for assembly/disassembly of the track and front idler.)
   After removing the front idler assy, pull out the spring assy (1) from the track frame.
   - Spring assy weight : approximately 17 kg (37 lbs)

(1) Spring assy

RY9212001MBS0113US0

Rubber track specification

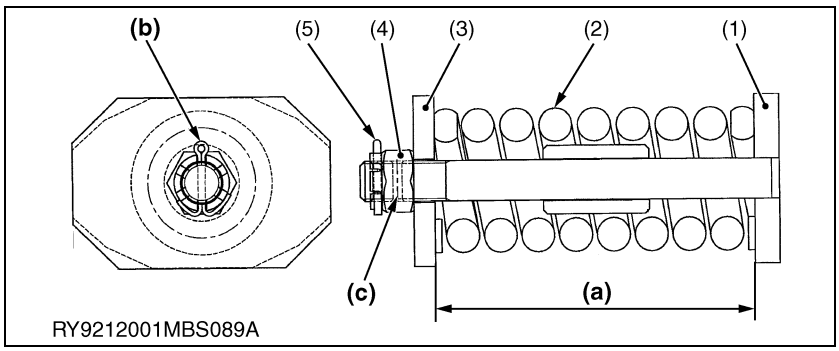


No.	Component names	Q'ty
(1)	Bolt (spring)	1
(2)	Spring	1
(3)	Retainer (spring)	1
(4)	Slotted nut	1
(5)	Cotter pin	1

(a) Set length for rubber track : 227.5 mm, 8.96 in.
(b) Make sure the cotter pin is set in the groove of the slotted nut
(c) Set position for iron track specifications

RY9212001MBS0114US0

Iron track specifications



No.	Component names	Q'ty
(1)	Bolt (spring)	1
(2)	Spring	1
(3)	Retainer (spring)	1
(4)	Slotted nut	1
(5)	Cotter pin	1

(a) Set length for iron track : 242.5 mm, 9.55 in.
(b) Make sure the cotter pin is set in the groove of the slotted nut
(c) Set position for rubber track specification

RY9212001MBS0115US0

[5] CYLINDER ASSEMBLY

(1) Assembly/disassembly of cylinder assy

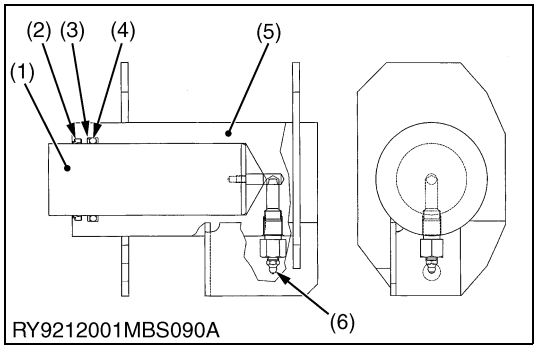
Removing the cylinder assy

1. Remove the track, front idler, and spring assy.
   (Refer to the spring idler chapter for assembly/disassembly of the track, front idler, and spring assy.)
   After removing the spring assy, pull out the cylinder assy (1) from the track frame.
   - Cylinder assy weight : approximately 14 kg (31 lbs)

(1) Cylinder Assembly

RY9212001MBS0116US0

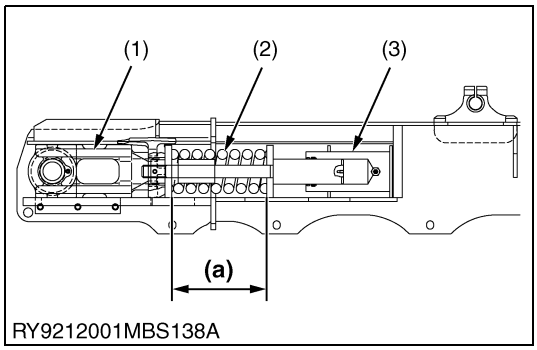
(2) Cylinder assembly structural components



No.	Component names	Q'ty
(1)	Rod	1
(2)	Rod seal	1
(3)	Backup ring	1
(4)	O-Ring	1
(5)	Cylinder tube	1
(6)	Nipple, assy	1

Tightening torque	Nipple, assy (6)	98 to 107.8 N·m 10 to 11 kgf·m 73 to 79.5 lbf·ft

RY9212001MBS0117US0

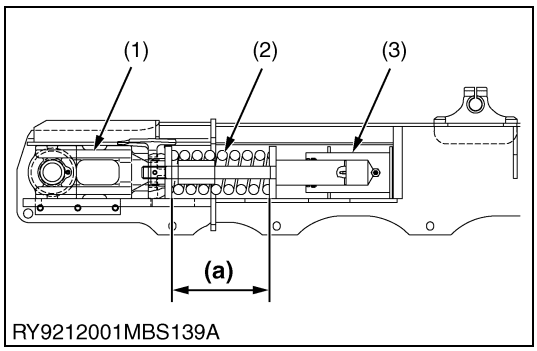


Rubber track specification structural components

No.	Component names
(1)	Idler assy
(2)	Spring assy
(3)	Cylinder assembly

(a) 227.5 mm, 8.96 in.

RY9212001MBS0126US0

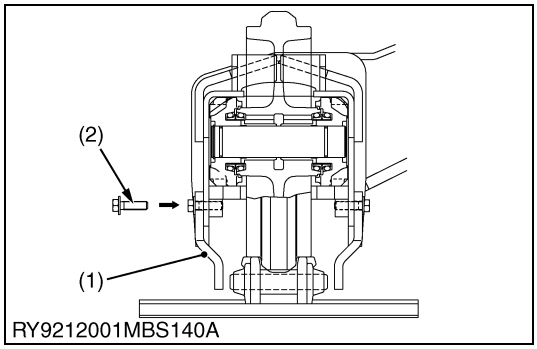


Iron track specification structural components

No.	Component names
(1)	Idler assy
(2)	Spring assy
(3)	Cylinder assembly

(a) 242.5 mm, 9.55 in.

RY9212001MBS0127US0



RY9212001MBS140A

Mounting an iron track guide

Tightening torque for iron track guide mounting bolt (2).

Tightening torque	Guide (1)	103.0 to 117.7 N·m 10.5 to 12.0 kgf·m 76.0 to 86.8 lbf·ft

Apply thread lock compound (Loctite 271).

(1) Guide (2) Bolt (diaphragm spring flat washer)

RY9212001MBS0128US0

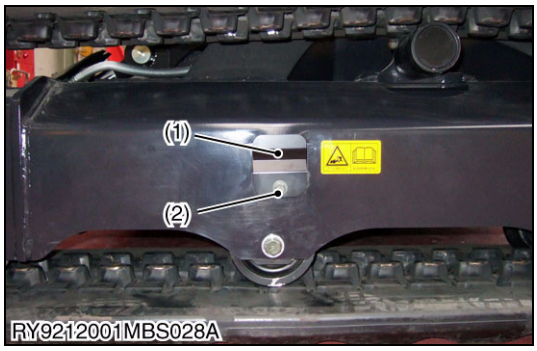
[6] TRACK ROLLER

(1) Assembly/disassembly of track roller

CAUTION

- **The pressure in the grease cylinder is high so if loosened quickly, the nipple may pop off and the highly pressurized grease in the cylinder may fly out so do not get your face near the nipple nor place your body in front of the nipple and loosen the nipple gradually.**

RY9212001MBS0008US0



Removing the grease nipple

1. Remove one bolt (2) and then the cover (1).

2. Place a wrench (socket) at the base of the grease nipple and loosen slowly.
   If there is a rock etc. caught in the sprocket, remove the rock first.

(1) Cover
(2) Bolt (M10)
(3) Grease nipple

RY9212001MBS0009US0

Loosen track

1. Jack up the body using the front end and blade, expel grease from inside the grease cylinder, and fully loosen up the track.
   When the track is loose, attach the grease nipple and place a block under the track frame.

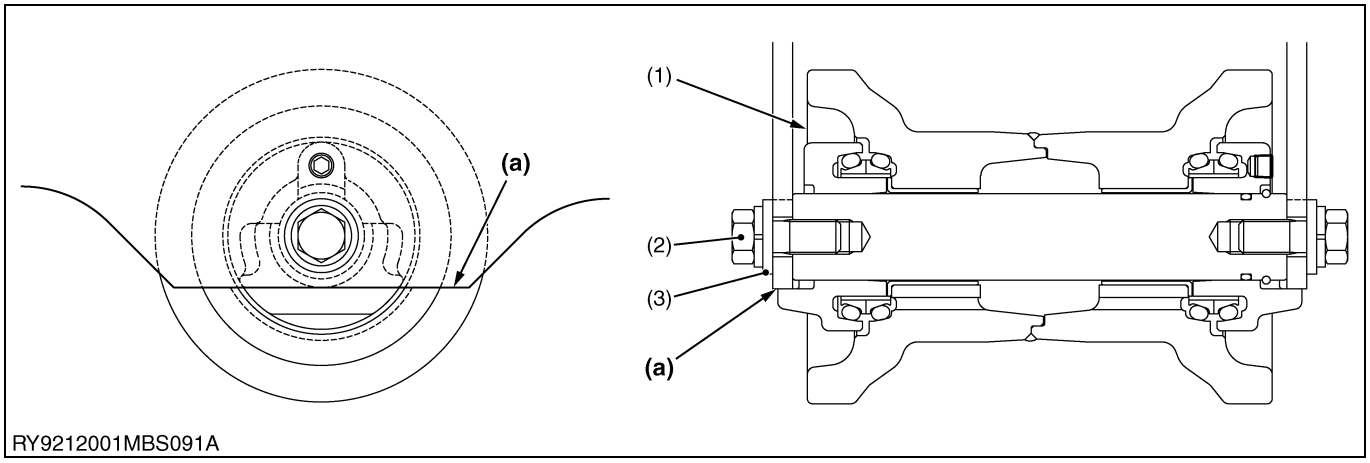
RY9212032MBS0036US0

Removing the track roller

1. Loosen the track roller mounting bolt, and remove the track roller.
   Track roller weight : 10 kg (22 lbs)

RY9212001MBS0118US0

Mounting the track roller



(1) Track roller, assy (2) Bolt (3) Flat metal washer **(a) Less than 1.5 mm (0.06 in.) (gap between working surfaces)**

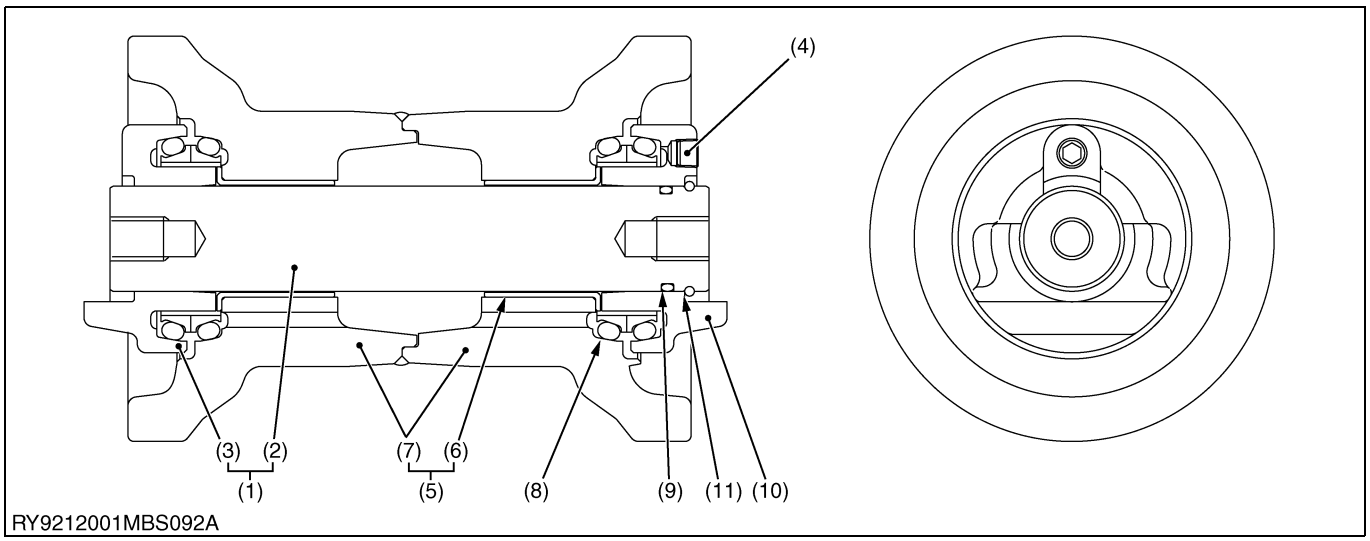
Please perform the procedure in reverse for assembly.

Tightening torque	Track roller assy	259.9 to 304.0 N·m 26.5 to 31.0 kgf·m 191.7 to 224.2 lbf·ft

Thread locking compound : Three Bond 1305P
Apply the thread locking compound to the female threads.

RY9212001MBS0119US0

(2) Track roller structural components



No.	Component names	Q'ty	No.	Component names	Q'ty
1	Shaft assy	1	7	Track roller (body)	1
2	Shaft (track roller)	1	8	Seal (floating)	2
3	Bracket (track roller)	1	9	O-Ring	1
4	Plug (R1/8)	1	10	Bracket (track roller)	1
5	Track roller	1	11	Wire	1
6	Bushing	2			

RY9212001MBS0120US0

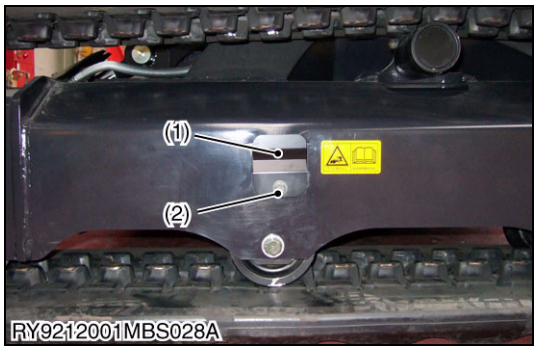
[7] CARRIER ROLLER

(1) Assembly/disassembly of carrier roller

CAUTION

- **The pressure in the grease cylinder is high so if loosened quickly, the nipple may pop off and the highly pressurized grease in the cylinder may fly out so do not get your face near the nipple nor place your body in front of the nipple and loosen the nipple gradually.**

RY9212001MBS0008US0



Removing the grease nipple

1. Remove one bolt (2) and then the cover (1).

2. Place a wrench (socket) at the base of the grease nipple and loosen slowly.
   If there is a rock etc. caught in the sprocket, remove the rock first.

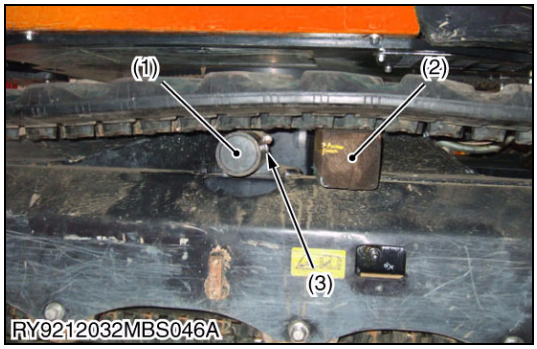
(1) Cover
(2) Bolt (M10)
(3) Grease nipple

RY9212001MBS0009US0

Loosen track

1. Jack up the body using the front end and blade, expel grease from inside the grease cylinder, and fully loosen up the track.
   When the track is loose, attach the grease nipple and place a block under the track frame.

RY9212032MBS0036US0

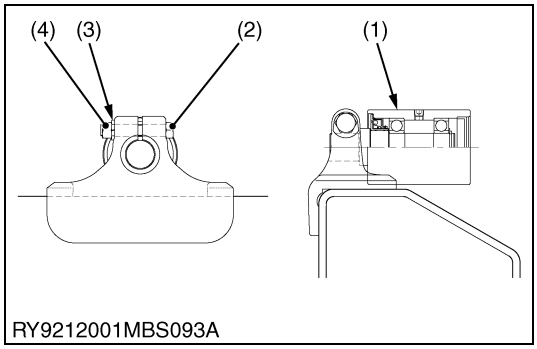


Removing the carrier roller

1. Insert a block (2) into the gap between the carrier roller and the track.
2. Loosen the nut (3) and remove the carrier roller (1).
   Carrier weight : approximately 4 kg (9 lbs)

(1) Carrier roller
(2) Block
(3) Nut

RY9212032MBS0037US0



Mounting the carrier roller

Please perform the procedure in reverse for assembly.

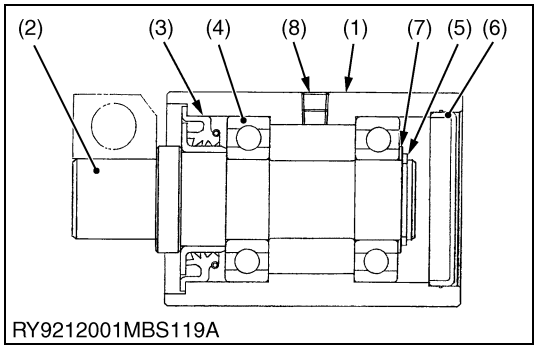
Tightening torque	Carrier roller assy	77.5 to 90.2 N·m 7.9 to 9.2 kgf·m 57.2 to 66.5 lbf·ft

Apply thread locking compound : (Loctite 271)

(1) Carrier roller, assy
(2) Bolt
(3) Spring washer
(4) Nut

RY9212001MBS0122US0

(2) Carrier roller structural components



No.	Component names	Q'ty
1	Roller	1
2	Shaft	1
3	Shaft seal	1
4	Ball bearing	2
5	Ring stopper	1
6	Cap seal	1
7	Spacer	1
8	Plug	1

RY9212001MBS0123US0

2 ENGINE

GENERAL

CONTENTS

1. ENGINE 2-G1
   [1] ENGINE SPECIFICATIONS 2-G1
   [2] PERFORMANCE CURVE 2-G2
   [3] DIMENSIONS 2-G3
2. SPECIAL TOOLS 2-G4

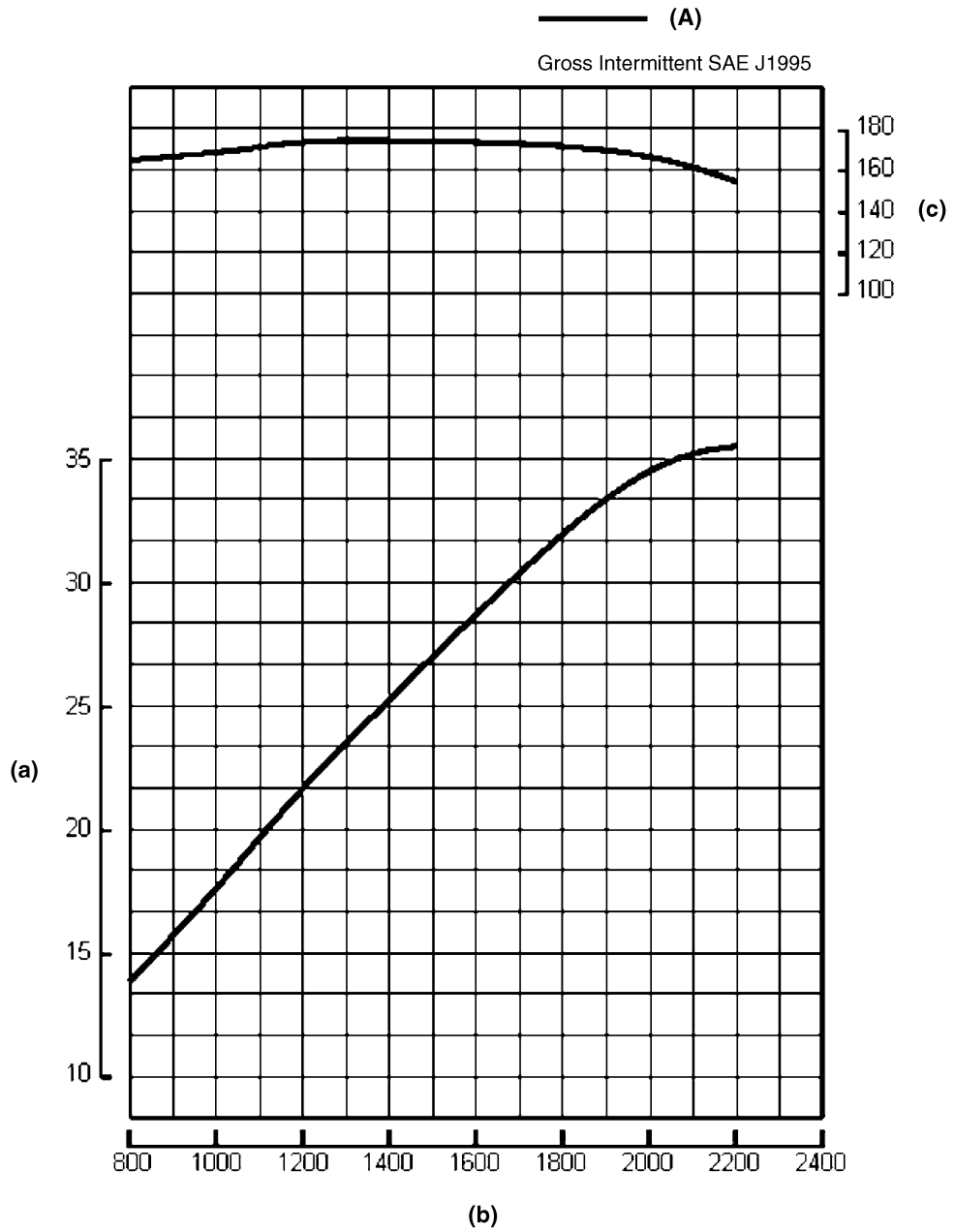
1. ENGINE

[1] ENGINE SPECIFICATIONS

	KX057-4 (Air conditioner type)	KX057-4	Remarks
Model	V2607-DI-E3-BH-3	V2607-DI-E3-BH-5	
Number of cylinder	4		
Bore x Stroke	87 x 110 mm 3.43 x 4.33 in.		
Displacement	2615 cc, 159.59 in^3		
Max. output / rpm	33.8 / 2200 kW/rpm 46.0 / 2200 PS/rpm 45.4 / 2200 HP/rpm	34.3 / 2200 kW/rpm 46.6 / 2200 PS/rpm 46.0 / 2200 HP/rpm	ISO 9249 NET SAEJ 9249 NET
Compression ratio	20		
Max. torque/rpm	169.7 / 1300 ± 200 N·m 17.3 / 1300 ± 200 kgf·m 125.2 / 1300 ± 200 lbf·ft	170.4 / 1300 ± 200 N·m 17.4 / 1300 ± 200 kgf·m 125.7 / 1300 ± 200 lbf·ft	
Dimensions : L x W x H	687 x 497 x 653 mm 27.0 x 19.6 x 25.7 in.		
Dry weight	225 kg 496.0 lbs	225 kg 496.0 lbs	
Valve clearance	0.15 mm, 0.01in.		Cold condition
Firing sequence	1-3-4-2		
Combustion chamber	(Direct Injection)		
Compression pressure	3.20 MPa 32.6 kgf/cm^2 464 psi		Ref. valve at 150 rpm starter speed
Fan belt	Bando RPF3355	Bando RPF3350	
Fuel consumption ratio	232.7 g/kWh 171.2 g/PSh 0.383 lbs/HPh	229.3 g/kWh 168.7 g/PSh 0.377 lbs/HPh	Net value
Engine speed with idling	1050 to 1200 rpm		On the machine
Engine oil pressure with rated engine rpm	245 to 441 kPa 2.50 to 4.50 kgf/cm^2 35.6 to 64.0 psi		
Fuel injection pressure 1st stage / 2nd stage	1st stage : 18.6 MPa (190 kgf/cm^2, 2700 psi) 2nd stage : 21.6 MPa (220 kgf/cm^2, 3130 psi)		
Engine oil consumption ratio	0.68 g/kWh 0.50 g/PSh 0.00112 lbs/HPh		
Alternator	12 V – 720 w		DENSO Co.
Charging current	60 A		
Regulation voltage	14.2 ~ 14.8 V		
Battery	105D31L		
Electrolyte gravity	1.26 ≤		
Starter	12 V – 2.0 kW		DENSO Co.
Glow plug	0.95 Ω		

RY9212032END0001US0

[2] PERFORMANCE CURVE

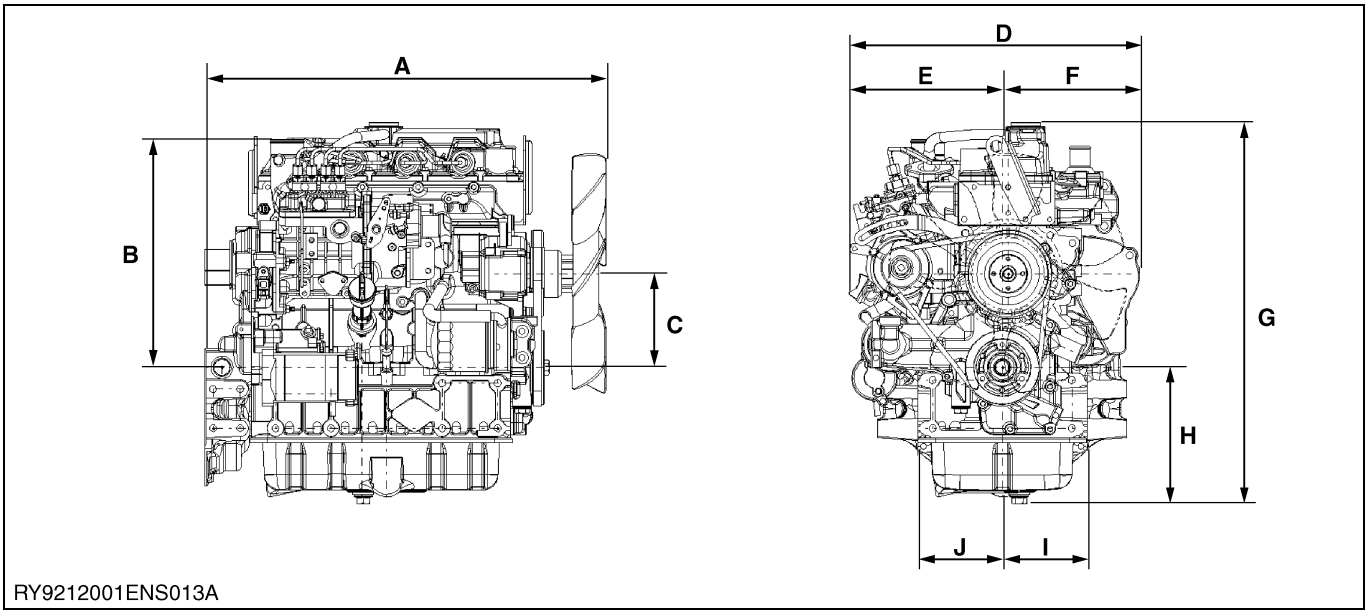


RY9212032GES010A

(a) Brake Horse Power (kW) **(b) Engine Speed (rpm)** **(c) Torque (N·m)** **(A) V2607-DI-E3-BH**

RY9212050END0001US0

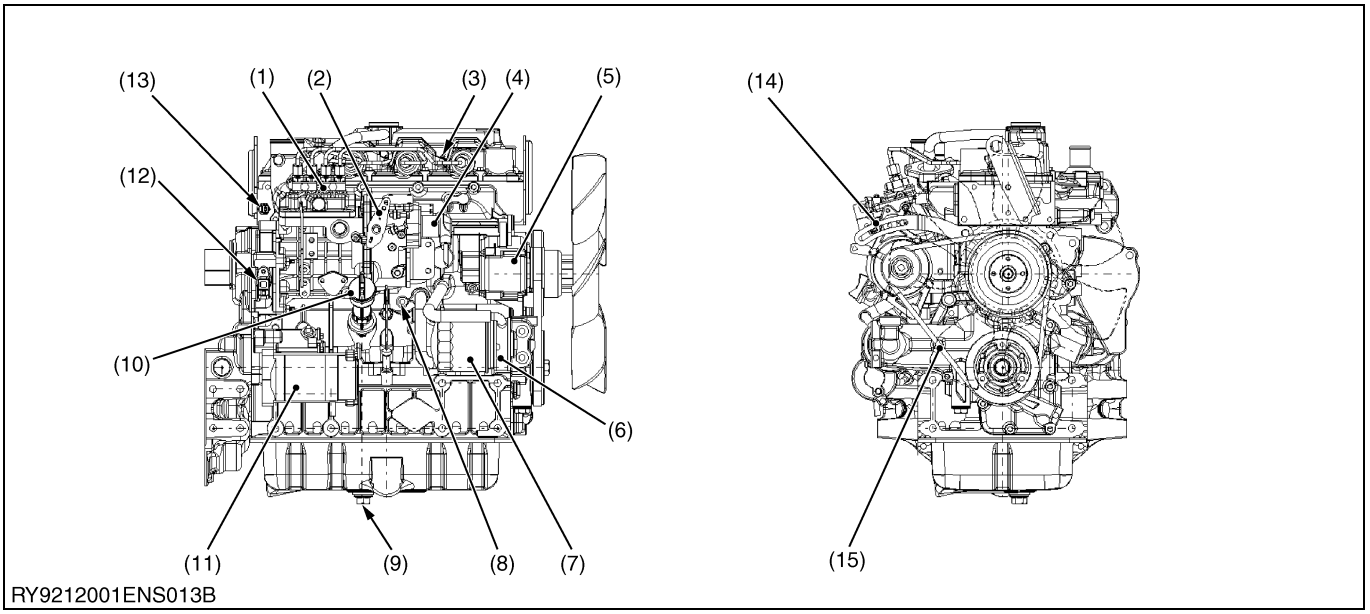
[3] DIMENSIONS



RY9212001ENS013A

	Dimension		Dimension		Dimension
A	686.59 mm (27.03 in.)	**E**	262.47 mm (10.33 in.)	**I**	145 mm (5.71 in.)
B	389.3 mm (15.33 in.)	**F**	234.5 mm (9.23 in.)	**J**	145 mm (5.71 in.)
C	160 mm (6.30 in.)	**G**	652.5 mm (25.69 in.)		
D	496.97 mm (19.57 in.)	**H**	233.1 mm (9.18 in.)		

Component layout

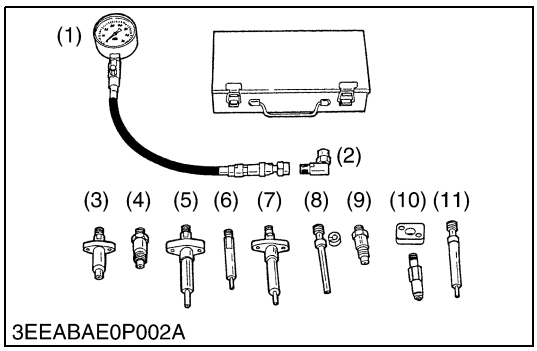


RY9212001ENS013B

No.	Part name	No.	Part name	No.	Part name
(1)	Injection pump	(6)	Oil cooler	(11)	Starter
(2)	Governor	(7)	Oil filter	(12)	Revolution sensor
(3)	Glow plug	(8)	Oil switch	(13)	Water temperature sensor
(4)	Stop solenoid	(9)	Drain plug (oil)	(14)	Belt tensioner
(5)	Alternator	(10)	Oil filter plug	(15)	V-belt

RY9212050END0003US0

2. SPECIAL TOOLS



3EEABAE0P002A

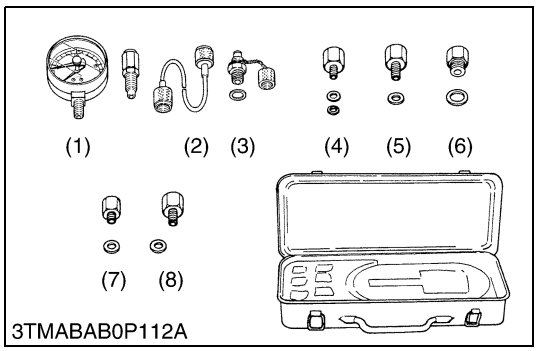
Diesel Engine Compression Tester

Code No.
- 07909-30208 (Assembly)
- 07909-30934 (**A** to **F**)
- 07909-31211 (**E** and **F**)
- 07909-31231 (**H**)
- 07909-31251 (**G**)
- 07909-31271 (**I**)
- 07909-31281 (**J**)

Application
- Use to measure diesel engine compression and diagnostics of need for major overhaul.

(1) Gauge
(2) **L** Joint
(3) Adaptor **A**
(4) Adaptor **B**
(5) Adaptor **C**
(6) Adaptor **E**
(7) Adaptor **F**
(8) Adaptor **G**
(9) Adaptor **H**
(10) Adaptor **I**
(11) Adaptor **J**

RY9212050END0004US0



3TMABAB0P112A

Oil Pressure Tester

Code No.
- 07916-32032

Application
- Use to measure lubricating oil pressure.

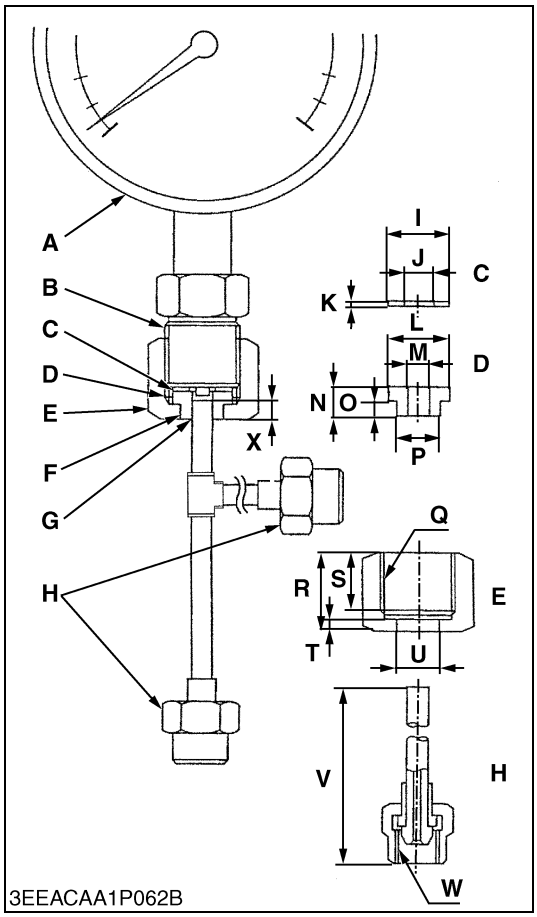
(1) Gauge
(2) Cable
(3) Threaded Joint
(4) Adaptor **1**
(5) Adaptor **2**
(6) Adaptor **3**
(7) Adaptor **4**
(8) Adaptor **5**

RY9212050END0005US0

■ **NOTE**

- **The following special tools are not provided, make them referring to the figure.**

RY9212050END0006US0



3EEACAA1P062B

Injection Pump Pressure Tester

Application

- Use to check fuel tightness of injection pumps.

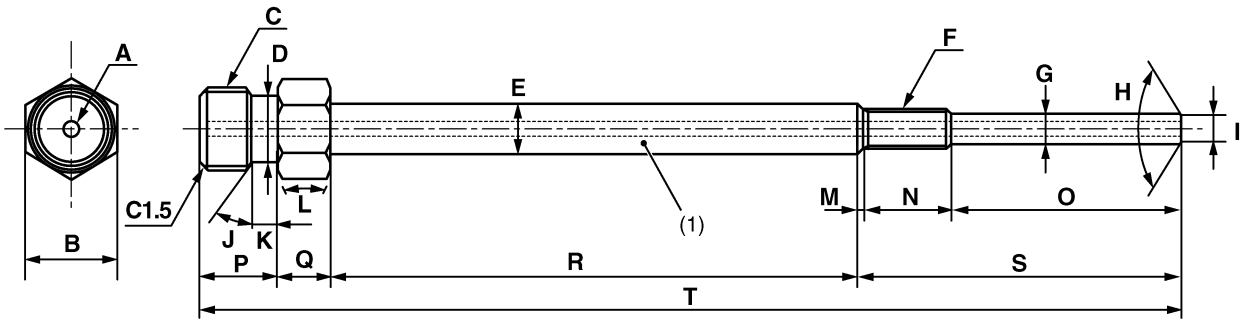
A	Pressure gauge full scale : More than 29.4 MPa (300 kgf/cm^2, 4270 psi)
B	PF 1/2
C	Copper gasket
D	Flange (Material Steel)
E	Hex. nut 27 mm (1.1 in.) across the plat
F	Adhesive application
G	Fillet welding on the enter circumference
H	Retaining nut
I	17 mm dia. (0.67 in. dia.)
J	8.0 mm dia. (0.31 in. dia.)
K	1.0 mm (0.039 in.)
L	17 mm dia. (0.67 in. dia.)
M	6.10 to 6.20 mm dia. (0.241 to 0.244 in. dia.)
N	8.0 mm (0.31 in.)
O	4.0 mm (0.16 in.)
P	11.97 to 11.99 mm dia. (0.4713 to 0.4720 in. dia.)
Q	PF 1/2
R	23 mm (0.91 in.)
S	17 mm (0.67 in.)
T	4.0 mm (0.16 in.)
U	12.00 to 12.02 mm dia. (0.4725 to 0.4732 in. dia.)
V	100 mm (3.94 in.)
W	M12 × P1.5
X	5.0 mm (0.20 in.)

RY9212050END0007US0

Glow Plug Adapter

Application

- Use to check compression pressure through glow plug hole.



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A	3.0 mm dia. (0.12 in. dia.) through hole	**L**	1.0 rad (60 °)
B	17.0 mm (0.669 in.)	**M**	1.0 mm (0.039 in.)
C	16.0 mm dia. (0.630 in. dia.) P0.5	**N**	17.0 mm (0.669 in.)
D	13.0 mm dia. (0.512 in. dia.)	**O**	47.0 mm (1.85 in.)
E	9.5 mm dia. (0.37 in. dia.)	**P**	15.0 mm (0.591 in.)
F	M8 × 1.0	**Q**	10.0 mm (0.394 in.)
G	6.50 to 6.70 mm dia. (0.256 to 0.263 in. dia.)	**R**	100 mm (3.94 in.)
H	2.12 to 2.18 rad (121 to 125 °)	**S**	65.0 mm (2.56 in.)
I	4.90 to 5.50 mm dia. (0.193 to 0.216 in. dia.)	**T**	190 mm (7.48 in.)
J	0.52 rad (30 °)	**C1.5**	Chamfer 1.5 mm (0.059 in.)
K	5.0 mm (0.20 in.)		

(1) Material : SS400

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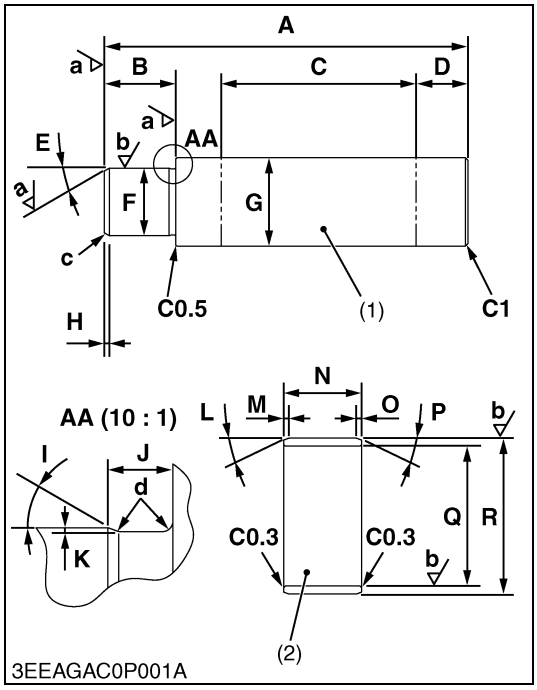

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Small End Bushing Replacing Tool

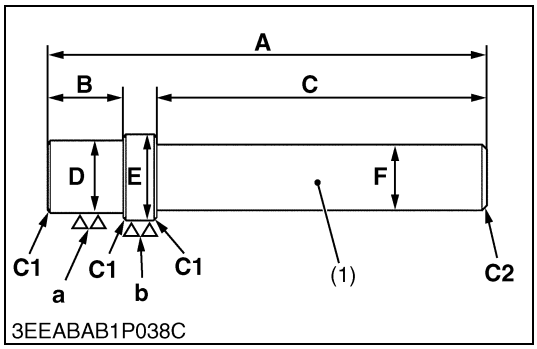
Application

- Use to press fit the small end bushing.

A	140 mm (5.51 in.)
B	27.2 to 27.5 mm (1.07 to 1.08 in.)
C	75.0 mm (2.95 in.) : Roulette
D	20.0 mm (0.787 in.)
E	0.52 rad (30 °)
F	25.967 to 25.980 mm dia. (1.0224 to 1.0228 in. dia.)
G	34.0 mm dia. (1.34 in. dia.)
H	2.0 mm (0.079 in.)
I	0.35 rad (20 °)
J	2.5 mm (0.098 in.)
K	0.15 to 0.25 mm (0.0059 to 0.0098 in.)
L	0.35 rad (20 °)
M	1.0 mm (0.039 in.)
N	14.5 mm (0.571 in.)
O	1.0 mm (0.039 in.)
P	0.35 rad (20 °)
Q	26.000 to 26.021 mm (1.0237 to 1.0244 in.)
R	28.900 to 28.950 mm (1.1378 to 1.1397 in.)
a	Ra = 3.2 a
b	Ra = 1.6 a
c	1.0 mm radius (0.039 in radius)
d	0.40 mm radius (0.016 in. radius)
C0.3	Chamfer 0.30 mm (0.012 in.)
C0.5	Chamfer 0.50 mm (0.020 in.)
C1	Chamfer 1.0 mm (0.039 in.)

(1) Shaft Material : SS400 (2) Guide Material : STKM12A

RY9212050END0009US0



3EEABAB1P038C

Idle Gear Bushing Replacing Tool

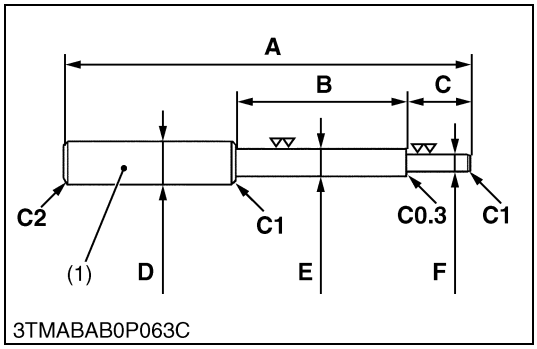
Application

- Use to press out and to press fit the bushing.

A	196 mm (7.72 in.)
B	25.0 mm (0.984 in.)
C	150 mm (5.91 in.)
D	34.5 mm dia. (1.36 in. dia.)
E	38.075 to 38.100 mm dia. (1.4991 to 1.5000 in. dia.)
F	20 mm dia. (0.79 in. dia.)
a	6.3 µm (250 µin.)
b	6.3 µm (250 µin.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)

(1) Material : SS400

RY9212050END0010US0



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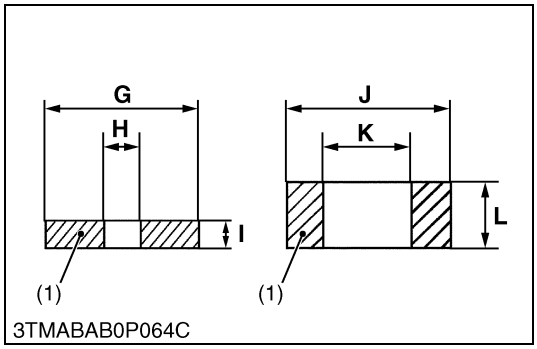


3TMABAB0P064C

Valve Guide Replacing Tool

Application

- Use to press out and press fit the valve guide.

A	220 mm (8.66 in.)
B	80 mm (3.1 in.)
C	40 mm (1.6 in.)
D	20 mm dia. (0.79 in. dia.)
E	9.960 to 9.980 mm dia. (0.3922 to 0.3929 in. dia.)
F	5.50 to 5.70 mm dia. (0.217 to 0.224 in. dia.)
G	25 mm dia. (0.98 in. dia.)
H	6.00 to 6.10 mm dia. (0.237 to 0.240 in. dia.)
I	5.0 mm (0.20 in.)
J	18 mm dia. (0.71 in. dia.)
K	10.6 to 10.7 mm dia. (0.418 to 0.421 in. dia.)
L	6.90 to 7.10 mm (0.272 to 0.279 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)
C0.3	Chamfer 0.30 mm (0.012 in.)

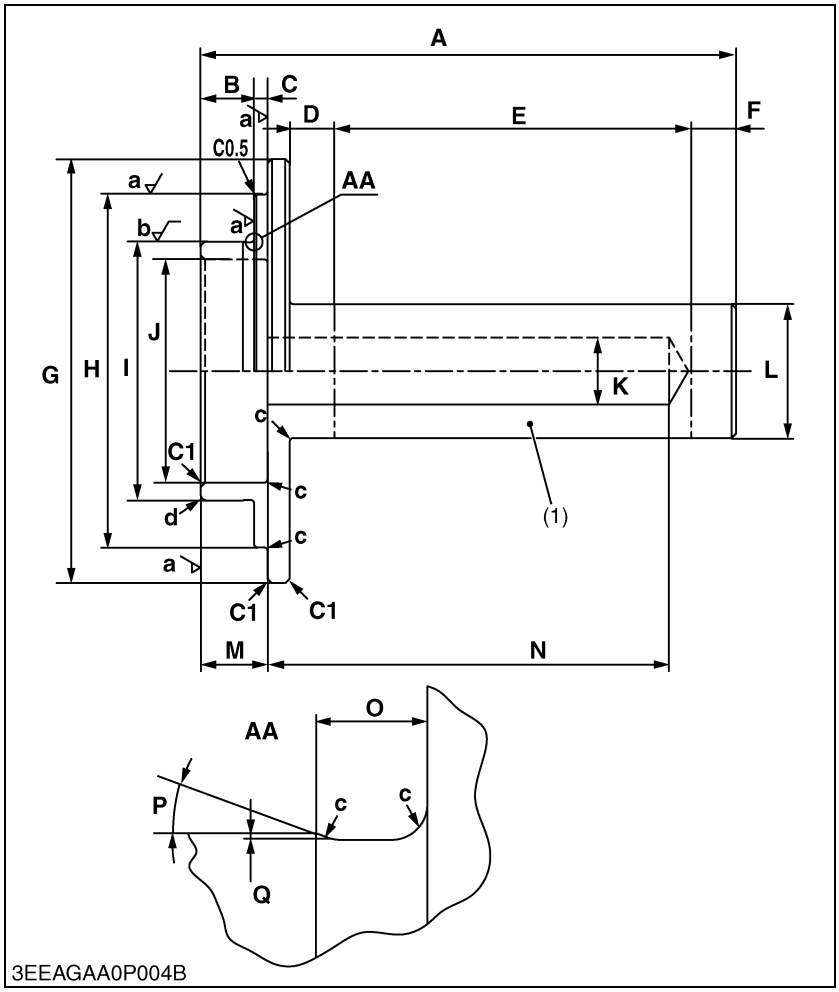
(1) Material : SS400

RY9212050END0011US0

Front Cover Oil Seal Replacing Tool

Application

- Use to press fit the front cover oil seal.



3EEAGAA0P004B

A	120 mm (4.72 in.)
B	12.0 mm (0.472 in.)
C	2.90 to 3.00 mm (0.115 to 0.118 in.)
D	10.0 mm (0.394 in.)
E	80.0 mm (3.15 in.)
F	10.0 mm (0.394 in.)
G	95.0 mm dia. (3.74 in. dia.)
H	78.900 to 79.100 mm dia. (3.1063 to 3.1141 in. dia.)
I	57.971 to 57.990 mm dia. (2.2824 to 2.2830 in. dia.)
J	50.0 mm dia. (1.97 in. dia.)
K	15.0 mm dia. (0.591 in. dia.)
L	30.0 mm dia. (1.18 in. dia.)
M	15.0 mm (0.591 in.)
N	90.0 mm (3.54 in.)
O	2.50 mm (0.0984 in.)
P	0.35 rad (20 °)
Q	0.15 to 0.25 mm (0.0059 to 0.0098 in.)
a	Ra = 3.2 a
b	Ra = 1.6 a
c	0.80 mm radius (0.031 in. radius)
d	1.5 mm radius (0.059 in. radius)
C0.5	Chamfer 0.50 mm (0.020 in.)
C1	Chamfer 1.0 mm (0.039 in.)

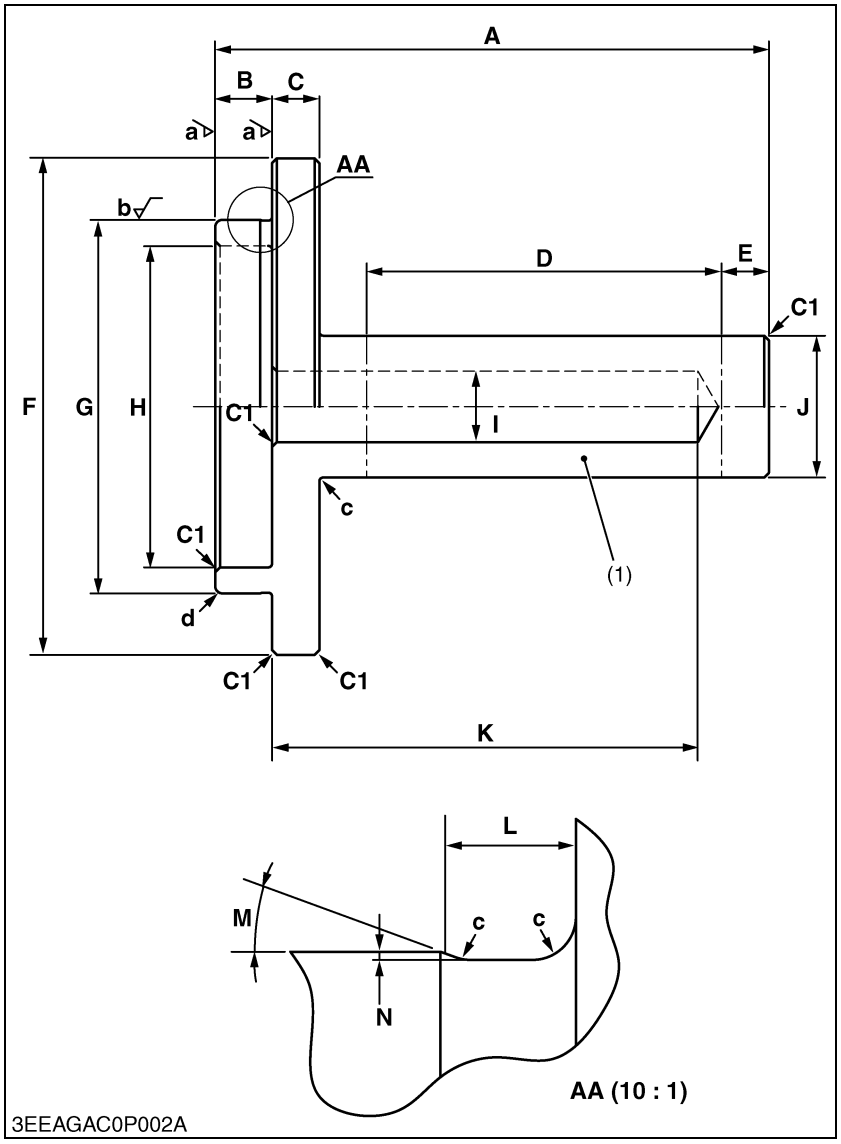
(1) Material : S43C-D

RY9212050END0012US0

Flywheel Housing Oil Seal Replacing Tool

Application

- Use to press fit the flywheel housing oil seal.



A	117 mm (4.61 in.)
B	12.0 mm (0.472 in.)
C	10.0 mm (0.394 in.)
D	75.0 mm (2.95 in.) : Roulette
E	10.0 mm (0.394 in.)
F	105 mm dia. (4.13 in. dia.)
G	78.9971 to 78.9990 mm dia. (3.11013 to 3.11019 in. dia.)
H	68.0 mm dia. (2.68 in. dia.)
I	15.0 mm dia. (0.591 in. dia.)
J	30.0 mm dia. (1.18 in. dia.)
K	90.0 mm (3.54 in.)
L	2.5 mm (0.098 in.)
M	0.35 rad (20 °)
N	0.15 to 0.25 mm (0.0059 to 0.0098 in.)
a	Ra = 3.2 a
b	Ra = 1.6 a
c	0.80 mm radius (0.031 in. radius)
d	1.5 mm radius (0.059 in. radius)
C1	Chamfer 1.0 mm (0.039 in.)

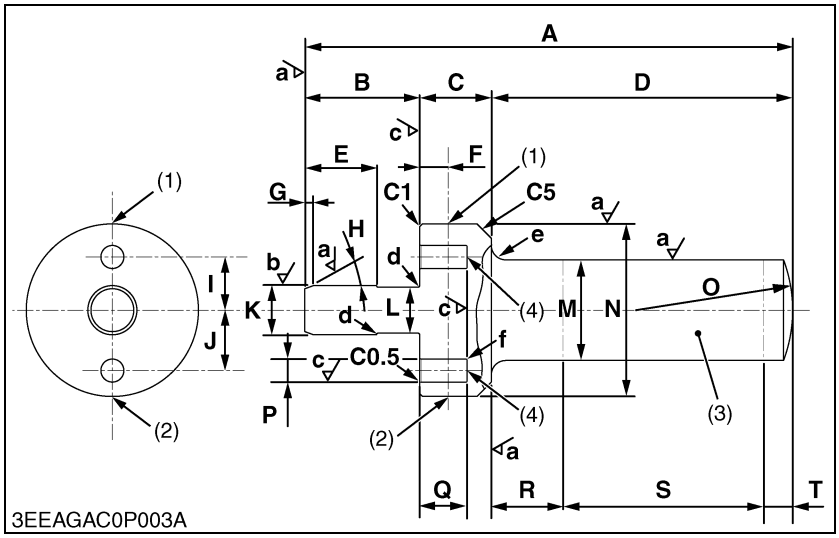
(1) Material : SS400

RY9212050END0013US0

Valve Bridge Shaft Replacing Tool

Application

- Use to press fit the valve bridge shaft.



A	170 mm (6.69 in.)
B	40.0 mm (1.57 in.)
C	25.0 mm (0.984 in.)
D	105 mm (4.13 in.)
E	25.0 mm (0.984 in.)
F	10.0 mm (0.394 in.)
G	3.0 mm (0.12 in.)
H	0.35 rad (20 °)
I	18.45 to 18.55 mm (0.7264 to 0.7303 in.)
J	20.95 to 21.05 mm (0.8248 to 0.8287 in.)
K	17.057 to 17.084 mm dia. (0.67154 to 0.67259 in. dia.)
L	16.0 mm dia. (0.630 in. dia.)
M	35.0 mm dia. (1.38 in. dia.)
N	60.0 mm dia. (2.36 in. dia.)
O	SR 50.0 mm (1.97 in.)
P	8.10 to 8.15 mm dia. (0.319 to 0.320 in. dia.)
Q	16.4 to 16.6 mm (0.646 to 0.653 in.)
R	25.0 mm (0.984 in.)
S	70.0 mm (2.76 in.) : Roulette
T	10.0 mm (0.394 in.)
a	Ra = 6.3 a
b	Ra = 1.6 a
c	Ra = 3.2 a
d	0.50 mm radius (0.020 in. radius)
e	5.0 mm radius (0.20 in. radius)
f	Under 0.30 mm radius (0.012 in. radius)
C0.5	Chamfer 0.50 mm (0.020 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C5	Chamfer 5.0 mm (0.20 in.)

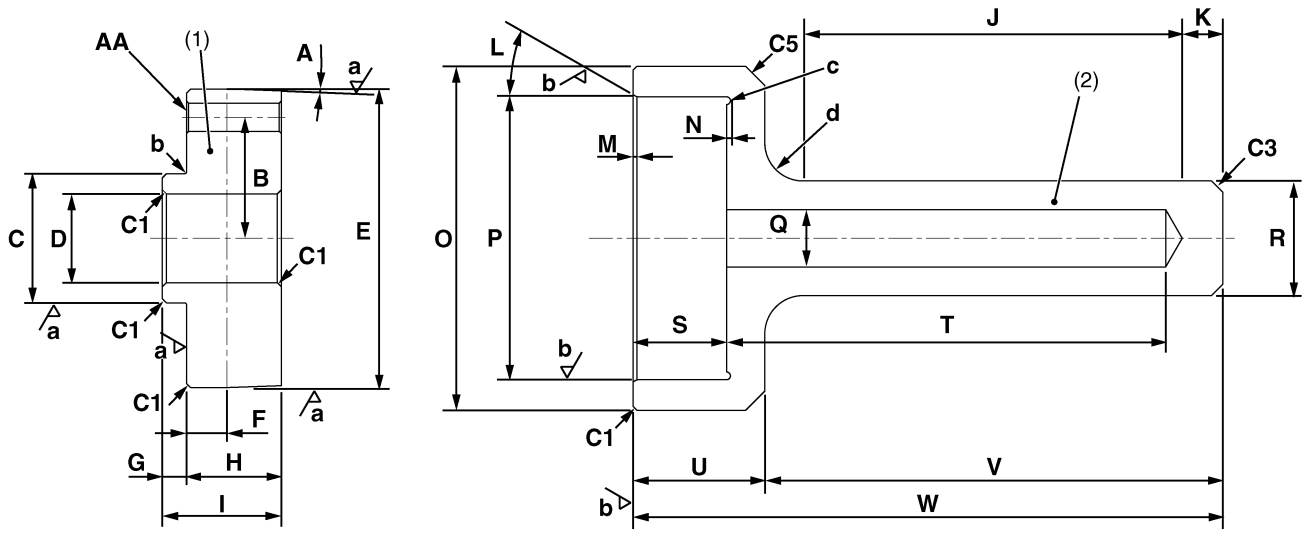
(1) "IN" side
(2) "EX" side
(3) Material : S43C-D
(4) Bottom flat

RY9212050END0014US0

Crankshaft Sleeve Replacing Tool

Application

- Use to fix the crankshaft sleeve of the diesel engine.

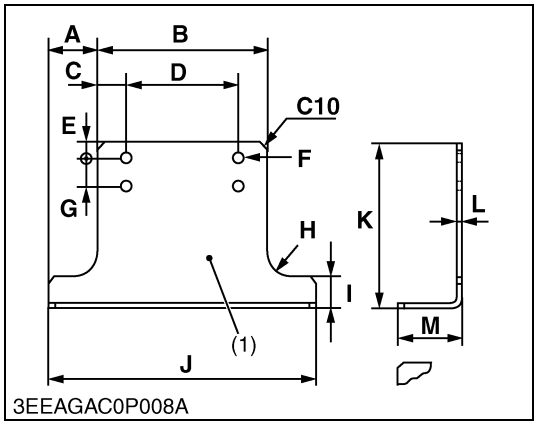


3EEAGAC0P004A

A	0.035 rad (2.0 °)	**Q**	15.0 mm dia. (0.591 in. dia.)
B	30.0 mm (1.18 in.)	**R**	30.0 mm dia. (1.18 in. dia.)
C	31.925 to 31.950 mm dia. (1.2569 to 1.2578 in. dia.)	**S**	24.45 to 24.55 mm (0.9626 to 0.9665 in.)
D	22.0 mm dia. (0.866 in. dia.)	**T**	115 mm depth (4.53 in. depth)
E	73.60 to 73.70 mm dia. (2.898 to 2.901 in. dia.)	**U**	34.5 mm (1.36 in.)
F	10.0 mm (0.394 in.)	**V**	120 mm (4.72 in.)
G	6.0 mm (0.24 in.)	**W**	154.5 mm (6.083 in.)
H	23.45 to 23.55 mm (0.9233 to 0.9272 in.)	**AA**	7.0 mm dia. (0.28 in. dia.), Chamfer 0.50 mm (0.020 in.) both side
I	29.5 mm (1.16 in.)	**a**	Ra = 1.6 a
J	95.0 mm (3.74 in.) : Roulette	**b**	Ra = 3.2 a
K	10.0 mm (0.394 in.)	**c**	1.0 mm radius (0.039 in. radius)
L	0.52 rad (30 °)	**d**	10.0 mm radius (0.394 in. radius)
M	0.70 to 1.0 mm dia. (0.028 to 0.039 in. dia.)	**C1**	Chamfer 1.0 mm (0.039 in.)
N	1.0 mm (0.039 in.)	**C3**	Chamfer 3.0 mm (0.12 in.)
O	90.0 mm dia. (3.54 in. dia.)	**C5**	Chamfer 5.0 mm (0.20 in.)
P	74.10 to 74.20 mm dia. (2.918 to 2.921 in. dia.)		

(1) Sleeve Guide Material : SGD400-D
(2) Shaft Material : SGD400-D

RY9212050END0015US0



3EEAGAC0P008A

Engine Stand

Application

- Use to support engine.

A	107 mm (4.21 in.)
B	246 mm (9.68 in.)
C	28 mm (1.1 in.)
D	190 mm (7.48 in.)
E	15 mm (0.59 in.)
F	14 mm dia. (0.55 in. dia.)
G	59 mm (2.3 in.)
H	80 mm radius (3.1 in. radius)
I	70 mm (2.8 in.)
J	460 mm (18.1 in.)
K	270 mm (10.6 in.)
L	6.0 mm (0.24 in.)
M	70 mm (2.8 in.)
C10	Chamfer 10 mm (0.39 in.)

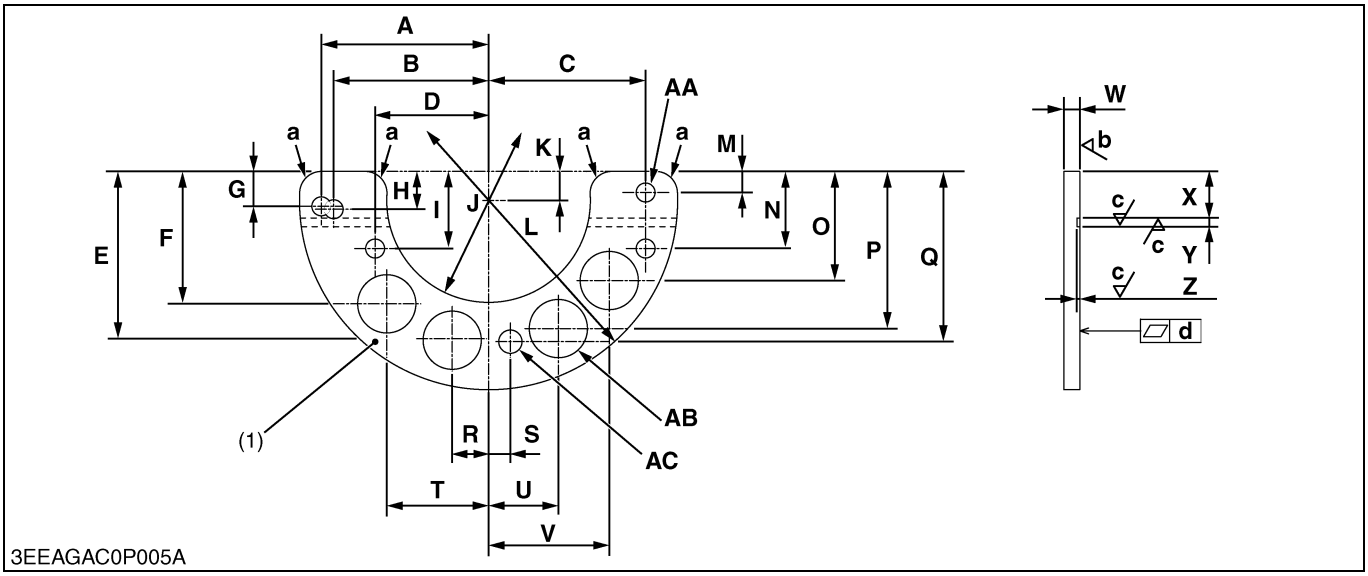
(1) Material : S43C

RY9212050END0016US0

Crankcase Aligning Plate

Application

- Use for aligning the crankcase 1 and 2.



3EEAGAC0P005A

A	115 mm (4.53 in.)	**R**	25.0 mm (0.984 in.)
B	106.5 mm (4.193 in.)	**S**	15.0 mm (0.591 in.)
C	108 mm (4.25 in.)	**T**	70.0 mm (2.76 in.)
D	78.0 mm (3.07 in.)	**U**	48.0 mm (1.89 in.)
E	115 mm (4.53 in.)	**V**	83.0 mm (3.27 in.)
F	91.0 mm (3.58 in.)	**W**	11.0 mm (0.433 in.)
G	24.0 mm (0.945 in.)	**X**	32.0 mm (1.26 in.)
H	26.0 mm (1.02 in.)	**Y**	6.0 mm (0.24 in.)
I	53.0 mm (2.09 in.)	**Z**	2.0 mm (0.079 in.)
J	140 mm dia. (5.51 in. dia.)	**AA**	5 × 13.0 mm dia. (0.512 in. dia.), Chamfer 0.50 mm (0.020 in.)
K	20.0 mm (0.787 in.)	**AB**	4 × 40.0 mm dia. (1.57 in. dia.), Chamfer 0.50 mm (0.020 in.)
L	260 mm dia. (10.2 in. dia.)	**AC**	16.0 mm dia. (0.630 in. dia.), Chamfer 0.50 mm (0.020 in.)
M	14.5 mm (0.571 in.)	**a**	15.0 mm radius (0.591 in. radius)
N	53.0 mm (2.09 in.)	**b**	Ra = 3.2 a
O	75.0 mm (2.95 in.)	**c**	Ra = 6.3 a
P	108 mm (4.25 in.)	**d**	0.05 mm (0.002 in.)
Q	117 mm (4.61 in.)		

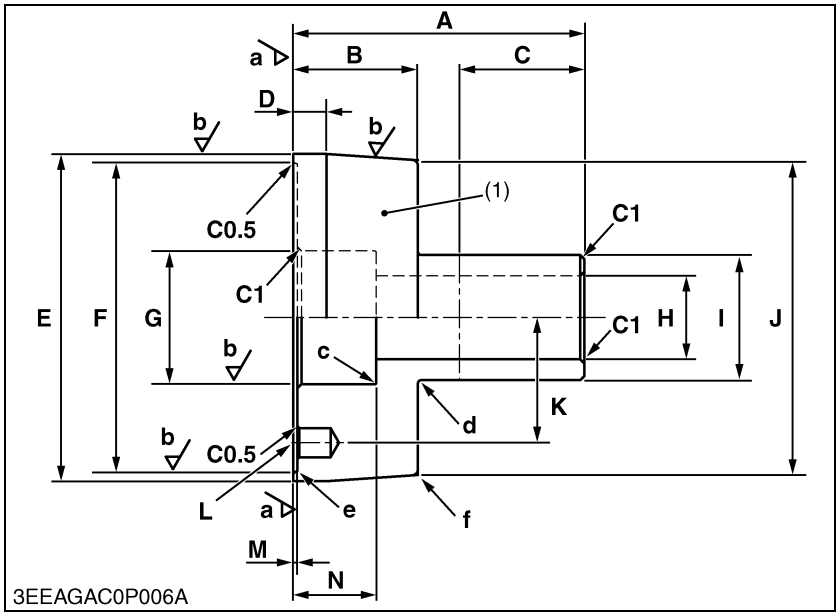
(1) Material : SS400

RY9212050END0017US0

Flywheel Housing Guide

Application

- Use to install the flywheel housing to the crankcase.



A	70.0 mm (2.76 in.)
B	30.0 mm (1.18 in.)
C	30.0 mm (1.18 in.) : Roulette
D	8.0 mm (0.31 in.)
E	78.60 to 78.70 mm dia. (3.095 to 3.098 in. dia.)
F	73.8 to 74.2 mm dia. (2.91 to 2.92 in. dia.)
G	32.009 to 32.034 mm dia. (1.2602 to 1.2611 in. dia.)
H	20.0 mm dia. (0.787 in. dia.)
I	30.0 mm dia. (1.18 in. dia.)
J	75.5 mm dia. (2.97 in. dia.)
K	30.0 mm (1.18 in.)
L	7.0 mm dia., 8.0 mm depth (0.28 in. dia., 0.31 in. depth)
M	1.1 to 1.3 mm (0.044 to 0.051 in.)
N	20.0 mm (0.787 in.)
a	Ra = 3.2 a
b	Ra = 1.6 a
c	0.40 mm radius (0.016 in. radius)
d	0.80 mm radius (0.031 in. radius)
e	0.20 mm radius (0.0079 in. radius)
f	1.5 mm radius (0.059 in. radius)
C0.5	Chamfer 0.50 mm (0.020 in.)
C1	Chamfer 1.0 mm (0.039 in.)

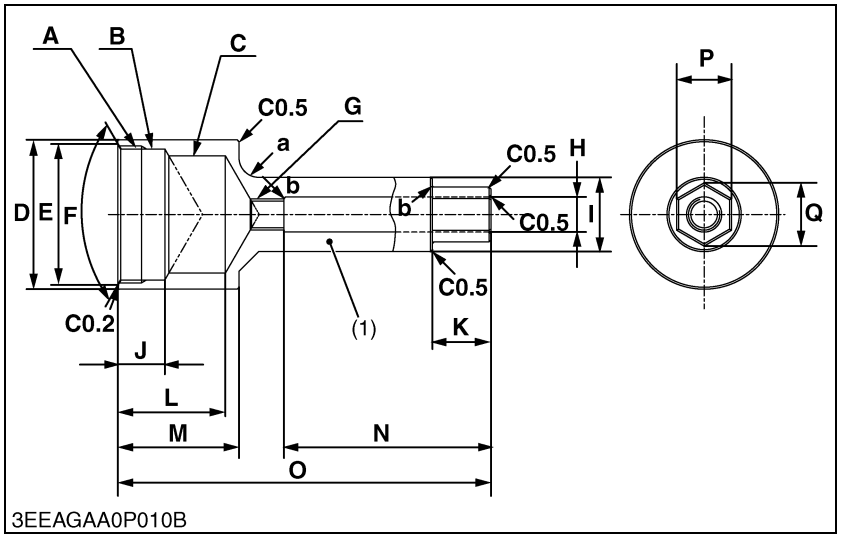
(1) Material : SS400

RY9212050END0018US0

Injection Pump Gear Puller

Application

- Use for remove the injection pump gear from governor shaft.

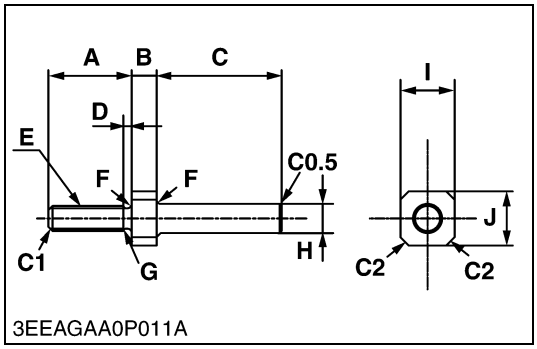


3EEAGAA0P010B

A	M35 × P1.5, 6.0 mm depth (0.24 in. depth)
B	35.0 mm dia., 12.0 mm depth (1.38 in. dia., 0.472 in. depth)
C	30.0 mm dia., 27.5 mm depth (1.18 in. dia., 1.08 in. depth)
D	40.00 to 40.20 mm dia. (1.575 to 1.582 in. dia.)
E	35.90 to 36.10 mm dia. (1.414 to 1.421 in. dia.)
F	2.09 rad (120 °)
G	M8 × P1.25
H	9.0 mm dia. (0.35 in. dia.)
I	19.0 mm dia. (0.748 in. dia.)
J	12.0 mm (0.472 in.)
K	15.0 mm (0.591 in.)
L	27.5 mm (1.08 in.)
M	31.0 mm (1.22 in.)
N	57.5 mm (2.26 in.)
O	100 mm (3.94 in.)
P	13.75 to 14.00 mm (0.5414 to 0.5511 in.)
Q	16.17 mm (0.6366 in.)
a	5.0 mm radius (0.20 in. radius)
b	0.40 mm radius (0.016 in. radius)
C0.2	Chamfer 0.20 mm (0.0079 in.)
C0.5	Chamfer 0.50 mm (0.020 in.)

(1) Material : SS400

RY9212050END0019US0



3EEAGAA0P011A

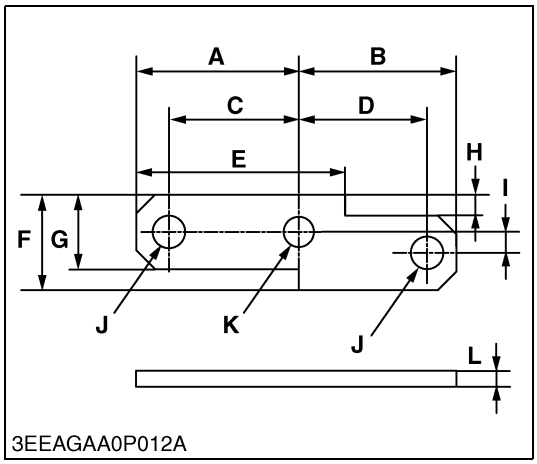
Fuel Control Rack Fixing Tool

Application

- Use to fix the fuel control rack of the injection pump.

1) Shaft

A	20.0 mm (0.787 in.)
B	6.0 mm (0.24 in.)
C	28.90 to 29.10 mm (1.138 to 1.145 in.)
D	2.0 to 3.0 mm (0.079 to 0.11 in.)
E	M6 × P1.0
F	1.0 mm radius (0.039 in. radius)
G	0.50 mm radius (0.020 in. radius)
H	7.0 mm dia. (0.28 in. dia.)
I	13.0 mm (0.512 in.)
J	13.0 mm (0.512 in.)
C0.5	Chamfer 0.50 mm (0.020 in.)
C1	Chamfer 1.0 mm (0.039 in.)
C2	Chamfer 2.0 mm (0.079 in.)



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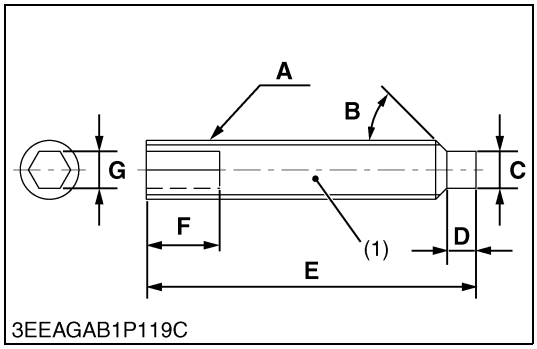
2) Flange

A	35.0 mm (1.38 in.)
B	34.0 mm (1.34 in.)
C	28.0 mm (1.10 in.)
D	27.64 mm (1.088 in.)
E	45.0 mm (1.77 in.)
F	20.5 mm (1.807 in.)
G	16.0 mm (0.630 in.)
H	4.5 mm (0.18 in.)
I	4.5 mm (0.18 in.)
J	7.0 mm dia. (0.28 in. dia.) through hole
K	6.5 mm dia. (0.26 in. dia.) through hole
L	3.2 mm (0.13 in.)

RY9212050END0020US0



3EEAGAB1P119C

Fuel Camshaft Lock Screw (Socket Set Screw Dog Point Type)

Application

- Use to fix the fuel camshaft.

A	M8 × Pitch 1.25
B	0.79 rad (45 °)
C	5.0 mm dia. (0.20 in. dia.)
D	4.0 mm (0.16 in.)
E	45 mm (1.8 in.)
F	10 mm (0.39 in.) : Conspicuously Painted
G	5.0 mm (0.20 in.)

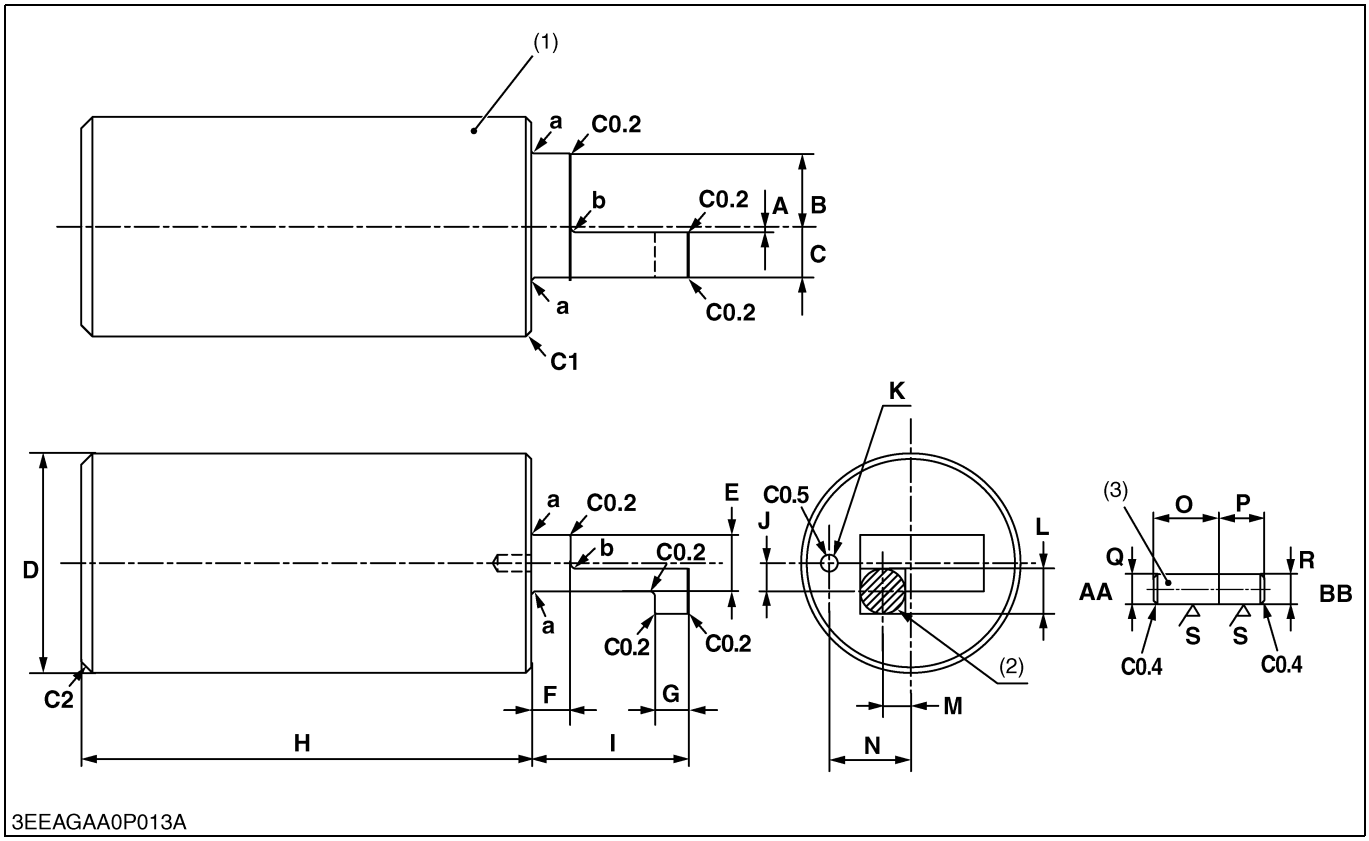
(1) Material : SS400

RY9212050END0021US0

Jig for Governor Connecting Rod

Application

- Use for connecting the governor connecting rod to the rack pin of the fuel injection pump assembly.



3EEAGAA0P013A

A	0.50 mm (0.020 in.)	**O**	5.0 mm (0.20 in.)
B	12.7 to 13.0 mm (0.500 to 0.511 in.)	**P**	4.0 mm (0.16 in.)
C	8.70 to 9.00 mm (0.343 to 0.354 in.)	**Q**	2.955 to 2.965 mm dia. (0.1164 to 0.1167 in. dia.)
D	39.0 mm (1.54 in.)	**R**	3.020 to 3.030 mm dia. (0.1189 to 0.1192 in. dia.)
E	10.0 mm (0.394 in.)	**S**	Ra = 1.6 a
F	7.0 mm (0.28 in.)	**AA**	Governor housing side
G	6.0 mm (0.24 in.)	**BB**	Press in side
H	80.0 mm (3.15 in.)	**a**	0.60 mm radius (0.024 in. radius)
I	27.95 to 28.05 mm (1.101 to 1.104 in.)	**b**	1.0 mm radius (0.039 in. radius)
J	5.0 mm (0.20 in.)	**C0.2**	Chamfer 0.20 mm (0.0079 in.)
K	3.000 to 3.010 mm dia., 6.0 mm depth (0.1182 to 0.1185 in. dia., 0.24 in. depth)	**C0.4**	Chamfer 0.40 mm (0.016 in.)
L	9.0 mm (0.35 in.)	**C0.5**	Chamfer 0.50 mm (0.020 in.)
M	5.0 mm (0.20 in.)	**C1**	Chamfer 1.0 mm (0.039 in.)
N	14.45 to 14.55 mm (0.5689 to 0.5728 in.)	**C2**	Chamfer 2.0 mm (0.079 in.)

(1) Material : S43C-D

(2) Permanent Magnet :
8.0 mm dia. (0.31 in. dia.)
Thickness : 3.0 mm (0.12 in.)

(3) Pin Material : SUM22

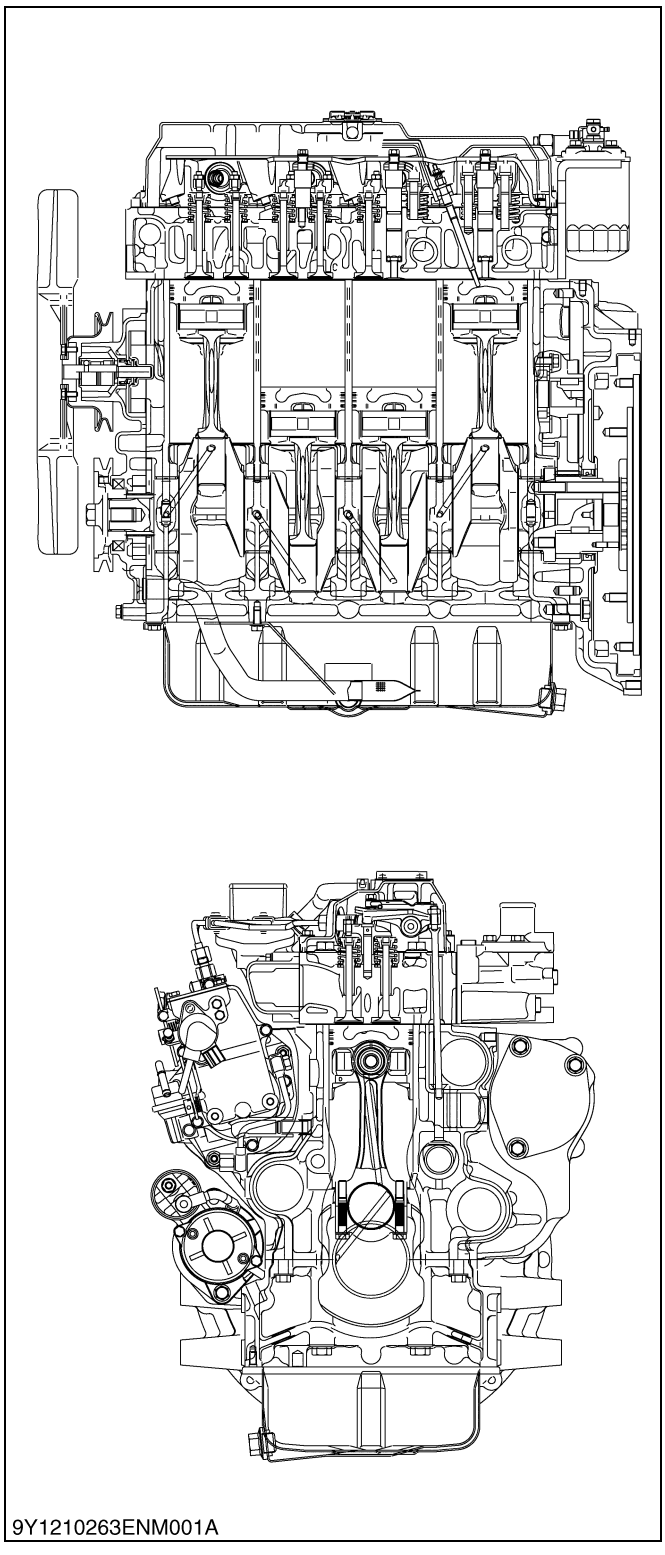
RY9212050END0022US0

MECHANISM

CONTENTS

1. FEATURE 2-M1
2. ENGINE BODY 2-M2
   [1] CYLINDER BLOCK 2-M2
   [2] COOLING JACKET 2-M2
   [3] HALF-FLOATING HEAD COVER 2-M3
   [4] CYLINDER HEAD 2-M3
   [5] 4 SCREWS PER EACH CYLINDER ASSEMBLING STRUCTURE 2-M4
   [6] CENTER DIRECT INJECTION SYSTEM (E-CDIS) 2-M5
   [7] GEAR TRAIN CONFIGURATION 2-M6
   [8] PISTON 2-M6
3. LUBRICATING SYSTEM 2-M7
   [1] OIL COOLER 2-M7
4. COOLING SYSTEM 2-M8
   [1] THERMOSTAT 2-M8
   [2] BOTTOM BYPASS SYSTEM 2-M9
5. FUEL SYSTEM 2-M10
   [1] GOVERNOR 2-M10
   [2] 2 STAGE DI NOZZLE 2-M12
   [3] INJECTION PUMP WITH F.S.P. 2-M13
   [4] CPV EQUIPPED DELIVERY VALVE 2-M14

1. FEATURE


9Y1210263ENM001A

The 07 series DI engine are the vertical type 4-cycle diesel engine featuring the advanced performances shown below.

■ **New Concept**

- The Kubota 07 Series is a totally new concept in engine design developed with various requirements necessary for a wide range of industrial applications.
- Kubota's unique cylinder block design was developed using Kubota's original casting technology allowing for a larger displacement within the current 2.4 L compact engine package.
- The improved cooling system with a main water gallery and water passages between cylinder bores as a countermeasure against heat load provides high power density, superior endurance and a reliable Kubota 07 Series.
- The Kubota 07 Series completes Kubota's seamless range up to 100 hp.

■ **Emissions**

- The NEW Kubota 07 Series engines have been designed to comply with EPA Interim Tier 4 (Option 1) emissions regulations, which are the most stringent in this size range. The Kubota 07 Series engines also comply with EU Stage IIIA requirements. The Kubota 07 Series engines offer the benefit of one year longer validity than Tier 3. Therefore, these engines are good through the end of 2012 in both the North American and European markets, which would save engineering resources for the future Tier levels.
- Meeting emission regulations with minimal additional required devices : NOx is reduced only by mechanical means such as a compactly designed cooled exhaust gas recirculation (EGR) system.

■ **Clean and Quiet Power**

- Kubota's original E-CDIS (Center Direct Injection System) combustion system, renowned for clean combustion in the Kubota V3 (DI) Series, has been renovated. The fuel injection pressure was increased and the combustion chamber was redesigned to achieve a 25 % lower particulate matter (PM) level, resulting in a better condition when compared to engines that only meet EPA Tier 3 regulations in this class.
- These new engines have been designed to reduce transmitted vibrations and radiated sound, resulting in lower noise levels. Operator and environmentally friendly, the Kubota 07 Series begins a new era of Kubota's engine design.

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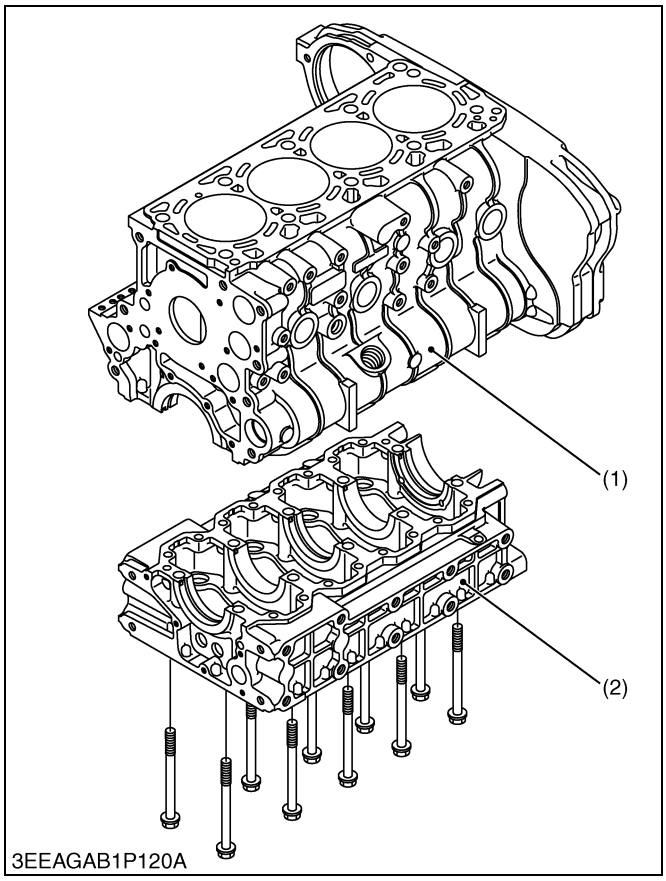
2. ENGINE BODY

[1] CYLINDER BLOCK



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The 07 series DI engine employs ladder frame structure type crankcases - the crankcase 1 (1) with combustion part and the crankcase 2 (2) which supports the crankcase 1 (1).

The following benefits are in the ladder frame structure.

1. Minimizing parts.
2. Noise reduction.
3. Reduction of loss and dispersion on friction thanks to accuracy of axial concentricity.

The cylinder is a linerless type which enables good cooling operation, less strain and good abrasion resistance.

(1) Crankcase 1 (2) Crankcase 2

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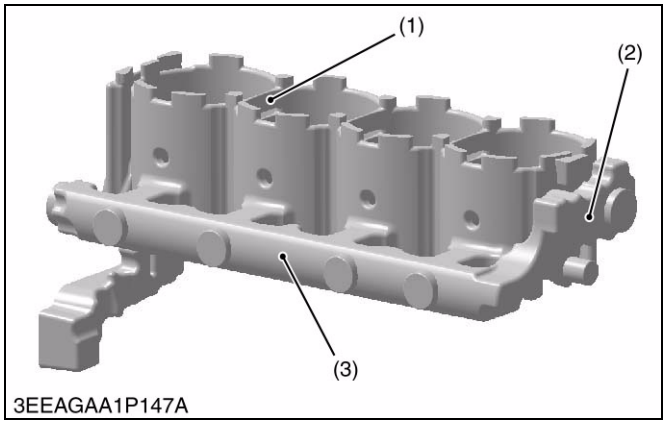
[2] COOLING JACKET



3EEAGAA1P147A

The 07 series DI engine employs coolant evenness distribution type cooling jacket inside crankcase 1. The coolant is evenly supplied to each cylinder through the main gallery (3) in the jacket mold core (2).

(1) Coolant Passage between Cylinder (2) Jacket Mold Core
(3) Main Gallery

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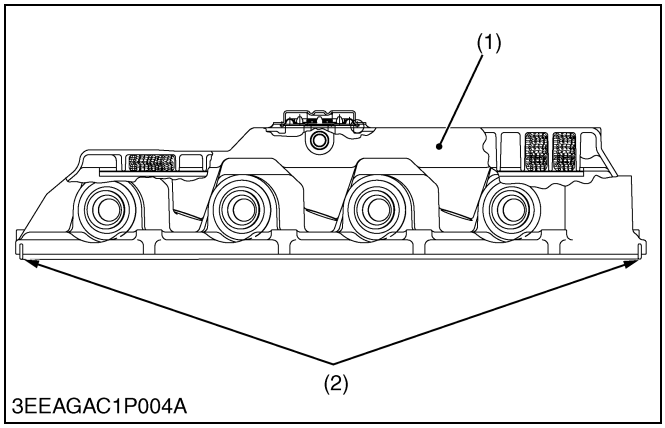
[3] HALF-FLOATING HEAD COVER



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The rubber packing (2) is fitted in to maintain the head cover 0.5 mm (0.02 in.) or so off the cylinder head. This arrangement helps reduce noise coming from the cylinder head.

(1) Cylinder Head Cover (2) Rubber Packing

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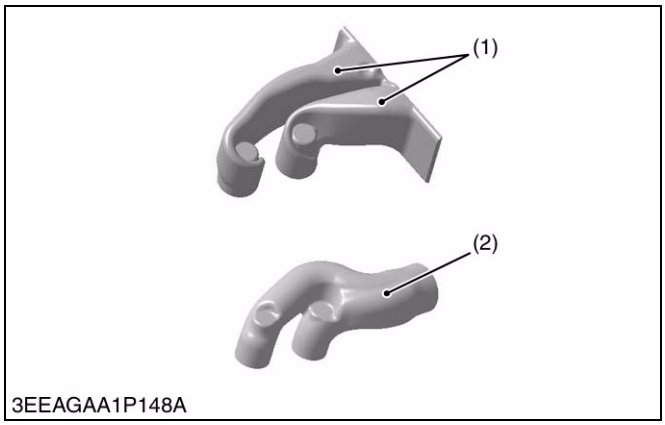
[4] CYLINDER HEAD



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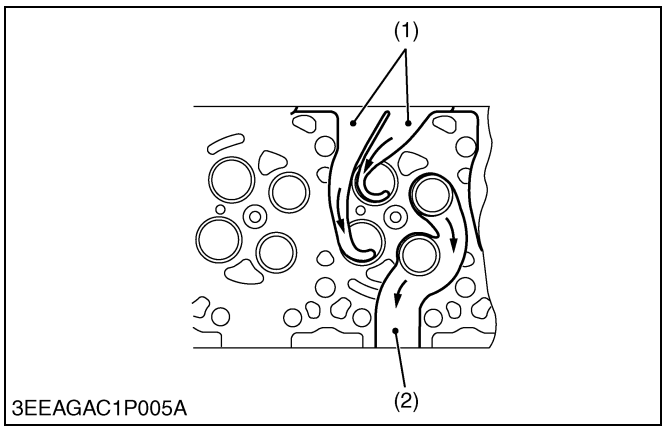

3EEAGAC1P005A

This engine employs four valve system, the cylinder head is provided with double intake passage in order to ensure appropriate air suction and give an optimum swirl.

(1) Intake (2) Exhaust

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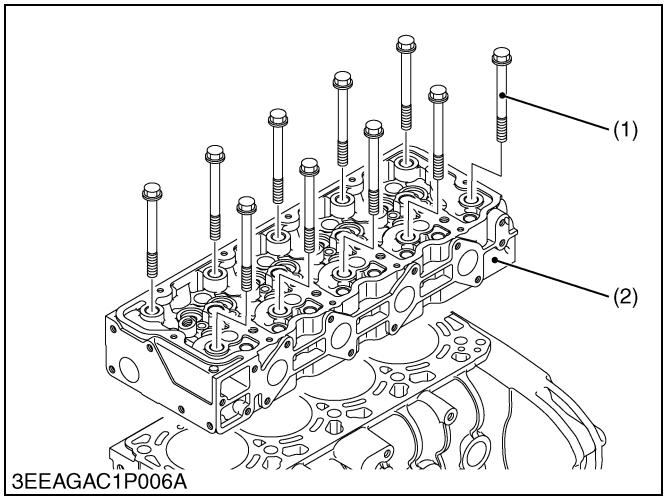
[5] 4 SCREWS PER EACH CYLINDER ASSEMBLING STRUCTURE



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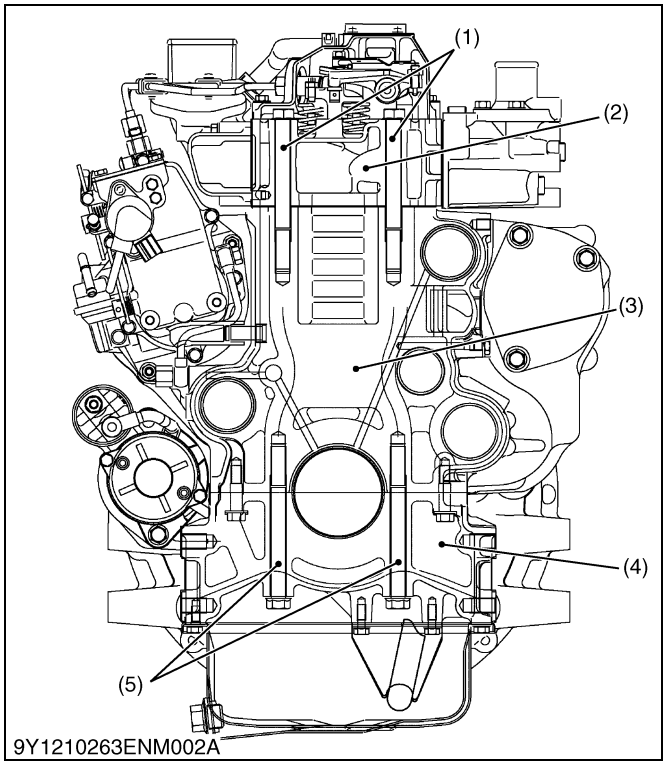

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The 07 series DI engine employs 4 screws per each cylinder assembling structure.

The cylinder head (2) and the crankcase 2 (4) are assembled from the top and bottom to the crankcase 1 (3) with each of 10 screws.

The following objectives are in the 4 screws per each cylinder assembling structure.

1. Reduce the load share rate of combustion pressure on outer block surface wall.
2. Flexibility of cylinder head design.

(1) Cylinder Head Mounting Screw
(2) Cylinder Head
(3) Crankcase 1
(4) Crankcase 2
(5) Crankcase 2 Mounting Screw

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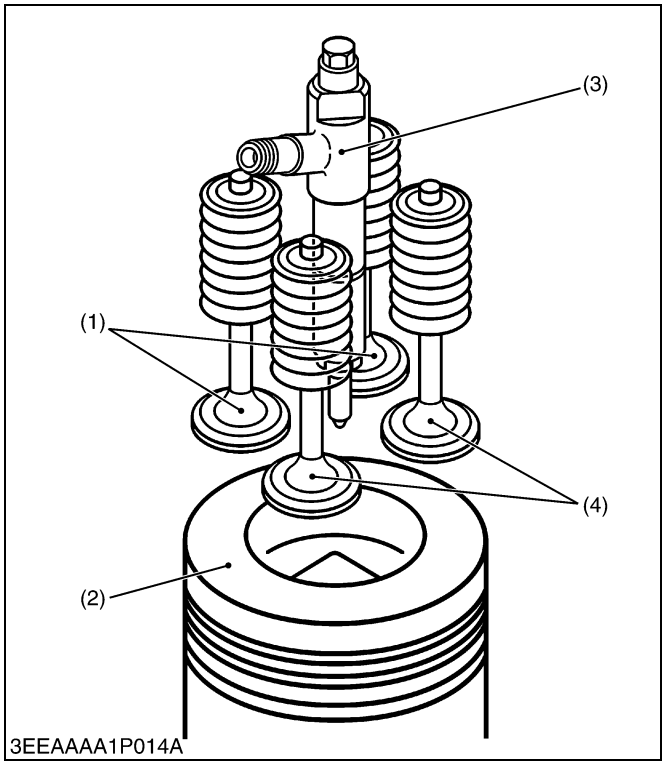
[6] CENTER DIRECT INJECTION SYSTEM (E-CDIS)



3EEAAAA1P014A

The 07 series DI engine adopts the Center Direct Injection System (E-CDIS), in which the injection nozzle (3) is positioned upright at the center of the cylinder.

This system serves to inject fuel directly at the center of the cylinder. By so doing, injected fuel and suction air can be mixed more uniformly, leading to more stable, higher combustion performance. In other words, cleaner emission, higher power output, lower fuel consumption, lower operating noise and higher start-up performance have been achieved.

(1) Exhaust Valves
(2) Piston
(3) Injection Nozzle
(4) Intake Valves

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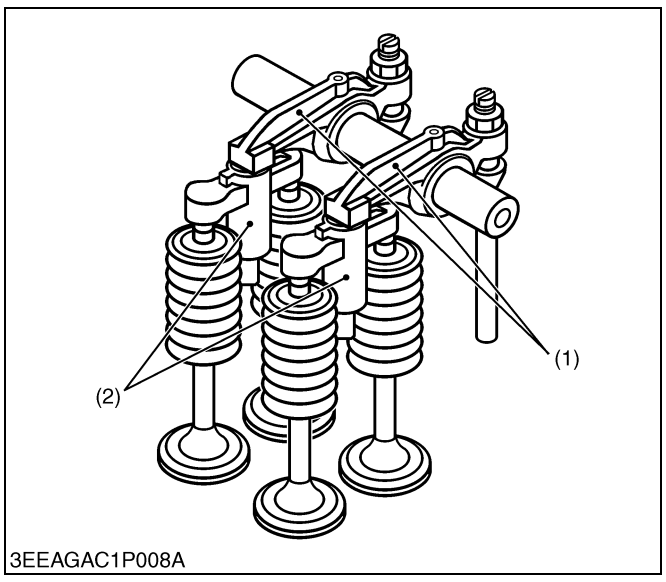

3EEAGAC1P008A

The 07 series DI engine has two intake valves and two exhaust valves per each cylinder.

The rocker arm (1) contacts a valve bridge arm (2) instead of the valves stem tip.

The valve bridge arm (2) then contacts both intake valves or both exhaust valves and causes two valves to open simultaneously.

(1) Rocker Arm
(2) Valve Bridge Arm

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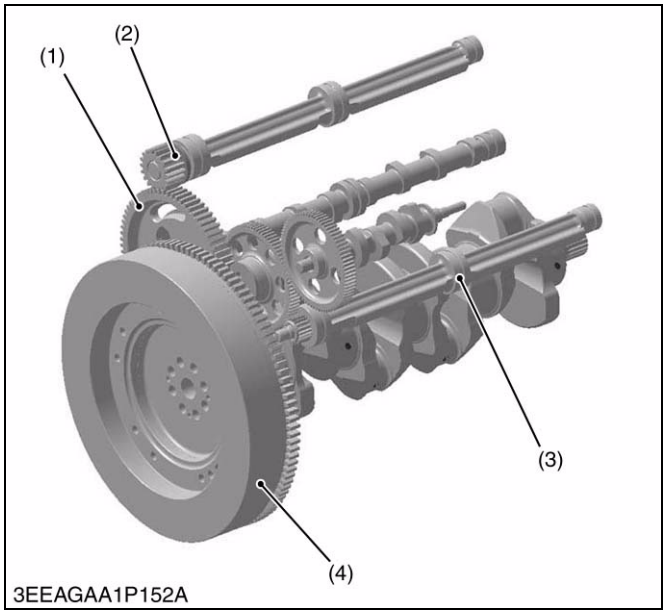
[7] GEAR TRAIN CONFIGURATION



3EEAGAA1P152A

The 07 series DI engine employs gear train located at flywheel side. The following benefits are in the rear gear train configuration.

1. Flexibility of auxiliary parts arrangement.
2. Reduction of gear chattering noise from crankshaft of torsional and bending vibration.

(1) Rear Gear Train
(2) Balancer Shaft 1 (Option)
(3) Balancer Shaft 2 (Option)
(4) Flywheel

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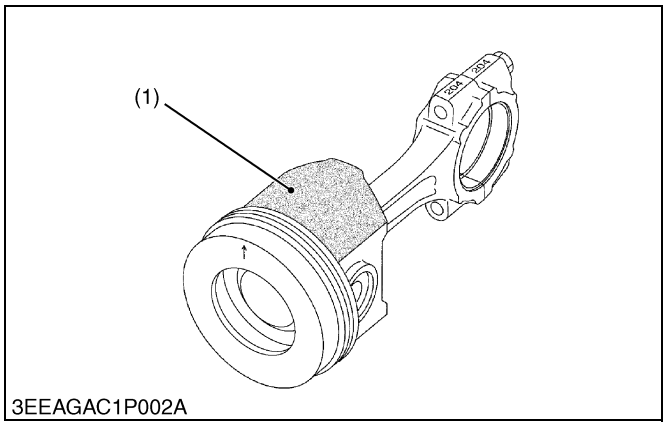
[8] PISTON



3EEAGAC1P002A

Piston's skirt is coated with **molybdenum disulfide★**, which reduces the piston slap noise and thus the entire operating noise.

★Molybdenum disulfide (MoS_2)

The molybdenum disulfide (1) serves as a solid lubricant, like a Graphite or Teflon. This material helps resist metal wears even with little lube oil.

(1) Molybdenum Disulfide

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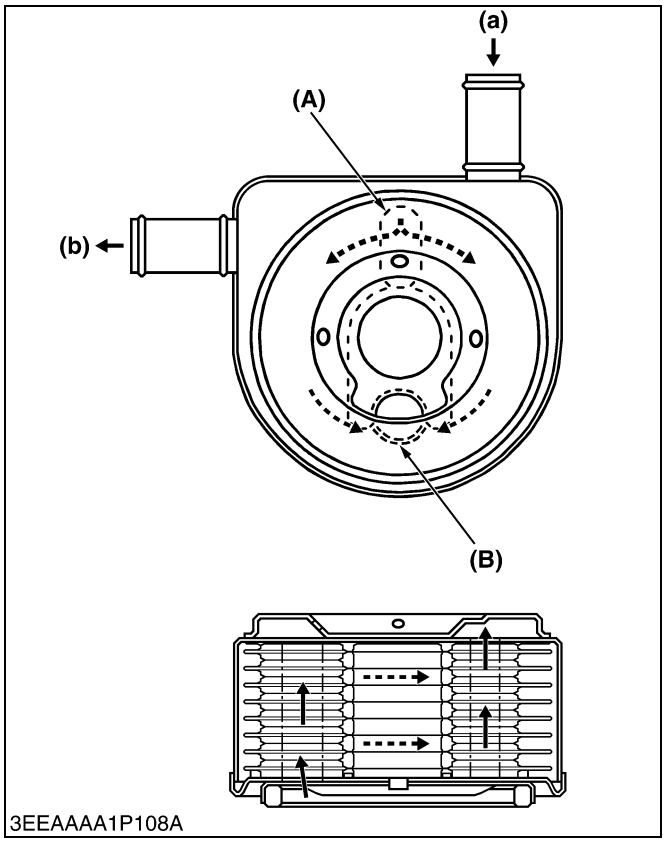
3. LUBRICATING SYSTEM

[1] OIL COOLER



3EEAAAA1P108A

The 07 series engine has a coolant-cooled oil cooler that not only cools hot oil, but also warms the cool engine oil shortly after start up.

As shown in the figure, the oil flows inside the connected cooler plate, whereas coolant is kept circulating outside the cooler plate, thereby cooling down or warming the oil.

(A) Oil Inlet Port
(B) Oil Outlet Port
(a) Coolant Inlet Port
(b) Coolant Outlet Port

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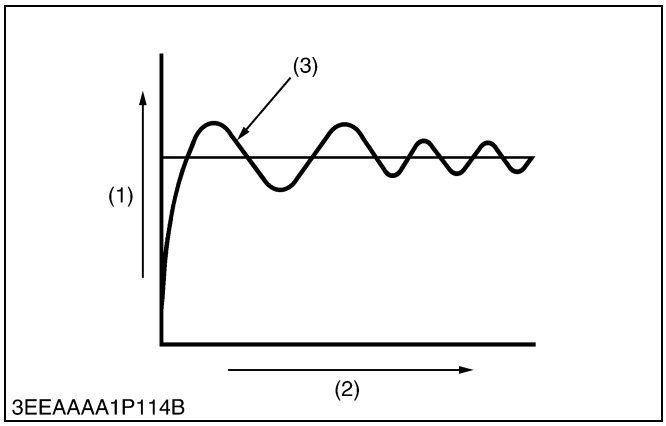
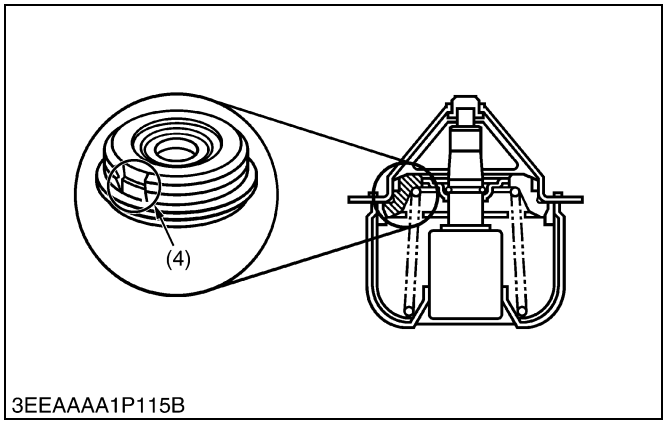
4. COOLING SYSTEM

[1] THERMOSTAT



3EEAAAA1P114B



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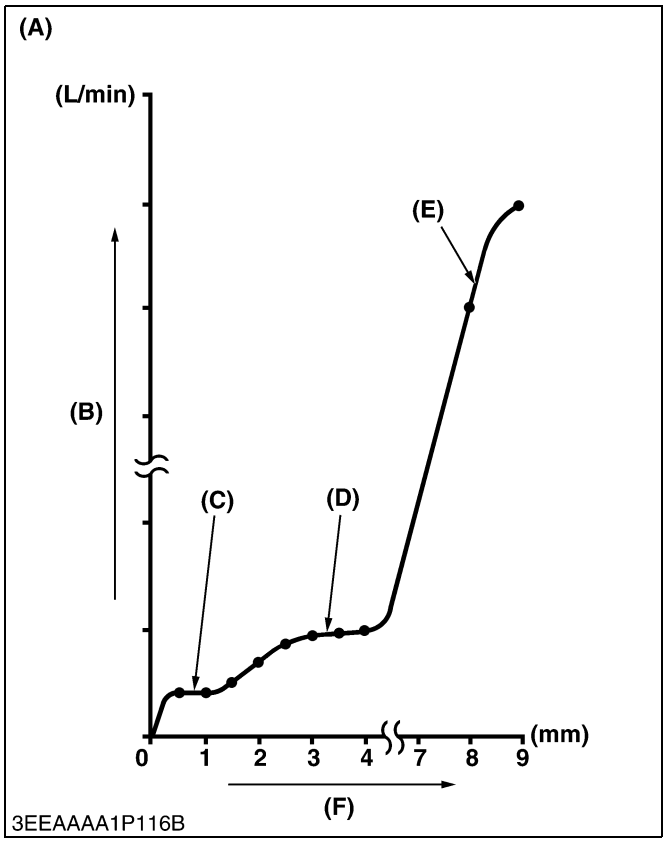

3EEAAAA1P116B

Conventional thermostatically-controlled valves (outlet water temperature control type) open against the flow of coolant. In this design, the pressure (steam pressure + water pump's discharge pressure) affects the open/close performance of such valve. In other words, the valve may be delayed in opening at a preset opening temperature opening suddenly, above the preset temperature. This is called the overshoot phenomenon.

The overshoot problem invites the undershoot phenomenon too. Too much water cooled by the radiator flows through the water passage, which suddenly closes the valve below the thermostat's preset valve closing temperature.

A repeated cycle of such overshoot (3) and undershoot phenomena is called the water temperature hunting. This hunting problem may adversely affect the cooling system parts, and also the engine and its related components.

To cope with this trouble, the 07 series engine is equipped with the flow control thermostat. The valve has a notch (4) to control the coolant flow-rate smoothly in small steps.

(1) Coolant Temperature
(2) Time
(3) Overshoot
(4) Notch

(A) Valve Lift Versus Flow-rate
(B) Flow-rate
(C) At Short Valve Lift
(D) At Medium Valve Lift
(E) At High Valve Lift
(F) Valve Lift

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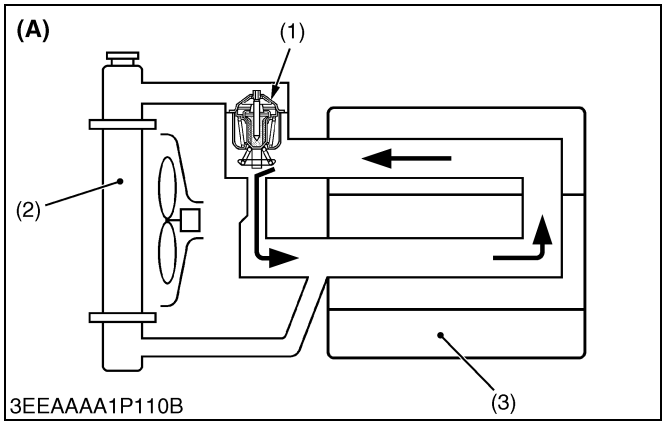
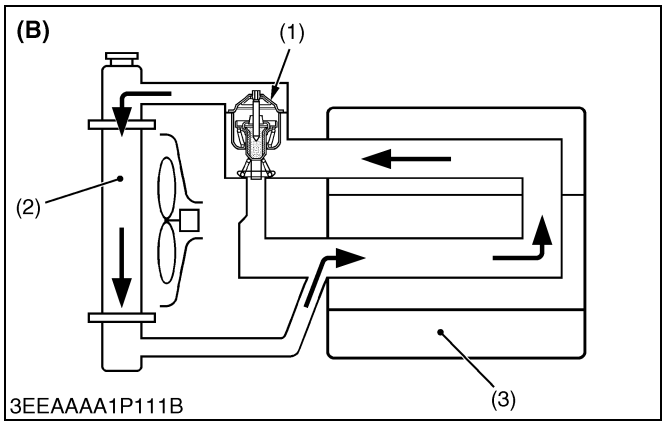
[2] BOTTOM BYPASS SYSTEM





Bottom bypass system is introduced in the 07 series for improving the cooling performance of the radiator.

While the temperature of coolant in the engine is low, the thermostat (1) is held closed and the coolant is allowed to flow through the bypass pipe and to circulate in the engine.

When the temperature exceeds the thermostat (1) valve opening level, the thermostat (1) fully opens itself to prevent the hot coolant from flowing through the bypass into the engine.

In this way, the radiator can increase its cooling performance.

(1) Thermostat
(2) Radiator
(3) Engine

(A) Bypass Opened
(B) Bypass Closed

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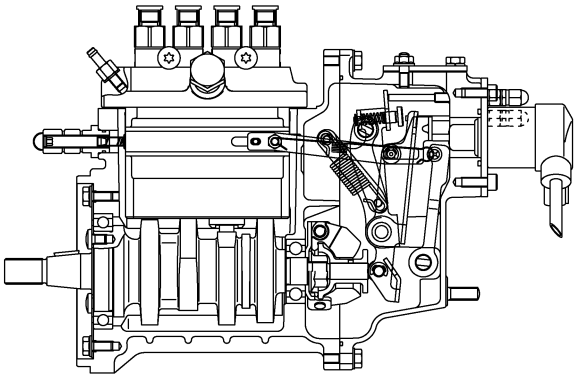
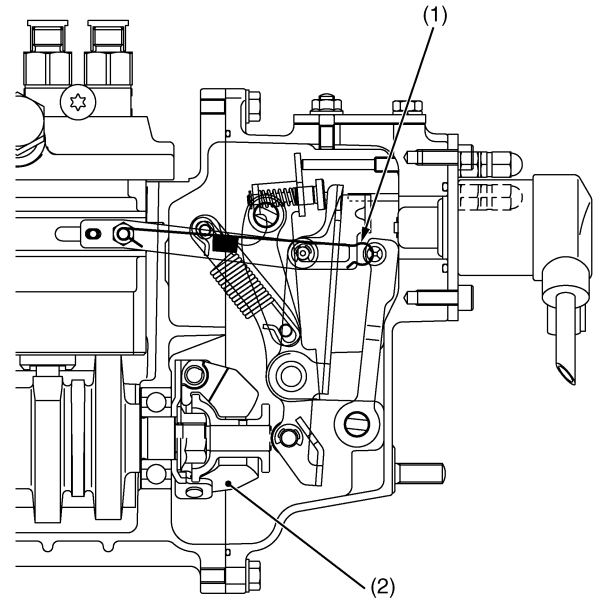
5. FUEL SYSTEM

[1] GOVERNOR



3EEAGAA1P155A



3EEAGAA1P156A

The engine employs the separated fuel injection pump in combination with Kubota's own small multi-function mechanical governor, which enables more dependability.

It also employs the torque limiting mechanism to control the maximum peak torque so that it complies with the regulations of exhaust gas.

This mechanism maintains engine speed at a constant level even under fluctuating loads, provides stable idling and regulates maximum engine speed by controlling the fuel injection rate.

This engine uses a mechanical governor that controls the fuel injection rate at all speed ranges (from idling to maximum speed) by utilizing the balance between the flyweight's centrifugal force and spring tension.

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At Start

The stop solenoid (energized-to-run type) is powered to release the stop lever.

As no centrifugal force is applied to flyweight (2), low tension of start spring (1) permits control rack to move the starting position, supplying the amount of fuel required to start the engine.

(1) Start Spring (2) Flyweight

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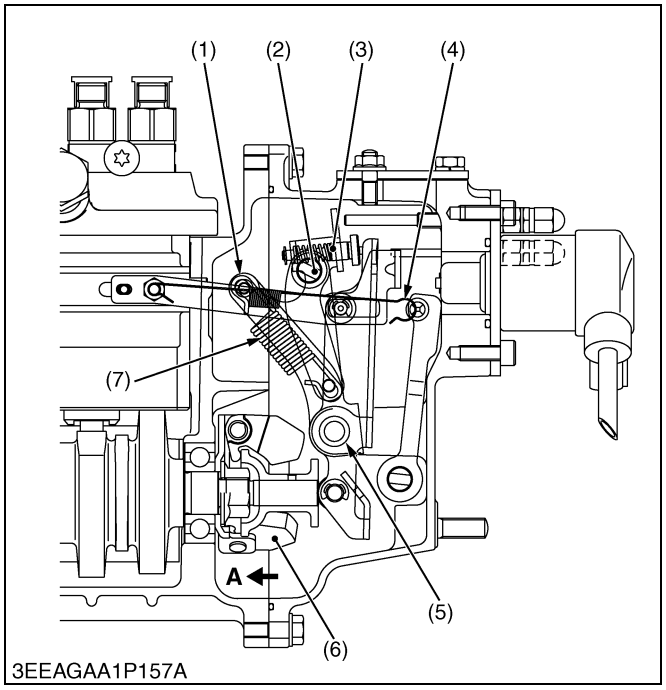

3EEAGAA1P157A

At Idling

Turn the speed control lever (2) clockwise to idle the engine. It tensions the governor spring (7) to pull the fork lever 2 (1).

When the fork lever 2 (1) is pulled, it moves the torque spring pin (3) and the fork lever 1 (5) in the direction of the arrow **A** to restrain the weight. In combination with the start spring tension, it is balanced with the centrifugal force of flywheel weight to keep idling.

(1) Fork Lever 2
(2) Speed Control Lever
(3) Spring Pin
(4) Start Spring
(5) Fork Lever 1
(6) Flyweight
(7) Governor Spring

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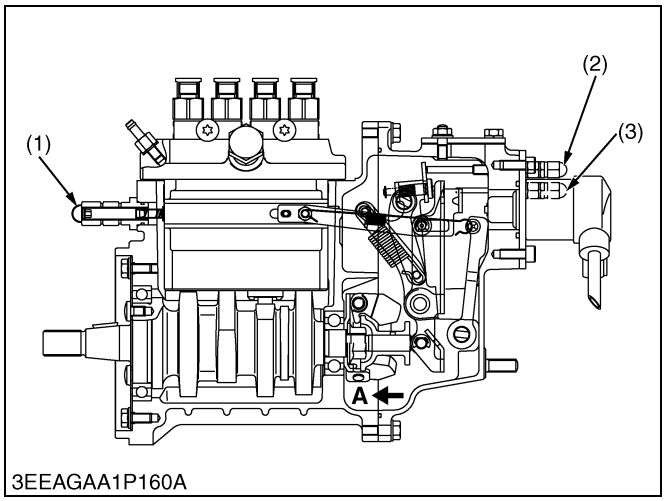

3EEAGAA1P160A

At rated speed with full load and overload

As the speed control lever is changed from the middle speed to high speed, the governor spring tension increases to compress the torque spring and move the fork lever 1 in the direction of the arrow **A**.

The fork lever 2 moves until it reaches the output limiting bolt (2) to keep rated rotation and rated output.

When the engine is overloaded, the engine rotating speed decreases and the centrifugal force of flywheel weight decreases. Then the torque spring moves the fork lever 1 in the direction of arrow **A**.

The control rack moves in the direction that increases fuel supply to increase the output. It is balanced with the centrifugal force of the flywheel weight to produce low-speed output (torque output).

(1) No-load Maximum Rotation
(2) Output Limiting Bolt
(3) Torque Limiting Bolt

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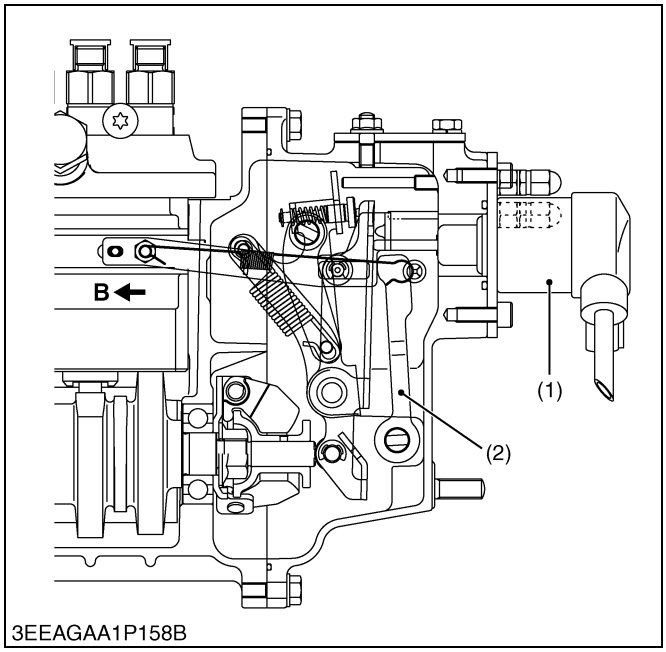

3EEAGAA1P158B

To stop engine

When the stop solenoid (1) is turned off, the spring tension of the solenoid is released, the rod extrudes and the stop lever moves the control rack in the direction of the arrow **B** which stops the engine.

To stop the engine manually, move the external stop lever to the left.

(1) Stop Solenoid (2) Stop Lever Shaft

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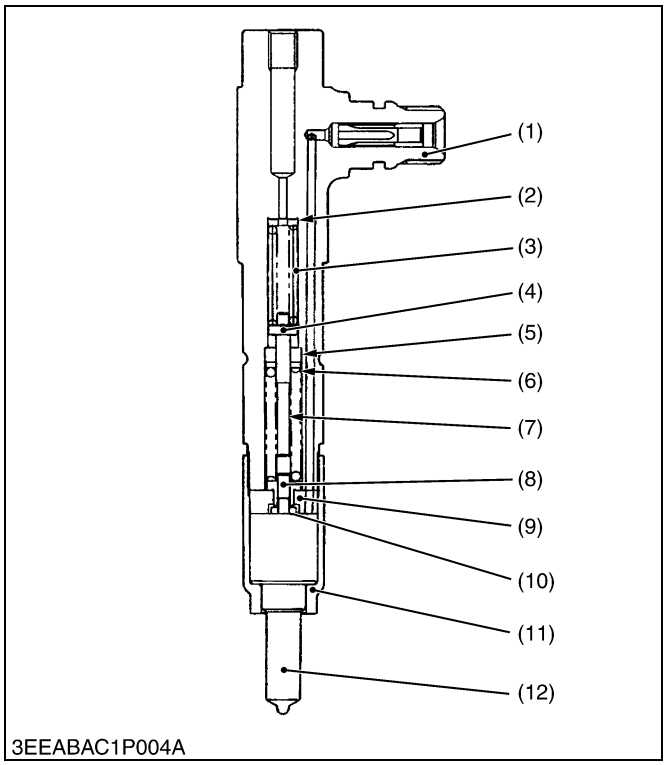
[2] 2 STAGE DI NOZZLE



3EEABAC1P004A

Exhaust and noise regulations are becoming increasingly strict, particularly in regard to the reduction of NOx (nitrogen oxides) and particulates.

The two-spring nozzle holder has been developed to reduce NOx (nitrogen oxides) and particulates from direct injection diesel engine exhaust.

■ **Features**

The two-spring nozzle holder limits needle valve lift at initial valve opening to throttle the injection quantity. Main injection occurs when the in-line pressure has increased sufficiently to move the needle valve through its full lift.

This gives the following features.

- Improved engine stability at low and intermediate speeds.
- Decreased engine hunting and surge.
- Decreased noise at idling.
- Decreased idling speed because of improved engine stability.
- Stabilized fuel injection characteristics from the injection pump and nozzle system, and easier matching of governor characteristics to engine demand.

(1) Nozzle Holder Body
(2) 1st Stage Injection Pressure Adjusting Shim
(3) First Spring
(4) Pressure Pin
(5) Spring Seat
(6) 2nd Stage Injection Pressure Adjusting Shim
(7) Second Spring
(8) Pre-lift Adjusting Spring Seat
(9) Chip-packing
(10) Max-lift Adjusting Washer
(11) Retaining Nut
(12) Nozzle

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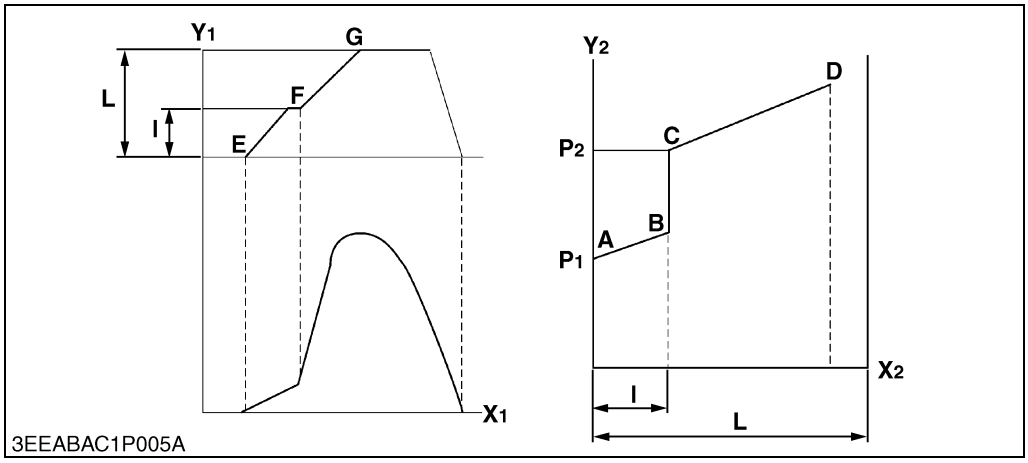

A-B : First Spring's Set Force
B-C-D : Combined Force of First and Second Springs
P1 : First Opening Pressure
P2 : Second Opening Pressure

L : Full Needle Valve Lift
I : Needle Valve Pre-lift

X1 : Cam Angle (°)
Y1 : Injection Rate (mm^3/°)
X2 : Needle Valve Lift (mm)
Y2 : In-line Pressure

■ **First opening pressure**

The force of the high pressure fuel delivered by the injection pump acts to push the needle valve up. When this force exceeds the set force of the first spring, the nozzle's needle valve pushes the first pushrod up and the valve opens. (First opening pressure is represented by point **E** in the bottom left hand figure, and point **A** in the above figure.)

■ **Second opening pressure**

When the first pushrod has been lifted through the pre-lift, it contacts the second pushrod. As the set force of the second spring is acting on the second pushrod, the combined forces of both the first spring and the second spring then act on the needle valve, which will not lift unless these forces are overcome.

When the high pressure fuel (i.e., in-line pressure) overcomes the combined forces of the first and second springs, the needle valve is again lifted and main injection can begin. (Second opening pressure is represented by point **F** in the bottom left hand figure and **B**-**C** in the above figure.)

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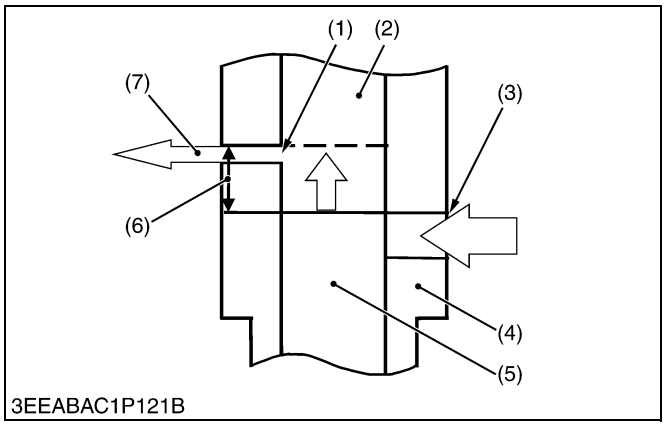
[3] INJECTION PUMP WITH F.S.P.



The fuel injection pump with F.S.P. (Fine Spill Port) mechanism is equipped with two functions: speed timer function and injection rate control function.

The former function works like this. As the rpm is low, the injection timing gets delayed. This helps cut down on NOx and operating noise.

The latter function serves to keep down the initial injection rate and keep up the later injection rate, which cuts down on NOx and PM as well.

(1) Fine Spill Port (F.S.P.)
(2) Plunger Chamber
(3) Main Port
(4) Cylinder
(5) Plunger
(6) F.S.P. Stroke
(7) Leaking Fuel at Initial Fuel Pressure-Feed Stage

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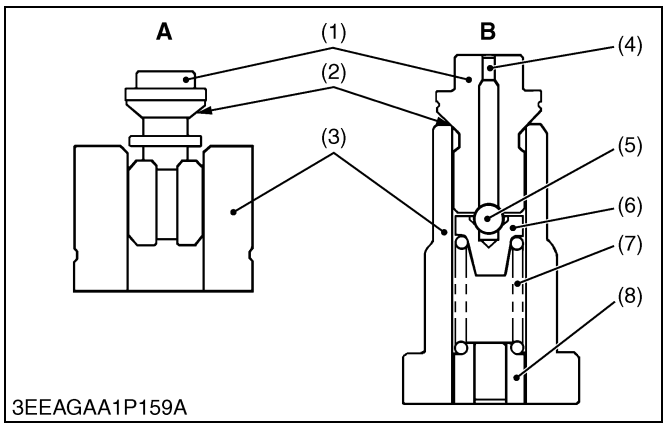
[4] CPV EQUIPPED DELIVERY VALVE



The Constant Pressure Valve (CPV) is a mechanism that maintains uniform residual pressure in the high pressure pipe. It stabilizes overall delivery quantity characteristics and especially delivery quantity characteristics at low speeds.

■ **At high fuel pressure**

The delivery valve (1), the steel ball (5) and the snapper valve (6) are moved up together. The delivery valve seat surface (2) opens when the fuel pressure becomes more than the delivery valve set pressure.

■ **At after injection**

The delivery valve (1), the steel ball (5) and the snapper valve (6) are moved down and the delivery valve seat surface (2) closes. The steel ball still opens on the way and the fuel returns to the injection pump side. The steel ball (5) closes when the fuel pressure becomes less than the snapper valve set pressure.

(1) Delivery Valve
(2) Seat Surface
(3) Valve Seat
(4) Orifice
(5) Steel Ball
(6) Snapper Valve
(7) Snapper Valve Spring
(8) Snapper Valve Seat

A : Current Delivery Valve
B : CPV Equipped Delivery Valve

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SERVICING

CONTENTS

1. TROUBLESHOOTING....2-S1
2. SERVICING SPECIFICATIONS....2-S4
3. TIGHTENING TORQUES....2-S10
   [1] TIGHTENING TORQUES FOR GENERAL USE SCREWS, BOLTS AND NUTS....2-S10
   [2] TIGHTENING TORQUES FOR SPECIAL USE SCREWS, BOLTS AND NUTS....2-S11
4. CHECKING, DISASSEMBLING AND SERVICING....2-S13
   [1] CHECKING AND ADJUSTING....2-S13
      (1) Engine Body....2-S13
      (2) Lubricating System....2-S15
      (3) Cooling System....2-S15
      (4) Fuel System....2-S18
      (5) Electrical System....2-S21
   [2] DISASSEMBLING AND ASSEMBLING....2-S25
      (1) Draining Oil and Coolant....2-S25
      (2) External Components....2-S25
      (3) Cylinder Head and Valves....2-S26
      (4) Thermostat....2-S30
      (5) Injection Pump Unit....2-S31
      (6) Water Pump and Oil Cooler....2-S41
      (7) Front Cover....2-S41
      (8) Flywheel and Timing Gears....2-S42
      (9) Piston and Connecting Rod....2-S45
      (10)Crankshaft and Crankcase....2-S49
      (11)Starter....2-S51
      (12)Alternator....2-S51
   [3] SERVICING....2-S54
      (1) Cylinder Head and Valves....2-S54
      (2) Timing Gears....2-S60
      (3) Piston and Connecting Rod....2-S62
      (4) Crankshaft....2-S66
      (5) Cylinder....2-S71
      (6) Oil Pump....2-S71
      (7) Relief Valve....2-S72
      (8) Starter....2-S73
      (9) Alternator....2-S75

1. TROUBLESHOOTING

Symptom	Probable Cause	Solution
Engine Does Not Start	No fuel	Replenish fuel
	Air in the fuel system	Vent air
	Water in the fuel system	Change fuel and repair or replace fuel system
	Fuel hose clogged	Clean or replace
	Fuel filter clogged	Replace
	Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil
	Fuel with low cetane number	Use specified fuel
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut
	Incorrect injection timing	Adjust
	Fuel camshaft worn	Replace
	Injection nozzle clogged	Repair or replace
	Injection pump malfunctioning	Repair or replace
	Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or replace
	Compression leak from cylinder	Replace head gasket, tighten cylinder head screw, glow plug and nozzle holder
	Improper valve timing	Correct or replace timing gear
	Piston ring and cylinder worn	Replace
	Excessive valve clearance	Adjust
	Stop solenoid malfunctioning	Replace
Starter Does Not Run	Battery discharged	Charge
	Starter malfunctioning	Repair or replace
	Key switch malfunctioning	Replace
	Wiring disconnected	Connect
Engine Revolution Is Not Smooth	Fuel filter clogged or dirty	Replace
	Air cleaner clogged	Clean or replace
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut
	Injection pump malfunctioning	Repair or replace
	Incorrect nozzle opening pressure	Repair or replace
	Injection nozzle stuck or clogged	Repair or replace
	Governor malfunctioning	Repair
Either White or Blue Exhaust Gas Is Observed	Excessive engine oil	Reduce to specified level
	Piston ring and cylinder worn or stuck	Repair or replace
	Incorrect injection timing	Adjust
Either Black or Dark Gray Exhaust Gas Is Observed	Overload	Reduce the load
	Low grade fuel used	Use specified fuel
	Fuel filter clogged	Replace
	Air cleaner clogged	Clean or replace
	Deficient nozzle injection	Repair or replace nozzle

Symptom	Probable Cause	Solution
Deficient Output	Incorrect injection timing	Adjust
	Engine's moving parts seem to be seizing	Repair or replace
	Injection pump malfunctioning	Repair or replace
	Deficient nozzle injection	Repair or replace nozzle
	Compression leak	Check the compression pressure and repair
	Air cleaner dirty or clogged	Clean or replace
Excessive Lubricant Oil Consumption	Piston ring's gap facing the same direction	Shift ring gap direction
	Oil ring worn or stuck	Replace
	Piston ring groove worn	Replace piston
	Valve stem and valve guide worn	Replace
	Crankshaft bearing and crank pin bearing worn	Replace
	Oil leaking due to defective seals or packing	Replace
Fuel Mixed into Lubricant Oil	Injection pump's plunger worn	Repair or replace
	Deficient nozzle injection	Repair or replace nozzle
	Injection pump broken	Replace
Water Mixed into Lubricant Oil	Head gasket defective	Replace
	Cylinder block or cylinder head flawed	Replace
Low Oil Pressure	Engine oil insufficient	Replenish
	Oil strainer clogged	Clean
	Relief valve stuck with dirt	Clean
	Relief valve spring weaken or broken	Replace
	Excessive oil clearance of crankshaft bearing	Replace
	Excessive oil clearance of crankpin bearing	Replace
	Excessive oil clearance of rocker arm	Replace
	Oil passage clogged	Clean
	Different type of oil	Use specified type of oil
	Oil pump defective	Replace
High Oil Pressure	Different type of oil	Use specified type of oil
	Relief valve defective	Replace
Engine Overheated	Engine oil insufficient	Replenish
	Fan belt broken or elongated	Replace or adjust
	Coolant insufficient	Replenish
	Radiator net and radiator fin clogged with dust	Clean
	Inside of radiator corroded	Clean or replace
	Coolant flow route corroded	Clean or replace
	Radiator cap defective	Replace
	Overload running	Reduce the load
	Head gasket defective	Replace
	Incorrect injection timing	Adjust
	Unsuitable fuel used	Use specified fuel

Symptom	Probable Cause	Solution
Battery Quickly Discharged	Battery electrolyte insufficient	Replenish distilled water and charge
	Fan belt slips	Adjust belt tension or replace
	Wiring disconnected	Connect
	Rectifier defective	Replace
	Alternator defective	Replace
	Battery defective	Replace

RY9212050ENS0001US0

2. SERVICING SPECIFICATIONS

ENGINE BODY

Item		Factory Specification	Allowable Limit
Compression Pressure		3.20 MPa / 150 min^{-1} (rpm) 32.6 kgf/cm^2 / 150 min^{-1} (rpm) 464 psi / 150 min^{-1} (rpm)	2.20 MPa / 150 min^{-1} (rpm) 22.4 kgf/cm^2 / 150 min^{-1} (rpm) 319 psi / 150 min^{-1} (rpm)
Variance Among Cylinders		–	10 % or less
Valve Clearance (Cold)		0.13 to 0.17 mm 0.0052 to 0.0068 in.	–
Top Clearance		0.60 to 0.80 mm 0.024 to 0.031 in.	–
Cylinder Head Surface	Flatness	–	0.05 mm 0.002 in.
Valve Recessing (Intake and Exhaust)		0.65 to 0.85 mm 0.026 to 0.033 in.	1.20 mm 0.0472 in.
Valve Stem to Valve Guide (Intake)	Clearance	0.030 to 0.057 mm 0.0012 to 0.0022 in.	0.10 mm 0.0039 in.
• Valve Stem	O.D.	5.968 to 5.980 mm 0.2350 to 0.2354 in.	–
• Valve Guide	I.D.	6.010 to 6.025 mm 0.2367 to 0.2372 in.	–
Valve Stem to Valve Guide (Exhaust)	Clearance	0.045 to 0.072 mm 0.0018 to 0.0028 in.	0.10 mm 0.0039 in.
• Valve Stem	O.D.	5.953 to 5.965 mm 0.2344 to 0.2348 in.	–
• Valve Guide	I.D.	6.010 to 6.025 mm 0.2367 to 0.2372 in.	–
Valve Face (Intake and Exhaust)	Angle	0.79 rad 45 °	–
Valve Seat (Intake and Exhaust)	Angle	0.79 rad 45 °	–
	Width	3.3 to 3.6 mm 0.13 to 0.14 in.	–
Intake Valve Timing	Open	0.21 rad (12 °) before T.D.C.	–
	Close	0.77 rad (44 °) after B.D.C.	–
Exhaust Valve Timing	Open	0.86 rad (49 °) before B.D.C.	–
	Close	0.30 rad (17 °) after T.D.C.	–

Item		Factory Specification	Allowable Limit
Valve Spring (Intake and Exhaust)	Tilt	–	1.0 mm 0.039 in.
	Free Length	35.4 to 35.9 mm 1.40 to 1.41 in.	34.9 mm 1.37 in.
Valve Spring (Intake and Exhaust)	Setting Load / Setting Length	60.8 N / 29.7 mm 6.20 kgf / 29.7 mm 13.7 lbf / 1.17 in.	45.9 N / 29.7 mm 4.68 kgf / 29.7 mm 10.3 lbf / 1.17 in.
Rocker Arm Shaft to Rocker Arm	Oil Clearance	0.016 to 0.045 mm 0.00063 to 0.0017 in.	0.15 mm 0.0059 in.
• Rocker Arm Shaft	O.D.	13.973 to 13.984 mm 0.55012 to 0.55055 in.	–
• Rocker Arm	I.D.	14.000 to 14.018 mm 0.55119 to 0.55188 in.	–
Valve Bridge Arm and Valve Bridge Shaft	Oil Clearance	0.018 to 0.057 mm 0.00071 to 0.0022 in.	0.15 mm 0.0059 in.
• Valve Bridge Shaft	O.D.	8.023 to 8.032 mm 0.3159 to 0.3162 in.	–
• Valve Bridge Arm	I.D.	8.050 to 8.080 mm 0.3170 to 0.3181 in.	–
Push Rod	Alignment	–	0.25 mm 0.0098 in.
Tappet to Tappet Bore	Oil Clearance	0.020 to 0.050 mm 0.00079 to 0.0019 in.	0.07 mm 0.003 in.
• Tappet	O.D.	9.965 to 9.980 mm 0.3924 to 0.3929 in.	–
• Tappet Bore	I.D.	10.000 to 10.015 mm 0.39370 to 0.39429 in.	–
Timing Gear • Crank Gear to Cam Gear	Backlash	0.0400 to 0.137 mm 0.00158 to 0.00539 in.	0.22 mm 0.0087 in.
• Cam Gear to Idle Gear	Backlash	0.0460 to 0.136 mm 0.00182 to 0.00535 in.	0.22 mm 0.0087 in.
• Idle Gear to Injection Pump Gear	Backlash	0.0460 to 0.136 mm 0.00182 to 0.00535 in.	0.22 mm 0.0087 in.
Idle Gear	Side Clearance	0.050 to 0.20 mm 0.0020 to 0.0078 in.	0.90 mm 0.035 in.
Idle Gear Shaft to Idle Gear Bushing	Oil Clearance	0.025 to 0.096 mm 0.00099 to 0.0037 in.	0.10 mm 0.0039 in.
• Idle Gear Shaft	O.D.	34.959 to 34.975 mm 1.3764 to 1.3769 in.	–
• Idle Gear Bushing	I.D.	35.000 to 35.055 mm 1.3780 to 1.3801 in.	–
Camshaft	Side Clearance	–	0.10 mm 0.0039 in.

Item		Factory Specification	Allowable Limit
Camshaft	Alignment	–	0.01 mm 0.0004 in.
Cam Height	Intake	32.56 mm 1.282 in.	32.10 mm 1.264 in.
	Exhaust	33.00 mm 1.299 in.	32.50 mm 1.280 in.
Camshaft	Oil Clearance	0.050 to 0.091 mm 0.0020 to 0.0035 in.	0.15 mm 0.0059 in.
• Camshaft Journal 1	O.D.	34.934 to 34.950 mm 1.3754 to 1.3759 in.	–
• Cylinder Block Bore 1	I.D.	35.000 to 35.025 mm 1.3780 to 1.3789 in.	–
• Camshaft Journal 2	O.D.	41.934 to 41.950 mm 1.6510 to 1.6515 in.	–
• Cylinder Block Bore 2	I.D.	42.000 to 42.025 mm 1.6536 to 1.6545 in.	–
Piston Pin Bore	I.D.	26.000 to 26.013 mm 1.0237 to 1.0241 in.	26.05 mm 1.026 in.
Piston Pin to Small End Bushing	Oil Clearance	0.014 to 0.034 mm 0.00056 to 0.0013 in.	0.15 mm 0.0059 in.
• Piston Pin	O.D.	26.006 to 26.011 mm 1.0239 to 1.0240 in.	–
• Small End Bushing	I.D.	26.025 to 26.040 mm 1.0246 to 1.0252 in.	–
Connecting Rod	Alignment	–	0.05 mm 0.002 in.
Piston Ring Gap	Top Ring	0.20 to 0.35 mm 0.0079 to 0.013 in.	1.25 mm 0.0492 in.
	Second Ring	0.30 to 0.45 mm 0.012 to 0.017 in.	1.25 mm 0.0492 in.
	Oil Ring	0.25 to 0.45 mm 0.0099 to 0.017 in.	1.25 mm 0.0492 in.
Piston Ring to Piston Ring Groove • Top Ring	Clearance	0.050 to 0.090 mm 0.0020 to 0.0035 in.	0.15 mm 0.0059 in.
• Second Ring	Clearance	0.090 to 0.12 mm 0.0035 to 0.0047 in.	0.20 mm 0.0079 in.
• Oil Ring	Clearance	0.020 to 0.060 mm 0.00079 to 0.0023 in.	0.15 mm 0.0059 in.
Crankshaft	Side Clearance	0.15 to 0.35 mm 0.0059 to 0.013 in.	0.50 mm 0.020 in.
Crankshaft	Alignment	–	0.02 mm 0.0008 in.

Item		Factory Specification	Allowable Limit
Crank Pin to Crank Pin Bearing	Oil Clearance	0.011 to 0.058 mm 0.00044 to 0.0022 in.	0.20 mm 0.0079 in.
• Crank Pin	O.D.	46.980 to 46.991 mm 1.8496 to 1.8500 in.	–
Crankshaft Journal to Crankshaft Bearing	Oil Clearance	0.030 to 0.051 mm 0.0012 to 0.0020 in.	0.20 mm 0.0079 in.
• Crankshaft Journal	O.D.	72.977 to 72.990 mm 2.8732 to 2.8736 in.	–
Cylinder Bore	I.D.	87.000 to 87.022 mm 3.4252 to 3.4260 in.	87.15 mm 3.431 in.
Cylinder Bore (Oversize)	I.D.	87.250 to 87.272 mm 3.4350 to 3.4359 in.	87.40 mm 3.441 in.

LUBRICATING SYSTEM

Item		Factory Specification	Allowable Limit
Engine Oil Pressure	At Idle Speed	–	49 kPa 0.50 kgf/cm^2 7.1 psi
	At Rated Speed	245 to 441 kPa 2.50 to 4.50 kgf/cm^2 35.6 to 64.0 psi	147 kPa 1.50 kgf/cm^2 21.3 psi
Engine Oil Pressure Switch	Working Pressure	40 to 58 kPa 0.40 to 0.60 kgf/cm^2 5.7 to 8.5 psi	–
Inner Rotor to Outer Rotor	Clearance	0.030 to 0.090 mm 0.0012 to 0.0035 in.	0.30 mm 0.012 in.
Outer Rotor to Pump Body	Clearance	0.100 to 0.184 mm 0.00394 to 0.00724 in.	0.30 mm 0.012 in.
Rotor to Cover	Clearance	0.025 to 0.075 mm 0.00099 to 0.0029 in.	0.225 mm 0.00886 in.
Relief Valve	Spring Free Length	60.0 to 60.5 mm 2.37 to 2.38 in.	55.0 mm 2.17 in.
	Working Pressure	392 kPa 4.00 kgf/cm^2 56.9 psi	–

COOLING SYSTEM

Item		Factory Specification	Allowable Limit
Fan Belt	Tension	10.0 to 12.0 mm / 98 N 0.394 to 0.472 in. / 98 N (10 kgf, 22 lbf)	–
Radiator Cap	Pressure Falling Time	10 seconds or more 88 → 59 kPa 0.90 → 0.60 kgf/cm^2 13 → 8.5 psi	–
Radiator	Water Leakage Test Pressure	No leak at specified pressure	–
Thermostat	Valve Opening Temperature	80 to 84 °C 176 to 183 °F	–
	Valve Opening Temperature (Opened Completely)	95 °C 203 °F	–

FUEL SYSTEM

Item		Factory Specification	Allowable Limit
Injection Timing	V2607-DI-E3B	0.035 to 0.061 rad before T.D.C. (2.0 to 3.5 ° before T.D.C.)	–
Pump Element	Fuel Tightness	–	18.63 MPa 190.0 kgf/cm^2 2702 psi
Delivery Valve	Fuel Tightness	10 seconds 18.63 → 17.65 MPa 190.0 → 180.0 kgf/cm^2 2702 → 2560 psi	5 seconds 18.63 → 17.65 MPa 190.0 → 180.0 kgf/cm^2 2702 → 2560 psi
Fuel Injection Nozzle	Injection Pressure (1st stage)	18.64 to 20.10 MPa 190.0 to 205.0 kgf/cm^2 2703 to 2915 psi	–
	Injection Pressure (2nd stage)	21.58 to 23.04 MPa 220.0 to 235.0 kgf/cm^2 3130 to 3342 psi	–
	Valve Seat Tightness	When the pressure is 16.67 MPa (170.0 kgf/cm^2, 2418 psi), the valve seat must be fuel tightness.	–

ELECTRICAL SYSTEM

Item		Factory Specification	Allowable Limit
Glow Plug	Resistance	Approx. 0.95 Ω	–
Starter • Commutator	O.D.	32.0 mm 1.26 in.	31.4 mm 1.24 in.
• Mica	Undercut	0.50 mm 0.020 in.	0.20 mm 0.0079 in.
• Brush	Length	18.0 mm 0.709 in.	11.0 mm 0.433 in.
• Brush Holder - Holder Support	Resistance	Infinity	–
• Commutator - Armature Coil Core	Resistance	Infinity	–
• Commutator - Segment	Resistance	0 Ω	–
• Field Coil Lead - Brush	Resistance	0 Ω	–
• Field Coil Brush - Yoke	Resistance	Infinity	–
Alternator • No-load Voltage	Output Voltage	13.8 to 14.8 V at 25 °C (77 °F), 4000 min^{-1} (rpm)	–
• Stator	Resistance	Less than 1.0 Ω	–
• Rotor	Resistance	2.8 to 3.3 Ω	–
• Slip Ring	O.D.	22.7 mm 0.894 in.	22.1 mm 0.870 in.
• Brush	Length	18.5 mm 0.728 in.	5.0 mm 0.20 in.

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3. TIGHTENING TORQUES

Screws, bolts and nuts must be tightened to the specified torque using a torque wrench, several screws, bolts and nuts such as those used on the cylinder head must be tightened in proper sequence and the proper torque.

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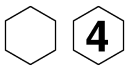
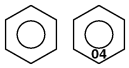
[1] TIGHTENING TORQUES FOR GENERAL USE SCREWS, BOLTS AND NUTS

When the tightening torques are not specified, tighten the screws, bolts and nuts according to the table below.

Indication on top of bolt	 **No-grade or 4T**			**7T**		
Indication on top of nut	 **No-grade or 4T**					
Unit	**N·m**	**kgf·m**	**lbf·ft**	**N·m**	**kgf·m**	**lbf·ft**
M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.8	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
M8	18 to 20	1.8 to 2.1	13 to 15	24 to 27	2.4 to 2.8	18 to 20
M10	40 to 45	4.0 to 4.6	29 to 33	49 to 55	5.0 to 5.7	37 to 41
M12	63 to 72	6.4 to 7.4	47 to 53	78 to 90	7.9 to 9.2	58 to 66

RY9212050ENS0004US0

Screw and bolt material grades are shown by numbers punched on the screw and bolt heads. Prior to tightening, be sure to check out the numbers as shown below.

Punched number	Screw and bolt material grade
None or 4	Standard screw and bolt SS41, S20C
7	Special screw and bolt S43C, S48C (Refined)

RY9212050ENS0005US0

[2] TIGHTENING TORQUES FOR SPECIAL USE SCREWS, BOLTS AND NUTS

■ **NOTE**

- **For "*" marked screws, bolts and nuts on the table, apply engine oil to their threads and seats before tightening.**
- **The letter "M" in Size × Pitch means that the screw, bolt or nut dimension stands for metric. The size is the nominal outside diameter in mm of the threads. The pitch is the nominal distance in mm between two threads.**

Item	Size × Pitch	N·m	kgf·m	lbf·ft
Glow lead mounting nut	M4 × 0.7	0.98 to 1.7	0.10 to 0.18	0.73 to 1.3
Glow plug	M8 × 1.0	7.7 to 9.3	0.78 to 0.95	5.7 to 6.8
Cylinder head cover screw	M6 × 1.0	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
Injection pipe retaining nut	M12 × 1.5	23 to 36	2.3 to 3.7	17 to 26
Oil switch taper screw	R 1/8	15 to 19	1.5 to 2.0	11 to 14
Injection pump unit mounting nut	M8 × 1.25	18 to 20	1.8 to 2.1	13 to 15
Drain plug	M22 × 1.5	45 to 53	4.5 to 5.5	33 to 39
Nozzle holder clamp screw	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
Overflow pipe assembly retaining screw	M6 × 1.0	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
*Lubricating oil pipe mounting screw	M10 × 1.25	16 to 19	1.6 to 2.0	12 to 14
Governor housing mounting screw	M6 × 1.0	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
Lock nut	M5 × 0.8	2.9 to 4.0	0.29 to 0.41	2.1 to 2.9
Injection pump assembly mounting screw	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
Injection pump assembly mounting nut	M8 × 1.25	18 to 20	1.8 to 2.1	13 to 15
Governor weight mounting nut	M12 × 1.25	63 to 72	6.4 to 7.4	47 to 53
Fuel camshaft stopper mounting screw	M6 × 1.0	9.81 to 11.2	1.00 to 1.15	7.24 to 8.31
Fuel camshaft bearing stopper mounting screw	M6 × 1.0	3.9 to 4.2	0.39 to 0.43	2.9 to 3.1
*Crankshaft screw	M16 × 1.5	255 to 274	26.0 to 28.0	188 to 202
Relief valve retaining screw	M22 × 1.5	69 to 78	7.0 to 8.0	51 to 57
*Flywheel screw	M12 × 1.25	98.1 to 107	10.0 to 11.0	72.4 to 79.5
Camshaft set screw	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
Balancer shaft set screw	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
Starter's terminal **B** mounting nut	M8 × 1.25	9.8 to 11	1.0 to 1.2	7.3 to 8.6
Alternator pulley nut	M24	58.4 to 78.9	5.95 to 8.05	43.1 to 58.2
Oil pump cover screw	M6	7.9 to 9.3	0.80 to 0.95	5.8 to 6.8
Rocker arm bracket screw	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
*Cylinder head mounting screw	M13 × 1.25	147 to 156	15.0 to 16.0	109 to 115
Injection pump gear mounting nut (left-handed screw)	M16 × 1.5 -LH	93.2 to 102	9.50 to 10.5	68.8 to 75.9
Oil cooler joint screw	M20 × 1.5	64 to 73	6.5 to 7.5	47 to 54
Front cover mounting screw	M8 × 1.25	24 to 27	2.4 to 2.8	18 to 20
Flywheel housing mounting screw	M12 × 1.25	78 to 90	7.9 to 9.2	58 to 66
Idle gear mounting screw	M10 × 1.25	49 to 55	5.0 to 5.7	37 to 41

Item	Size × Pitch	N·m	kgf·m	lbf·ft
*Connecting rod screw [Serial No.: 8G0001 to 9K9999]	M8 × 1.0	45 to 49	4.5 to 5.0	33 to 36
*Connecting rod screw [Serial No.: 9L0001 and above]	M8 × 1.0	41 to 45	4.1 to 4.6	30 to 33
*Crankcase 2 mounting screw	M13 × 1.25	128 to 137	13.0 to 14.0	94.1 to 101
Crankcase 2 flange screw	M10 × 1.25	49 to 55	5.0 to 5.7	37 to 41

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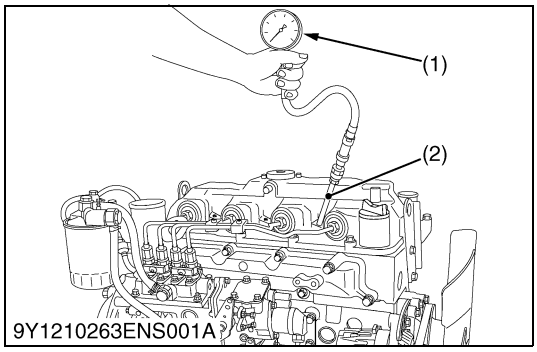
4. CHECKING, DISASSEMBLING AND SERVICING

[1] CHECKING AND ADJUSTING

(1) Engine Body



Compression Pressure

1. After warming up the engine, shut it down and remove the air cleaner, the muffler, breather tube, glow lead and all glow plugs.
2. Install a compression tester (1) (Code No : 07909-30208) and glow plug adaptor (2) to glow plug hole. (Refer to "SPECIAL TOOLS" at "GENERAL" Section.)
3. After making sure that the stop lever is set at the stop position (Non-injection), run the engine at about 150 rpm with the starter.
4. Read the maximum pressure. Measure the pressure more than twice.

■ **NOTE**

- **Check the compression pressure with the specified valve clearance.**
- **Always use a fully charged battery for performing this test.**
- **Variances in cylinder compression values should be under 10 %.**

Compression pressure	Factory specification	3.20 MPa / 150 rpm 32.6 kgf/cm^2 / 150 rpm 464 psi / 150 rpm
	Allowable limit	2.20 MPa / 150 rpm 22.4 kgf/cm^2 / 150 rpm 319 psi / 150 rpm

Tightening torque	Glow lead mounting nut	0.98 to 1.7 N·m 0.10 to 0.18 kgf·m 0.73 to 1.3 lbf·ft
	Glow plug	7.7 to 9.3 N·m 0.78 to 0.95 kgf·m 5.7 to 6.8 lbf·ft

(1) Compression Tester (2) Glow Plug Adaptor

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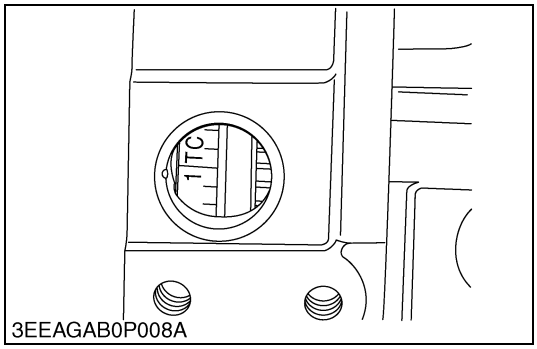

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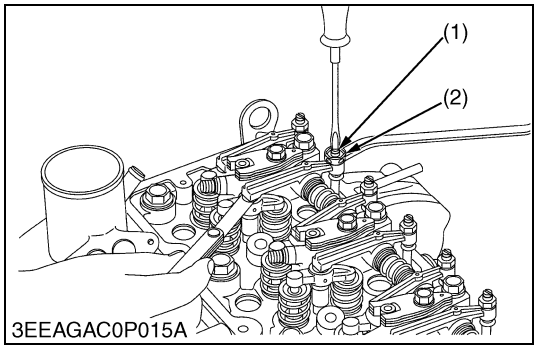

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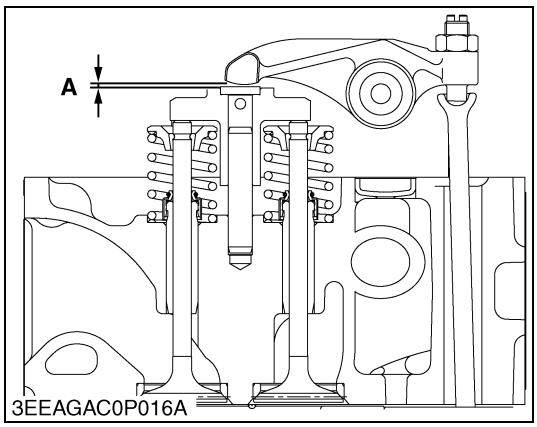

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Valve Clearance

■ **IMPORTANT**

- **Valve clearance must be checked and adjusted when engine is cold.**

1. Remove the high pressure pipes, glow lead, glow plugs and the cylinder head cover.
2. Align the 1TC mark of flywheel and the convex of flywheel housing timing windows so that the first piston (front cover side) comes to the compression top dead center.
3. Loosen the lock nut (2) of adjusting screw (1) (push rod side) and insert the feeler gauge between the rocker arm and the head of valve bridge arm. Set the adjusting screw (1) to the specified value, then tighten the lock nut (2).

Valve clearance **"A"**	Factory specification	0.13 to 0.17 mm 0.0052 to 0.0066 in.

■ **NOTE**

- **After adjusting, tighten the lock nut (2) securely.**

Valve arrangement Adjustment cylinder Location of piston		**IN.**	**EX.**
When No.1 piston is at compression top dead center	1st	☆	☆
	2nd	☆	
	3rd		☆
	4th		
When No.1 piston is at overlap position	1st		
	2nd		☆
	3rd	☆	
	4th	☆	☆

Tightening torque	Cylinder head cover screw	9.81 to 11.2 N·m 1.00 to 1.15 kgf·m 7.24 to 8.31 lbf·ft
	Injection pipe retaining nut	23 to 36 N·m 2.3 to 3.7 kgf·m 17 to 26 lbf·ft

(1) Adjusting Screw
(2) Lock Nut

A : Valve Clearance

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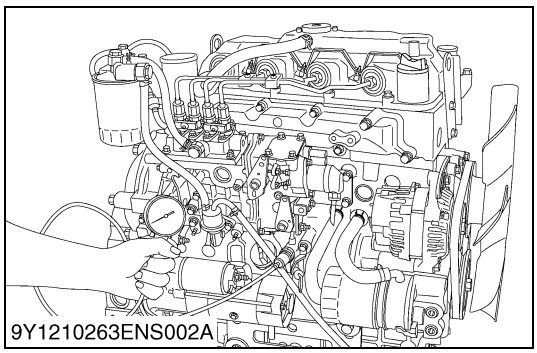
(2) Lubricating System



Engine Oil Pressure

1. Remove the oil switch and set a pressure tester (Code No. : 07916-32032).
2. Start the engine. After warming up, measure the oil pressure of both idling and rated speeds.
3. If the oil pressure is less than the allowable limit, check the following.
   - Engine oil insufficient
   - Oil pump defective
   - Oil strainer clogged
   - Oil filter cartridge clogged
   - Oil gallery clogged
   - Excessive oil clearance
   - Foreign matter in the relief valve

(When reassembling)

- After checking the engine oil pressure, tighten the engine oil pressure switch to the specified torque.

Engine oil pressure	At idle speed	Allowable limit	49 kPa 0.50 kgf/cm^2 7.1 psi
	At rated speed	Factory specification	245 to 441 kPa 2.50 to 4.50 kgf/cm^2 35.6 to 64.0 psi
		Allowable limit	147 kPa 1.50 kgf/cm^2 21.3 psi

Tightening torque	Oil switch taper screw	15 to 19 N·m 1.5 to 2.0 kgf·m 11 to 14 lbf·ft

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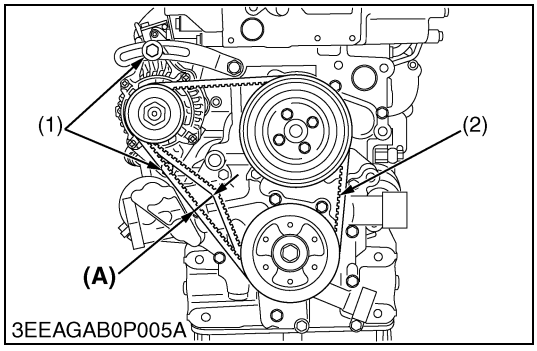
(3) Cooling System



Fan Belt Tension

1. Measure the deflection **(A)**, depressing the fan belt (2) halfway between the fan drive pulley and alternator pulley at specified force 98 N (10 kgf, 22 lbf).
2. If the measurement is not within the factory specifications, loosen the alternator mounting screws (1) and relocate the alternator to adjust.

Deflection **(A)**	Factory specification	10.0 to 12.0 mm 0.394 to 0.472 in.

(1) Alternator Mounting Screw **(A) Deflection**
(2) Fan Belt

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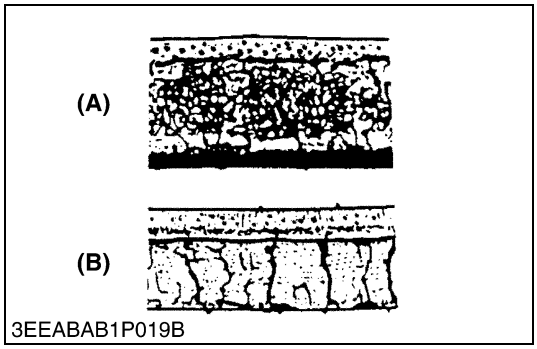

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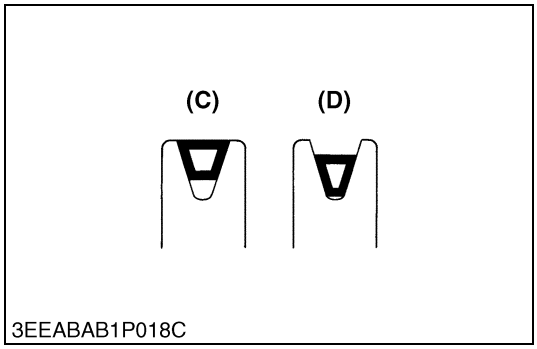

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Checking Fan Belt Damage and Wear

1. Check the fan belt for damage.
2. If the fan belt is damaged, replace it.
3. Check if the fan belt is worn and sunk in the pulley groove.
4. If the fan belt is nearly worn out and deeply sunk in the pulley groove, replace it.

(A) One-side wear **(C) Good**
(B) Crack **(D) Bad**

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CAUTION
- **When removing the radiator cap, wait at least ten minutes after the engine has stopped and cooled down. Otherwise, hot water may gush out, scalding nearby people.**

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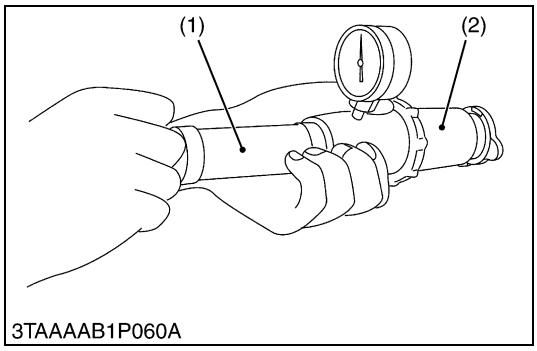

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Radiator Cap Air Leakage

1. Set a radiator tester (1) and an adaptor (2) on the radiator cap.
2. Apply the specified pressure of 88 kPa (0.90 kgf/cm^2, 13 psi), and measure the time for the pressure to fall to 59 kPa (0.60 kgf/cm^2, 8.5 psi).
3. If the measurement is less than the factory specification, replace the radiator cap.

Pressure falling time	Factory specification	More than 10 seconds for pressure fall 88 → 59 kPa (0.90 → 0.60 kgf/cm^2, 13 → 8.5 psi)

(1) Radiator Tester (2) Adaptor

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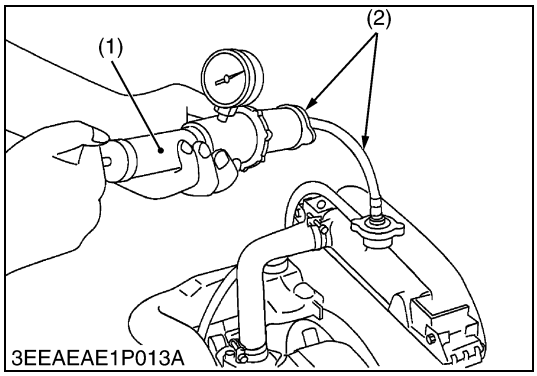

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Radiator Water Leakage

1. Pour a specified amount of water into the radiator.
2. Set a radiator tester (1) and an adaptor (2) and raise the water pressure to the specified pressure.
3. Check the radiator for water leaks.
4. For water leak from the pinhole, replace the radiator or repair with the radiator cement. When water leak is excessive, replace the radiator.

Radiator water leakage test pressure	Factory specification	No leak at specified pressure

■ **NOTE**
- **The pressure of the leak test is different from each radiator specification.**
  Thus, do the leak test, refer to the test pressure of each radiator specification.

(1) Radiator Tester (2) Adaptor

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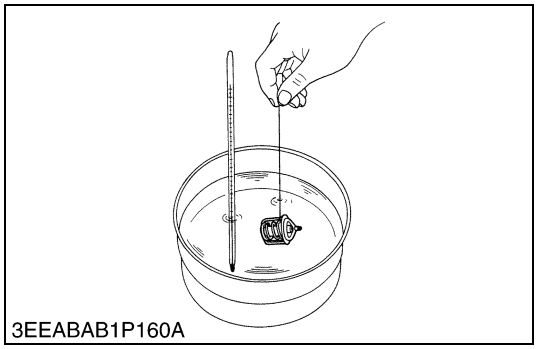
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Thermostat Valve Opening Temperature

1. Push down the thermostat valve and insert a string between the valve and the valve seat.
2. Place the thermostat and a thermostat in a container with water and gradually heat the water.
3. Hold the string to suspend the thermostat in the water. When the water temperature rises, the thermostat valve will open, allowing it to fall down from the string.
   Read the temperature at this moment on the thermometer.
4. Continue heating the water and read the temperature when the valve has risen by about 8 mm (0.3 in.).
5. If the measurement is not acceptable, replace the thermostat.

Thermostat's valve opening temperature	Factory specification	80 to 84 °C 176 to 183 °F
Temperature at which thermostat completely opens	Factory specification	95 °C 203 °F

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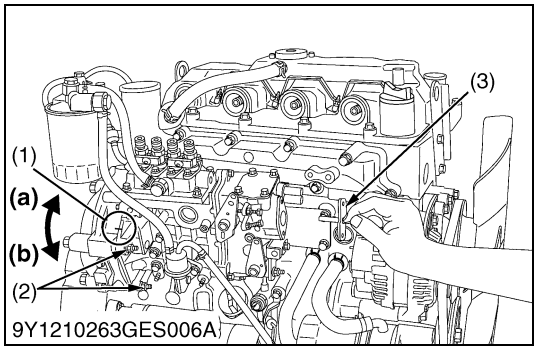
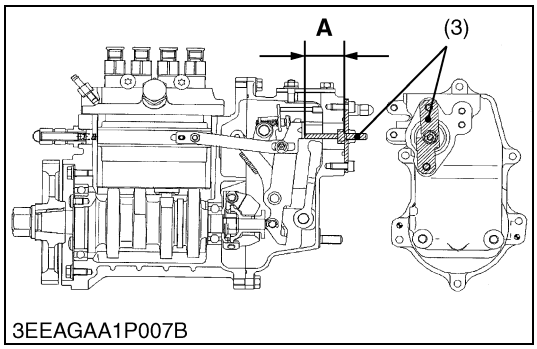
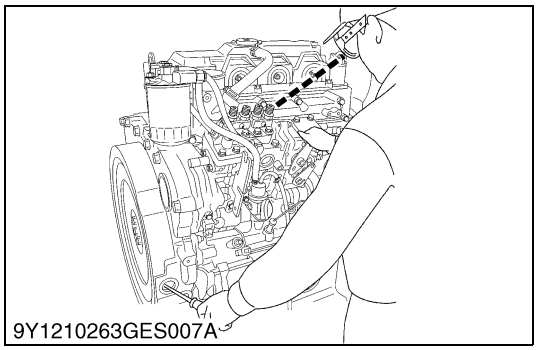
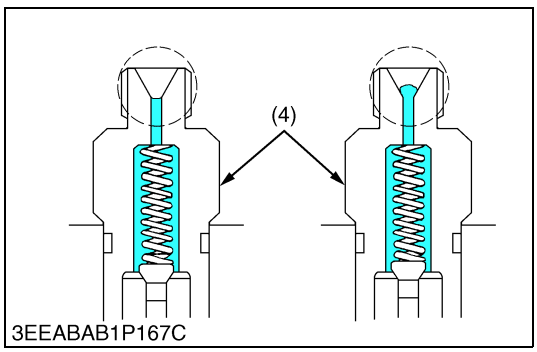
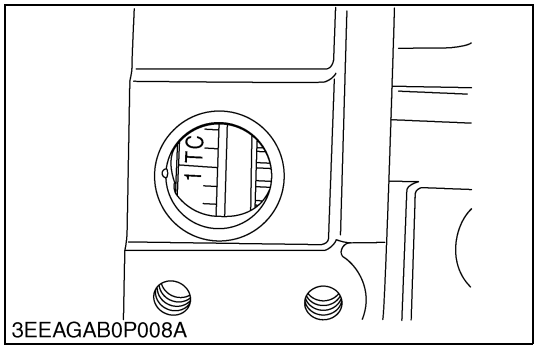
(4) Fuel System











Injection Timing

1. Make sure of matching the injection timing align mark (1) of the injection pump unit and the flywheel housing, as shown in the illustration.
2. Remove the injection pipes.
3. Remove the stop solenoid.
4. Set the fuel control rack fixing tool (3) to fix injection pump control rack as shown in the illustration. (Refer to "SPECIAL TOOLS" at "GENERAL" section.)
5. Turn the flywheel counterclockwise (viewed from flywheel side) until the fuel fills up to the hole of the delivery valve holder (4) for No.1 cylinder.
6. After the fuel fills up to the hole of the delivery valve holder (4) for No.1 cylinder, turn back (clockwise) the flywheel around 1.6 rad (90 °).
7. Turn the flywheel counterclockwise to set at around 0.17 rad (10 °) before T.D.C..
8. Slowly turn the flywheel counterclockwise and stop turning when the fuel begins to come up, to get the present injection timing.
9. Check to see the degree on flywheel.
   The flywheel has mark **"1TC"** for the crank angle before the top dead center of No.1 piston.
10. If the injection timing is not within the specification, rotate the injection pump unit to adjust the injection timing.

■ **IMPORTANT**

- **When installing the injection pump unit to the engine body, follow the correct procedure.**
  See the "Injection Pump Unit".

Injection Timing	Factory specification	0.035 to 0.061 rad (2.0 ° to 3.5 °) before T.D.C.

Tightening torque	Injection pipe retaining nut	23 to 36 N·m 2.3 to 3.7 kgf·m 17 to 26 lbf·ft
	Injection pump unit mounting nut	18 to 20 N·m 1.8 to 2.1 kgf·m 13 to 15 lbf·ft

(1) Injection Timing Align Mark
(2) Injection Pump Unit Mounting Nut
(3) Fuel Control Rack Fixing Tool
(4) Delivery Valve Holder

(a) Injection Timing Advanced
(b) Injection Timing Retarded
A : 34.9 to 35.1 mm (1.374 to 1.381 in.)

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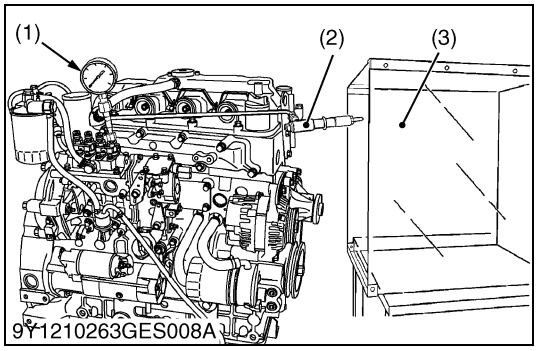

Fuel Tightness of Pump Element

1. Remove the engine stop solenoid.
2. Remove the injection pipes.
3. Install the injection pump pressure tester (1) to the injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1). (Refer to the figure.)
5. Set the speed control lever to the maximum speed position.
6. Run the starter to increase the pressure.
7. If the pressure can not reach the allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

Fuel tightness of pump element	Allowable limit	18.63 MPa 190.0 kgf/cm^2 2702 psi

■ **NOTE**

- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester (3) Protection Cover for Jetted Fuel
(2) Injection Nozzle

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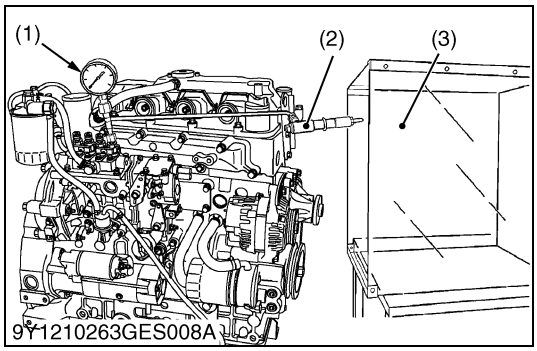

Fuel Tightness of Delivery Valve

1. Remove the engine stop solenoid.
2. Remove the injection pipes.
3. Install a pressure tester to the fuel injection pump.
4. Install the injection nozzle (2) jetted with the proper injection pressure to the injection pump pressure tester (1).
5. Run the starter to increase the pressure.
6. Stop the starter when the fuel jets from the injection nozzle (2). After that, turn the flywheel by the hand and raise the pressure to approx. 18.63 MPa (190.0 kgf/cm^2, 2702 psi).
7. Now turn the flywheel back about half a turn (to keep the plunger free). Maintain the flywheel at this position and clock the time taken for the pressure to drop from 18.63 to 17.65 MPa (from 190.0 to 180.0 kgf/cm^2, from 2702 to 2560 psi).
8. Measure the time needed to decrease the pressure from 18.63 to 17.65 MPa (from 190.0 to 180.0 kgf/cm^2, from 2702 to 2560 psi).
9. If the measurement is less than allowable limit, replace the pump with new one or repair with a Kubota-authorized pump service shop.

Fuel tightness of delivery valve	Factory specification	10 seconds 18.63 → 17.65 MPa 190.0 → 180.0 kgf/cm^2 2702 → 2560 psi
	Allowable limit	5 seconds 18.63 → 17.65 MPa 190.0 → 180.0 kgf/cm^2 2702 → 2560 psi

■ **NOTE**

- **Never try to disassemble the injection pump assembly. For repairs, you are strongly requested to contact a Kubota-authorized pump service shop.**

(1) Injection Pump Pressure Tester (3) Protection Cover for Jetted Fuel
(2) Injection Nozzle

RY9212050ENS0018US0

⚠ CAUTION

- **Check the nozzle injection pressure and condition after confirming that there is nobody standing in the direction the spray goes.**
- **If the spray from the nozzle directly contacts the human body, cells may be destroyed and blood poisoning may be caused.**

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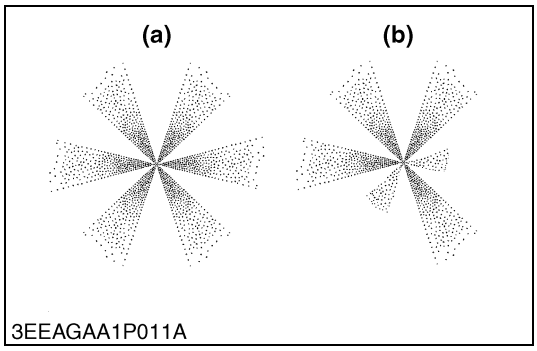

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Nozzle Spraying Condition

1. Attach the injection nozzle to the nozzle tester, and check the nozzle spraying condition.
2. If the spraying condition is defective, replace the injection nozzle assembly or repair at Kubota-authorized nozzle service shop.

(a) Good **(b) Bad**

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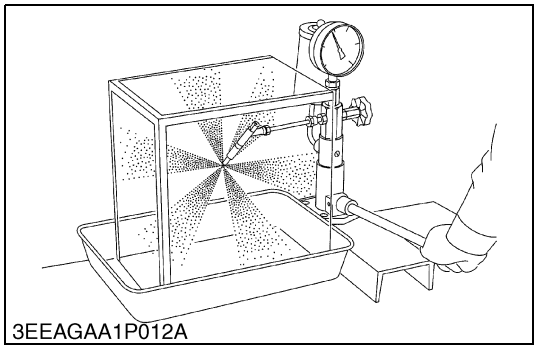
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Checking Nozzle Injection Pressure

1. Attach the injection nozzle to the nozzle tester.
2. Slowly move the tester handle to measure the pressure at which fuel begins jetting out from the nozzle.
3. If the measurement is not within the factory specifications, replace the injection nozzle assembly or repair at Kubota-authorized nozzle service shop.

■ **NOTE**

- **Injection nozzle gasket must be replaced when the injection nozzle is removed for checking.**

Injection pressure (1st stage)	Factory specification	18.64 to 20.10 MPa 190.0 to 205.0 kgf/cm^2 2703 to 2915 psi

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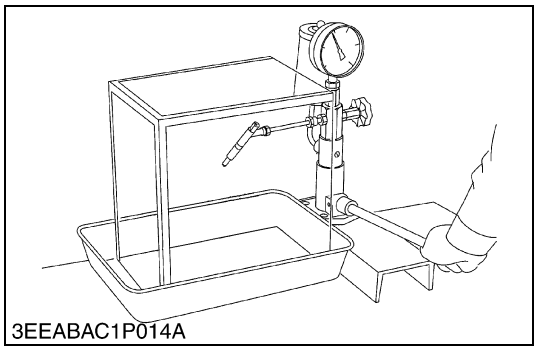
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Valve Seat Tightness

1. Attach the injection nozzle to the nozzle tester.
2. Raise the fuel pressure, and keep at 16.67 MPa (170.0 kgf/cm^2, 2418 psi) for 10 seconds.
3. If any fuel leak is found, replace the injection nozzle assembly or repair at Kubota-authorized nozzle service shop.

Valve seat tightness	Factory specification	No fuel leak at 16.67 MPa 170.0 kgf/cm^2 2418 psi

RY9212050ENS0022US0

(5) Electrical System

CAUTION

- **To avoid accidental short circuit, be sure to attach the positive cable to the positive terminal before the negative cable is attached to the negative terminal.**
- **Never remove the battery cap while the engine is running.**
- **Keep electrolyte away from eyes, hands and clothes. If you are spattered with it, wash it away completely with water immediately.**
- **Keep open sparks and flames away from the battery at all times. Hydrogen gas mixed with oxygen becomes very explosive.**

■ **IMPORTANT**

- **If the machine is to be operated for a short time without battery (using a slave battery for starting), use additional current (lights) while engine is running and insulate terminal of battery. If this advice is disregarded, damage to alternator and regulator may result.**

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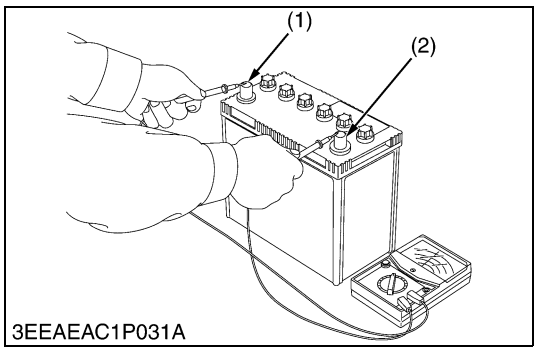

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Battery Voltage

1. Stop the engine.
2. Measure the voltage with a circuit tester between the battery terminals.
3. If the battery voltage is less than the factory specification, check the battery specific gravity and recharge the battery.

Battery voltage	Factory specification	More than 12 V

(1) Positive Terminal (2) Negative Terminal

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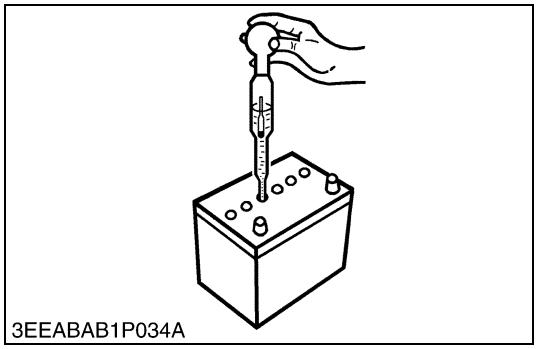
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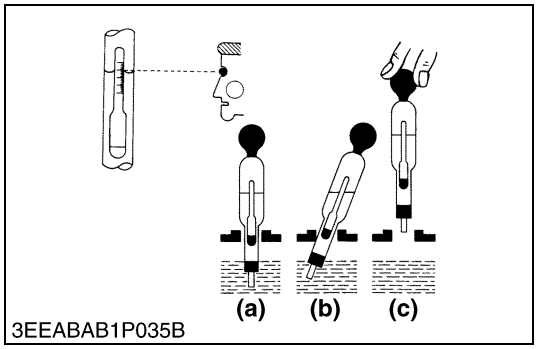

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Battery Specific Gravity (for Refillable Battery's only)

1. Check the specific gravity of the electrolyte in each cell with a hydrometer.
2. When the electrolyte temperature differs from that at which the hydrometer was calibrated, correct the specific gravity reading following the formula mentioned in **(Reference)**.
3. If the specific gravity is less than 1.215 (after it is corrected for temperature), charge or replace the battery.
4. If the specific gravity differs between any two cells by more than 0.05, replace the battery.

■ **NOTE**

- **Hold the hydrometer tube vertical without removing it from the electrolyte.**
- **Do not suck too much electrolyte into the tube.**
- **Allow the float to move freely and hold the hydrometer at eye level.**
- **The hydrometer reading must be taken at the highest electrolyte level.**

(Reference)

- Specific gravity slightly varies with temperature. To be exact, the specific gravity decreases by 0.0007 with an increase of 1 °C (0.0004 with an increase of 1 °F) in temperature, and increases by 0.0007 with a decreases of 1 °C (0.0004 with a decrease of 1 °F).
  Therefore, using 20 °C (68 °F) as a reference, the specific gravity reading must be corrected by the following formula :
  – Specific gravity at 20 °C = Measured value + 0.0007 × (electrolyte temperature : 20 °C)
  – Specific gravity at 68 °F = Measured value + 0.0004 × (electrolyte temperature : 68 °F)

Specific Gravity	State of Charge
1.260 Sp. Gr.	100 % Charged
1.230 Sp. Gr.	75 % Charged
1.200 Sp. Gr.	50 % Charged
1.170 Sp. Gr.	25 % Charged
1.140 Sp. Gr.	Very Little Useful Capacity
1.110 Sp. Gr.	Discharged

At an electrolyte temperature of 20 °C (68 °F)

(a) Good
(b) Bad
(c) Bad

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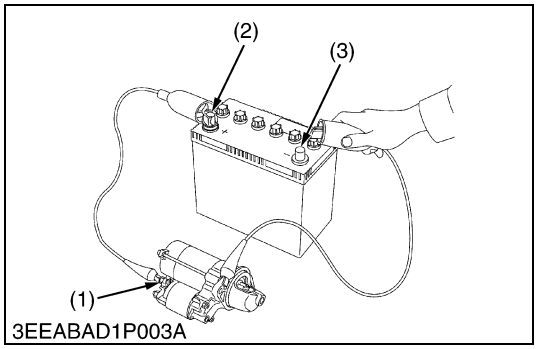

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Motor Test

CAUTION

- **Secure the starter to prevent it from jumping up and down while testing the motor.**

1. Disconnect the battery negative cable from the battery.
2. Disconnect the battery positive cable from the battery.
3. Disconnect the leads from the starter **B** terminal.
4. Remove the starter from the engine.
5. Connect a jumper lead from the starter **C** terminal (1) to the battery positive terminal (2).
6. Connect a jumper lead momentarily between the starter's body and the battery negative terminal (3).
7. If the motor does not run, starter is failure.
   Repair or replace the starter.

■ **NOTE**

- **B terminal : It is the terminal which connects the cable from the battery to the starter.**
- **C terminal : It is the terminal which connects the cable from the motor to the magnet switch.**

(1) **C** Terminal
(2) Positive Terminal
(3) Negative Terminal

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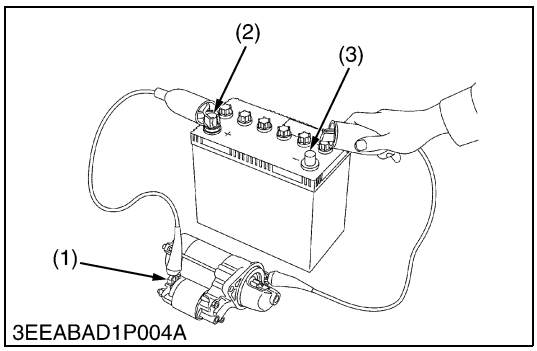

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Magnetic Switch Test

1. Disconnect the battery negative cable from the battery.
2. Disconnect the battery positive cable from the battery.
3. Disconnect the leads from the starter **B** terminal.
4. Remove the starter from the engine.
5. Connect a jumper lead from the starter **S** terminal (1) to the battery positive terminal (2).
6. Connect a jumper lead momentarily between the starter's body and the battery negative terminal (3).
7. If the pinion gear does not pop out, the magnetic switch is failure. Repair or replace the starter.

■ **NOTE**

- **B terminal : It is the terminal which connects the cable from the battery to the starter.**
- **S terminal : It is the terminal which connects the cable from the starter switch to the magnet switch.**

(1) **S** Terminal
(2) Positive Terminal
(3) Negative Terminal

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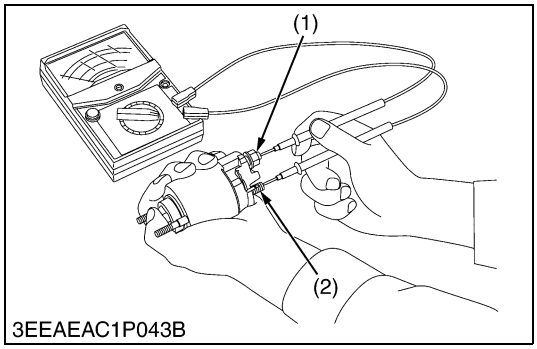

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Magnet Switch Continuity Test

1. Check the continuity across the **C** terminal (1) and the **B** terminal (2) with a circuit tester, pushing in the plunger.
2. If not continuous or if a certain value is indicated, replace the magnet switch.

(1) **C** Terminal
(2) **B** Terminal

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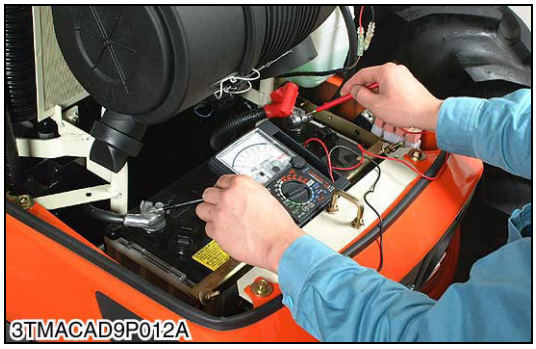

Alternator on Unit Test

(Before testing)

- Before alternator on unit test, check the battery terminal connections, circuit connection, fan belt tension, charging indicator lamp, fuses on the circuit, and abnormal noise from the alternator.
- Prepare full charged battery for the test.

■ **NOTE**

- **Be careful not to touch the rotating engine parts while engine is running.**
  Keep safety distance from the engine rotating parts.

1. Start the engine.
2. When the engine is operating measure the voltage between two battery terminals. If the voltage is between 13.8 V and 14.8 V, the alternator is operating normally.
3. If the results of alternator on unit test are not within the specifications, disassemble the alternator and check the each component part for finding out the failure. See the "DISASSEMBLING AND ASSEMBLING" and "SERVICING" for alternator.

Regulating voltage at no load	Factory specification	13.8 to 14.8 V at 25 °C (77 °F)

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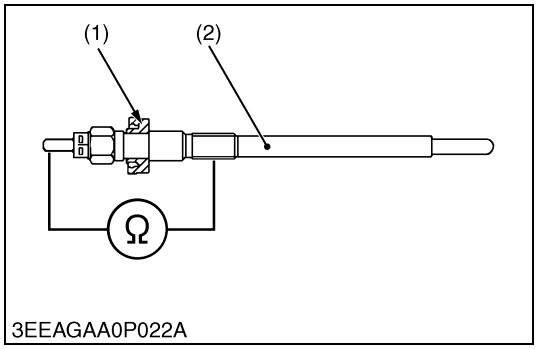

Glow Plug Continuity

1. Remove the glow plug (2).
2. Measure the resistance with a circuit tester between the glow plug terminal and the glow plug housing.
3. If the factory specification is not indicated, glow plug (2) is faulty.

■ **NOTE**

- **Adjust the direction of the ditch to the terminal side when the seal (1) is installed in the glow plug (2).**

Resistance	Factory specification	Approx. 0.95 Ω

(1) Seal (2) Glow Plug

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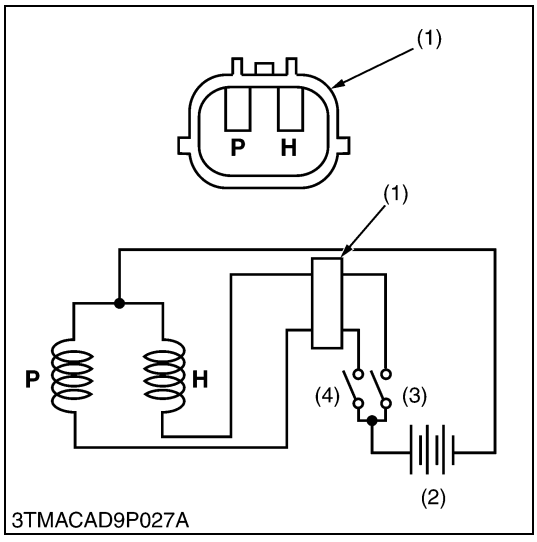

Engine Stop Solenoid

1. Remove the engine stop solenoid from the engine.
2. Connect the jumper leads from the pulling coil **P** terminal to the switch (3), and from switch (3) to the battery positive terminal.
3. Connect the jumper leads from the holding coil **H** terminal to the switch (4), and from switch (4) to the battery positive terminal.
4. Connect the jumper leads from the engine stop solenoid body to the battery negative terminal.
5. When switch (4) is turn on, the plunger pull into the solenoid body and then turn off the switch (4), the plunger comes out.
6. Turn on the switch (3) then turn on the switch (4), the plunger pull into the solenoid body and it keep in holding position after turn off the switch (4).
7. If the plunger is not attracted, the engine stop solenoid is faulty.

■ **IMPORTANT**

- **Never apply the current for pulling coil more than two seconds when inspecting.**

(1) Connector
(2) Battery
(3) Switch for Holding Coil
(4) Switch for Pulling Coil

P : Terminal for Pulling Coil
H : Terminal for Holding Coil

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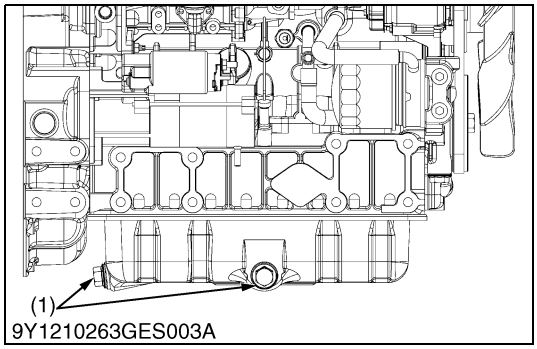
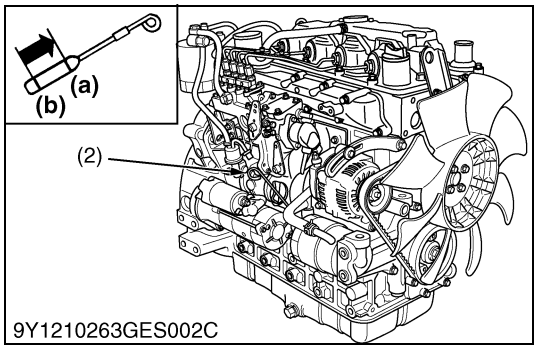
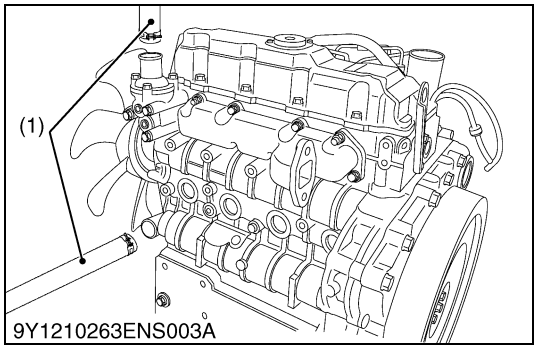
[2] DISASSEMBLING AND ASSEMBLING

(1) Draining Oil and Coolant







Draining Engine Oil

1. Start and warm up the engine for approx. 5 minutes.
2. Place an oil pan underneath the engine.
3. Remove the drain plug (1) to drain oil.
4. After draining, screw in the drain plug (1).

(When refilling)

- Fill the engine oil up to the upper line on the dipstick (2).

■ **IMPORTANT**

- **Never mix two different types of oil.**
- **Use the proper SAE Engine Oil according to ambient temperature.**

Tightening torque	Drain plug	45 to 53 N·m 4.5 to 5.5 kgf·m 33 to 39 lbf·ft

(1) Drain Plug
(2) Dipstick
(a) Upper Line
(b) Lower Line

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Draining Coolant

CAUTION

- **Never remove radiator cap while operating or immediately after stopping. Otherwise, hot water will spout out from the radiator. Wait for more than ten minutes to cool the radiator, before opening the cap.**

1. Open the radiator drain plug and remove the radiator cap.
2. Remove the radiator hose (1) from engine body.

(1) Radiator Hose

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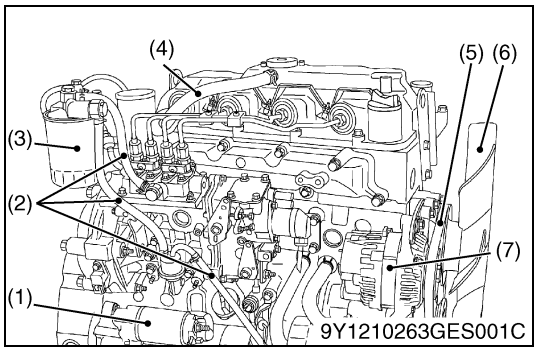
(2) External Components



Air Cleaner, Muffler and Others

1. Remove the air cleaner and muffler.
2. Remove the fan (6), fan belt (5), breather hose (4), fuel filter cartridge (3), fuel tubes (2), alternator (7) and starter (1).

(When reassembling)

- Check to see that there are no cracks on the belt surface.
- Mount the check valve with the ↓ mark toward the tank.

■ **IMPORTANT**

- **After reassembling the fan belt (5), be sure to adjust the fan belt tension.**
- **Do not confuse the direction of the fan (6). Attach the fan (6) with its marking facing frontward (toward the radiator).**

(1) Starter
(2) Fuel Tube
(3) Fuel Filter Cartridge
(4) Breather Hose
(5) Fan Belt
(6) Fan
(7) Alternator

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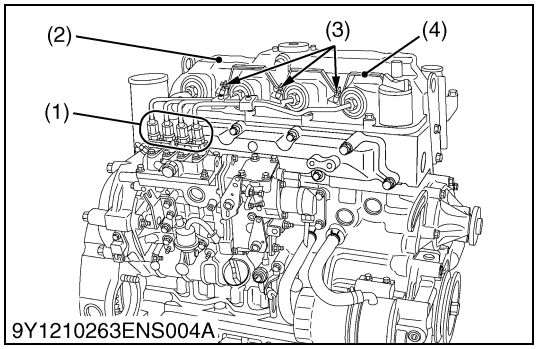
(3) Cylinder Head and Valves



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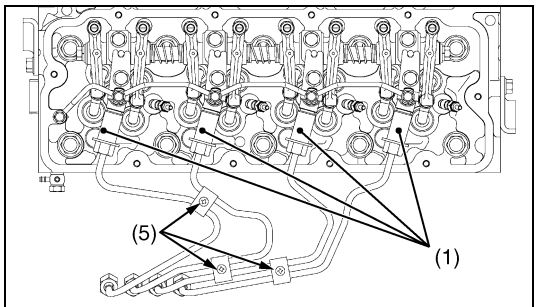

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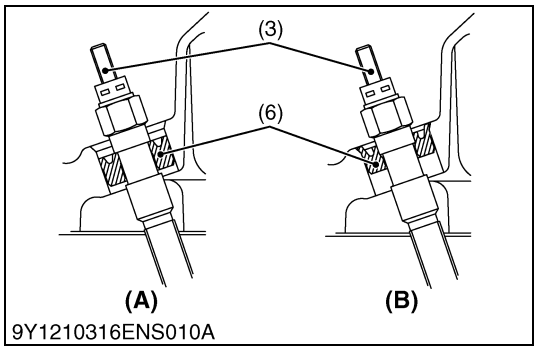

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Cylinder Head Cover

1. Remove the glow lead (4) and the glow plugs (3).
2. Remove the injection pipes (1).
3. Remove the cylinder head cover (2).

(When reassembling)

- Check to see that the cylinder head cover gasket is not detective.
- Tighten the head cover mounting screws to specified torque.
- Check the position of the injection pipe clamps (5) to reduce the vibration of the injection pipes (1). (See the figure.)
- Adjust the direction of the ditch to the terminal side when the seal (6) is installed in the glow plug (3).
- After installing the glow plug (3), confirm that the seal (6) was set to the specified position.

Tightening torque	Cylinder head cover screw	9.81 to 11.2 N·m 1.00 to 1.15 kgf·m 7.24 to 8.31 lbf·ft
	Injection pipe retaining nut	23 to 36 N·m 2.3 to 3.7 kgf·m 17 to 26 lbf·ft
	Glow plug	7.7 to 9.3 N·m 0.78 to 0.95 kgf·m 5.7 to 6.8 lbf·ft

(1) Injection Pipe
(2) Cylinder Head Cover
(3) Glow Plug
(4) Glow Lead
(5) Injection Pipe Clamp
(6) Seal

(A) Good
(B) Bad

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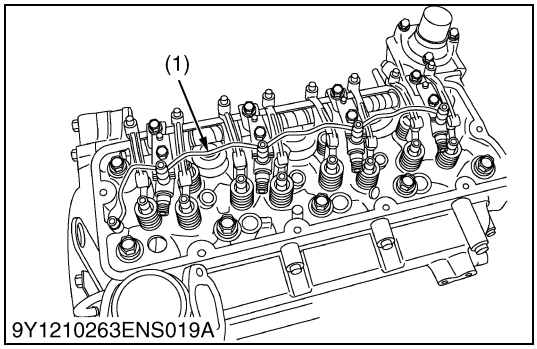

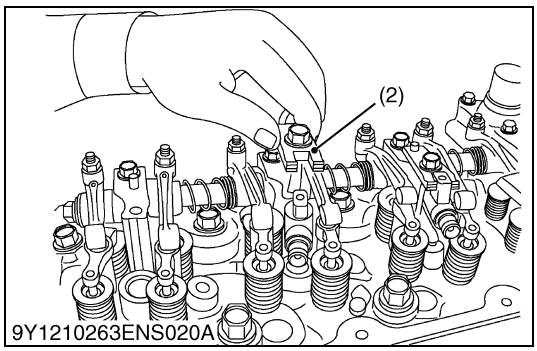

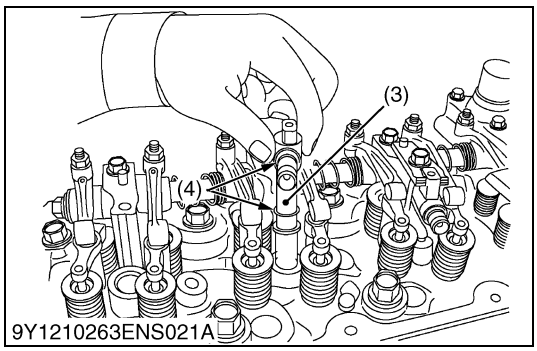

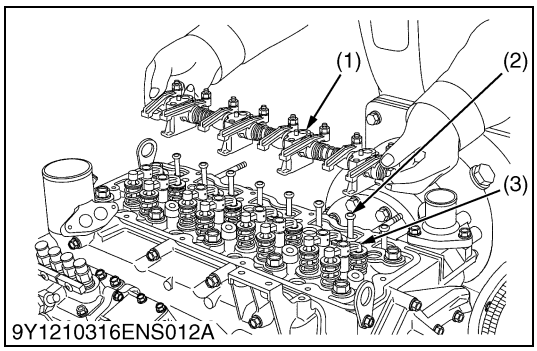

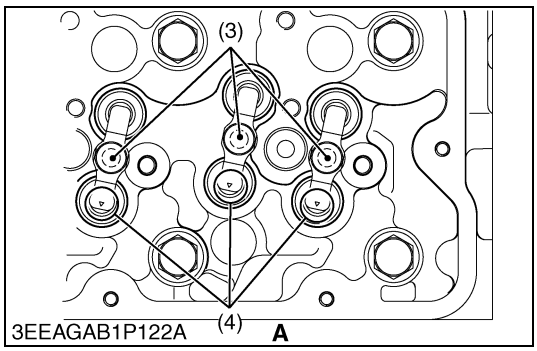

Nozzle Holder

1. Remove the overflow pipe (1).
2. Remove the nozzle holder clamps (2), nozzle holder assembly (3) and nozzle gaskets.

(When reassembling)

- Be sure to place the nozzle gaskets and the O-rings (4).

Tightening torque	Nozzle holder clamp screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft
	Overflow pipe assembly retaining screw	9.81 to 11.2 N·m 1.00 to 1.15 kgf·m 7.24 to 8.31 lbf·ft

(1) Overflow Pipe
(2) Nozzle Holder Clamp
(3) Nozzle Holder Assembly
(4) O-ring

RY9212050ENS0036US0

Rocker Arm, Push Rod and Valve Bridge Arm

1. Remove the rocker arm (1) as a unit.
2. Remove the push rods (2).
3. Remove the valve bridge arm (3).

(When reassembling)

- When putting the push rods (2) onto the tappets, check to see if their ends are properly engaged with the grooves.
- When installing the valve bridge arm (3), apply engine oil to the valve bridge shaft sufficiently and face the mark (4) to intake side **"A"**. Check weather to move smoothly.

■ **IMPORTANT**

- **After reassembling the rocker arm (1), be sure to adjust the valve clearance. See the "Valve Clearance".**

Tightening torque	Rocker arm bracket screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft

(1) Rocker Arm
(2) Push Rod
(3) Valve Bridge Arm
(4) Mark

A : Intake Side

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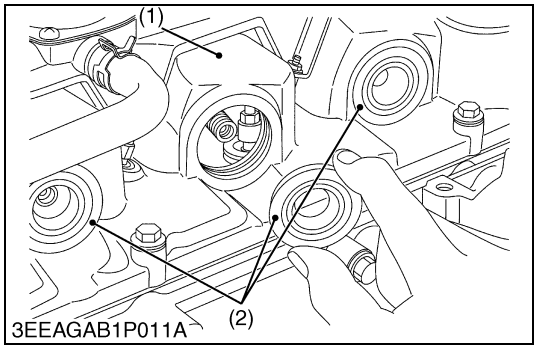

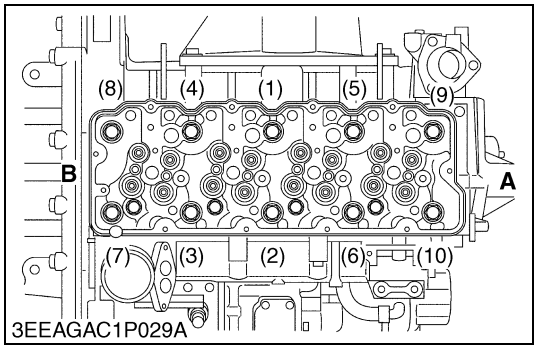

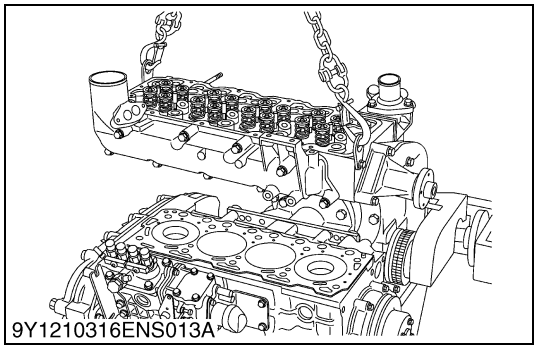

Injection Nozzle Oil Seal (If necessary)

1. Remove the injection nozzle oil seal (2) from cylinder head cover (1).

(When reassembling)

- When installing the injection nozzle oil seal (2), use new one.

(1) Cylinder Head Cover (2) Injection Nozzle Oil Seal

RY9212050ENS0038US0

Cylinder Head

1. Remove the cylinder head screw in the order of (10) to (1), and remove the cylinder head.
2. Remove the cylinder head gasket.

(When reassembling)

- Replace the head gasket with a new one.
- When mounting the gasket, set it to the knock pin hole. Take care not to mount it reversely.
- The cylinder head should be free of scratches and dust.
- Take care for handling the gasket not to damage it.
- Install the cylinder head.
- Tighten the cylinder head screw gradually in the order of (1) to (10) after applying engine oil.
- Be sure to adjust the valve clearance. See the "Valve Clearance".
- It is not necessary to retighten the cylinder head screw after running the engine for 30 minutes.

■ **IMPORTANT**

- **When replacing a piston, piston pin bush, connecting rod or crankpin bearing, select the cylinder head gasket thickness to meet with the top clearance refer to the "Selecting Cylinder Head Gasket".**

Tightening torque	Cylinder head mounting screw	147 to 156 N·m 15.0 to 16.0 kgf·m 109 to 115 lbf·ft

(10) to (1) : To Loosen
(1) to (10) : To Tighten

A : Front Cover Side
B : Flywheel Housing Side

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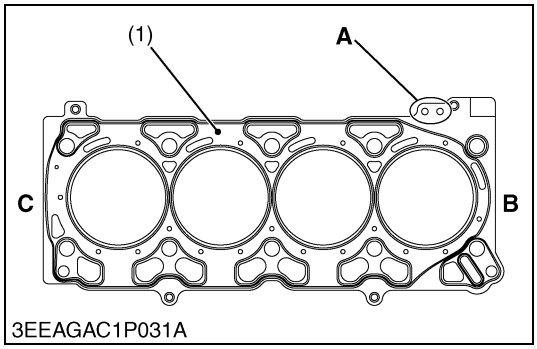

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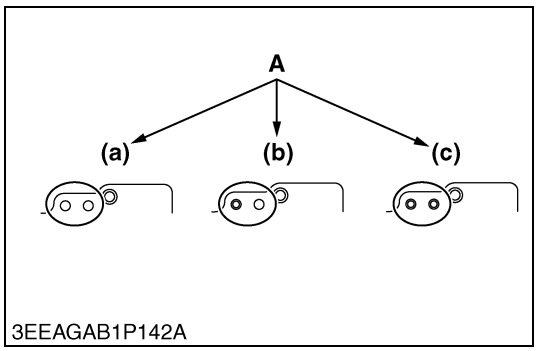

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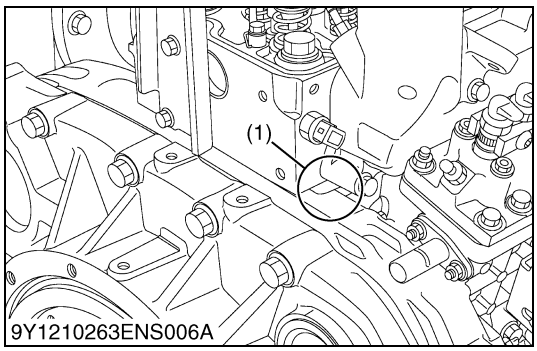

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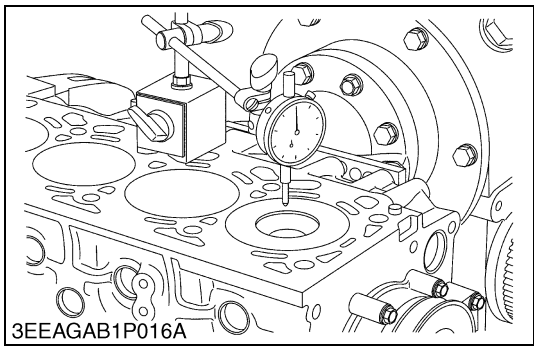
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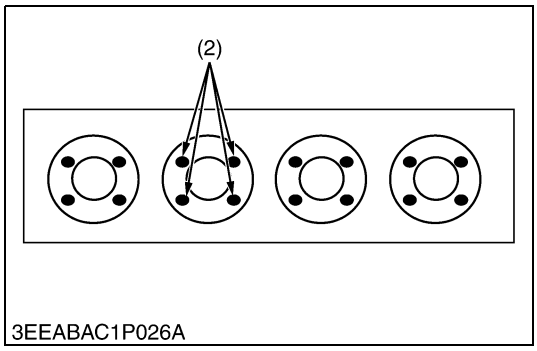

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Selecting Cylinder Head Gasket

■ Replacing the Cylinder Head Gasket

1. Make sure to note the hole **(a)**, **(b)** or **(c)** of cylinder head gasket (1) in advance.
2. Replace the same hole **(a)**, **(b)** or **(c)** as the original cylinder head gasket (1).

■ Selecting the Cylinder Head Gasket

- Select the cylinder head gasket (1) thickness to meet with the top clearance when replacing the piston, piston pin bush, connecting rod or crankpin bearing.

1. Measure the piston head's protrusion or recessing from the crankcase cylinder face (4 spots per each piston and average of four pistons) using the dial gauge as shown in figure.
2. Select the suitable cylinder head gasket (1) refer to the table below.

Hole of Cylinder Head Gasket	Thickness of cylinder head gasket		Part Code	Piston Head's protrusion or recessing from the level of crankcase cylinder face. (average of 4 pistons)
	Before tightening	After tightening		
Without hole **(a)**	1.10 mm 0.0433 in.	1.00 mm 0.0394 in.	1J700-03310	0.250 to 0.350 mm 0.00985 to 0.0137 in.
1 hole **(b)**	1.20 mm 0.0472 in.	1.10 mm 0.0433 in.	1J700-03320	0.350 to 0.450 mm 0.0138 to 0.0177 in.
2 holes **(c)**	1.30 mm 0.0512 in.	1.20 mm 0.0472 in.	1J700-03330	0.450 to 0.550 mm 0.0178 to 0.0216 in.

(1) Cylinder Head Gasket
(2) Measuring Point

(a) Without Hole (0 Through Hole)
(b) 1 Hole (1 Through Hole)
(c) 2 Holes (2 Through Holes)

A : Hole of Cylinder Head Gasket
B : Flywheel Housing Side
C : Front Cover Side

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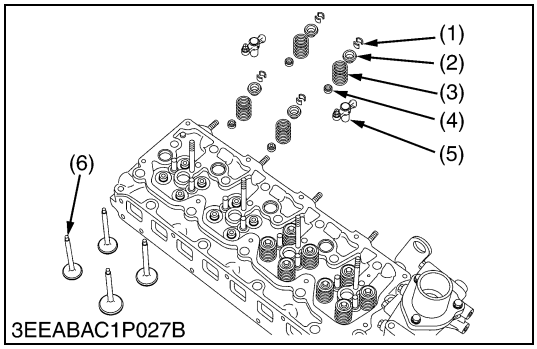

Valve

1. Remove the valve spring collets (1) after compressing the valve spring (3) with the valve spring retainer (2).

(When reassembling)

- Wash the valve stem and valve guide hole, and apply engine oil sufficiently.
- After installing the valve spring collets (1), lightly tap the stem tip to assure proper fit with a plastic hammer.

(1) Valve Spring Collet
(2) Valve Spring Retainer
(3) Valve Spring
(4) Valve Stem Seal
(5) Valve Bridge Arm
(6) Valve

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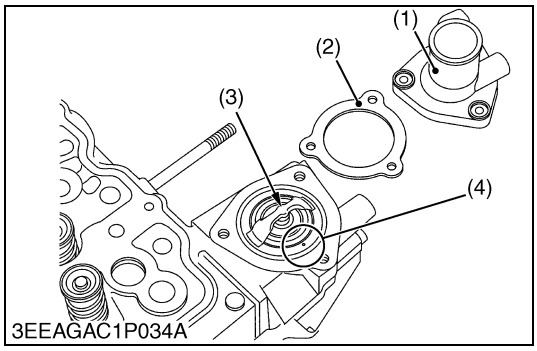
(4) Thermostat



Thermostat Assembly

1. Remove the thermostat cover mounting screws, and remove the thermostat cover (1).
2. Remove the thermostat assembly (3).

(When reassembling)

- Attach the thermostat assembly (3) with its hole (4) facing toward the front cover side.

(1) Thermostat Cover
(2) Thermostat Cover Gasket
(3) Thermostat Assembly
(4) Hole

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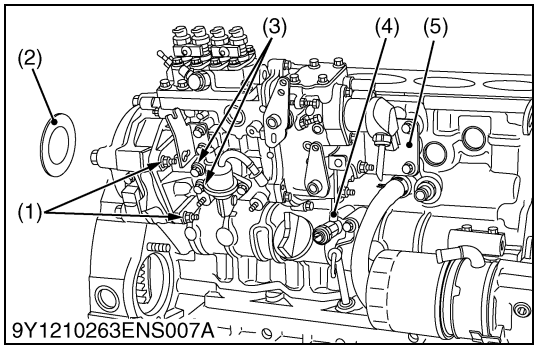
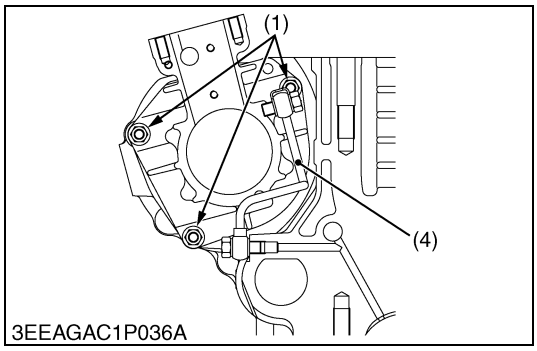
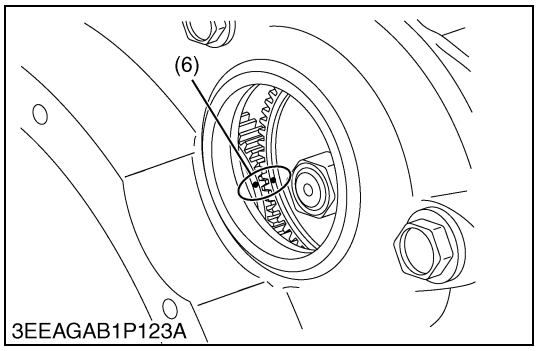
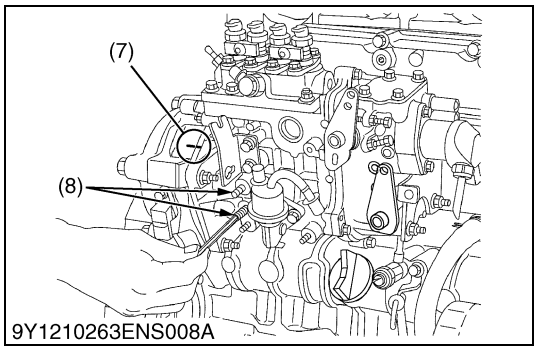
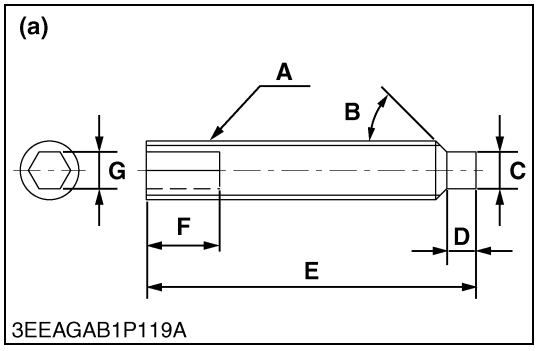
(5) Injection Pump Unit











Injection Pump Unit

(Removing the fuel injection pump unit)

1. Detach the window cover (2) for the fuel injection pump unit from the flywheel housing.
2. Place the piston of the 4th cylinder at the top dead center in the compression stroke. Fix the flywheel with the flywheel stopper.

■ **IMPORTANT**

- **Look for the alignment mark (6) on the idle gear and the injection pump gear. Using a white marking pen or the like, put an alignment mark (6) on the engaged tooth of the both gears. This helps to reassemble these gears in mesh later.**

■ **NOTE**

- **When the already existing alignment marks (6) align with each other, there is no need to put another alignment mark (6).**

3. Unscrew the two plugs (3) of the injection pump unit.
4. Tighten the upper fuel camshaft lock screw (8) until it comes into contact with the fuel camshaft. Make sure the camshaft does not move any longer.
5. Tighten the lower fuel camshaft lock screw (8) until it comes into contact with the fuel camshaft.

■ **NOTE**

- **Never overtighten the lock screws when they have come into contact with the camshaft. Otherwise the injection pump itself may get damaged.**
- **Use of a socket set screw (dog point type) is recommended for best results. Such screw can be constructed as shown in figure (a).**

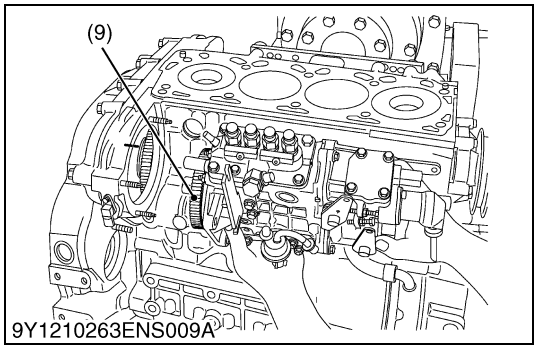
6. Disconnect the lubricating oil pipe (4).
7. Using a white marking pen or the like, put an injection timing mark (7) on the injection pump unit and on the crankcase 1.
8. Loosen the three injection pump unit mounting nuts (1).
9. Remove the injection pump unit support (5) and take out the injection pump unit.

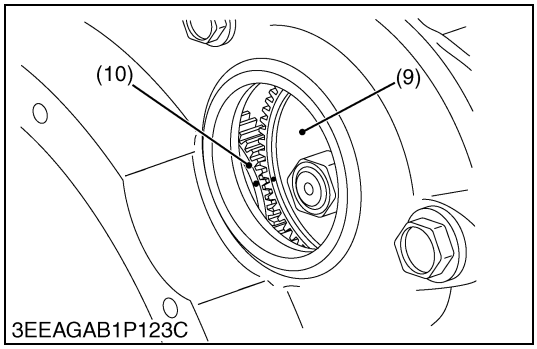
A	M8 × Pitch 1.25
B	0.79 rad (45 °)
C	5.0 mm dia. (0.20 in. dia.)
D	4.0 mm (0.16 in.)
E	45 mm (1.8 in.)
F	10 mm (0.39 in.) : Conspicuously Painted
G	5.0 mm (0.20 in.)

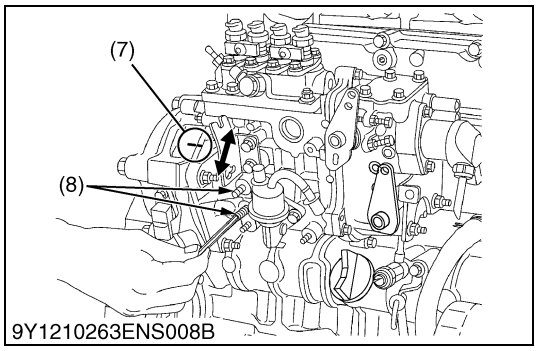
(1) Injection Pump Unit Mounting Nut
(2) Window Cover
(3) Plug
(4) Lubricating Oil Pipe
(5) Injection Pump Unit Support
(6) Alignment Mark
(7) Injection Timing Mark
(8) Fuel Camshaft Lock Screw (Socket Set Screw Dog Point Type)

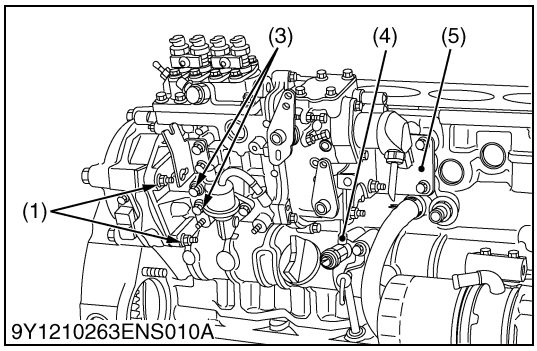
(To be continued)

(Continued)









(Reassembling the fuel injection pump unit)

1. Place the piston of the 4th cylinder at the top dead center in the compression stroke. Fix the flywheel with the flywheel stopper.
2. Install the injection pump unit to the crankcase 1.
3. Make sure of aligning the alignment marks of the injection pump gear (9) and the idle gear (10).
4. Take off the fuel camshaft lock screws (8) and tighten the plugs (3) for plugging.
5. Moving the injection pump unit clockwise (viewed from front cover side), align the injection timing marks (7) on the injection pump unit and on the crankcase 1.
6. Tighten the injection pump unit mounting nut (1) to the specified torque.
7. Reconnect the lubricating oil pipe (4) and place the injection pump unit support (5) and the window cover of the injection pump unit.
8. Remove the flywheel stopper.
9. Check the injection timing. (See the "Injection Timing".)
10. If the injection timing is not within the specification, repeat "4." to "9." again.

Tightening torque	Injection pump unit mounting nut	18 to 20 N·m 1.8 to 2.1 kgf·m 13 to 15 lbf·ft
	Lubricating oil pipe mounting screw	16 to 19 N·m 1.6 to 2.0 kgf·m 12 to 14 lbf·ft

(1) Injection Pump Unit Mounting Nut
(3) Plug
(4) Lubricating Oil Pipe
(5) Injection Pump Unit Support
(7) Injection Timing Mark
(8) Fuel Camshaft Lock Screw (Socket Set Screw Dog Point Type)
(9) Injection Pump Gear
(10) Idle Gear

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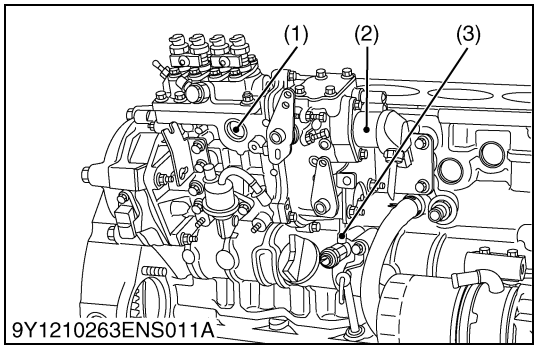

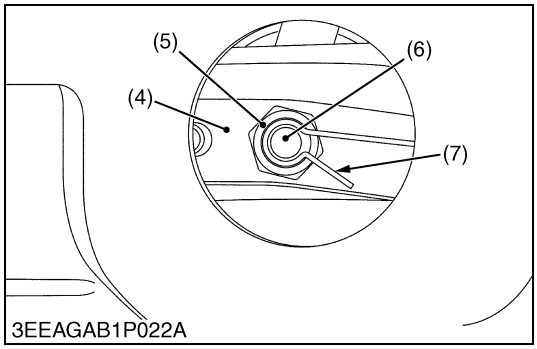

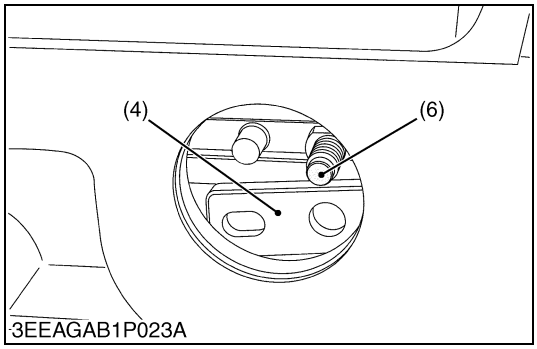

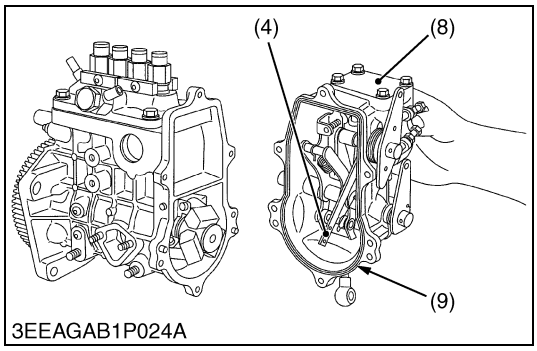

Governor Housing Assembly

1. Remove the injection pump unit from the engine. (See the "Injection Pump Unit".)
2. Remove the lubricating oil pipe (3).
3. Remove the stop solenoid (2).
4. Detach the sight cover (1) from the injection pump unit.
5. Unhook the start spring (7) from the rack pin (6) of injection pump assembly.
6. Remove the lock nut (5).

■ **NOTE**

- **Be careful not to drop the nut inside.**

7. Slide off the governor connecting rod (4) from the rack pin (6) of injection pump assembly.
8. For convenient sake, temporarily hook the start spring (7) on the rack pin (6) hole of the governor connecting rod (4).
9. Remove the governor housing mounting screws.
10. Detach the governor housing assembly (8) from the injection pump unit.

(When reassembling)

- When reassembling the inside parts, put the oil on each inside part slightly.
- After sliding on the governor connecting rod (4) to the rack pin (6), tighten the nut with the specified torque with using the jig for keeping the governor connecting rod (4) horizontal. (See the "Replacing Injection Pump Assembly".)
- After tightening the nut, hook the start spring (7) on the rack pin (6).
- Check the movement of control rack of injection pump assembly by the stop lever.

■ **NOTE**

- **When installing the governor housing assembly (8) to the injection pump unit, be careful not to damage O-ring (9).**
- **When linking the governor connecting rod (4) to the rack pin (6) of injection pump, use the jig for keeping the governor connecting rod (4) horizontal. Otherwise the control rack may be stuck, and causes to be difficult to start the engine or hunting of governor. (See the "Replacing Injection Pump Assembly".)**

Tightening torque	Governor housing mounting screw	9.81 to 11.2 N·m 1.00 to 1.15 kgf·m 7.24 to 8.31 lbf·ft
	Lock nut	2.9 to 4.0 N·m 0.29 to 0.41 kgf·m 2.1 to 2.9 lbf·ft

(1) Sight Cover
(2) Stop Solenoid
(3) Lubricating Oil Pipe
(4) Governor Connecting Rod
(5) Lock Nut
(6) Rack Pin
(7) Start Spring
(8) Governor Housing Assembly
(9) O-ring

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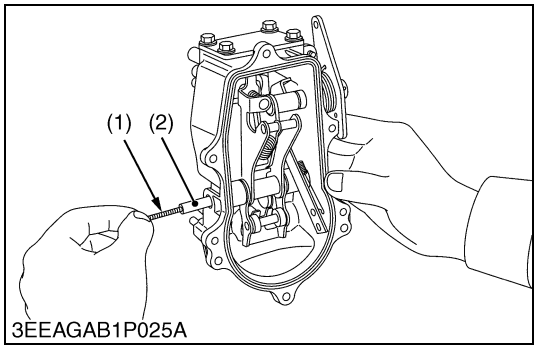

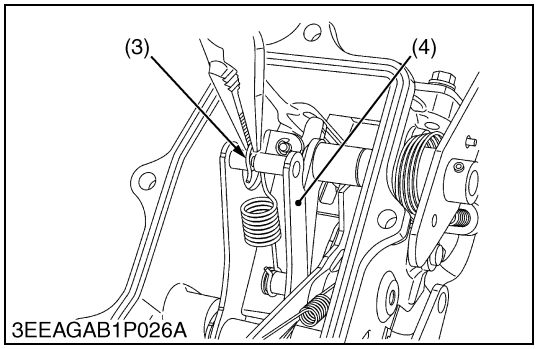

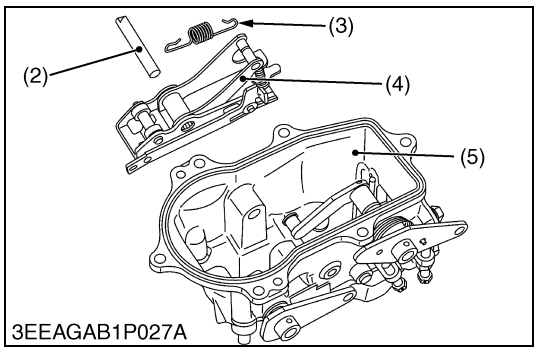

Governor Fork Lever Assembly

1. Pull off the governor fork lever shaft (2) with the extra bolt (Dia. : 4.0 mm (0.16 in.), Pitch : 0.7 mm (0.03 in.), Length : more than 25 mm (0.98 in.)) (1).
2. Unhook the governor spring (3) at the governor fork lever (4) side.
3. Remove the governor fork lever assembly from the governor housing (5).

(When reassembling)

- After reassembling the governor housing assembly, check the movement of the governor fork lever assembly, the speed control lever and the stop lever.

■ **NOTE**

- **When assembling the inside parts, put the oil on each inside part slightly.**
- **Be careful not to deform the start spring.**

(1) Extra Bolt (Dia. : 4.0 mm (0.16 in.), Pitch : 0.7 mm (0.03 in.), Length : more than 25 mm (0.98 in.))
(2) Governor Fork Lever Shaft
(3) Governor Spring
(4) Governor Fork Lever
(5) Governor Housing

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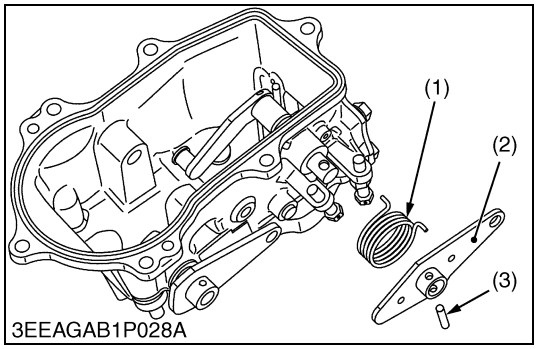

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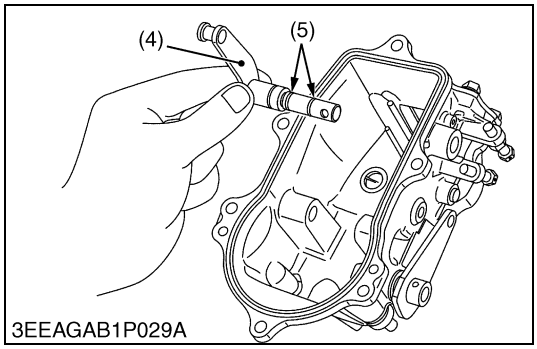

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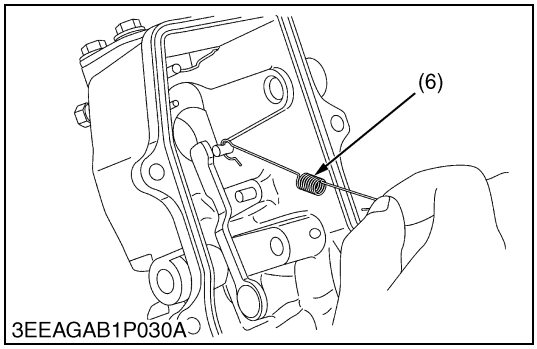

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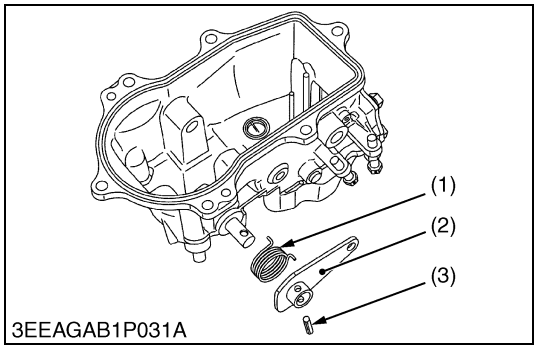

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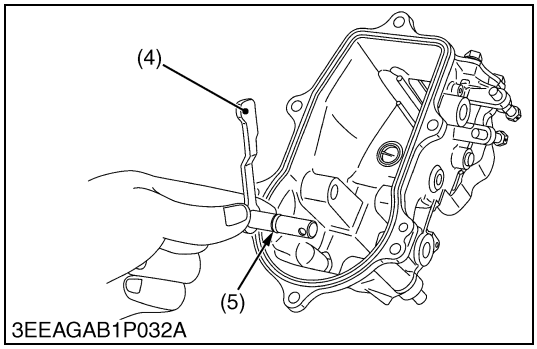

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Governor Lever

1. Remove the spring pin (3).
2. Remove the speed control lever (2) and the return spring (1).
3. Remove the governor lever assembly (4) from the governor housing.
4. Remove the start spring (6).

(1) Return Spring
(2) Speed Control Lever
(3) Spring Pin
(4) Governor Lever Assembly
(5) O-ring
(6) Start Spring

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Stop Lever

1. Remove the spring pin (3).
2. Remove the stop lever (2) and the return spring (1).
3. Remove the stop lever shaft (4).

(1) Return Spring
(2) Stop Lever
(3) Spring Pin
(4) Stop Lever Shaft
(5) O-ring

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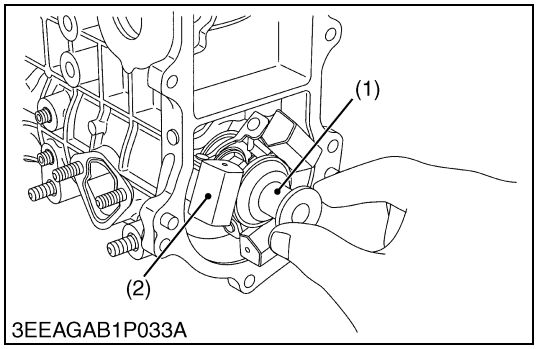

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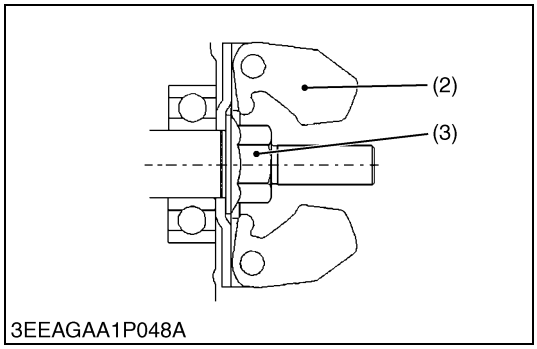

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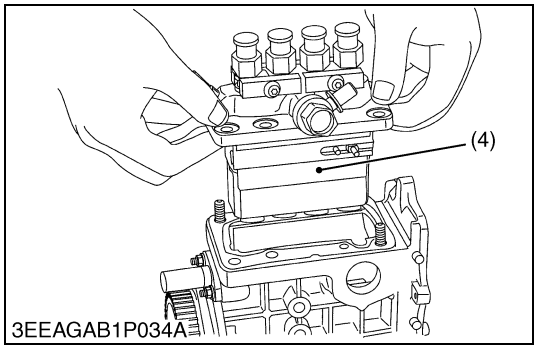

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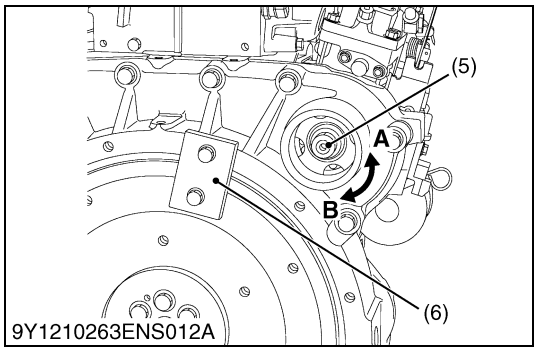

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Fuel Camshaft and Governor Weight

1. Separate the governor housing assembly from the injection pump unit. (See the "Injection Pump Unit".)
2. Remove the governor sleeve (1).
3. Remove the injection pump assembly (4).
4. Remove the fuel camshaft lock screws.
5. Install the injection pump unit to the crankcase 1 again and temporarily tighten unit.
6. Fix the flywheel with the flywheel stopper (6) and loosen the injection pump gear mounting nut (5).
7. Remove the governor weight mounting nut (3) and the governor weight (2).
8. Separate the injection pump unit from the crankcase 1.

■ **NOTE**

- **Do not use the fuel camshaft lock screws, when removing the governor weight mounting nut (3). Otherwise, the lock screws or injection pump housing might get damage.**

■ **IMPORTANT**

- **This injection pump gear mounting nut (5) has left-handed screw. To loose this nut, rotate clockwise (viewed from flywheel side).**

Tightening torque	Injection pump assembly mounting screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft
	Injection pump assembly mounting nut	18 to 20 N·m 1.8 to 2.1 kgf·m 13 to 15 lbf·ft
	Injection pump gear mounting nut (left-handed screw)	93.2 to 102 N·m 9.50 to 10.5 kgf·m 68.8 to 75.9 lbf·ft
	Governor weight mounting nut	63 to 72 N·m 6.4 to 7.4 kgf·m 47 to 53 lbf·ft

(1) Governor Sleeve
(2) Governor Weight
(3) Governor Weight Mounting Nut
(4) Injection Pump Assembly
(5) Injection Pump Gear Mounting Nut
(6) Flywheel Stopper

A : To Tighten
B : To Loosen

(To be continued)

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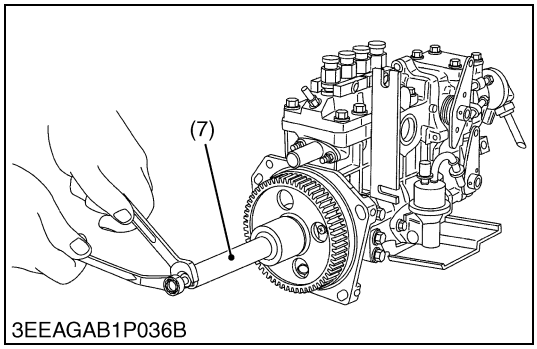

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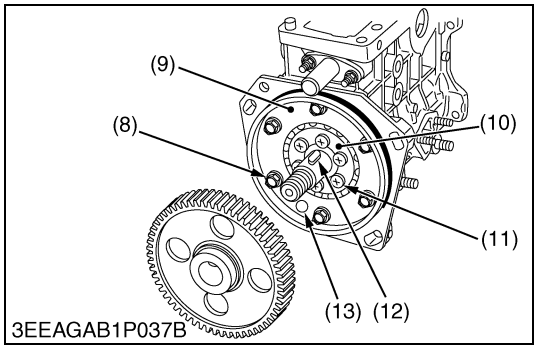

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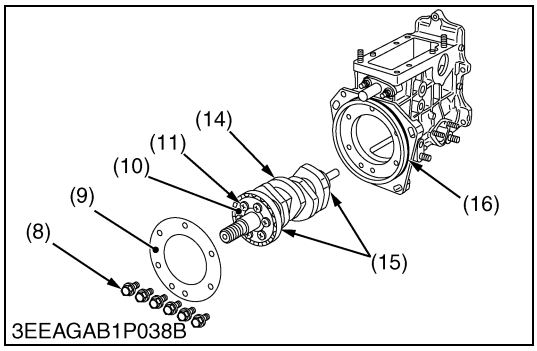

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1. Pull out the injection pump gear using gear puller (7). (Refer to "SPECIAL TOOLS" at "GENERAL" section.)
2. Loosen the fuel camshaft stopper mounting screws (8) and remove the fuel camshaft stopper (9).
3. Pull out the fuel camshaft (14) and bearings (15) together.
4. Loosen the fuel camshaft bearing stopper mounting screws (11).
5. After removing the fuel camshaft bearing stopper (10), press out the bearings (15).

■ **NOTE**
- **Do not use the fuel camshaft lock bolts, when removing the governor weight mounting nut. Otherwise, the lock bolts or injection pump housing might get damage.**

(When reassembling)
- Press the bearings (15) into the fuel camshaft.
- Confirm that the oil hole (13) set in position and attach the fuel camshaft bearing stopper (10). Then tighten the fuel camshaft bearing stopper mounting screws (11) with the specified torque.
- Install the fuel camshaft and bearings (15) to the injection pump housing.
- Attach the fuel camshaft stopper (9) and tighten the fuel camshaft stopper mounting screws (8) with the specified torque.
- Install the injection pump gear and mounting nut to the fuel camshaft and temporarily tighten nut.
- Install the injection pump unit to the crankcase 1 and temporarily tighten unit.
- Fix the flywheel with the flywheel stopper. Then tighten the injection pump gear mounting nut and the governor weight mounting nut with specified torque.
- Install the injection pump assembly to the injection pump housing.
- Install the governor sleeve to the fuel camshaft.
- Check the movement of the governor sleeve.

■ **NOTE**
- **Be careful not to damage the O-ring (16).**
- **Be careful the direction of the governor sleeve.**
- **When reassembling the inside parts, put the oil on each inside part slightly.**

Tightening torque	Fuel camshaft stopper mounting screw	9.81 to 11.2 N·m 1.00 to 1.15 kgf·m 7.24 to 8.31 lbf·ft
	Fuel camshaft bearing stopper mounting screw	3.9 to 4.2 N·m 0.39 to 0.43 kgf·m 2.9 to 3.1 lbf·ft

(7) Injection Pump Gear Puller
(8) Fuel Camshaft Stopper Mounting Screw
(9) Fuel Camshaft Stopper
(10) Fuel Camshaft Bearing Stopper
(11) Fuel Camshaft Bearing Stopper Mounting Screw
(12) Key Way of Fuel Camshaft
(13) Oil Hole
(14) Fuel Camshaft
(15) Bearing
(16) O-ring

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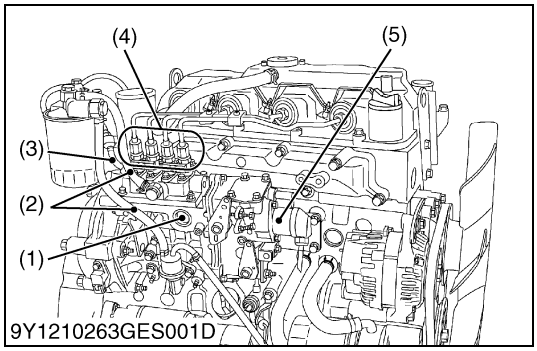

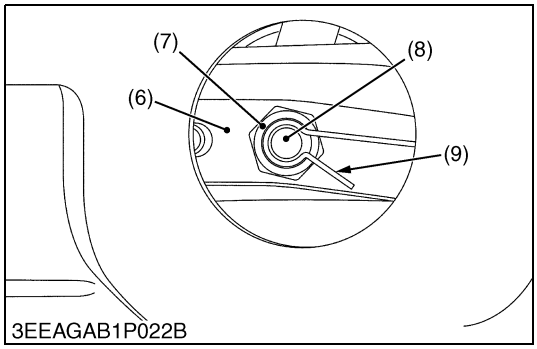

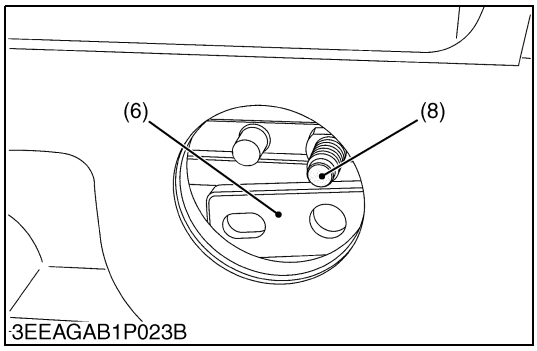

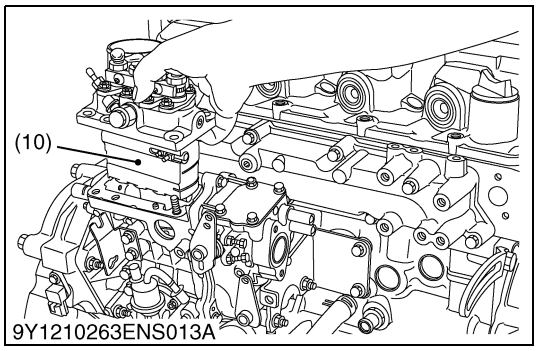

Replacing Injection Pump Assembly (If necessary)

- **The injection pump can be replaced with the crankshaft in whatever position.**

1. Disconnect all injection pipes (4).
2. Disconnect the fuel hose (2) and fuel overflow pipe (3).
3. Disconnect the connector from the stop solenoid (5). Then remove the stop solenoid (5).
4. Detach the sight cover (1) from the injection pump unit.
5. Unhook the start spring (9), and remove the lock nut (7).
6. Slide off the governor connecting rod (6) from the rack pin (8) of injection pump assembly (10).
7. Remove the injection pump mounting screws and nuts, and take out the injection pump assembly (10).

■ **NOTE**

- **Be careful not to drop the lock nut (7).**
- **Be careful not to deform the start spring (9).**
- **When taking out the injection pump assembly (10), be careful not to hit it against the governor connecting rod (6).**

(When reassembling)

- Install the new injection pump according to the installing procedure.

(1) Sight Cover
(2) Fuel Hose
(3) Fuel Overflow Pipe
(4) Injection Pipe
(5) Stop Solenoid
(6) Governor Connecting Rod
(7) Lock Nut
(8) Rack Pin
(9) Start Spring
(10) Injection Pump Assembly

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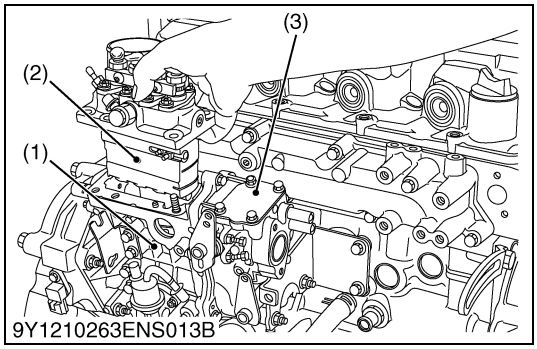

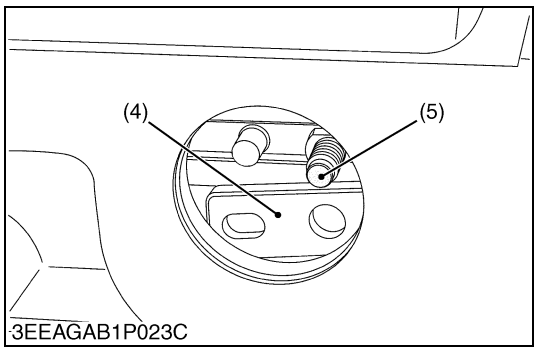

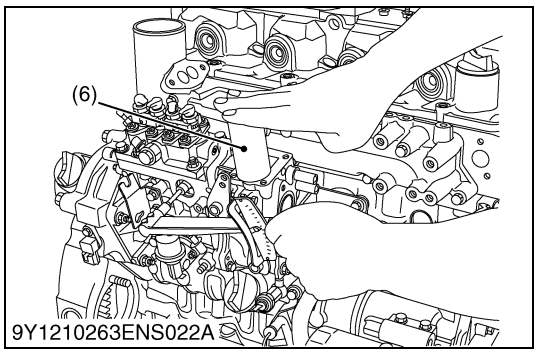

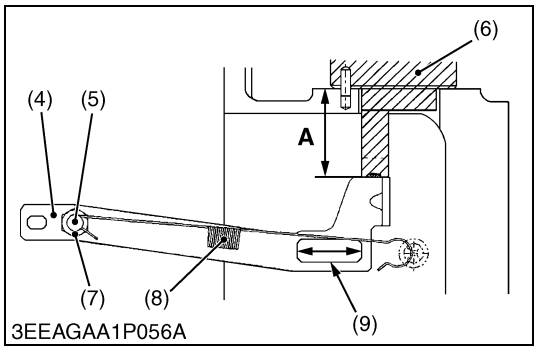

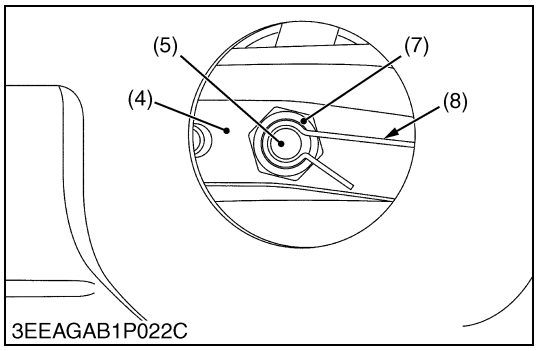

Installing Procedure of Injection Pump Assembly

1. Install the fuel injection pump assembly (2) in its unit (1), and tighten the mounting screws and nuts.
2. Hook the governor connecting rod (4) to the rack pin (5) of the fuel injection pump assembly (2).
3. Tighten the mounting screws and nuts with the specified torque, not to slide off the governor connecting rod (4) from the rack pin (5).
4. Remove the top cover (3) and place the service jig (6) to the hole of the fuel injection pump unit (1). (Refer to "SPECIAL TOOLS" at "GENERAL" section.)
5. Make sure the permanent magnet at the tip of the service jig (6) is attracted to the governor connecting rod (4).
6. Slightly tighten the lock nut (7) of the governor connecting rod (4).
7. Holding down the service jig (6) by hand, tighten up the lock nut (7) to the specified torque.
8. Hook the start spring (8) to the rack pin (5).

(1) Fuel Injection Pump Unit
(2) Fuel Injection Pump Assembly
(3) Top Cover
(4) Governor Connecting Rod
(5) Rack Pin
(6) Service Jig
(7) Lock Nut
(8) Start Spring
(9) Sliding Point between Governor Fork Lever and Governor Connecting Rod

A : 27.95 to 28.05 mm (1.100 to 1.104 in.)

(To be continued)

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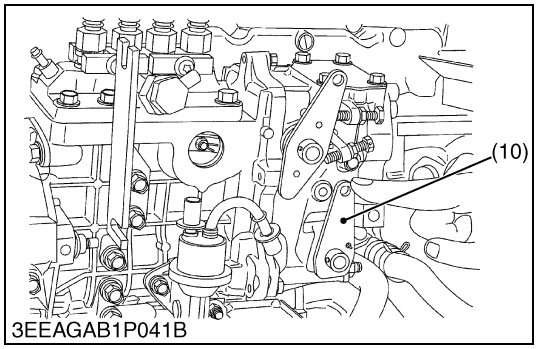

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1. Move the stop lever (10) and visually check to see if the fuel injection pump control rack comes smoothly back to the start position by the counter force of the start spring.
2. If the control rack fails to move back smoothly, remove the start spring and the lock nut, take the above steps from 2 of the former page again.
3. Finally fit the sight cover and the stop solenoid back into place.

Tightening torque	Lock nut	2.9 to 4.0 N·m 0.29 to 0.41 kgf·m 2.1 to 2.9 lbf·ft
	Injection pump assembly mounting screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft
	Injection pump assembly mounting nut	18 to 20 N·m 1.8 to 2.1 kgf·m 13 to 15 lbf·ft

(10) Stop Lever

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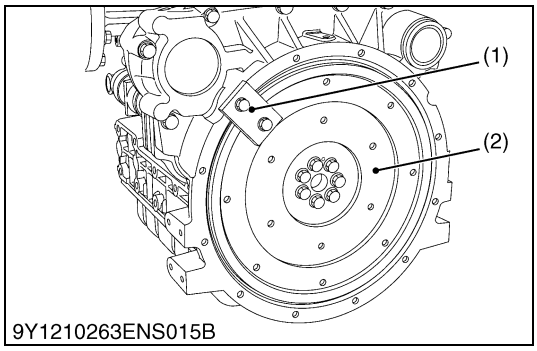

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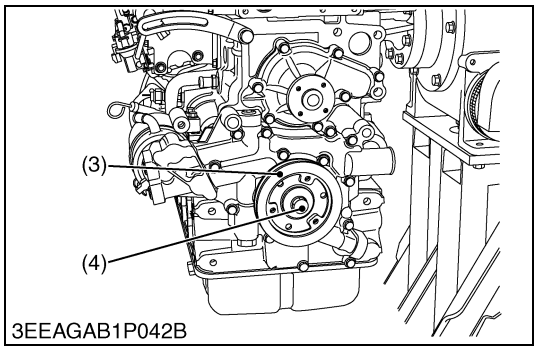
Fan Drive Pulley

1. Set the stopper (1) to the flywheel (2).
2. Remove the crankshaft screw (4).
3. Draw out the fan drive pulley (3).

(When reassembling)

- Tighten the crankshaft screw (4) to specified torque after applying engine oil.

Tightening torque	Crankshaft screw	255 to 274 N·m 26.0 to 28.0 kgf·m 188 to 202 lbf·ft



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(1) Stopper
(2) Flywheel
(3) Fan Drive Pulley
(4) Crankshaft Screw

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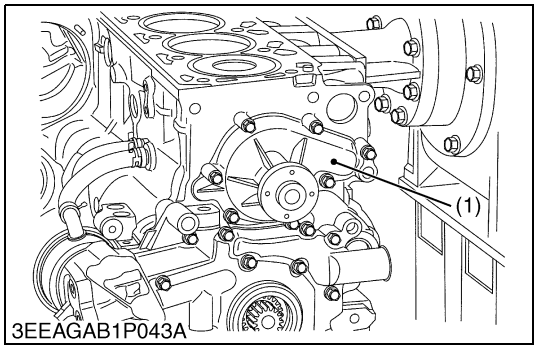
(6) Water Pump and Oil Cooler



Water Pump (If necessary)

1. Remove the water pump (1).

(When reassembling)

- When mounting the water pump (1), use the new water pump gasket.

(1) Water Pump

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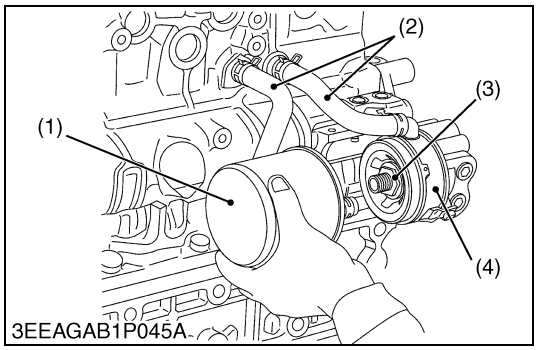

Oil Cooler

1. Remove the water pipe (2).
2. Remove the oil filter cartridge (1) and the oil cooler joint screw (3).
3. Remove the oil cooler (4).

Tightening torque	Oil cooler joint screw	64 to 73 N·m 6.5 to 7.5 kgf·m 47 to 54 lbf·ft

(1) Oil Filter Cartridge
(2) Water Pipe
(3) Oil Cooler Joint Screw
(4) Oil Cooler

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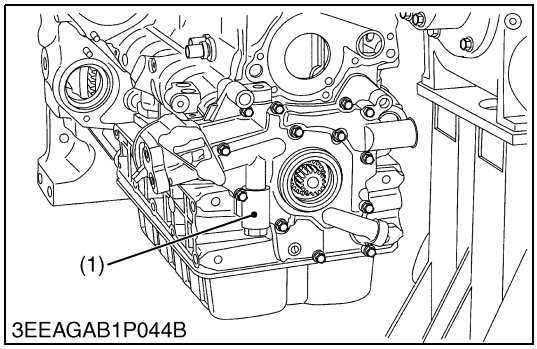
(7) Front Cover



Front Cover

1. Remove the front cover (1).

(When reassembling)

- Confirm that the front cover gasket (4) set in position.
- Confirm that the liquid gasket coating surface is free of water, dust and oil in order to maintain sealing effect.

■ **NOTE**

- **Assemble the adhesive-applied parts within ten minutes.**
- **Apply a liquid gasket (Three Bond 1217H or equivalent) (5) to the seam between crankcase 1 (3) and crankcase 2 (2).**

Tightening torque	Front cover mounting screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft

(1) Front Cover
(2) Crankcase 2
(3) Crankcase 1
(4) Front Cover Gasket
(5) Liquid Gasket

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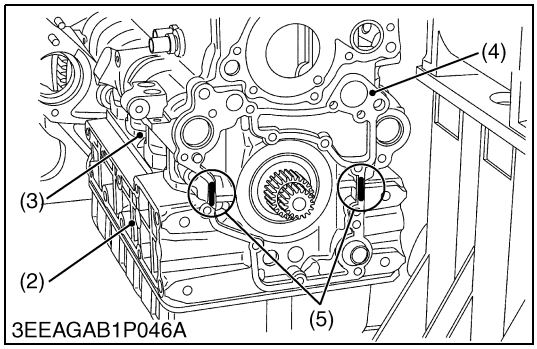

Relief Valve

1. Remove the relief valve retaining screw (5).
2. Remove the relief valve (2), the spring (3) and the packing (4).

Tightening torque	Relief valve retaining screw	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

(1) Front Cover
(2) Relief Valve
(3) Spring
(4) Packing
(5) Relief Valve Retaining Screw

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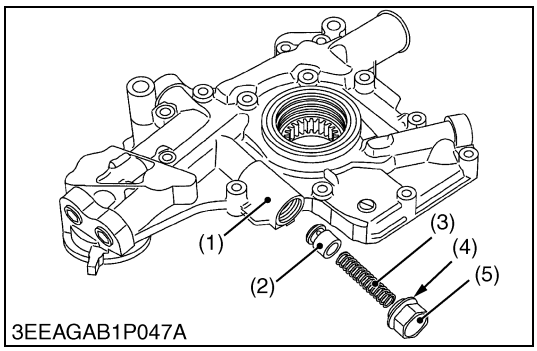
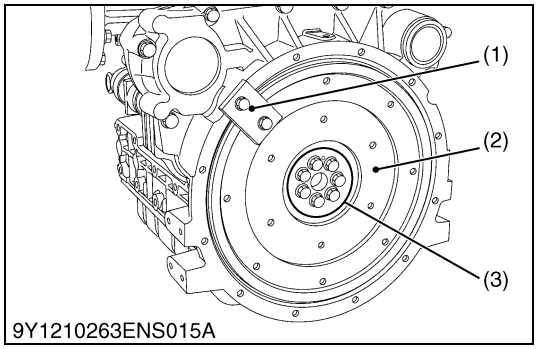


(8) Flywheel and Timing Gears



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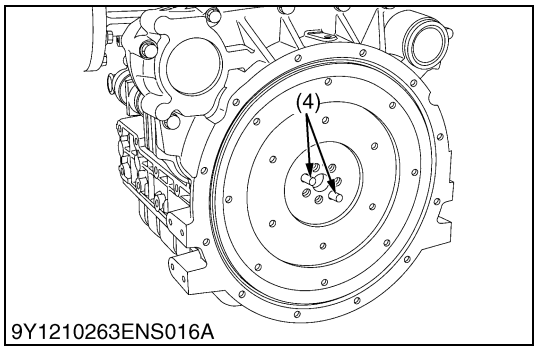

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Flywheel

1. Install the stopper (1) to the flywheel (2) so that the flywheel (2) does not turn.

■ **NOTE**
- **Do not use an impact wrench. Serious damage will occur.**
- **There is one positioning pin in the crankshaft gear and it is installed in the flywheel (2).**

2. Detach the flywheel screws (3) and set the flywheel guide screws (4).
3. Remove the flywheel (2).

(When reassembling)
- Apply engine oil to the flywheel screws (3).
- Before fitting the flywheel (2) and the crankshaft gear together, wipe oil, dust and other foreign substances off their mating faces.
- The flywheel (2) and the crankshaft gear are fitting together in just one position. Make sure they are tightly fit and drive the screws.

Tightening torque	Flywheel screw	98.1 to 107 N·m 10.0 to 11.0 kgf·m 72.4 to 79.5 lbf·ft

(1) Stopper
(2) Flywheel
(3) Flywheel Screw
(4) Flywheel Guide Screw

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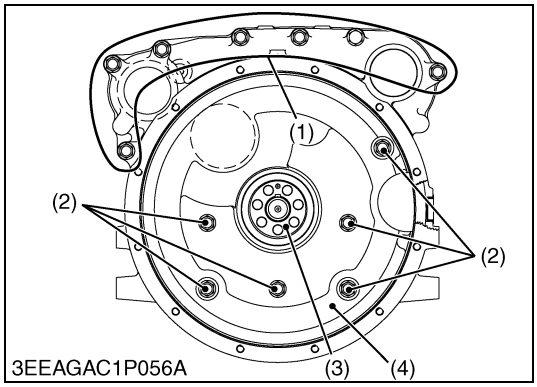

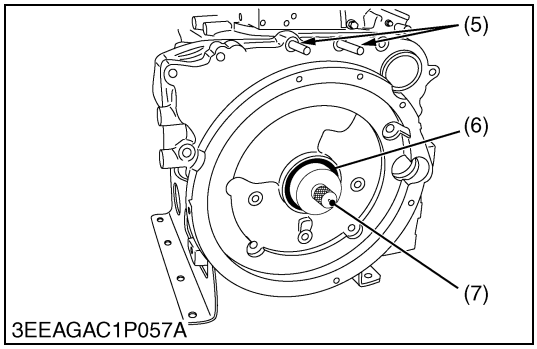

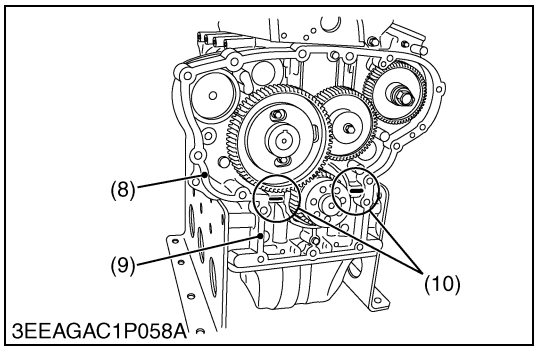

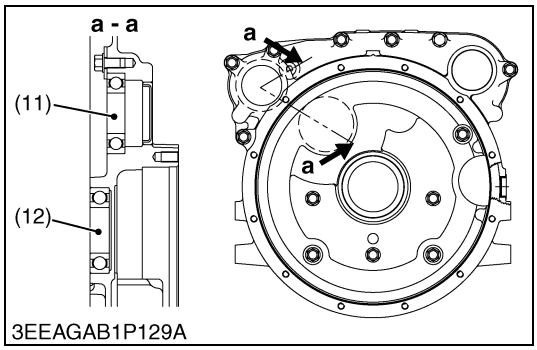

Flywheel Housing

1. Remove the outside flywheel housing mounting screws (1).
2. Remove the inside flywheel housing mounting screws (2).
3. Remove the flywheel housing (4).

(When reassembling)

- Apply engine oil to the flywheel housing oil seal (6).
- Set the flywheel guide screws (5) and the flywheel housing guide jig (7) to the crankshaft gear (3). (Refer to "SPECIAL TOOLS" at "GENERAL" section.)
- Apply a liquid gasket (Three Bond 1217H or equivalent) (10) to the seam between crankcase 1 (8) and crankcase 2 (9), and set gasket.
- Assemble the adhesive-applied parts within ten minutes.
- Confirm that the bearing 1 (11) and the bearing 2 (12) set in position.

Tightening torque	Flywheel housing mounting screw	78 to 90 N·m 7.9 to 9.2 kgf·m 58 to 66 lbf·ft

(1) Flywheel Housing Mounting Screw (Outside)
(2) Flywheel Housing Mounting Screw (Inside)
(3) Crankshaft Gear
(4) Flywheel Housing
(5) Flywheel Guide Screw
(6) Oil Seal
(7) Jig
(8) Crankcase 1
(9) Crankcase 2
(10) Liquid Gasket
(11) Bearing 1
(12) Bearing 2

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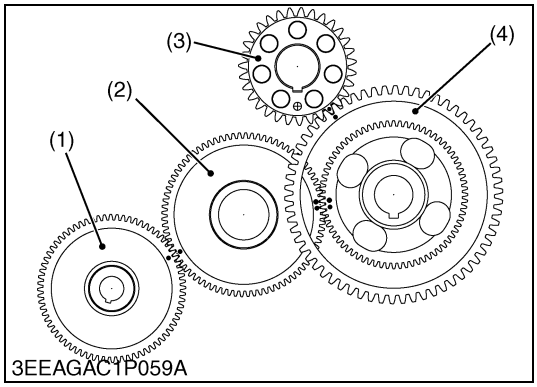

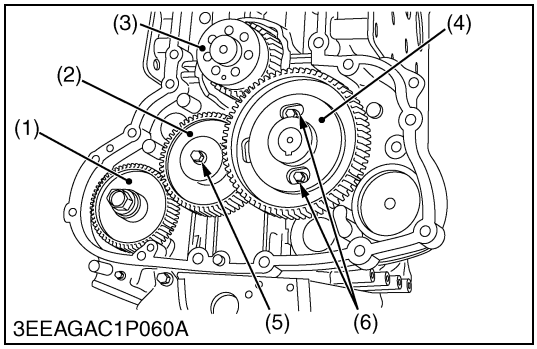

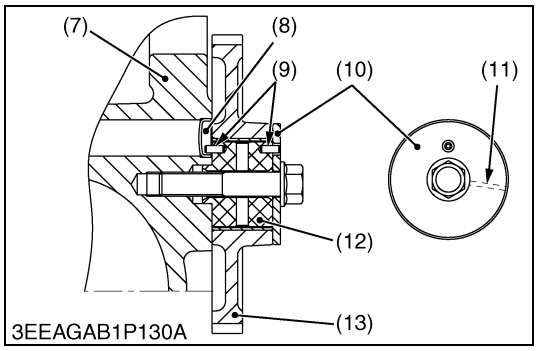

Camshaft and Idle Gear

1. Rotate the cylinder head side of the engine crankcase to the lower side.
2. Remove the camshaft set screws (6) and draw out the cam gear (4).
3. Remove the idle gear mounting screws (5) and draw out the idle gear (2).

■ **NOTE**

- **If the cylinder head side of the engine crankcase does not become lower side, the tappets drop and become the trouble to the camshaft. The camshaft will not be able to be drawn out.**

(When reassembling)

- When installing the idle gear (2) and cam gear (4), be sure to place the 4th cylinder piston at the top dead center in compression then, align all mating marks on each gear to assemble the timing gears, set the cam gear last.
- Mount the injection pump gear (1) after installing the flywheel housing.
- Make sure the idle gear shaft (12) is clean.
- Apply oil to the idle gear shaft (12) and set the crankcase 1 (7).
- Set the idle gear (13) and the collar (10) with the oil groove (11) facing crankcase 1 side.

Tightening torque	Camshaft set screw	24 to 27 N·m 2.4 to 2.8 kgf·m 18 to 20 lbf·ft
	Idle gear mounting screw	49 to 55 N·m 5.0 to 5.7 kgf·m 37 to 41 lbf·ft

(1) Injection Pump Gear
(2) Idle Gear
(3) Crank Gear
(4) Cam Gear
(5) Idle Gear Mounting Screw
(6) Camshaft Set Screw
(7) Crankcase 1
(8) Plug
(9) Spring Pin
(10) Collar
(11) Oil Groove
(12) Idle Gear Shaft
(13) Idle Gear

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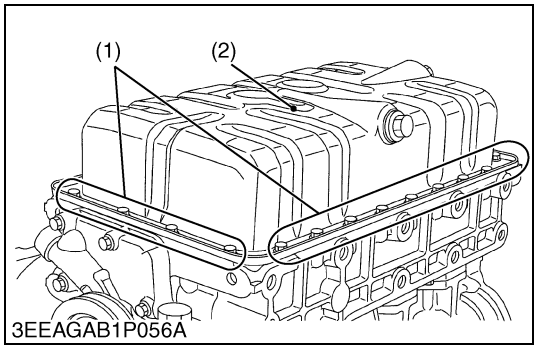
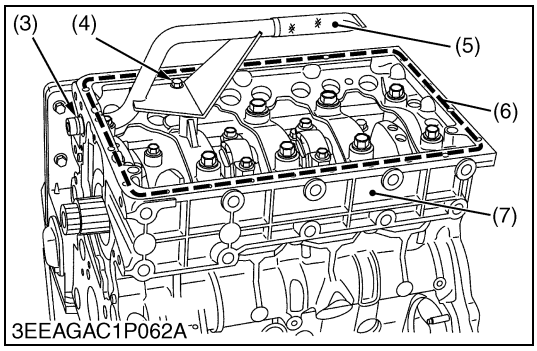
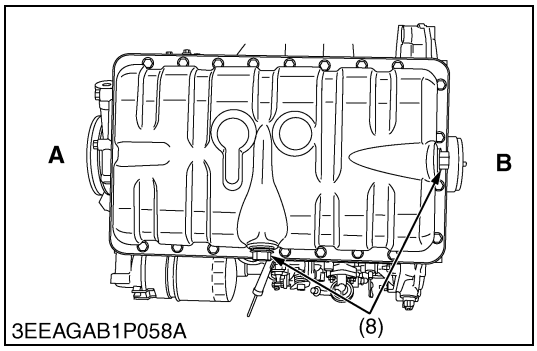
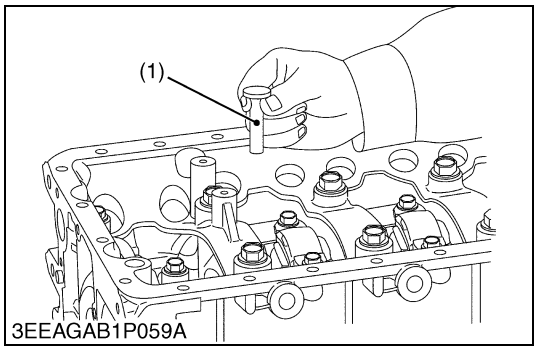
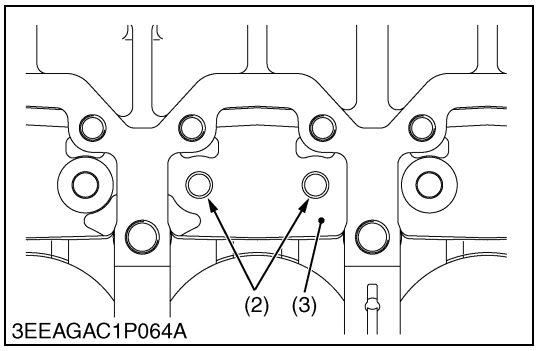
(9) Piston and Connecting Rod











Oil Pan and Oil Strainer

1. Unscrew the oil pan mounting screws (1) and remove the oil pan (2).
2. Unscrew the oil strainer mounting screws (4), and remove the oil strainer (5).

(When reassembling)

- Install the oil strainer (5), using care not to damage the O-ring (3).
- Apply liquid gasket (Three Bond 1217H or equivalent) (6) to the crankcase 2 (7) as shown in the figure.
- Confirm that the liquid gasket coating surface is free of water, dust and oil in order to maintain sealing effect.
- Carefully apply the adhesive evenly.

■ **NOTE**

- **When mounting the adhesive-applied parts, take care to fit them to the mating parts.**
- **Assemble the adhesive-applied parts within ten minutes.**
- **To avoid uneven tightening, tighten mounting screws (1) in diagonal order from the center.**
- **After cleaning the oil strainer (5), install it.**
- **Attach the oil pan (2) so that the drain plugs (8) will approach the flywheel housing side "B".**

(1) Oil Pan Mounting Screw
(2) Oil Pan
(3) O-ring
(4) Oil Strainer Mounting Screw
(5) Oil Strainer
(6) Liquid Gasket
(7) Crankcase 2
(8) Drain Plug

A : Front Cover Side
B : Flywheel Housing Side

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Tappet

1. Remove the tappets (1) from the tappet bore (2) of the crankcase 1 (3) using magnetic tool.

(When reassembling)

- Before installing the tappets (1), apply engine oil thinly around them.

■ **NOTE**

- **Mark the cylinder number to the tappets (1) to prevent interchanging.**

(1) Tappet
(2) Tappet Bore
(3) Crankcase 1

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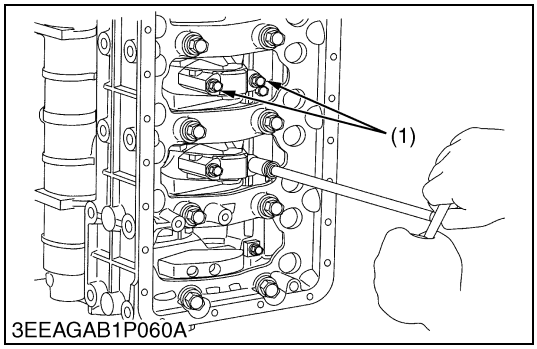

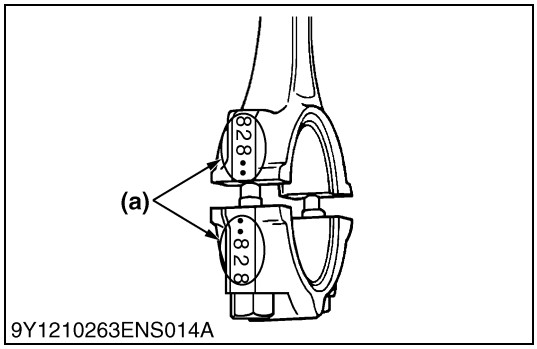

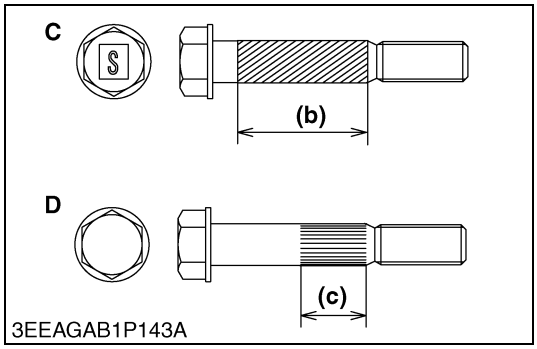

Connecting Rod Cap

1. Remove the connecting rod screws (1) from connecting rod cap.
2. Remove the connecting rod caps.

(When reassembling)

- Align the marks **(a)** with each other. (Face the marks toward the injection pump.)
- Apply engine oil to the connecting rod screws (1) and lightly screw it in by hand, then tighten it to the specified torque.
  If the connecting rod screw (1) won't be screwed in smoothly, clean the threads.
  If the connecting rod screw (1) is still hard to screw in, replace it.
- When using the existing crank pin metal again, put tally marks on the crank pin metal and the connecting rod in order to keep their positioning.

■ **NOTE**

- **At the time of reassembling the connecting rod caps, use a combination of the connecting rod screws with the same specified tightening torque.**

Tightening torque	Connecting rod screw	V2607-DI-E3B, V2607-DI-T-E3B [Serial No.: 8G0001 to 9K9999] (Fig. C)	45 to 49 N·m 4.5 to 5.0 kgf·m 33 to 36 lbf·ft
		V2607-DI-E3B, V2607-DI-T-E3B [Serial No.: 9L0001 and above] (Fig. D)	41 to 45 N·m 4.1 to 4.6 kgf·m 30 to 33 lbf·ft
		V3007-DI-T-E3B V3307-DI-T-E3B	69 to 73 N·m 7.0 to 7.5 kgf·m 51 to 54 lbf·ft

(1) Connecting Rod Screw

C : Old Connecting Rod Screw
D : New Connecting Rod Screw

(a) Mark
(b) Serration (Spiral): 26 mm (1.0 in.)
(c) Serration (Axial direction): 13 mm (0.51 in.)

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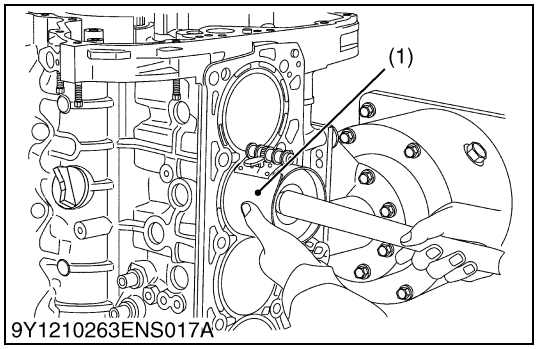

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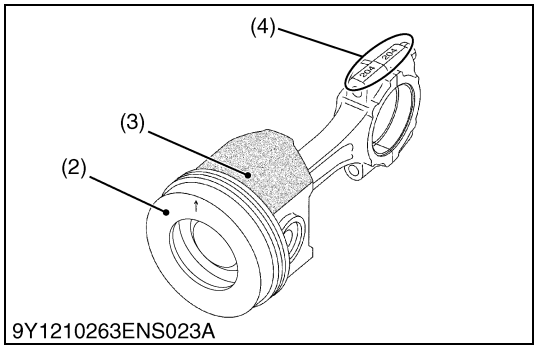

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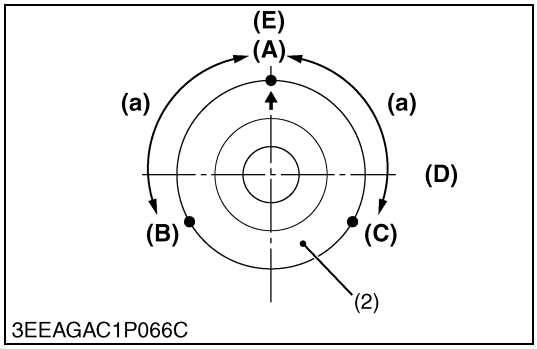

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Piston

1. Completely clean carbon in the cylinders.
2. Turn the flywheel and set a piston to the top dead center.
3. Pull out the piston upward by lightly tapping it from the bottom of the crankcase with the grip of a hammer.

(When reassembling)

- Before inserting the piston into the cylinder, apply enough engine oil to the cylinder.
- When inserting the piston into the cylinder, face the mark (4) on the connecting rod to the injection pump.

■ **IMPORTANT**

- **Do not change the combination of cylinder and piston. Make sure of the position of each piston by marking. For example, mark "1" on the No. 1 position.**
- **When inserting the piston into the cylinder, place the gap of each piston ring like the figure.**
- **Carefully insert the pistons using a piston ring compressor (1). Otherwise, their chrome-plated section of piston rings may be scratched, causing trouble inside the liner.**
- **When inserting the piston in place, be careful not to get the molybdenum disulfide coating (3) torn off its skirt. This coating is useful in minimizing the clearance with the cylinder liner. Just after the piston pin has been press-fitted, in particular, the piston is still hot and the coating is easy to peel off. Wait until the piston cools down.**

(1) Piston Ring Compressor
(2) Piston
(3) Molybdenum Disulfide Coating
(4) Mark

(A) Top Ring Gap
(B) Second Ring Gap
(C) Oil Ring Gap
(D) Piston Pin Hole
(E) Injection Pump Side

(a) 2.09 rad (120 °)

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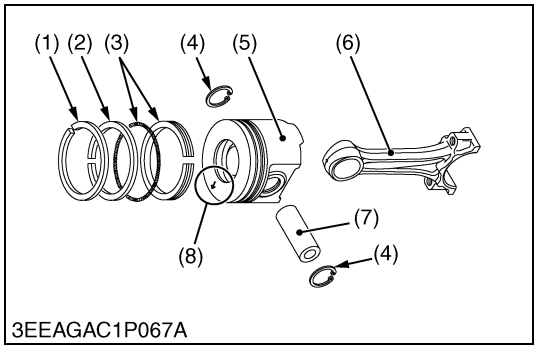

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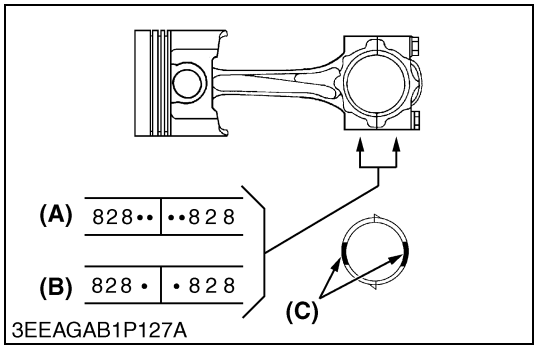

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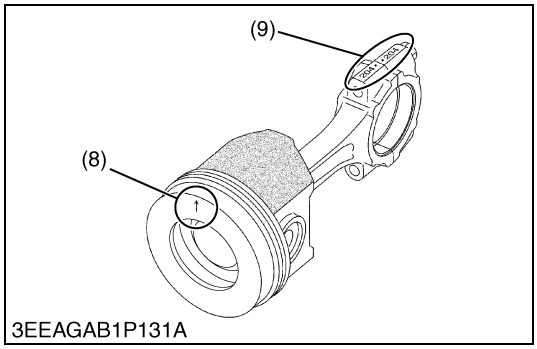

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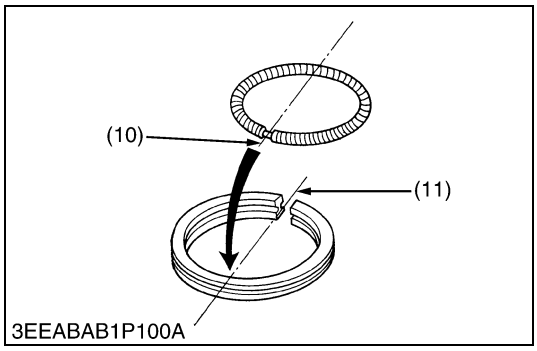

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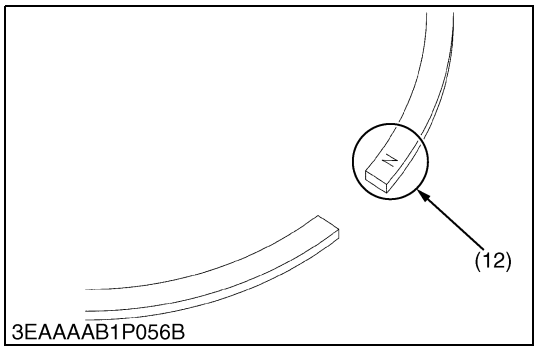

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Piston Ring and Connecting Rod

1. Remove the piston rings using a piston ring tool.
2. Remove the piston pin (7), and separate the connecting rod (6) from the piston (5).

(When reassembling)

- Make sure the combination of the crankpin bearing ID color and the connecting rod mark.

Connecting rod mark	Crankpin bearing ID color (Figure (C))
2 stamps (Figure **(A)**)	Blue
1 stamp (Figure **(B)**)	Without color

- When installing the ring, assemble the rings so that the manufacture's mark (12) near the gap faces the top of the piston (5).
- When installing the oil ring (3) onto the piston (5), place the expander joint (11) on the opposite side of the oil ring gap (10).
- Apply engine oil to the piston pin (7).
- When installing the piston pin (7), immerse the piston (5) in 80 °C (176 °F) oil for 10 to 15 minutes and insert the piston pin (7) to the piston (5).
- Assemble the piston (5) to the connecting rod (6) with the - mark (8) and the connecting rod numbering mark (9) facing same side.
- The end faces of the oil ring (3) are plated with hard chrome. In putting the piston (5) into the cylinder, be careful not to get the oil ring (3) scratched by the cylinder. Use the piston ring fitter to tighten up the oil ring (3). If the ring's planting is scratched, it may get stuck on the cylinder wall, causing a serious trouble.

■ **IMPORTANT**

- **Mark the same number on the connecting rod (6) and the piston (5) so as not to change the combination.**

(1) Top Ring
(2) Second Ring
(3) Oil Ring
(4) Piston Pin Snap Pin
(5) Piston
(6) Connecting Rod
(7) Piston Pin
(8) Mark (↑)
(9) Numbering Mark
(10) Oil Ring Gap
(11) Expander Joint
(12) Manufacture's Mark

(A) Connecting Rod Mark : 2 Stamps
(B) Connecting Rod Mark : 1 Stamp
(C) Crankpin Bearing ID Color : Blue or without Color

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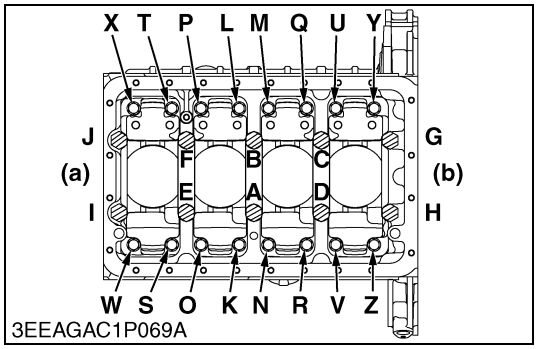
(10) Crankshaft and Crankcase



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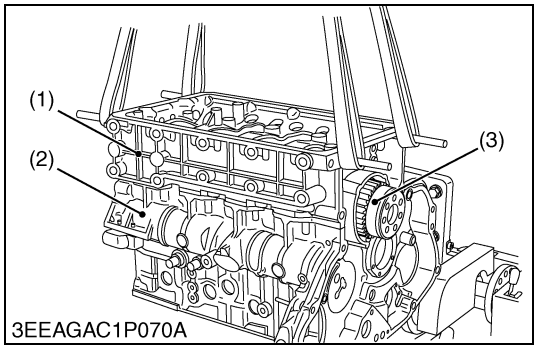

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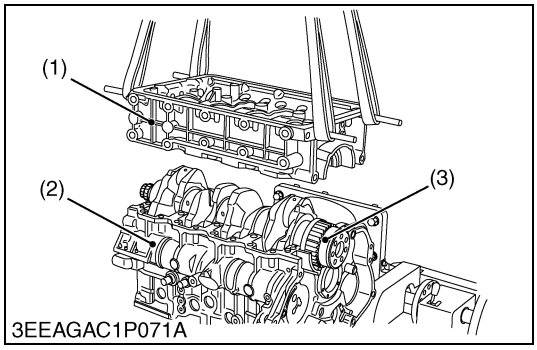

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Crankshaft and Crankcase

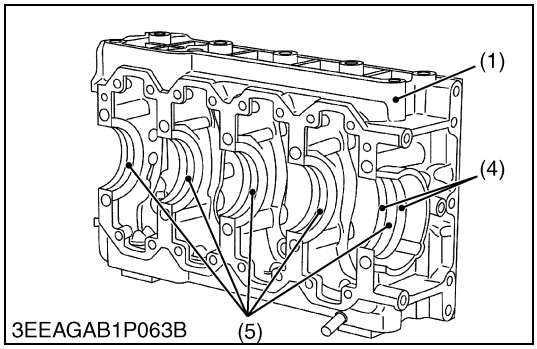
1. Remove the crankcase 2 mounting screw and crankcase 2 flange screw in the order of **Z** to **A**.
2. Remove the crankcase 2 (1) from the crankcase 1 (2).
3. Remove the crankshaft (3).

(1) Crankcase 2
(2) Crankcase 1
(3) Crankshaft

(a) Front Cover Side
(b) Flywheel Housing Side
A to J : Crankcase 2 Mounting Screw
K to Z : Crankcase 2 Flange Screw

(To be continued)

(Continued)



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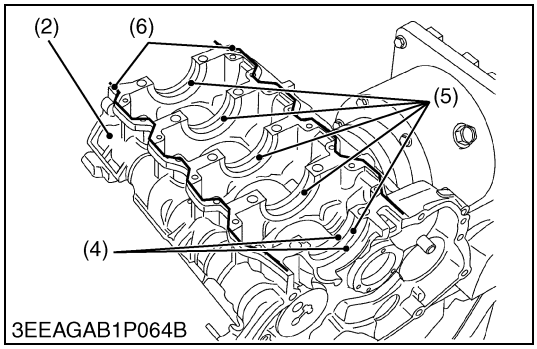

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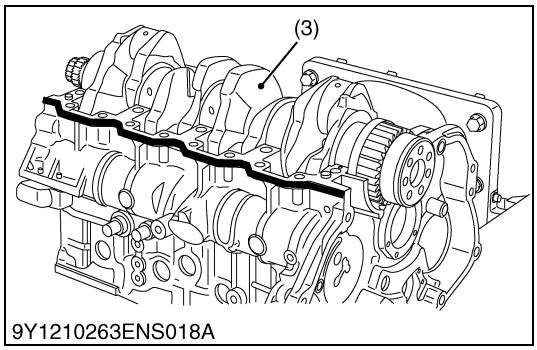

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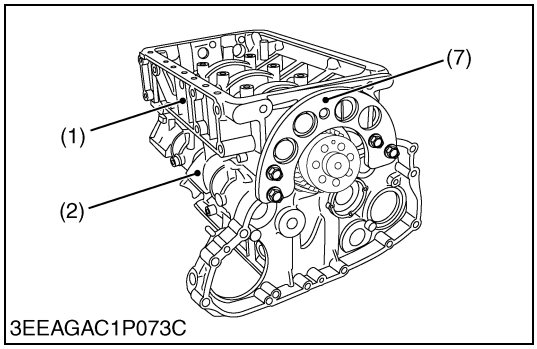

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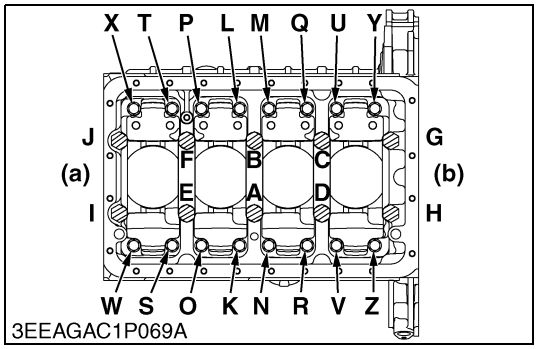

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(When reassembling)

- Make sure the crankcase 1 (2) and 2 (1) are clean.
- Reassemble the crankshaft bearing (5) into crankcase 1 (2) and 2 (1).
- Reassemble the thrust bearing (4), with the oil groove facing outside, into both flywheel housing edge journal side of the crankcase 1 (2) and 2 (1).
- Apply oil to the thrust bearing and set the crankshaft (3).
- Apply liquid gasket (Three Bond 1217H or equivalent) (6) to the crankcase 1 as shown in the figure.
- Confirm that the liquid gasket coating surface is free of water, dust and oil in order to maintain sealing effect.
- Carefully apply the adhesive evenly.
- Match the crankcase 1 (2) and 2 (1), referring to the flywheel housing's contoured face.
- Tighten the crankcase 2 mounting screws (**A** to **J**) and the crankcase 2 flange screws (**K** to **Z**) loosely after applying engine oil.
- Tighten up the jig (7) to the specified torque same as the flywheel housing screw. (Refer to "SPECIAL TOOLS" at "GENERAL" section.) This helps to minimize the level difference between the crankcase 1 (2) and the crankcase 2 (1) (at the flywheel side). Possible gap must be 0.05 mm (0.002 in.) or smaller.
- Tighten the crankcase 2 mounting screw and the crankcase 2 flange screw in the order of **A** to **Z**.

■ **NOTE**

- **When mounting the adhesive-applied parts, take care to fit them to the mating parts.**
- **Assemble the adhesive-applied parts within ten minutes.**

Tightening torque	Crankcase 2 mounting screw (**A** to **J**)	128 to 137 N·m 13.0 to 14.0 kgf·m 94.1 to 101 lbf·ft
	Crankcase 2 flange screw (**K** to **Z**)	49 to 55 N·m 5.0 to 5.7 kgf·m 37 to 41 lbf·ft
	Flywheel housing mounting screw	78 to 90 N·m 7.9 to 9.2 kgf·m 58 to 66 lbf·ft

(1) Crankcase 2
(2) Crankcase 1
(3) Crankshaft
(4) Thrust Bearing
(5) Crankshaft Bearing
(6) Liquid Gasket
(7) Jig

(a) Front Cover Side
(b) Flywheel Housing Side

A to J : Crankcase 2 Mounting Screw
K to Z : Crankcase 2 Flange Screw

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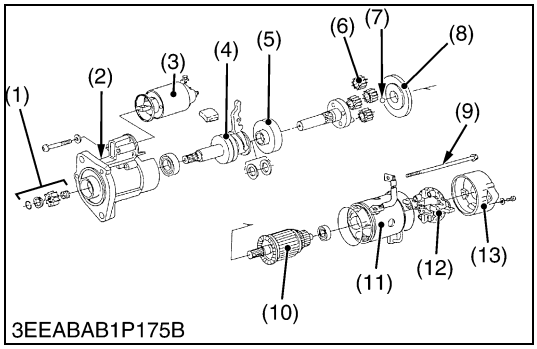
(11) Starter



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Disassembling Motor

1. Disconnect the solenoid switch (3).
2. Remove the 2 through screws (9) and the 2 brush holder lock screws. Take out the rear end frame (13) and the brush holder (12).
3. Disconnect the armature (10) and the yoke (11). Remove also the ball (7) from the tip of the armature (10).
4. Remove the set of packing (8), the 4 planetary gears (6) and another packing.
5. Take out the shaft assembly. Take note of the position of the lever.

■ **IMPORTANT**

- **Before disconnecting the yoke (11), put tally marks on the yoke (11) and the front bracket (2).**
- **Take note of the positions of the set of packing (8) and the setup bolt.**
- **Apply grease to the gears, bearings, shaft's sliding part and ball (7).**

■ **NOTE**

- **Do not damage to the brush and commutator.**

(When reassembling)

- Apply grease (DENSO CO. No.50 or equivalent) to the parts indicated in the figure.

Tightening torque	Starter's terminal **B** mounting nut	9.8 to 11 N·m 1.0 to 1.2 kgf·m 7.3 to 8.6 lbf·ft

(1) Gear
(2) Front Bracket
(3) Solenoid Switch
(4) Overrunning Clutch
(5) Internal Gear
(6) Planetary Gear
(7) Ball
(8) Set of Packing
(9) Through Screw
(10) Armature
(11) Yoke
(12) Brush Holder
(13) Rear End Frame

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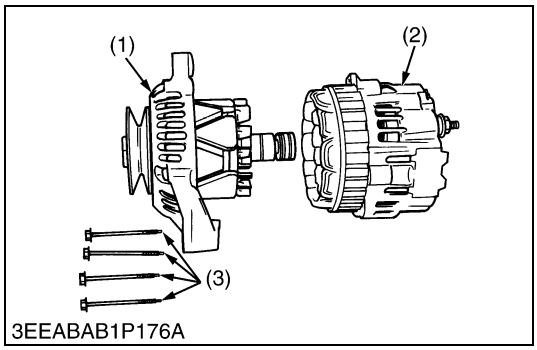
(12) Alternator



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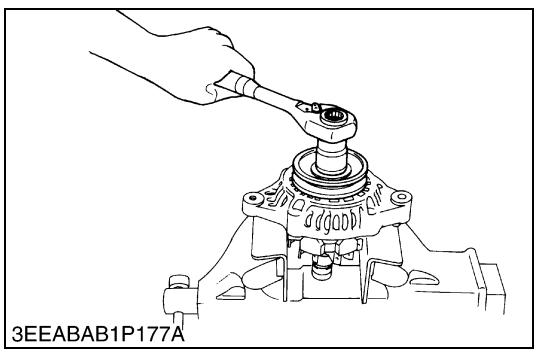
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Front Bracket

1. Remove the 4 screws (3).
2. Separate the front bracket (1) and the rear bracket (2) from each other.

■ **IMPORTANT**

- **Put a tally line on the front bracket (1) and the rear bracket (2) for reassembling them later.**

(1) Front Bracket
(2) Rear Bracket
(3) Screw

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Pulley

1. Hold the rotor (base of the claw) in a vise. Loosen the lock nut using a M24 box wrench.

Tightening torque	Alternator pulley nut	58.4 to 78.9 N·m 5.95 to 8.05 kgf·m 43.1 to 58.2 lbf·ft

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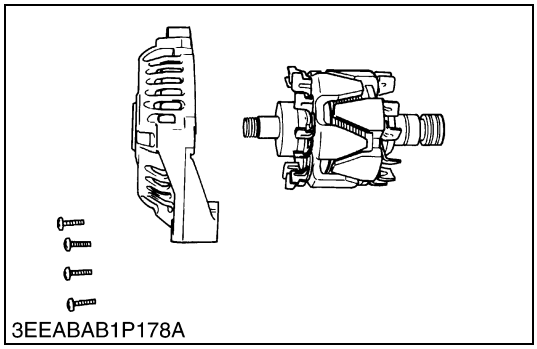
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Rotor

1. Remove the 4 screws and detach the bearing retainer.
2. Temporarily install the nut on the pulley screw, and detach the rotor.

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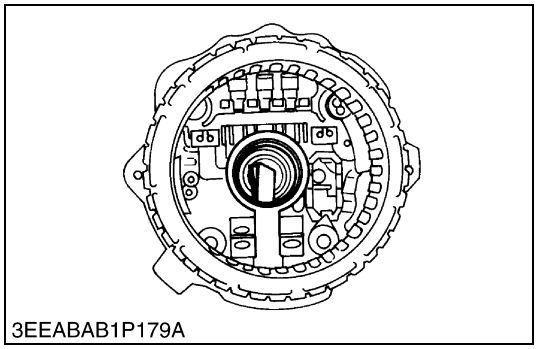
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Brush

1. When the rotor is detached, the 2 brushes are found to stretch out of the shaft hole.

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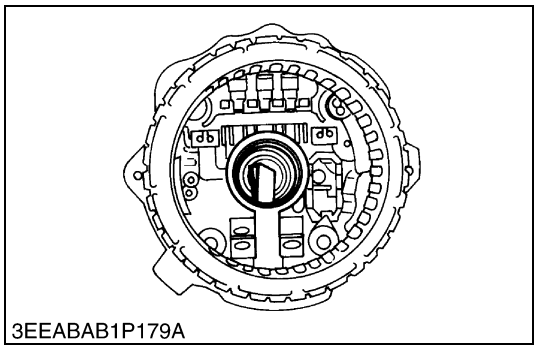
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Reassembling the Brush

1. Fit the brush with its sliding face in the clockwise direction when viewed from front.

■ **IMPORTANT**

- **Be sure to keep the 2 brushes deep in the brush holder. Otherwise the rotor and the rear section can not be fitted into the position.**
- **Use a 4.0 mm (0.16 in.) hex. wrench to push the brushes into place.**
- **Using a pin-pointed (2.0 mm (0.079 in.)) punch, keep the brushes from popping out.**

2. Match the tally line of the front section with that of the rear section.
3. Tighten the 4 screws, and draw out the pin-pointed punch out of the brush holder.

(1) Marking

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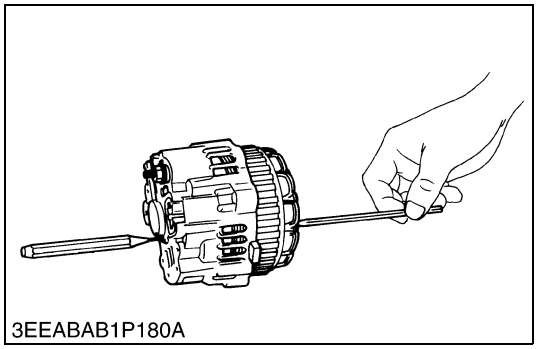
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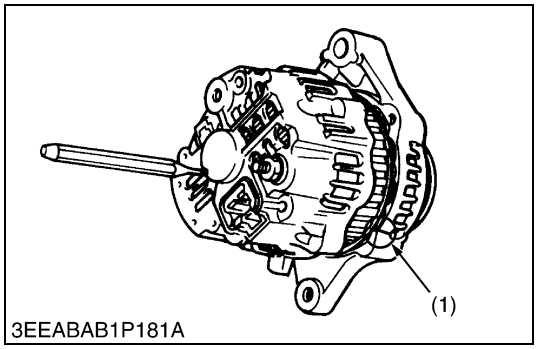

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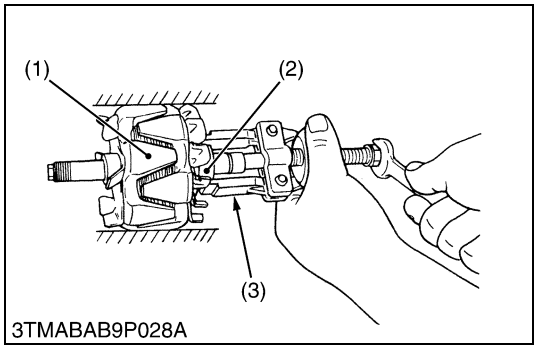

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Bearing at Slip Ring Side

1. Lightly secure the rotor (1) with a vise to prevent damage, and remove the bearing (2) with a puller (3).

(1) Rotor
(2) Bearing
(3) Puller

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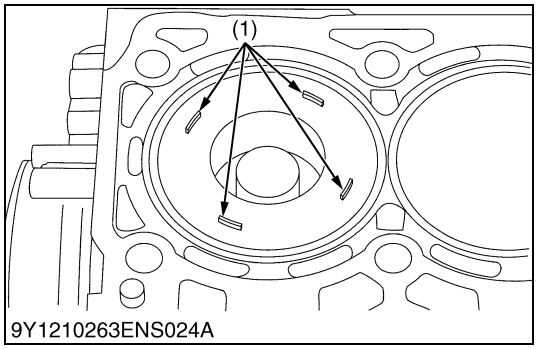
[3] SERVICING
(1) Cylinder Head and Valves



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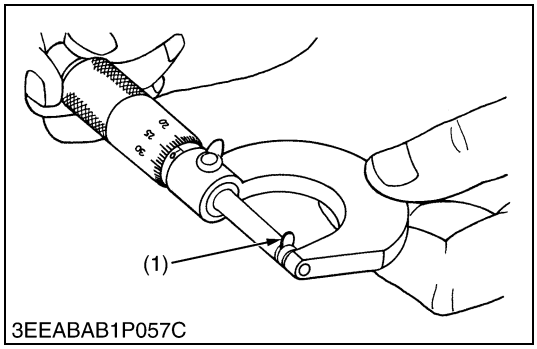

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Top Clearance

1. Remove the cylinder head (remove the cylinder head gasket completely).
2. Bring the piston to its top dead center, fasten fuse wires (Dia. : 1.5 mm (0.059 in.), long : 5.0 to 7.0 mm (0.20 to 0.28 in.)) (1) to 3 to 4 spots on the piston top with grease so as to avoid the intake and exhaust valves and the combustion chamber ports.
3. Bring the piston to its middle position, install the cylinder head, and tighten the cylinder head screws to specification. (Head gasket must be changed to new one.)
4. Turn the crank shaft until the piston exceeds its top dead center.
5. Remove the cylinder head, and measure squeezed fuse wires (1) for thickness.
6. If the measurement is not within the specified value, check the oil clearance of the crankpin journal and the piston pin.

Top clearance	Factory specification	0.60 to 0.80 mm 0.024 to 0.031 in.

Tightening torque	Cylinder head mounting screw	147 to 156 N·m 15.0 to 16.0 kgf·m 109 to 115 lbf·ft

(1) Fuse Wire

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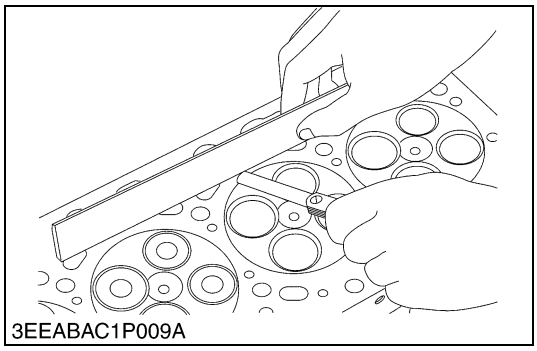
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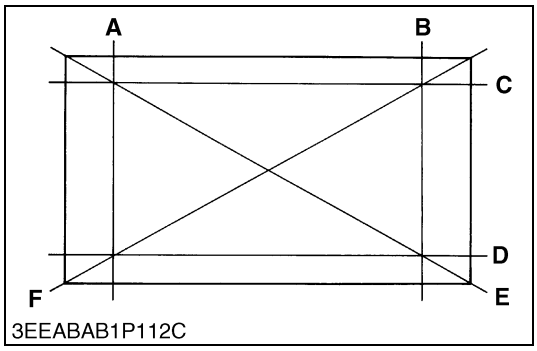
Cylinder Head Surface Flatness

1. Clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides (**A**), (**B**), (**C**) and (**D**) and two diagonal (**E**) and (**F**) as shown in the figure. Measure the clearance with a feeler gauge.
3. If the measurement exceeds the allowable limit, correct it with a surface grinder.

■ **IMPORTANT**
- **Be sure to check the valve recessing after correcting.**



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Cylinder head surface flatness	Allowable limit	0.05 mm 0.002 in.

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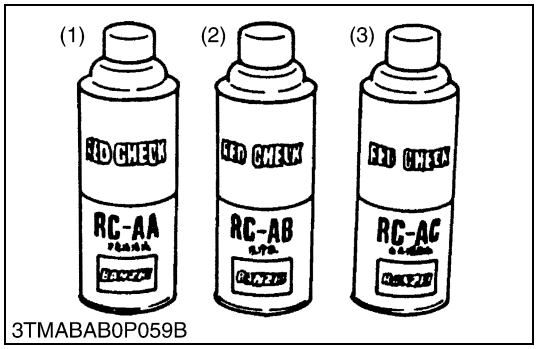

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Cylinder Head Flaw

1. Prepare an air spray red check.
2. Clean the surface of the cylinder head with the detergent (2).
3. Spray the cylinder head surface with the red permeative liquid (1). Leave it five to ten minutes after spraying.
4. Wash away the red permeative liquid on the cylinder head surface with the detergent (2).
5. Spray the cylinder head surface with the white developer (3).
6. If flawed, it can be identified as red marks.

(1) Red Permeative Liquid
(2) Detergent
(3) White Developer

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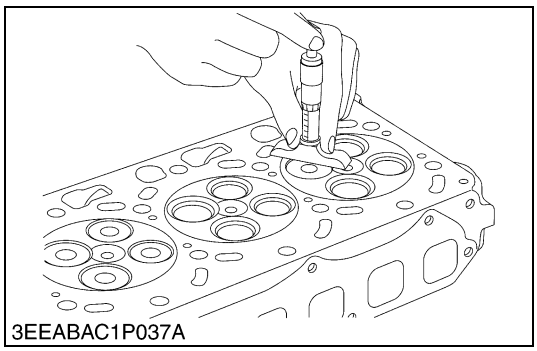
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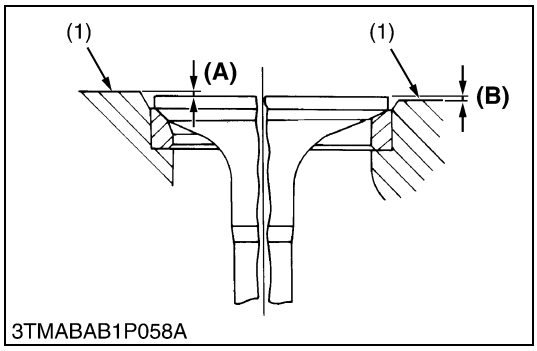
Valve Recessing

1. Clean the cylinder head, the valve face and seat.
2. Insert the valve into the valve guide.
3. Measure the valve recessing with a depth gauge.
4. If the measurement exceeds the allowable limit, replace the valve.
   If it still exceeds the allowable limit after replacing the valve, replace the cylinder head.

Valve recessing (Intake and exhaust)	Factory specification	(recessing) 0.65 to 0.85 mm 0.026 to 0.033 in.
	Allowable limit	(recessing) 1.20 mm 0.0472 in.



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(1) Cylinder Head Surface
(A) Recessing
(B) Protrusion

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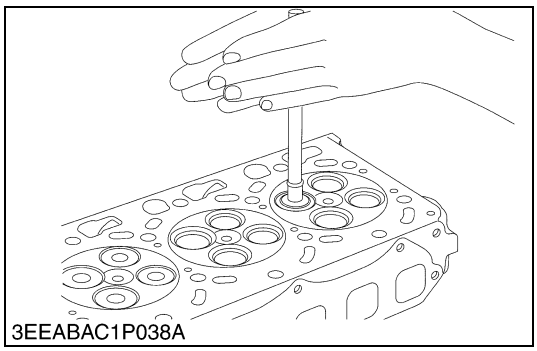
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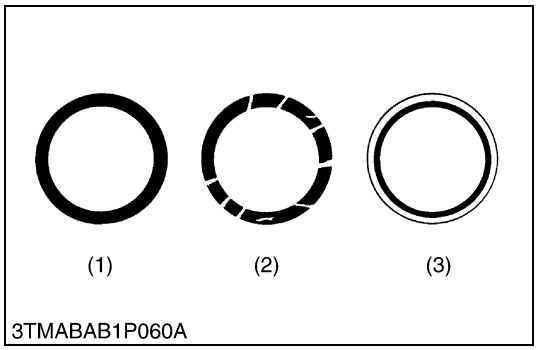
Valve Lapping

1. Apply compound evenly to the valve lapping surface.
2. Insert the valve into the valve guide. Lap the valve onto its seat with a valve flapper or screwdriver.
3. After lapping the valve, wash the compound away and apply oil, then repeat valve lapping with oil.
4. Apply prussian blue to the contact surface to check the seated rate. If it is less than 70 %, repeat valve lapping again.

■ **IMPORTANT**

- **When valve lapping is performed, be sure to check the valve recessing and adjust the valve clearance after assembling the valve.**



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(1) Correct
(2) Incorrect
(3) Incorrect

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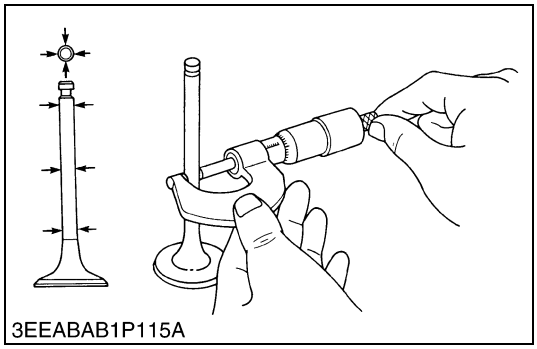
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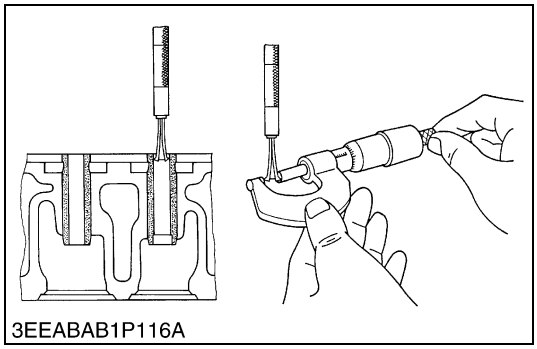
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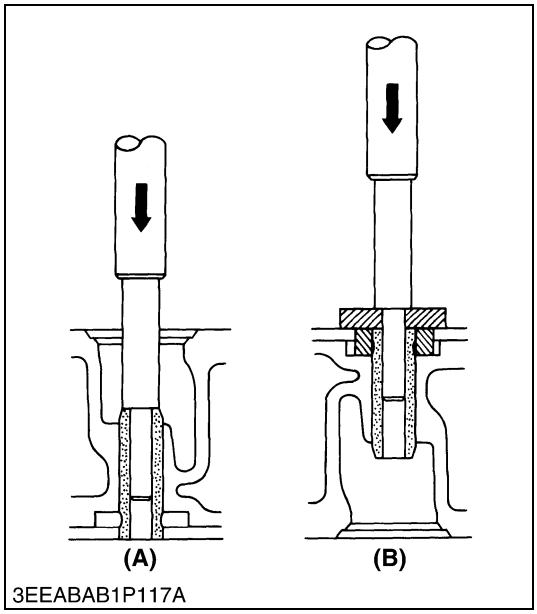

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Clearance between Valve Stem and Valve Guide

1. Remove carbon from the valve guide section.
2. Measure the valve stem O.D. with an outside micrometer.
3. Measure the valve guide I.D. of the cylinder head at the most wear part as shown in the figure below with a small hole gauge. And calculate the clearance.
4. If the clearance exceeds the allowable limit, replace the valves. If it still exceeds the allowable limit, replace the valve guide.

Clearance between valve stem and guide (Intake and exhaust)	Factory specification	0.030 to 0.057 mm 0.0012 to 0.0022 in.
	Allowable limit	0.10 mm 0.0039 in.

Valve stem O.D. (Intake and exhaust)	Factory specification	5.968 to 5.980 mm 0.2350 to 0.2354 in.
Valve guide I.D. (Intake and exhaust)	Factory specification	6.010 to 6.025 mm 0.2367 to 0.2372 in.

RY9212050ENS0077US0

Replacing Valve Guide

(When removing)

1. Using a valve guide replacing tool, press out the used valve guide. (Refer to "SPECIAL TOOLS" at "GENERAL" section.)

(When installing)

1. Clean a new valve guide, and apply engine oil to it.
2. Using a valve guide replacing tool, press in a new valve guide until it is flush with the cylinder head as shown in the figure.
3. Ream precisely the I.D. of the valve guide to the specified dimension.

Valve guide I.D. (Intake and exhaust)	Factory specification	6.010 to 6.025 mm 0.2367 to 0.2372 in.

■ **IMPORTANT**

- **Do not hit the valve guide with a hammer, etc. during replacement.**

(A) When Removing **(B) When Installing**

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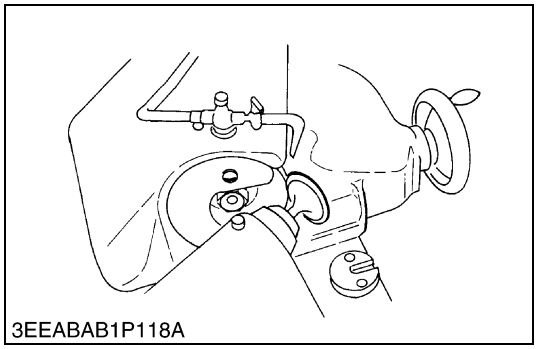
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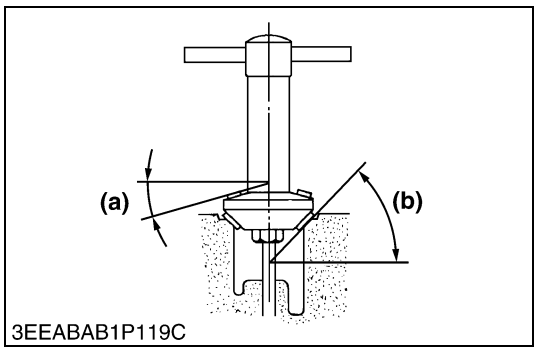

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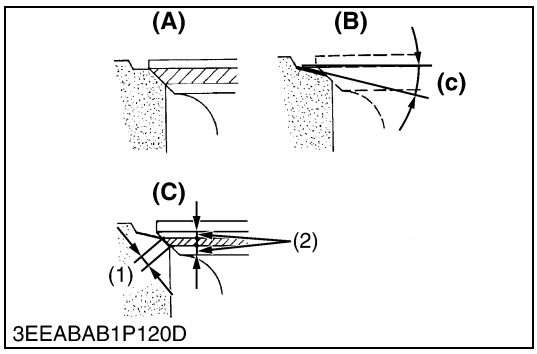

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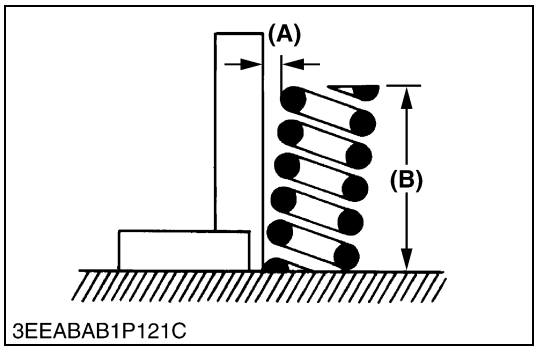

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Correcting Valve and Valve Seat

■ **NOTE**

- **Before correcting the valve and seat, check the valve stem and the I.D. of valve guide section, and repair them if necessary.**
- **After correcting the valve seat, be sure to check the valve recessing.**

1) Correcting Valve

1. Correct the valve with a valve refacer.

Valve face angle (Intake and exhaust)	Factory specification	0.79 rad 45 °

2) Correcting Valve Seat

1. Slightly correct the seat surface with a 0.79 rad (45 °) valve seat cutter.
2. Resurface the seat surface with a 0.26 rad (15 °) valve seat cutter so that the width is close to specified valve seat width.

Valve seat width (Intake and exhaust)	Factory specification	3.3 to 3.6 mm 0.13 to 0.14 in.

3. After resurfacing the seat, inspect for even valve seating, apply a thin film of compound between the valve face and valve seat, and fit them with valve lapping tool.
4. Check the valve seating with prussian blue. The valve seating surface should show good contact all the way around.

Valve seat angle (Intake and exhaust)	Factory specification	0.79 rad 45 °

(1) Valve Seat Width
(2) Identical Dimensions

(A) Check Contact
(B) Correct Seat Width
(C) Check Contact
(a) 0.26 rad (15 °)
(b) 0.79 rad (45 °)
(c) 0.52 rad (30 °)

RY9212050ENS0079US0

Free Length and Tilt of Valve Spring

1. Measure the free length **(B)** with vernier calipers. If the measurement is less than the allowable limit, replace it.
2. Put the spring on a surface plate, place a square on the side of the spring, and check to see if the entire side is contact with the square. Rotate the spring and measure the maximum tilt **(A)**. If the measurement exceeds the allowable limit, replace.
3. Check the entire surface of the spring for scratches. Replace it, if any.

Tilt **(A)**	Allowable limit	1.0 mm 0.039 in.

Free length **(B)**	Factory specification	35.4 to 35.9 mm 1.40 to 1.41 in.
	Allowable limit	34.9 mm 1.37 in.

(A) Tilt
(B) Free length

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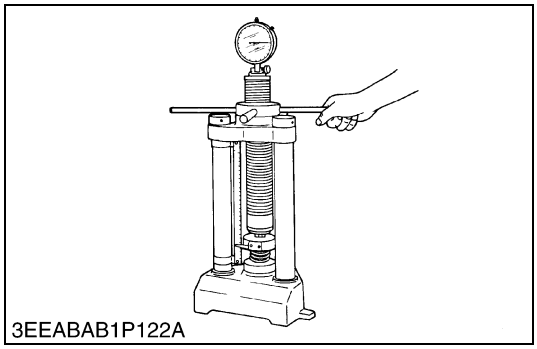
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Valve Spring Setting Load

1. Place the valve spring on a tester and compress it to the same length it is actually compressed in the engine.
2. Read the compression load on the gauge.
3. If the measurement is less than the allowable limit, replace it.

Setting load / setting length	Factory specification	60.8 N / 29.7 mm 6.20 kgf / 29.7 mm 13.7 lbf / 1.17 in.
	Allowable limit	45.9 N / 29.7 mm 4.68 kgf / 29.7 mm 10.3 lbf / 1.17 in.

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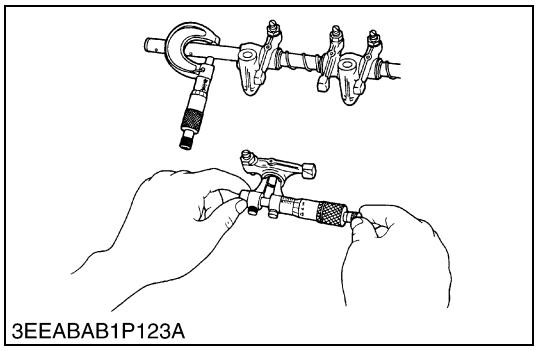
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Oil Clearance between Rocker Arm Shaft and Bearing

1. Measure the rocker arm bearing I.D. with an inside micrometer.
2. Measure the rocker arm shaft O.D. with an outside micrometer, and then calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the rocker arm and measure the oil clearance again. If it still exceeds the allowable limit, replace also the rocker arm shaft.

Oil clearance of rocker arm shaft and bearing	Factory specification	0.016 to 0.045 mm 0.00063 to 0.0017 in.
	Allowable limit	0.15 mm 0.0059 in.

Rocker arm shaft O.D.	Factory specification	13.973 to 13.984 mm 0.55012 to 0.55055 in.
Rocker arm I.D. for shaft	Factory specification	14.000 to 14.018 mm 0.55119 to 0.55188 in.

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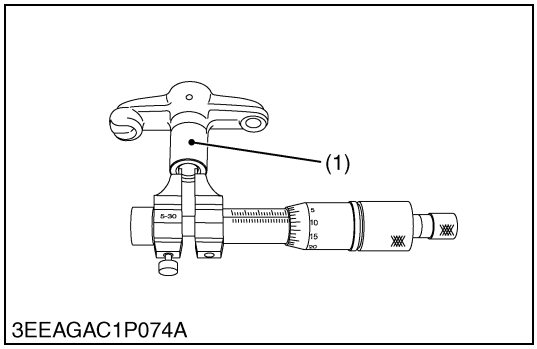

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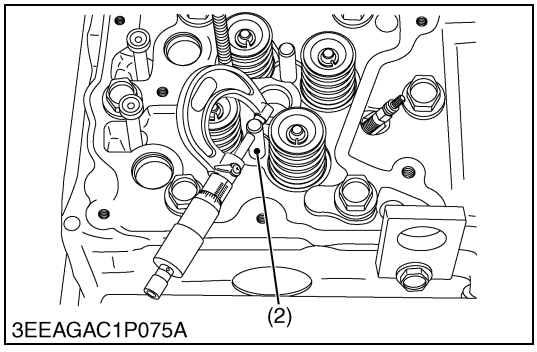

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Oil Clearance between Valve Bridge Arm and Valve Bridge Shaft

1. Measure the valve bridge arm (1) I.D. with an inside micrometer.
2. Measure the valve bridge shaft (2) O.D. with an outside micrometer, and then calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the valve bridge arm (1) and measure the oil clearance again. If it still exceeds the allowable limit, replace also the valve bridge shaft (2).

Oil clearance between valve bridge arm and valve bridge shaft	Factory specification	0.018 to 0.057 mm 0.00071 to 0.0022 in.
	Allowable limit	0.15 mm 0.0059 in.

Valve bridge shaft O.D.	Factory specification	8.023 to 8.032 mm 0.3159 to 0.3162 in.
Valve bridge arm I.D.	Factory specification	8.050 to 8.080 mm 0.3170 to 0.3181 in.

(1) Valve Bridge Arm (2) Valve Bridge Shaft

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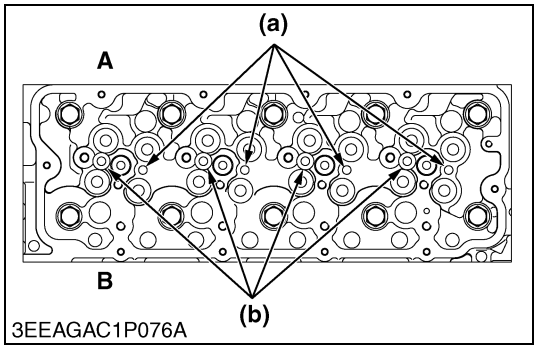

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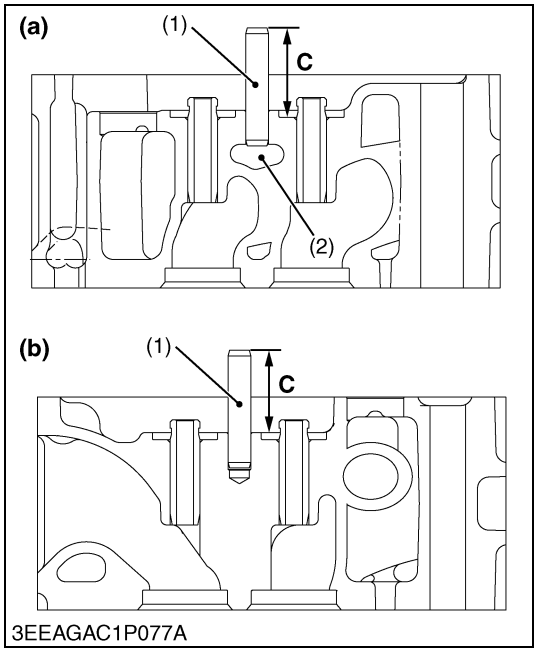

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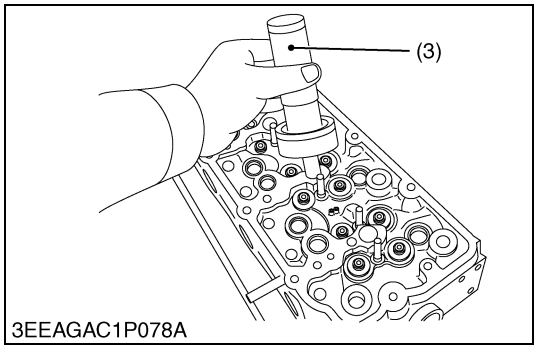

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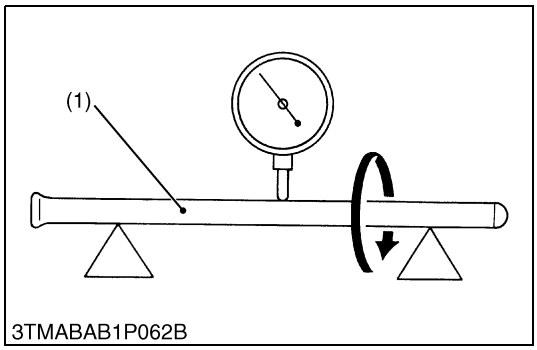

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Replacing Valve Bridge Shaft (If necessary)

1. Remove the used valve bridge shaft (1).
2. Clean the valve bridge shaft mounting hole.
3. Apply the liquid seal (Three Bond 1386B or equivalent) to the tip of the valve bridge shaft when installing shaft at the position shown in figure **(a)**.
4. Using valve bridge shaft replacing tool (3), press in the new shaft. (Refer to "SPECIAL TOOLS" at "GENERAL" section.)

(1) Valve Bridge Shaft
(2) Coolant Passage
(3) Valve Bridge Shaft Replacing Tool

A : Intake Side
B : Exhaust Side
C : 31.30 to 31.70 mm (1.233 to 1.248 in.)
(a) Shaft Hole (Through To The Coolant Passage)
(b) Shaft Hole (Not Through To The Coolant Passage)

RY9212050ENS0084US0

Push Rod Alignment

1. Place the push rod on V blocks.
2. Measure the push rod alignment.
3. If the measurement exceeds the allowable limit, replace the push rod.

Push rod alignment	Allowable limit	0.25 mm 0.0098 in.

(1) Push Rod

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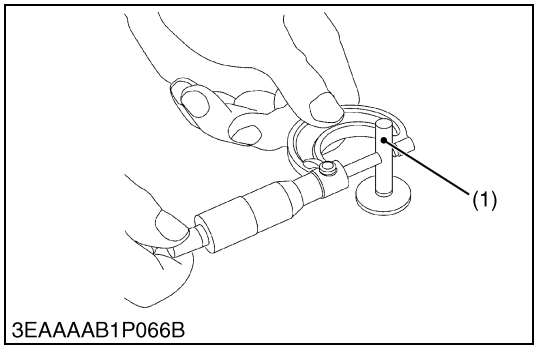

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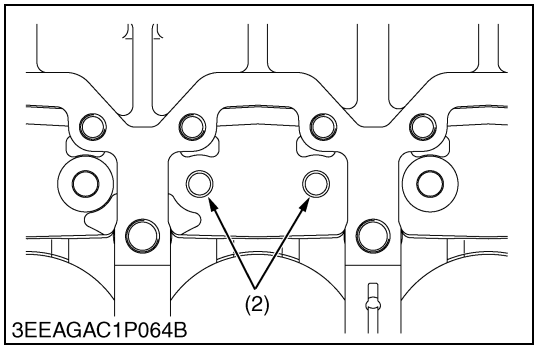

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Oil Clearance between Tappet and Tappet Bore

1. Measure the tappet O.D. with an outside micrometer.
2. Measure the I.D. of the tappet bore at the most wear part with a small hole gauge.
3. If the oil clearance exceeds the allowable limit or the tappet is damaged, replace the tappet.

Oil clearance between tappet and tappet bore	Factory specification	0.020 to 0.050 mm 0.00079 to 0.0019 in.
	Allowable limit	0.07 mm 0.003 in.

Tappet O.D.	Factory specification	9.965 to 9.980 mm 0.3924 to 0.3929 in.
Tappet bore I.D.	Factory specification	10.000 to 10.015 mm 0.39370 to 0.39429 in.

(1) Tappet (2) Tappet Bore

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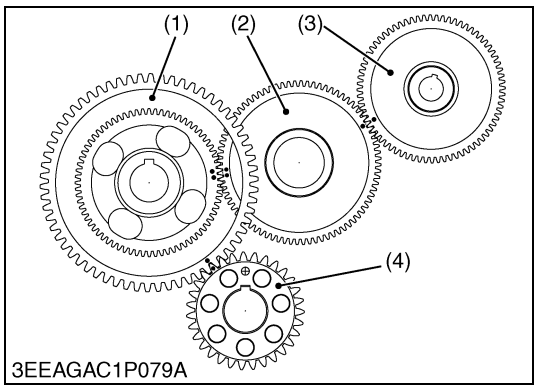
(2) Timing Gears



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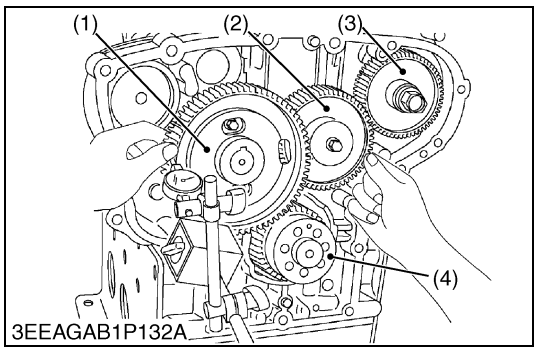

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Timing Gear Backlash

1. Set a dial indicator (lever type) with its tip on the gear tooth.
2. Move the gear to measure the backlash, holding its mating gear.
3. If the backlash exceeds the allowable limit, check the oil clearance of the shafts and the gear.
4. If the oil clearance is proper, replace the gear.

Backlash between crank gear and cam gear	Factory specification	0.0400 to 0.137 mm 0.00158 to 0.00539 in.
	Allowable limit	0.22 mm 0.0087 in.

Backlash between cam gear and idle gear	Factory specification	0.0460 to 0.136 mm 0.00182 to 0.00535 in.
	Allowable limit	0.22 mm 0.0087 in.

Backlash between idle gear and injection pump gear	Factory specification	0.0460 to 0.136 mm 0.00182 to 0.00535 in.
	Allowable limit	0.22 mm 0.0087 in.

(1) Cam Gear (3) Injection Pump Gear
(2) Idle Gear (4) Crank Gear

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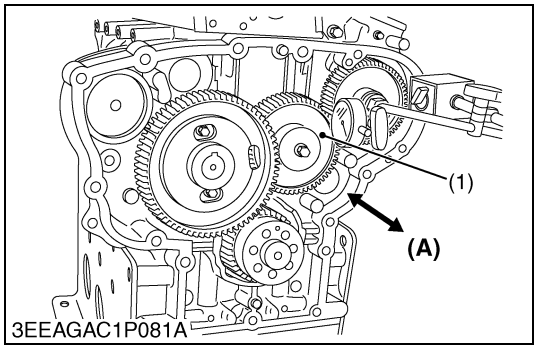

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Idle Gear Side Clearance

1. Set a dial indicator with its tip on the idle gear (1).
2. Measure the side clearance by moving the idle gear (1) to the front and rear.
3. If the measurement exceeds the allowable limit, replace the idle gear collars.

Side clearance of idle gear	Factory specification	0.050 to 0.20 mm 0.0020 to 0.0078 in.
	Allowable limit	0.90 mm 0.035 in.

(1) Idle Gear **(A) Side Clearance of Idle Gear**

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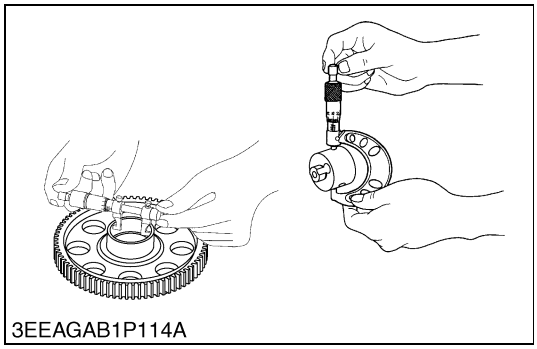
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Oil Clearance between Idle Gear Shaft and Idle Gear Bushing

1. Measure the idle gear shaft O.D. with an outside micrometer.
2. Measure the idle gear bushings I.D. with an inside micrometer, and calculate the oil clearance.
3. If the oil clearance exceeds the allowable limit, replace the bushing.

Oil clearance between idle gear shaft and idle gear bushing	Factory specification	0.025 to 0.096 mm 0.00099 to 0.0037 in.
	Allowable limit	0.10 mm 0.0039 in.

Idle gear shaft O.D.	Factory specification	34.959 to 34.975 mm 1.3764 to 1.3769 in.
Idle gear bushing I.D.	Factory specification	35.000 to 35.055 mm 1.3780 to 1.3801 in.

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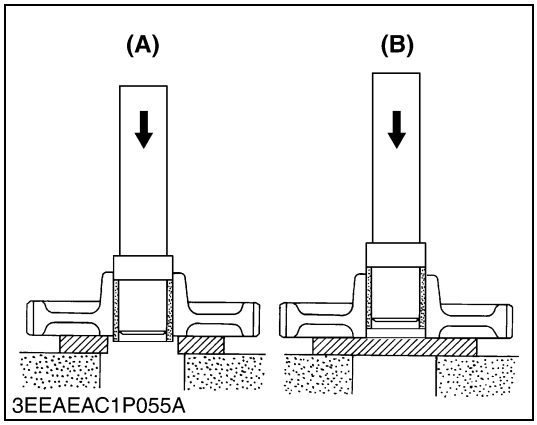

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Replacing Idle Gear Bushing

(When removing)

1. Using an idle gear bushing replacing tool, press out the used bushing. (Refer to "SPECIAL TOOLS" at "GENERAL" section.)

(When installing)

1. Clean a new idle gear bushing and idle gear bore, and apply engine oil to them.
2. Using an idle gear bushing replacing tool, press in a new bushing (service parts) to the specified dimension. (See figure.)

(A) When Removing **(B) When Installing**

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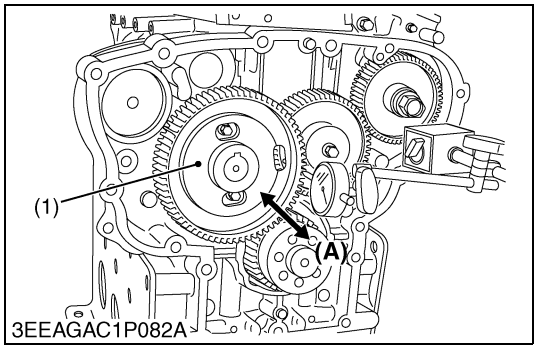

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Camshaft Side Clearance

1. Set a dial indicator with its tip on the camshaft.
2. Measure the side clearance by moving the cam gear (1) to the front and rear.
3. If the measurement exceeds the allowable limit, replace the camshaft bearing.

Side clearance of camshaft	Allowable limit	0.10 mm 0.0039 in.

(1) Cam Gear **(A) Side Clearance of Camshaft**

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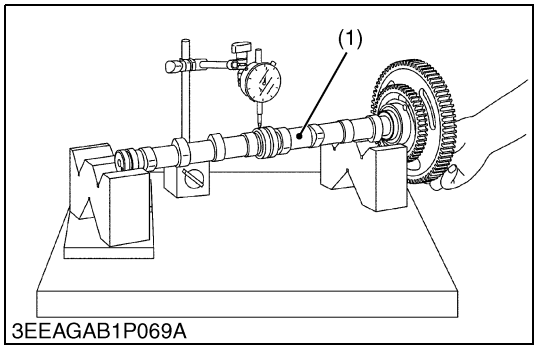

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Camshaft Alignment

1. Support the camshaft (1) with V block on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the camshaft (1) on the V blocks and get the misalignment (half of the measurement value).
3. If the misalignment exceeds the allowable limit, replace the camshaft (1).

Camshaft alignment	Allowable limit	0.01 mm 0.0004 in.

(1) Camshaft

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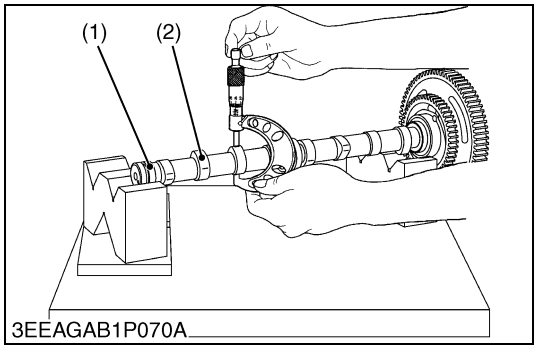

Cam Height

1. Measure the height of the cam (2) at its highest point with an outside micrometer.
2. If the measurement is less than the allowable limit, replace the camshaft (1).

Intake and exhaust cam height	Factory specification	Intake valve	32.56 mm 1.282 in.
		Exhaust valve	33.00 mm 1.299 in.
	Allowable limit	Intake valve	32.10 mm 1.264 in.
		Exhaust valve	32.50 mm 1.280 in.

(1) Camshaft (2) Cam

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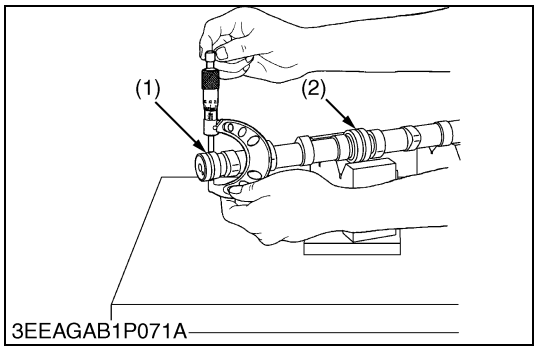

Oil Clearance between Camshaft Journal and Cylinder Block Bore

1. Measure the camshaft journal O.D. with an outside micrometer.
2. Measure the cylinder block bore I.D. for camshaft with an inside micrometer.
3. If the clearance exceeds the allowable limit, replace the camshaft.

Oil clearance between camshaft journal and cylinder block bore	Factory specification	0.050 to 0.091 mm 0.0020 to 0.0035 in.
	Allowable limit	0.15 mm 0.0059 in.

Camshaft journal 1 O.D.	Factory specification	34.934 to 34.950 mm 1.3754 to 1.3759 in.
Cylinder block bore 1 I.D.	Factory specification	35.000 to 35.025 mm 1.3780 to 1.3789 in.

Camshaft journal 2 O.D.	Factory specification	41.934 to 41.950 mm 1.6510 to 1.6515 in.
Cylinder block bore 2 I.D.	Factory specification	42.000 to 42.025 mm 1.6536 to 1.6545 in.

(1) Camshaft Journal 1 (2) Camshaft Journal 2

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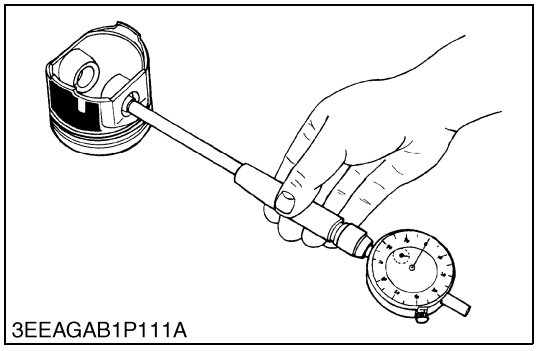
(3) Piston and Connecting Rod



Piston Pin Bore I.D.

1. Measure the piston pin bore I.D. in both the horizontal and vertical directions with a cylinder gauge.
2. If the measurement exceeds the allowable limit, replace the piston.

Piston pin bore I.D.	Factory specification	26.000 to 26.013 mm 1.0237 to 1.0241 in.
	Allowable limit	26.05 mm 1.026 in.

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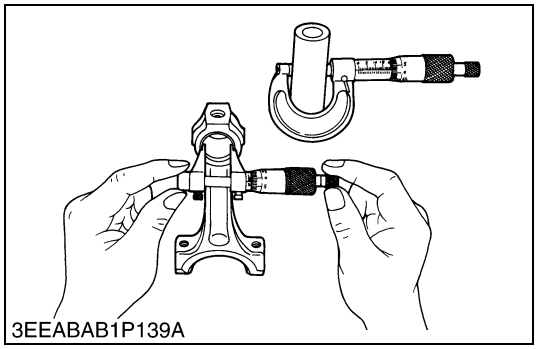
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Oil Clearance between Piston Pin and Small End Bushing

1. Measure the O.D. of the piston pin where it contacts the bushing with an outside micrometer.
2. Measure the I.D. of the piston pin bushing at the connecting rod small end with a cylinder gauge. Calculate the oil clearance.
3. If the clearance exceeds the allowable limit, replace the bushing. If it still exceeds the allowable limit, replace the piston pin.

Oil clearance between piston pin and small end bushing	Factory specification	0.014 to 0.034 mm 0.00056 to 0.0013 in.
	Allowable limit	0.15 mm 0.0059 in.

Piston pin O.D.	Factory specification	26.006 to 26.011 mm 1.0239 to 1.0240 in.
Small end bushing I.D.	Factory specification	26.025 to 26.040 mm 1.0246 to 1.0252 in.

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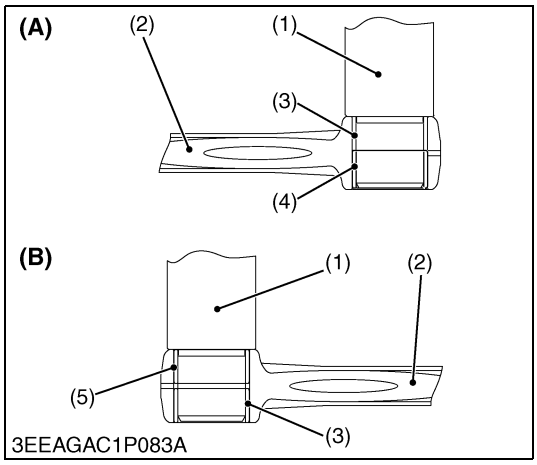

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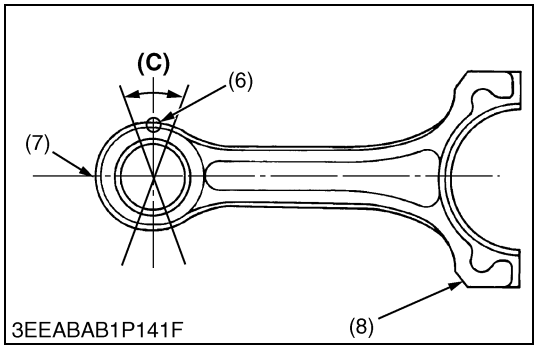

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Replacing Small End Bushing

(When removing)

1. Press out the used bushing.

(When installing)

1. Clean a new small end bushing and bore, and apply engine oil to them.
2. Set the guide (4) to the bore of the connecting rod (2).
3. Insert a new first bushing (3) onto the small end bushing replacing tool. (Refer to "SPECIAL TOOLS" at "GENERAL" section.)
4. Press-fit it with a press so that the seam (6) of bushing position as shown in the figure.
5. Turn the connecting rod inside out, and press-fit the second bushing similarly.

(1) Small End Bushing Replacing Tool
(2) Connecting Rod
(3) First Bushing
(4) Guide
(5) Second Bushing
(6) Seam
(7) Oil Hole
(8) Mark

(A) When Installing First Bushing
(B) When Installing Second Bushing
(C) 0.26 rad (15 °)

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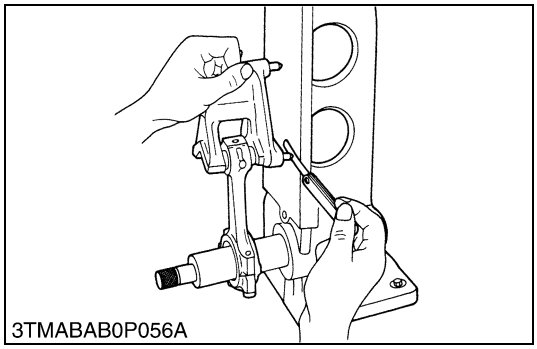
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Connecting Rod Alignment

■ **NOTE**
- **Since the I.D. of the connecting rod small end bushing is the basis of this check, check the bushing for wear beforehand.**

1. Remove the piston pin from the piston.
2. Install the piston pin in the connecting rod.
3. Install the connecting rod on the connecting rod alignment tool.
4. Put a gauge over the piston pin, and move it against the face plate.
5. If the gauge does not fit squarely against the face plate, measure the space between the pin of the gauge and the face plate.
6. If the measurement exceeds the allowable limit, replace the connecting rod.

Connecting rod alignment	Allowable limit	0.05 mm 0.002 in.

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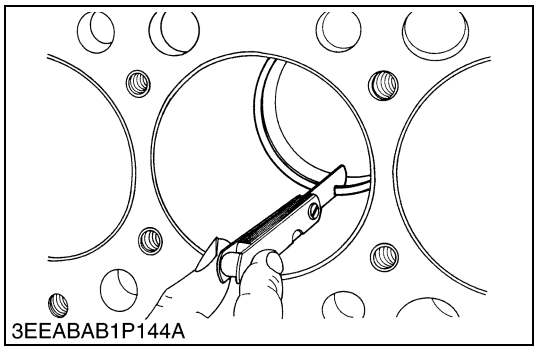
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Piston Ring Gap

1. Insert the piston ring into the lower part of the liner (the least worn part) with the piston.
2. Measure the ring gap with a feeler gauge.
3. If the gap exceeds the allowable limit, replace the piston ring.

Top ring	Factory specification	0.20 to 0.35 mm 0.0079 to 0.013 in.
	Allowable limit	1.25 mm 0.0492 in.
Second ring	Factory specification	0.30 to 0.45 mm 0.012 to 0.017 in.
	Allowable limit	1.25 mm 0.0492 in.
Oil ring	Factory specification	0.25 to 0.45 mm 0.0099 to 0.017 in.
	Allowable limit	1.25 mm 0.0492 in.

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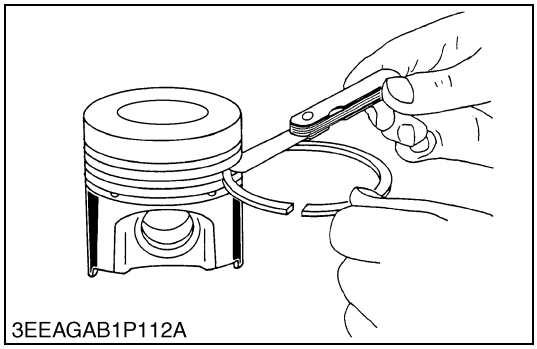
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Clearance between Piston Ring and Groove

1. Clean the rings and the ring grooves, and install each ring in its groove.
2. Measure the clearance between the ring and the groove with a feeler gauge or depth gauge.
3. If the clearance exceeds the allowable limit, replace the piston ring.
4. If the clearance still exceeds the allowable limit with new ring, replace the piston.

Factory specification	Top ring	0.050 to 0.090 mm 0.0020 to 0.0035 in.
	Second ring	0.090 to 0.12 mm 0.0036 to 0.0047 in.
	Oil ring	0.020 to 0.060 mm 0.00079 to 0.0023 in.

Allowable limit	Top ring	0.15 mm 0.0059 in.
	Second ring	0.20 mm 0.0079 in.
	Oil ring	0.15 mm 0.0059 in.

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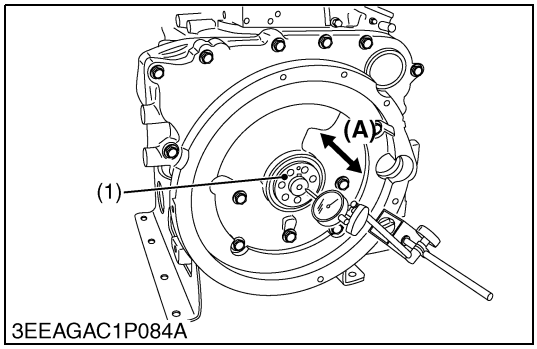
(4) Crankshaft



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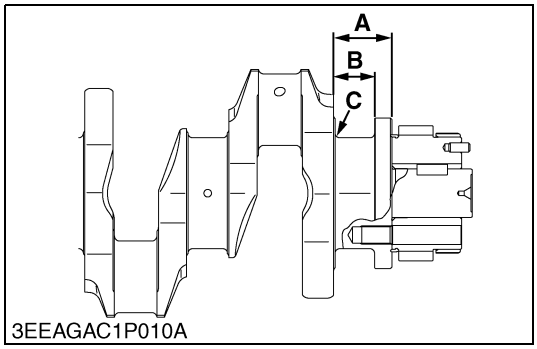

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Crankshaft Side Clearance

1. Set a dial indicator with its tip on the end of the crankshaft (1).
2. Measure the side clearance by moving the crankshaft (1) to the front and rear.
3. If the measurement exceeds the allowable limit, replace the thrust bearings.
4. If the same size bearing is out of specifications because of the crankshaft journal wear, replace it with an oversize one referring to the table and figure.

Side clearance of crankshaft	Factory specification	0.15 to 0.35 mm 0.0059 to 0.013 in.
	Allowable limit	0.50 mm 0.020 in.

(Reference)

- Oversize dimensions of crankshaft journal.

Oversize	0.20 mm 0.0079 in.	0.40 mm 0.016 in.
Dimension **A**	37.50 to 37.70 mm 1.477 to 1.484 in.	37.60 to 37.80 mm 1.481 to 1.488 in.
Dimension **B**	26.20 to 26.25 mm 1.032 to 1.035 in.	26.40 to 26.45 mm 1.040 to 1.041 in.
Dimension **C**	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius
The crankshaft journal must be fine-finished to higher than Rmax = 0.8S		

(1) Crankshaft **(A) Side Clearance of Crankshaft**

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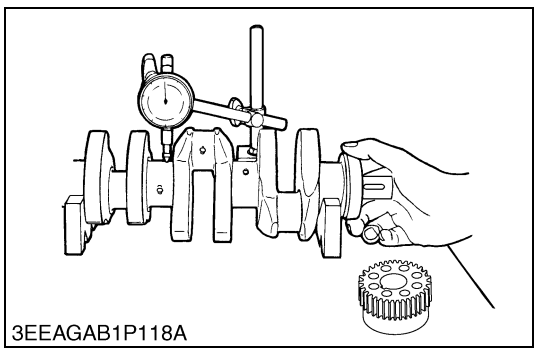
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Crankshaft Alignment

1. Support the crankshaft with V block on the surface plate and set a dial indicator with its tip on the intermediate journal at right angle.
2. Rotate the crankshaft on the V block and get the misalignment (half of the measurement value).
3. If the misalignment exceeds the allowable limit, replace the crankshaft.

Crankshaft alignment	Allowable limit	0.02 mm 0.0008 in.

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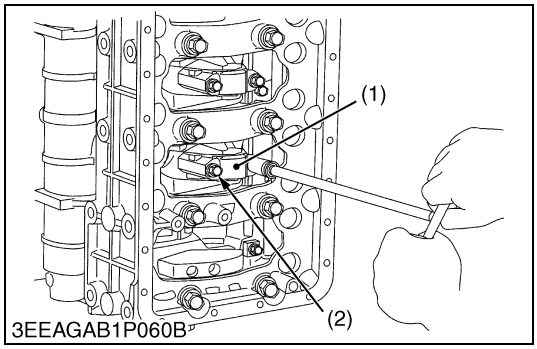

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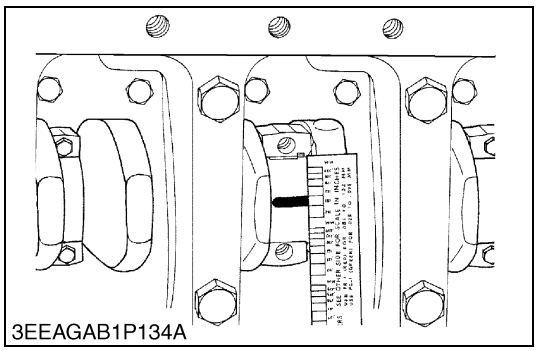
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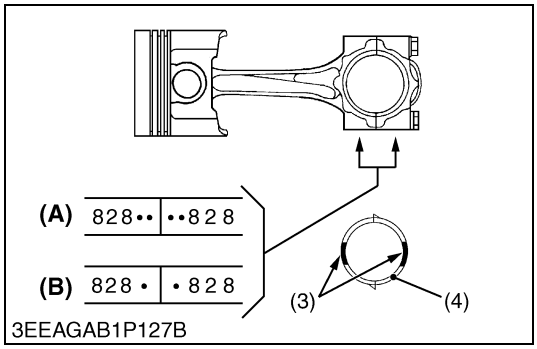

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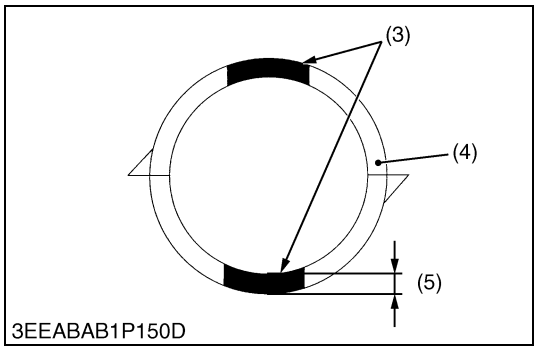

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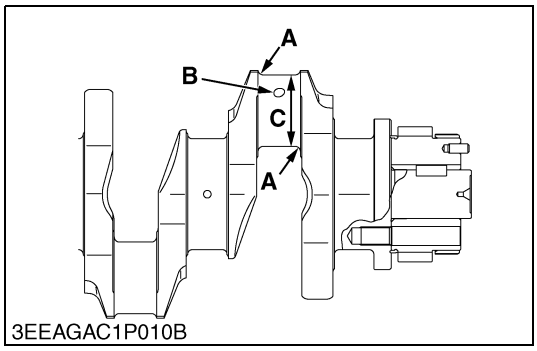

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Oil Clearance between Crankpin and Crankpin Bearing

1. Clean the crankpin and crankpin bearing (4).
2. Put a strip of plastigage on the center of the crankpin.
3. Install the connecting rod cap (1) and tighten the connecting rod screws (2) to the specified torque, and remove the cap again.
4. Measure the amount of the flattening with the scale, and get the oil clearance.
5. If the oil clearance exceeds the allowable limit, replace the crankpin bearing (4).
6. If the same size bearing is useless because of the crankpin wear, replace it with an undersize one referring to the table and figure.

■ **NOTE**
- **Never insert the plastigage into the crankpin oil hole.**
- **Be sure not to move the crankshaft while the connecting rod screws (2) are tightened.**

Crankpin O.D.	Factory specification	46.980 to 46.991 mm 1.8496 to 1.8500 in.

Oil clearance between crankpin and crankpin bearing	Factory specification	0.011 to 0.058 mm 0.00044 to 0.0022 in.
	Allowable limit	0.20 mm 0.0079 in.

■ **IMPORTANT**
- **STD size crankpin bearing (4).**
  To replace it with a specific STD service part, make sure the combination of the crankpin bearing ID color (3) and the connecting rod mark.

Connecting rod		Crankpin bearing		
Mark	**Large-end in. dia.**	**ID color**	**Part code**	**Center wall thick**
Figure **(A)**	50.010 to 50.020 mm 1.9689 to 1.9692 in.	Blue (L class)	1J700-22310	1.496 to 1.501 mm 0.05890 to 0.05909 in.
Figure **(B)**	50.000 to 50.010 mm 1.9685 to 1.9688 in.	Without color (S class)	1J700-22330	1.491 to 1.496 mm 0.05870 to 0.05889 in.

(Reference)
- Undersize dimensions of crankpin.

Undersize	**0.20 mm 0.0079 in.**	**0.40 mm 0.016 in.**
Dimension **A**	3.3 to 3.7 mm radius 0.13 to 0.14 in. radius	3.3 to 3.7 mm radius 0.13 to 0.14 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension **C**	46.780 to 46.791 mm dia. 1.8418 to 1.8421 in. dia.	46.580 to 46.591 mm dia. 1.8339 to 1.8342 in. dia.
The crankpin must be fine-finished to higher than Rmax = 0.8S *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.040 to 0.059 in.) relief.		

(1) Connecting Rod Cap
(2) Connecting Rod Screw
(3) ID Color
(4) Crankpin Bearing
(5) Center Wall Thick

(A) Connecting Rod Mark : 2 Stamps
(B) Connecting Rod Mark : 1 Stamp

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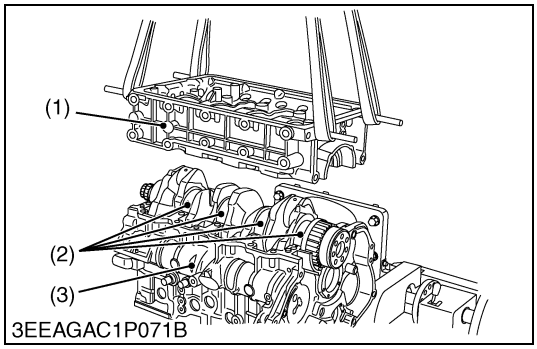

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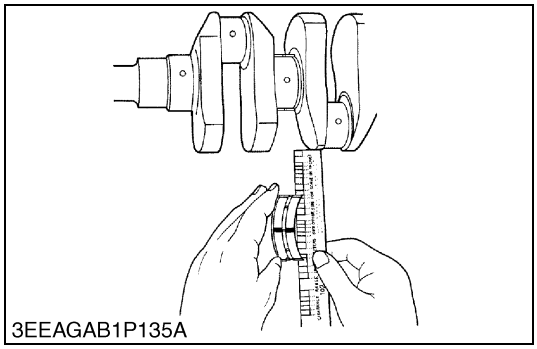
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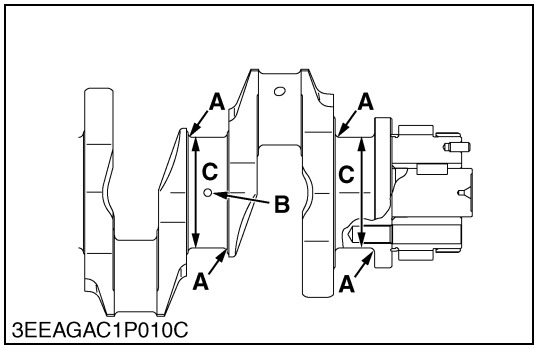

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Oil Clearance between Crankshaft Journal and Crankshaft Bearing

1. Clean the crankshaft journal (2) and crankshaft bearing.
2. Put a strip of press gauge on the center of the journal.

■ **IMPORTANT**

- **Never insert the press gauge into the oil hole of the journal.**

3. Install the crankcase 2 (1) and tighten the crankcase 2 mounting screws to the specified torque, and remove the crankcase 2 (1) again.
4. Measure the amount of the flattening with the scale and get the oil clearance.
5. If the clearance exceeds the allowable limit, replace the crankshaft bearing.

Crankshaft journal O.D.	Factory specification	72.977 to 72.990 mm 2.8732 to 2.8736 in.

Oil clearance between crankshaft journal and crankshaft bearing	Factory specification	0.030 to 0.051 mm 0.0012 to 0.0020 in.
	Allowable limit	0.20 mm 0.0079 in.

(Reference)

- Undersize dimensions of crankshaft journal.

Undersize	**0.20 mm 0.0079 in.**	**0.40 mm 0.016 in.**
Dimension **A**	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius	2.8 to 3.2 mm radius 0.11 to 0.12 in. radius
*Dimension **B**	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief	1.0 to 1.5 mm relief 0.040 to 0.059 in. relief
Dimension **C**	72.777 to 72.790 mm dia. 2.8653 to 2.8657 in. dia.	72.577 to 72.590 mm dia. 2.8574 to 2.8578 in. dia.
The crankshaft journal must be fine-finished to higher Rmax = 0.8S *Holes to be de-burred and edges rounded with 1.0 to 1.5 mm (0.040 to 0.059 in.) relief.		

(1) Crankcase 2
(2) Crankshaft Journal
(3) Crankcase 1

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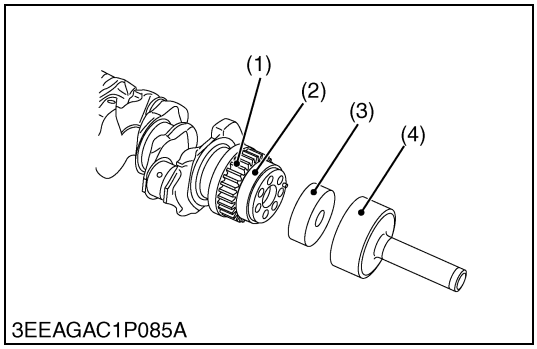

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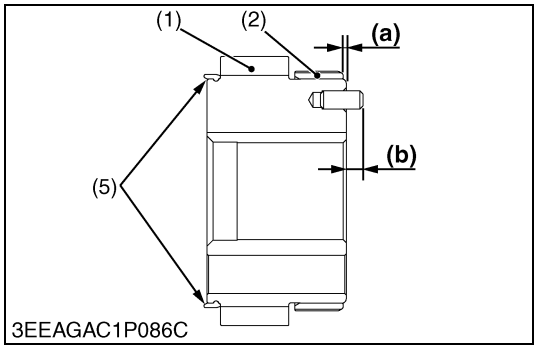

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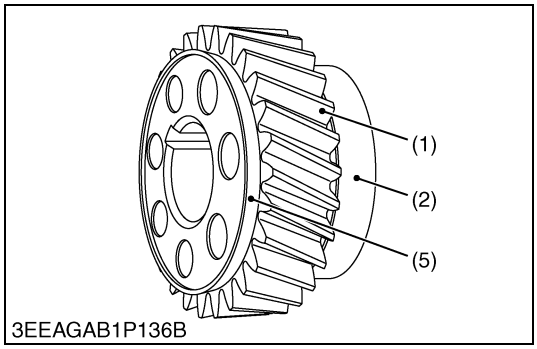

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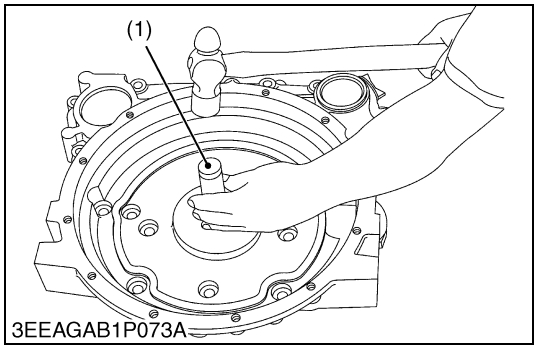

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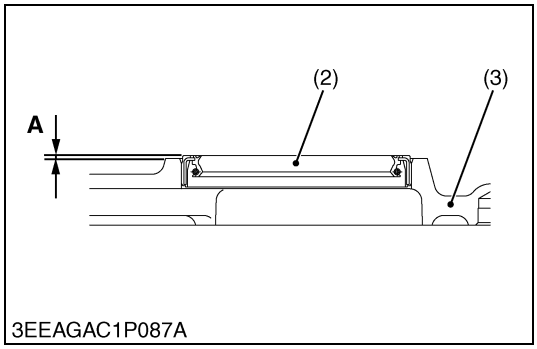

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Replacing Crankshaft Sleeve

1. Remove the used crankshaft sleeve (2).
2. Set the sleeve guide (3) to the crankshaft gear (1).
3. Heat a new crankshaft sleeve (2) to a temperature between 150 and 200 °C (302 and 392 °F), and fix the sleeve to the crankshaft as shown in figure.
4. Press fit the sleeve using the crankshaft sleeve replacing tool (4). (Refer to "SPECIAL TOOLS" at "GENERAL" section.)

■ **NOTE**

- **Mount the sleeve with its largely chamfered surface facing outward.**
- **Keep the space (a) between the edge of the crankshaft gear (1) and the crankshaft sleeve (2).**
- **Be sure to place the seal (5) when reassembling.**

(1) Crankshaft Gear
(2) Crankshaft Sleeve
(3) Sleeve Guide
(4) Crankshaft Sleeve Replacing Tool
(5) Seal

(a) 0.850 to 1.15 mm (0.0335 to 0.0452 in.)
(b) 5.5 mm (0.22 in.)

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Replacing Flywheel Housing Oil Seal

1. Remove the used oil seal (2).
2. Clean the new flywheel housing oil seal (2) and apply engine oil to it.
3. Install the new oil seal (2) to the specific position using the flywheel housing oil seal replacing tool (1). (Refer to "SPECIAL TOOLS" at "GENERAL" section.)

(1) Flywheel Housing Oil Seal Replacing Tool
(2) Oil Seal
(3) Flywheel Housing

A : 0 to 0.50 mm (0 to 0.019 in.)

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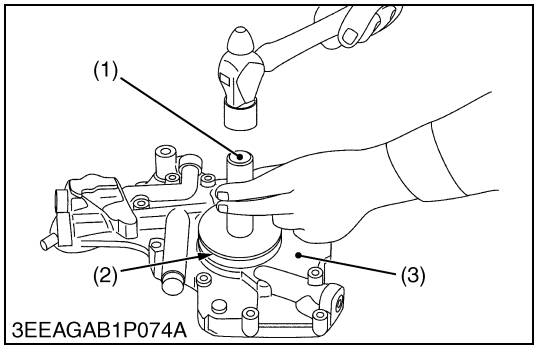

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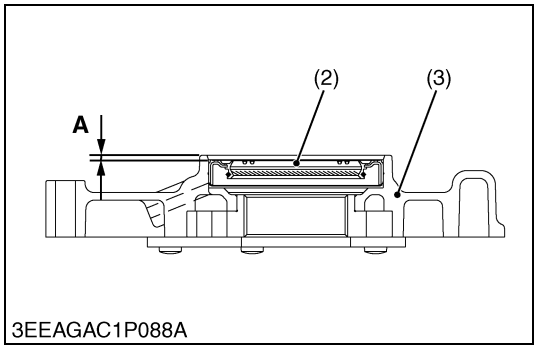

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Replacing Front Cover Oil Seal

1. Remove the used front cover oil seal (2).
2. Clean a new front cover oil seal (2) and apply engine oil to it.
3. Install the new oil seal (2) using the front cover oil seal replacing tool (1). (Refer to "SPECIAL TOOLS" at "GENERAL" section.)

(1) Front Cover Oil Seal Replacing Tool **A : 2.0 mm (0.079 in.)**
(2) Oil Seal
(3) Front Cover

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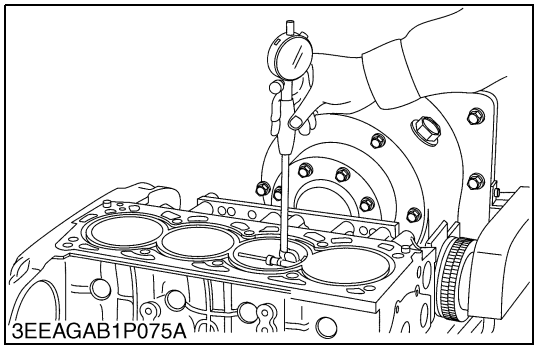
(5) Cylinder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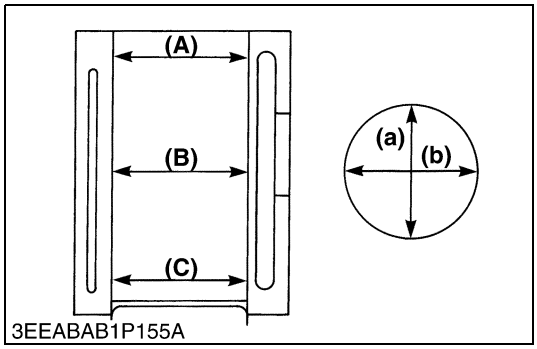

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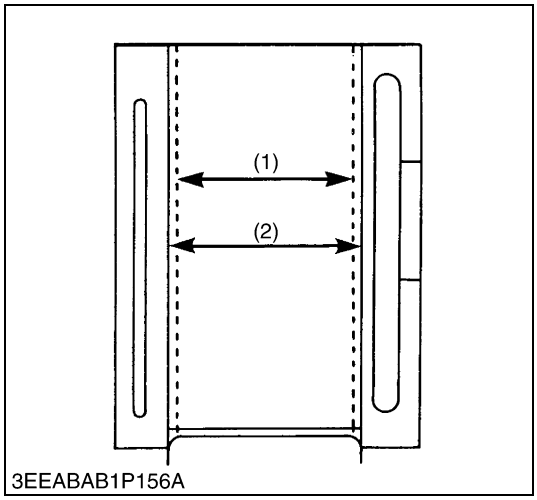

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Cylinder Wear

1. Measure the I.D. of the cylinder at the six positions (see figure) with a cylinder gauge to find the maximum and minimum I.D.'s.
2. Get the difference (Maximum wear) between the maximum and the minimum I.D.'s.
3. If the wear exceeds the allowable limit, bore and hone to the oversize dimension. (Refer to "Correcting Cylinder".)
4. Visually check the cylinder wall for scratches. If deep scratches are found, the cylinder should be bored. (Refer to "Correcting Cylinder".)

Cylinder Bore I.D.	Factory specification	87.000 to 87.022 mm 3.4252 to 3.4260 in.
	Allowable limit	87.15 mm 3.431 in.

(A) Top
(B) Middle
(C) Bottom (Skirt)
(a) Right-angled to piston pin
(b) Piston pin direction

RY9212050ENS0108US0

Correcting Cylinder (Oversize)

1. When the cylinder is worn beyond the allowable limit, bore and hone it to the specified dimension.

Cylinder I.D. (Oversize)	Factory specification	87.250 to 87.272 mm 3.4350 to 3.4359 in.
Maximum wear	Allowable limit	87.40 mm 3.441 in.
Finishing	Hone to 2.2 to 3.0 mm Rz (0.000087 to 0.00011 in. Rz)	

2. Replace the piston and piston rings with oversize 0.25 mm (0.0098 in.) ones.

■ **NOTE**
- **When the oversize cylinder is worn beyond the allowable limit, replace the cylinder block with a new one.**

(1) Cylinder I.D. (Before Correction) (2) Cylinder I.D. (Oversize)

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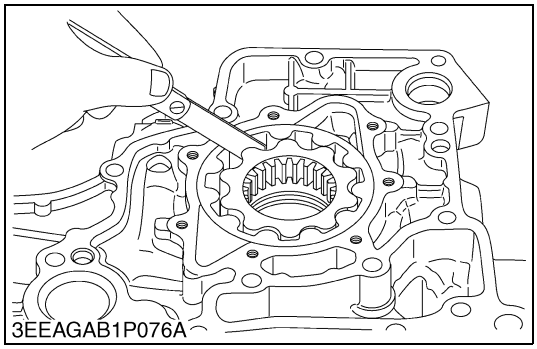
(6) Oil Pump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Rotor Lobe Clearance

1. Measure the clearance between lobes of the inner rotor and the outer rotor with a feeler gauge.
2. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.

Clearance between inner rotor and outer rotor	Factory specification	0.030 to 0.090 mm 0.0012 to 0.0035 in.
	Allowable limit	0.30 mm 0.012 in.

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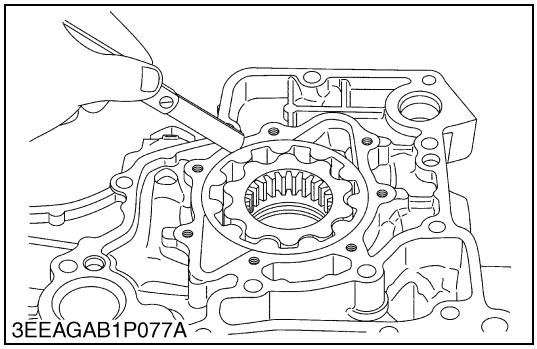
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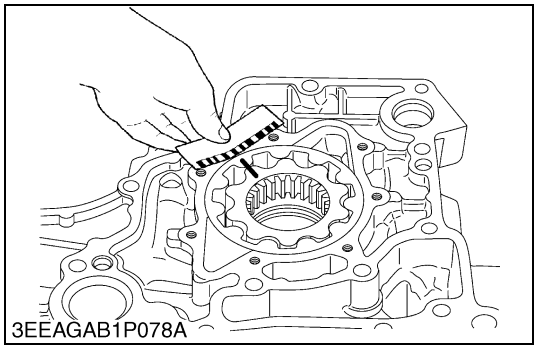
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Clearance between Outer Rotor and Pump Body

1. Measure the clearance between the outer rotor and the pump body with a feeler gauge.
2. If the clearance exceeds the allowable limit, replace the oil pump rotor assembly.

Clearance between outer rotor and pump body	Factory specification	0.100 to 0.184 mm 0.00394 to 0.00724 in.
	Allowable limit	0.30 mm 0.012 in.

RY9212050ENS0111US0

Clearance between Rotor and Cover

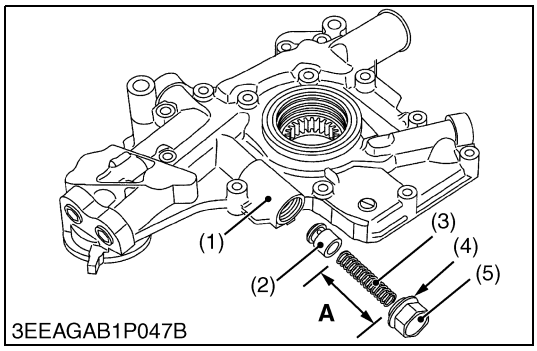
1. Put a strip of plastigage onto the rotor face with grease.
2. Install the cover and tighten the screws with the specified torque.
3. Remove the cover carefully, and measure the amount of the flattening with the scale and get the clearance.
4. If the clearance exceeds the allowable limit, replace oil pump rotor assembly and the cover.

Clearance between rotor and cover	Factory specification	0.025 to 0.075 mm 0.00099 to 0.0029 in.
	Allowable limit	0.225 mm 0.00886 in.

Tightening torque	Oil pump cover screw	7.9 to 9.3 N·m 0.80 to 0.95 kgf·m 5.8 to 6.8 lbf·ft

RY9212050ENS0112US0

(7) Relief Valve



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Free Length of Relief Valve Spring

1. Measure the free length **"A"** with vernier calipers. If the measurement is less than the allowable limit, replace it.
2. Check the entire surface of the spring for scratches. Replace it, if any.

Free length **"A"**	Factory specification	60.0 to 60.5 mm 2.37 to 2.38 in.
	Allowable limit	55.0 mm 2.17 in.

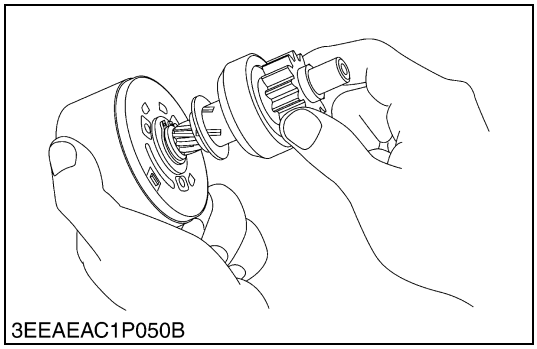
Tightening torque	Relief valve retaining screw	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

(1) Front Cover
(2) Relief Valve
(3) Spring
(4) Packing
(5) Relief Valve Retaining Screw

A : Free Length

RY9212050ENS0113US0

(8) Starter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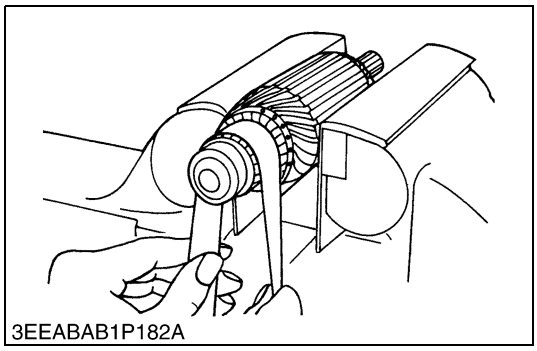
Overrunning Clutch

1. Inspect the pinion for wear or damage.
2. If there is any defect, replace the overrunning clutch assembly.
3. Check that the pinion turns freely and smoothly in the overrunning direction and does not slip in the cranking direction.
4. If the pinion slips or does not rotate in the both directions, replace the overrunning clutch assembly.

RY9212050ENS0114US0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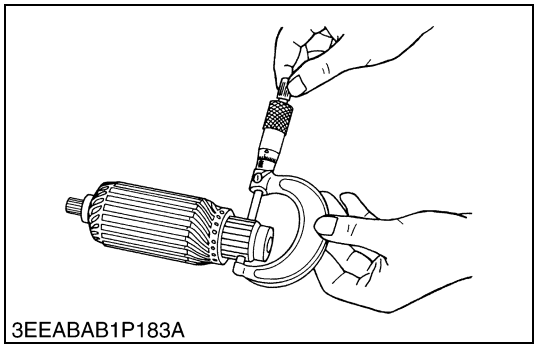
Commutator and Mica

1. Check the contact face of the commutator for wear, and grind the commutator with emery paper if it is slightly worn.
2. Measure the commutator O.D. with an outside micrometer at several points.
3. If the minimum O.D. is less than the allowable limit, replace the armature.
4. If the difference of the O.D.'s exceeds the allowable limit, correct the commutator on a lathe to the factory specification.
5. Measure the mica undercut.
6. If the undercut is less than the allowable limit, correct if with a saw blade and chamfer the segment edges.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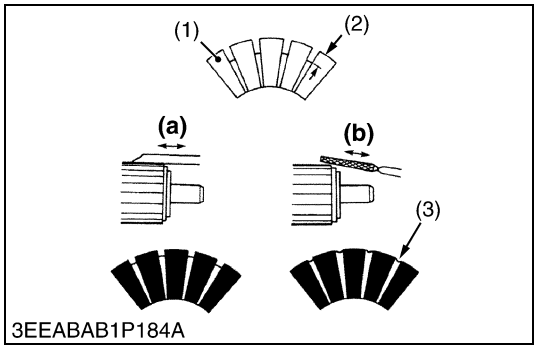
Commutator O.D.	Factory specification	32.0 mm 1.26 in.
	Allowable limit	31.4 mm 1.24 in.

Mica under cut	Factory specification	0.50 mm 0.020 in.
	Allowable limit	0.20 mm 0.0079 in.



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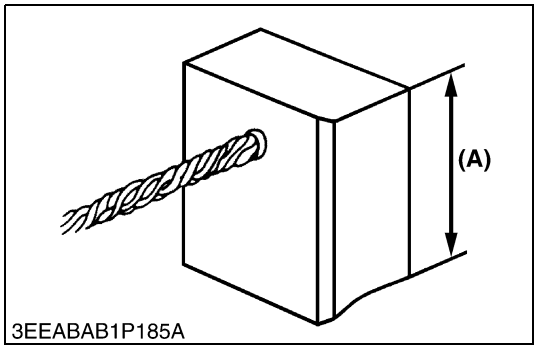
(1) Segment
(2) Depth of Mica
(3) Mica
(a) Good
(b) Bad

RY9212050ENS0115US0



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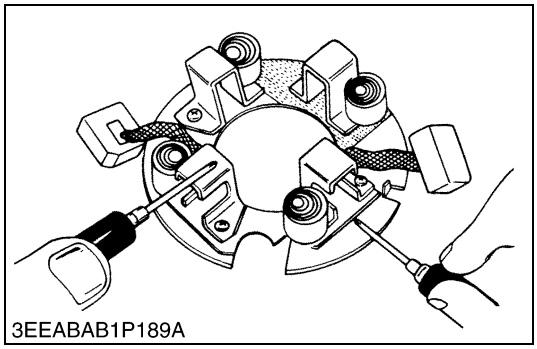
Brush Wear

1. If the contact face of the brush is dirty or dusty, clean it with emery paper.
2. Measure the brush length **(A)** with vernier calipers.
3. If the length is less than the allowable limit, replace the yoke assembly and brush holder.

Brush length **(A)**	Factory specification	18.0 mm 0.709 in.
	Allowable limit	11.0 mm 0.433 in.

(A) Brush Length

RY9212050ENS0116US0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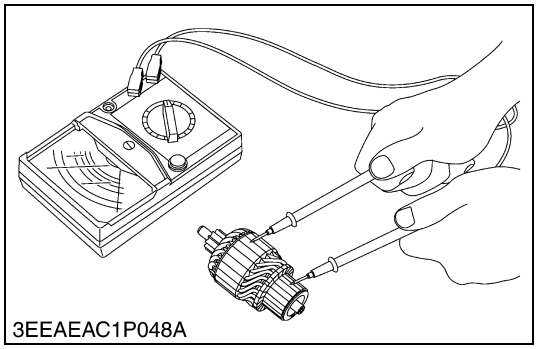
Brush Holder

1. Check the continuity across the brush holder and the holder support with an ohmmeter.
2. If it conducts, replace the brush holder.

Resistance	Brush holder – Holder support	Infinity

RY9212050ENS0117US0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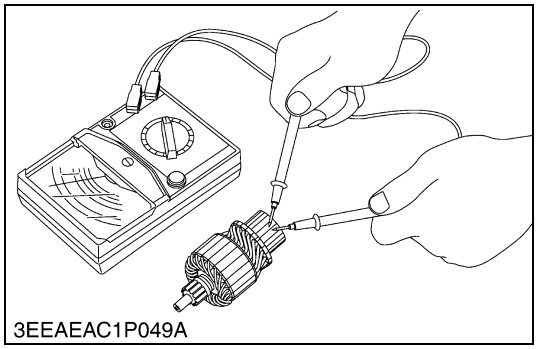
Armature Coil

1. Check the continuity across the commutator and armature coil core with an ohmmeter.
2. If it conducts, replace the armature.
3. Check the continuity across the segments of the commutator with an ohmmeter.
4. If it does not conduct, replace the armature.

Resistance	Commutator – Armature coil core	Infinity
	Commutator segment	0 Ω

RY9212050ENS0118US0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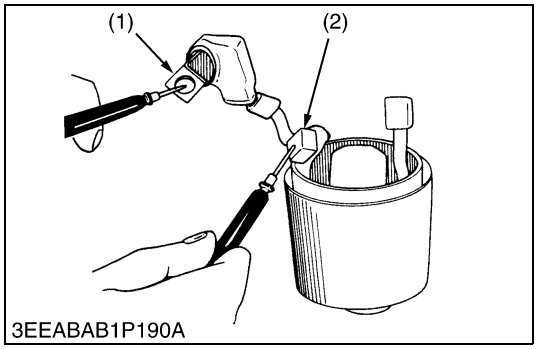


3EEABAB1P190A

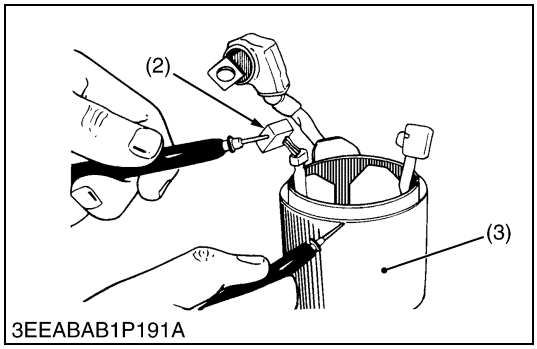
Field Coil

1. Check the continuity across the lead (1) and brush (2) with an ohmmeter.
2. If it does not conduct, replace the yoke assembly.
3. Check the continuity across the brush (2) and yoke (3) with an ohmmeter.
4. If it conducts, replace the yoke assembly.

Resistance	Lead (1) – Brush (2)	0 Ω
	Brush (2) – Yoke (3)	Infinity

(1) Lead
(2) Brush
(3) Yoke

RY9212050ENS0119US0



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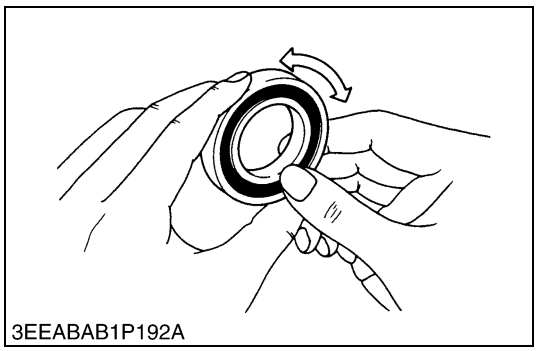
(9) Alternator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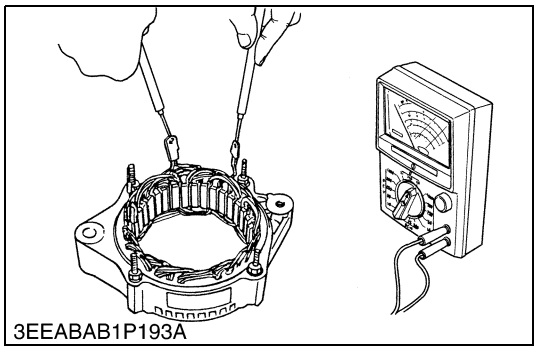
Bearing

1. Check the bearing for smooth rotation.
2. If it does not rotate smoothly, replace it.

RY9212050ENS0120US0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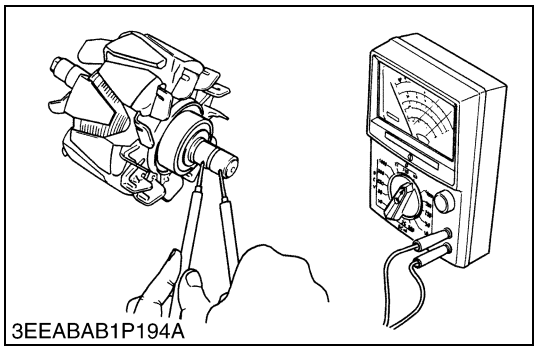
Stator

1. Measure the resistance across each lead of the stator coil with resistance range of circuit tester.
2. If the measurement is not within factory specification, replace it.
3. Check the continuity across each stator coil lead and core with resistance range of circuit tester.
4. If infinity is not indicated, replace it.

Resistance	Factory specification	Less than 1.0 Ω

RY9212050ENS0121US0

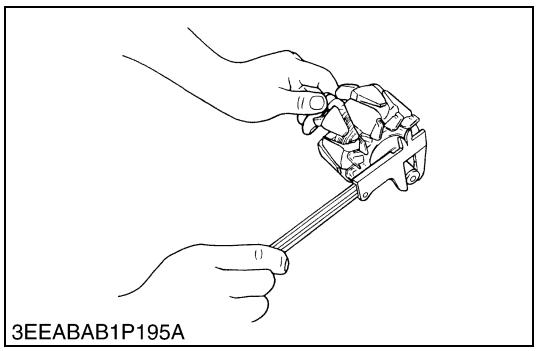

3EEABAB1P194A

Rotor

1. Measure the resistance across the slip rings with an ohmmeter.
2. If the resistance is not the factory specification, replace it.
3. Check the continuity across the slip and core with an ohmmeter.
4. If infinity is not indicated, replace it.

Resistance	Factory specification	2.8 to 3.3 Ω

RY9212050ENS0122US0

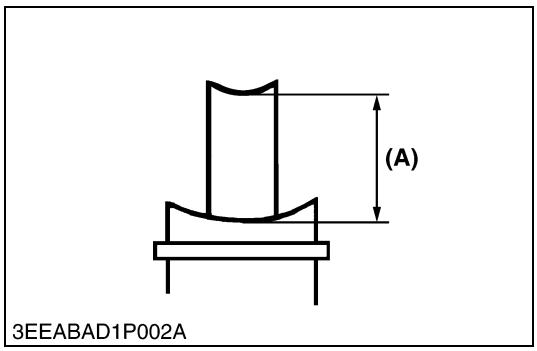

3EEABAB1P195A

Slip Ring

1. Check the slip ring for score.
2. If scored, correct with an sand paper or on a lathe.
3. Measure the O.D. of slip ring with vernier calipers.
4. If the measurement is less than the allowable limit, replace it.

Slip ring O.D.	Factory specification	22.7 mm 0.894 in.
	Allowable limit	22.1 mm 0.870 in.

RY9212050ENS0123US0



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Brush Wear

1. Measure the brush length **(A)** with vernier calipers.
2. If the measurement is less than allowable limit, replace it.
3. Make sure that the brush moves smoothly.
4. If the brush is defective, replace it.

Brush length **(A)**	Factory specification	18.5 mm 0.728 in.
	Allowable limit	5.0 mm 0.20 in.

(A) Brush Length

RY9212050ENS0124US0

3 HYDRAULIC SYSTEM

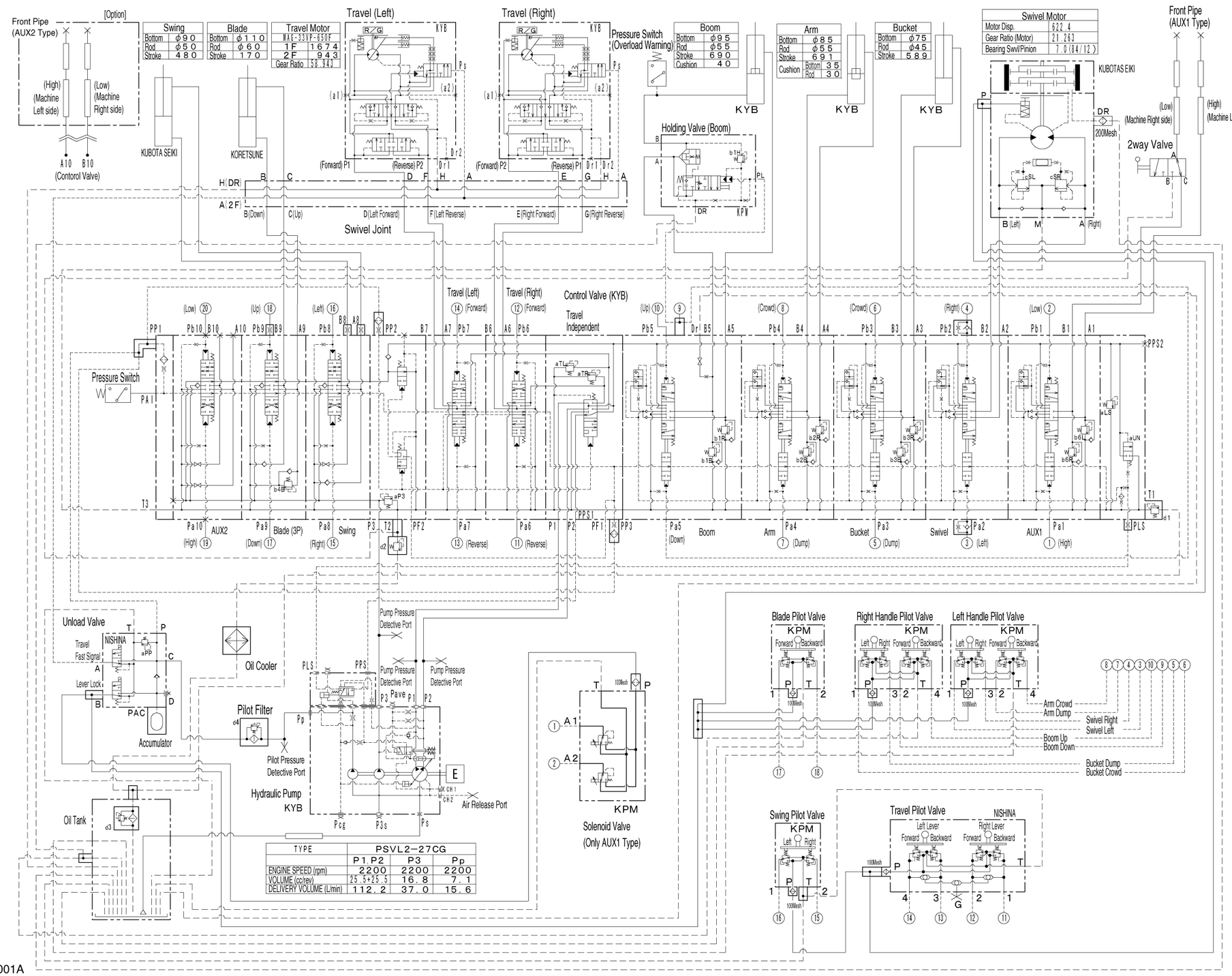
MECHANISM

CONTENTS

1. DIAGRAM OF HYDRAULIC CIRCUIT (KX057-4EU, U55-4 AUX1, AUX2 TYPE) 3-M1
2. HYDRAULIC DEVICE LAYOUT 3-M2
3. FEATURES 3-M3
   [1] ADOPTION OF THE 3-PUMP LS SYSTEM 3-M3
   [2] LOAD PRESSURE DETECTION SYSTEM 3-M4
   [3] ADOPTION OF AN AUTOMATIC SPEED REDUCTION FUNCTION ON THE TRAVEL MOTOR 3-M4
   [4] ADOPTION OF A PARKING BRAKE TO THE TRAVEL MOTOR 3-M4
   [5] ADOPTION OF AN OIL PRESSURE PILOT SYSTEM FOR ALL OPERATIONS 3-M5
   [6] CHARACTERISTICS OF LS PUMPS 3-M5
      (1) Variable displacement pump with LS control functions 3-M5
      (2) Variable displacement pump without LS control functions 3-M5
      (3) Gear Pump 3-M6
4. PUMP 3-M7
   [1] PUMP WITH LS CONTROL FUNCTIONS 3-M7
      (1) Specifications 3-M7
      (2) Components 3-M11
      (3) Function and Structure 3-M13
5. CONTROL VALVE 3-M20
   [1] CONTROL VALVE 3-M20
      (1) Specifications 3-M20
      (2) Diagram of Hydraulic Circuit 3-M22
      (3) Function and Structure 3-M22
6. SWIVEL MOTOR 3-M30
   [1] SWIVEL MOTOR 3-M30
      (1) Specifications 3-M30
      (2) Components 3-M31
      (3) Function and Structure 3-M33
7. TRAVEL MOTOR 3-M36
   [1] TRAVEL MOTOR 3-M36
      (1) Specifications 3-M36
      (2) Components 3-M38
      (3) Function and Structure 3-M40
8. HYDRAULIC CYLINDER 3-M47
   [1] BOOM CYLINDER 3-M47
      (1) Specifications 3-M47
      (2) Components 3-M47
      (3) Function and Structure 3-M48
   [2] ARM CYLINDER 3-M49
      (1) Specifications 3-M49
      (2) Components 3-M49
      (3) Function and Structure 3-M50
   [3] BUCKET CYLINDER 3-M51
      (1) Specifications 3-M51
      (2) Components 3-M51
   [4] SWING CYLINDER 3-M52
      (1) Specifications 3-M52
      (2) Components 3-M52

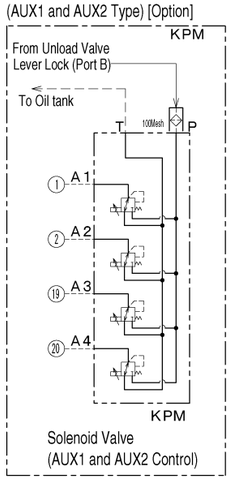
[5] BLADE CYLINDER 3-M53
(1) Specifications 3-M53
(2) Components 3-M53
9. PILOT VALVE 3-M54
[1] PILOT VALVE (BOOM, ARM, BUCKET, SWIVEL) 3-M54
(1) Specifications 3-M54
(2) Components 3-M56
(3) Function and Structure 3-M57
[2] PILOT VALVE (TRAVEL) 3-M58
(1) Specifications 3-M58
(2) Components 3-M59
(3) Function and Structure 3-M60
[3] PILOT VALVE (SWING AND BLADE) 3-M62
(1) Specifications 3-M62
(2) Components 3-M63
(3) Function and Structure 3-M64
10. UNLOAD VALVE 3-M65
[1] UNLOAD VALVE 3-M65
(1) Specifications 3-M65
(2) Components 3-M66
(3) Function and Structure 3-M67
11. HOLDING VALVE 3-M69
[1] BOOM HOLDING VALVE 3-M69
(1) Specifications 3-M69
(2) Components 3-M70
(3) Function and Structure 3-M71
12. SERVICE PORT 3-M73
[1] SERVICE PORT 3-M73
(1) Specifications 3-M73
(2) Components 3-M75
(3) Function and Structure 3-M77

1. DIAGRAM OF HYDRAULIC CIRCUIT (KX057-4EU, U55-4 AUX1, AUX2 TYPE)

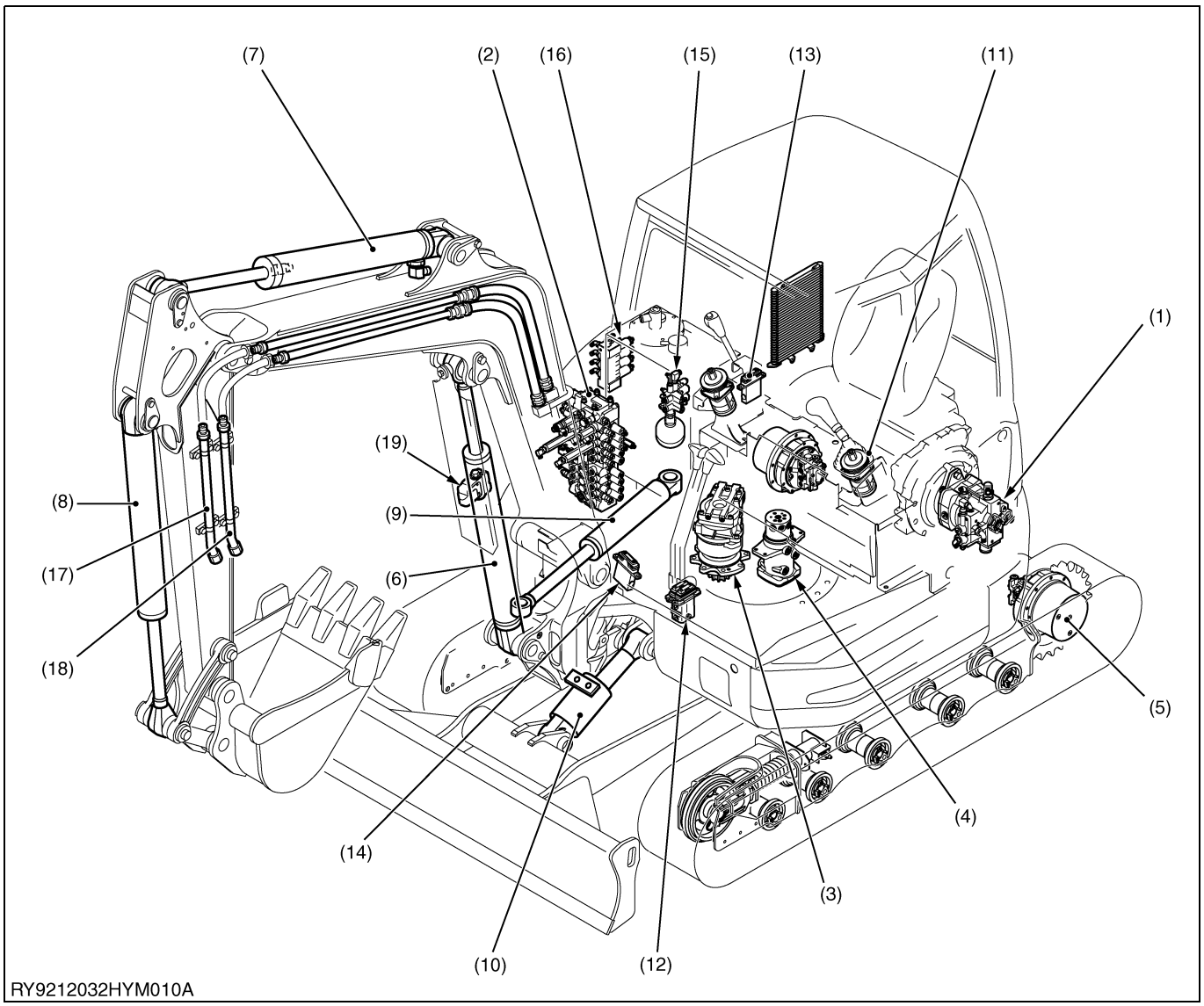


Mark	Relief Pressure (MPa)		
aUN	Unload LS		2.55
aLS	Main LS		27.4
aTR	Main Travel Right		26.5
aTL	Main Travel Left		26.5
aP3	Main P3		19.1
aPP	Pilot Primary		3.92
b1B	Boom	Bottom	31.4
b1R		Rod	31.4
b1H		Holding V	30.4
b2B	Arm	Bottom	31.4
b2R		Rod	31.4
b3B	Bucket	Bottom	31.4
b3R		Rod	31.4
b4B	Blade	Bottom	27.4
b4R		Rod	—
b5B	Swing	Bottom	—
b5R		Rod	—
b6L	Aux1 (SP1)	LH	20.6
b6R		RH	20.6
b10L	Aux2 (SP2)	LH	—
b10R		RH	—
cSL	Swivel Motor	LH	20.6
cSR		RH	20.6
cTF	Travel Motor	Forward	—
cTR		Backward	—
d1	Main Return		0.4
d2	Cooler Return		0.1
d3	Return Filter By-Pass		0.15
d4	Pilot Line Filter By-pass		0.15

(AUX1 and AUX2 Type) [Option]



2. HYDRAULIC DEVICE LAYOUT



RY9212032HYM010A

(1) Pump
(2) Control Valve
(3) Swivel Motor
(4) Swivel Joint
(5) Travel Motor
(6) Boom Cylinder
(7) Arm Cylinder
(8) Bucket Cylinder
(9) Swing Cylinder
(10) Blade Cylinder
(11) Pilot Valve (Control)
(12) Pilot Valve (Travel)
(13) Pilot Valve (Blade)
(14) Pilot Valve (Swing)
(15) Unload Valve
(16) Solenoid Valve (AUX1 / AUX2)
(17) AUX1
(18) AUX2
(19) Holding Valve

RY9212032HYM0003US0

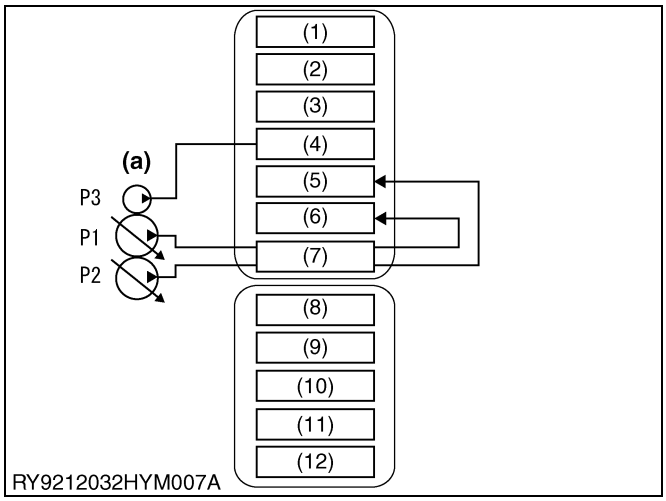
3. FEATURES

[1] ADOPTION OF THE 3-PUMP LS SYSTEM

The front (AUX1, swivel, bucket, arm and boom) is under LS control, while travel left and right, swing and blade, AUX2 operations are under open control.

Travel is an independent circuit. The entire flow of pumps P1 and P2 are supplied to travel left and travel right. The blade is supplied by pump P3, so when travel and blade are operated simultaneously, a great deal of travel horsepower is attained that is only marginally affected by speed changes.

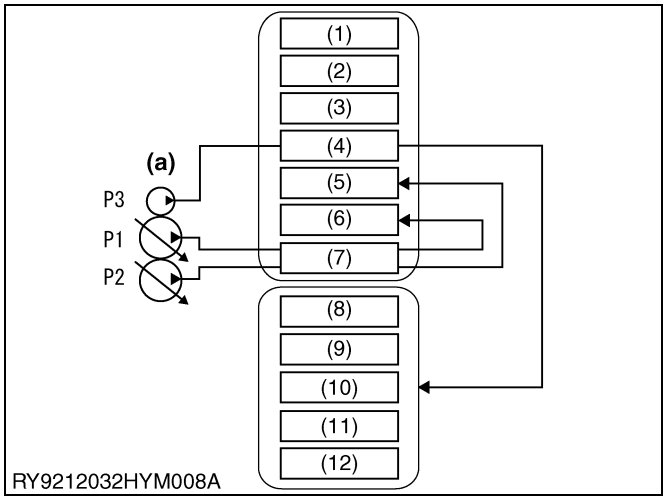
In addition, when the front (AUX1, swivel, bucket, arm or boom) is operated simultaneously, the oil from gear pump P3 is supplied to the front, so there is little change in speed and the mini-excavator harnesses a great deal of horsepower for traveling.



[During travel operation]

OPEN control section	(1) AUX2
	(2) Blade
	(3) Swing
	(4) Communication valve
	(5) Travel left
	(6) Travel right
	(7) Independent travel valve
LS control section	(8) Boom
	(9) Arm
	(10) Bucket
	(11) Swivel
	(12) AUX1

- Variable pump supplies independently for travel only. In this case, the swash plate is set to maximum angle, and it is not under LS control.



[During travel and excavator operation]

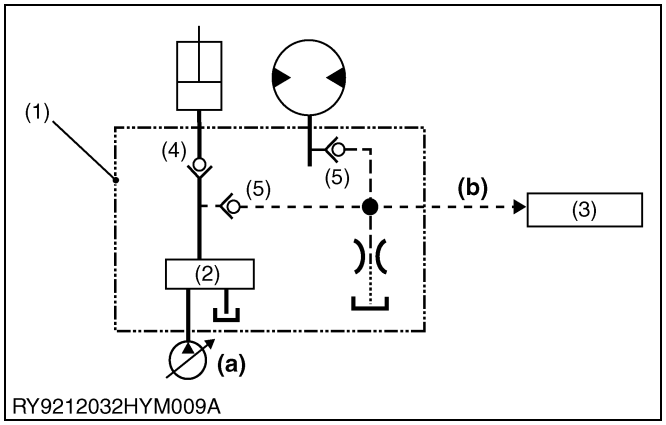
OPEN control section	(1) AUX2
	(2) Blade
	(3) Swing
	(4) Communication valve
	(5) Travel left
	(6) Travel right
	(7) Independent travel valve
LS control section	(8) Boom
	(9) Arm
	(10) Bucket
	(11) Swivel
	(12) AUX1

- Variable pump supplies independently for travel only. In this case, the swash plate is set to maximum angle, and it is not under LS control.
- Excavator operated by P3 only.

(a) Pump

RY9212032HYM0004US0

[2] LOAD PRESSURE DETECTION SYSTEM



RY9212032HYM009A

[New LS Signal Control (Bleed System)]

The system detects the maximum load among the front tools (AUX1, swivel, bucket, arm and boom) and employs a bleed system as a means for communicating information on that load pressure to the pump.

Features of the Bleed System:
- Smooth Operation
- Improved operability during compaction
- Prevents jerking
- Quick temperature responsiveness

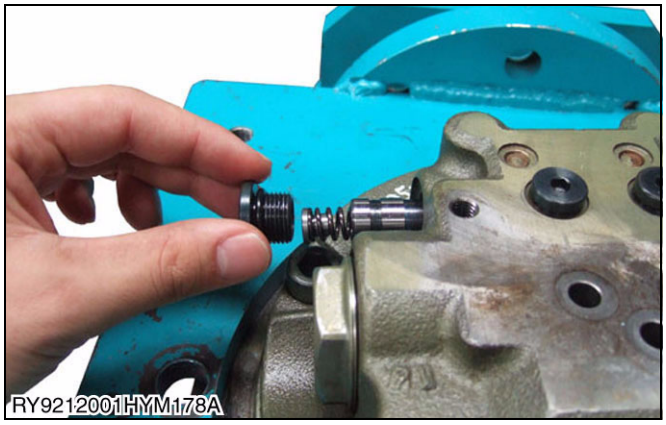
- With the bleed system, some bleeding is sustained also during operation.

(1) Valve
(2) Spool
(3) Pump LS valve
(4) Load check valve
(5) Check valve

(a) Pump
(b) LS signal (maximum load among all front tools)

RY9212032HYM0005US0

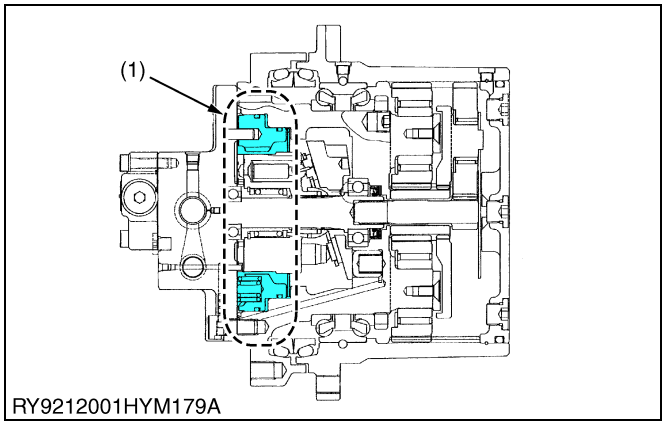
[3] ADOPTION OF AN AUTOMATIC SPEED REDUCTION FUNCTION ON THE TRAVEL MOTOR


RY9212001HYM178A

If a large load is put on the travel motor while it is turning in 2nd speed, it automatically switches to the 1st speed to obtain robust travel horsepower.

RY9212001HYM0011US0

[4] ADOPTION OF A PARKING BRAKE TO THE TRAVEL MOTOR



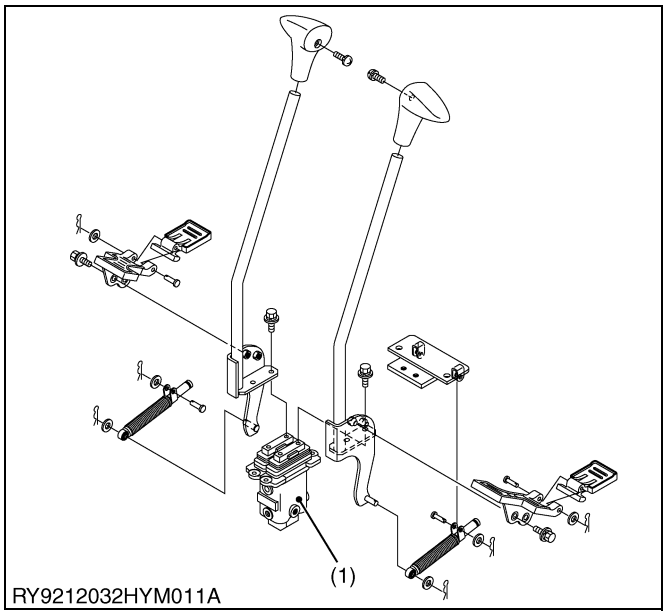
RY9212001HYM179A

We have adopted a friction plate style of parking brake. When the travel lever is put in neutral, the brake is actuated by springs; operating the travel lever releases the brake via oil pressure.

(1) Parking Brake

RY9212001HYM0012US0

[5] ADOPTION OF AN OIL PRESSURE PILOT SYSTEM FOR ALL OPERATIONS



RY9212032HYM011A

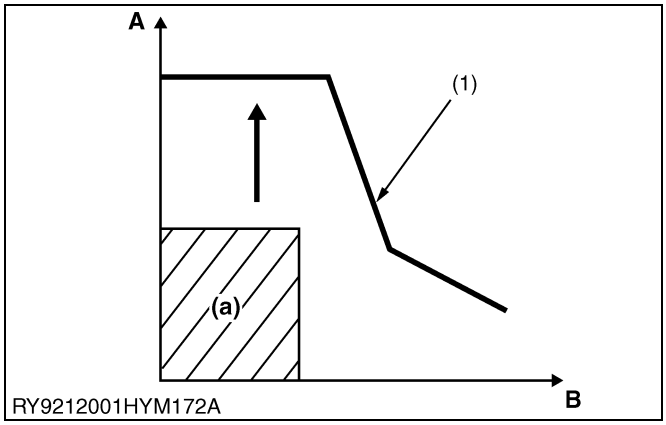
- We adopted an oil pressure pilot system for all operations in order to achieve an easy and smooth operability.
- Because an accumulator is used, the front-loader or the blade can be lowered to the ground for up to 30 seconds after the engine stops.

(1) Hydraulic Pilot Valve (Travel)

RY9212032HYM0006US0

[6] CHARACTERISTICS OF LS PUMPS

(1) Variable displacement pump with LS control functions



RY9212001HYM172A

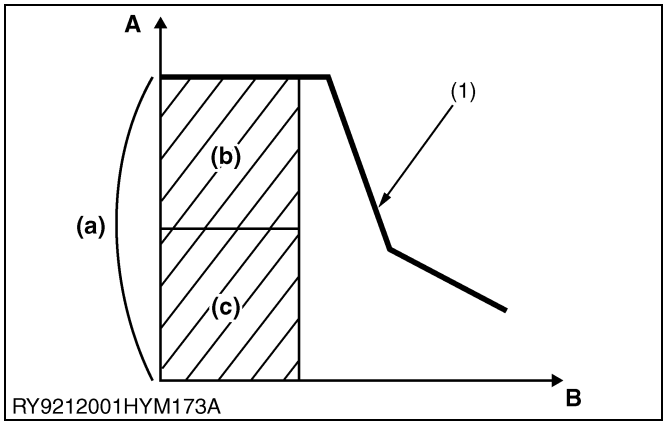
The LS control works when there is a light load. The LS control works inside the horsepower control curve. Horsepower is the product of flow and pressure. Effective horsepower (horsepower a pump needs for a load) = consumed horsepower

When the load becomes great, it moves in the direction of the arrow; after peak flow, it operates along the horsepower control curve.

(1) Horsepower control curve
A: Flow rate
B: Pressure
(a) Horsepower consumed = effective horsepower

RY9212001HYM0014US0

(2) Variable displacement pump without LS control functions



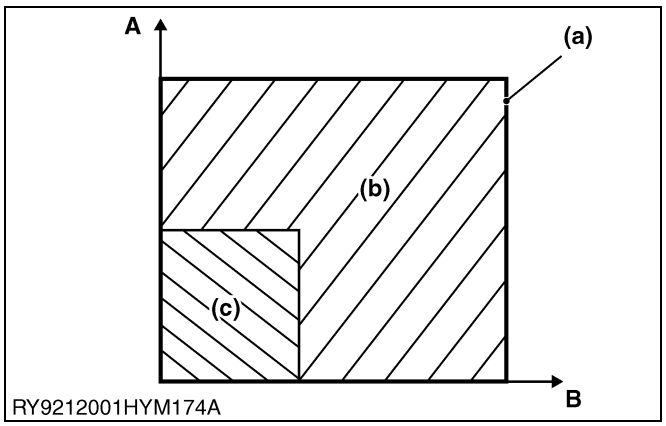
RY9212001HYM173A

Operates along the horsepower control curve. It does not have LS control, so even when the load is small, a constant horsepower is required.

(1) Horsepower control curve
A: Flow rate
B: Pressure
(a) Horsepower consumed
(b) Horsepower lost
(c) Effective horsepower

RY9212001HYM0015US0

(3) Gear Pump



A fixed displacement pump.
A great deal of horsepower is lost.

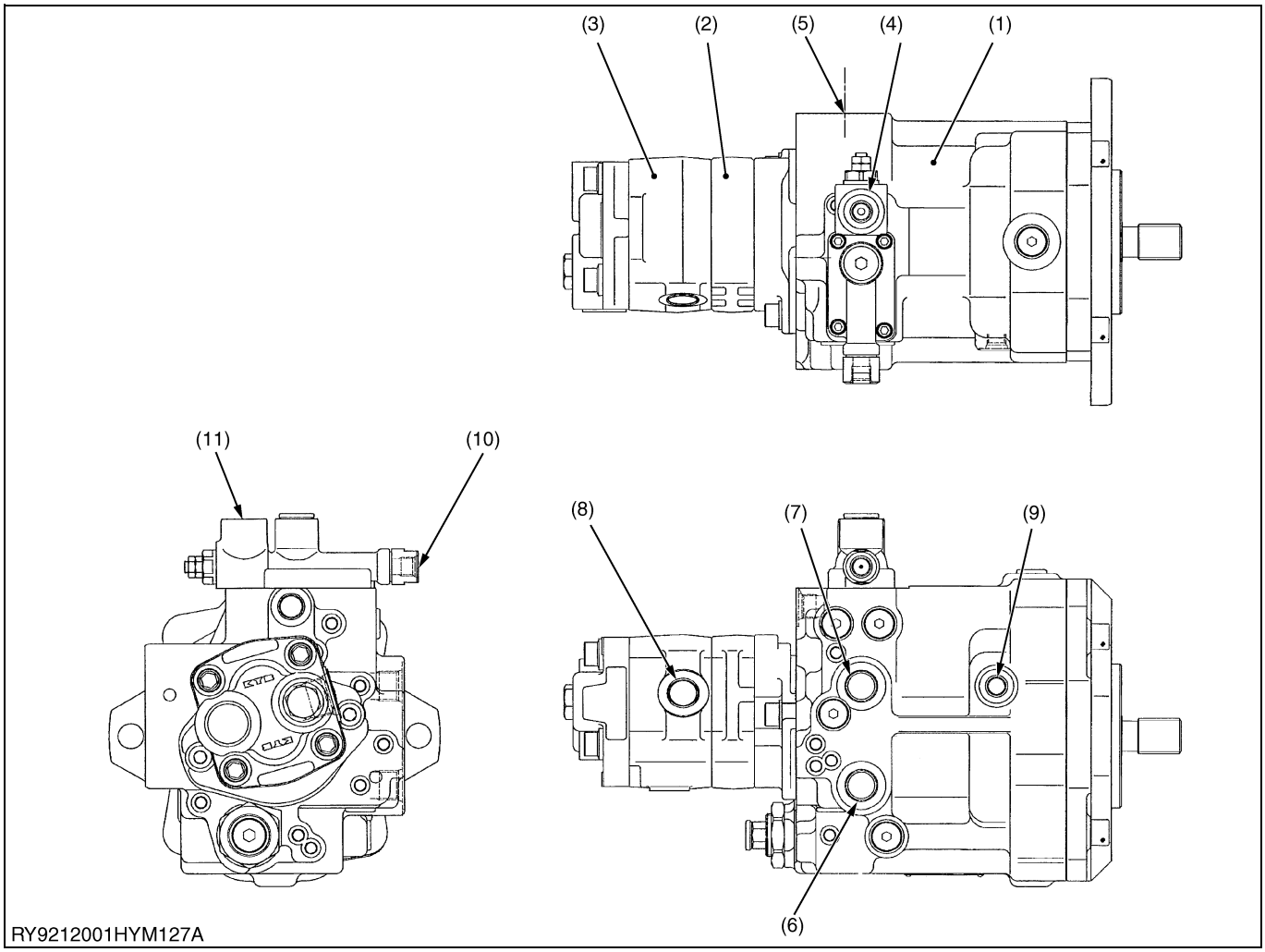
(a) Horsepower consumed (Everything in shaded areas)
(b) Horsepower lost
(c) Effective horsepower
A: Flow rate
B: Pressure

RY9212001HYM0016US0

4. PUMP

[1] PUMP WITH LS CONTROL FUNCTIONS

(1) Specifications



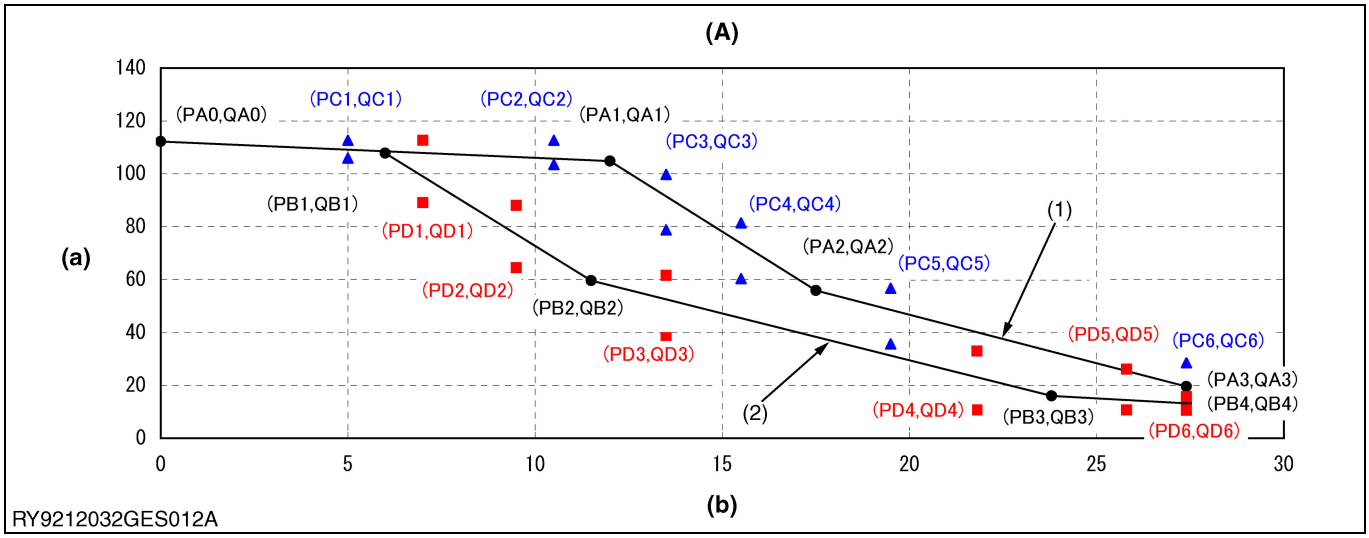
RY9212001HYM127A

(1) Variable Pump (piston pump) (P1, P2)
(2) Gear Pump P3
(3) Gear pump (pilot pump)
(4) L/S Regulator
(5) PS Port (section)
(6) P1 Port
(7) P2 Port
(8) P3 Port
(9) Port T
(10) PPS Port
(11) PLS Port

RY9212032HYM0007US0

Specifications of pump

		Unit	KX057-4	Remarks
Manufacturer			KYB Co.,Ltd.	
Model			PSVL2-27CG	
Rated pump rpm		rpm	2200	
Rated load pressure	Main relief pressure a LS	MPa kgf/cm^2 psi	27.4 280 3983	
	Main relief pressure a TR/TL	MPa kgf/cm^2 psi	26.5 270 3843	at travel open
	Main relief pressure a P3	MPa kgf/cm^2 psi	19.1 195 2770	
	Pilot primary pressure a Pp	MPa kgf/cm^2 psi	3.92 40 569	
Theoretical discharge capacity	Main pump P1/P2	cc/rev cu.in./rev	25.5 / 25.5 1.56 / 1.56	Split flow of variable displacement piston pump At 1000 rpm 5.2 x 2 cc/rev (0.32 x 2 cu.in./rev)
	Main pump P3	cc/rev cu.in./rev	16.8 1.03	Gear pump
	Pilot pump Pp	cc/rev cu.in./rev	7.1 0.43	Gear pump
Theoretical discharge capacity	Main pump P1/P2	L/min USGPM	56.1 / 56.1 14.82 / 14.82	
	Main pump P3	L/min USGPM	37.0 9.78	
	Pilot pump Pp	L/min USGPM	15.6 4.12	
Differential pressure	LS control valve	MPa kgf/cm^2 psi	1.65 16.8 239	Engine rpm proportional control with P4, Idling / Rated = about 50 - 70%
Standby flow rate		L/min USGPM	10.4 to 22.9 2.75 to 6.04	At 1000 to 2200 rpm
Horsepower control			PC horsepower control valve: With P3 horsepower shift Swash plate control aided by self-tilting moment (Small piston deleted.) P1 + P2 pressure: Average pressure by orifice	
Structure			Bearing: Cradle Shoe plate: Spherical Large-diameter piston (with shoe)	



(1) P_3 = 2 MPa, 21 kgf/cm^2, 291 psi
(2) P_3 = 19.1 MPa, 195 kgf/cm^2, 2770 psi

(A) Piston Pump Power Constant Characteristics

(a) Delivery Flow : Q_1+Q_2 (L/min)

(b) Pressure : P_1 = P_2 (MPa)

Shaft speed : 2200 rpm			
At gear pump pressure : P_3 = 2 MPa		At gear pump pressure : P_3 = 19.1 MPa	
Total input torque : Below 128 N·m		Total input torque Below : 133 N·m +0, -3.0	
Pressure (MPa)	Delivery flow (L/min)	Pressure (MPa)	Delivery flow (L/min)
PA0 = 0.0	QA0 = 112.2 (Target value)		
PA1 = 12.0	QA1 = 104.8 (Target value)	PB1 = 6.0	QB1 = 107.8 (Target value)
PA2 = 17.5	QA2 = 55.9 (Target value)	PB2 = 11.5	QB2 = 59.6 (Target value)
PA3 = 27.4	QA3 = 19.6(Target value)	PB3 = 23.8	QB3 = 16.0 (Target value)
		PB4 = 27.4	QB4 = 13.2 (Target value)
PC1 = 5.0	QC1 = 109.3 ± 3.4	PD1 = 7.0	QD1 = 100.9 ± 11.8
PC2 = 10.5	QC2 = 108.1 ± 4.6	PD2 = 9.5	QD2 = 76.3 ± 11.8
PC3 = 13.5	QC3 = 89.3 ± 10.5	PD3 = 13.5	QD3 = 49.8 ± 11.8
PC4 = 15.5	QC4 = 70.9 ± 10.5	PD4 = 21.8	QD4 = 21.8 ± 11.1
PC5 = 19.5	QC5 = 46.2 ± 10.5	PD5 = 25.8	QD5 = 18.4 ± 7.7
PC6 = 27.4	QC6 = 19.6 ± 8.9	PD6 = 27.4	QD6 = 13.2 ± 2.5

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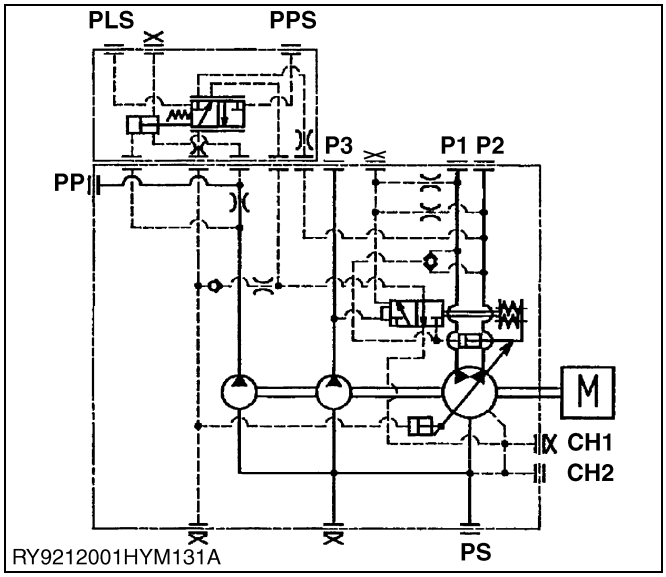

Diagram of Hydraulic Circuit

P1/P2: Piston pump discharge pressure
P3: Gear pump discharge pressure
PP: Pilot pump discharge pressure
PLS: Load pressure
PPS: Valve inlet pressure
PS: Suction pressure
CH: Air bleeds

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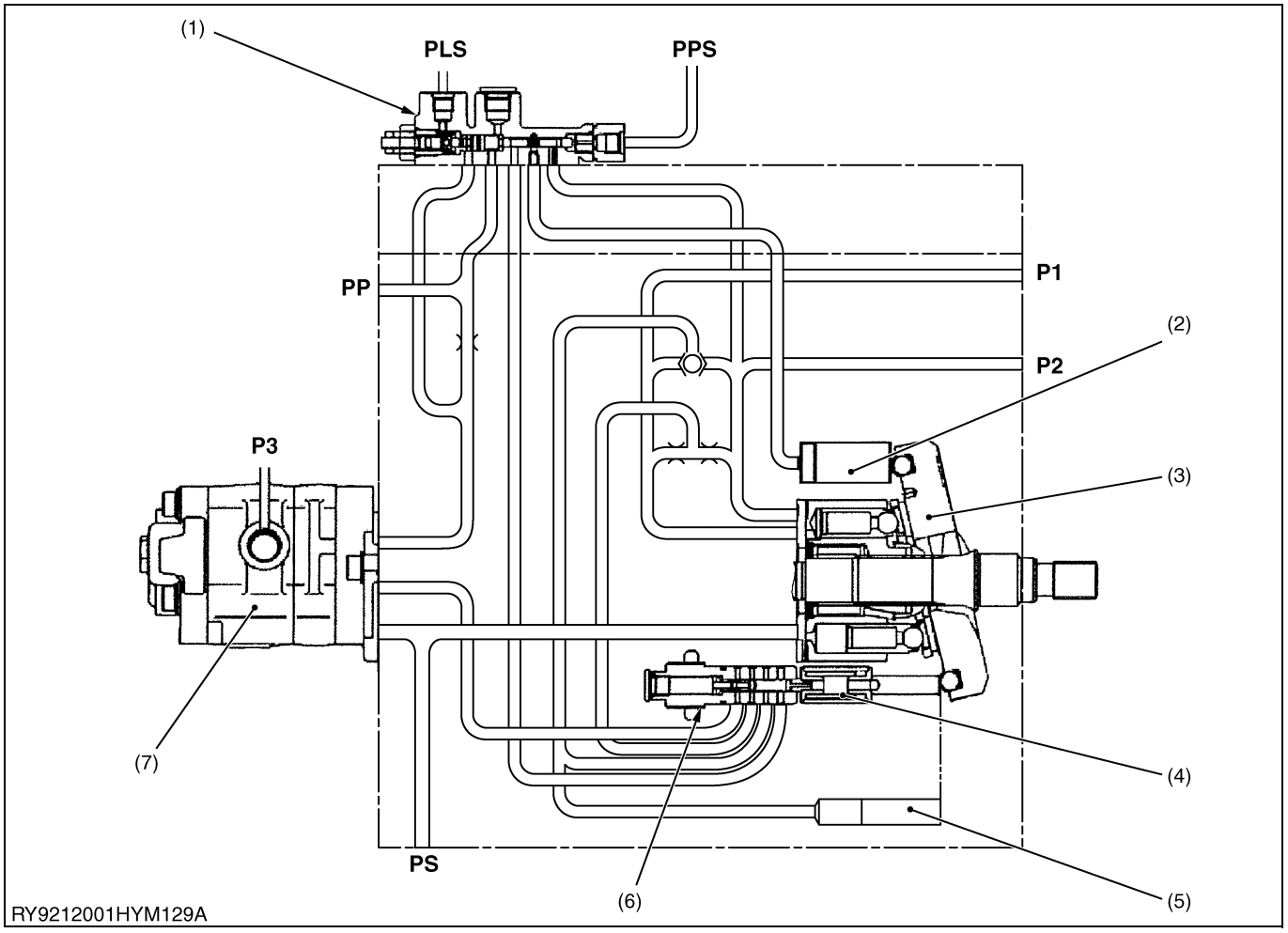
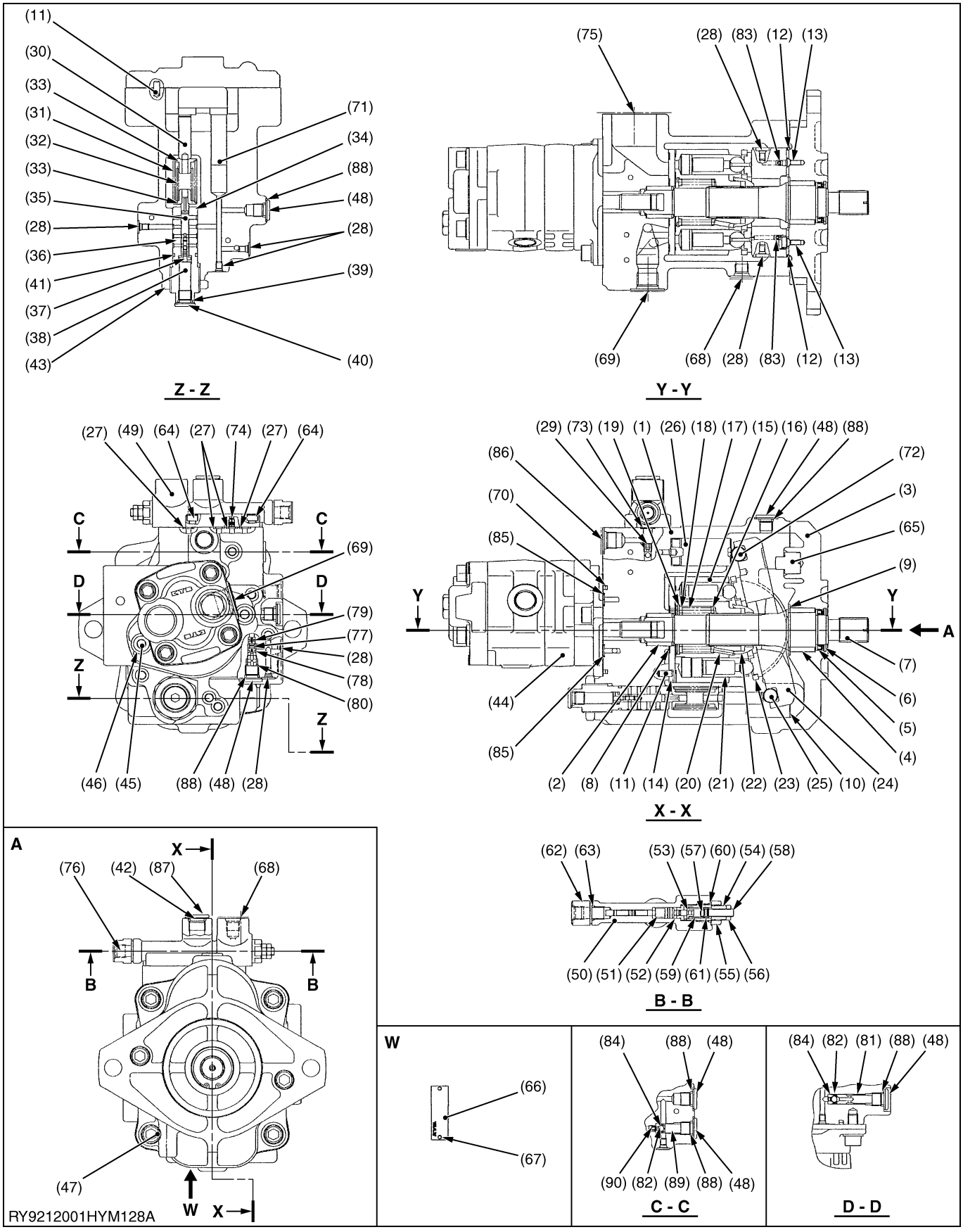
Configuration Diagram



(1) L/S Regulator
(2) Control pin B
(3) Swash plate
(4) Horsepower control spring
(5) Control pin A
(6) Horsepower control valve
(7) Gear Pump

RY9212001HYM0032US0

(2) Components

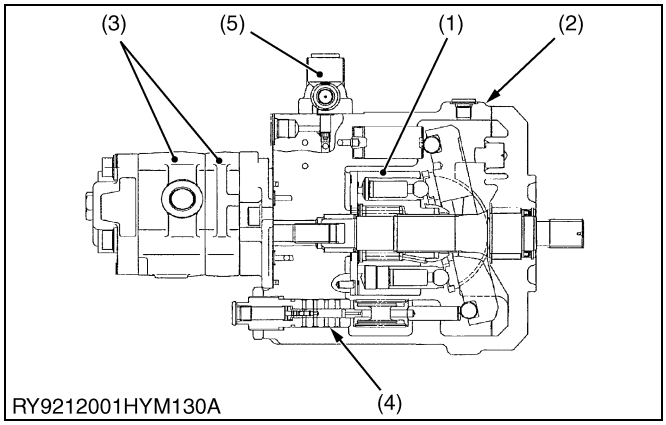


No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Case	1		(46)	Washer	2	JIS B 1256,8
(2)	Bearing	1		(47)	Socket head bolt	6	JIS B 1176, M12x35 L
(3)	Flange	1		(48)	Plug	6	
(4)	Needle bearing	1		(49)	Valve ASSY	1	(50) to (63)
(5)	Oil Seal	1		(50)	Valve body	1	
(6)	Snap ring	1	JIS B 2804, 42 HOLE	(51)	Spool	1	
(7)	Shaft	1		(52)	Bushing	1	
(8)	Thrust washer	1		(53)	Spring seat	1	
(9)	Thrust washer	1		(54)	Cap	1	
(10)	Gasket	1		(55)	Nut	1	
(11)	Pin	3	6x12	(56)	Nut	1	
(12)	Bushing	2		(57)	Holder	1	
(13)	Screw	2		(58)	Set screw	1	
(14)	Valve plate	1		(59)	Spring	1	
(15)	Cylinder block	1		(60)	O-Ring	1	JIS B 2401,1B,P16
(16)	Collar	1		(61)	O-Ring	1	JIS B 2401,1B,P8
(17)	Spring	1		(62)	Plug	1	
(18)	Collar	1		(63)	O-Ring	1	
(19)	Snap ring	1	JIS B 2804,48 HOLE	(64)	Socket head bolt	4	4 JIS B 1176, M6x16 L
(20)	Pin	3		(65)	Stopper	1	
(21)	Piston ASSY	10		(66)	Nameplate	1	
(22)	Retainer holder	1		(67)	Drive screw	2	
(23)	Retainer plate	1		(68)	Shipping plug	2	PF1/4
(24)	Swash-plate	1		(69)	Shipping plug	3	PF1/2
(25)	Pin	1		(70)	O-Ring	1	
(26)	Pin	1		(71)	Pin	1	
(27)	O-Ring	4	JIS B 2401,1B,P8	(72)	Pin	1	
(28)	Plug	29		(73)	O-Ring	1	
(29)	Orifice	1		(74)	Orifice	1	
(30)	Pin	1		(75)	Shipping plate	1	
(31)	Spring	1		(76)	Shipping plug	1	
(32)	Spring	1		(77)	Orifice	1	
(33)	Spring seat	2		(78)	O-Ring	1	
(34)	Valve ASSY	1	(35) to (41)	(79)	O-Ring	1	
(35)	Spool	1		(80)	Stopper	1	
(36)	Valve sleeve	1		(81)	Valve seat	1	
(37)	Pin	1		(82)	Steel ball	2	
(38)	Collar	1		(83)	Orifice	2	
(39)	O-Ring	1		(84)	Seat	2	
(40)	Plug	1		(85)	O-Ring	2	
(41)	O-Ring	1		(86)	Shipping plug	1	PF3/8
(42)	O-Ring	1		(87)	Plug	1	PF3/8
(43)	Nut	1		(88)	O-Ring	6	
(44)	Gear Pump	1		(89)	Collar	1	
(45)	Socket head bolt	2		(90)	Orifice	1	

RY9212001HYM0033US0

(3) Function and Structure

[A] Structure



RY9212001HYM130A

This pump is a quadruple pump configuration consisting of one cylinder block (1), a piston pump (2) with a 2-pump function and a twin gear pump (3), all arranged in-line.

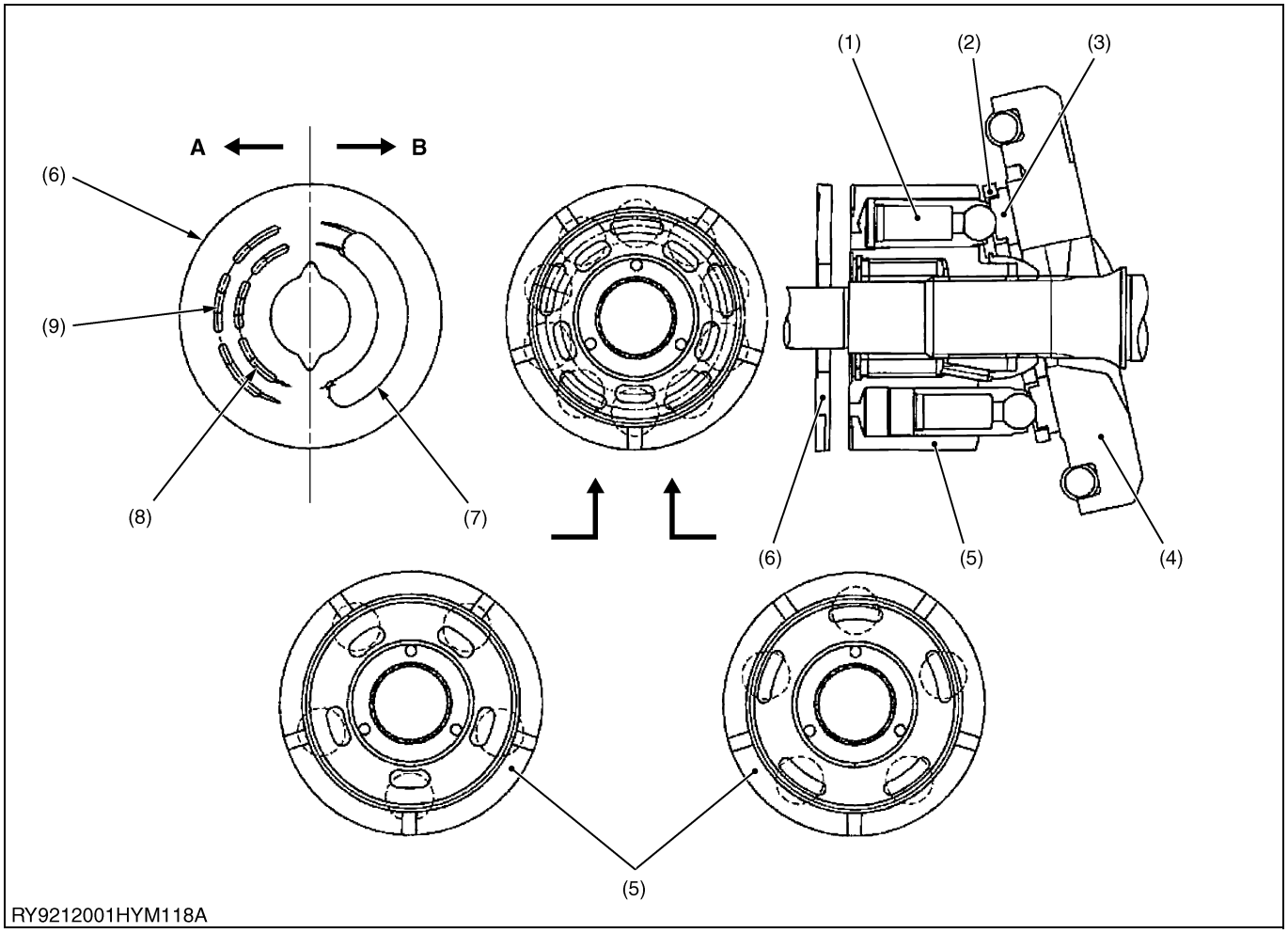
It has a fixed horsepower control function that controls maximum discharge according to the load and a load sensing control function (hereafter, L/S), which supplies the pressure and flow required by the load within that control range.

The fixed horsepower control (4) is built into the piston pump and the L/S regulator (5) is attached outside the piston pump.

(1) Cylinder block
(2) Piston pump (variable pump)
(3) Gear Pump
(4) Constant horsepower controller
(5) L/S Regulator

RY9212001HYM0034US0

[B] Operating Principles



(1) Piston	(4) Swash plate	(7) Suction port	**A : Discharge side**
(2) Retainer plate	(5) Cylinder block	(8) Discharge port (P1)	**B : Suction side**
(3) Shoe	(6) Valve plate	(9) Discharge port (P2)	

There are 10 pistons (1) built into the cylinder block (5) and coupled to the axle via a spline.

Also, one end of the cylinder block is in contact with a valve plate (6), which has two half-moon shaped ports (kidney ports); these two kidney ports are connected to suction and discharge ports respectively, so when the cylinder block rotates, the pistons are connected to the passage on the suction side for an interval of 180 degrees and to the discharge side for the remaining interval.

The shoes (3) crimped so they can rotate freely against the ball on the end of the piston, and the retainer plate (2) presses them against the swash-plate (4).

As a result, the shoes are always in contact with the swash-plate as it moves, so as the angle of the swash-plate changes, that translates into changes in the stroke of the piston and ultimately alters the amount of discharge from the pump.

As a result of the cylinder block rotation, the side that is pressed into the cylinder block by the piston via the swash-plate is the discharge path.

At this time the compressed chambers of the cylinder block are connected to the kidney ports on the discharge side **A** and the side where the pistons are being withdrawn become the suction path and are connected to the suction side kidney port.

As a consequence, during the interval of one revolution of the cylinder block, each piston alternately provides suction at the suction port and then discharge at the discharge port. Thus, smooth pump operation is achieved by having 10 pistons constantly alternating between suction and discharge.

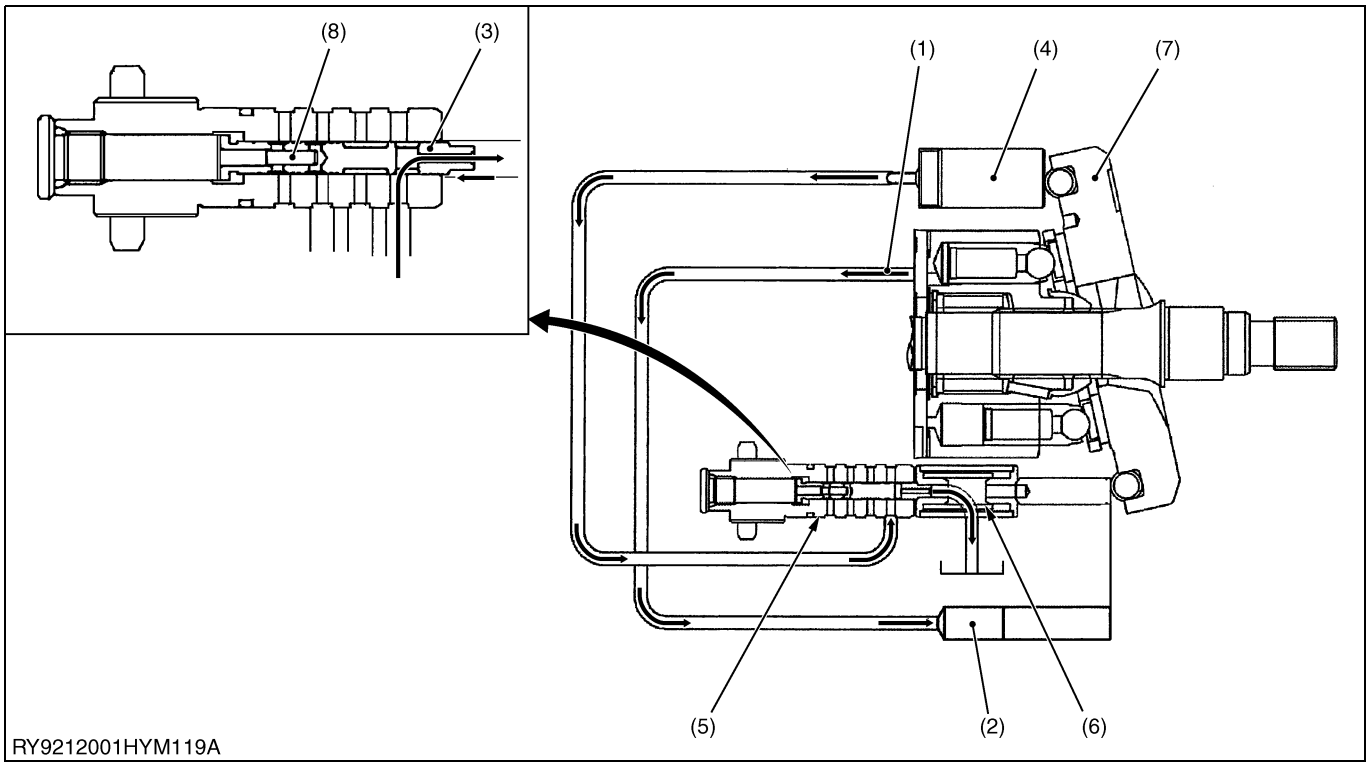
The ports of the cylinder block are arranged alternately in different diameters; the discharge ports of the valve plate also have two kinds of ports arranged inside/outside to match, so the flow to be discharged can be split off to the inner/outer ports and consequently equivalent flow amounts can be obtained simultaneously.

RY9212001HYM0035US0

[C] Horsepower Control

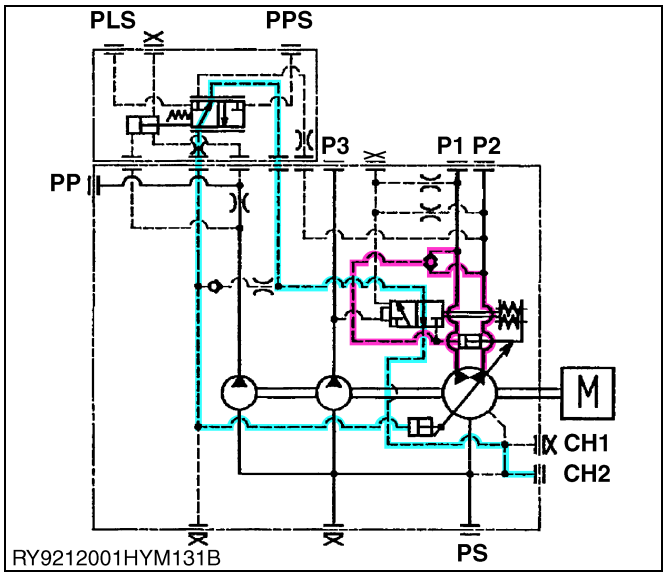
1. Horsepower Control

Horsepower control is a matter of controlling the discharge flow of the piston pump in such a way that the total consumed horsepower (torque) of the pump does not exceed the specified horsepower (torque) of the engine.



(1) Discharge pressure P
(2) Control pin A
(3) Horsepower control spool
(4) Control pin B
(5) Horsepower control valve
(6) Horsepower control spring
(7) Swash plate
(8) Reaction pin

RY9212001HYM0036US0



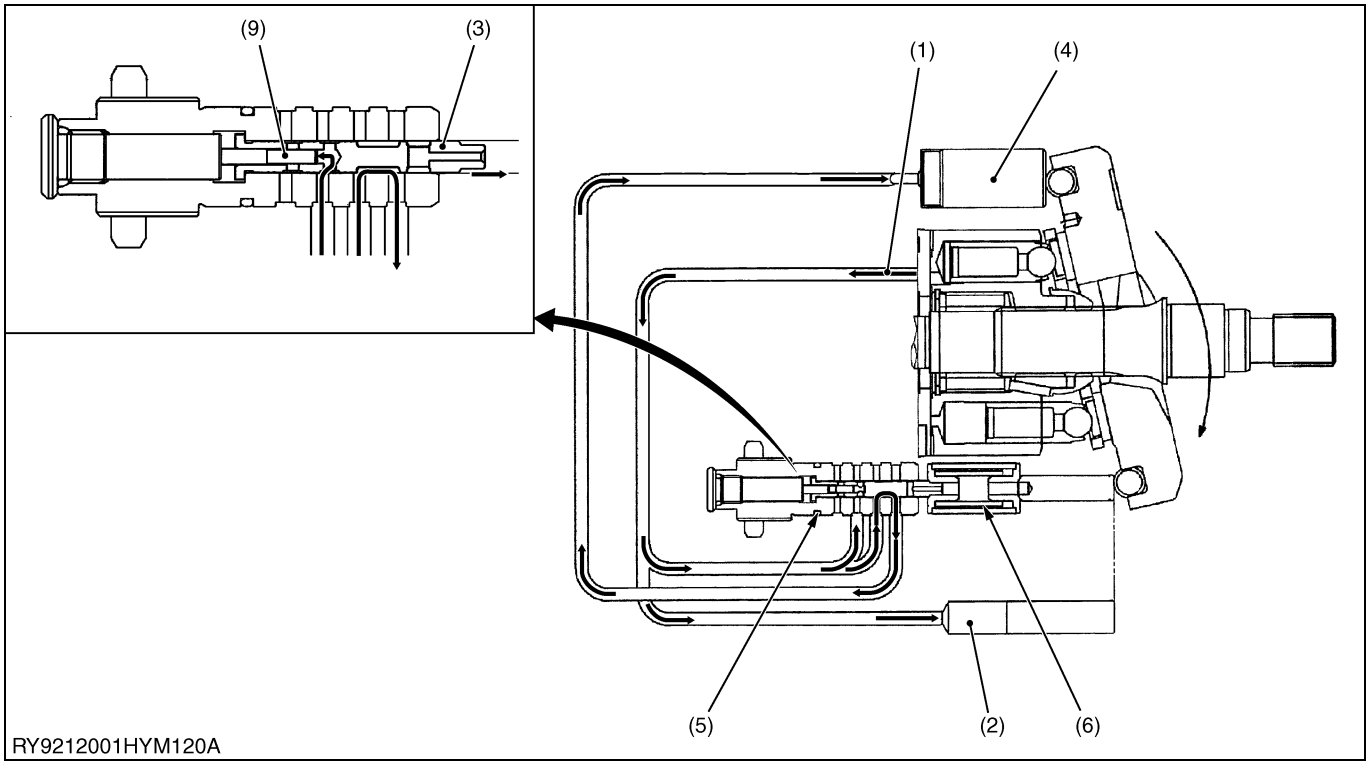
2. When pressure P is low (when the load is low)

The discharge pressure (1) from the piston pump is guided to control pin A (2) via oil passages inside the case. The pressure guided to control pin A produces a bias pressure equivalent to the pressure P against the swash-plate, thus pressuring the swash-plate. When pressure P is low, the horsepower control spool (3) is positioned at the far left, thus connecting control pin B (4) to the tank via the horsepower control spool, so there is no force on control pin B, which results in the maximum swash-plate tilt angle and discharge flow.

P1/P2: Piston pump discharge pressure
P3: Gear pump discharge pressure
PP: Pilot pump discharge pressure
PLS: Load pressure
PPS:Valve inlet pressure
PS: Suction pressure
CH: Air bleeds

RY9212001HYM0037US0

3. When pressure P increases (when the load is great)



(1) Discharge pressure P
(2) Control pin A
(3) Horsepower control spool
(4) Control pin B
(5) Horsepower control valve
(6) Horsepower control spring
(9) Reaction pin

When the piston pump discharge pressure P (1) rises due to the load, the horsepower control spool (3) in the middle of the diagram moves to the right. This connects discharge pressure P to control pin B (4), creating pressure on control pin B and thus reducing the swash-plate tilt angle and reducing discharge flow. The pump discharge pressure P is also connected to control pin A (2), but due to the difference in surface area, the swash-plate tilt angle is reduced. When the swash-plate tilt angle is reduced, the horsepower control spool is moved back to the left by the horsepower control springs (6), cutting off the connection between discharge pressure P and control pin B, and this results in a balance of pressure.

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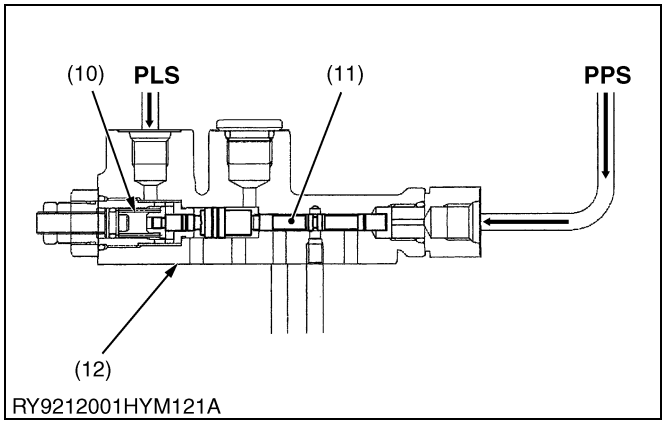
[D] LS Control

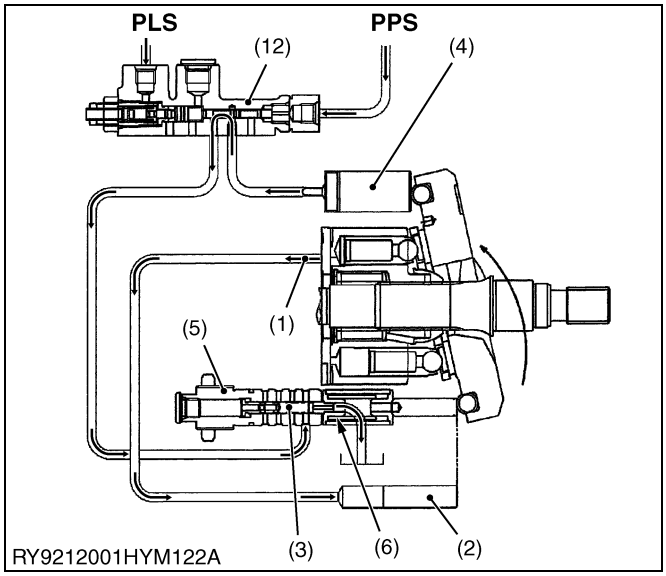


1. LS Control

LS control supplies the pressure and flow needed for a given load by controlling the pump's discharge pressure and flow so that pump discharge pressure PPS = load pressure PLS + spring pressure.

(10) Spring
(11) Spool
(12) L/S regulator

RY9212001HYM0004US0



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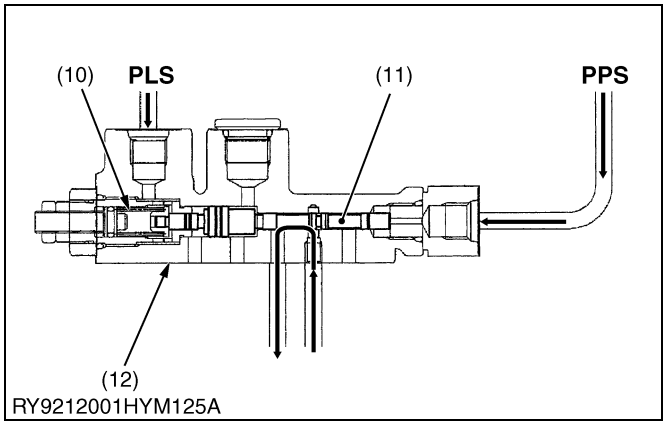
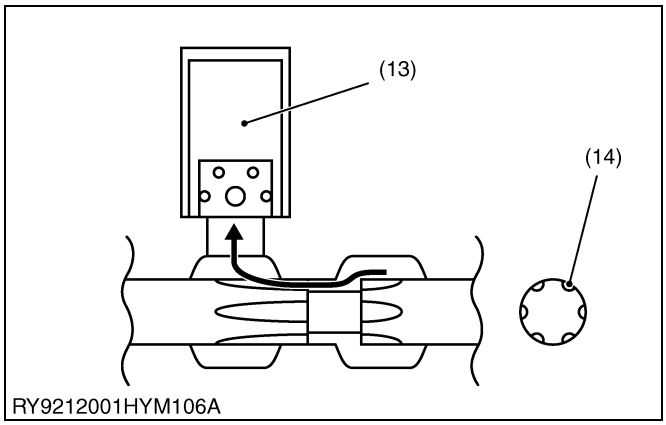


RY9212001HYM125A



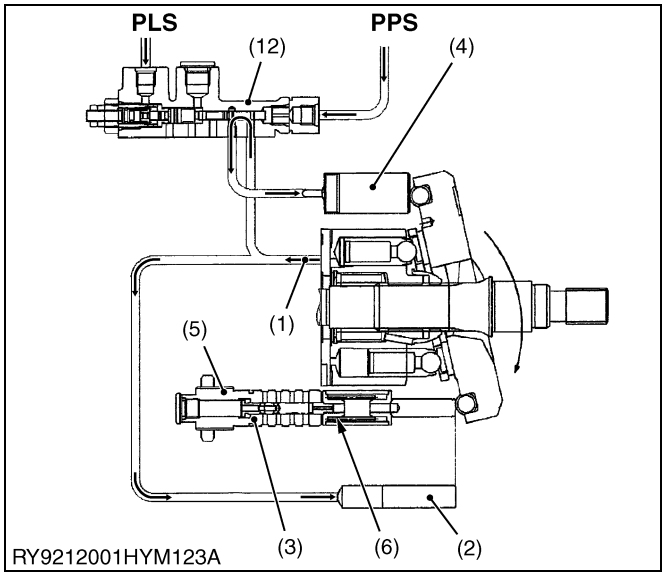
RY9212001HYM106A

2. When the control valve is open wide

If the control valve is opened wide (14) in order to quickly actuate the actuator, the pressure differential between the pump discharge pressure P (1) and the load pressure drops temporarily, moving the spool (11) of the L/S regulator (12) to the right; this connects control pin B (4) to the horsepower control valve (5). When this happens, the horsepower control spool (3) moves to the left, connecting the control pin B to the tank, thus increasing the swash-plate tilt angle and increasing discharge flow. This equalizes the differential pressure and moves the L/S regulator spool back to the left.

(1) Discharge pressure P
(2) Control pin A
(3) Horsepower control spool
(4) Control pin B
(5) Horsepower control valve
(6) Horsepower control spring
(10) Spring
(11) Spool
(12) L/S Regulator
(13) Compensator spool
(14) Opening area

RY9212001HYM0039US0



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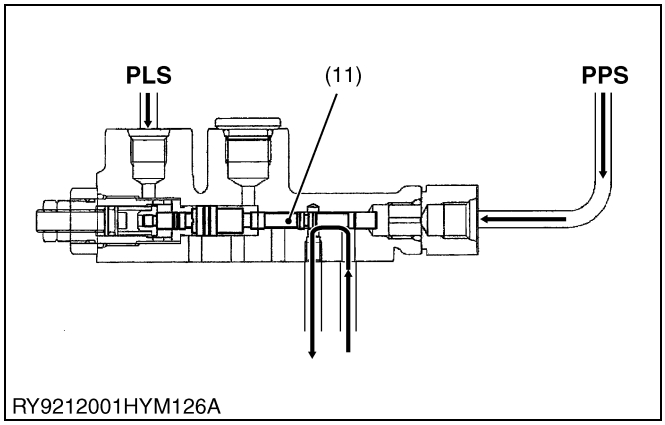


RY9212001HYM126A

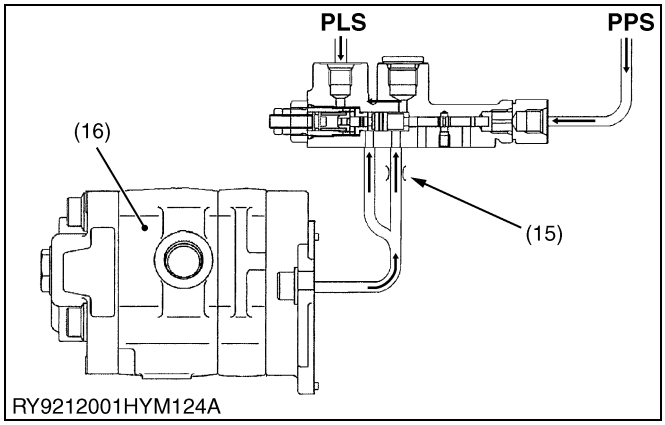
3. When the control valve is slightly open

By contrast, when the control valve is only slightly open, it produces a large difference in pressure between the pump discharge pressure P (1) and the load pressure, so the spool of the L/S regulator moves to the left and the discharge pressure P and control pin B (4) are connected. When this happens, it creates pressure on control pin B, thus reducing the swash-plate tilt angle and reducing the discharge flow. The pump discharge pressure is also connected to control pin A (2), but due to the difference in surface area, the swash-plate tilt angle is reduced.

(1) Discharge pressure P
(2) Control pin A
(3) Horsepower control spool
(4) Control pin B
(5) Horsepower control valve
(6) Horsepower control spring
(11) Spool
(12) L/S Regulator

RY9212001HYM0040US0

[E] Gain Control



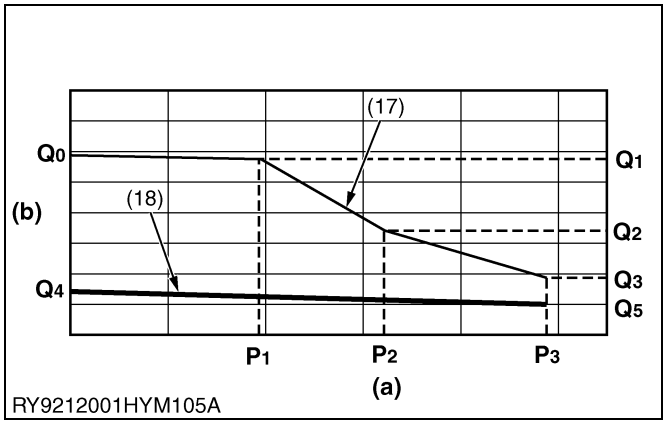
RY9212001HYM124A

There is an orifice (15) in the discharge circuit of the pilot pump (16) that leads to the spool of the L/S regulator for differential pressures that arise from acceleration in engine RPM. This orifice makes it possible to control pump discharge pressure and flows so that pump discharge pressure PPS = load pressure PLS + spring pressure + differential pressure. In other words, it changes the PPS and PLS differential pressure control from a constant control to a variable control and enables the proportional flow control of the engine RPM by how wide the same control valve is open.

(15) Orifice
(16) Gear pump (pilot pump)

RY9212001HYM0041US0

[F] Standby Flow Amount



RY9212001HYM105A

A standby flow volume is established so that oil is always flowing in the hydraulic system, even when idling. Because oil is always flowing to the oil cooler, it is possible to lower the oil temperature. The front end (AUX1, swivel, bucket, arm, boom) is in a center closed circuit, so when all the sections are in neutral, the operating oil returns to the tank via an unload valve.

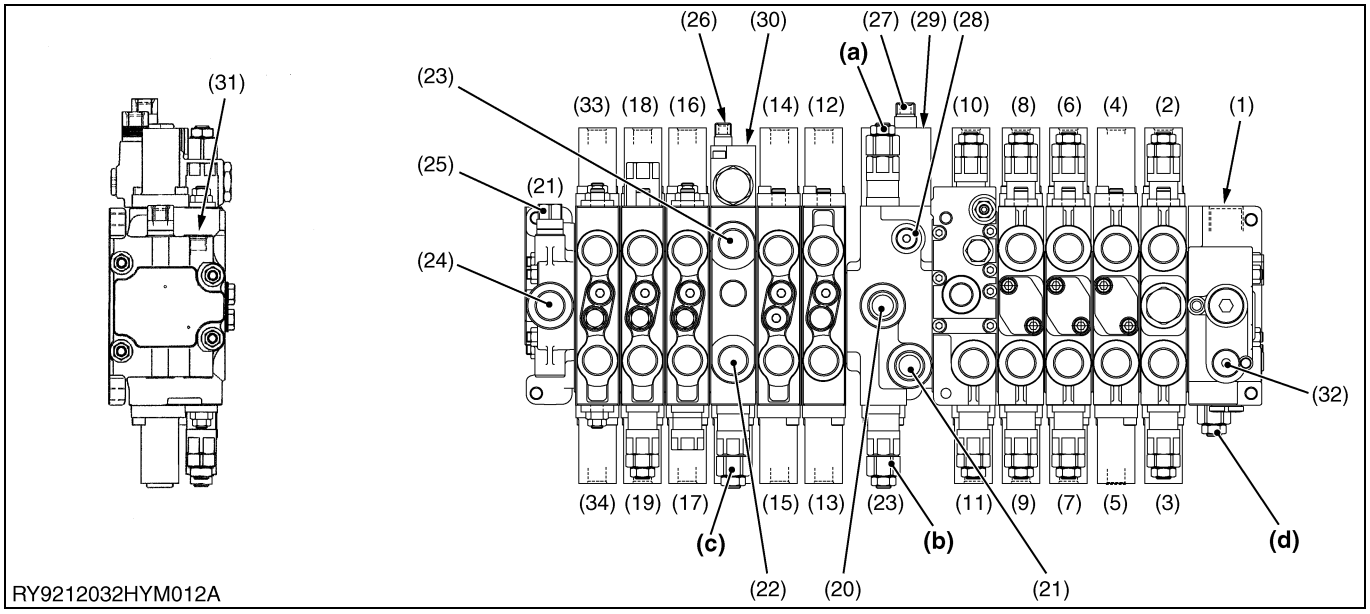
(17) Horsepower control curve
(18) Standby Flow Amount
(a) Discharge pressure
(b) Discharge flow

RY9212001HYM0042US0

5. CONTROL VALVE

[1] CONTROL VALVE

(1) Specifications



(1) T1 Port
(2) AUX1 (Pb1)
(3) AUX1 (Pa1)
(4) Swivel Right (Pb2)
(5) Swivel Left (Pa2)
(6) Bucket Bottom (Pb3)
(7) Bucket Rod (Pa3)
(8) Arm Bottom (Pb4)
(9) Arm Rod (Pa4)
(10) Boom bottom (Pb5)
(11) Boom Rod (Pa5)
(12) Travel Right Forward (Pb6)
(13) Travel Right Reverse (Pa6)
(14) Travel Left Forward (Pb7)
(15) Travel Left Reverse (Pa7)
(16) Swing Bottom (Pb8)
(17) Swing Rod (Pa8)
(18) Blade Rod (Pb9)
(19) Blade Bottom(Pa9)
(20) P1 Port
(21) P2 Port
(22) P3 Port
(23) T2 Port
(24) T3 Port
(25) PP1 Port
(26) PP2 Port
(27) PP3 Port
(28) PPS1 Port
(29) PF1 Port
(30) PF2 Port
(31) PAi Port
(32) PLS Port
(33) AUX2 (Pb10)
(34) AUX2 (Pa10)

(a) Main Travel Right Relief valve (aTR)
(b) Main Travel Left Relief valve (aTL)
(c) Main P3 Relief valve (aP3)
(d) Main LS Relief valve (aLS)

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Item		Unit		Notes
Maker			KYB	
Model			KVSX-14C-72	
Main relief valve pressure setting	P1 (aTR)	MPa kgf/cm^2 psi	26.5 270 3840	at 13 L/min (790 cu.in./min, 3.4 USGPM)
	P2 (aTL)	MPa kgf/cm^2 psi	26.5 270 3840	at 13 L/min (790 cu.in./min, 3.4 USGPM)
	P3 (aP3)	MPa kgf/cm^2 psi	19.1 195 2770	at 37 L/min (2300 cu.in./min, 9.8 USGPM)
	LS (aLS)	MPa kgf/cm^2 psi	27.4 280 3980	at 11 L/min (670 cu.in./min, 2.9 USGPM)
Unload LS valve pressure setting (aUN)		MPa kgf/cm^2 psi	2.55 26 370	at 23 L/min (1400 cu.in./min, 6.1 USGPM)
Overload relief valve pressure setting	AUX1 (2), (3)	MPa kgf/cm^2 psi	20.6 210 2990	at 5 L/min (300 cu.in./min, 1.3 USGPM)
	Bucket (6), (7)	MPa kgf/cm^2 psi	31.4 320 4550	at 5 L/min (300 cu.in./min, 1.3 USGPM)
	Arm (8), (9)	MPa kgf/cm^2 psi	31.4 320 4550	at 5 L/min (300 cu.in./min, 1.3 USGPM)
	Boom (10), (11)	MPa kgf/cm^2 psi	31.4 320 4550	at 5 L/min (300 cu.in./min, 1.3 USGPM)
	Blade (18)	MPa kgf/cm^2 psi	–	Anti-void valve
	Blade (19)	MPa kgf/cm^2 psi	27.4 280 3980	at 11 L/min (670 cu.in./min, 2.9 USGPM)

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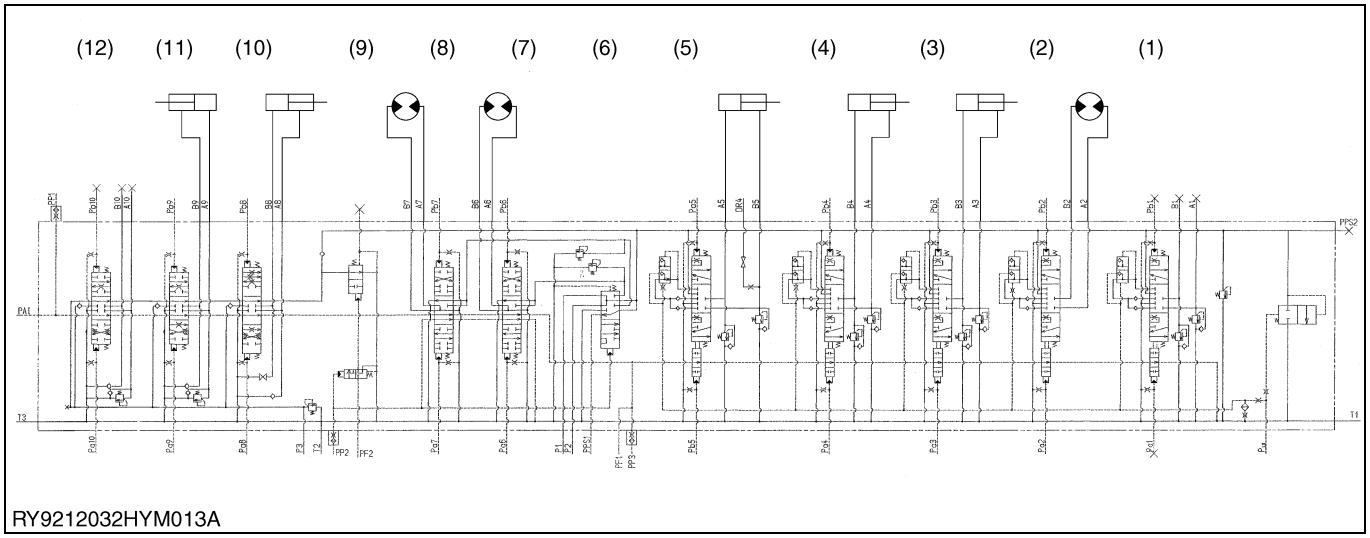
(2) Diagram of Hydraulic Circuit



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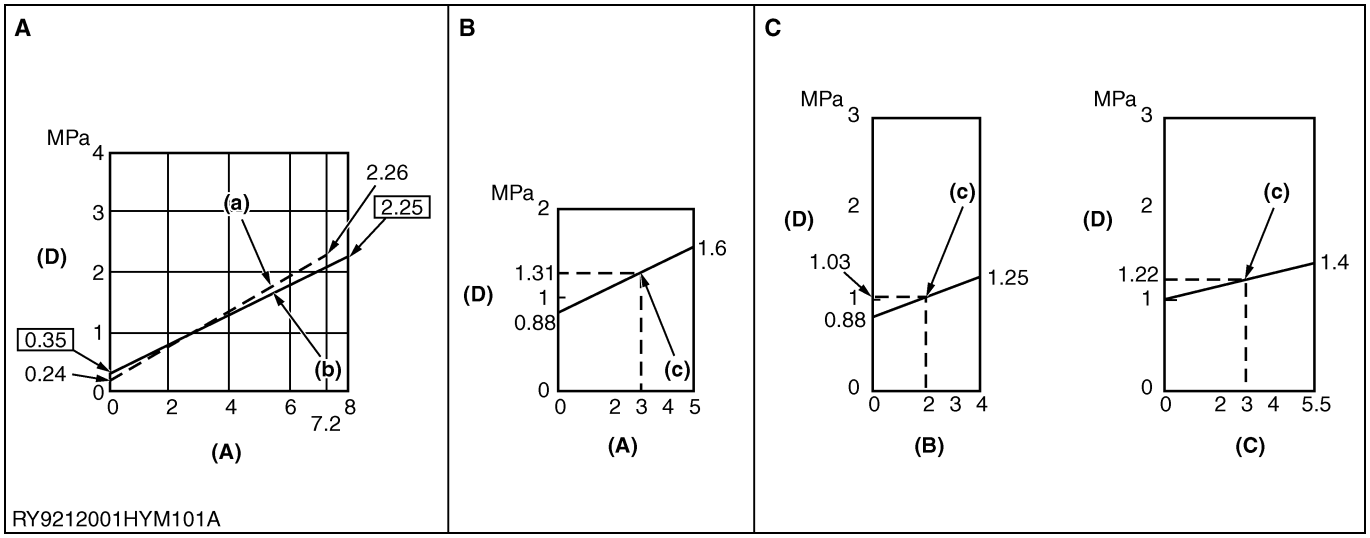

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(1) AUX1
(2) Swivel
(3) Bucket
(4) Arm
(5) Boom
(6) Independent travel valve
(7) Travel right
(8) Travel left
(9) Communication valve
(10) Swing
(11) Blade
(12) AUX2

A : Main spool pressure receiver characteristics
B : Independent travel valve
C : Communication valve

(A) Spool stroke (mm)
(B) Spool stroke (sub-spool) (mm)
(C) Spool stroke (main spool) (mm)
(D) Pilot pressure (MPa)

(a) Boom, arm, bucket, AUX1, swivel
(b) Travel, AUX2, swing, blade
(c) Spool closed

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(3) Function and Structure

[A] Diagram of independent travel circuit

When the travel lever is operated, the hydraulic oil from pumps P1 and P2 passes through the independent travel valve and the oil from P1 is supplied to the travel right motor while the oil from P2 goes to the travel left motor.

When a front-end operation (AUX1, swivel, boom, arm or bucket) is executed at the same time, oil from the gear pump P3 is supplied to the front (AUX1, swivel, boom, arm or bucket), so there is little change in speed and the mini-excavator harnesses a great deal of horsepower for traveling.

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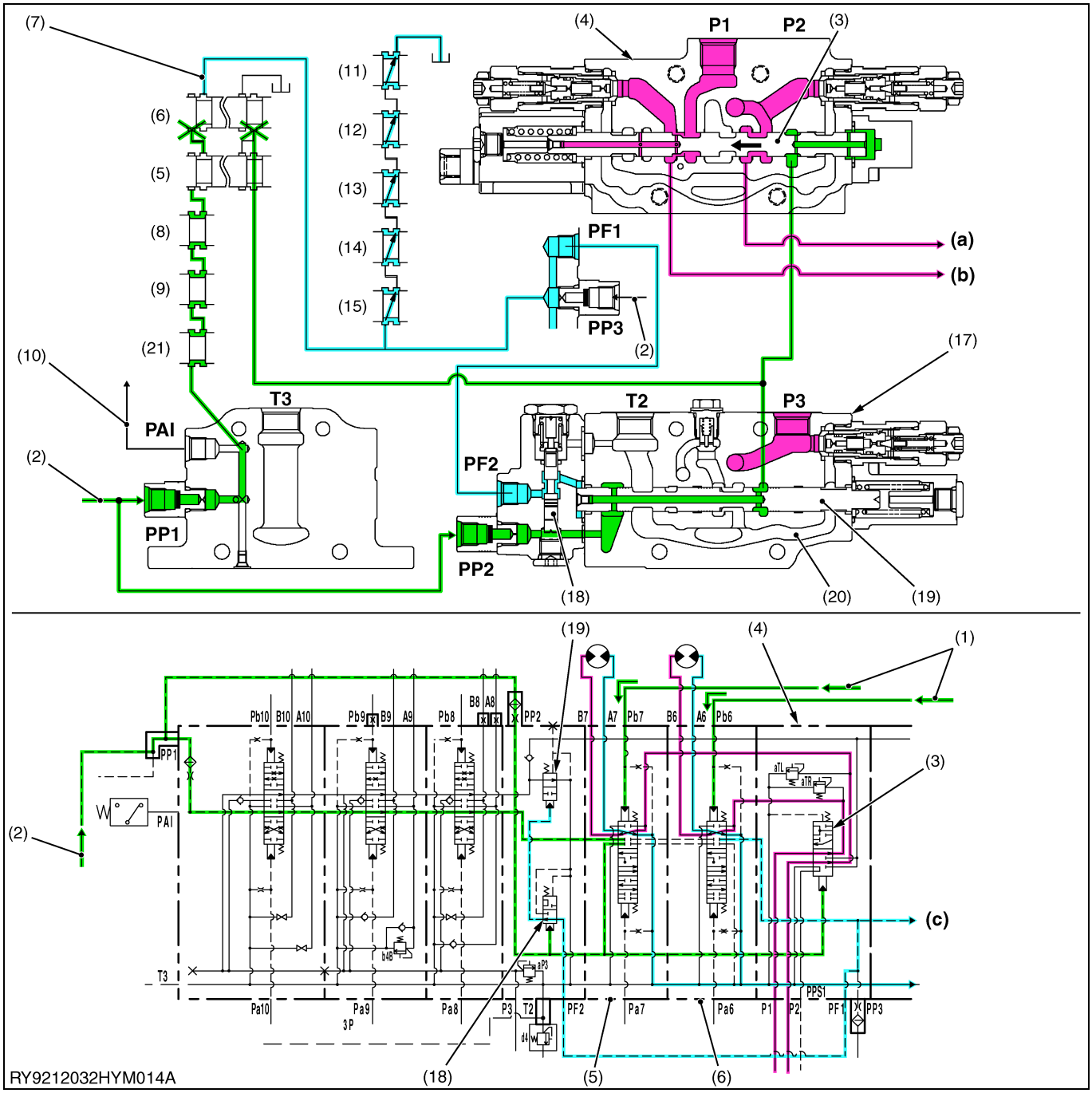
[B] When traveling independently (operation of left/right forward travel)



(1) Pilot pressure
(2) Pilot pressure
(3) Independent travel valve spool
(4) Independent travel valve section
(5) Travel left section
(6) Travel right section
(7) Main spool signal passage section
(8) Swing
(9) Blade
(10) PAI port differential pressure
(11) AUX1
(12) Swivel
(13) Bucket
(14) Arm
(15) Boom
(17) Communication valve section
(18) Communication valve sub-spool
(19) Communication valve spool
(20) Tank circuit
(21) AUX2

(a) To travel left section
(b) To travel right section
(c) To tank

When forward travel is initiated, the pilot pressure (1) from the pilot valve presses the main spool for right/left travel down, as in the circuit diagram.

The pilot pressure (2) from the pilot pump is cut off by the travel left section (5), which raises the pressure inside the pilot circuit and causes the independent travel spool (3) to be pressed upwards, as in the circuit diagram.

As a result, the oil from the P1 pump is supplied to the travel right section (6) and the oil of the P2 pump goes to the travel left section (6).

That being the case, the communication valve sub-spool (18) is pressed upwards, as in the diagram, but the pilot circuit is linked to the hydraulic oil tank, so the communication valve spool (19) does not switch.

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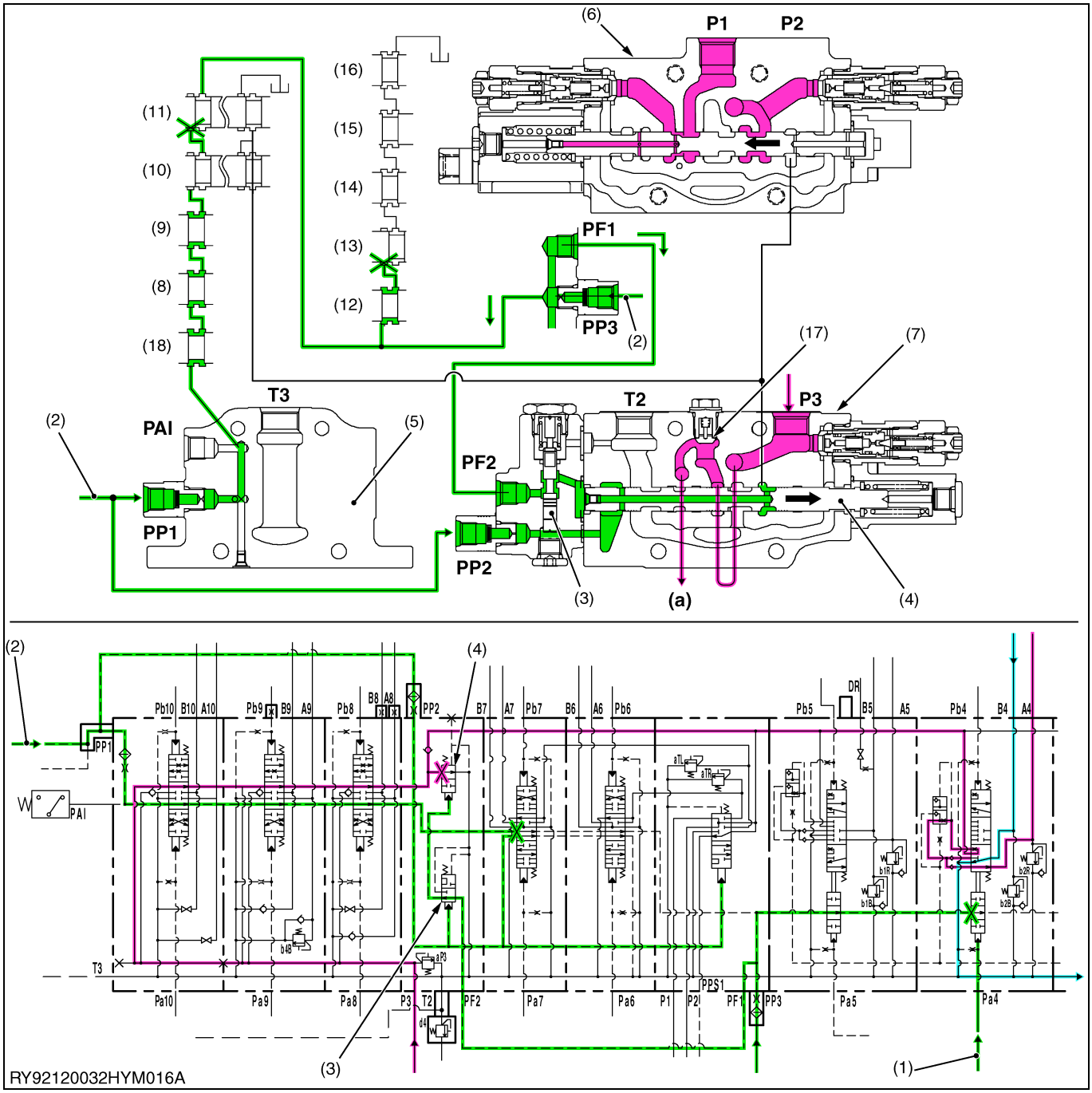
[C] When operating multiple functions (travel and front-end operation(s))



(1) Arm dump
(2) Pilot pressure
(3) Communication valve sub-spool
(4) Communication valve spool
(5) Outlet section
(6) Independent travel valve section
(7) Communication valve section
(8) Blade
(9) Swing
(10) Travel left
(11) Travel right
(12) Boom
(13) Arm
(14) Bucket
(15) Swivel
(16) AUX1
(17) Check valve
(18) AUX2

(a) Front (AUX1, swivel, bucket, arm and boom) section

(To be continued)

(Continued)

When travel and front-end operations (AUX1, swivel, boom, arm and bucket) are executed at the same time, the travel is supplied by oil from pumps P1 and P2, while front operations are supplied by oil from pump P3. Refer to section [B] "When traveling independently" for information on oil flow for traveling. If a front-end operation (arm dump (1) operation for example) is initiated while traveling or traveling is initiated while operating the front-end, the pilot pressure (2) passes through PF1 and is cut off by the arm section, so the pilot pressure passes through the communication valve sub-spool (3) and presses the communication valve spool (4) upwards, as in the circuit diagram.

Once the communication valve spool is pressed, the oil from pump P3 is cut off by the communication valve spool and unable to return to the tank, the oil flows to the front-end operation section (arm dump for example).

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[D] Front-end Operation

During front-end operations (AUX1, swivel, boom, arm or bucket) the LS control functions.

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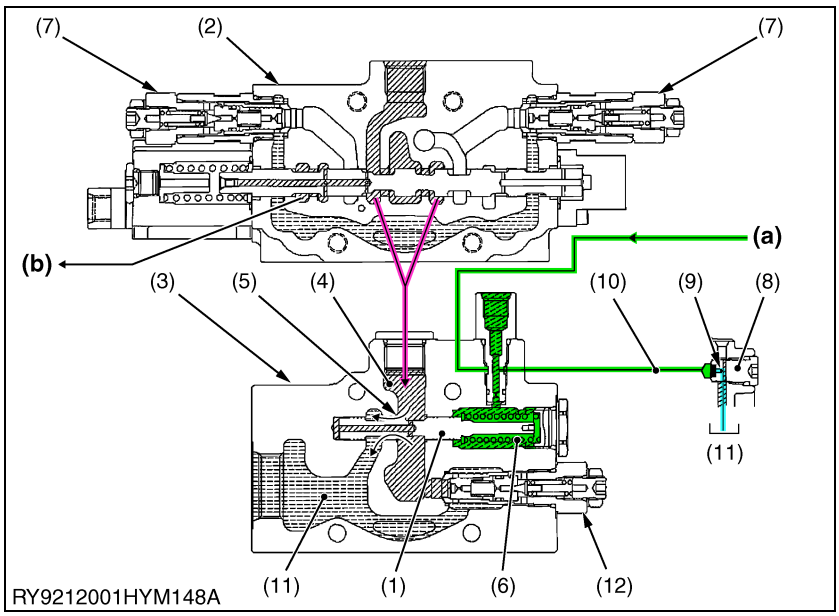
Unload LS Valve

- When spool is in neutral
- When spool is under fine control (unload LS valve control)



(1) Unload LS spool
(2) Independent travel valve section
(3) Outlet section
(4) PPS
(5) Notch
(6) Unload LS valve spring chamber
(7) Main travel relief valve
(8) LS drain plug
(9) Micro orifice
(10) PLS pressure passage
(11) Tank line
(12) Main LS relief valve

(a) PLS passage
(b) To variable pump

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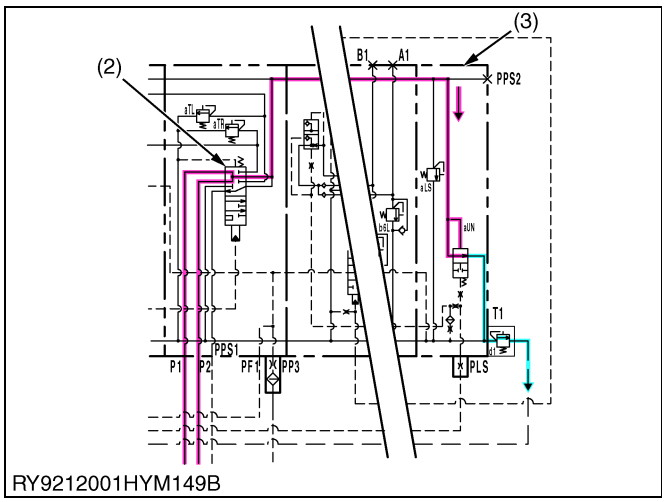

When main spool is in neutral

- When the main spool is in neutral, no load pressure PLS is generated, so the PLS pressure does not work on the unload LS spool (1).
- The oil from pumps P1 and P2 come together inside the independent travel valve (2) and is guided to the outlet section (3) via each valve section, but it is dead-ended by the pump's LS controller so the pump pressure PPS (4) rises.
- The pump pressure PPS rises until it reaches the pressure setting of the unload LS valve, at which point the unload LS spool (1) moves to the right and the hydraulic oil passes through the notch (5) and returns to the hydraulic oil tank.
- The discharge flow of the pump when the main spool is in neutral is controlled by the pressure setting of the unload LS valve. (Standby Flow Amount)

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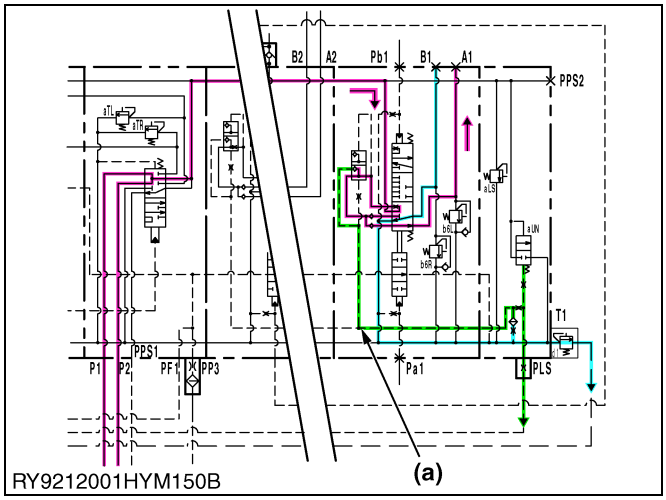

When main spool is under fine control (unload LS control)

When the main spool moves (fine control), the hydraulic oil from the pump is channeled to the acutator. (For example, to A1)

On the other hand, the load pressure on the actuator passes through the PLS line **(a)** and operates the unload LS valve spring chamber (6).

When the main spool is under fine control, the opening at the spool is small, so the pressure differential between PPS and PLS becomes great.

The pressure differential increases until it reaches the pressure setting of the unload LS valve, at which point the unload LS spool (1) moves to the right, the opening of the notch between the pump pressure passage and the tank line is adjusted automatically, thus maintaining a constant differential pressure between PPS and PLS.

Consequently, even if the load changes, the differential pressure between PPS and PLS is maintained constantly.

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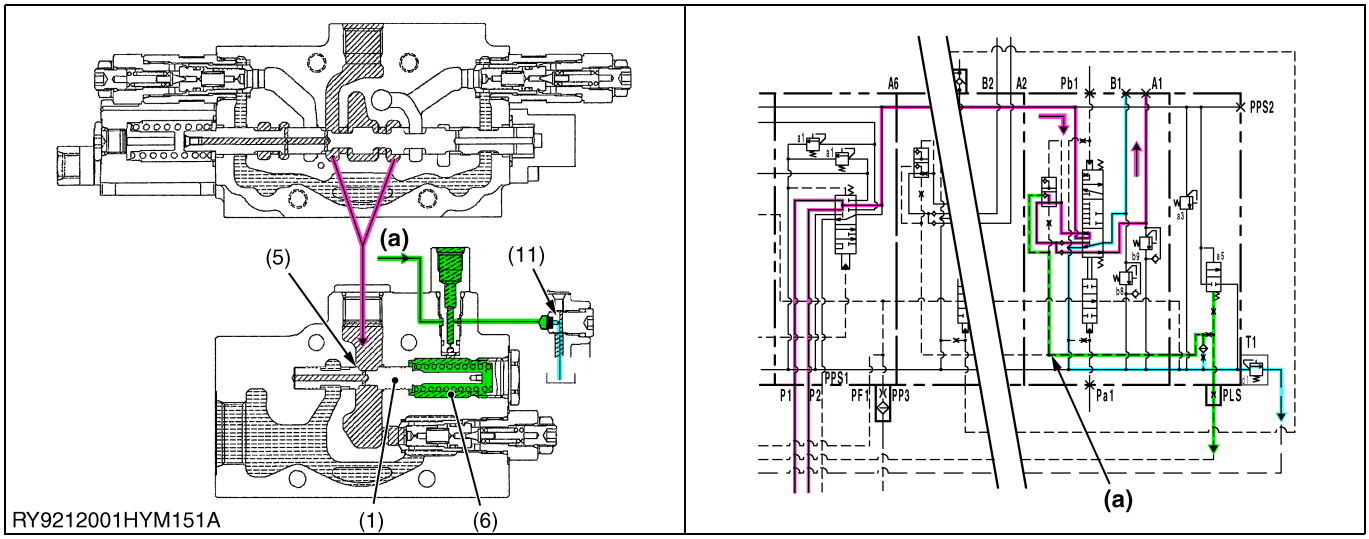
- When spool is operating normally (pump operating)



(1) Unload LS spool
(5) Notch
(6) Unload LS valve spring chamber
(11) Micro orifice
(a) PLS passage

When the main spool moves, the hydraulic oil from the pump is channeled to the acutator. (For example, to A1)

On the other hand, the load pressure on the actuator passes through the PLS line **(a)** and operates the unload LS valve spring chamber (6).

When the stroke of the main spool is large, the opening of the spool also becomes large and the pressure differential between PPS and PLS becomes small. When the differential pressure drops below the pressure setting of the unload LS valve, the unload LS spool (1) moves to the left, closing off the notch (5). Furthermore, the differential pressure drops and once it drops to the pump's LS control differential pressure setting (refer to the pump's chapter), the pump's swash-plate tilt angle becomes large and it causes an increase in the pump's discharge.

In order to prevent pressure from getting pent up in the PLS circuit in cases such as when the operator releases the control lever, some of the hydraulic oil in the PLS circuit is released via the orifice (11) back to the tank.

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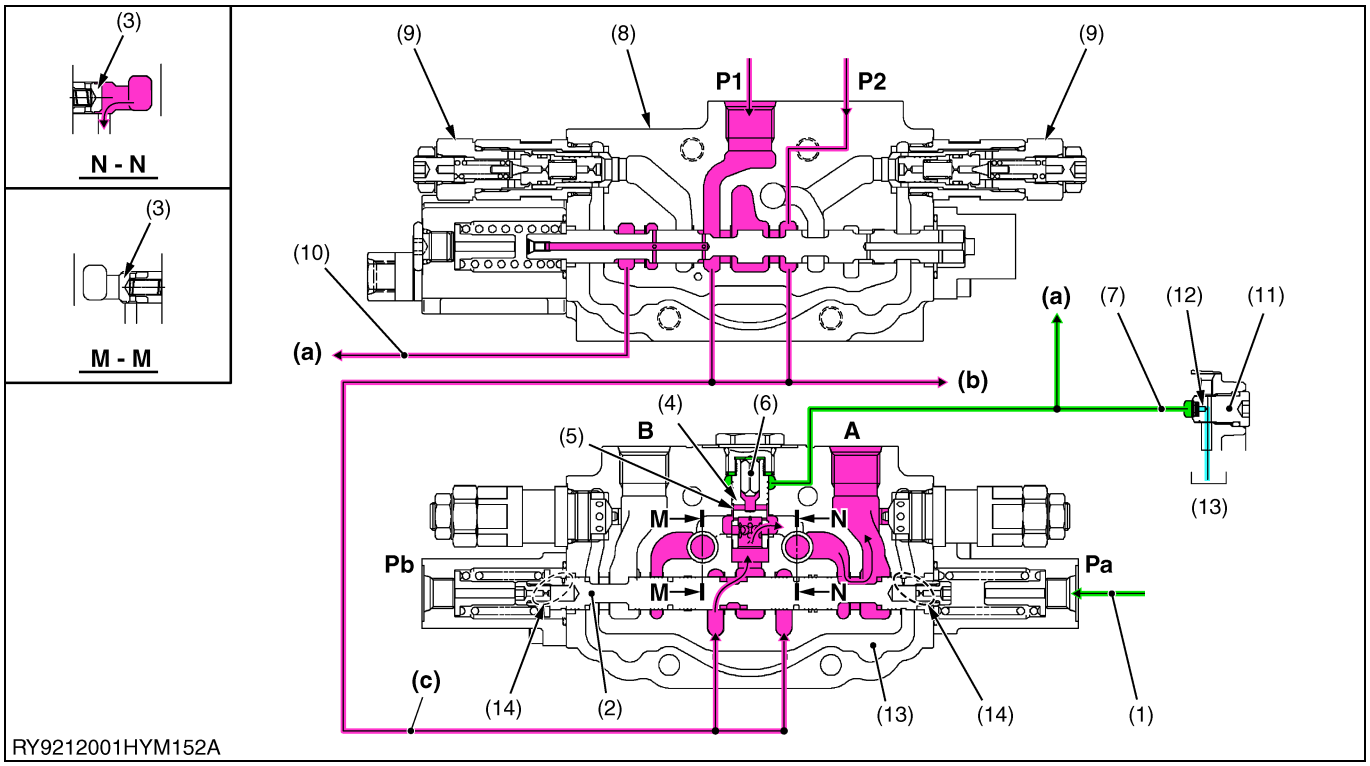
High Pressure Selection Function

- When operating independently (when an AUX1 Pa port has been added, for example)



(1) Pilot pressure
(2) Main spool
(3) Load check poppet
(4) Control spool
(5) LS pressure inlet orifice
(6) Shuttle poppet
(7) PLS pressure passage
(8) Independent travel valve section
(9) Main travel relief valve
(10) PPS pressure
(11) LS drain plug
(12) Micro orifice
(13) Tank line
(14) Air bleed micro-orifice
(a) To variable pump
(b) From unload LS valve to tank line
(c) Pump passage

When the pilot pressure (1) operates the Pa port, it moves the main spool (2) to the left and the pressurized oil from the pump passes through the Pc notch in the main spool and then the pressurized oil flows through the C notch of the compensator spool (pressure compensator valve), the right side load check (3) and the LSC notch and then from port A to the actuator.

Part of the oil that passed through the Pc notch goes through the LS pressure inlet orifice (5) of the compensator spool (4), pushing up the shuttle poppet (6), passing through the PLS pressure passage (7) and to the variable pump as the PLS pressure.

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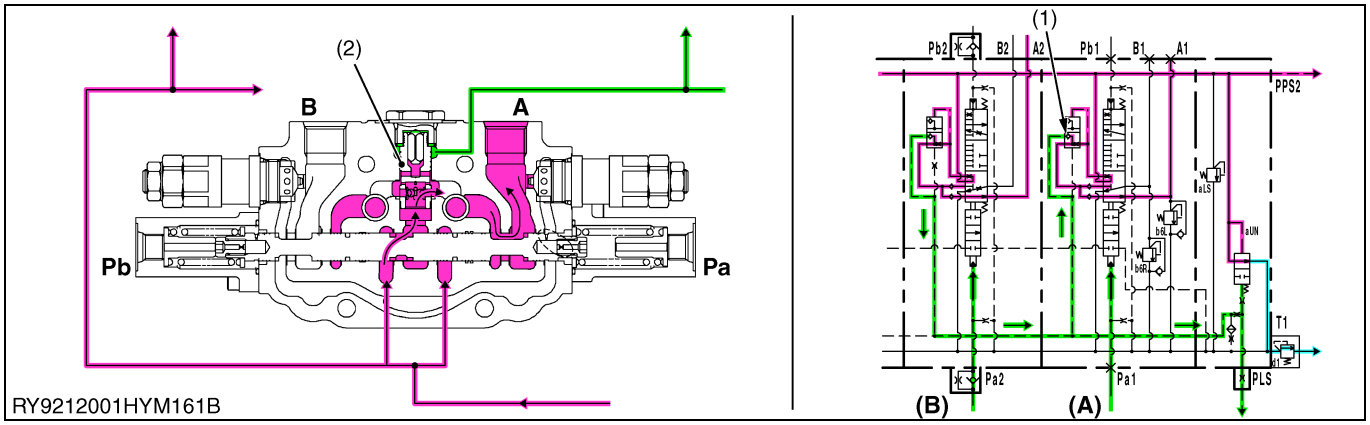
When operating multiple functions (when using AUX1 and swiveling, for example)



(1) High pressure selection location
(2) Compensator spool
(A) AUX1
(B) Swivel

When AUX1 **(A)** and swivel **(B)** are operated at the same time, if the pressure load of swiveling is higher than that of AUX1, the load pressure of swiveling is selected as the PLS pressure.

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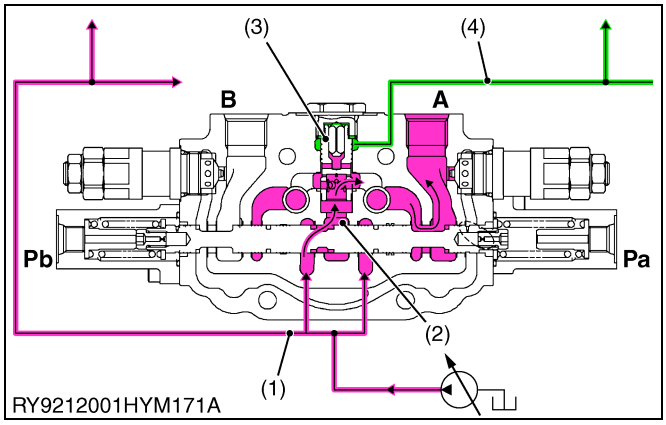
[E] Compensator Spool (pressure compensator valve)



When operating independently

The hydraulic oil passes through the pump pressure passage (1), the PC passage (2) and the compensator spool (3) and is guided to the top of the compensator spool as the PLS pressure (4). When operating independently, the PC passage pressure acts as the load pressure, so the compensator spool is adjusted to a position that matches this pressure.

When operating multiple functions

- Sections with a heavy load pressure
  The load pressure of such a section is selected as the PLS pressure (4), so it operates the same way as with independent operation.
- Sections with a light load pressure
  The load pressure of a section with a heavy load pressure is selected as the PLS pressure (4) and the swash-plate is controlled by this PLS pressure (4), so an almost identical pressure is exerted on each section of PC passage pressure.
  The difference between the PC passage pressure and the load pressure of a section with a low load pressure is generated by the orifice built into the compensator spool (3), the compensator spool (3) moves to the position where the differential pressure is balanced (when the compensator spool (3) is down, the total area of the compensator spool's orifice is small, so the difference between PC passage pressure and load pressure becomes great).
  As a result, even if the load pressures of two sections are different, the compensator spool (3) works to equalize pressure so an almost identical pressure exists in the PC passage, thus changes in load are not received and a flow is obtained simply by the size of the opening in the spool.

(1) Pump pressure passage
(2) PC passage
(3) Compensator spool
(4) PLS pressure

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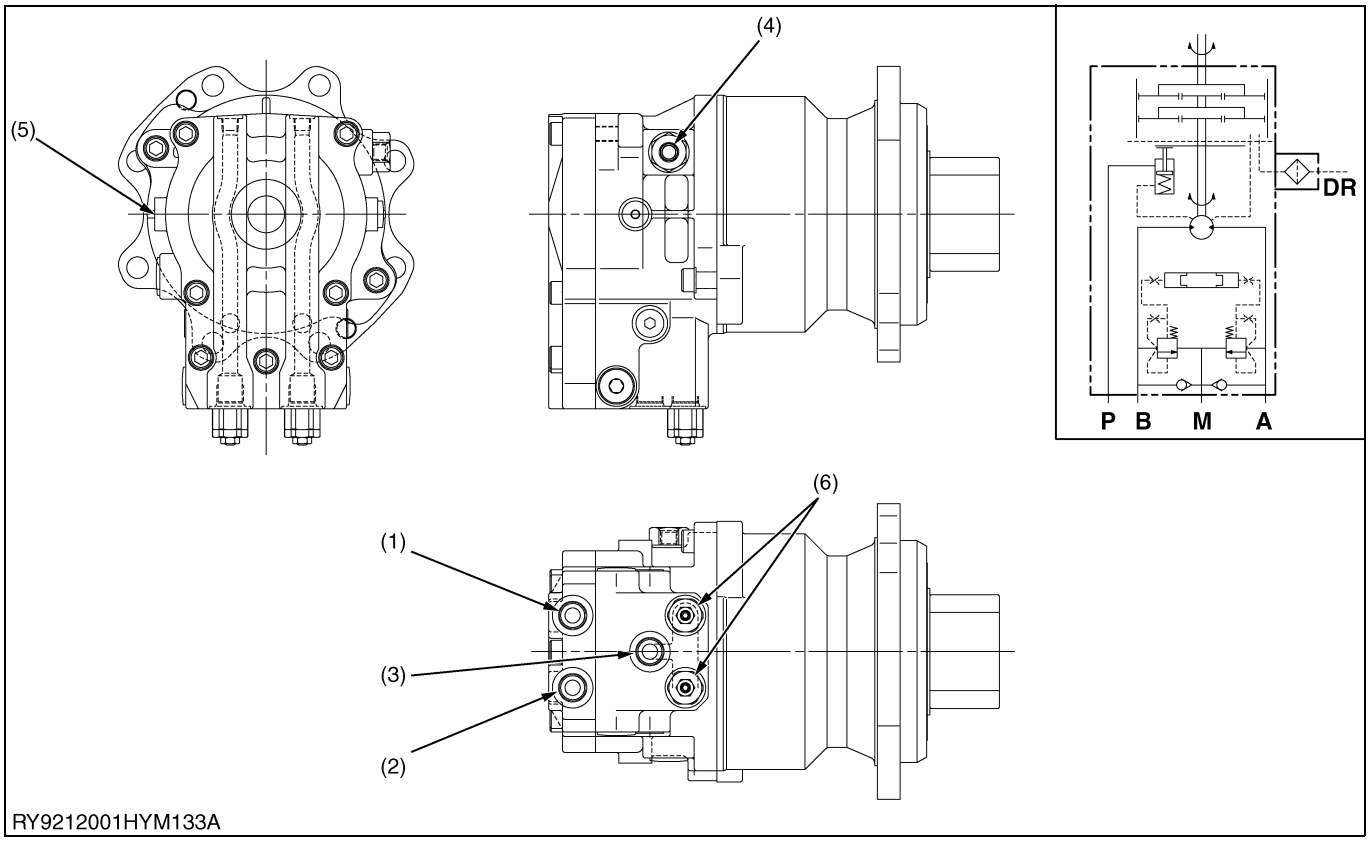
6. SWIVEL MOTOR

[1] SWIVEL MOTOR

(1) Specifications



(1) Port A
(2) Port B
(3) Make-up port
(4) Drain port
(5) Pilot port (parking brake)
(6) Relief valve

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Item	Unit		Notes
Maker		Kubota Seiki	
Model		SM29G2	
Motor Displacement	cc/rev cu.in./rev	29.271 1.786	
Reduction Ratio		21.263	
Total Displacement	cc/rev cu.in./rev	622.4 37.98	
Max Flow	L/min cu.in./min	41.0 2500	
Theoretical RPM	rpm	65.9	
Relief Valve Brake Pressure	MPa kgf/cm^2 psi	20.6 210 2990	at 41 L/min (2500 cu.in./min, 10.8 USGPM)
Mechanical Brake Torque	N·m kgf·m lbf·ft	2040 208.0 2958	
Parking Brake Release Pressure	MPa kgf/cm^2 psi	1.5 ≥ 15 ≥ 220 ≥	

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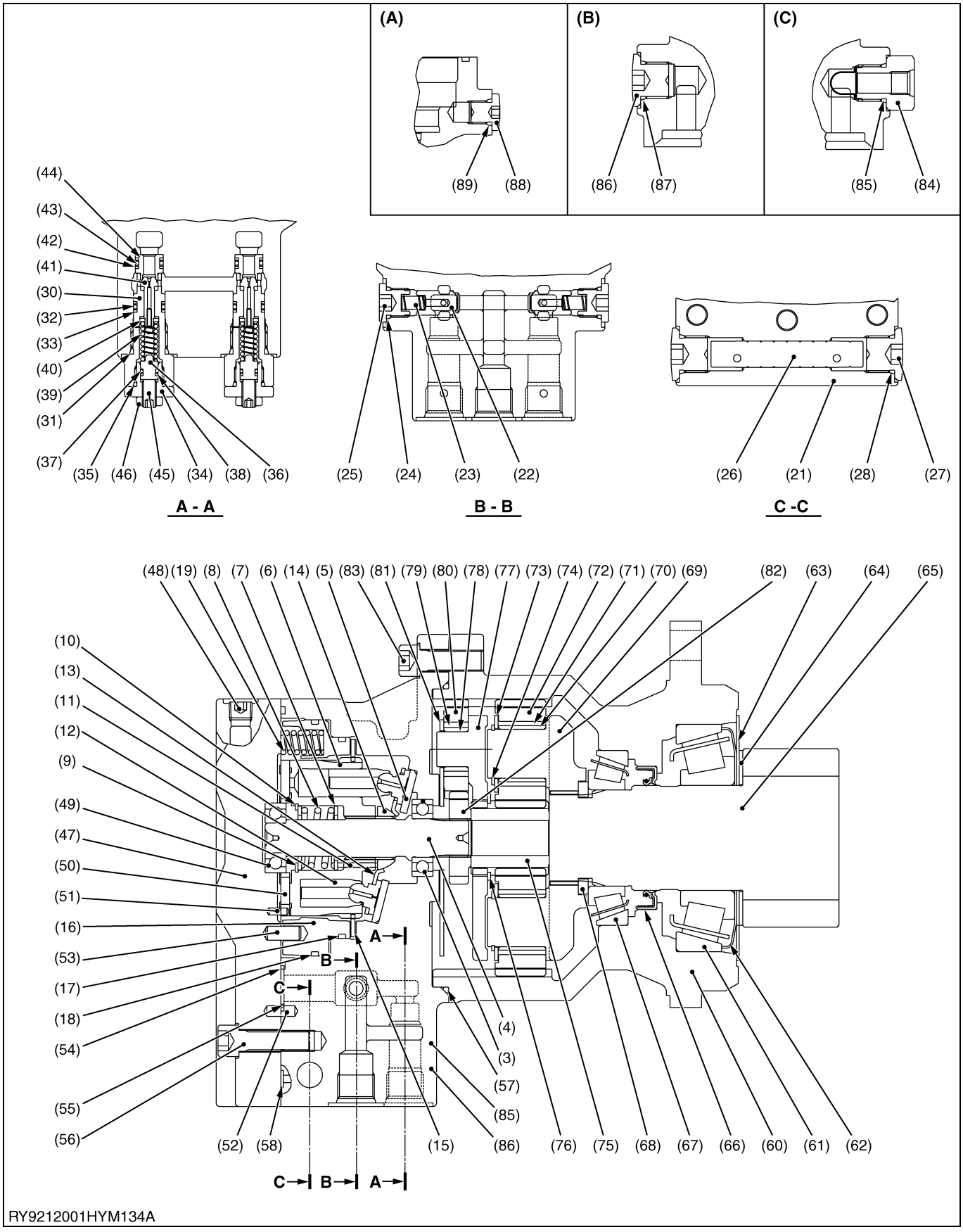
(2) Components



(A) Plug parts (1) **(B) Plug parts (2)** **(C) Drain parts**

No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Motor ASSY (with valves)	1	(2),(20), (47) to (57)	(46)	Nut	2	
(2)	Motor ASSY	1	(3) to (19),(58)	(47)	Cover (motor)	1	
(3)	Ball bearing	1		(48)	Plug (R1/4)	2	
(4)	Shaft	1		(49)	Ball bearing	1	
(5)	Thrust plate	1		(50)	Plate (valve)	1	
(6)	Cylinder block (swivel)	1		(51)	Parallel pin	1	
(7)	Metal washer (spring)	1		(52)	Parallel pin	2	
(8)	Spring CY	1		(53)	Parallel pin	2	
(9)	Metal washer (spring)	1		(54)	O-Ring	1	
(10)	Internal circlip	1		(55)	O-Ring	2	
(11)	Pin	1		(56)	Hex socket bolt	7	
(12)	Piston ASSY	9		(57)	O-Ring	1	
(13)	Plate (retainer)	1		(58)	O-Ring	2	
(14)	Holder (retainer)	1		(59)	Gear case ASSY (swivel)	1	(60) to (82)
(15)	Plate (friction)	1		(60)	Gear case	1	
(16)	Piston (brake)	1		(61)	Tapered roller bearing	1	
(17)	O-Ring	1		(62)	Plate (valve)	1	
(18)	O-Ring	1		(63)	Plate (pinion)	1	
(19)	Spring (NB)	12		(64)	Plate (pinion 2)	1	
(20)	Valve ASSY (swivel)	1	(21) to (46)	(65)	Shaft (pinion)	1	
(21)	Housing (motor and valves)	1		(66)	Oil Seal	1	
(22)	Poppet	2		(67)	Tapered roller bearing	1	
(23)	Compression spring	2		(68)	Spacer	2	
(24)	Plug	2		(69)	Holder (2)	1	
(25)	O-Ring	2		(70)	Collar (2)	4	
(26)	Piston (shockless)	1		(71)	Needle bearing	4	
(27)	Plug (G1/2)	2		(72)	Gear (planetary 2)	4	
(28)	O-Ring	2		(73)	Plate (thrust 2)	4	
(29)	Valve ASSY (relief)	2	(30) to (46)	(74)	External circlip	4	
(30)	Housing (relief)	2		(75)	Gear (sun)	1	
(31)	O-Ring	2		(76)	External circlip	1	
(32)	O-Ring	2		(77)	Holder (1)	1	
(33)	Ring (backup)	2		(78)	Collar (1)	3	
(34)	Plug (relief)	2		(79)	Needle bearing	3	
(35)	O-Ring	2		(80)	Gear (planetary 1)	3	
(36)	Guide (spring)	2		(81)	Plate (thrust)	1	
(37)	O-Ring	2		(82)	Gear (drive)	1	
(38)	Ring (backup)	2		(83)	Hex socket bolt	2	
(39)	Compression spring	2		(84)	Filter	1	
(40)	Ring (spring seat)	2		(85)	O-Ring	1	
(41)	Poppet	2		(86)	Plug (G1/2)	1	
(42)	Ring (Poppet seat)	2		(87)	O-Ring	1	
(43)	O-Ring	2		(88)	Plug (G1/4)	1	
(44)	Backup ring	4		(89)	O-Ring	1	
(45)	Set screw	2					

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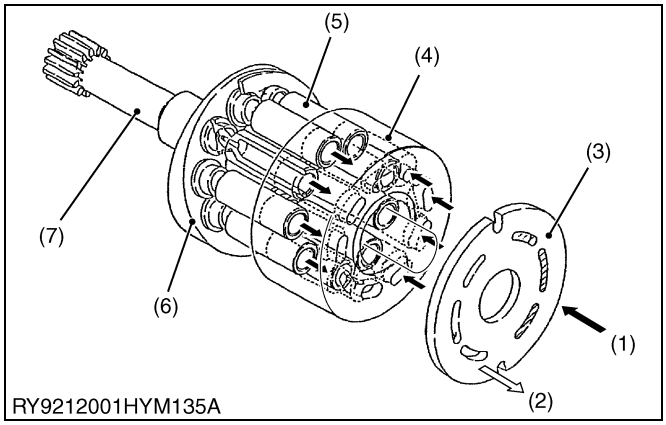
(3) Function and Structure

[A] Operating Principles



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The pressurized oil from port A (1) goes through valve plate (3), enters piston (5) inside cylinder block (4) and presses against the swash-plate (6). The pistons receive the counterforce from the swash-plate, part of which becomes rotational force, and the block rotates due to the sum total of the rotational forces exerted by the pistons that the hydraulic oil entered. The cylinder block and the shaft (7) are linked via a spline, so rotation is transferred to the shaft.

When in reverse, hydraulic oil flows in via port B (2) and is discharged via port A.

(1) Port A
(2) Port B
(3) Valve plate
(4) Cylinder block
(5) Piston
(6) Swash plate
(7) Shaft

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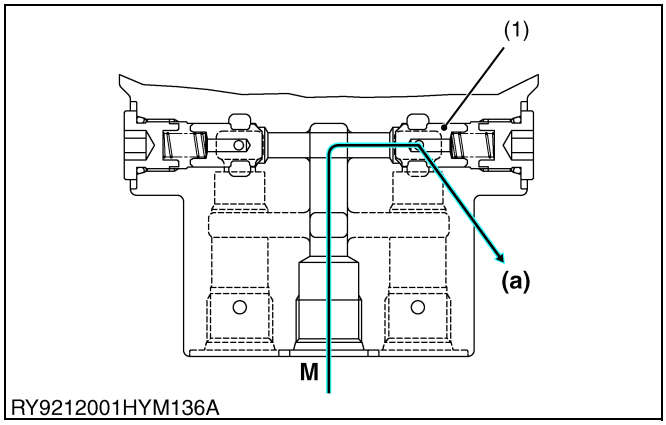
[B] Make Up Circuit



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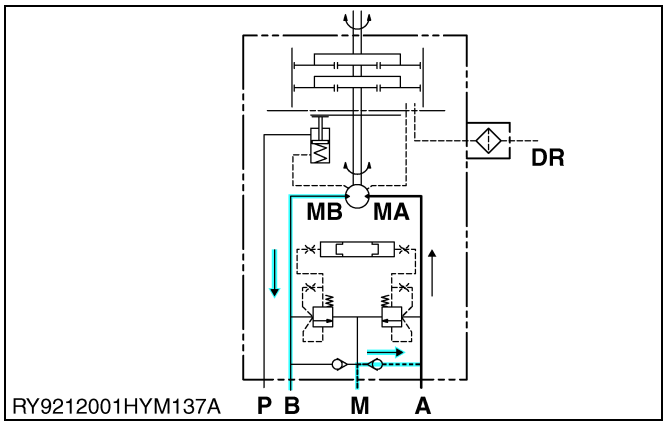

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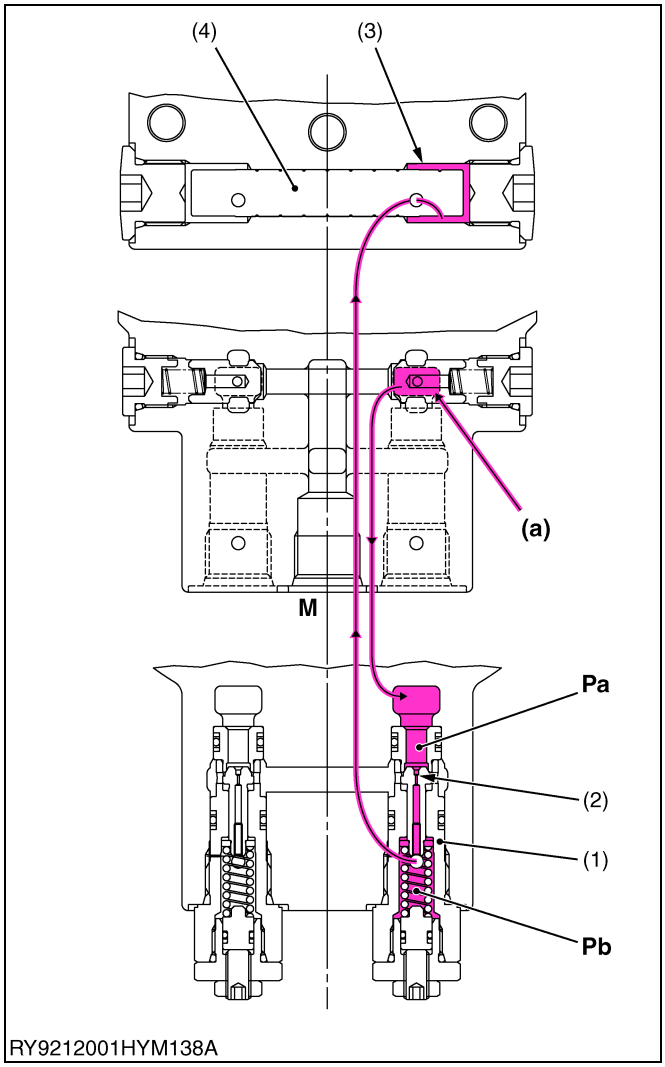
If the swivel is decelerated with the pressurized oil supplied via port A, the motor rotates due to the inertia of the swiveling equipment, and the motor drives the pump. As a result, the load shifts to the port A side.

In order to prevent this, the oil on the return side passes through the poppet (1) in the make up circuit and is supplied to the port A side.

(1) Poppet
(a) To motor MA circuit

RY9212001HYM0067US0

[C] Shockless Valves



RY9212001HYM138A

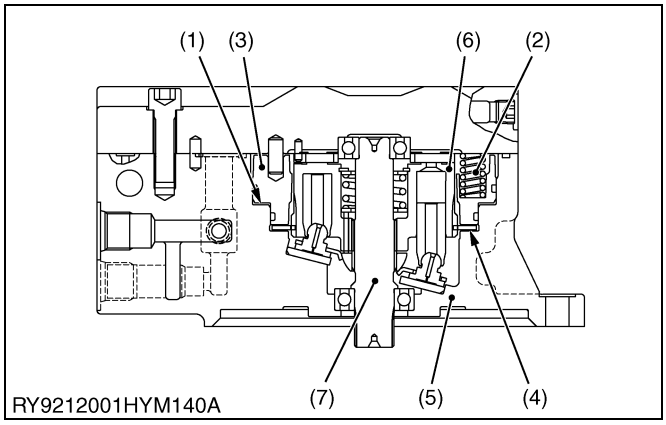
- At start up and shutdown, the oil that has flowed into port A passes through the orifice (2) of the relief valve (1) and into chamber A (3). At such time, the Pa pressure > Pb pressure, so the relief valve operates at a pressure lower than its pressure setting. (Primary relief pressure)
- When piston (4) reaches the left side as in the diagram, the pressure in chamber A rises, so Pa=Pb. For this reason, the relief valve operates at the pressure setting. (Secondary relief pressure)
- Because of this, the system can suppress dramatic changes in pressure and can mitigate the shock of starting up and stopping the equipment.

(1) Relief valve
(2) Orifice
(3) Chamber A
(4) Piston

(a) From port A

RY9212001HYM0068US0

[D] Parking Brake



1. When the parking brake is operated

When the unload lever is raised, the oil in the brake piston chamber (1) passes through the unload valve and returns to the hydraulic oil tank, thus allowing the force of the spring (2) to press the brake piston (3) downwards, as in the diagram.

As a result, the friction plate (4) is squeezed between the brake piston and the case (5), and the friction prevents any rotation.

The friction plate and the cylinder block (6), the cylinder block and the shaft (7) are coupled via a spline, so the motor (shaft) will not rotate.

2. When the parking brake is released

When the unload lever is lowered, the oil from the pilot pump passes through the unload valve and flows into the brake piston chamber, overpowering the spring and pressing the brake piston upwards, as in the diagram.

By doing so, the friction of the friction plate is released and the motor (shaft) rotates.

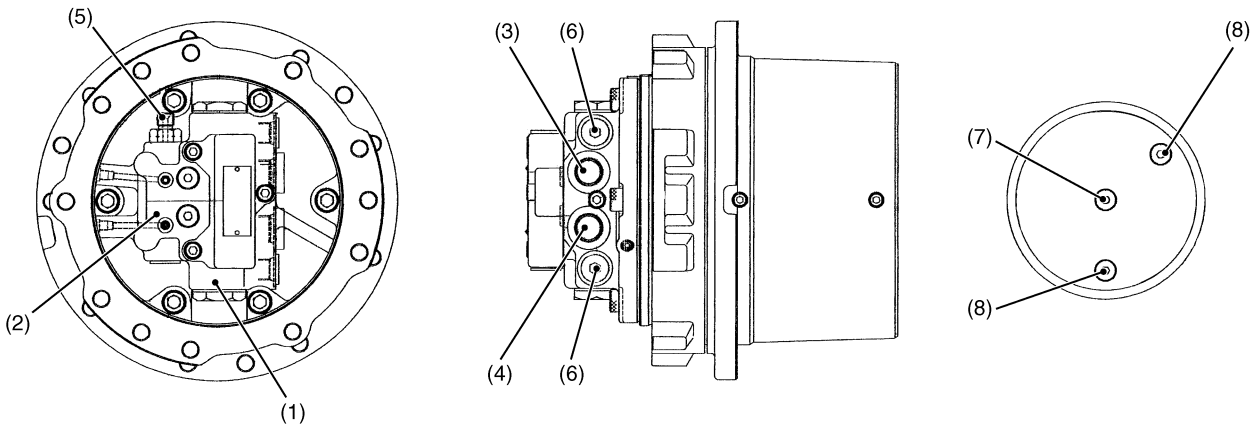
(1) Brake piston chamber
(2) Spring
(3) Brake piston
(4) Friction plate
(5) Case
(6) Cylinder block
(7) Shaft

RY9212001HYM0069US0

7. TRAVEL MOTOR

[1] TRAVEL MOTOR

(1) Specifications



RY9212001HYM063B

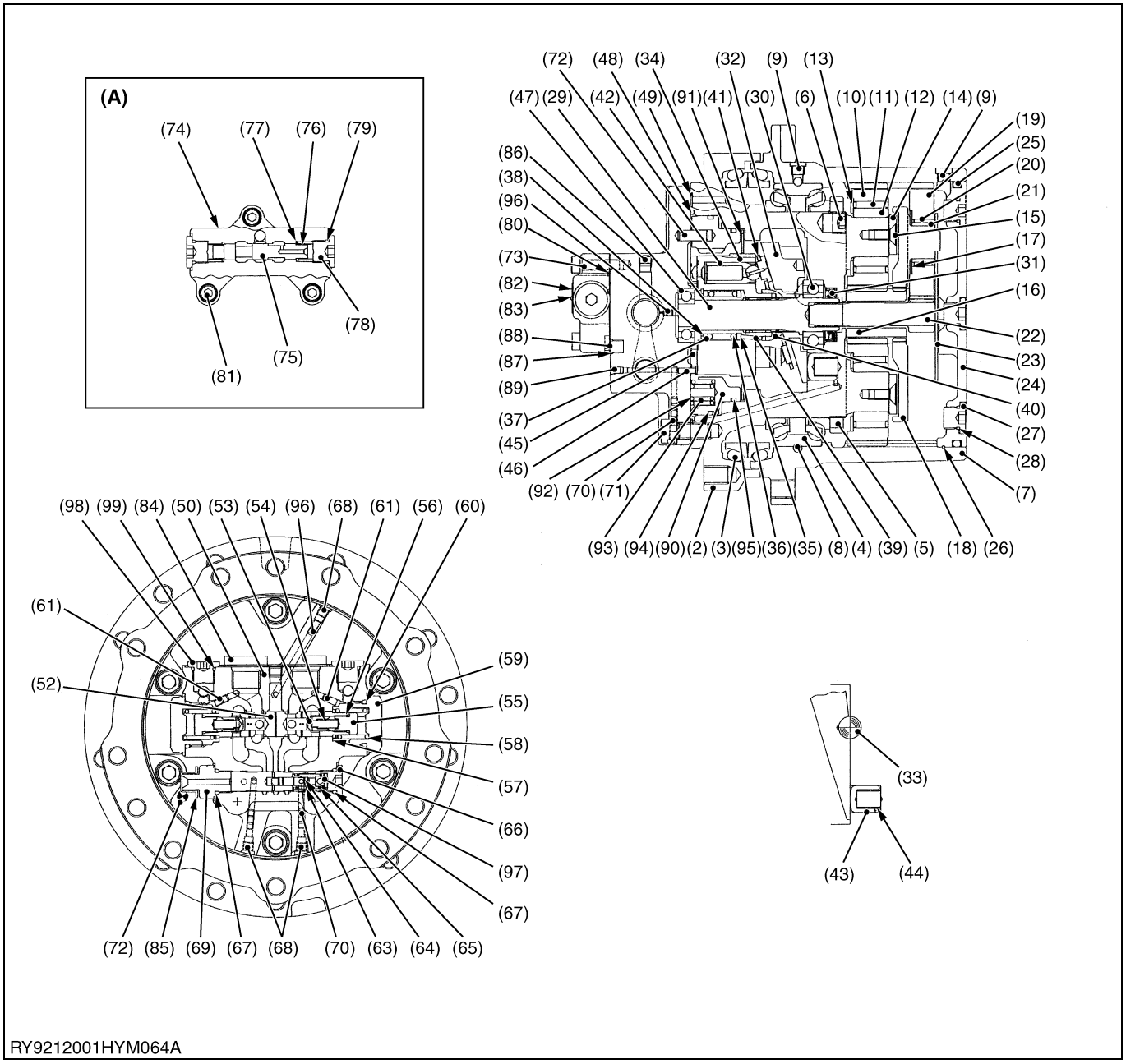
(1) Counterbalance valve/ anticavitation valve
(2) Travel 2-speed/travel automatic reduction
(3) Port P1 (G1/2)
(4) Port P2 (G1/2)
(5) Port PS (G1/4) (2-speed travel switch)
(6) Drain port (G1/4)
(7) Oil inspection port
(8) Oil fill drain port

RY9212032HYM0013US0

Item		Unit	
Maker			KYB
Model			MAG-33VP-650F-4
Total displacement 1-speed/2-speed		cc/rev cu.in./rev	1674 / 943 102.2 / 57.5
Motor displacement 1-speed/2-speed		cc/rev cu.in./rev	28.4 / 16.0 1.73 / 0.98
Reduction Ratio			1 : 58.943
Max Pressure		MPa kgf/cm^2 psi	26.5 270 3840
Rated Flow		L/min cu.in./min USGPM	56.1 3420 14.8
Theoretical RPM 1-speed/2-speed		rpm	33.5 / 59.5 at 56.1 L/min (3420 cu.in./min, 14.8 USGPM)
Theoretical Torque Output 1-speed/2-speed		N·m kgf·m lbf·ft	7060 / 3980 719.9 / 405.8 5207 / 2935 at 26.5 MPa (270 kgf/cm^2 , 3840 psi)
Parking Brake Control Torque		N·m kgf·m lbf·ft	4456 454.4 3287
Parking Brake Release Pressure		MPa kgf/cm^2 psi	1.2 12.2 174
Auto 2-speed Control Pilot Pressure (PS)		MPa kgf/cm^2 psi	3.92 40.0 569
Motor Displacement Control Pressure when PS=3.92 MPa, 40 kgf/cm^2, 570 psi	2nd speed→ 1st speed	MPa kgf/cm^2 psi	20.0 202.7 2883
	1st speed→ 2nd speed	MPa kgf/cm^2 psi	20.6 208.8 2970

RY9212032HYM0032US0

(2) Components



RY9212001HYM064A

(A) Anticavitation Valve

No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Decelerator ASSY	1	(1) to (28)	(12)	Inner race	4	
(2)	Flange holder	1		(13)	Thrust washer	4	
(3)	Floating Seal	2		(14)	Thrust plate	1	
(4)	Angular bearing	1		(15)	Screw	4	
(5)	Ring nut	1		(16)	Sun gear	1	
(6)	Plug	2		(17)	Thrust washer	3	JIS B 2804, 42 SHAFT
(7)	Housing	1		(18)	Holder	1	
(8)	Steel ball	99	JIS B 1501, 1/4	(19)	Planetary gear A	3	
(9)	Plug	2	PT1/8	(20)	Cage and roller	3	
(10)	Planetary gear B	4		(21)	Inner race	3	
(11)	Needle bearing	4		(22)	Drive gear	1	

No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(23)	Thrust plate	1		(62)	Spool ASSY	1	(63), (64)
(24)	Cover	1		(63)	Spool A	1	
(25)	O-Ring	1	JIS B 2401, 1B, G190	(64)	Spool C	1	
(26)	Wire	1		(65)	Spring	1	
(27)	Plug	3		(66)	Plug	1	PF3/8
(28)	O-Ring	3	JIS B 2401, 1B, P14	(67)	O-Ring	2	JIS B 2401, 1B, P14
(29)	Shaft	1		(68)	Plug	3	NPTF1/16
(30)	Ball bearing	1		(69)	Plug	1	
(31)	Oil Seal	1		(70)	Orifice	6	M5x0.8x5L 0.5
(32)	Swash-plate	1		(71)	Socket head bolt	6	JIS B 1176, M12x25L
(33)	Steel ball	2		(72)	Pin	4	
(34)	Cylinder block	1		(73)	Valve ASSY	1	(74) to (81)
(35)	Spring seat	1		(74)	Valve body	1	
(36)	Spring	1		(75)	Spool	1	
(37)	Washer	1		(76)	Spring	2	
(38)	Snap ring	1	JIS B 2804, 37 HOLE	(77)	Spring seat	2	
(39)	Pin	3	2.5x15.8L	(78)	Plug	2	PF3/8
(40)	Retainer holder	1		(79)	O-Ring	2	JIS B 2401, 1B, P14
(41)	Retainer plate	1		(80)	O-Ring	3	JIS B 2401, 1B, P12
(42)	Piston ASSY	9		(81)	Socket head bolt	3	JIS B 1176, M8x30L
(43)	Piston	2		(82)	Nameplate	1	
(44)	Spring	2		(83)	Drive screw	2	1.85x4.8L
(45)	Valve plate	1		(84)	Shipping plug	2	PT1/2
(46)	Pin	1	4x12L	(85)	Shipping plug	1	9/16UNF
(47)	Ball bearing	1		(86)	Plug	1	PT1/8
(48)	O-Ring	1	AS568-25B, 1A	(87)	O-Ring	2	JIS B 2401, 1B, P8
(49)	O-Ring	4	JIS B 2401, 1B, P7	(88)	Plug	2	
(50)	Baseplate	1		(89)	Plug	2	
(51)	Plunger ASSY	1	(52) to (56)	(90)	Brake piston	1	
(52)	Spool	1		(91)	Disc	1	
(53)	Check valve	2		(92)	Spring	8	
(54)	Spring	2		(93)	Spring	4	
(55)	Plug	2		(94)	O-Ring	1	
(56)	O-Ring	2	JIS B 2401, 1B, P10	(95)	O-Ring	1	
(57)	Spring seat	2		(96)	Orifice	2	M5x0.8x5L 0.5
(58)	Spring	2		(97)	Spring seat	1	
(59)	Cap	2		(98)	Plug	2	
(60)	O-Ring	2	JIS B 2401, 1B, P29	(99)	O-Ring	2	JIS B 2401, 1B, P14
(61)	Orifice	2	M5x0.8x5L 0.5				

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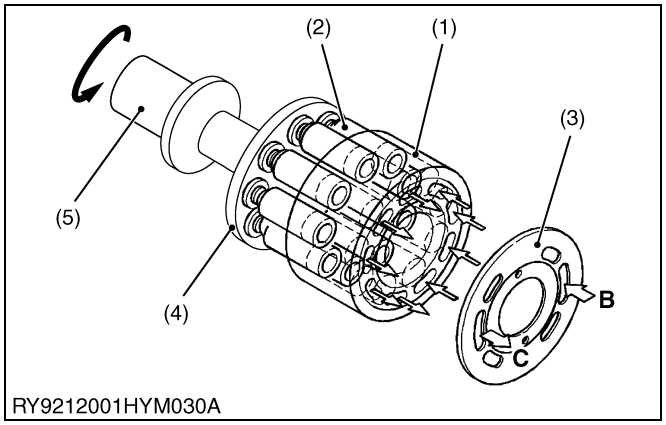
(3) Function and Structure

[A] Operating Principles



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Nine pistons (2) are built into the cylinder block (1), and the end section of the block is in contact with a valve plate (3), which has two half-moon shaped ports (port B and port C for switching between high and low pressure).

If high-pressure oil is guided to port B, the pressurized oil passes through port B and presses on the swash-plate (4). The pistons receive the counterforce from the swash-plate, part of which is converted into rotational force, and the block rotates due to the sum total of the rotational forces exerted by pistons that the hydraulic oil entered.

The cylinder block and the shaft (5) are linked via a spline, so the rotation is transferred to the shaft.

(1) Cylinder block
(2) Piston
(3) Valve plate
(4) Swash plate
(5) Shaft

B : Port B
C : Port C

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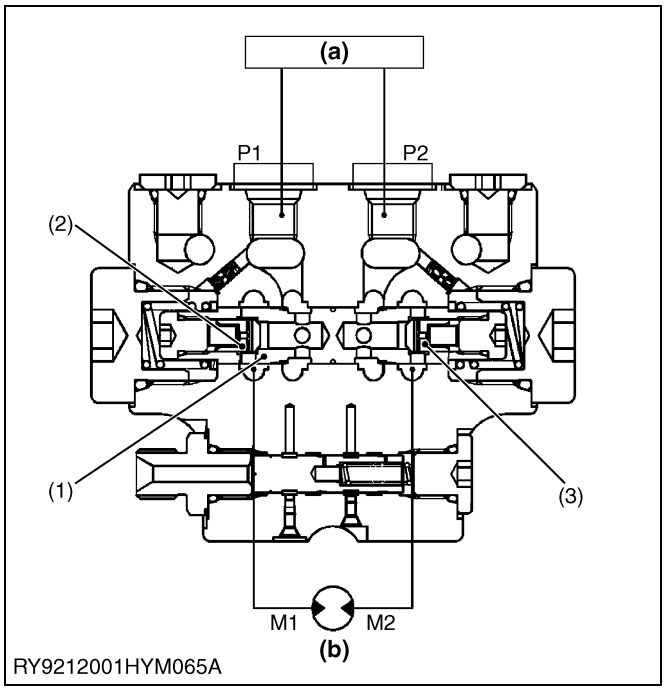
[B] Counter-balance valve



RY9212001HYM065A

When in neutral

Role of the counter-balance valve

1. Stops the motor **(b).**
2. Prevents overrun.

When control valve **(a)** is in neutral, no pressure is generated at either port P1 or P2, so ports M1 and M2 are blocked by plunger (1), check valve L (2) and check valve R (3), so the motor does not rotate.

(1) Plunger
(2) Check valve L
(3) Check valve R

(a) Control Valve
(b) Motor

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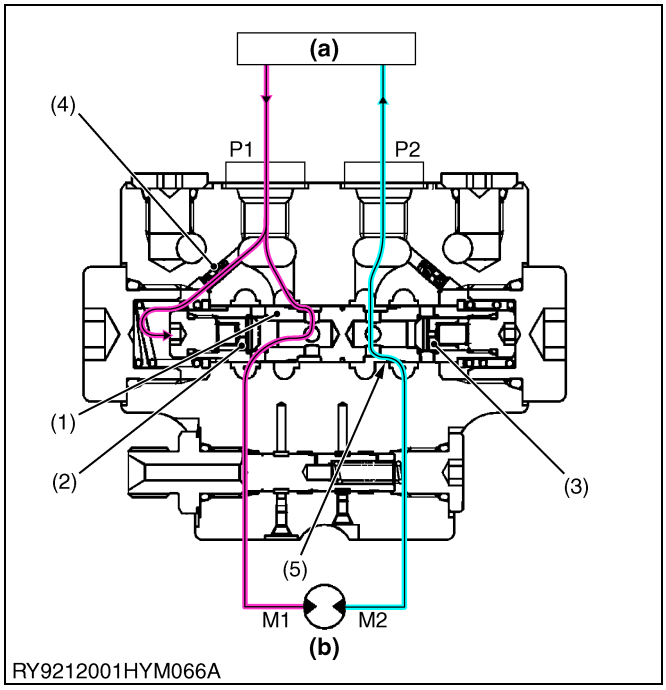


RY9212001HYM066A

If pressurized oil flows to P1

The pressurized oil that passed through P1 flows through check valve L (2) to the motor **(b)** via the M1 port, thus turning the motor.

The oil returning from the motor flows to the counter-balance valve from port M2, but it is blocked by the check valve R (3), so the pump discharge pressure rises. Pressurized oil passes through orifice L (4) and acts on the left side of plunger (1), moving the plunger to the right.

Oil returning from port M2 passes through the plunger notch (5) and while generating back pressure on port M2, returns to the tank via port P2 and the control valve **(a)**.

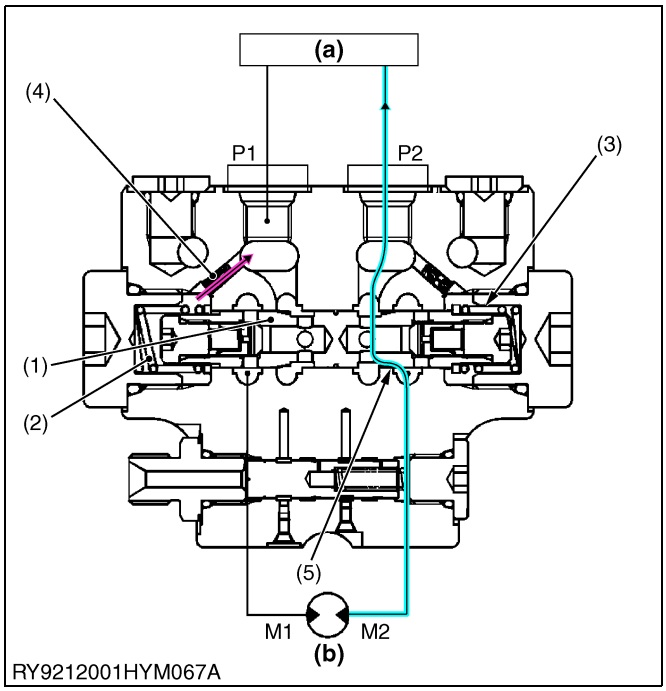
As the pump's discharge pressure rises further, the plunger moves further to the right, enlarging the opening of the orifice at the plunger notch, thus reducing the back pressure.

In this way the degree of opening of the plunger notch orifice automatically adjusts the return passage area so that the motor rotates at a speed that matches the pressure on the port P1 side.

(1) Plunger
(2) Check valve L
(3) Check valve R
(4) Orifice L
(5) Plunger notch section

(a) Control valve
(b) Motor

RY9212001HYM0084US0



RY9212001HYM067A

Brake operation

When the control valve **(a)** returns to neutral, it cuts off the supply of pressurized oil from the pump, and the pressures at ports P1 and P2 equalize, so spring R (3) works to return the plunger (1) to its neutral position. (moves to the left)

When the plunger moves to the left, the size of the orifice in the plunger notch (5) becomes smaller. Also, the motor **(b)** tries to turn due to inertia, which causes the pressure on the port M2 side to rise. When the plunger moves to the left, the oil in the left pressure chamber (2) escapes to the port P1side, but due to the constricting effect of orifice L (4), the speed with which the plunger moves to the left is limited.

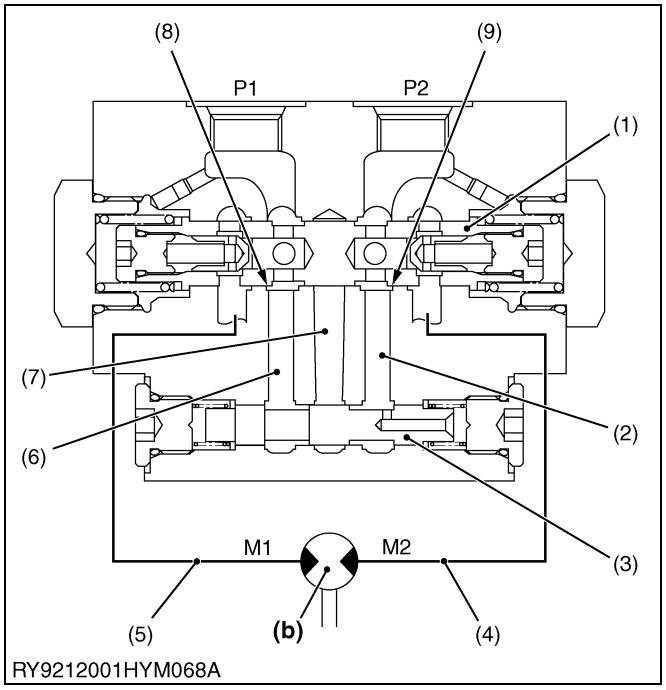
By controlling the speed of the plunger, the motor is stopped without generating cavitation while also absorbing the shock pressure from the inertia of the motor.

(1) Plunger
(2) Left pressure chamber
(3) Spring R
(4) Orifice L
(5) Plunger notch section

(a) Control valve
(b) Motor

RY9212001HYM0085US0

[C] Anti-cavitation valve



RY9212001HYM068A

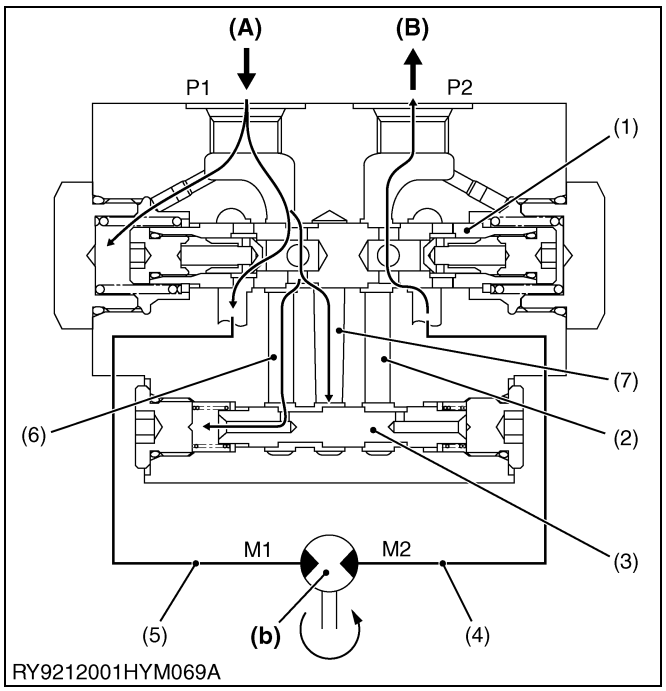
The anti-cavitation valve functions in conjunction with the counterbalance valve.

The figure at left shows the counterbalance valve in neutral.

(1) Plunger
(2) Oil passage C
(3) Spool
(4) Oil passage M2
(5) Oil passage M1
(6) Oil passage B
(7) Oil passage A
(8) Orifice B
(9) Orifice C

(b) Motor

RY9212001HYM0086US0



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Motor stopped → start

If pressurized oil flows to port P1, plunger (1) moves to the right and oil flows to the motor **(b)** via passage M1(5), passes through passage M2 (4) and is expelled from port P2.

Although pressurized oil also flows to oil passage A (7), since it is cut off by the spool (3), pressurized oil does not flow to oil passage C (2).

Under steady motor rotation

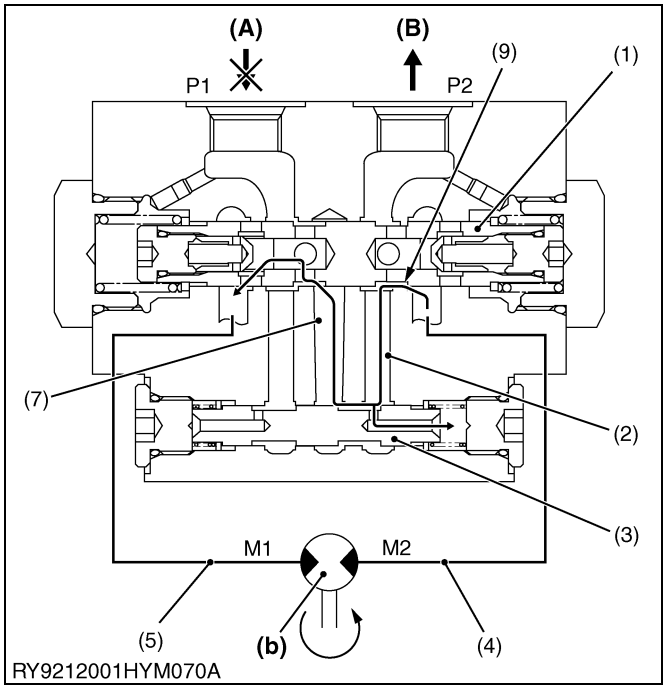
Although pressurized oil also flows to oil passage A (7), since it is cut off by the spool, the pressurized oil does not flow to oil passage C.

(1) Plunger
(2) Oil passage C
(3) Spool
(4) Oil passage M2
(5) Oil passage M1
(6) Oil passage B
(7) Oil passage A

(b) Motor

(A) [High Pressure] Inflow
(B) [Low Pressure] Discharge

RY9212001HYM0087US0



RY9212001HYM070A

When going from a steady motor speed → deceleration

When decelerating, the motor **(b)** continues to turn due to its inertia.

As long as the counterbalance valve is open (the plunger (1) is moved to the right), the motor's return oil passes through oil passage M2 (4) and is expelled from port P2. At that time, there is not enough oil supplied under pressure from port P1, resulting in cavitation.

On the other hand, the pressure in oil passage M2 rises due to inertia, moving the spool (3) to the left, and during the interval until the plunger moves to the left, it passes through oil passage M2 → orifice C (9) → oil passage C (2) → spool (3) → oil passage A (7) → P1 → oil passage M1 (5) and resupplies the motor, thus reducing cavitation. (Anticavitation function)

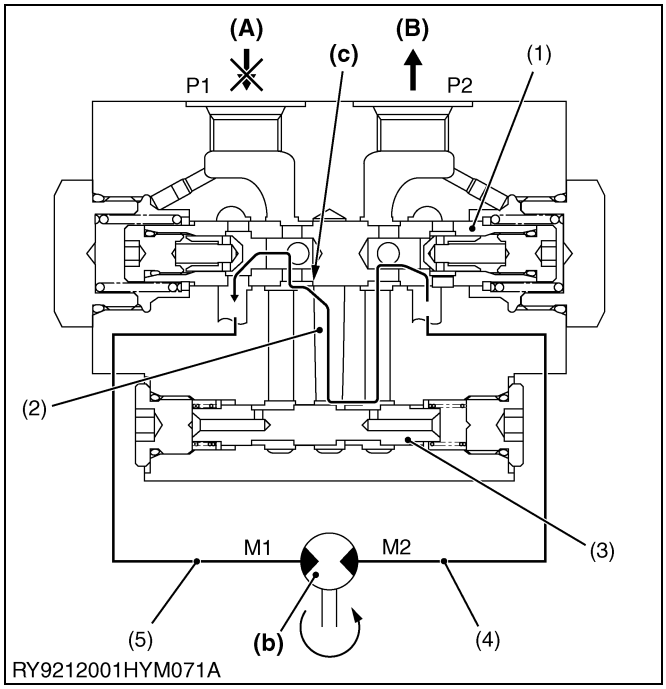
The mechanism is structured so the spool (3) switches instantaneously and the anti-cavitation function starts operating. (High-pressure selection method)

(1) Plunger
(2) Oil passage C
(3) Spool
(4) Oil passage M2
(5) Oil passage M1
(7) Oil passage A
(9) Orifice C

(b) Motor

(A) Inflow
(B) Discharge

RY9212001HYM0088US0



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When motor decelerating → stop

The anticavitation function moves the plunger (1) further to the left until oil passage A (2) and port P1 are cut off.

(1) Plunger
(2) Oil passage A
(3) Spool
(4) Oil passage M2
(5) Oil passage M1

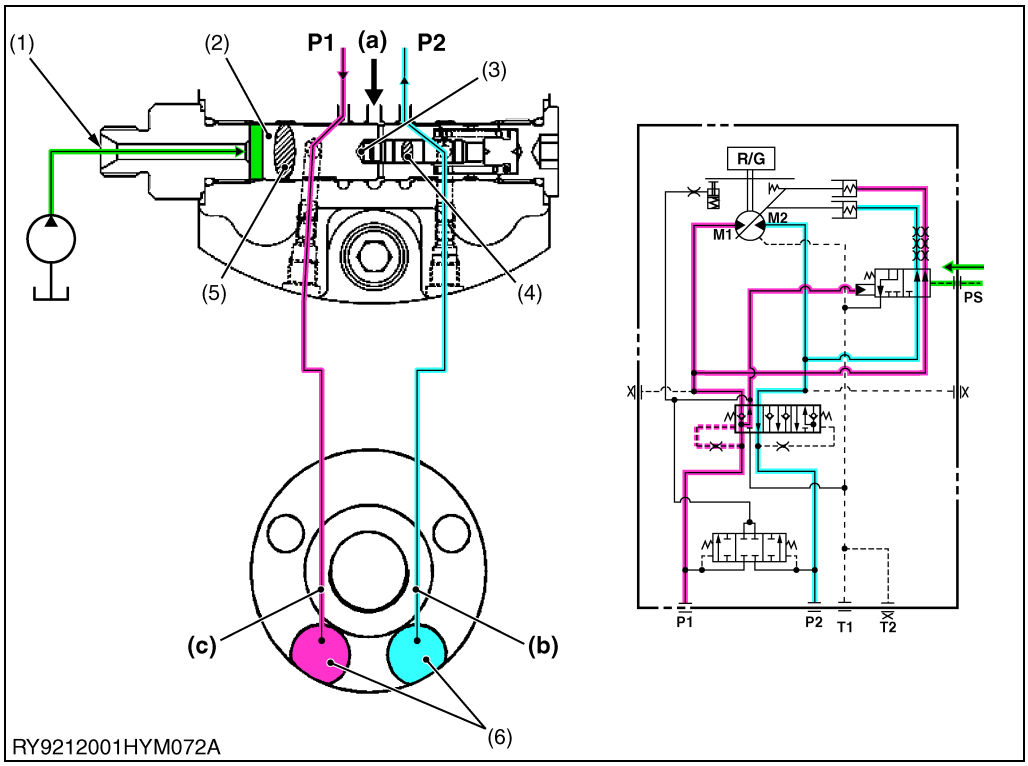
(b) Motor
(c) Position that cuts oil passage A off from P1

(A) Inflow
(B) Discharge

RY9212001HYM0089US0

[D] Auto-decelerator Function

When under low load



(1) PS Port
(2) Spool
(3) Motor load pressure chamber
(4) Motor load pressure area
(5) Pilot pressure area
(6) 2-speed switch piston

(a) Motor load pressure
(b) Low pressure
(c) High pressure

When the mini-excavator is traveling in 2nd speed, if the travel load becomes great, this function gives priority to power for traveling, automatically decelerating to 1st speed (low-speed). When the load is low, it operates in the 2nd speed (high-speed).

When the green button on top of the dozer lever is pressed, it actuates the solenoid of the unload valve, thus guiding oil from the pilot pump to the PS port (1). When pressure oil flows to the PS port, it moves the spool (2) to the right.

On one hand, the motor load pressure **(a)** is applied in the motor load chamber (3) and moves the spool to the left. When the load is low, the force applied in the motor load pressure chamber is slight and the motor load pressure area (4) is also small, due to the pilot pressure area (5), so the spool is pushed to the right and the pressurized oil from P1 is supplied to the 2-speed switch piston (6) on the P1 side.

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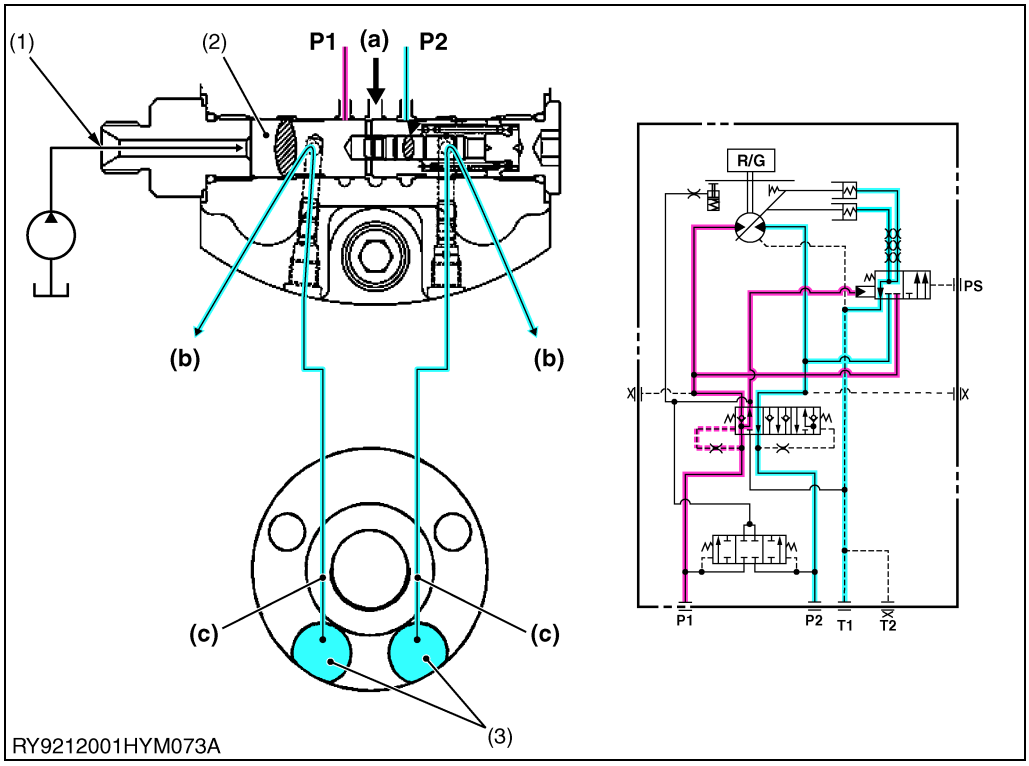
When the load is heavy



(1) PS Port
(2) Spool
(3) 2-speed switch piston

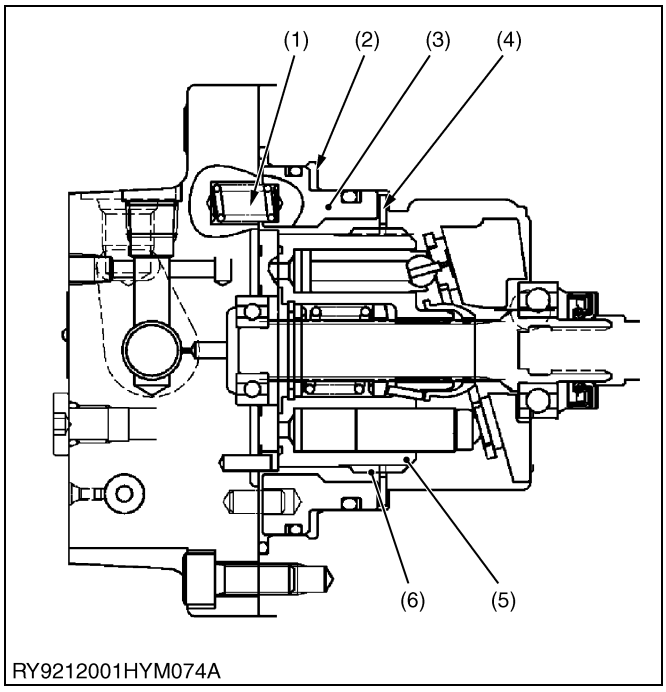
(a) Motor load pressure
(b) Case drain
(c) Low pressure

The motor load pressure **(a)** rises, so it overpowers the oil pressure from the PS port (1) and moves the spool (2) to the left, and switches to 1st speed (low speed).

When traveling in 1st speed, pressurized oil is not applied to the PS port, so it acts the same as when under a heavy load.

RY9212001HYM0091US0

[E] Parking Brake



The parking brake is a negative brake composed of a rotating disc (friction material) (4), a brake piston (3) and a spring (1). When the travel motor is stopped (the travel lever in neutral), the parking brake takes effect.

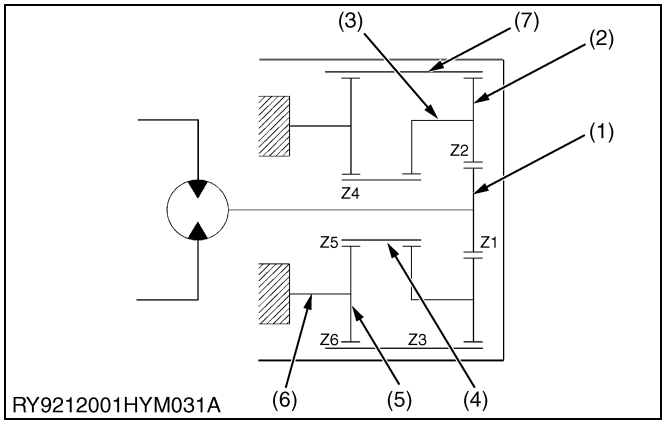
The cylinder block (5) and the disc are linked via a spline (6) and a friction material is applied to both sides of the disc. The disc is spring-loaded and friction is generated between the flange holder and the brake piston, and this limits the force with which the motor can turn, allowing it to function as a parking brake.

When pressurized oil is guided into the brake piston chamber (2), it generates an amount of thrust that matches the area of the brake piston that receives the pressure and overcomes the spring, thus moving the brake piston. The disk rotates freely between the flange holder and the brake piston, eliminating the parking brake function.

(1) Spring
(2) Brake piston chamber
(3) Brake piston
(4) Disc (friction material)
(5) Cylinder block
(6) Spline

RY9212001HYM0092US0

[F] Decelerator



The drive gear (1) meshes with the 1st stage planetary gear (2) while the 2nd stage sun gear (4) meshes with the 2nd stage planetary gear (5). The 2nd stage planetary carrier (6) is fixed to the body of the decelerator.

Planetary gears (2) and (5) mesh with ring gear (7) (the housing).

The drive force from the piston motor is transmitted to the drive gear, which is decelerated by each of the gears. The decelerated drive force is transmitted to the ring gears via the 2nd stage planetary gear of the 2nd stage planetary carrier, which is fixed to the final stage of the decelerator. (The drive force from the 1st stage planetary gear is also transmitted.)

However, the input rotation is opposite the output rotation.

(1) Drive gear
(2) 1st stage planetary gear
(3) 1st stage planetary carrier
(4) 2nd stage sun gear
(5) 2nd stage planetary gear
(6) 2nd stage planetary carrier
(7) Ring gear (housing)

RY9212001HYM0003US0

8. HYDRAULIC CYLINDER

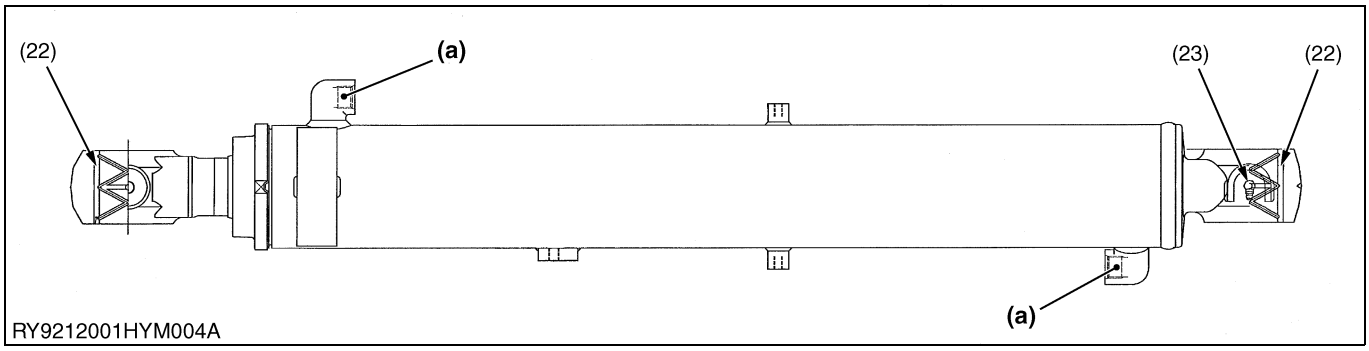
[1] BOOM CYLINDER

(1) Specifications

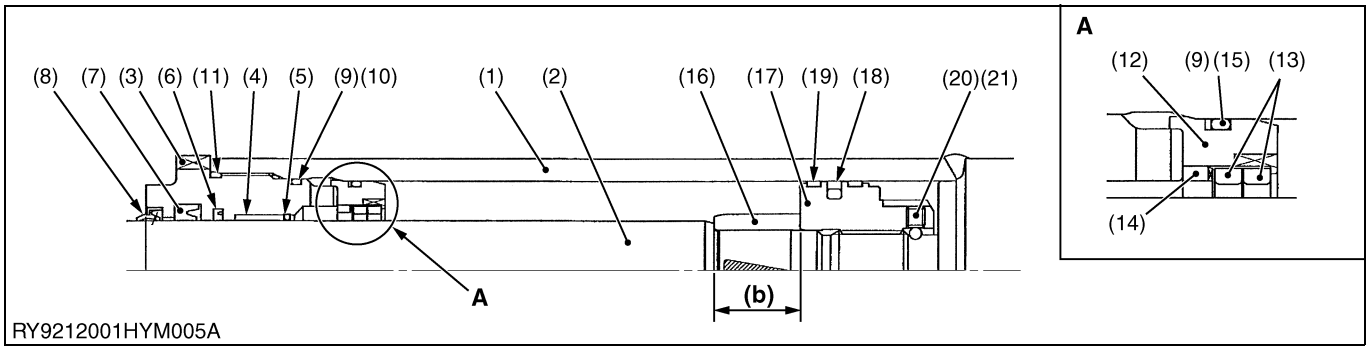
Maker	KYB
Tube outer diameter	ϕ117 mm (4.61 in.)
Tube inner diameter	ϕ95 mm (3.7 in.)
Rod diameter	ϕ55 mm (2.2 in.)
Stroke	690 mm (27.2 in.)
Max compressed length	1,074 mm (42.28 in)

RY9212032HYM0014US0

(2) Components



RY9212001HYM004A



RY9212001HYM005A

(a) G1/2(O-ring type)

(b) Cushion stroke 40 mm (1.6 in)

No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Cylinder tube ASSY	1		(13)	Cushion seal	2	
(2)	Piston rod ASSY	1		(14)	Collar	1	
(3)	Cylinder head	1		(15)	Backup ring	1	
(4)	Bushing	1		(16)	Cushion bearing	1	
(5)	Snap ring	1		(17)	Piston	1	
(6)	Buffer ring	1		(18)	Sealing ASSY	1	
(7)	U-ring	1		(19)	Slide ring	2	
(8)	Wiper ring	1		(20)	Set screw	1	B1177 M10x10
(9)	O-Ring	2	B2401 1B G 90	(21)	Steel ball	1	
(10)	Backup ring	1		(22)	Pin bushing	2	
(11)	O-Ring	1	B2401 1A G 95	(23)	Grease nipple	1	B1575 B-PT1/8
(12)	Holder	1					

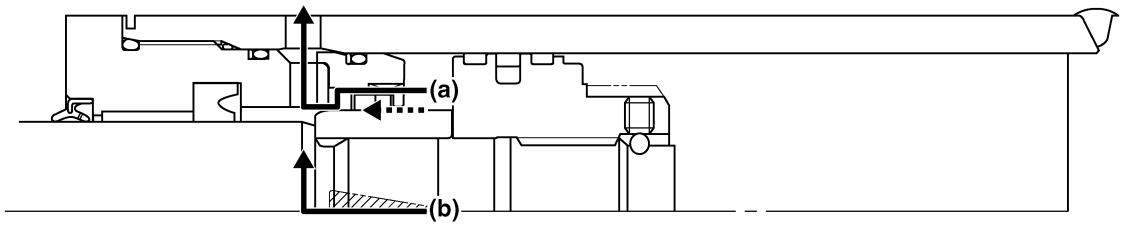
RY9212032HYM0015US0

(3) Function and Structure

Cushion Function

A cushion is utilized on the lift end of the boom (side of cylinder that extends) to prevent dirt from spilling.

- **Cushion function on the lift end of the boom**



RY9212001HYM182A

(a) Flow via a slit **(b) Flow from indentation**

The discharge pressurized oil is automatically reduced on the lift end of the boom, slowing the operation of the cylinder and cushioning the shock on the lift end of the boom. An indentation and a split in the cushion bearing are provided as a means to reduce the pressure.

RY9212001HYM0096US0

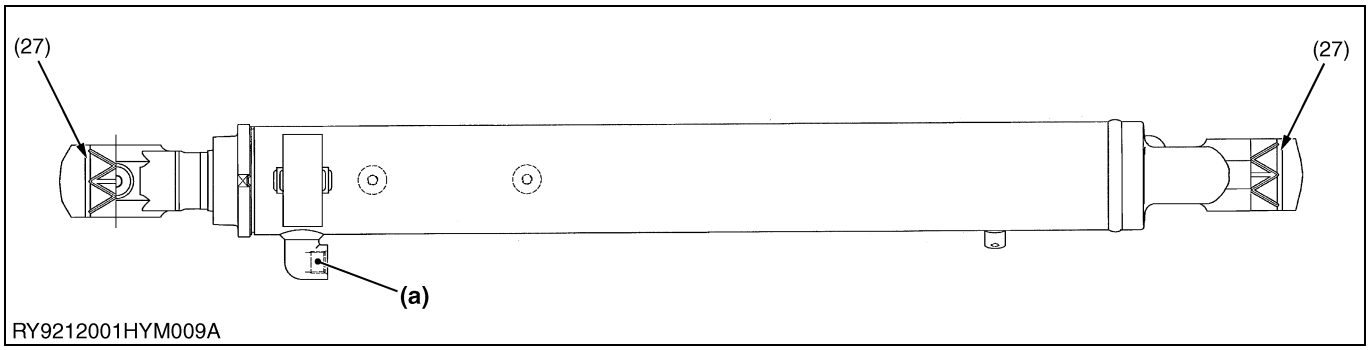
[2] ARM CYLINDER

(1) Specifications

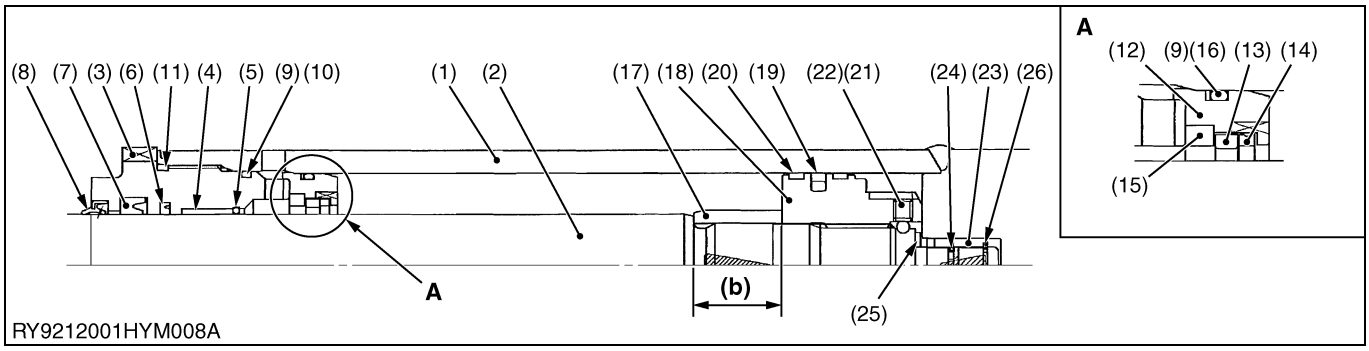
Maker	KYB
Tube outer diameter	ϕ105 mm (4.13 in)
Tube inner diameter	ϕ85 mm (3.3 in.)
Rod diameter	ϕ55 mm (2.2 in.)
Stroke	691 mm (27.2 in.)
Max compressed length	1,105 mm (43.5 in.)

RY9212032HYM0016US0

(2) Components



RY9212001HYM009A



RY9212001HYM008A

(a) G1/2(O-ring type)

(b) Cushion stroke 35 mm (1.4 in.)

No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Cylinder tube ASSY	1		(15)	Collar	1	
(2)	Piston rod ASSY	1		(16)	Backup ring	1	
(3)	Cylinder head	1		(17)	Cushion bearing	1	
(4)	Bushing	1		(18)	Piston	1	
(5)	Snap ring	1		(19)	Sealing ASSY	1	
(6)	Buffer ring	1		(20)	Slide ring	2	
(7)	U-ring	1		(21)	Set screw	1	B1177 M10x10
(8)	Wiper ring	1		(22)	Steel ball	1	
(9)	O-Ring	2	B2401 1B G 80	(23)	Cushion bearing	1	
(10)	Backup ring	1		(24)	Cushion seal	1	
(11)	O-Ring	1	B2401 1A G 85	(25)	Snap ring	1	
(12)	Holder	1		(26)	Stopper	2	
(13)	Cushion seal	1		(27)	Pin bushing	2	
(14)	Spacer	1					

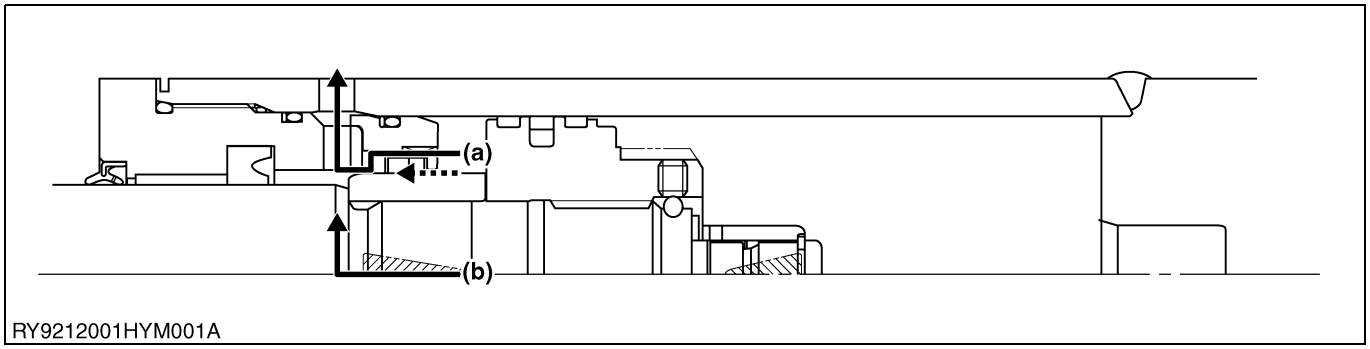
RY9212032HYM0017US0

(3) Function and Structure

Cushion Function

A cushion is utilized on the rake end of the arm (side of cylinder that extends) to prevent dirt from spilling.

- **Cushion function on the rake end of the arm**



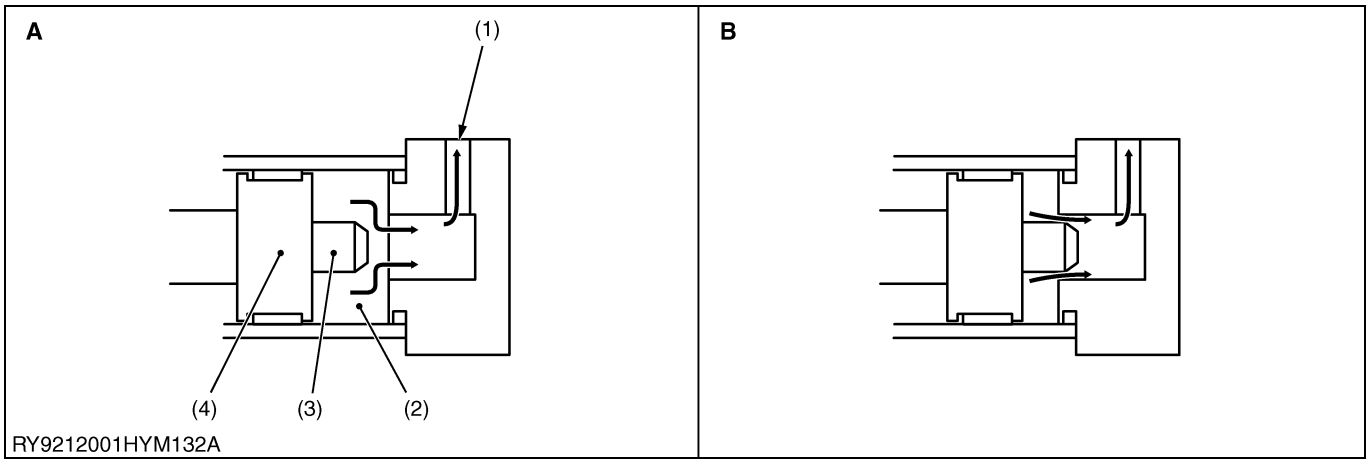
RY9212001HYM001A

(a) Flow via a slit **(b) Flow from indentation**

The discharge pressurized oil is automatically reduced on the rake end of the arm, slowing the operation of the cylinder and cushioning the shock on the rake end of the arm. An indentation and a split in the cushion bearing are provided as a means to reduce the pressure.

RY9212001HYM0100US0

- **Cushion function on dumping end of arm**



RY9212001HYM132A

(1) Port
(2) Cushion chamber
(3) Cushion plunger
(4) Piston

A : Before cushion enters
B : After cushion enters

RY9212001HYM0101US0

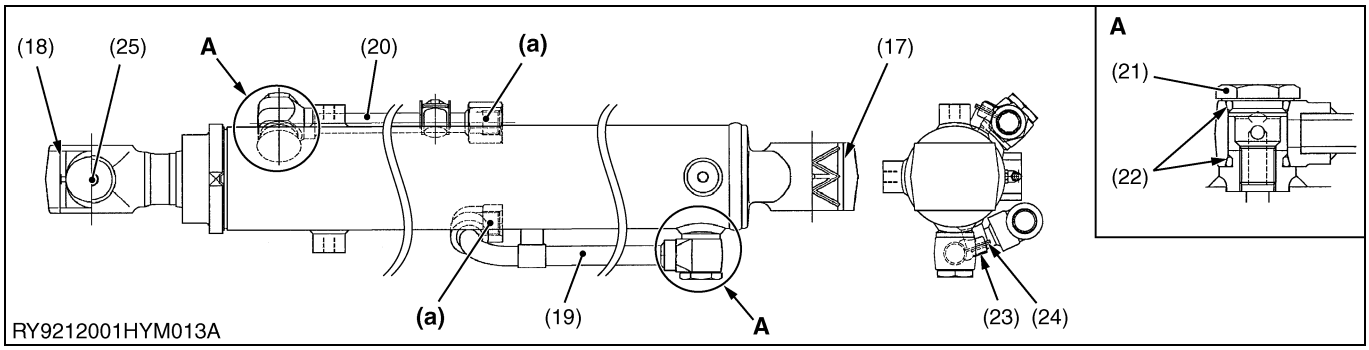
[3] BUCKET CYLINDER

(1) Specifications

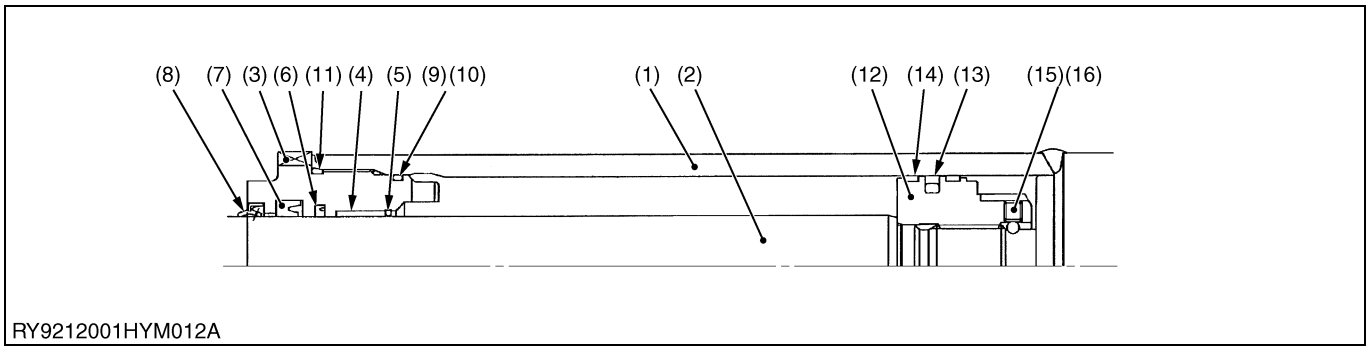
Maker	KYB
Tube outer diameter	ϕ91 mm (3.6 in.)
Tube inner diameter	ϕ75 mm (3.0 in.)
Rod diameter	ϕ45 mm (1.8 in.)
Stroke	589 mm (23.2 in.)
Max compressed length	896 mm (35.3 in.)

RY9212032HYM0018US0

(2) Components



RY9212001HYM013A



RY9212001HYM012A

(a) G1/2(O-ring type)

No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Cylinder tube ASSY	1		(14)	Slide ring	2	
(2)	Piston rod ASSY	1		(15)	Set screw	1	
(3)	Cylinder head	1		(16)	Steel ball	1	
(4)	Bushing	1		(17)	Pin bushing	1	
(5)	Snap ring	1		(18)	Pin bushing	1	
(6)	Buffer ring	1		(19)	Pipe ASSY	1	
(7)	U-ring	1		(20)	Pipe ASSY	1	
(8)	Wiper ring	1		(21)	Plug	2	
(9)	O-Ring	1	B2401 1B G 70	(22)	O-Ring	4	B2401 1B P 22A
(10)	Backup ring	1		(23)	Bolt ASSY	2	
(11)	O-Ring	1	B2401 1A G 75	(24)	Pipe holder	2	
(12)	Piston	1		(25)	Grease nipple	1	B1575 B-PT1/8
(13)	Seal ring ASSY	1					

RY9212001HYM0104US0

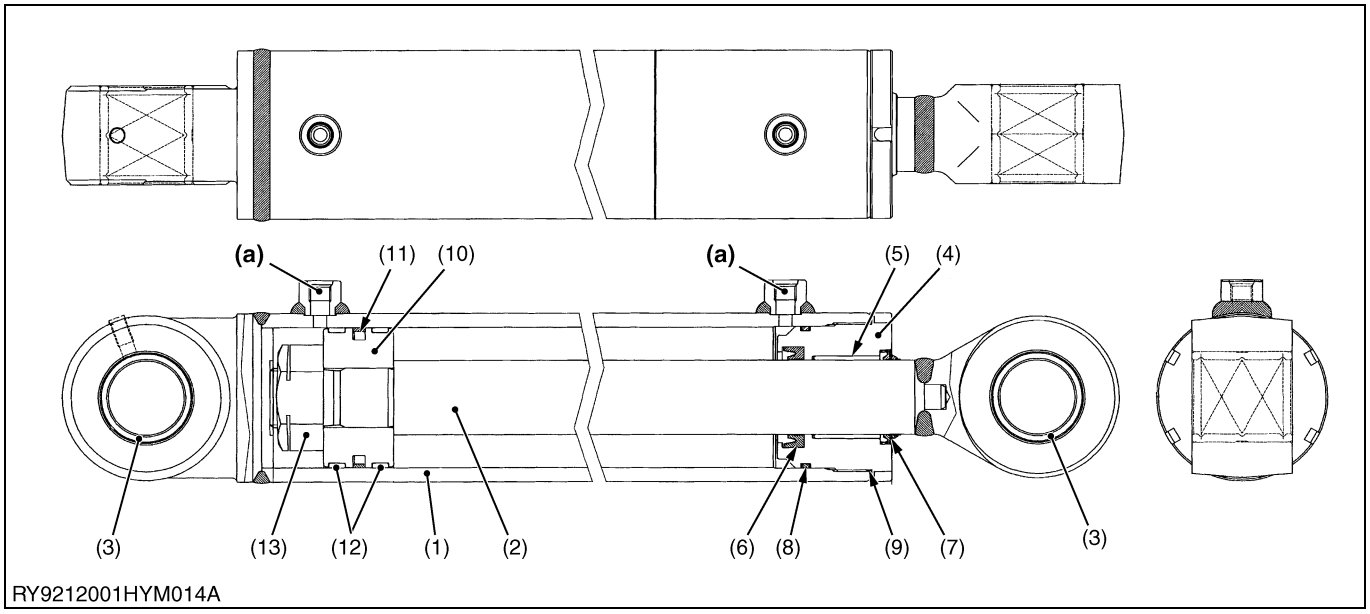
[4] SWING CYLINDER

(1) Specifications

Maker	KUBOTA SEIKI
Tube outer diameter	ϕ107 mm (4.21 in.)
Tube inner diameter	ϕ90 mm (3.5 in.)
Rod diameter	ϕ50 mm (2.0 in.)
Stroke	486 mm (19.1 in.)
Max compressed length	931 mm (36.7 in.)

RY9212032HYM0019US0

(2) Components



RY9212001HYM014A

(a) G1/4

No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Cylinder tube (W)	1		(8)	Gasket (dual)	1	
(2)	Rod (swing)	1		(9)	O-Ring	1	
(3)	Bushing	2		(10)	Piston	1	
(4)	Cylinder head	1		(11)	Seal (piston)	1	
(5)	DU bushing	1		(12)	Bushing	2	
(6)	Gasket	1		(13)	Nut (SSN36)	1	M36x3
(7)	Scraper	1					

RY9212001HYM0106US0

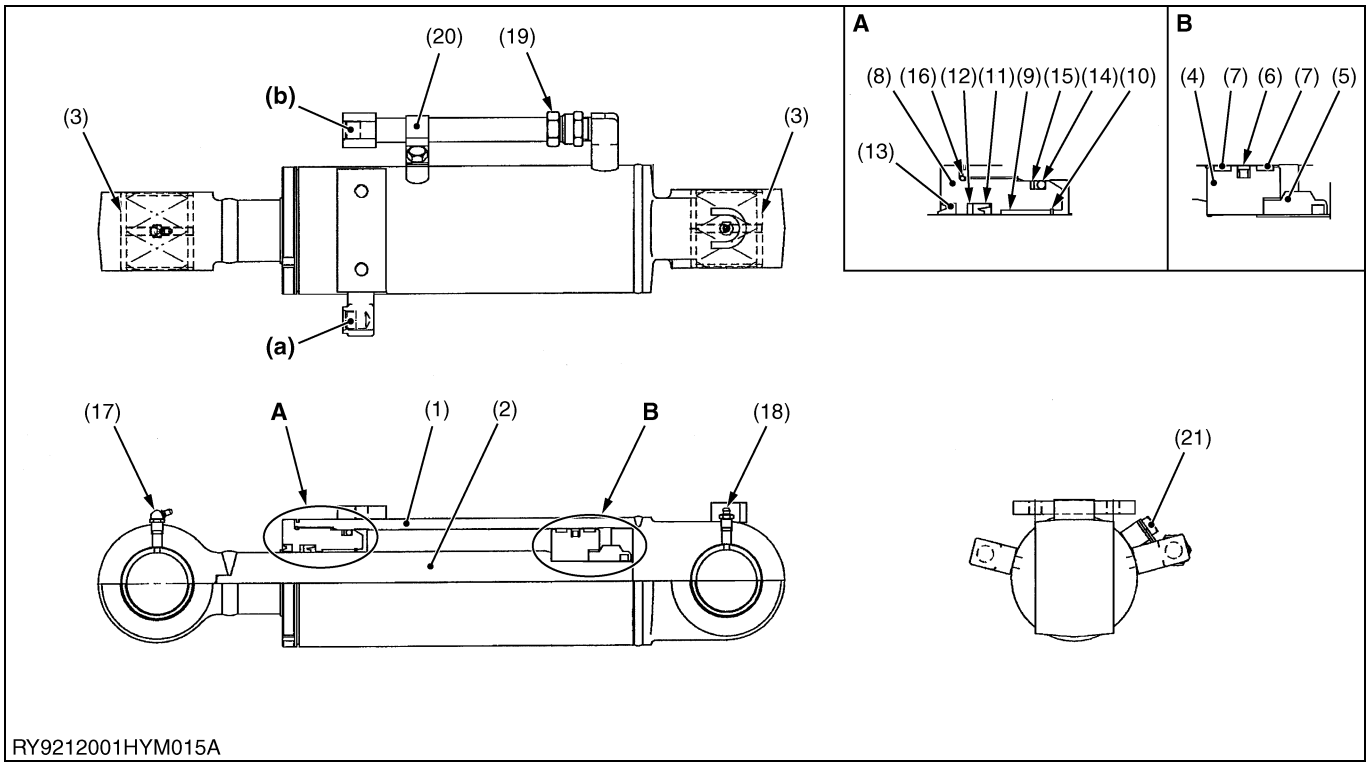
[5] BLADE CYLINDER

(1) Specifications

Maker	Koretsune Seiko
Tube outer diameter	ϕ131 mm (5.16 in.)
Tube inner diameter	ϕ110 mm (4.33 in.)
Rod diameter	ϕ60 mm (2.4 in.)
Stroke	170 mm (6.69 in.)
Max compressed length	515 mm (20.3 in.)

RY9212032HYM0020US0

(2) Components



RY9212001HYM015A

(a) G3/8 **(b) G1/2**

No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Tube ASSY	1		(12)	Backup ring	1	
(2)	Rod ASSY	1		(13)	Seal	1	
(3)	Bearing	2		(14)	O-Ring	1	
(4)	Piston	1		(15)	Backup ring	1	
(5)	Nut	1		(16)	O-Ring	1	
(6)	Seal ASSY	1		(17)	Grease nipple	1	
(7)	Ring	2		(18)	Grease nipple	1	
(8)	Head	1		(19)	Pipe ASSY	1	
(9)	Bushing	1		(20)	Clamp	1	
(10)	Circlip	1		(21)	Bolt	1	
(11)	Seal	1					

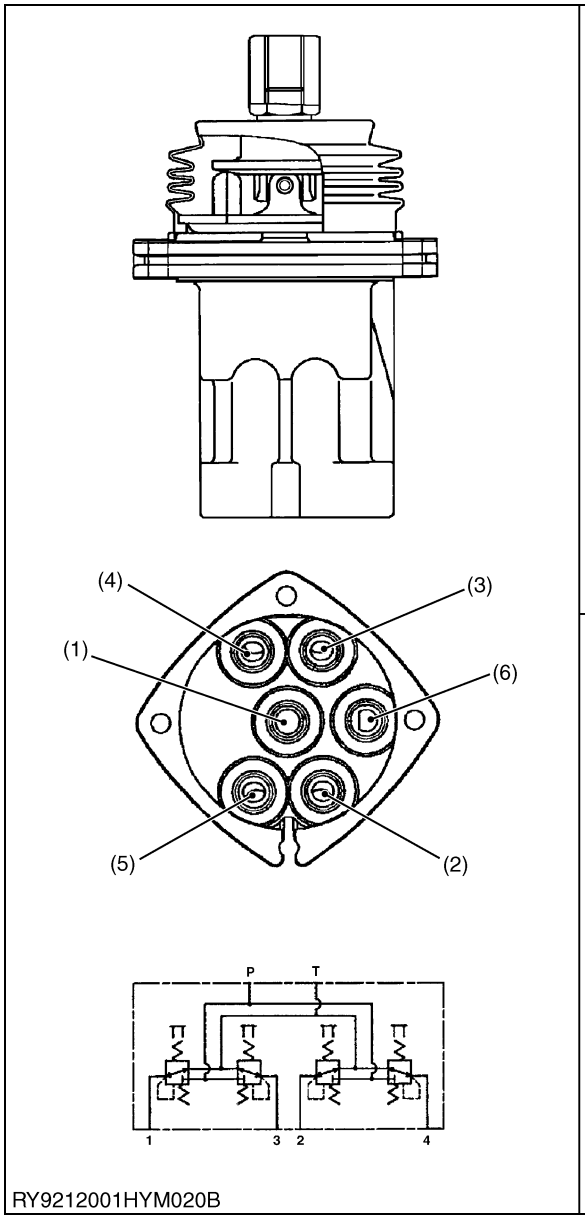
RY9212001HYM0108US0

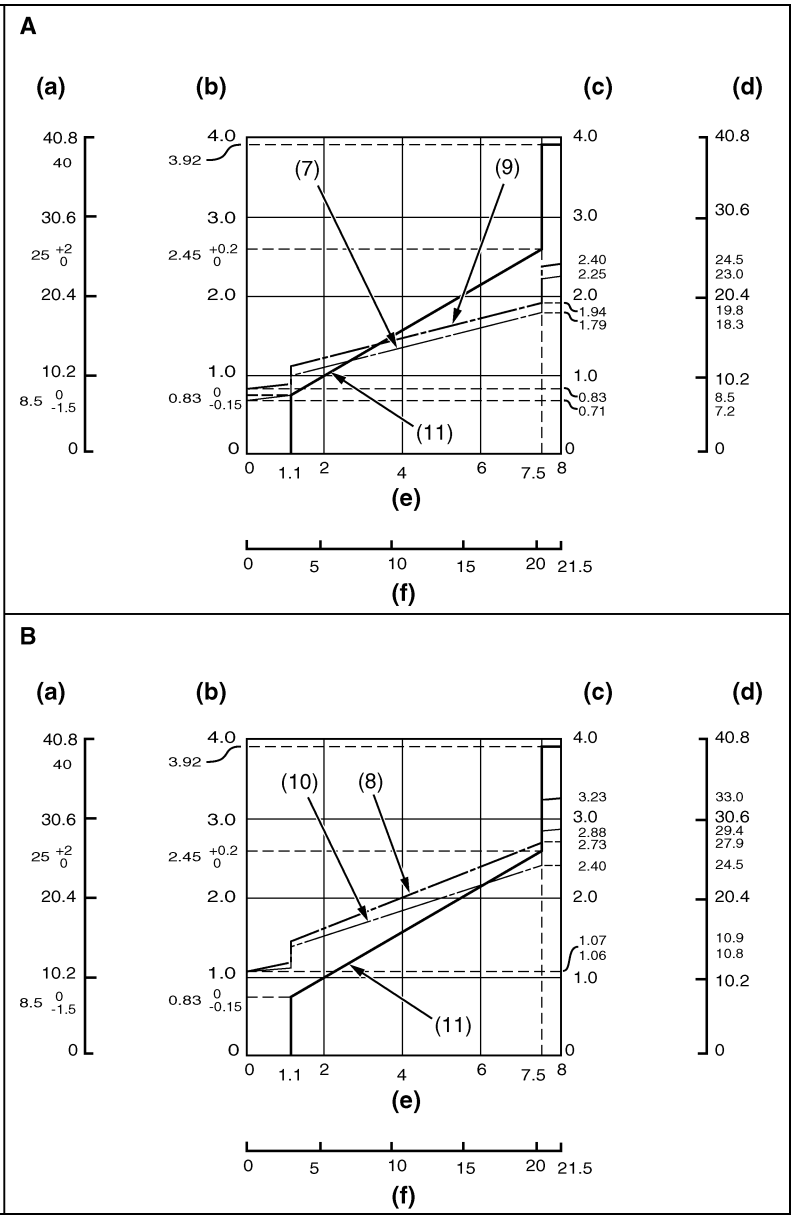
9. PILOT VALVE

[1] PILOT VALVE (BOOM, ARM, BUCKET, SWIVEL)

(1) Specifications

1. Pilot Valve Left





RY9212001HYM020B

(1) Port P
(2) Port 1 (swivel left)
(3) Port 2 (arm dump)
(4) Port 3 (swivel right)
(5) Port 4 (arm rake)
(6) Port T
(7) Independent operation torque (port 1)
(8) Independent operation torque (port 2)
(9) Independent operation torque (port 3)
(10) Independent operation torque (port 4)
(11) Secondary pressure

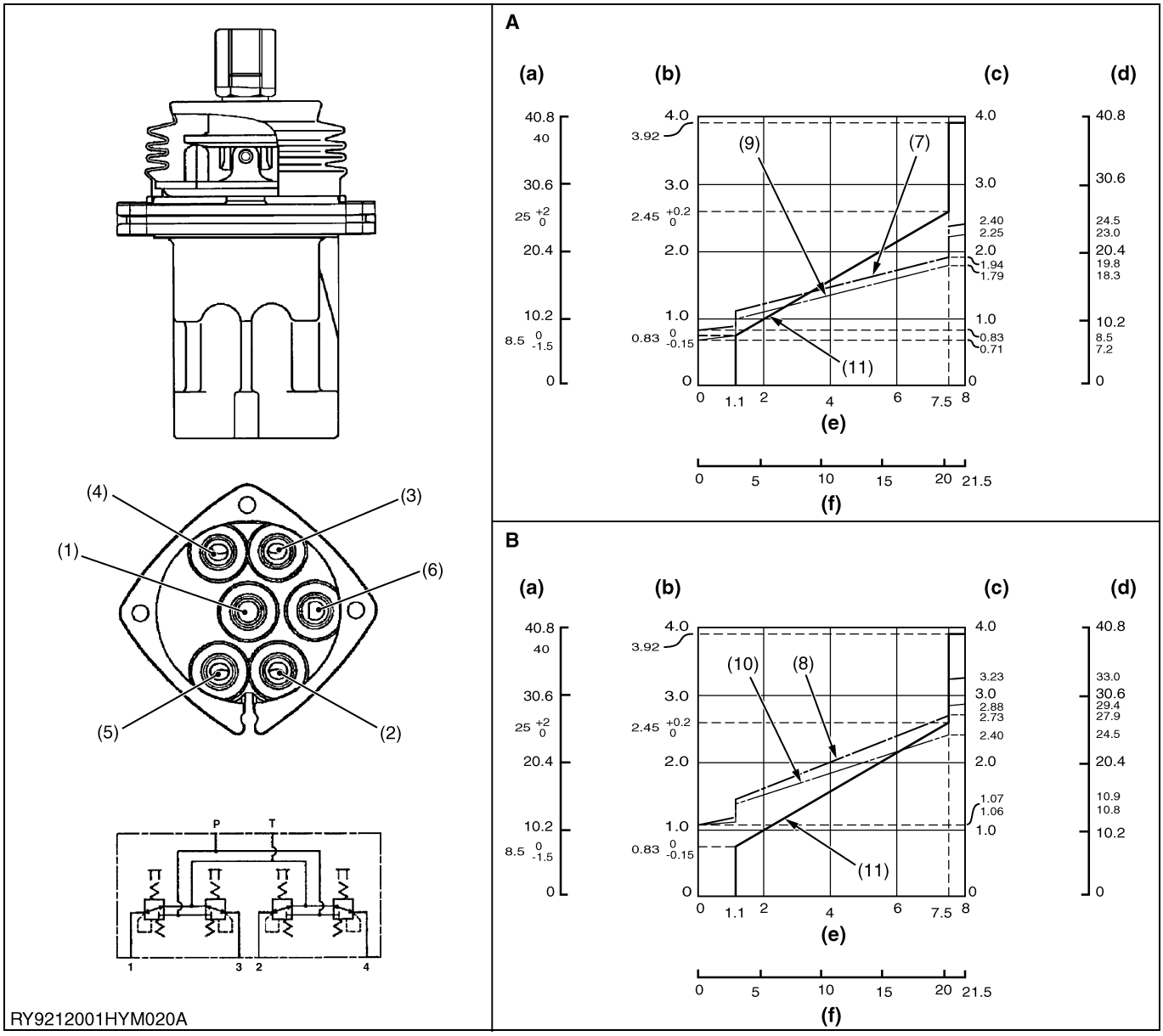
A : Port 1, 3
B : Port 2, 4

(a) Secondary pressure (kgf/cm^2)
(b) Secondary pressure (MPa)
(c) Operating torque (N·m)
(d) Operating torque (kgf·cm)
(e) Pushrod stroke (mm)
(f) Operating angle (deg)

Maker	KPM (Kawasaki Precision Machinery)
Model	PV48M2160A (LH)
Secondary pressure	Noted separately

RY9212001HYM0109US0

2. Pilot Valve Right



(1) Port P
(2) Port 1 (bucket rake)
(3) Port 2 (lower boom)
(4) Port 3 (dump bucket)
(5) Port 4 (lift boom)
(6) Port T
(7) Independent operation torque (port 1)
(8) Independent operation torque (port 2)
(9) Independent operation torque (port 3)
(10) Independent operation torque (port 4)
(11) Secondary pressure

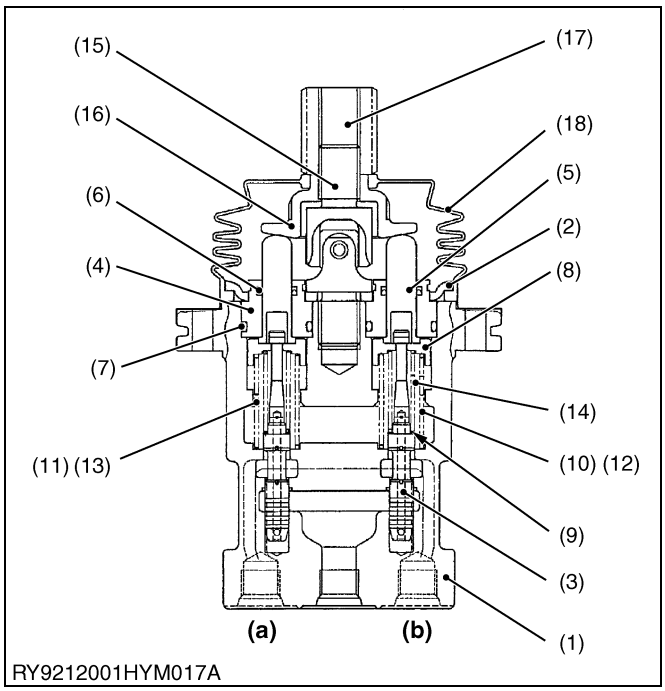
A : Port 1, 3
B : Port 2, 4

(a) Secondary pressure (kgf/cm^2)
(b) Secondary pressure (MPa)
(c) Operating torque (N·m)
(d) Operating torque (kgf·cm)
(e) Pushrod stroke (mm)
(f) Operating angle (deg)

Maker	KPM (Kawasaki Precision Machinery)
Model	PV48M2161 (RH)
Secondary pressure	Noted separately

RY9212001HYM0110US0

(2) Components



RY9212001HYM017A

Pilot valves left and right

No.	Name of part	Q'ty	Notes
(1)	Casing	1	
(2)	Plate	1	
(3)	Spool	4	
(4)	Plug	4	
(5)	Pushrod	4	
(6)	Seal	4	
(7)	O-Ring	4	
(8)	Spring seat	4	
(9)	Washer 2	4	
(10)	Spring	1	For port 1
(11)	Spring	1	For port 2
(12)	Spring	1	For port 3
(13)	Spring	1	For port 4
(14)	Spring	4	
(15)	Joint	1	
(16)	Round plate	1	
(17)	Adjusting nut	1	
(18)	Bellows	1	

(a) Port 2, 4 **(b) Port 1, 3**

RY9212001HYM0111US0

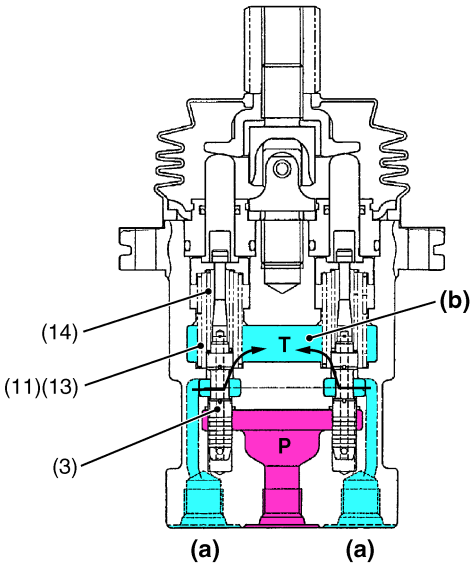
(3) Function and Structure

[A] Function

The pilot valve is the valve that controls the direction and volume of the stroke of the control valve, and lowers the primary pressure from the unload valve to a secondary pressure only as much as is necessary to move the control valve spool.

RY9212001HYM0001US0

[B] Operation



RY9212001HYM017B

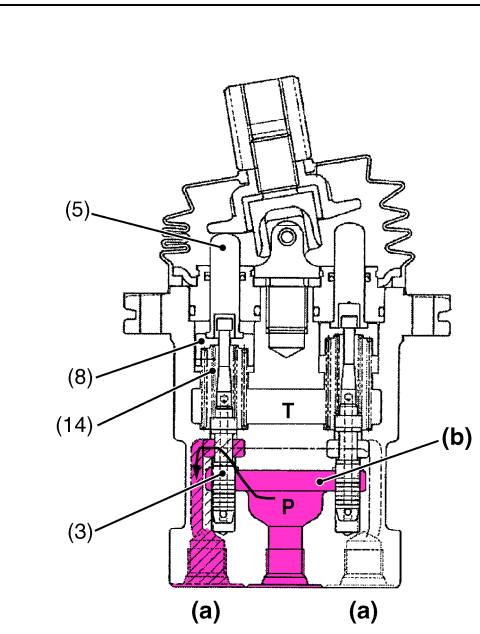
1. When the control lever is in neutral

The force of the secondary pressure setting spring (14) does not press on the spool (3). As a result, the spool is held in a neutral position by return spring (11) or (13). At such time, the output port (control valve port) **(a)** and port T **(b)** are connected.

(3) Spool
(11) Return spring
(13) Return spring
(14) Secondary pressure setting spring

(a) Output port
(b) Port T

RY9212001HYM0112US0



RY9212001HYM018A

2. When the control lever has been actuated

When the control lever is actuated, the pushrod (5) presses down on the spool (3) via the spring seat (8) and the secondary pressure setting spring (14). When doing so, port P **(b)** and the output port **(a)** are connected, so the oil from the pilot pump flows through the output port to the control valve.

The pressure at the output port rises until it is equivalent to the force of the secondary pressure setting spring, thus balancing the hydraulic pressure on the spool with the tension of the secondary pressure setting spring and maintaining a fixed output port pressure.

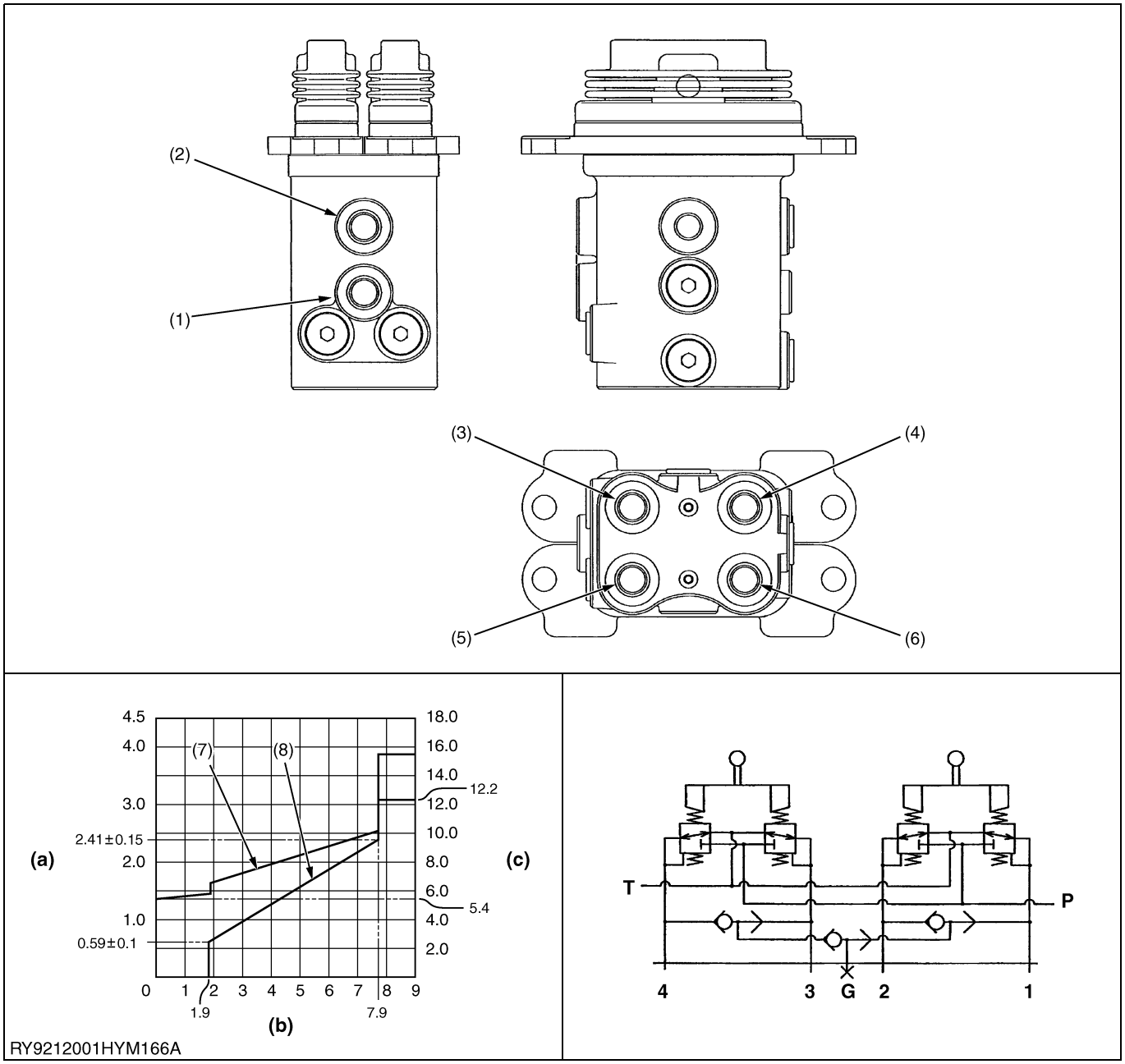
(3) Spool
(5) Pushrod
(8) Spring seat
(14) Secondary pressure setting spring

(a) Output port
(b) Port P

RY9212001HYM0113US0

[2] PILOT VALVE (TRAVEL)

(1) Specifications



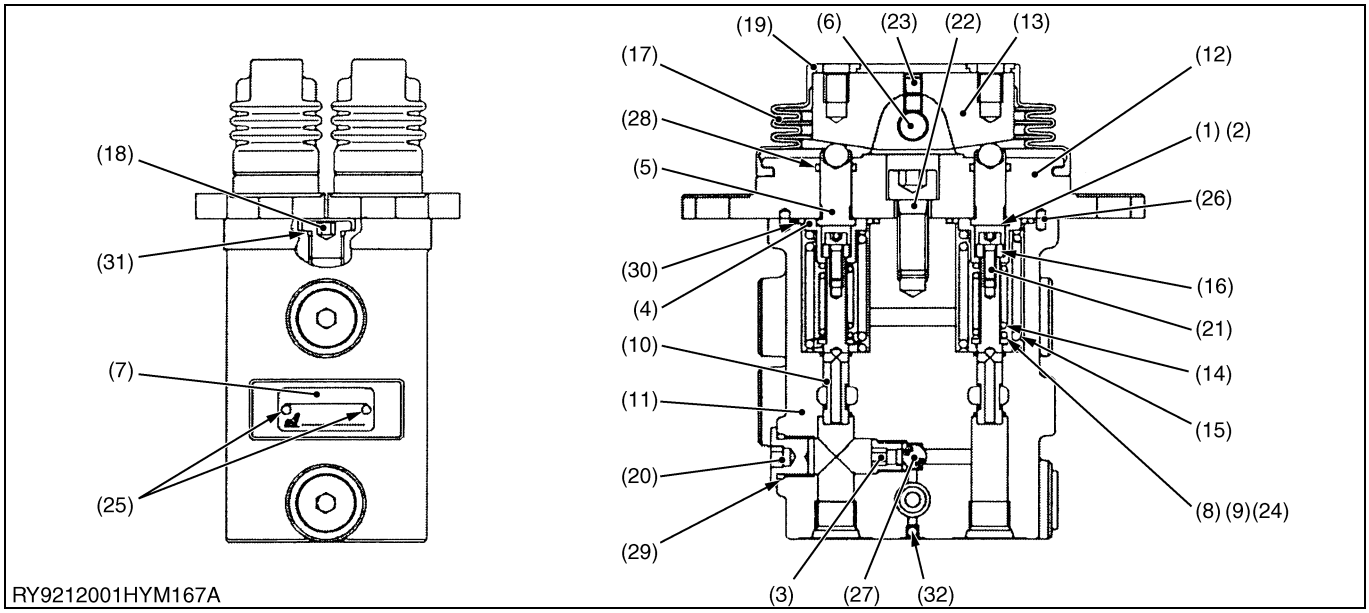
(1) Port P
(2) Port T
(3) Port 1
(4) Port 2
(5) Port 3
(6) Port 4
(7) Operating torque
(8) Secondary pressure

(a) Secondary pressure (MPa)
(b) Operating angle (deg)
(c) Operating torque (N·m)

Maker	Nishina Industrial
Model	–
Secondary pressure	Noted separately

RY9212001HYM0114US0

(2) Components



No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Shim	4	0.1T	(17)	Bushing	2	
(2)	Shim	4	0.2T	(18)	Plug	1	
(3)	Seat	3		(19)	Collar	4	
(4)	Spring seat	4		(20)	Flanged plug	6	
(5)	Pushrod	4		(21)	Hex socket bolt	4	JISB1176 M4x12xP0.7
(6)	Pin	2		(22)	Hex socket bolt	2	JISB1176 M10x25xP1.5
(7)	Plate, name	1		(23)	Hex set screw	4	JISB1177 M6x6
(8)	Shim	4	0.2T	(24)	Flat metal washer	4	JISB1256
(9)	Shim	4	0.1T	(25)	Rivet screw	2	#2x4.8
(10)	Spool	4		(26)	Parallel pin	4	JISB1354
(11)	Body	1		(27)	Steel ball	7	JISB1501
(12)	Cover	2		(28)	O-Ring	4	JISB2401 1A P10
(13)	Cam	2		(29)	O-Ring	6	JISB2401 1B P11
(14)	Spring	4		(30)	O-Ring	4	1B AS568-022
(15)	Spring	4		(31)	O-Ring	1	1B AS568-904
(16)	Collar	4		(32)	Expander	2	

RY9212001HYM0115US0

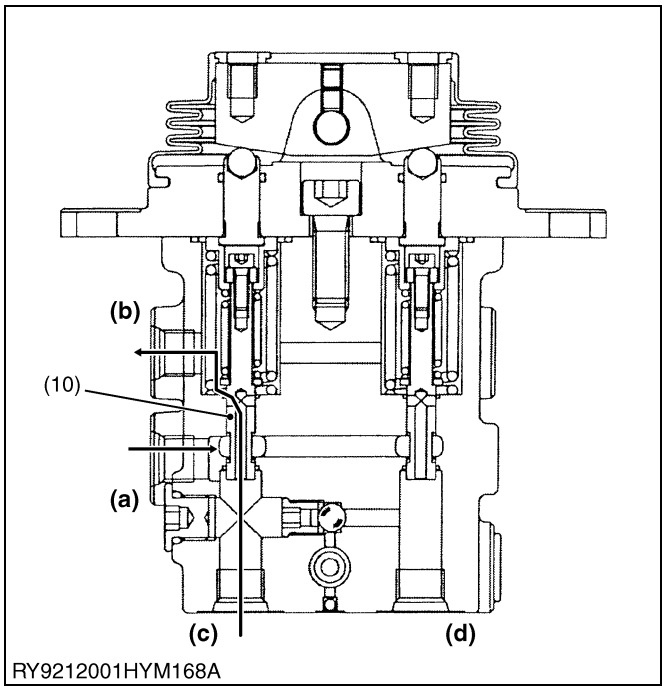
(3) Function and Structure

[A] Function

The pilot valve is the valve that controls the direction and volume of the stroke of the control valve, and lowers the primary pressure from the unload valve to a secondary pressure only as much as is necessary to move the control valve spool.

RY9212001HYM0001US0

[B] Operation



RY9212001HYM168A

1. When the control lever is in neutral

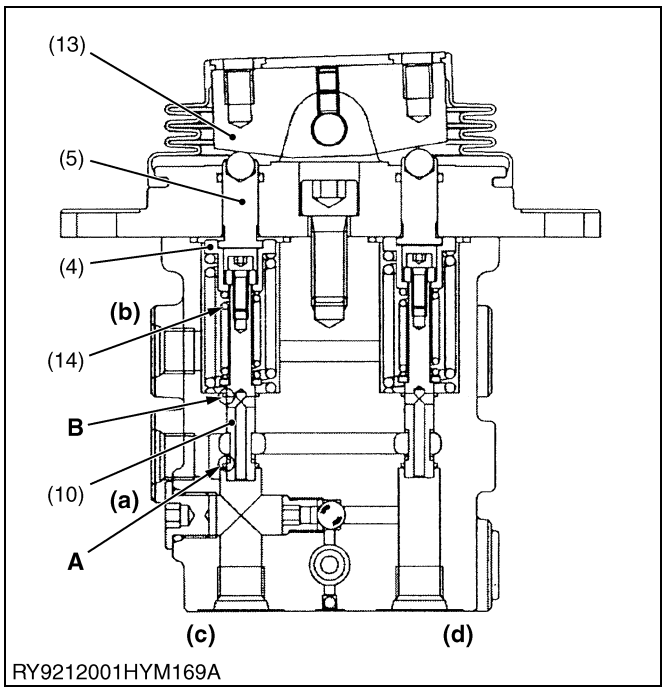
The oil from the pilot pump that flows into Port P **(a)** via the unload valve is cut off from port T **(b)** and port 1 **(c)** by the spool **(10)**.

And port 1 is connected to port T through the inside of the spool, so port 1 is at the tank pressure.

(10) Spool

(a) Port P
(b) Port T
(c) Port 1
(d) Port 2

RY9212001HYM0116US0



RY9212001HYM169A

2. When the control lever has been actuated (during governing pressure)

When the cam (13) operating angle exceeds 1.9 °, the pushrod (5) presses down on the spool (10) via the spring seat (4) and the secondary pressure setting spring (14).

At part A, port P **(a)** and port 1 **(c)** are connected, while at part **B**, port 1 and port T **(b)** are cut off, so the oil flows from port P to port 1.

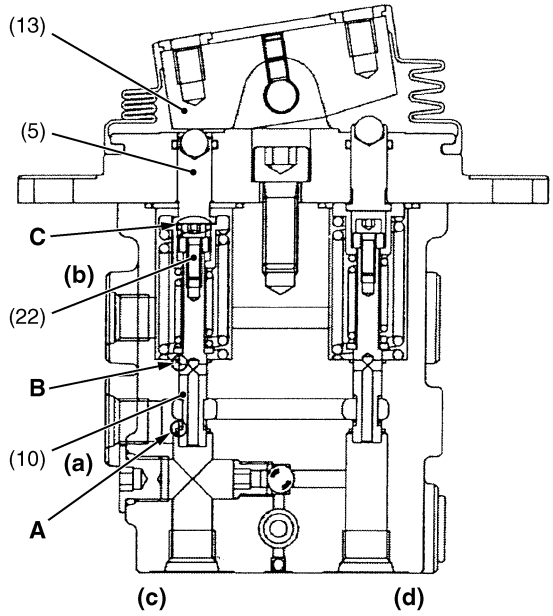
When the pressure at port 1 gets high enough, it counters the secondary pressure setting spring and presses the spool up, thus cutting off port P and port 1 at part **A** and allowing port 1 and port T to be connected at part **B**, and lowering the pressure at port 1. The repetition of this process maintains a constant pressure equal to the secondary pressure setting spring load.

If the cam is depressed further, the position of the spool does not change and the pushrod and spring seat move downwards, compressing the secondary pressure setting spring and putting a large load on the spring; this generates pressure equivalent to this load at port 1.

(4) Spring seat
(5) Pushrod
(10) Spool
(13) Cam
(14) Spring

(a) Port P
(b) Port T
(c) Port 1
(d) Port 2

RY9212001HYM0117US0



RY9212001HYM170A

3. When the control lever has been actuated (during short-circuit)

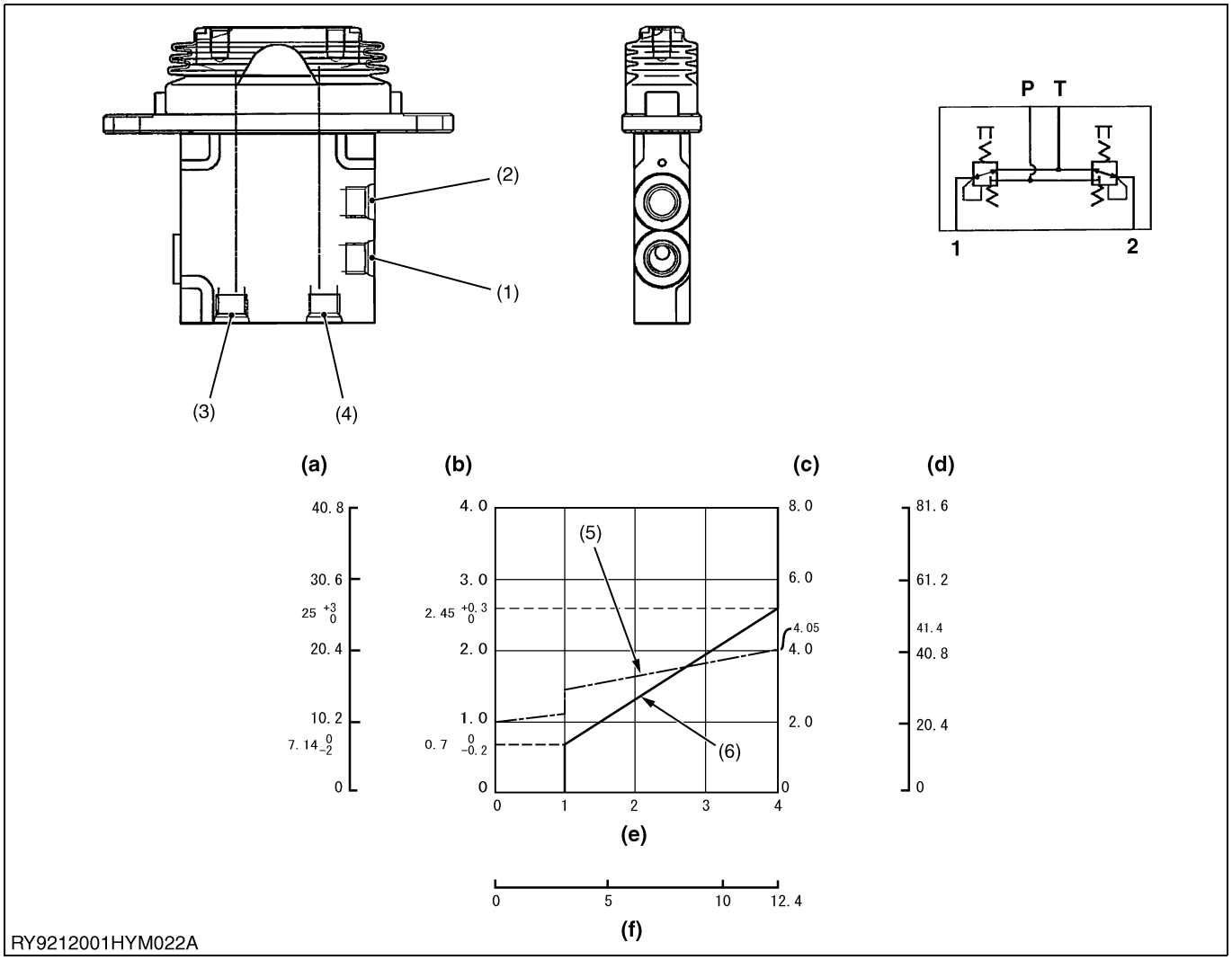
When the cam (13) operating angle exceeds 7.8 °, the pushrod (5) and the hex socket bolt (22) come in contact at part **C** and the spool (10) stops providing control by balancing the pressure. As a result, part **A** is left open, part B is left closed and the pressures of port P and port 1 equalize.

(5) Pushrod	**(a) Port P**
(10) Spool	**(b) Port T**
(13) Cam	**(c) Port 1**
(22) Hex socket bolt	**(d) Port 2**

RY9212001HYM0118US0

[3] PILOT VALVE (SWING AND BLADE)

(1) Specifications



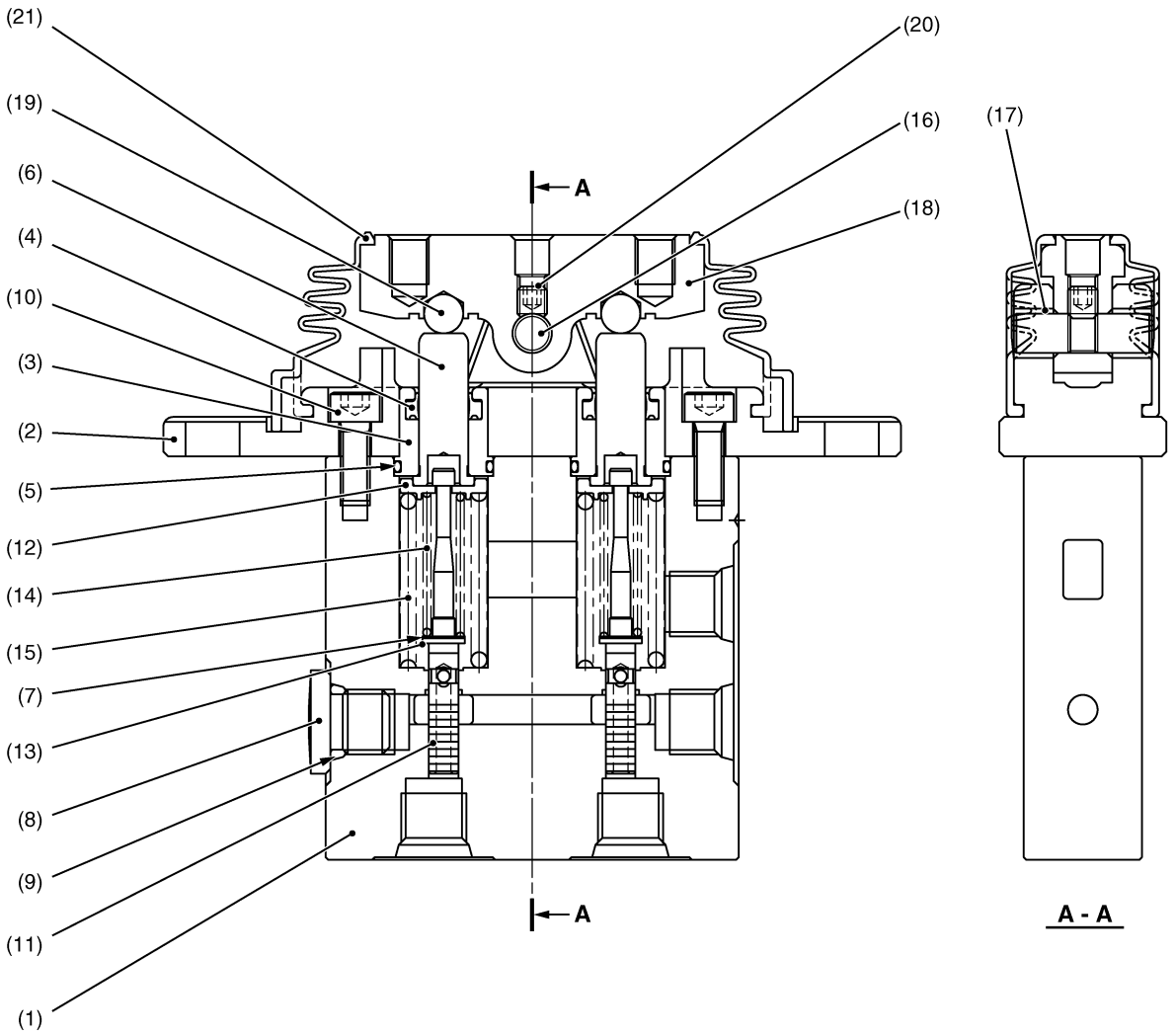
RY9212001HYM022A

(1) Port P
(2) Port T
(3) Port 1
(4) Port 2
(5) Operating torque
(6) Secondary pressure
(a) Secondary pressure (kgf/cm^2)
(b) Secondary pressure (MPa)
(c) Operating torque (N·m)
(d) Operating torque (kgf·cm)
(e) Pushrod stroke (mm)
(f) Pedal operating angle (deg)

Maker	KPM (Kawasaki Precision Machinery)
Model	PV6P1082A
Secondary pressure	Noted separately

RY9212001HYM0119US0

(2) Components



RY9212001HYM016A

No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Casing	1		(12)	Spring seat	2	
(2)	Cover	1		(13)	Washer	2	
(3)	Plug	2		(14)	Spring	2	
(4)	Gasket	2		(15)	Spring	2	
(5)	O-Ring	2	AS568-017	(16)	Cam axle	1	
(6)	Pushrod	2		(17)	Bushing	2	
(7)	Shim	2		(18)	Cam	1	
(8)	RO plug	1	G1/4	(19)	Steel ball	2	
(9)	O-Ring	1	JISB2401 P11 Hs90	(20)	Hex set screw	1	
(10)	Hex socket bolt	2	JIS B 1176 SB-M6-16	(21)	Bellows	1	HS50
(11)	Spool	2					

RY9212001HYM0120US0

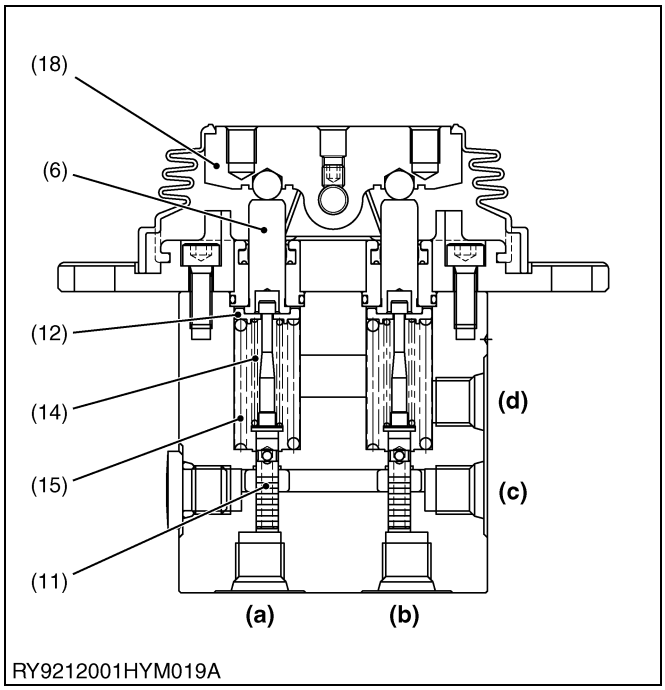
(3) Function and Structure

[A] Function

The pilot valve is the valve that controls the direction and volume of the stroke of the control valve, and lowers the primary pressure from the unload valve to a secondary pressure only as much as is necessary to move the control valve spool.

RY9212001HYM0001US0

[B] Operation



RY9212001HYM019A

1. When the control lever or pedal are in neutral

The force of the secondary pressure setting spring (14) does not press on the spool (11). As a result, the spool is held in a neutral position by the return spring (15). At such time, the output port (control valve port and port 1 **(a)** and port 2 **(b)**) and port T **(d)** are connected.

2. When the control lever or pedal have been actuated

The cam (18) is turned counterclockwise, the port 1 side pushrod (6) presses down on the spool (11) via the spring seat (12) and the secondary pressure setting spring (14). When doing so, port P **(c)** and port 1 **(a)** are connected, so the oil from the pilot pump flows through port 1 to the control valve.

The pressure at port 1 rises until it is equivalent to the force of the secondary pressure setting spring, thus balancing the hydraulic pressure on the spool with the tension of the secondary pressure setting spring and maintaining a fixed port 1 pressure.

(6) Pushrod
(11) Spool
(12) Spring seat
(14) Spring
(15) Spring
(18) Cam

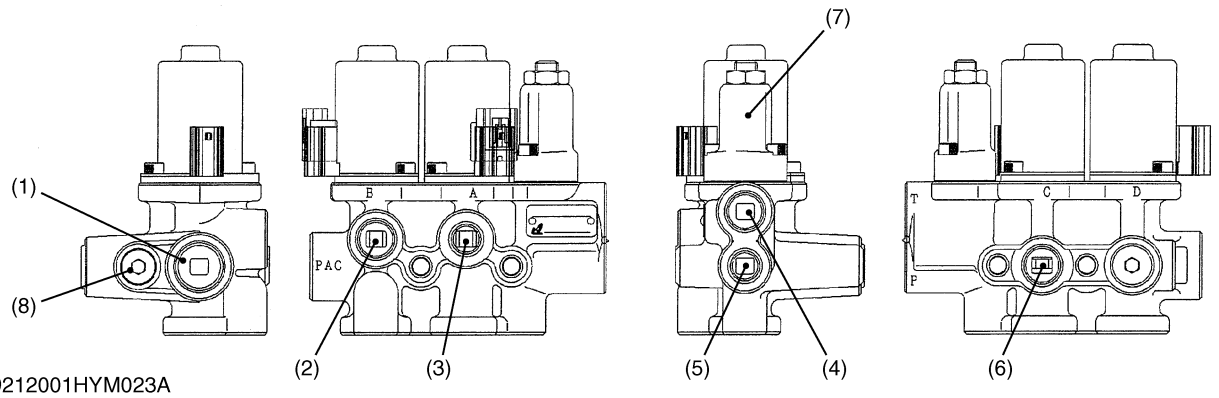
(a) Port 1
(b) Port 2
(c) Port P
(d) Port T

RY9212001HYM0121US0

10. UNLOAD VALVE

[1] UNLOAD VALVE

(1) Specifications



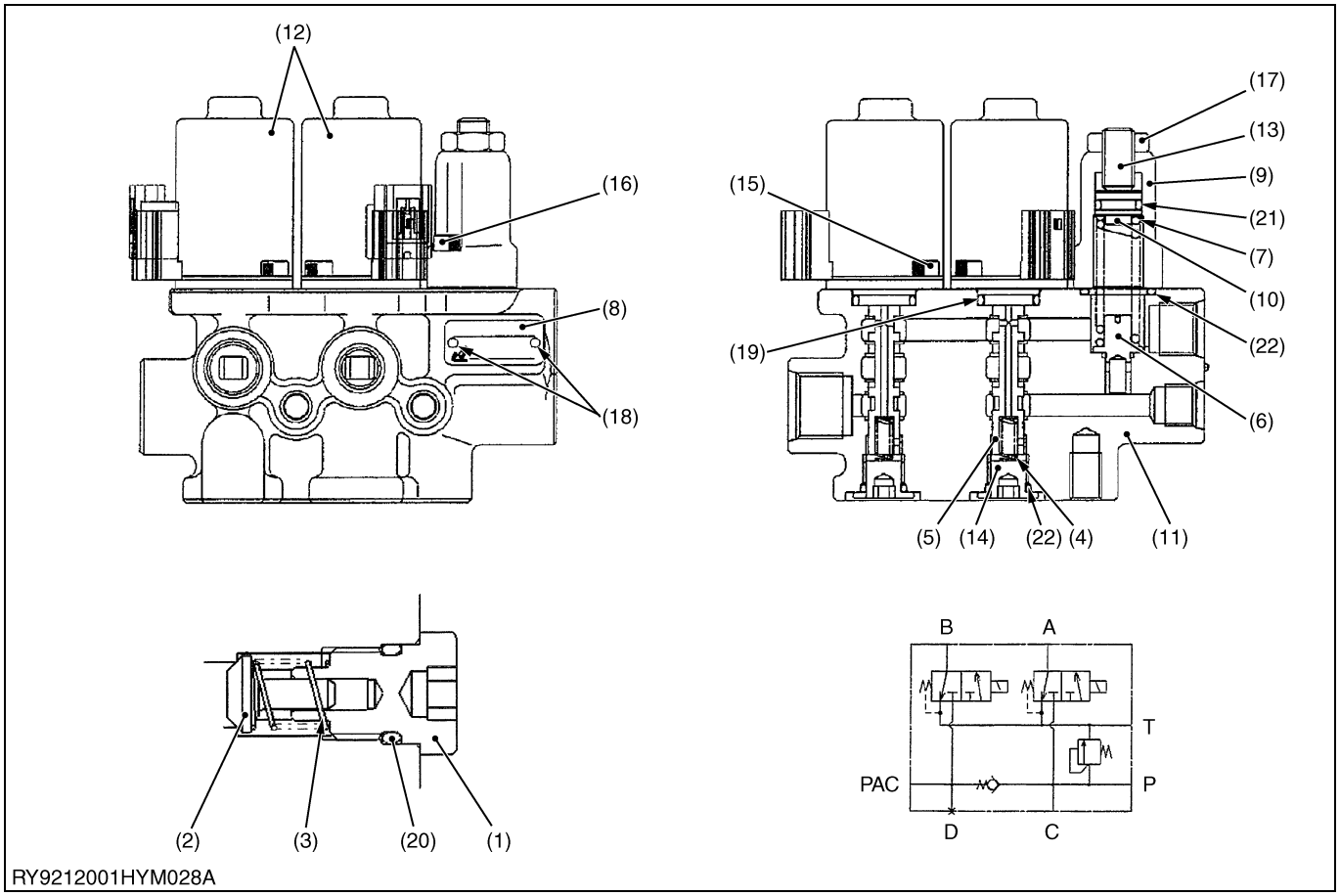
RY9212001HYM023A

(1) PAC port (accumulator)
(2) Port A (pilot operation, swivel parking brake)
(3) Port B (2-speed travel switch)
(4) Drain port (to hydraulic oil tank)
(5) Port P (to control valve)
(6) Port C (from pilot pump)
(7) Pilot primary relief valve (aPP)
(8) Check valve

Maker	Nishina Industrial	Notes
Rated Voltage	12 V	
Relief Valve Pressure Setting	3.92 +0.21 MPa 40 +3.0 kgf/cm^2 570 +43 psi	at Temp. 50 °C (144 °F), 14.7 L/min (897 cu.in./min, 3.9 USGPM)
Leak volume port P → port T	130 ml/min 7.9 cu.in./min 0.03 USGPM	at 2.5 MPa (25.5 kgf/cm^2, 363 psi)
Leak volume port PAC → other ports	90 ml/min 5 cu.in./min 0.02 USGPM	at 3.9 MPa (40.0 kgf/cm^2, 569 psi)

RY9212032HYM0021US0

(2) Components



RY9212001HYM028A

No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Plug	1		(12)	Solenoid	2	
(2)	Plunger	1		(13)	Screw adjustment	1	
(3)	Spring	1		(14)	Flanged plug	2	
(4)	Spring	2		(15)	Hex socket bolt	4	
(5)	Spool	2		(16)	Hex socket bolt	2	
(6)	Plunger	1		(17)	Hex nut	1	
(7)	Spring	1		(18)	Rivet screw	2	
(8)	Plate, name	1		(19)	O-Ring	2	
(9)	Cover	1		(20)	O-Ring	1	
(10)	Plug	1		(21)	O-Ring	1	
(11)	Body	1		(22)	O-Ring	2	

RY9212001HYM0123US0

(3) Function and Structure

[A] Function

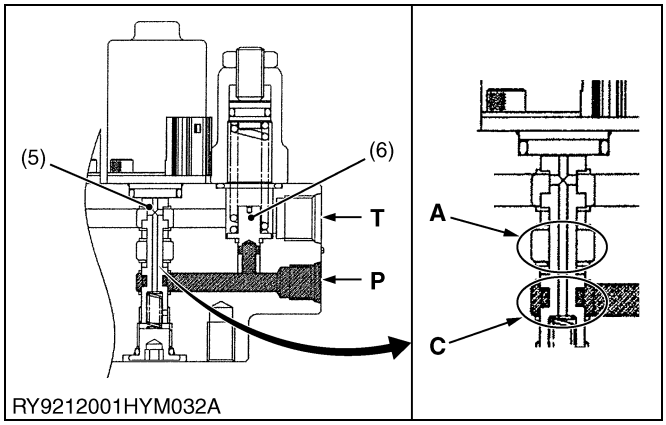
The unload valve consists of two directional change valves operated by solenoid, a check valve and a relief valve; it perform functions such as unloading control pressure from the pilot pump (returning oil to the hydraulic oil tank) and supplying control pressures to pilot valves for operation and travel, as well as to the swivel motor (for the parking brake) and the travel motor (for switching the two speeds).

RY9212001HYM0124US0

[B] Operation

With this device, oil from the pilot pump enters port C and is supplied to the control valve from port P, but that is functionally identical to when oil from the pilot pump enters from port P and supplied to the control valve from port C. Following is a description of when oil enters from port P from the pilot pump.

RY9212001HYM0125US0



RY9212001HYM032A

1. When the solenoid is off

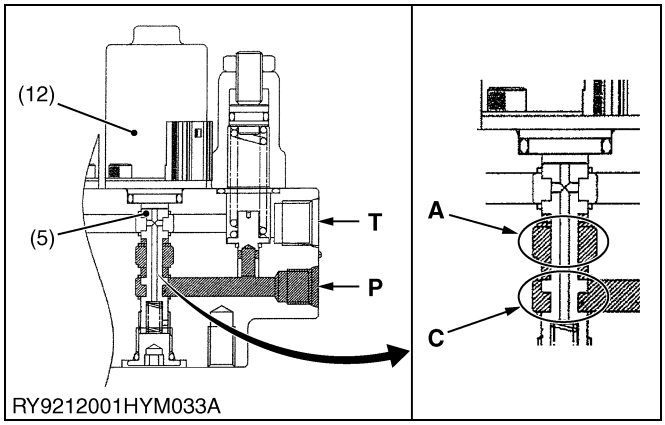
Oil from port P is cut off from passages to port A and port T by a spool (5) and plunger (6). Ports A and T are connected. And Port C and Port P are connected, so the pressures at port C and port P are always the same.

When the pressure from port P reaches the relief valve pressure setting, the oil from port P returns to the tank via the relief valve (pushes the plunger up).

(5) Spool
(6) Plunger

A : Port A
C : Port C
P : Port P
T : Port T

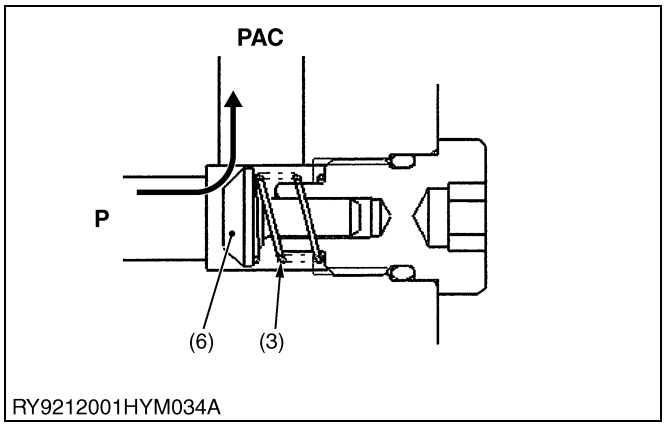
RY9212001HYM0126US0



RY9212001HYM033A

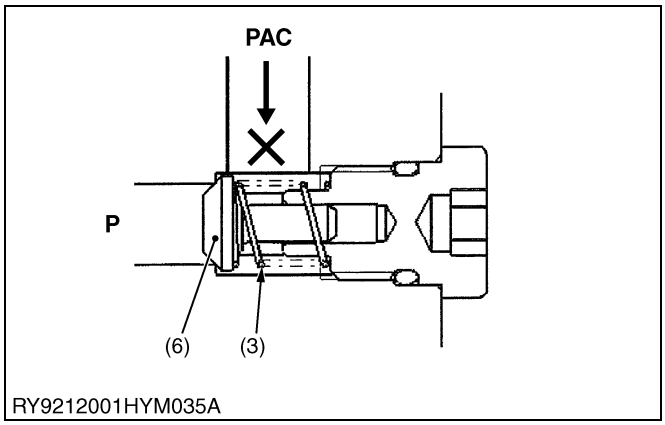
2. When the solenoid is on

When the solenoid (12) is energized, the solenoid's pushrod presses the spool (5) down, connecting port P to port A and cutting off port A and port T, so the oil from port P flows to port A.



RY9212001HYM034A

When port P pressure reaches a pressure at or greater than the spring (3), the plunger (6) moves to the right and pressure oil flows from port P to port PAC.



RY9212001HYM035A

When the pressure at port P is low, the oil from port PAC is cut off, preventing backflow.

(3) Spring
(5) Spool
(6) Plunger
(12) Solenoid

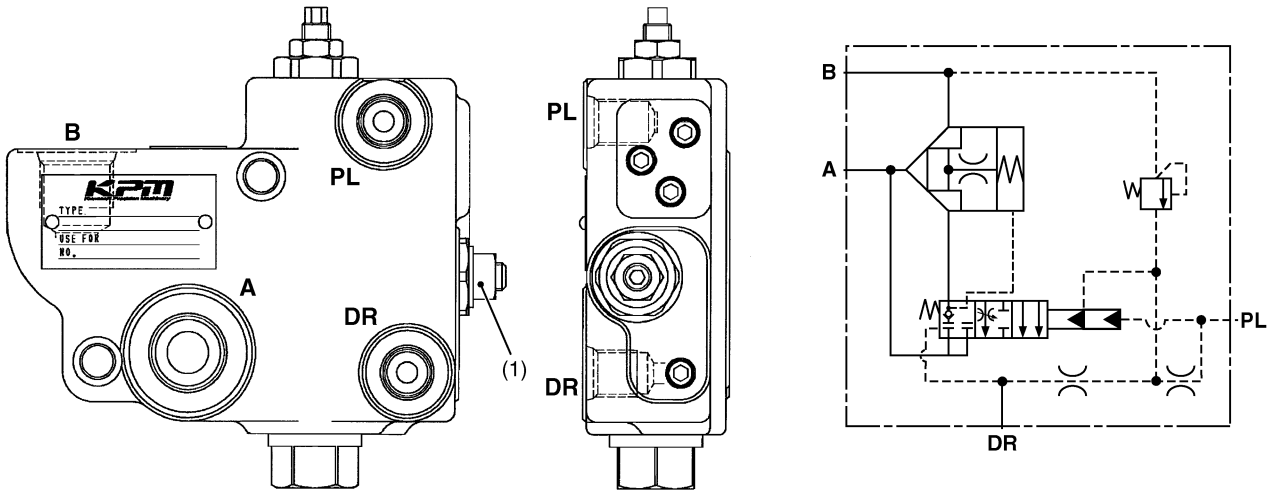
A : Port A
C : Port C
P : Port P
T : Port T

RY9212001HYM0127US0

11. HOLDING VALVE

[1] BOOM HOLDING VALVE

(1) Specifications



RY9212001HYM177A

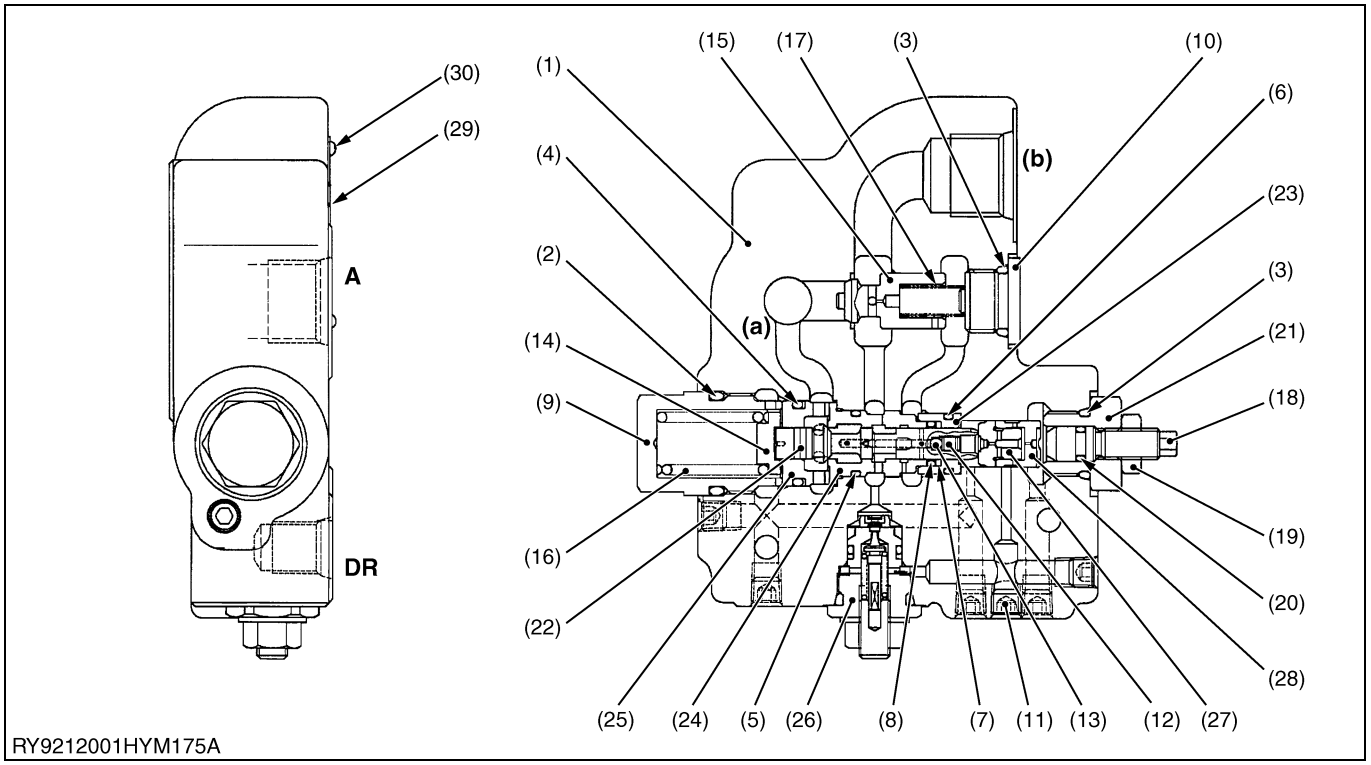
(1) Relief valve

A : Port A
B : Port B
PL : Pilot pressure port
DR : Drain port

Maker	KPM (Kawasaki Precision Machinery)	Notes
Model	KHCV10G-A101-3.0A	
Relief valve pressure setting	30.4 ±0.5 MPa 310 ±0.5 kgf/cm^2 4410 ±7.1 psi	
Leak Volume	0.8 cc/min 0.05 cu.in./min	at Temp. 50 °C (122 °F), B Port : 8.3 MPa (85 kgf/cm^2, 1200 psi) pressure

RY9212032HYM0022US0

(2) Components



RY9212001HYM175A

No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Casing	1		(16)	Spring	1	
(2)	O-Ring	1	AS568-118 (Hs90)	(17)	Spring	1	
(3)	O-Ring	2	JIS B 2401-P14 (Hs90)	(18)	Needle valve	1	
(4)	O-Ring	1	JIS B 2401-P18 (Hs90)	(19)	Hex nut	1	
(5)	O-Ring	1	AS568-015 (Hs90)	(20)	O-Ring	1	JIS B 2401-P6 (Hs90)
(6)	O-Ring	1	AS568-014 (Hs90)	(21)	Plug	1	
(7)	Backup ring	1		(22)	Spool	1	
(8)	Cap seal	1		(23)	(1) Bushing	1	
(9)	Plug	1	M26 x 1.5	(24)	Bushing (2)	1	
(10)	Plug	1	M6 x 1.5	(25)	Bushing (3)	1	
(11)	Plug	6		(26)	Relief valve	1	
(12)	Hex set screw	1		(27)	Piston A	1	
(13)	Steel ball	1		(28)	Piston B	1	
(14)	Spring seat	1		(29)	Nameplate	1	
(15)	Poppet	1		(30)	Parker coupler	2	

RY9212032HYM0023US0

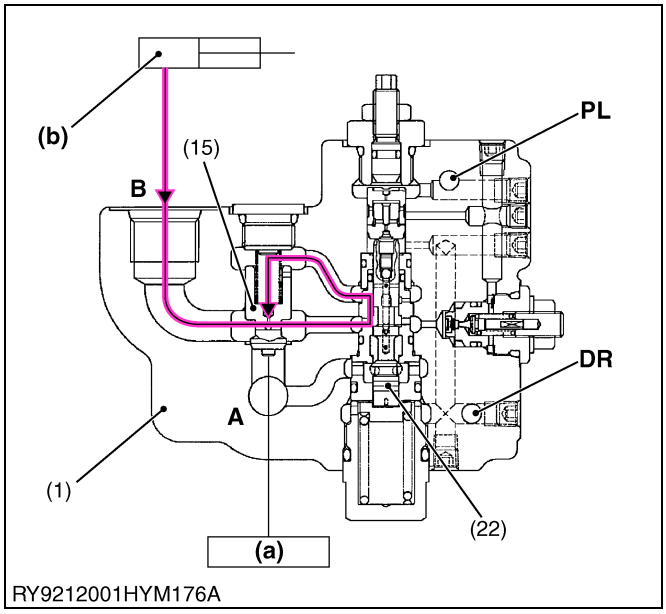
(3) Function and Structure

[A] Function

Located between the control valve and cylinder bottom side, the holding valve prevents drift of the cylinder due to leakage from the control valve as well as sudden descent of the boom in the event of a burst cylinder hose.

RY9212032HYM0024US0

[B] Operation



RY9212001HYM176A

1. During Cylinder Hold

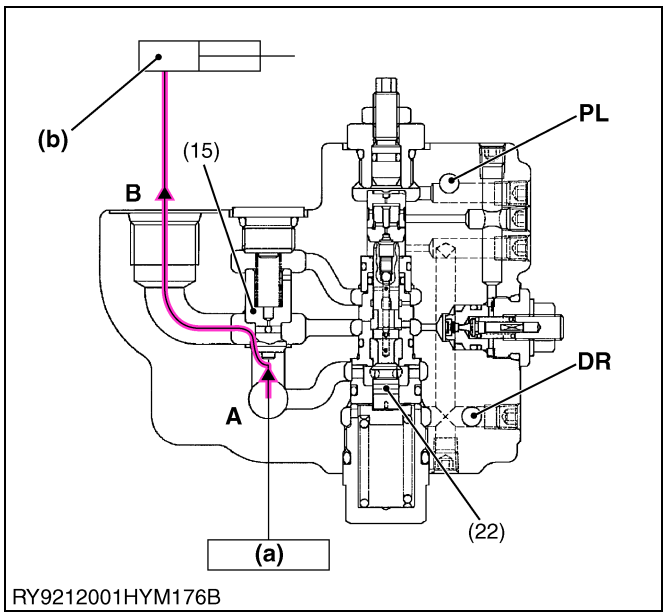
The holding pressure of boom cylinder **(b)** passes through port B, around spool (22) and is guided to the spring chamber of the poppet (15). Therefore, since the poppet is pressed onto the casing (1), it is seated. Due to this, the passage for oil returning to the boom cylinder bottom is shut off, so cylinder drift is prevented.

(1) Casing
(15) Poppet
(22) Spool

A : Port A
B : Port B
PL : Pilot pressure port
DR : Drain port

(a) Control Valve
(b) Boom Cylinder

RY9212032HYM0025US0



RY9212001HYM176B

2. Boom-up operation

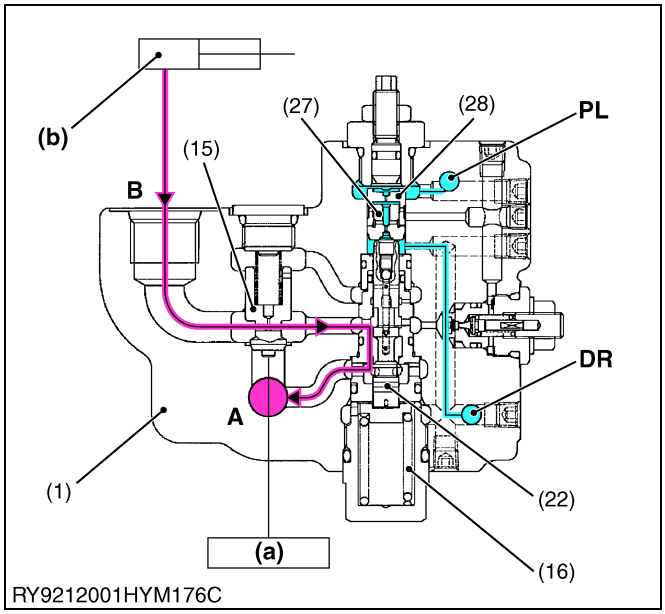
When a boom-up operation is conducted, pressure oil from control valve **(a)** passes through port A, pushes up the poppet (15), and flows from port B to the boom cylinder **(b)** bottom.

(1) Casing
(15) Poppet
(22) Spool

A : Port A
B : Port B
PL : Pilot pressure port
DR : Drain port

(a) Control Valve
(b) Boom Cylinder

RY9212032HYM0026US0



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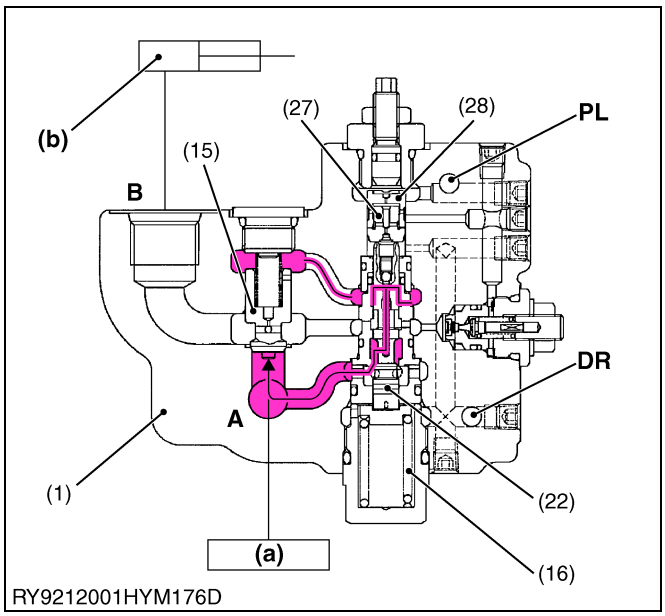

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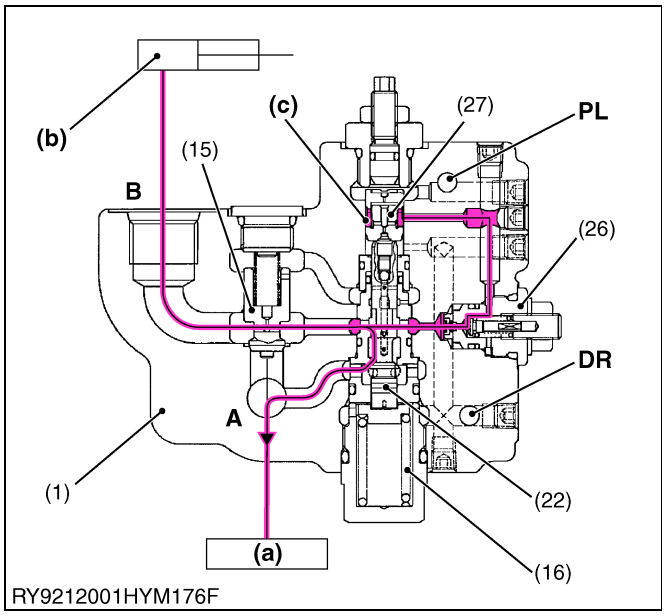


RY9212001HYM176F

3. Boom-down operation

When a boom-down operation is conducted, pressure oil flows to pilot pressure port PL; piston B (28), piston A (27) and spool (22) push against spring (16), and move downward.

Oil returning from the boom cylinder **(b)** bottom passes through port B and around the spool, and is discharged from port A to the control valve.

In addition, when the pilot pressure becomes high, the spring chamber of the poppet (15) connects with port A via an internal passage in the spool.

Due to the poppet's orifice, a pressure difference develops between port B and the spring chamber, which opens the poppet.

(1) Casing
(15) Poppet
(16) Spring
(22) Spool
(27) Piston A
(28) Piston B

(a) Control Valve
(b) Boom Cylinder

A : Port A
B : Port B
PL : Pilot pressure port
DR : Drain port

RY9212032HYM0027US0

4. During Overload

While the boom cylinder **(b)** is held, the relief valve (26) operates when the cylinder is overloaded. The hold pressure on the cylinder bottom side passes through the relief valve and is guided to the chamber K **(c)**.

Piston A (27) pushes against the spring (16) to press down the spool (22), so that oil from port B passes around the spool, though port A and the control valve **(a)**, avoiding the tank.

(1) Casing
(15) Poppet
(16) Spring
(22) Spool
(26) Relief valve
(27) Piston A

(a) Control Valve
(b) Boom Cylinder
(c) Chamber K

A : Port A
B : Port B
PL : Pilot pressure port
DR : Drain port

RY9212032HYM0028US0

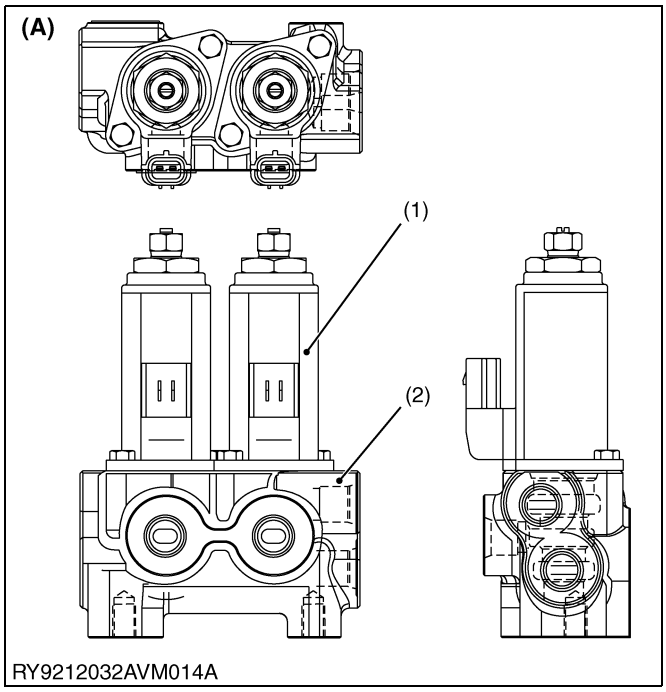
12. SERVICE PORT

[1] SERVICE PORT

(1) Specifications

Proportional Control Solenoid Valve (S/P Valve)

This valve is an electromagnetic solenoid valve. Normally, a solenoid valve is turned off and on via 12V battery voltage, but this valve is controlled via pulsed signals from the computer built into the ECU and the meter panel. (Duty Control)



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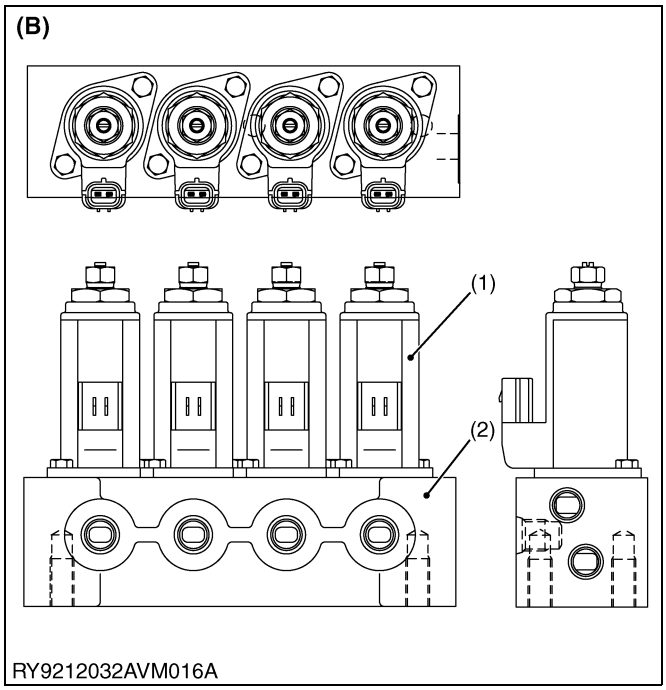


RY9212032AVM016A

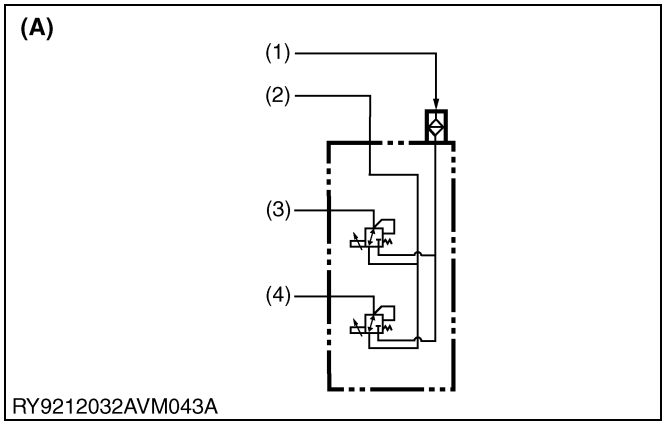
Item	Specifications
Max operating pressure (input pressure)	3.9 MPa 40 kgf/cm^2 570 psi
Allowable back pressure (pressure T)	1.0 MPa 10 kgf/cm^2 100 psi
Maximum proportional valve operating flow volume (input flow volume)	15.6 L/min, 4.1 GPM
Drain volume when solenoid off	AUX1: 0.4 L/min ≥ AUX1, 2: 0.8 L/min ≥ (At 20 cST, port P pressure = 4.9 MPa, 50 kgf/cm^2, 710 psi)
Waterproof Standard	JIS D 0203 S2 equivalent
Vibration Proof Standard	JIS D 1601–1995
Hydraulic Oil Grade	ISO VG32 to 68 equivalent
Hydraulic Oil Contamination Level	NAS Class 10 ≥
Electrical Specifications	Rated Amperage: 1600 mA Coil resistance: 3.2 ± 0.5 Ω (at 20 °C, 68 °F)
Second pressure control range	0 to 2.7 MPa 0 to 27 kgf/cm^2 0 to 390 psi

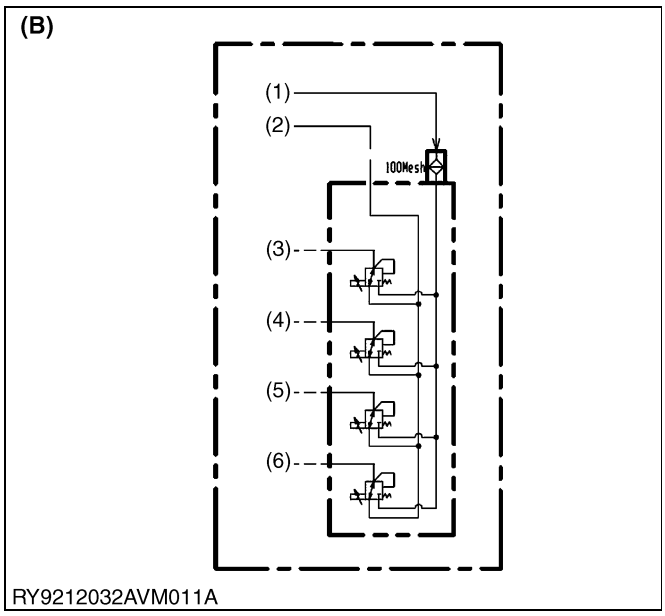
(1) Solenoid
(2) Case

(A) AUX1
(B) AUX1, 2

RY9212032HYM0035US0

Hydraulic Circuit Diagram

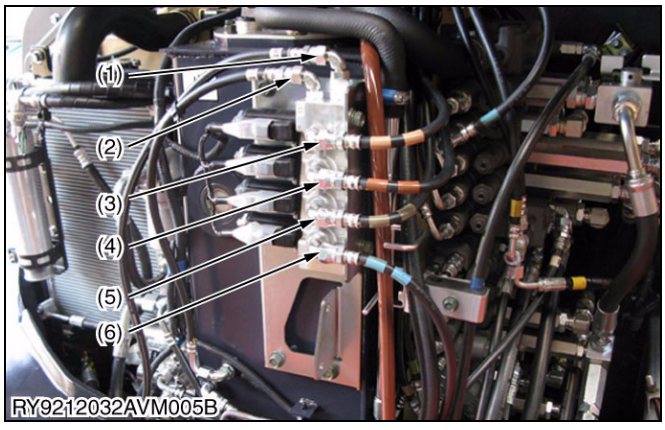


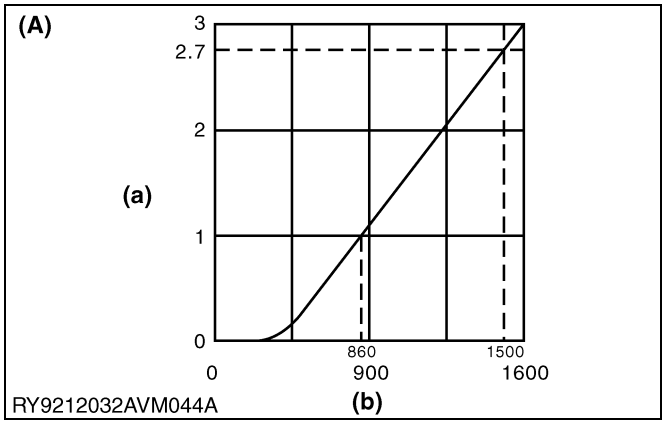


(1) Port P
(2) Port T
(3) AUX1 high pressure port
(4) AUX1 low pressure port
(5) AUX2 high pressure port
(6) AUX2 low pressure port

(A) AUX1
(B) AUX1, 2

RY9212032HYM0033US0





(1) Port P
(2) Port T
(3) AUX1 high pressure port
(4) AUX1 low pressure port
(5) AUX2 high pressure port
(6) AUX2 low pressure port

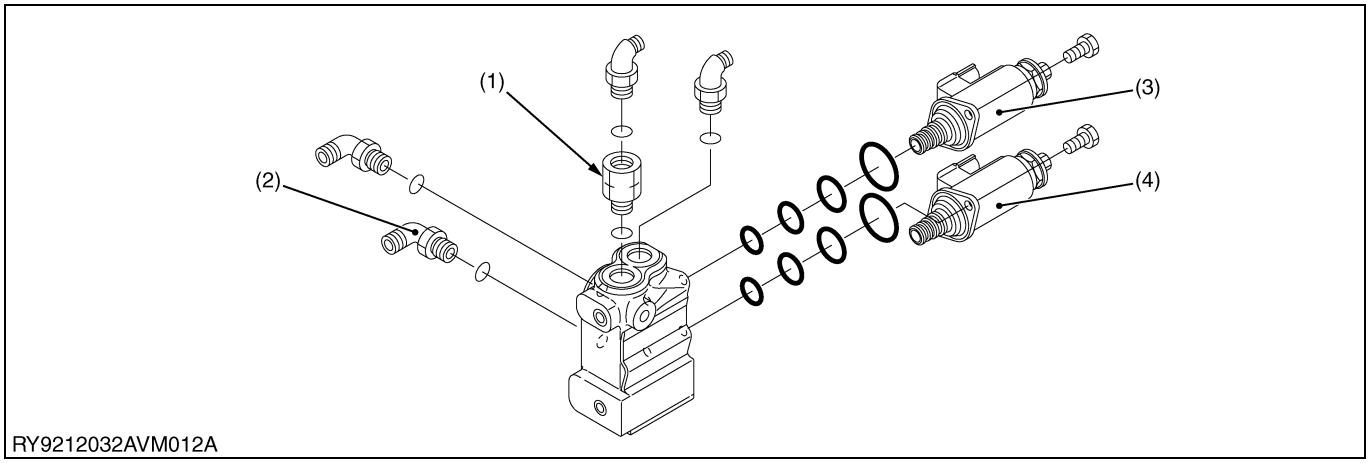
(A) Control diagram

(a) Secondary pressure (MPa)
(b) Input current (mA)

RY9212032HYM0037US0

(2) Components

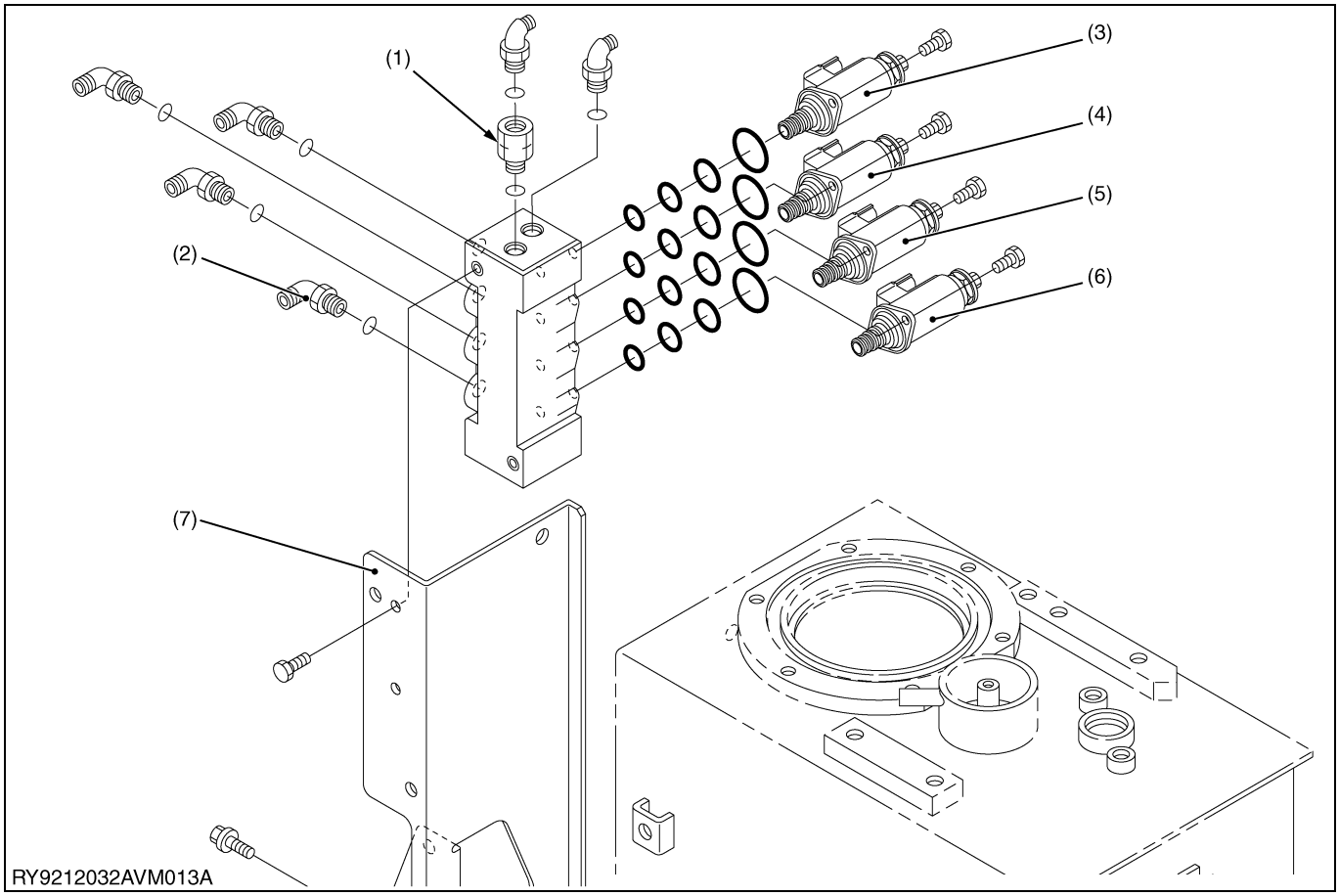
AUX1



(1) Filter (2) Adapter (3) AUX1 (SP1 High) (4) AUX1 (SP1 Low)

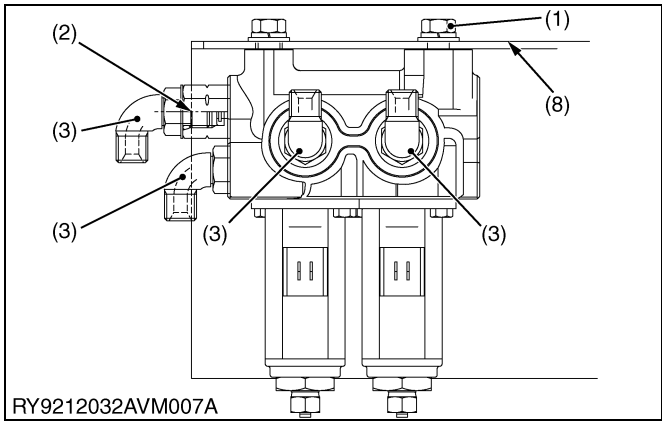
RY9212032HYM0038US0

AUX1, 2



(1) Filter (3) AUX1 (SP1 High) (5) AUX2 (SP2 High) (7) Base
(2) Adapter (4) AUX1 (SP1 Low) (6) AUX2 (SP2 Low)

RY9212032HYM0039US0



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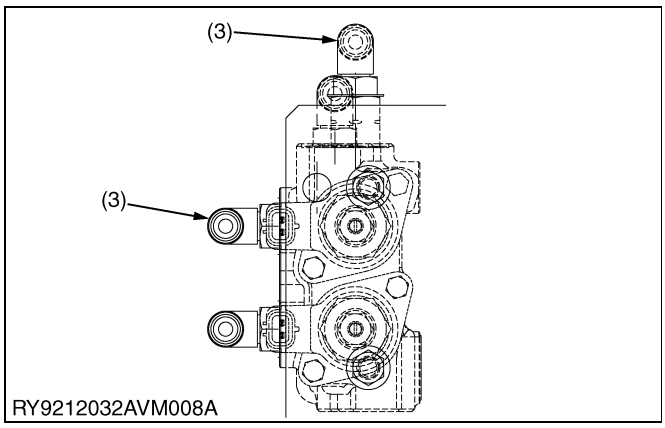

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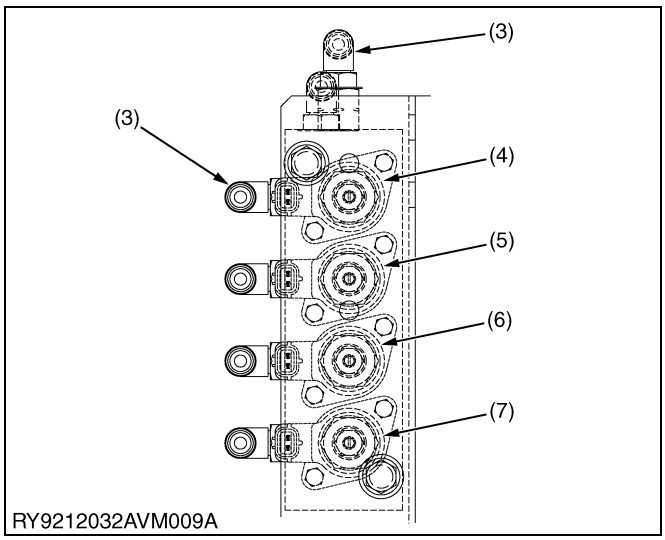

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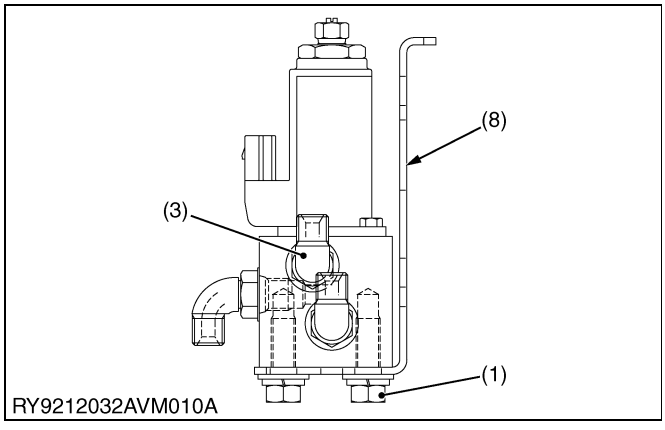


RY9212032AVM010A

Solenoid Valve Installation

1. Adapter (3) installation (install as in the figure at left)
2. Adapter size: G1/4

Tightening torque	Adapter (3)	24.5 to 29.4 N·m 2.5 to 3.0 kgf·m 18.1 to 21.7 lbf·ft

Be careful of hose contact when connecting.

For AUX1 Specification

3. Installation to the base (valve) (8)

Tightening torque	M8 bolt (1)	23.5 to 27.5 N·m 2.4 to 2.8 kgf·m 17.4 to 20.2 lbf·ft

When equipped with both AUX 1 and 2

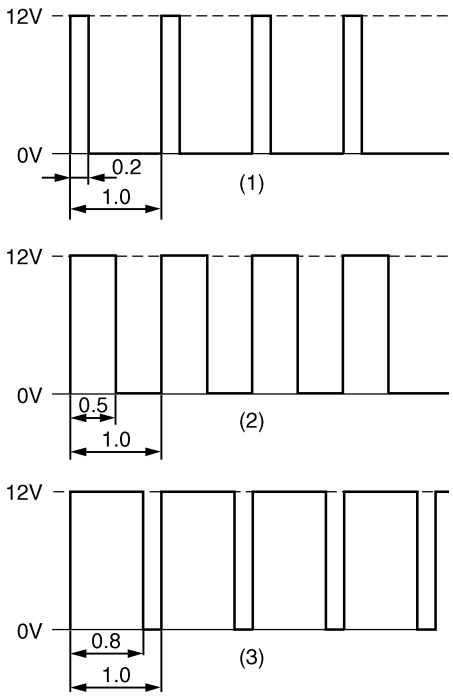
Tightening torque	M10 bolt (1)	39.2 to 45.1 N·m 4.0 to 4.6 kgf·m 28.9 to 33.3 lbf·ft

(1) Bolt
(2) Filter
(3) Adapter
(4) AUX1 (SP1 High)
(5) AUX1 (SP1 Low)
(6) AUX2 (SP2 High)
(7) AUX2 (SP2 Low)
(8) Base

RY9212032HYM0040US0

(3) Function and Structure

[A] Function



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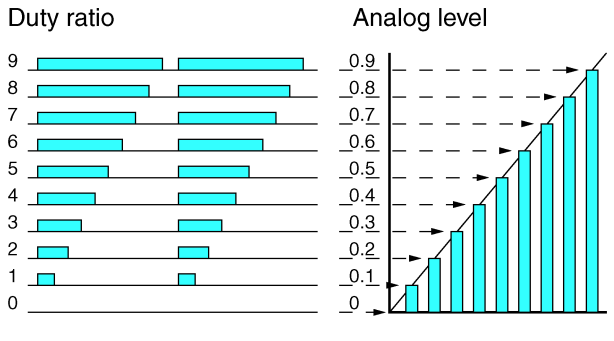


RY9212032AVM028A

PWM (Pulse Width Modulation) Control

A PWM circuit is a method for controlling an actuator by changing the duty cycle (ratio between pulse width H and L), given a fixed cycle, of the pulse width according to the magnitude of the input signal.

PWM control is an advanced form of pulse control method and this method freely alters the width of the on pulses of electricity.

In other words, PWM controls the energy supplied to the actuator (cylinder) by controlling the pulse width.

- With the duty ratio (small at 20 %) of (1), the cylinder only slightly in response, and the off time is the longest.
- In (2) the duty ratio is 50 %, so the on time and off time are equal, representing the middle of the control circuit.
- In (3) the duty ratio of 80 % exerts the most energy, which is reflected in the substantial movement of the cylinder.

In short, PWM achieves its effect by controlling the ratio of on-off time. This switching time is extremely short.

RY9212032HYM0041US0

Merits:

Very little power is lost and fine movements of work equipment can be controlled.

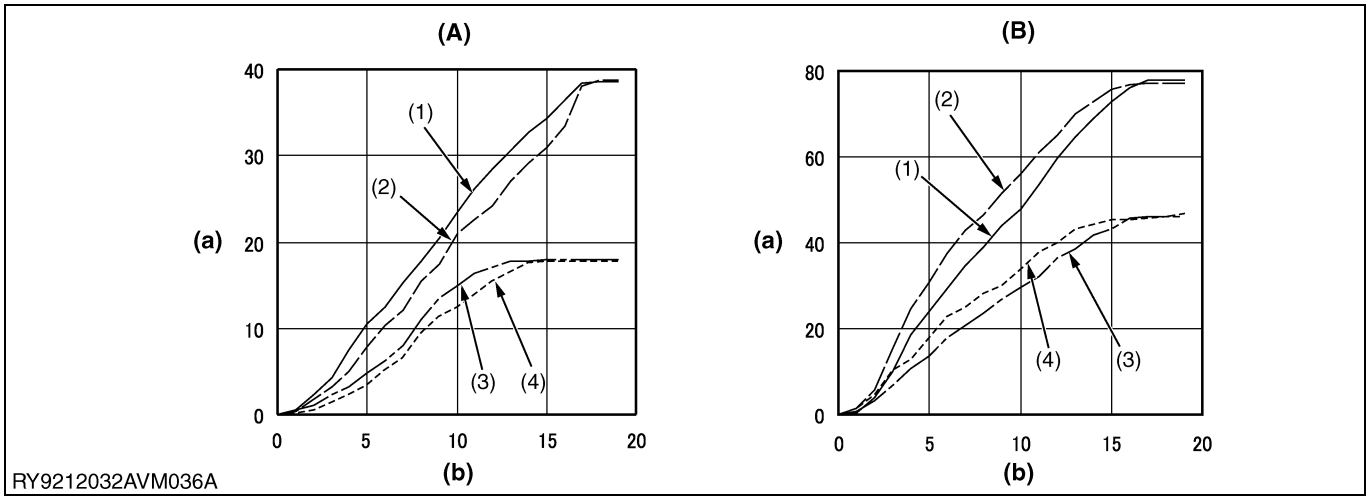
Demerits:

The circuitry is complex. And this complexity can easily lead to high rates of failure and increased costs.

- PWM Cycle and Analog Strength Levels
  The figure at left takes a motor as an example and shows the relationship between the duty ratio and analog strength. Even though previously it was difficult to control the analog strength, with PWM control it is easy to achieve precise control by manipulating the duty ratio.

RY9212032AVM0023US0

Relationship between Lever Operation and Hydraulic Flow (Proportional Control)



(1) Right (Max)
(2) Left (Max)
(3) Right (Idle)
(4) Left (Idle)
(A) AUX2
(B) AUX1
(a) Flow volume L/min
(b) Operating lever knob (limit value)

The relationship between pressure P, flow Q and lever knob operation (limit value) changes proportionally as shown in the figures above.

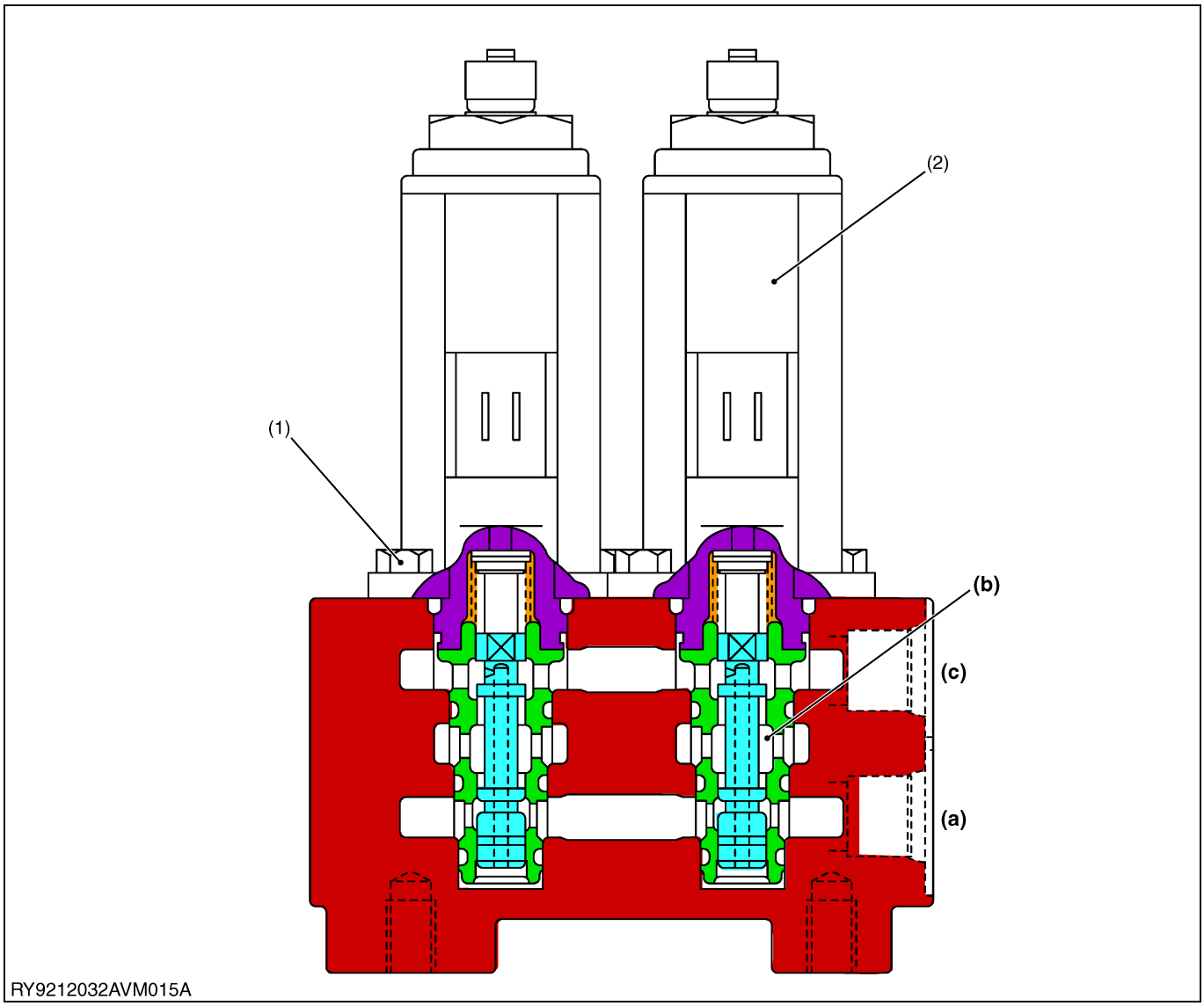
CAUTION

- **There is deviation between machines on account of the n = 1 measurement being entered.**

RY9212050HYM0008US0

[B] Structure

Solenoid Valve Cross-section (AUX1 Spec)



RY9212032AVM015A

(1) Hex bolt (M5x0.8) (2) Proportional control solenoid **(a) Port P** **(b) Port A** **(c) Port T**

Tightening torque	Hex bolt (1)	7 ± 1 N·m 0.7 ± 0.1 kgf·m 5.2 ± 0.7 lbf·ft

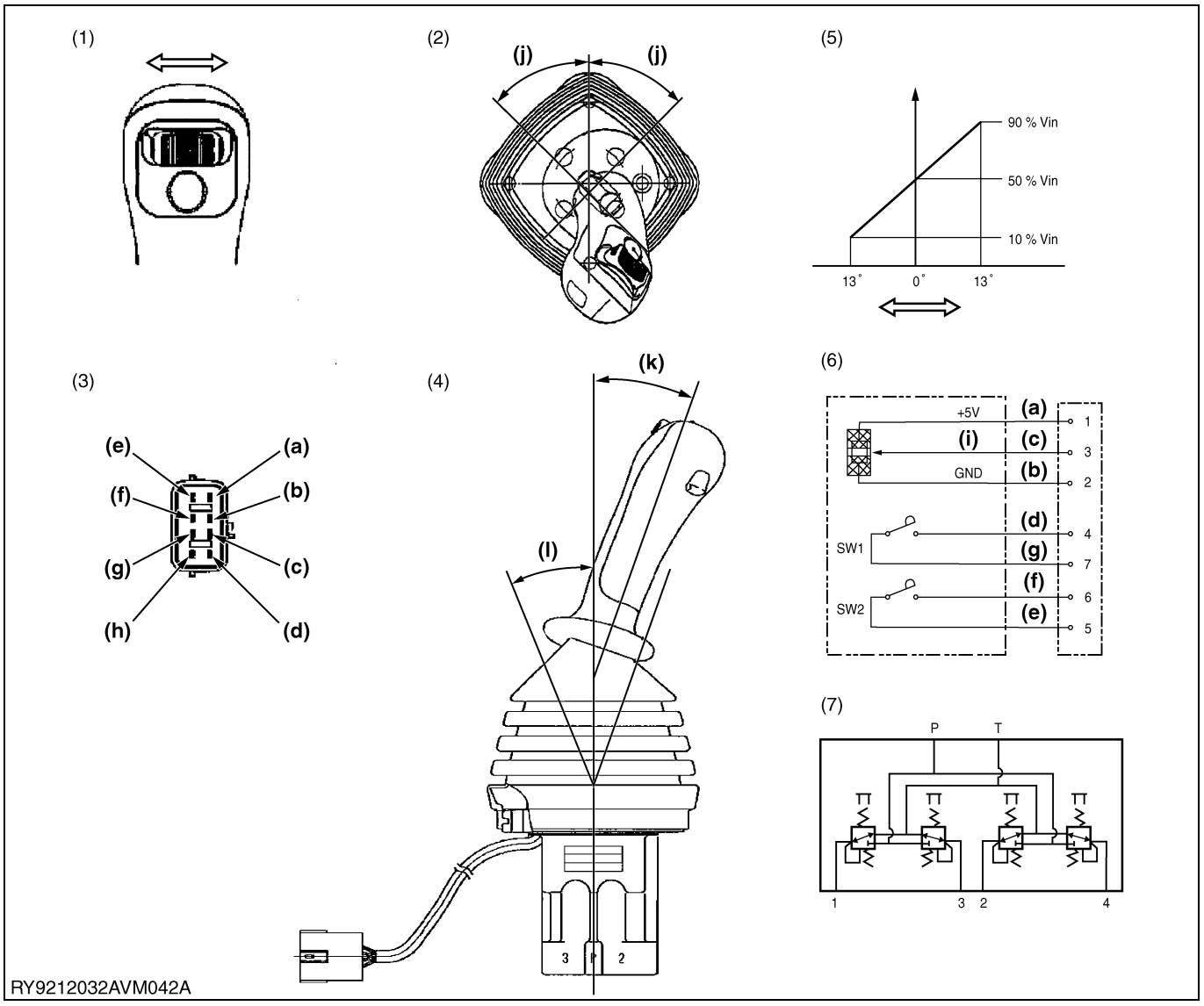
■ **NOTE**

- **The adjustment nut on top of the solenoid is set in advance when shipped from the factory.**
- **Service port flow. Do not adjust the feel with this nut. (Adjust according to the digital panel procedures.)**

RY9212032AVM0012US0

Knob Switch Configuration and Functions

Operating lever right



(1) Knob's slide switch
(2) Remote operation control knob (w/ one-way hold)
(3) Harness coupler
(4) Side view of entire knob
(5) Knob characteristics
(6) Characteristic circuit diagram
(7) Diagram of Hydraulic Circuit

(a) Red
(b) Black
(c) White
(d) Blue
(e) Gray
(f) Yellow
(g) Green
(h) Blanking pin
(i) Proportional control
(j) 45 °
(k) 19 °
(L) 21.5 °

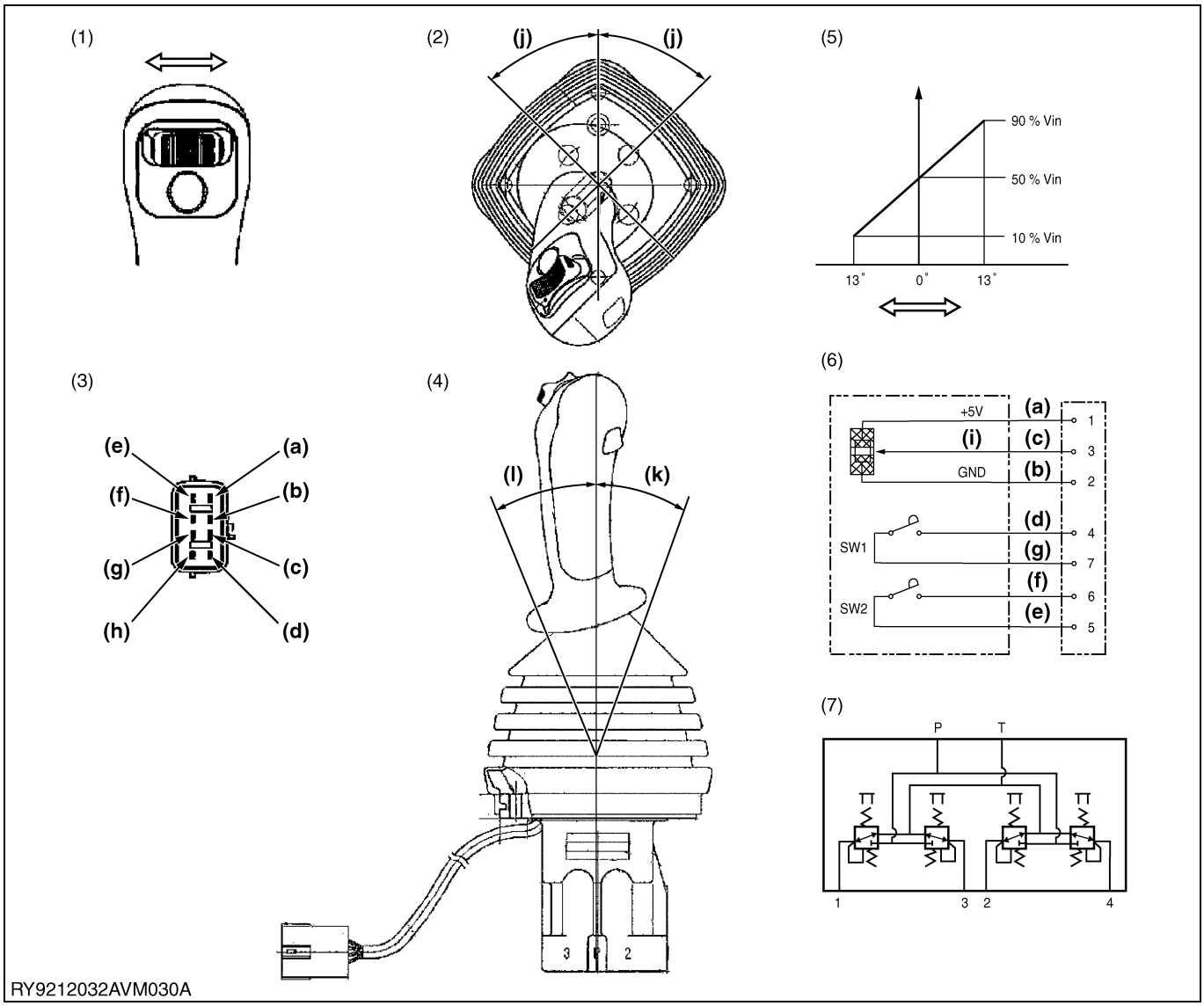
This knob switch comes equipped with an IC chip that processes the signal of the potentiometer.

1. Service mode: set up in the service mode of the meter panel.
2. Knob control: Output can be controlled with the left/right knob switch to suit operating conditions.
3. Breaker operation: the button on the front of the operation lever can be used to switch to one-way hold.

RY9212032HYM0044US0

Knob Switch Configuration and Functions

Operating lever left



(1) Knob's slide switch
(2) Remote operation control knob (w/ one-way hold)
(3) Harness coupler
(4) Side view of entire knob
(5) Knob characteristics
(6) Characteristic circuit diagram
(7) Diagram of Hydraulic Circuit

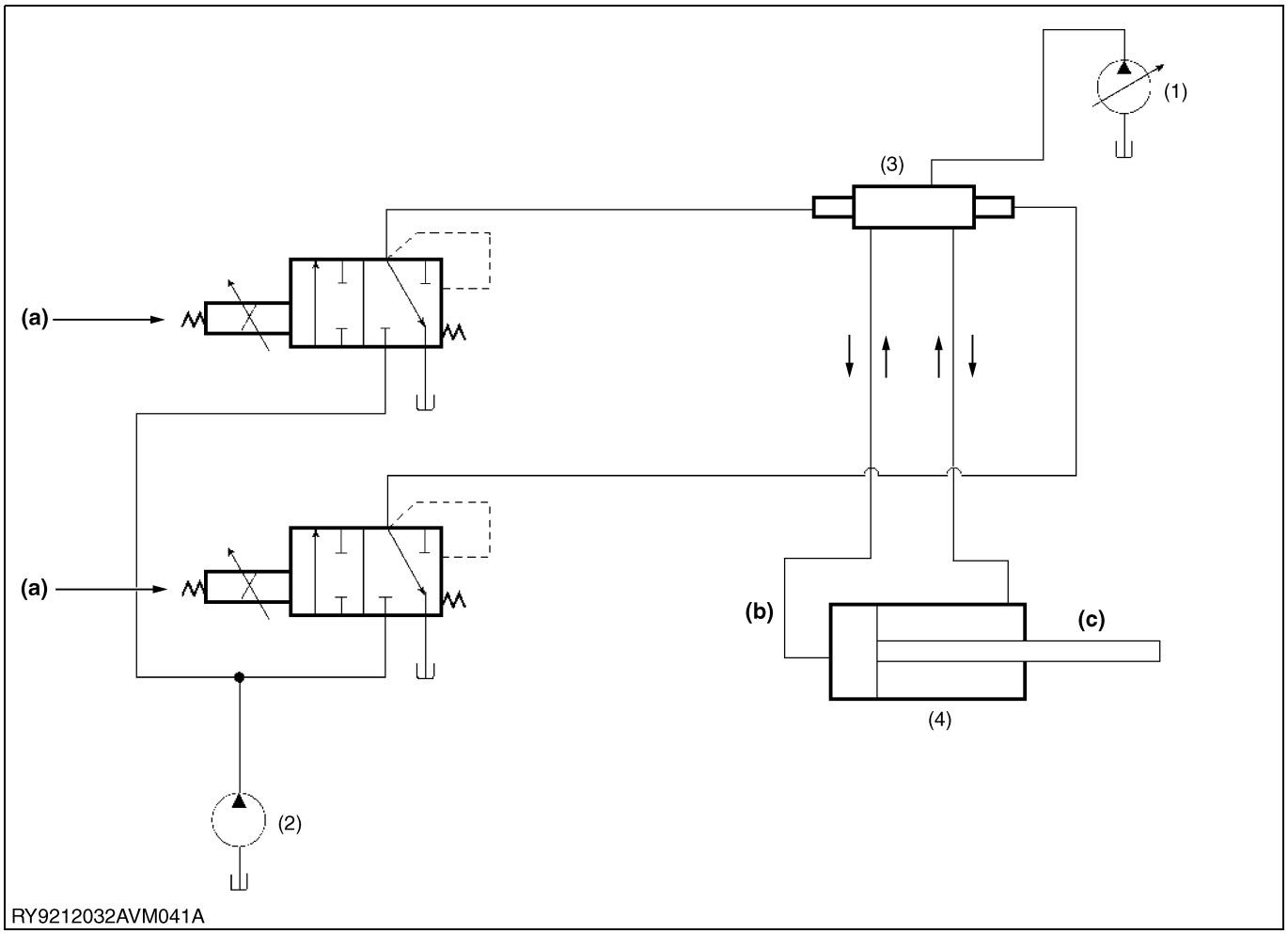
(a) Red
(b) Black
(c) White
(d) Blue
(e) Gray
(f) Yellow
(g) Green
(h) Blanking pin
(i) Proportional control
(j) 45 °
(k) 19 °
(L) 21.5 °

This knob switch comes equipped with an IC chip that processes the signal of the potentiometer.

1. Service mode: set up in the service mode of the meter panel.
2. Knob control: Output can be controlled with the left / right knob switch to suit operating conditions.

RY9212032HYM0045US0

(Ex.) Thumb Hydraulic Circuit Diagram



(1) Main pump
(2) Main pump Pp
(3) Main control valve, service port section
(4) Thumb cylinder

(a) PWM signal
(b) Bottom (Thumb crowd)
(c) Rod (Thumb dump)

RY9212032AVM0029US0

SERVICING

CONTENTS

1. PUMP 3-S1
   [1] PUMP DISASSEMBLY / ASSEMBLY 3-S1
   [2] PUMP DISASSEMBLY PROCEDURES 3-S7
      (1) Disassembly Procedures 3-S8
      (2) Assembly Procedures 3-S15
   [3] SPECIAL TOOLS 3-S21
   [4] STANDARDS FOR REPLACING PUMP PARTS 3-S22
2. CONTROL VALVE 3-S23
   [1] CONTROL VALVE REMOVAL 3-S23
   [2] CONTROL VALVE DISASSEMBLY / ASSEMBLY PROCEDURES 3-S26
3. SWIVEL MOTOR 3-S41
   [1] REMOVAL AND INSTALLATION OF THE SWIVEL MOTOR 3-S41
   [2] SWIVEL MOTOR ASSEMBLY PROCEDURES 3-S44
      (1) Assembly Procedures 3-S46
4. SWIVEL JOINT 3-S55
   [1] SWIVEL JOINT 3-S55
5. TRAVEL MOTOR 3-S57
   [1] REMOVAL AND INSTALLATION OF THE TRAVEL MOTOR 3-S57
   [2] TRAVEL MOTOR DISASSEMBLY / ASSEMBLY PROCEDURES 3-S60
      (1) Disassembly Procedures 3-S62
      (2) Assembly Procedures 3-S72
   [3] SPECIAL TOOLS 3-S86
6. HYDRAULIC CYLINDER 3-S89
   [1] HYDRAULIC CYLINDER DISASSEMBLY / ASSEMBLY PROCEDURES 3-S89
      (1) Cylinder Components 3-S89
      (2) Disassembly Procedures 3-S91
      (3) Assembly Procedures 3-S95
7. PILOT VALVE (CONTROL) 3-S102
   [1] PILOT VALVE (CONTROL) ASSEMBLY 3-S102
   [2] PILOT VALVE (CONTROL) DISASSEMBLY / ASSEMBLY PROCEDURES 3-S104
      (1) Pilot valve components 3-S104
      (2) Disassembly 3-S104
      (3) Assembly 3-S108
      (4) U-joint Tightening Tool 3-S111
8. PILOT VALVE (TRAVEL) 3-S112
   [1] PILOT VALVE (TRAVEL) ASSEMBLY 3-S113
   [2] PILOT VALVE (TRAVEL) DISASSEMBLY / ASSEMBLY PROCEDURES 3-S114
      (1) Disassembly Procedures 3-S114
      (2) Assembly Procedures 3-S118
9. PILOT VALVE (BLADE, SWING) 3-S123
   [1] PILOT VALVE (BLADE, SWING) ASSEMBLY 3-S123
   [2] PILOT VALVE (BLADE, SWING) DISASSEMBLY / ASSEMBLY PROCEDURES 3-S125
      (1) Disassembly 3-S125
      (2) Assembly 3-S129
10. UNLOAD VALVE 3-S133
   [1] UNLOAD VALVE ASSEMBLY 3-S133
   [2] UNLOAD VALVE DISASSEMBLY / ASSEMBLY PROCEDURES 3-S134
      (1) Disassembly / Assembly Procedures 3-S135

11. THIRD LINE VALVE ASSEMBLY 3-S138
[1] THIRD LINE VALVE ASSEMBLY COMPONENTS 3-S138
[2] THIRD LINE HOSE ROUTE 3-S139
12. ROUTING OF HYDRAULIC HOSES 3-S140
[1] TABLE OF HYDRAULIC HOSES 3-S140
(1) Hydraulic Hoses 3-S140
(2) Table of High-Pressure Hoses 3-S141
(3) Deliver Hose Routing 3-S142
(4) Delivery Hose Clamp Positions 3-S143
(5) Suction Pipe and Hose Routing 3-S144
(6) Installation of Pipes (suction) 3-S145
(7) Front Hose Routing 3-S145
(8) High-pressure Hydraulic Hose Routing (Front) 3-S146
(9) High-pressure Hydraulic Hose Routing (Travel, Swivel, Blade, Swing) 3-S146
(10)Swivel Hose Routing (KX057-4) 3-S147
(11)High-pressure Hydraulic Hose Routing (Travel, Blade Swivel) 3-S147
(12)Hose Routing Inside the Track Frame 3-S148
[2] TABLE OF HYDRAULIC HOSES (LOW-PRESSURE HOSES) 3-S149
(1) Table of Low-Pressure Hoses 3-S149
(2) Table of Protective Tubing 3-S149
(3) Drain Hose Routing 3-S150
[3] TABLE OF HYDRAULIC HOSES (PILOT HOSES) 3-S151
(1) Table of Pilot Hoses 3-S151
(2) Pilot Hose Routing 1 (P) 3-S153
(3) Pilot Hose Routing 2 (P) 3-S153
(4) Pilot Hose Routing (T) 3-S154
(5) Pilot Hose Routing (Front) 3-S154
(6) Pilot Hose Routing (Travel, Blade, Swing, AUX1, AUX2) 3-S155
(7) Pilot Hose Routing (Control Valve) 3-S156
(8) Overall Routing of Pilot Hoses (Front of Machine) 3-S157
(9) Overall Routing of Pilot Hoses (Right of Machine) 3-S158
(10)Pilot Hose Routing (around the driver's seat) 3-S159
13. BOOM HOLDING VALVE 3-S160
[1] BOOM HOLDING VALVE DISASSEMBLY / ASSEMBLY PROCEDURES 3-S160
(1) Boom Holding Valve Components 3-S160
(2) Disassembly Procedures 3-S161
(3) Assembly Procedures 3-S163
(4) Valve Assy Components 3-S165
(5) Assembling Valve Assy 3-S166
[2] GUIDE TO RELEASING THE HOLDING VALVE 3-S167
14. MEASURING HYDRAULIC DEVICE PERFORMANCE 3-S168
15. TROUBLESHOOTING 3-S187

1. PUMP

[1] PUMP DISASSEMBLY / ASSEMBLY

CAUTION

- **When removing a hydraulic device after operating the mini-excavator, lower the bucket and blade to the ground and turn off the engine.**
- **Each of the devices and the hydraulic oil are hot and under high pressure immediately after operating the mini-excavator. If the hydraulic oil reached a high operating temperature, it may cause a burn.**
- **Oil gushing out under pressure has enough force to pierce your skin and may cause you injury. Always allow the temperature to drop and relieve any remaining pressure prior to working to remove any hydraulic equipment.**

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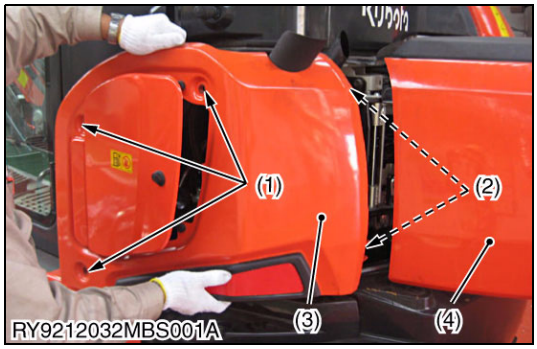
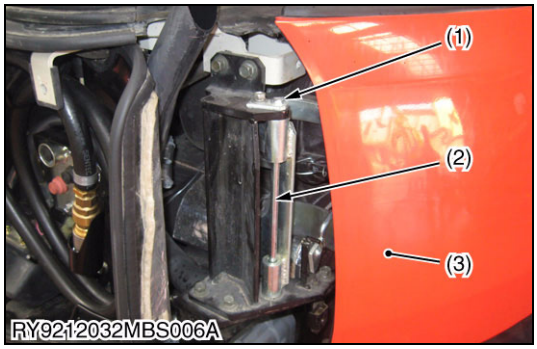


Removing the bonnet (left)

1. Remove five mounting bolts (1), (2) of the bonnet (left) (3) and remove the bonnet (left) (3).

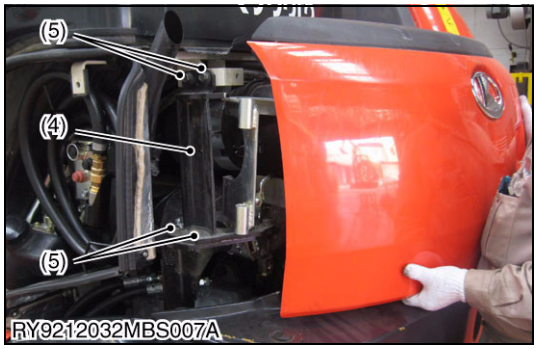
(1) Bolt (M10 × 35)
(2) Bolt (M10 × 25)
(3) Bonnet (left)
(4) Bonnet (rear)

RY9212032MBS0001US0



Removing the bonnet (rear)

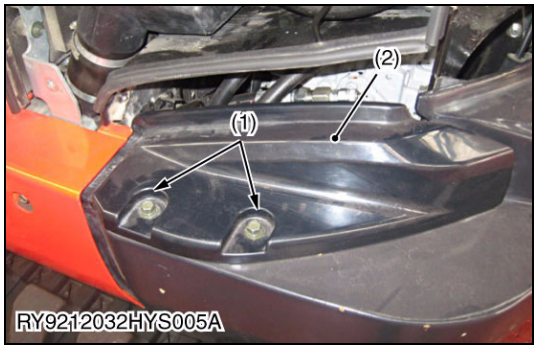
1. Remove the bolt (1), pull out the pin (2), and remove the bonnet (rear) (3).



2. Remove the mounting bracket (4) and four mounting bolts (5) of the bonnet (rear) and remove the bracket (4).

(1) Bolt (M8 × 16)
(2) Pin
(3) Bonnet (rear)
(4) Bracket
(5) Bolt (M10 × 20)

RY9212032MBS0002US0

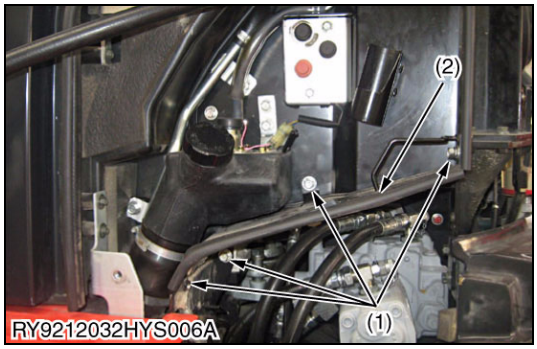


Removing the cover

1. Remove the bolts (1) in two locations, and remove the cover (2).

(1) Bolt (M10 × 2)
(2) Cover

RY9212032HYS0003US0

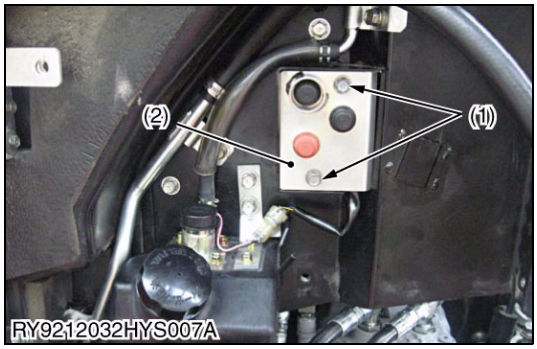


Removing the plate

1. Remove the bolts (1) in four locations, and remove the plate (partition 2) (2).

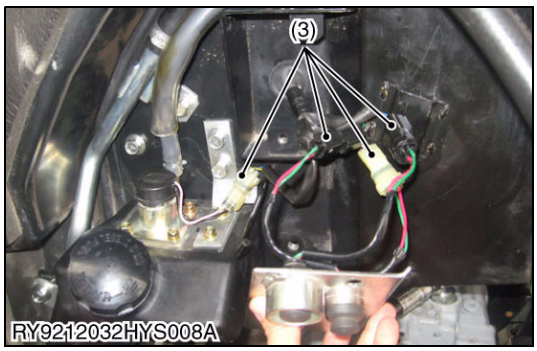
(1) Bolt (M10 × 20)
(2) Plate (partition 2)

RY9212032HYS0004US0



Removing the cover (switch box)

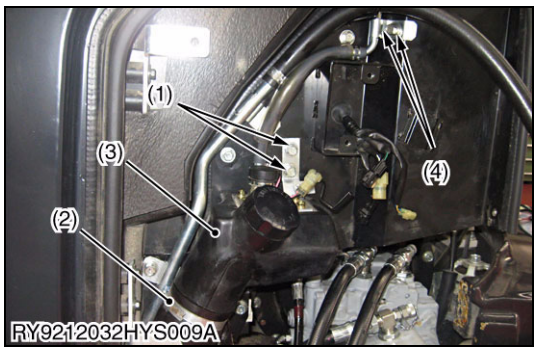
1. Remove the bolts (1) in two locations, and remove the cover (switch box) (2).



2. Remove the couplers (3) in five locations.

(1) Bolt (M8 × 16)
(2) Cover (switch box)
(3) Coupler

RY9212032HYS0005US0



Removing the tank and assembly (fuel subassembly)

1. Loosen the hose clamp (2), and remove the bolts (1) in two locations and bolts (4) in 2 locations.
2. Remove the hose from the tank and assembly (fuel subassembly) (3).

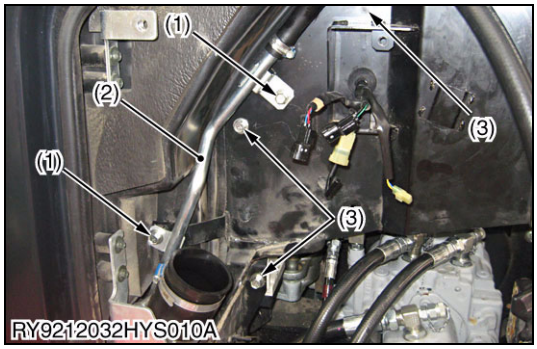
CAUTION

- **With the hose connected to the tank and assembly (fuel subassembly) (3), leave bolts (1) temporarily in place, as shown in the illustration.**
- **Tighten the hose clamp (2) to the specified torque.**
- **Tighten the bolts (1) to the specified torque.**

Tightening torque	Hose clamp (2)	2.9 to 3.9 N·m 0.2 to 0.3 kgf·m 2.2 to 2.8 lbf·ft

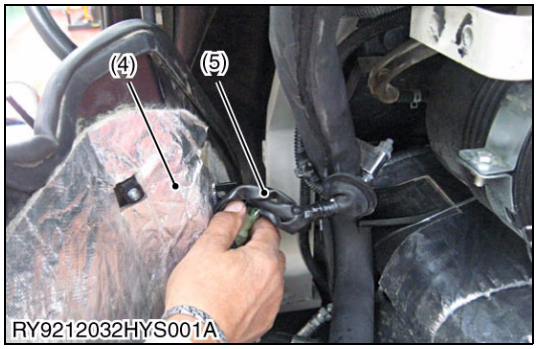
(1) Bolt (M10 × 20)
(2) Hose clamp (77-95)
(3) Fuel tank, assembly (sub)
(4) Bolt (M10 × 20)

RY9212032HYS0006US0



Removing the plate (partition, 1)

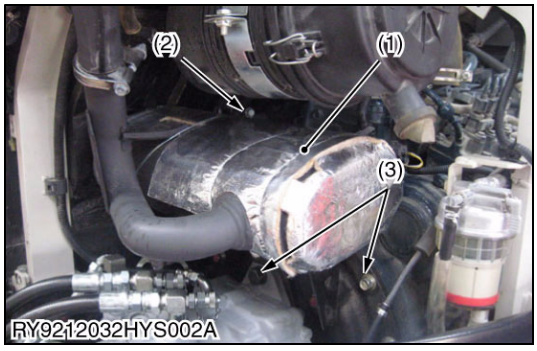
1. Remove the bolts (1), and remove the pipe (FS) (2) from the plate (partition 1) (4).



2. Remove the bolts (3), and after pulling the wire harness (5) off the plate (partition 1) (4), remove the plate (partition 1) (4) from the machine.

(1) Bolt (M10 × 20)
(2) Pipe (FS)
(3) Bolt (M10 × 20)
(4) Plate (partition 1)
(5) Wire harness

RY9212032HYS0007US0

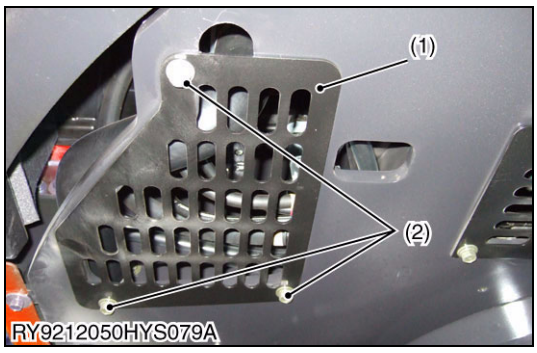


Removing the muffler assembly

1. Loosen the pipe (muffler) clamp (2), remove the bolts (3) in three locations, and remove the muffler assembly (1).

(1) Muffler assembly
(2) Band (muffler pipe)
(3) Bolt (M10 × 25)

RY9212032HYS0008US0

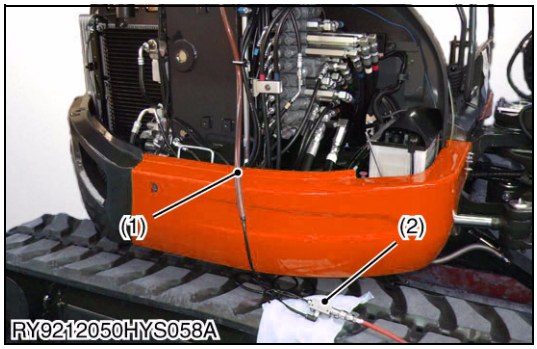


Removing the pump bottom cover

1. Remove the bolts (2) in three locations, and remove the bottom cover (1) from the underside of the pump.

(1) Cover
(2) Bolt (M10 × 20)

RY9212032HYS0079US0

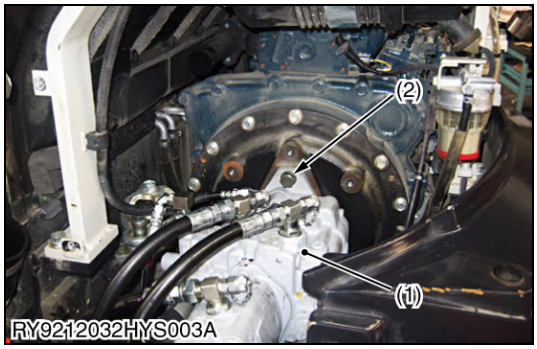


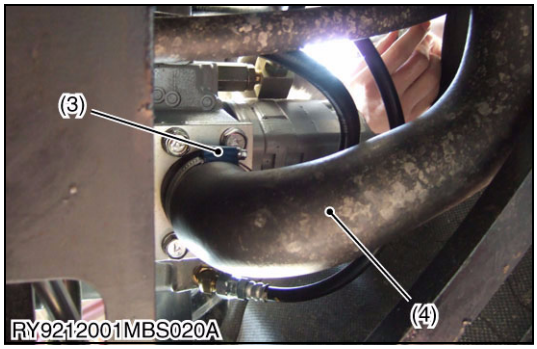
Attaching the vacuum pump

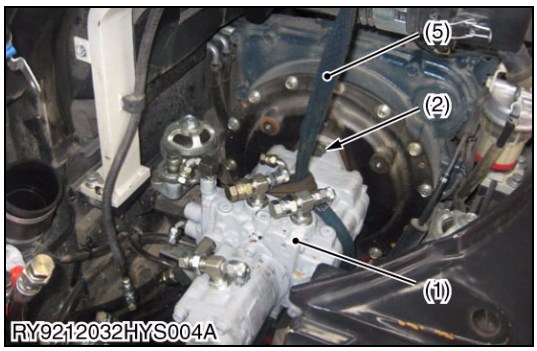
1. Attach the breather hose (1) of the hydraulic tank to the vacuum pump (2), and apply vacuum pressure to the hydraulic tank.

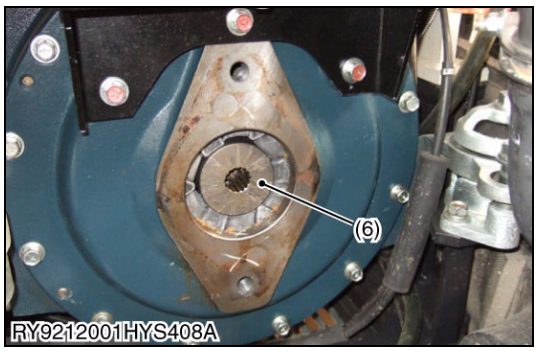
(1) Breather hose
(2) Pneumatic vacuum pump

RY9212050HYS0004US0









Removing the main pump

1. Remove all hoses from the pump (1), and fit plugs to the adapter and disconnected hoses.

2. Loosen the suction hose tightening clamp (3), and remove the suction hose (4) from the pump.

3. Suspend the pump (1) by a nylon sling (5), and support with a crane. Remove the bolts (2) in two locations, and pull the shaft of the pump suspended by the crane from the coupling.

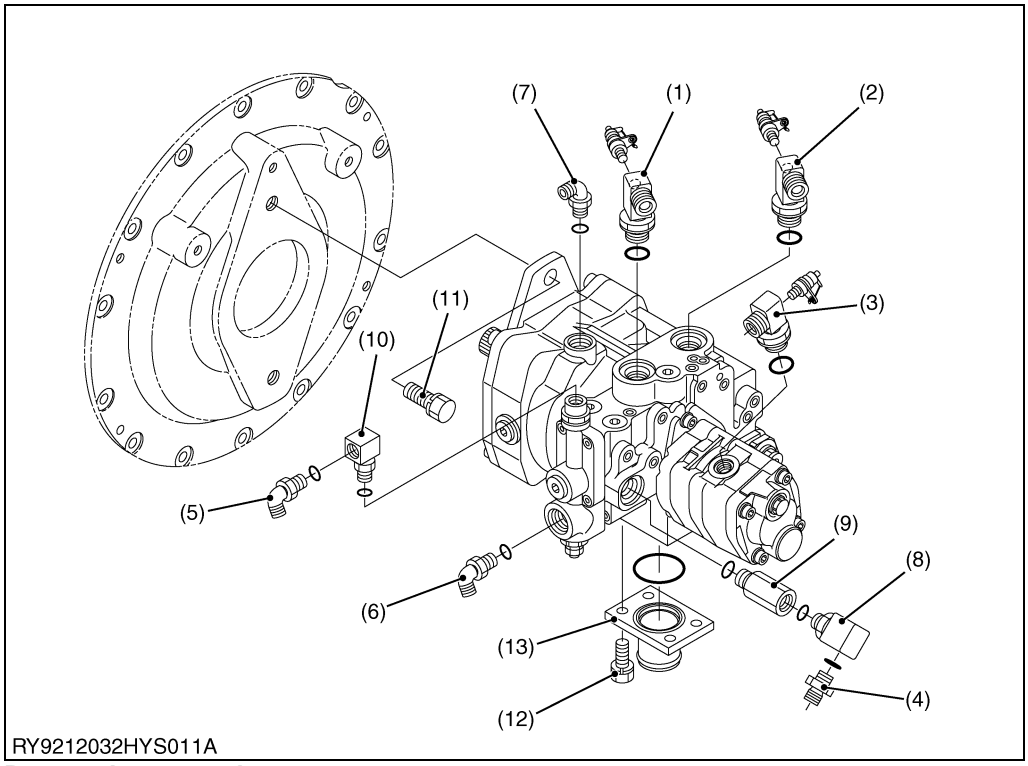
Tightening torque	Pump assembly (piston)	196.1 to 225.6 N·m 20 to 23 kgf·m 144.7 to 166.3 lbf·ft

- Pump weight : Approx. 38 kg (84 lbs)

(1) Pump assembly (piston)
(2) Bolt (M16 × 35)
(3) Hose clamp
(4) Hose (suction 1)
(5) Nylon sling
(6) Coupling

RY9212032HYS0009US0

Pump assembly diagram

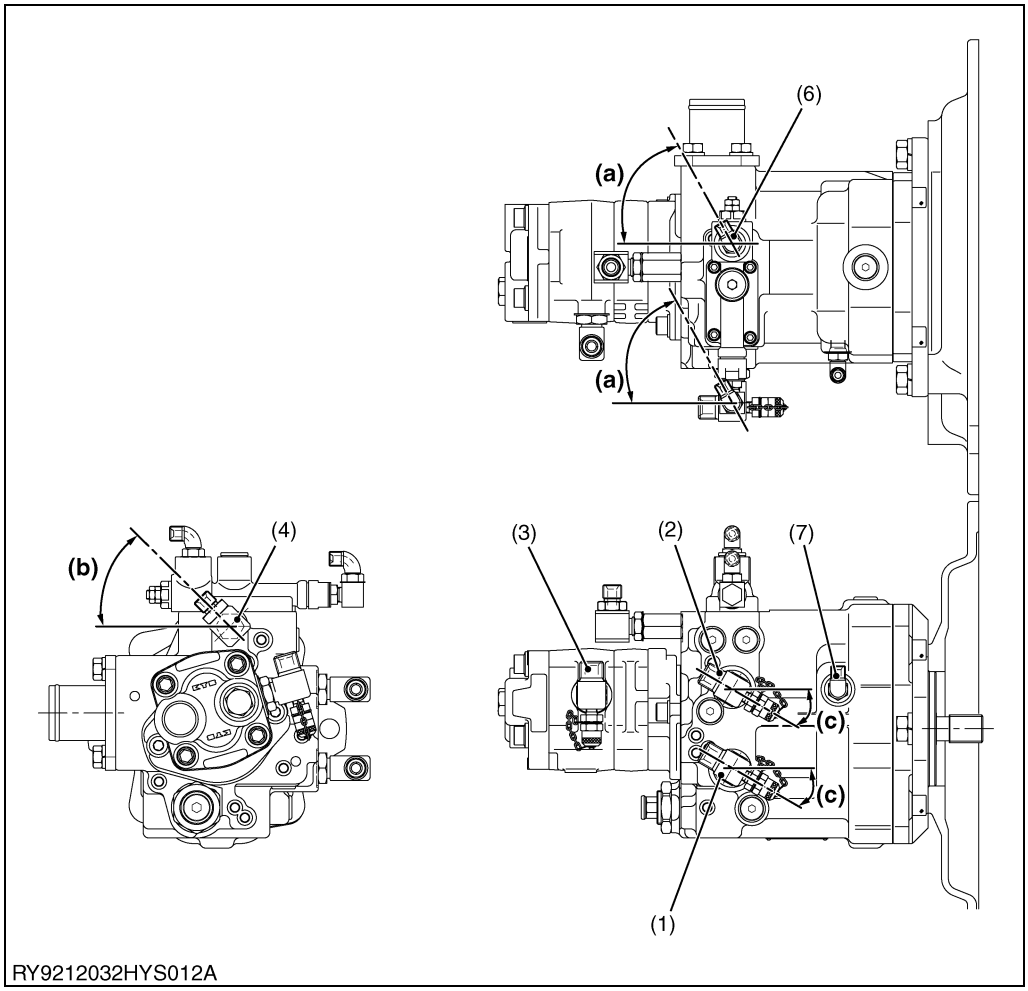


RY9212032HYS011A

(1) Pipe joint (L, G4-G4) P1
(2) Pipe joint (LG4-G4) P2
(3) Pipe joint (L, G4-G4) P3
(4) Straight pipe joint Pp
(5) Pipe joint (L, G1/4-G1/4) PPS
(6) Pipe joint (L, G1/4-G1/4) PLS
(7) Pipe joint (L, G1/4-G1/4) air bleed
(8) Pipe joint (L, G3/8-G3/8)
(9) Straight pipe joint Pp
(10) Pipe joint (L, G1/4-G1/4)
(11) Bolt (M16 × 35)
(12) Bolt (M12 × 25)
(13) Flange (suction)

RY9212032HYS0010US0

Pump adapter angles

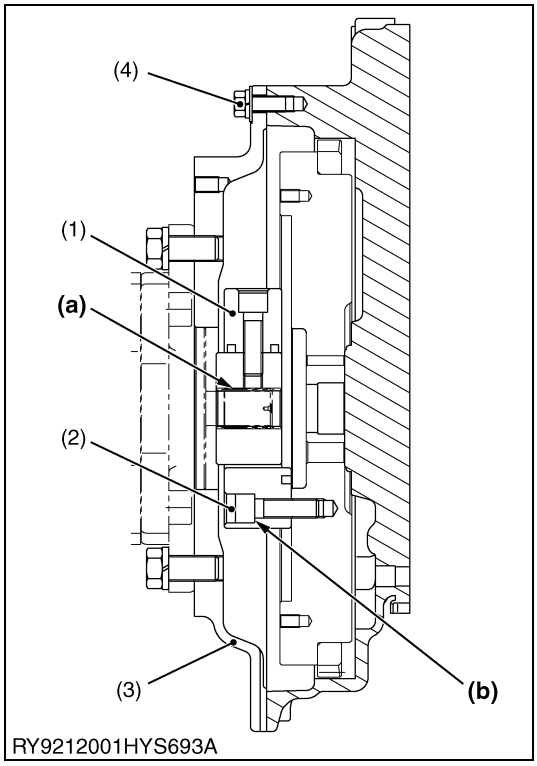


RY9212032HYS012A

(1) Pipe joint (L, G4-G4) P1
(2) Pipe joint (G4-G4) P2
(3) Pipe joint (L, G4-G4) P3
(4) Straight pipe joint Pp
(5) Pipe joint (L, G1/4-G1/4) PPS
(6) Pipe joint (L, G1/4-G1/4) PLS
(7) Pipe joint (L, G1/4-G1/4) air bleed

(a) 60 °
(b) 45 °
(c) 30 °

RY9212032HYS0011US0



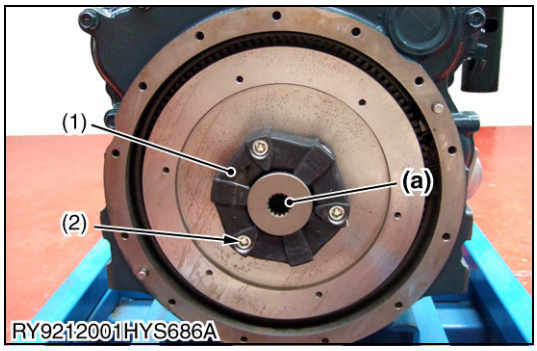
RY9212001HYS693A

Pump coupling block diagram

(1) Coupling
(2) Bolt (coupling)
(3) Housing (pump)
(4) Bolt (M10 × 25)

(a) Spline section grease application
(b) Apply an extremely thin layer of lubricating oil to the coupling seat surface before tightening

RY9212001HYS0027US0



RY9212001HYS686A

Spline section grease application

Apply the correct amount of grease to the spline section **(a)**.

■ **IMPORTANT**
- **Do not apply grease to the rubber section of the coupling.**

(1) Coupling
(2) Bolt (coupling)

(a) Spline section

RY9212001HYS0028US0

Tightening the coupling assembly bolts

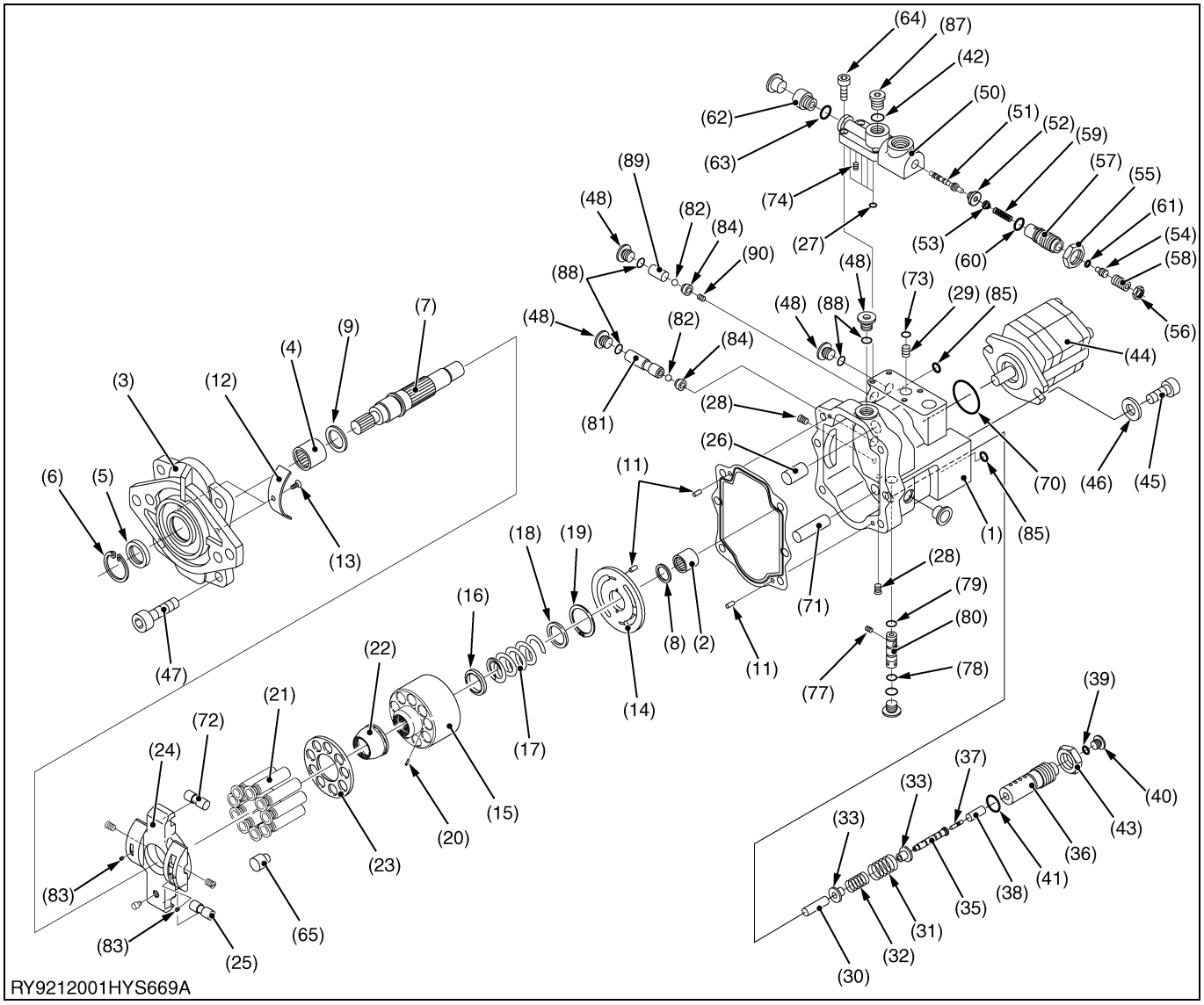
Apply an extremely thin layer of lubricating oil to the coupling seat surface, then tighten to the torque indicated in the following table.

Tightening torque	Bolt (coupling) (2)	85 to 94 N·m 8.6 to 9.6 kgf·m 63 to 69 lbf·ft

■ **IMPORTANT**
- **Do not apply a threadlock.**

RY9212001HYS0029US0

[2] PUMP DISASSEMBLY PROCEDURES

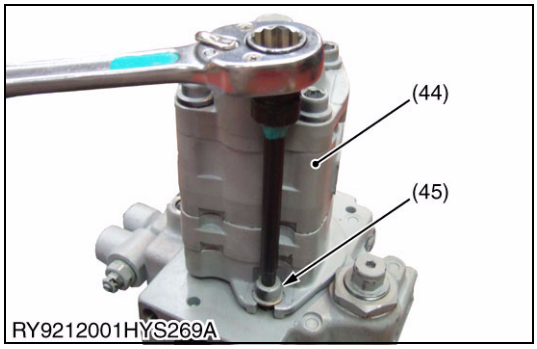


No.	Part Name	Q'ty	No.	Part Name	Q'ty
(1)	Case	1	(18)	Collar	1
(2)	Bearing	1	(19)	Internal circlip	1
(3)	Flange	1	(20)	Pin	3
(4)	Needle bearing	1	(21)	Piston ASSY	10
(5)	Oil Seal	1	(22)	Retainer holder	1
(6)	Internal circlip	1	(23)	Retainer plate	1
(7)	Shaft	1	(24)	Swash-plate	1
(8)	Thrust washer	1	(25)	Pin	1
(9)	Thrust washer	1	(26)	Pin	1
(10)	Gasket	1	(27)	O-Ring	4
(11)	Pin	3	(28)	Plug	29
(12)	Bushing	2	(29)	Orifice	1
(13)	Screw	2	(30)	Pin	1
(14)	Valve plate	1	(31)	Spring	1
(15)	Cylinder block	1	(32)	Spring	1
(16)	Collar	1	(33)	Spring seat	2
(17)	Spring	1	(34)	Valve ASSY	1

No.	Part Name	Q'ty	No.	Part Name	Q'ty
(35)	Spool	1	(63)	O-Ring	1
(36)	Valve sleeve	1	(64)	Socket head bolt	4
(37)	Pin	1	(65)	Stopper	1
(38)	Collar	1	(66)	Nameplate	1
(39)	O-Ring	1	(67)	Drive screw	2
(40)	Plug	1	(68)	Shipping plug	2
(41)	O-Ring	1	(69)	Shipping plug	3
(42)	O-Ring	1	(70)	O-Ring	1
(43)	Nut	1	(71)	Pin	1
(44)	Gear Pump	1	(72)	Pin	1
(45)	Socket head bolt	2	(73)	O-Ring	1
(46)	Metal washer	2	(74)	Orifice	1
(47)	Socket head bolt	6	(75)	Shipping plate	1
(48)	Plug	6	(76)	Shipping plug	1
(49)	Valve ASSY	1	(77)	Orifice	1
(50)	Valve body	1	(78)	O-Ring	1
(51)	Spool	1	(79)	O-Ring	1
(52)	Bushing	1	(80)	Stopper	1
(53)	Spring seat	1	(81)	Valve seat	1
(54)	Cap	1	(82)	Steel ball	2
(55)	Nut	1	(83)	Orifice	2
(56)	Nut	1	(84)	Seat	2
(57)	Holder	1	(85)	O-Ring	2
(58)	Set screw	1	(86)	Shipping plug	1
(59)	Spring	1	(87)	Plug	1
(60)	O-Ring	1	(88)	O-Ring	6
(61)	O-Ring	1	(89)	Collar	1
(62)	Plug	1	(90)	Orifice	1

RY9212001HYS0073US0

(1) Disassembly Procedures

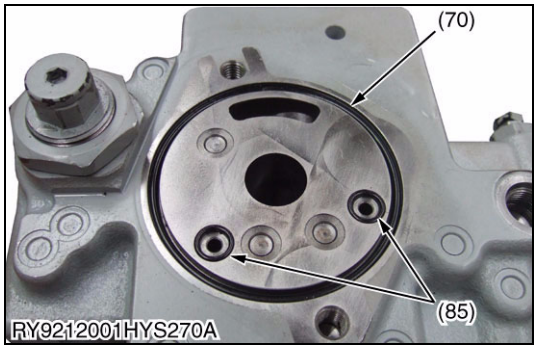


1. Remove the gear pump (44).

- Tool to use : M8 hex socket

(44) Gear Pump (45) Socket head bolt

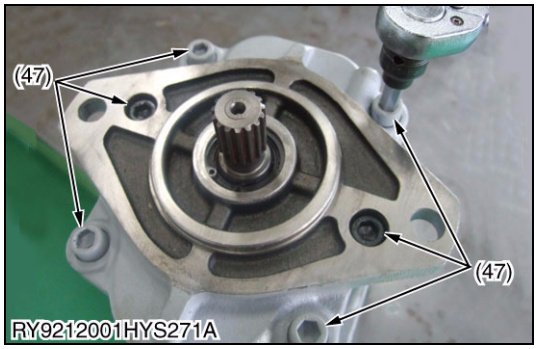
RY9212001HYS0074US0



2. Remove O-rings (70) and (85).

(70) O-Ring (85) O-Ring

RY9212001HYS0075US0



3. Turn so the input axle is facing up, clamp the pump into a vice and remove the bolts.

■ **IMPORTANT**
- **Take care not to scratch the suction or discharge ports in the vise.**
- Tool to use : M8 hex socket

(47) Socket head bolt

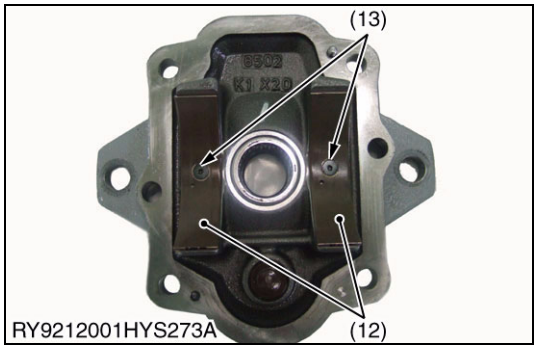
RY9212001HYS0076US0

4. Remove the flange (3).

CAUTION
- **If the flange is difficult to remove, tap lightly on it with a plastic hammer and take it apart.**
- **Don't pinch your fingers between the flange and the case.**

(3) Flange

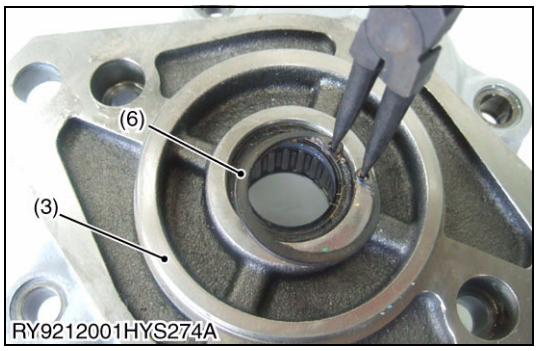
RY9212001HYS0077US0



5. Remove the screw (13) and the bushing (12).
- Tool to use : M4 hex socket

(12) Bushing (13) Screw

RY9212001HYS0078US0

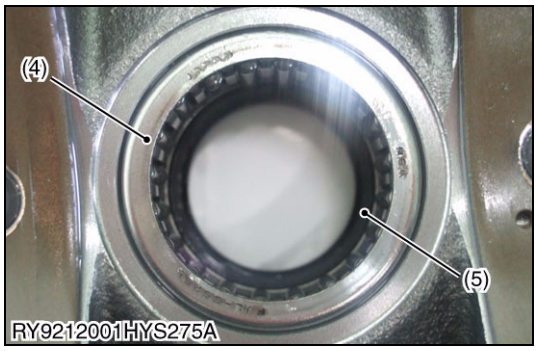


6. Remove the internal circlip (6) from the flange (3).

CAUTION
- **Take care so the circlip does not go flying.**
- Tool to use : Snap ring pliers

(3) Flange (6) Internal circlip

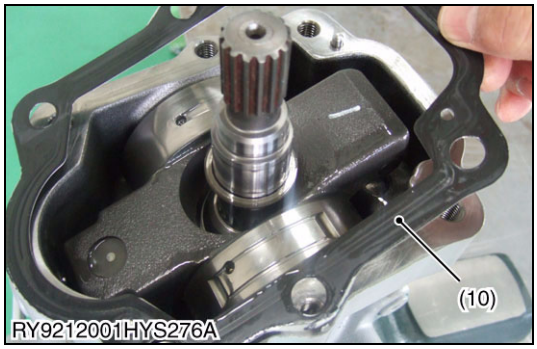
RY9212001HYS0079US0



7. Remove the oil seal (5) and the needle bearing (4) from the flange.

(4) Needle bearing (5) Oil Seal

RY9212001HYS0080US0

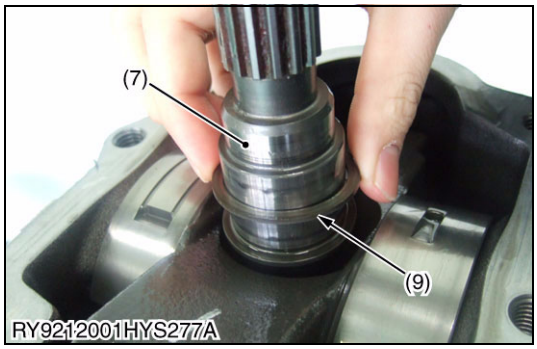


8. Remove the gasket (10).

CAUTION
- **Be careful not to cut your fingers on the gasket.**

(10) Gasket

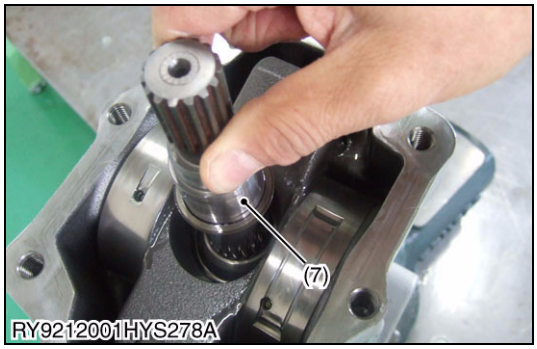
RY9212001HYS0081US0



9. Remove the thrust washer (9) from the shaft (7).

(7) Shaft (9) Thrust washer

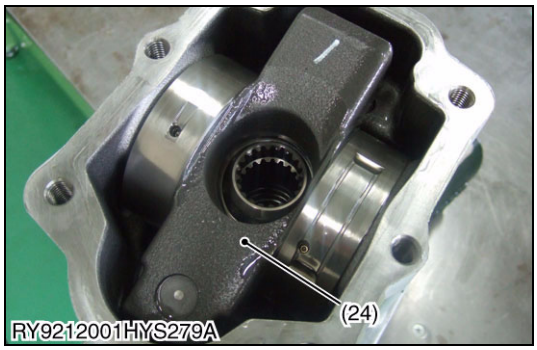
RY9212001HYS0082US0



10. Remove the shaft (7).

(7) Shaft

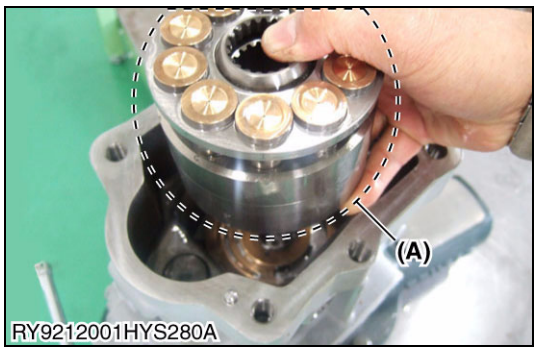
RY9212001HYS0083US0



11. Remove the swash-plate (24).

(24) Swash-plate

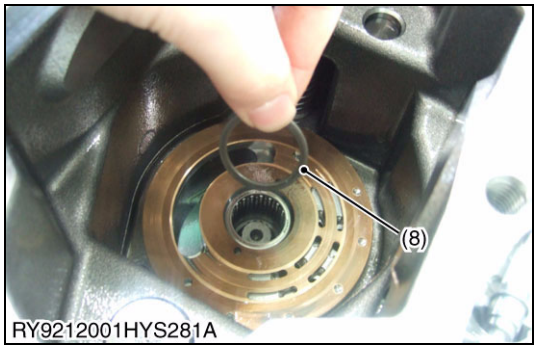
RY9212001HYS0084US0



12. Remove the cylinder block ASSY **(A)**.
(Cylinder block, collar, spring, collar, internal circlip, pin, piston ASSY, retainer holder, retainer plate)

(A) Cylinder block ASSY

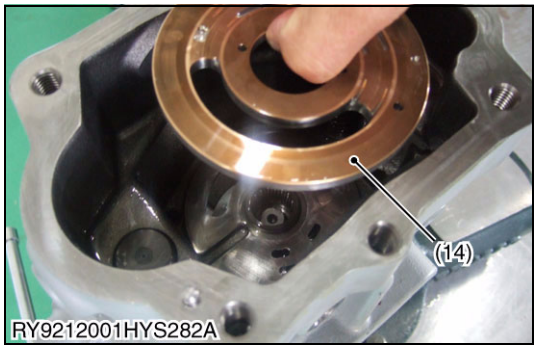
RY9212001HYS0085US0



13. Remove the thrust washer (8).

(8) Thrust washer

RY9212001HYS0086US0

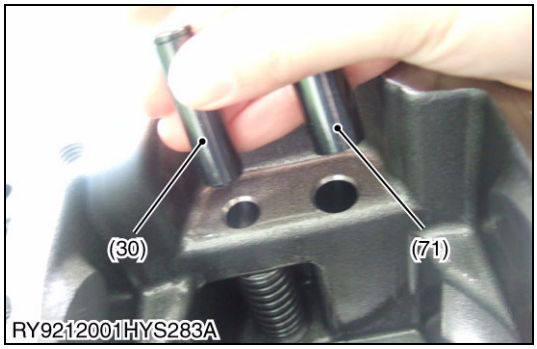


14. Remove the valve plate (14).

■ **IMPORTANT**
- **Do not scratch the valve plate.**

(14) Valve plate

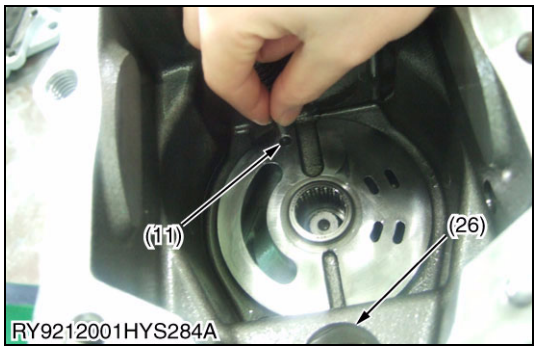
RY9212001HYS0087US0



15. Remove the pins (30) and (71).

(30) Pin (71) Pin

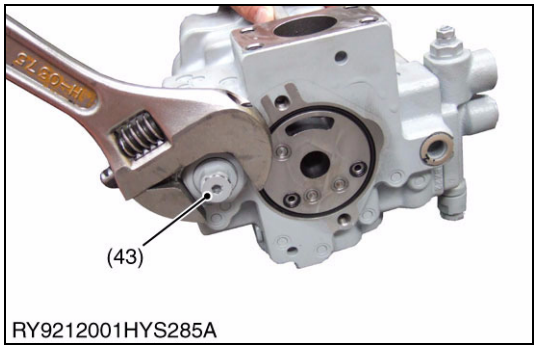
RY9212001HYS0088US0



16. Remove the pins (11) and (26).

(11) Pin (26) Pin

RY9212001HYS0089US0



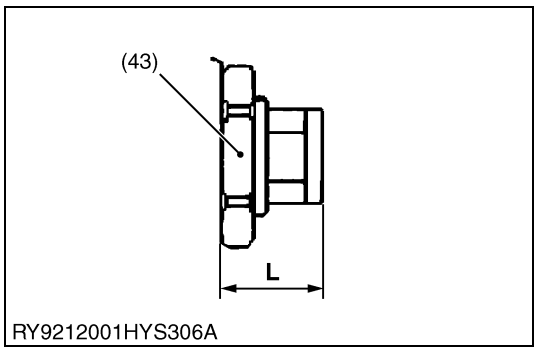
RY9212001HYS285A

17. Remove the nut (43).

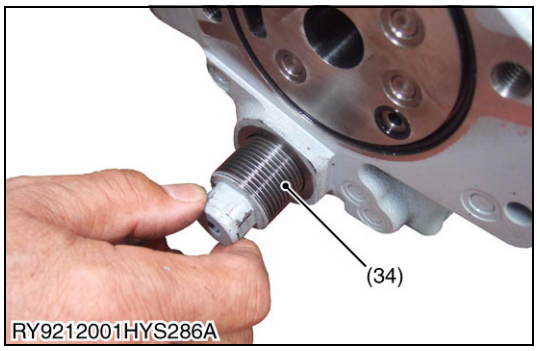
■ **IMPORTANT**
- **Measure the width of L before removing the nut.**
- Tool to use : Monkey wrench

(43) Nut

RY9212001HYS0090US0



RY9212001HYS306A



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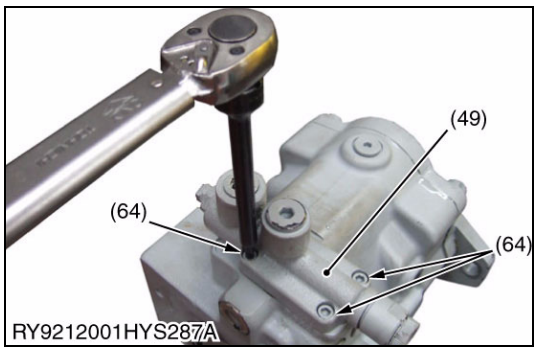
18. Remove the valve ASSY (34).

(34) Valve ASSY

RY9212001HYS0091US0



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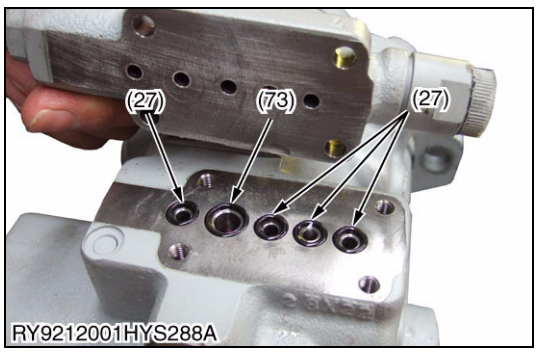
19. Remove the valve ASSY (49).

- Tool to use : M5 hex socket

(49) Valve ASSY (64) Socket head bolt

RY9212001HYS0092US0



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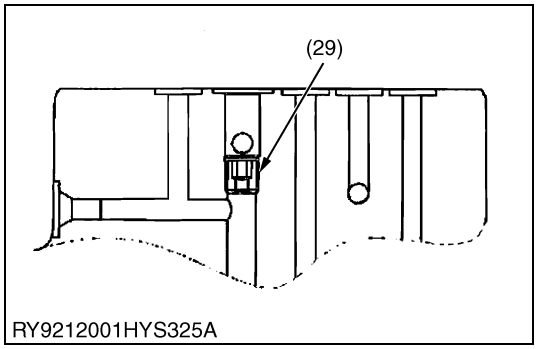
20. Remove O-rings (27) and (73).

(27) O-Ring (73) O-Ring

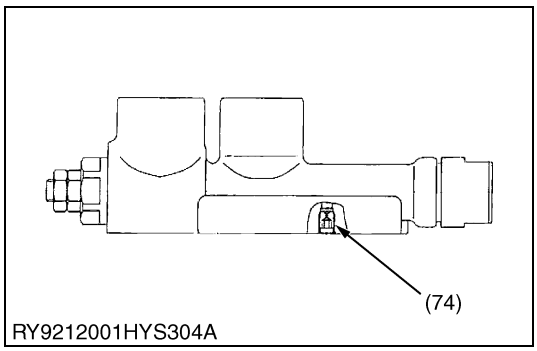
RY9212001HYS0093US0

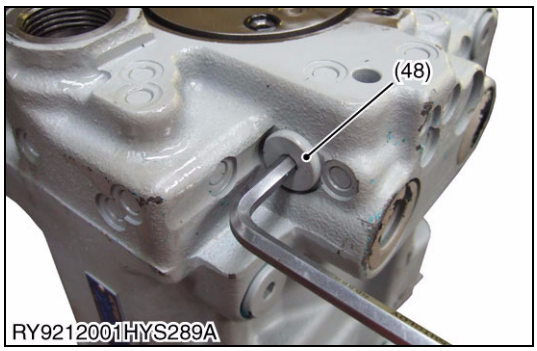


21. Remove orifices (29) and (74).

(29) Orifice (74) Orifice

RY9212001HYS0094US0



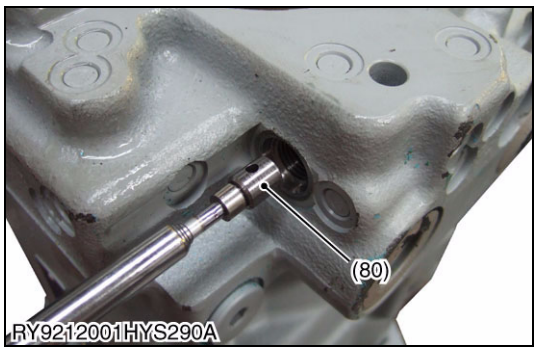


22. Remove the plug (48).

- Tool to use : M6 hex socket

(48) Plug

RY9212001HYS0095US0

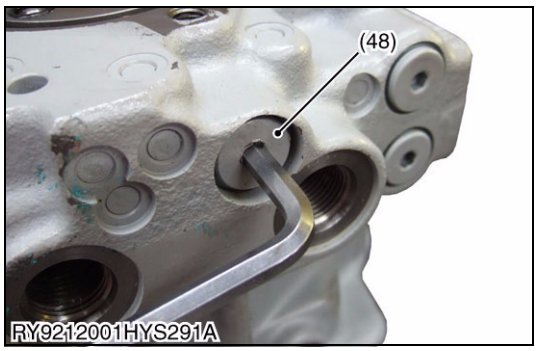


23. Pull out the stopper (80) with a magnet.

- Tool to use : Magnet

(80) Stopper

RY9212001HYS0096US0

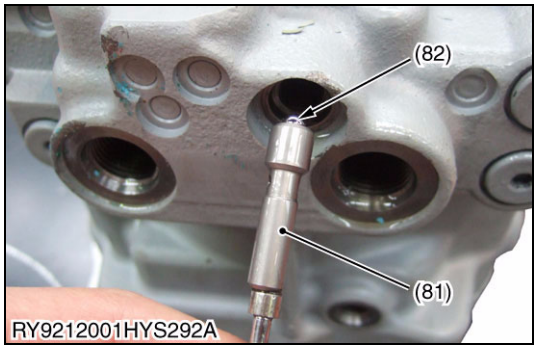


24. Remove the plug (48).

- Tool to use : M6 hex socket

(48) Plug

RY9212001HYS0097US0

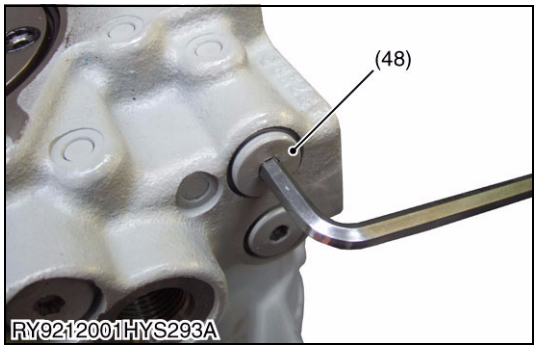


25. Pull out the valve seat (81) and the steel ball (82) with a magnet.

- Tool to use : Magnet

(81) Valve seat (82) Steel ball

RY9212001HYS0098US0

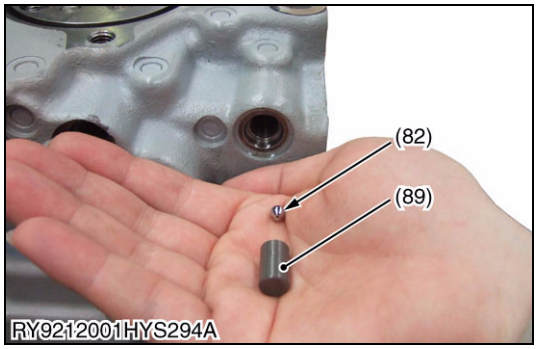


26. Remove the plug (48).

- Tool to use : M6 hex socket

(48) Plug

RY9212001HYS0099US0



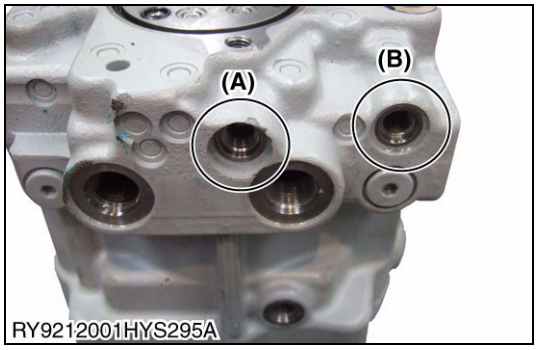
27. Pull out the collar (89) and the steel ball (82) with a magnet.

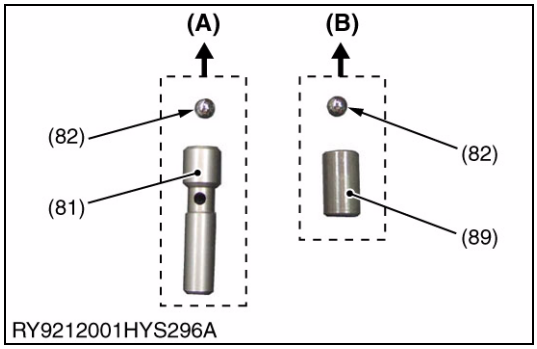
- Tool to use : Magnet

(82) Steel ball (89) Collar

RY9212001HYS0100US0

(2) Assembly Procedures





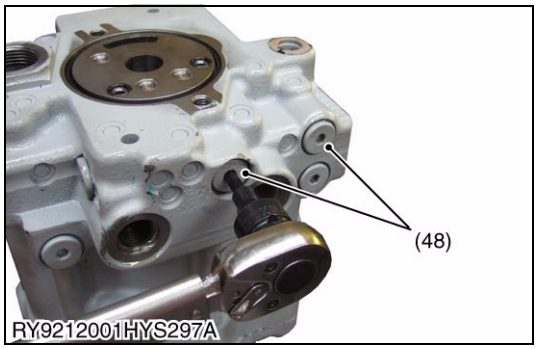
1. Assemble the steel ball (82), collar (89) and the valve seat (81).

■ **IMPORTANT**
- **Be careful that the valve seat faces the right direction.**

(81) Valve seat
(82) Steel ball
(89) Collar

(A) Positioning of the valve seat and steel ball
(B) Positioning of the collar and steel ball

RY9212001HYS0101US0



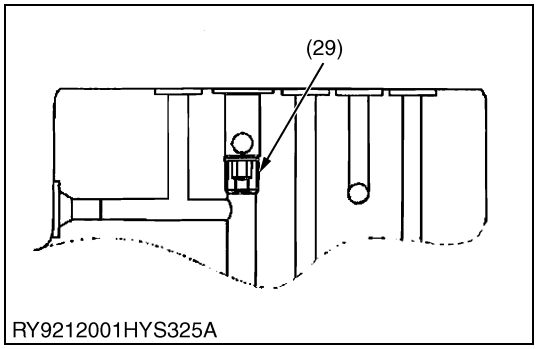
2. Install the plug (48).

Tightening torque	Plug (48)	29.4 N·m 3.0 kgf·m 21.7 lbf·ft

- Tool to use : M6 hex socket

(48) Plug

RY9212001HYS0102US0



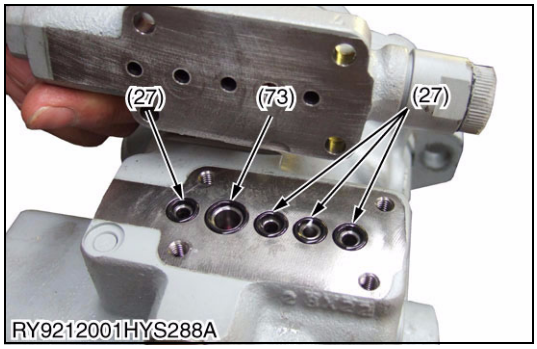
3. Install the orifice(29).

Tightening torque	Orifice (29)	10.3 N·m 1.1 kgf·m 7.6 lbf·ft

- Tool to use : M4 hex socket

(29) Orifice

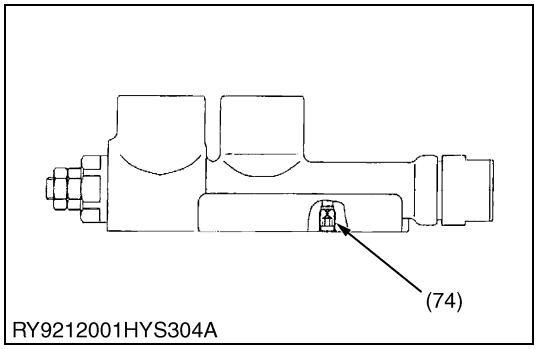
RY9212001HYS0103US0



4. Install the O-rings (27) and (73) on the face where the case's valve ASSY will be installed.

(27) O-Ring
(73) O-Ring

RY9212001HYS0104US0



RY9212001HYS304A

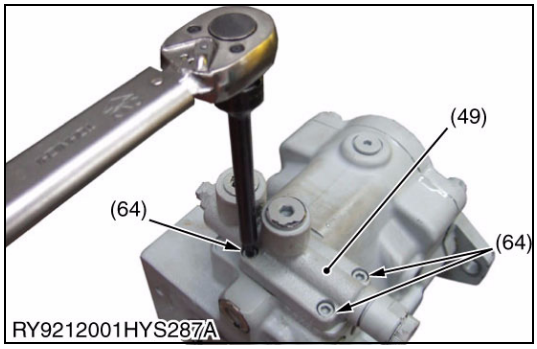
5. Install the orifice (74) in the valve ASSY.

Tightening torque	Orifice (74)	2.5 N·m 0.25 kgf·m 1.8 lbf·ft

- Tool to use : M3 hex socket

(74) Orifice

RY9212001HYS0105US0



RY9212001HYS287A

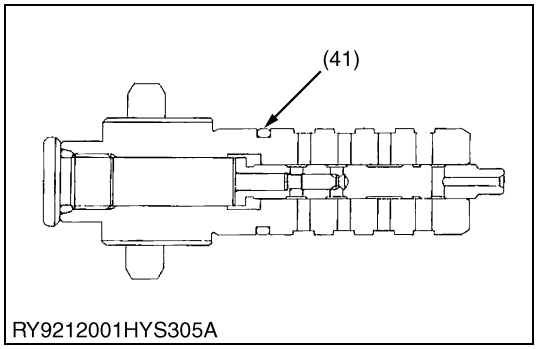
6. Attach the valve ASSY (49) to the case.

Tightening torque	Socket head bolt (64)	12.7 N·m 1.3 kgf·m 9.4 lbf·ft

- Tool to use : M5 hex socket

(49) Valve ASSY (64) Socket head bolt

RY9212001HYS0106US0

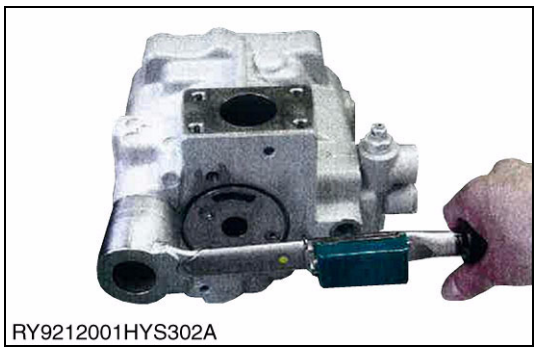


RY9212001HYS305A

7. Install the O-ring (41) on the valve ASSY sleeve.

(41) O-Ring

RY9212001HYS0107US0


RY9212001HYS302A

8. Attach the valve ASSY to the case.

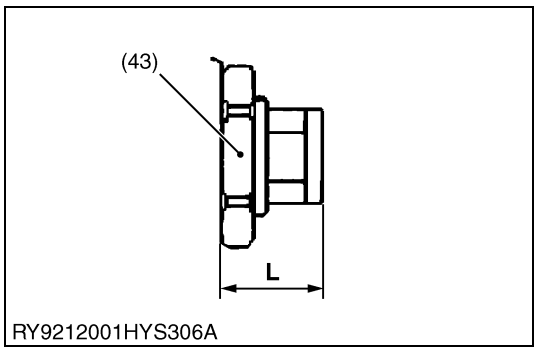
■ **IMPORTANT**
- **Install the nut and adjust it to the width measured before disassembly.**

Tightening torque	Nut (43)	68.6 N·m 7.0 kgf·m 50.6 lbf·ft

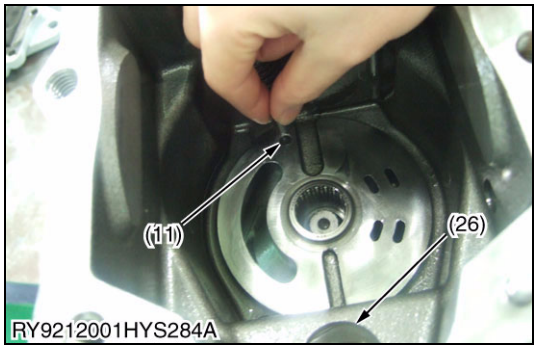
- Tool to use : M41 socket

(43) Nut

RY9212001HYS0108US0



RY9212001HYS306A

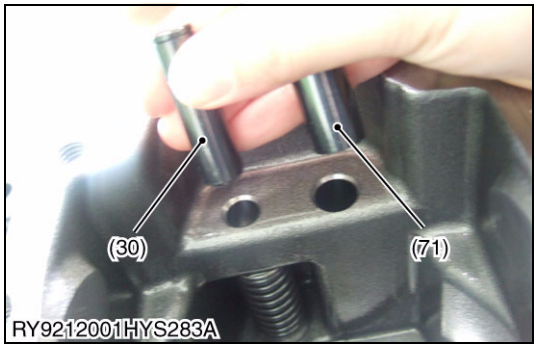


9. Clamp the case in a vice and install the pins (11) and (26).

■ **IMPORTANT**
- **Take care not to scratch the suction or discharge ports in the vise.**

(11) Pin (26) Pin

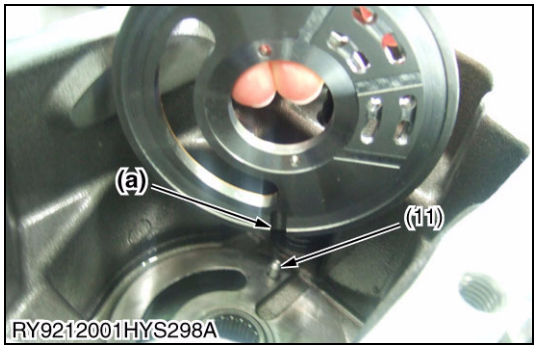
RY9212001HYS0109US0



10. Install the pins (30) and (71).

(30) Pin (71) Pin

RY9212001HYS0110US0

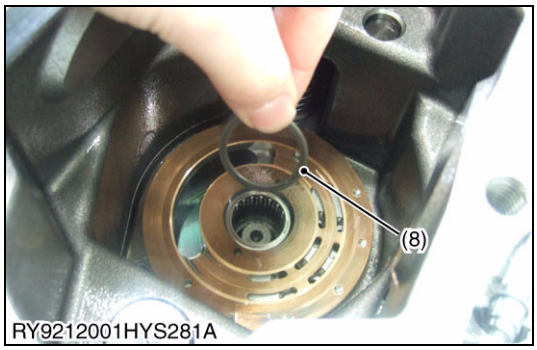


11. Install the valve plate.

■ **IMPORTANT**
- **Position so the notch is aligned with the pin.**
- **Apply hydraulic oil to both faces of the valve plate.**

(11) Pin **(a) Notch**

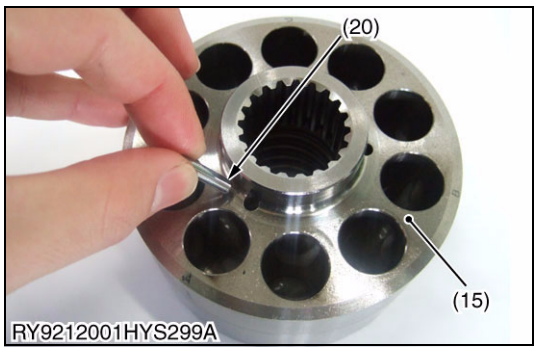
RY9212001HYS0111US0



12. Install the thrust washer (8).

(8) Thrust washer

RY9212001HYS0112US0



13. Insert the three pins (20) into the cylinder block (15).

■ **IMPORTANT**
- **Apply grease to the pins.**

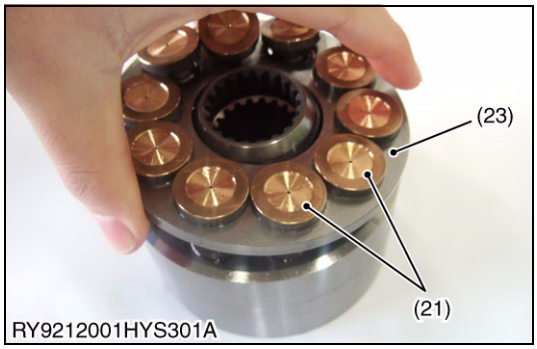
(15) Cylinder block (20) Pin

RY9212001HYS0113US0

14. Install the retainer holder (22) onto the cylinder block.

(22) Retainer holder

RY9212001HYS0114US0

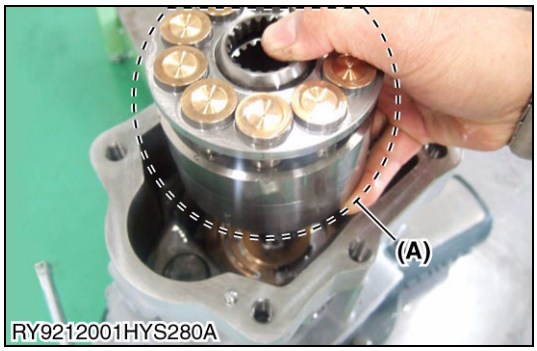


15. Install the piston ASSY (21) into the retainer plate (23) and then install it into the cylinder block.

■ **IMPORTANT**
- **Do not scratch the pistons.**
- **Do not use a hammer.**
- **Apply hydraulic oil to the body and shoe face of the pistons.**

(21) Piston ASSY (23) Retainer plate

RY9212001HYS0115US0

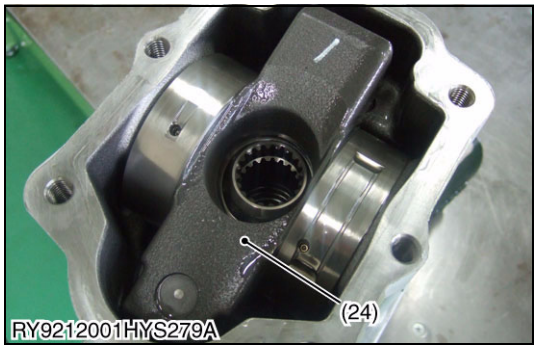


16. Cylinder block ASSY
Install **(A)**.

■ **IMPORTANT**
- **Apply hydraulic oil to the sliding surfaces of the cylinder block.**
- **Assemble carefully to avoid scratching.**

(A) Cylinder block ASSY

RY9212001HYS0116US0



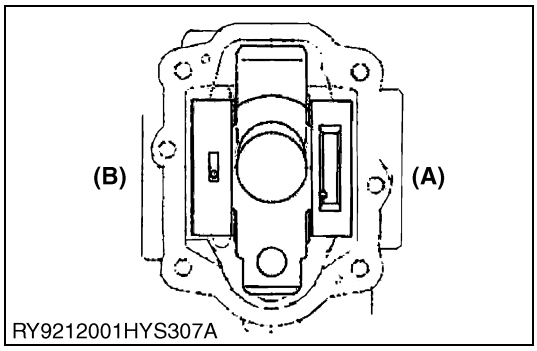
17. Install the swash-plate (24).

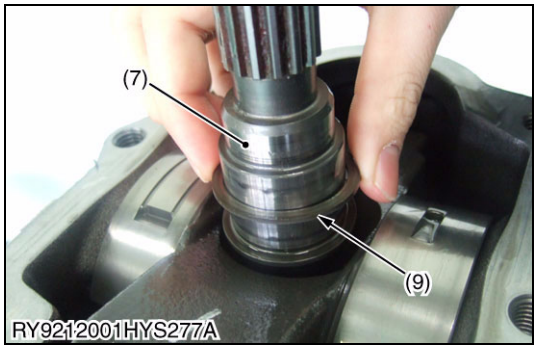
■ **IMPORTANT**
- **Install so the sliding surfaces of the piston shoes are not scratched.**
- **Double-check the swash-plate is facing the right direction.**

(24) Swash-plate

(A) Discharge port side
(B) Suction port side

RY9212001HYS0117US0

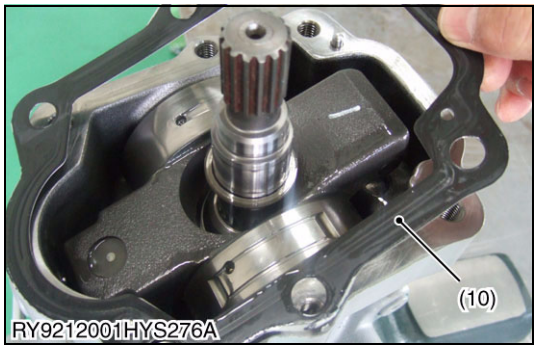




18. Install the shaft (7) and the thrust washer (9) onto the shaft.

(7) Shaft (9) Thrust washer

RY9212001HYS0118US0

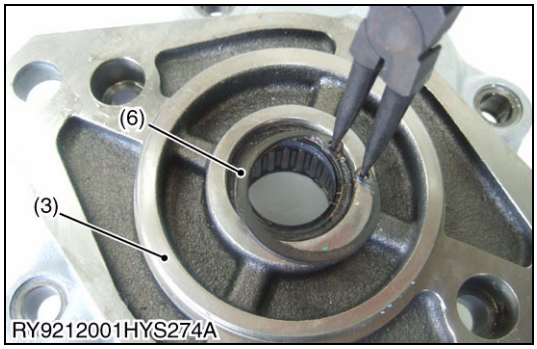


19. Install the gasket (10).

CAUTION
- **Be careful not to cut your fingers on the gasket.**

(10) Gasket

RY9212001HYS0119US0

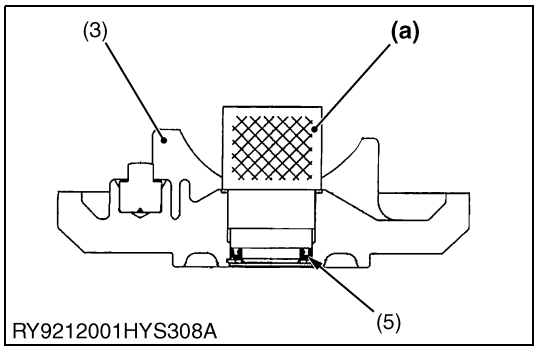


20. Install the internal circlip (6) onto the flange.

■ **IMPORTANT**
- **Install the internal circlip so its angled surface faces the outside of the housing.**
- Tool to use : Snap ring pliers

(3) Flange (6) Internal circlip

RY9212001HYS0120US0

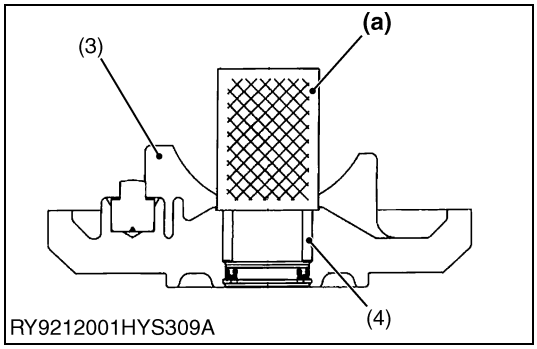


21. Use the jig **(a)** to insert the oil seal (3) into the flange (5).

■ **IMPORTANT**
- **Apply grease to the lip of the oil seal.**

(3) Flange **(a) Tool**
(5) Oil Seal

RY9212001HYS0121US0

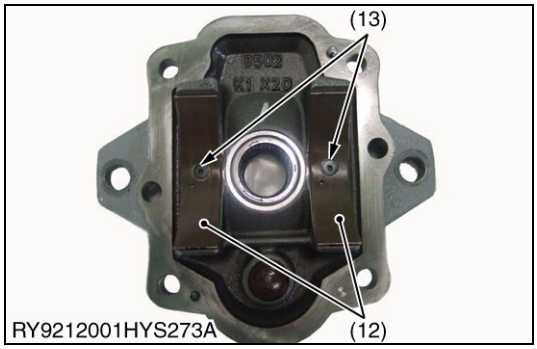


22. Use the jig **(a)** to install the needle bearing (4) into the flange (3).

■ **IMPORTANT**
- **Press the bearing in so its stamped side is facing up.**

(3) Flange **(a) Tool**
(4) Needle bearing

RY9212001HYS0122US0



23. Fasten the bushing (12) with the screws (13).

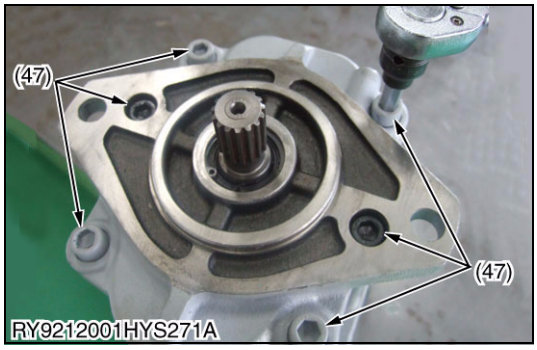
■ **IMPORTANT**
- **Be careful that the bushing faces the right direction.**

Tightening torque	Screws (13)	5.9 N·m 0.6 kgf·m 4.4 lbf·ft

- Tool to use : M3 hex socket

(12) Bushing (13) Screw

RY9212001HYS0123US0



24. Put the flange on the case and fasten it with the socket head bolts (47).

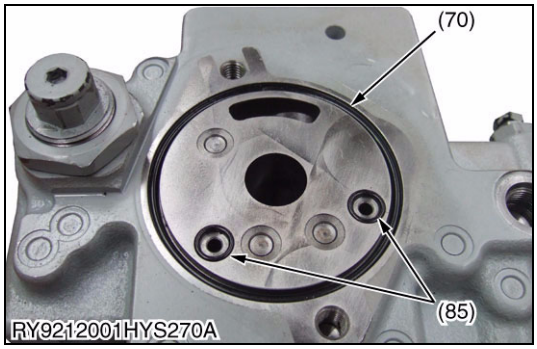
■ **IMPORTANT**
- **Don't score the lip of the oil seal.**

Tightening torque	Socket head bolt (47)	106.9 N·m 10.9 kgf·m 78.8 lbf·ft

- Tool to use : M10 hex socket

(47) Socket head bolt

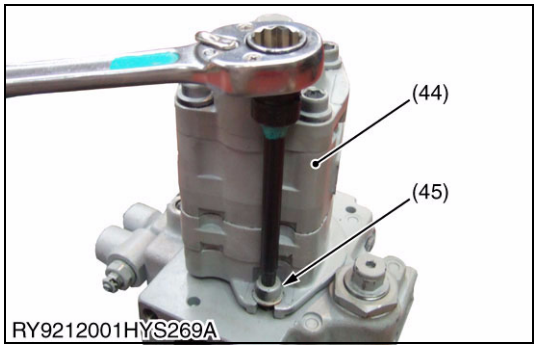
RY9212001HYS0124US0



25. Install the O-rings (70) and (85) on the face to mounting surface of the gear pump.

(70) O-Ring (85) O-Ring

RY9212001HYS0125US0



26. Attach the gear pump (44) to the case.

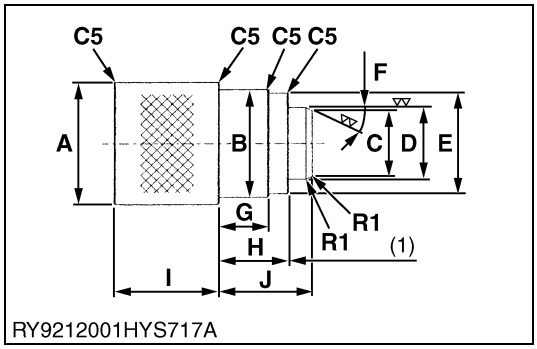
Tightening torque	Socket head bolt (45)	44.1 N·m 4.5 kgf·m 32.5 lbf·ft

- Tool to use : M8 hex socket

(44) Gear Pump (45) Socket head bolt

RY9212001HYS0126US0

[3] SPECIAL TOOLS



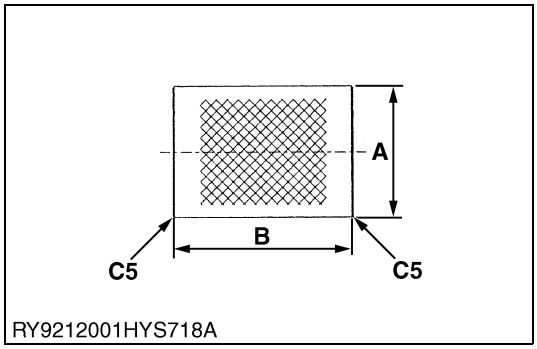
RY9212001HYS717A

Oil seal installation tool

A	ϕ51 mm, 0.2 in.
B	ϕ45 mm, 1.8 in.
C	ϕ27.5 mm, 1.08 in.
D	ϕ30 mm, 1.2 in.
E	ϕ42 mm, 1.7 in.
F	25 °
G	20 mm, 0.79 in.
H	30 mm, 1.2 in.
I	42.5 mm, 1.67 in.
J	37.5 mm, 1.48 in.
C5	0.5 mm, 0.02 in. bevel
R1	0.3 to 0.5 mm, 0.01 to 0.02 in.

(1) Surface the oil seal is against

RY9212001HYS0127US0

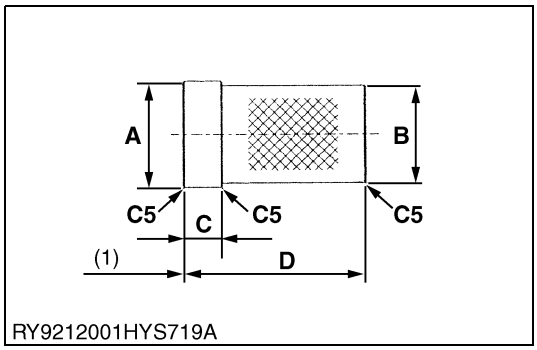


RY9212001HYS718A

Bearing installation tool

A	ϕ51 mm, 2.0 in.
B	70 mm, 2.8 in.
C5	0.5 mm, 0.02 in. bevel

RY9212001HYS0128US0



RY9212001HYS719A

Oil seal and bearing removal tool

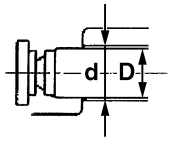
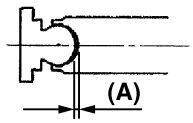
A	41.5 mm, 1.63 in.
B	ϕ38 mm, 1.5 in.
C	15 mm, 0.59 in.
D	70 mm, 2.8 in.
C5	0.5 mm, 0.02 in. bevel

(1) Surface the oil seal is against

RY9212001HYS0129US0

[4] STANDARDS FOR REPLACING PUMP PARTS

Refer to the table below for the parts to replace when the pump is disassembled. After referring to the parts list when replacing the parts, replace the kit parts as a set.

Part	Service Standard
Bearing	1. If any flaking or peeling exists on rolling surfaces.
	2. If there is any abnormal rotation or oscillation of the bearing (odd sounds or jerky movement).
Shaft	1. If the sliding surface of the oil seal has deep scratches or is very rough.
	2. If there is any abnormal wear or damage to the spline.
Oil Seal	1. If the lip is scored or shows obvious wear or hardening.
Valve plate	1. If the sliding surface of the cylinder block has deep scratches or is very rough.
Cylinder block ASSY	1. If each of the sliding surfaces has deep scratches or is very rough.
	2. If the piston clearance is too great.
	3. If there is any abnormal wear or damage to the spline.
Piston ASSY	1. If each of the sliding surfaces has deep scratches or is very rough.
	2. If the clearance with the cylinder block is too great. Standard **(A)** : 0.05 mm (0.002 in.) ≤ **(A) = d – D**  RY9212001HYS721A
	3. If there is too much shoe ball socket clearance. Standard **(A)** : 0.4 mm (0.02 in.) ≤  RY9212001HYS720A
Retainer plate Retainer holder	1. If the sliding surface has deep scratches, seizing, uneven wear or is very rough.
Swash-plate ASSY	1. If the sliding surface has deep scratches or is very rough.
Bushing	1. If the sliding surface has deep scratches or is very rough.

RY9212001HYS0130US0

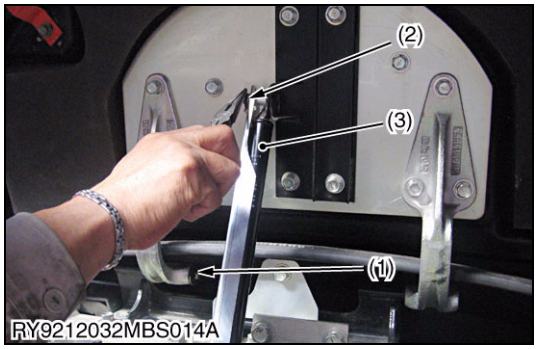
2. CONTROL VALVE

[1] CONTROL VALVE REMOVAL

CAUTION

- **When removing a hydraulic device after operating the mini-excavator, lower the bucket and blade to the ground and turn off the engine.**
- **Each of the devices and the hydraulic oil are hot and under high pressure immediately after operating the mini-excavator. If the hydraulic oil reached a high operating temperature, it may cause a burn.**
- **Oil gushing out under pressure has enough force to pierce your skin and may cause you injury. Always allow the temperature to drop and relieve any remaining pressure prior to working to remove any hydraulic equipment.**

RY9212001MBS0004US0



Removing the bonnet (right)

1. Open the bonnet (right) (4), remove the snap rings (1) and (2) in two locations, and separate the gas damper (3) and bonnet.

2. Slide the bonnet (right) (4) towards the front of the machine to remove.

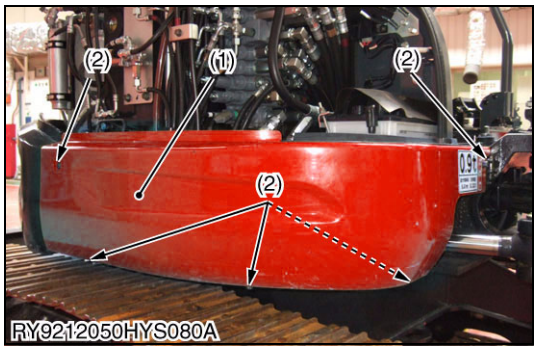
CAUTION

- **Be sure to use 2 or more persons for removing the bonnet (right).**

- Bonnet (right) weight : Approx. 27 kg (60 lbs)

(1) Snap pin - flat metal washer
(2) Snap pin - flat metal washer
(3) Gas damper
(4) Bonnet (right)

RY9212032HYS0012US0

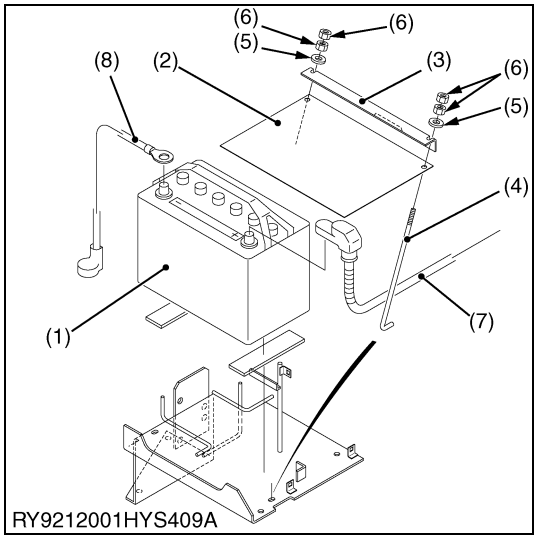


Removing the cover assembly (right)

1. Remove the cover assembly (right) (1) mounting bolts (2) and remove the cover assembly (right).

(1) Cover assembly (right)
(2) Bolt (M10 × 25)

RY9212032HYS0081US0



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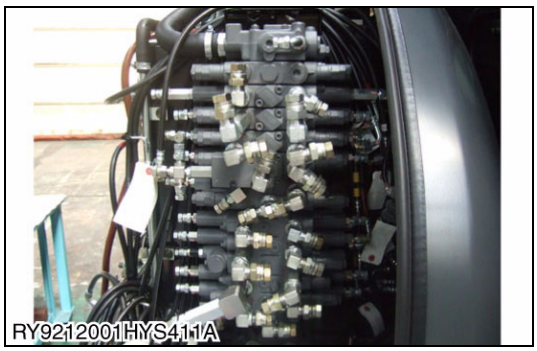
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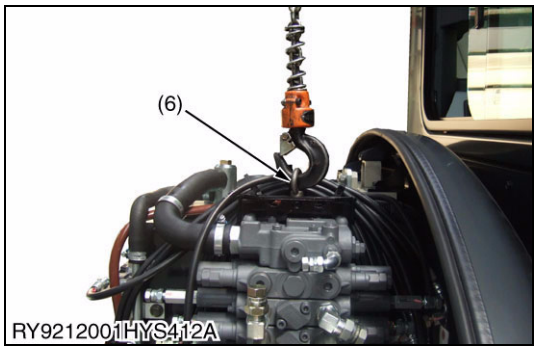

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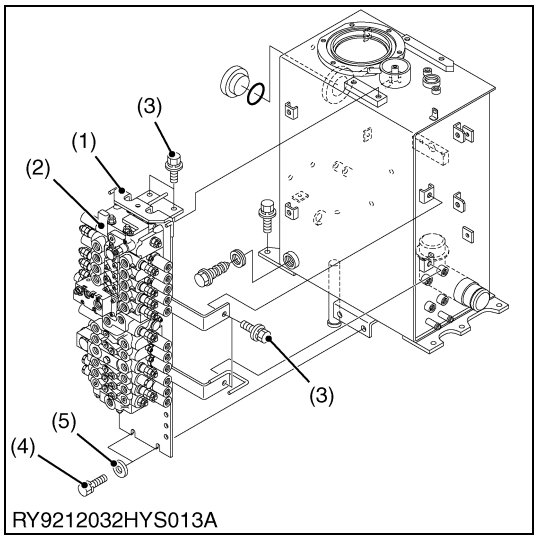


RY9212032HYS013A

Removing the battery

1. Remove the retainer (battery) (3) fastening nuts (6), and remove the cover (battery) (2) and retainer (battery) (3).
2. Disconnect the battery cord (negative) (8) and battery cord (positive) (7) from the battery side, and remove the battery from the machine.

WARNING
- **When disconnecting the battery cords, be sure to disconnect the negative cord first. When re-connecting, connect the positive cord first.**

(1) Battery (105D31L)
(2) Cover (battery)
(3) Retainer (battery)
(4) Bolt (battery)
(5) Flat metal washer
(6) Nut
(7) Battery cord (positive)
(8) Battery cord (negative)

RY9212001HYS0132US0

Removing the hydraulic hoses

1. Attach the breather hose of the hydraulic fluid tank to the vacuum pump, and apply vacuum pressure to the hydraulic fluid tank.
2. Disconnect all hydraulic hoses and electrical wiring from the control valve.

CAUTION
- **Plug all disconnected hydraulic hoses, and affix identification labels on each for reassembly.**

RY9212001HYS0133US0

Removing the control valve

1. Fit an eyebolt (M10 pitch 1.25) (6) into the bracket (control valve) (1) bolt hole, and suspend the control valve assembly (2) by the crane.
2. Remove the mounting bolts (3) and (4) (six locations) of the bracket (control valve) (1), and remove using the crane.

- Control valve weight: Approx. 59.5 kg (131 lbs)

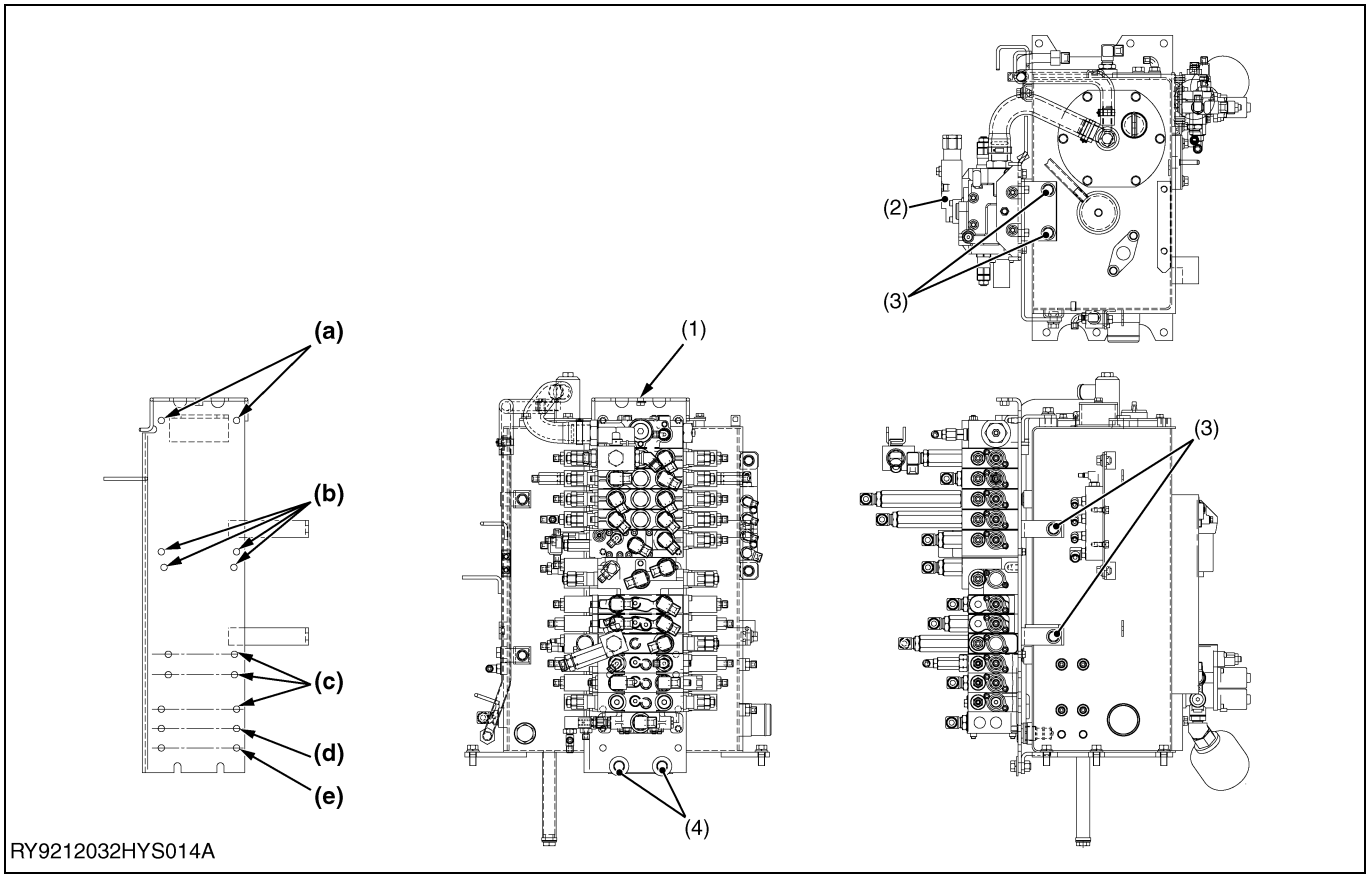
Tightening torque	Bracket (control valve) (1)	77.5 to 90.2 N·m 7.9 to 9.2 kgf·m

IMPORTANT
- **Apply a threadlock (Loctite #271).**

(1) Bracket (control valve)
(2) Control valve assembly
(3) Bolt (M12 × 25)
(4) Bolt (M12 × 25)
(5) Flat metal washer
(6) Eyebolt (M10 pitch 1.25)

RY9212032HYS0013US0

Control valve assembly diagram

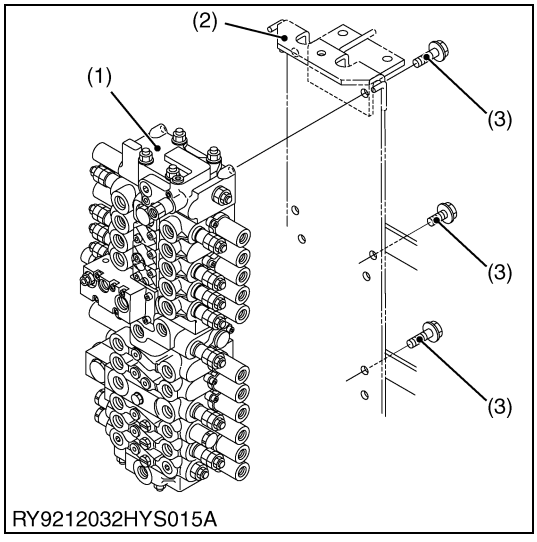


RY9212032HYS014A

(1) Bracket (control valve)
(2) Control Valve
(3) Bolt (M12 × 25)
(4) Bolt (M12 × 25)

(a) Mounting hole always used
(b) Mounting hole always used
(c) Hole not used
(d) Mounting hole always used
(e) Hole not used

RY9212032HYS0014US0



RY9212032HYS015A

Removing the control valve assembly

1. Remove the control valve assembly (1) mounting bolts (3), and remove the control valve assembly from the bracket (control valve) (2).

Tightening torque	Control valve assembly (1)	48.1 to 55.9 N·m 4.9 to 5.7 kgf·m 35.5 to 41.2 lbf·ft

■ **IMPORTANT**
- **Apply a threadlock (Loctite #271).**

(1) Control valve assembly
(2) Bracket (control valve)
(3) Flange bolt (M10 × 20)

RY9212032HYS0015US0

[2] CONTROL VALVE DISASSEMBLY / ASSEMBLY PROCEDURES

Precautions during Disassembly / Assembly

Precautions during Disassembly

1. Generally, hydraulic devices are precision machined, and disassembly should therefore be conducted in a clean environment to prevent entry of debris into the narrow interstices formed in the device structure.
2. Always use clean tools and cleaning oil.
3. After removing from the machine, first wash the outside of the assembly.
4. Before starting work, prepare the necessary parts for the aims and extent of disassembly. Before reassembling, as a rule you should replace all seals and O-rings, etc. Also, since a subassembly is available with the required parts if parts cannot be supplied as single items, refer to the parts catalog beforehand in preparation.

Precautions on Assembly

1. Apply clean grease or hydraulic fluid to O-rings and their countersunk parts for mounting.
2. There should be no flaws in O-rings due to forming, and no marks or heat deformation incurred when handling.
3. If permanently deformed, O-rings will not straighten out. (Make sure that no flaws are incurred by an O-ring when passing it through sharp angled sections of a spool.)
4. Do not turn over O-rings on installation. (Fouled O-rings are difficult to re-install and can easily result in oil leakage.)

Before assembling, at the mating surface of each section, make sure no cleaning oil, hydraulic fluid, etc., is adhered to the outer surface of the O-ring groove. (If you assemble with oil adhered to a mating surface, this may be mistakenly recognized as oil leakage from that location when the machine is running.)

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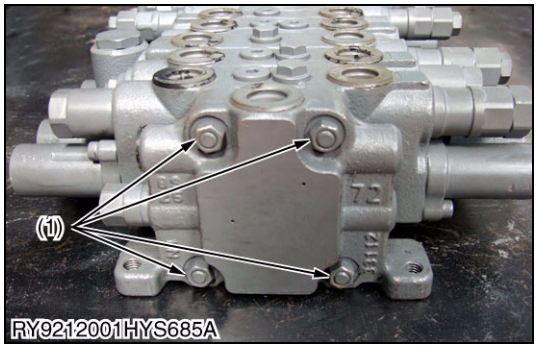
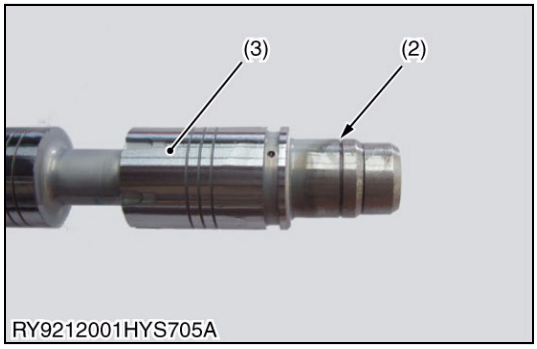




Control Valve Disassembly / Assembly Procedures

1. Loosen the nuts on one side with a ring spanner.

Tightening torque	Nut (four locations)	26.5 to 29.4 N·m 2.7 to 3.0 kgf·m 19.6 to 21.6 lbf·ft

2. Pull out each section with a tie rod, and arrange in order on a workbench.

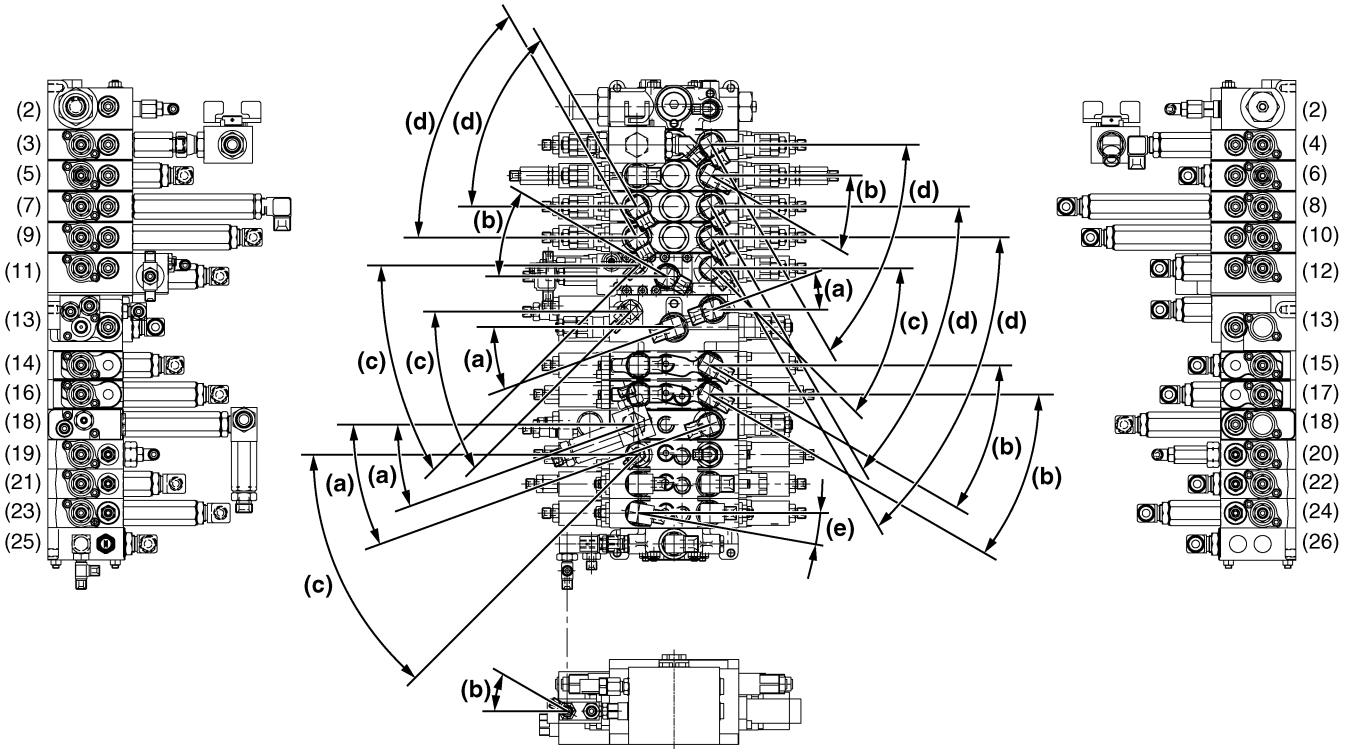
CAUTION

- **When removing each section, take care not to lose the load check valve and spring of the mating surface.**
- **Identify the load check valve and spring of each section so that they are not mismatched.**
- **Apply a location mark for each section.**
- **Excess torque on threads will cause defective spool operation. Therefore, be sure to use the specified torque.**
- **Take care over the direction of installation of each spool, align with the holes and insert slowly.**

(1) Nut
(2) Identification groove for spool assembly orientation
(3) Spool

RY9212001HYS0141US0

Control Valve Adapter Installation Angles

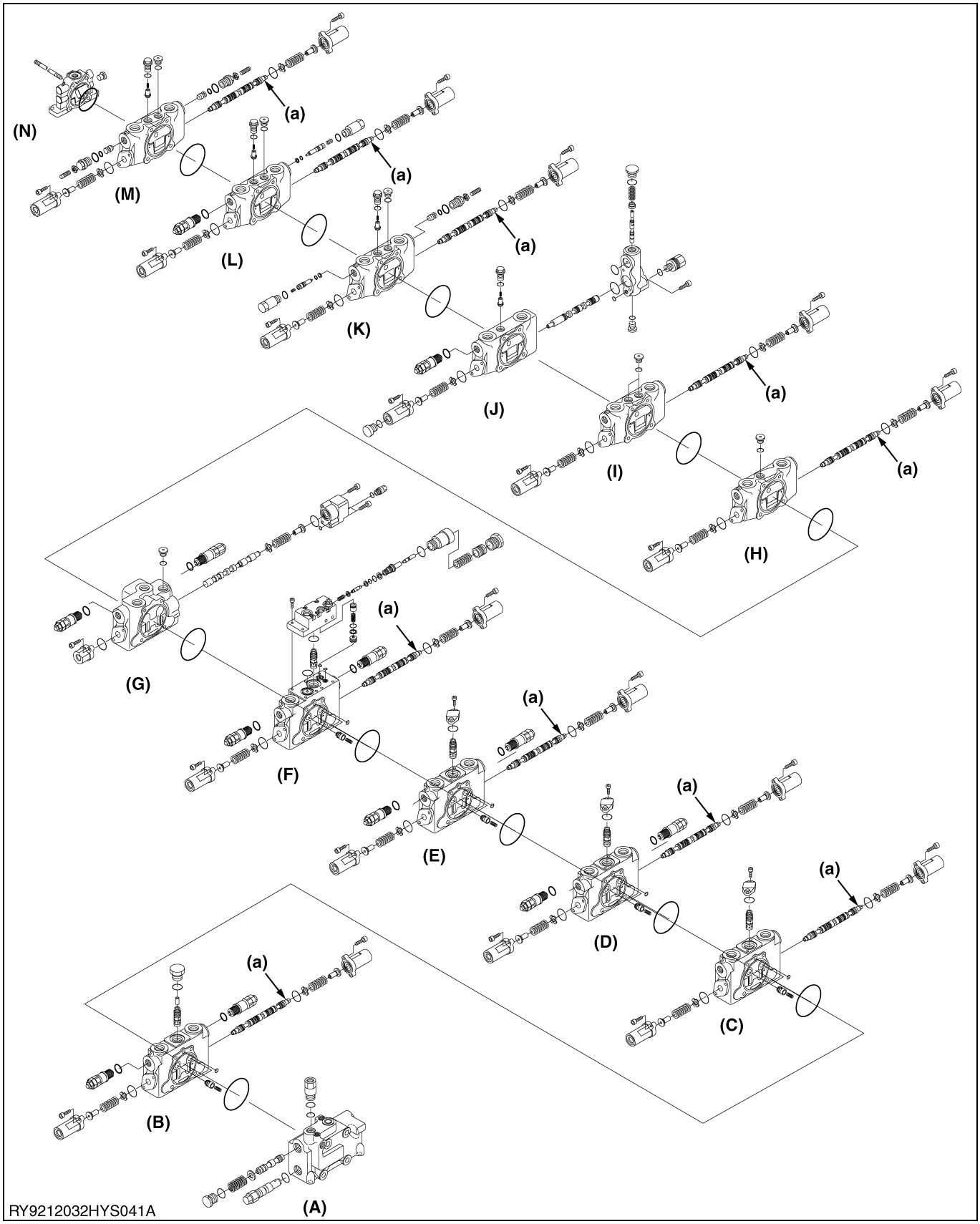


RY9212052HYS051A

(1) Control valve assembly
(2) T1, PLS
(3) AUX1. Low
(4) AUX1. High
(5) Swivel right
(6) Swivel left
(7) Bucket, bottom
(8) Bucket, rod
(9) Arm, bottom
(10) Arm, rod
(11) Boom, bottom
(12) Boom, rod
(13) P1, P2, PPS
(14) Travel right forward
(15) Travel right rear
(16) Travel left forward
(17) Travel left rear
(18) P3, T2
(19) Swing, bottom
(20) Swing, rod
(21) Blade, rod
(22) Blade, bottom
(23) AUX2, High
(24) AUX2, Low

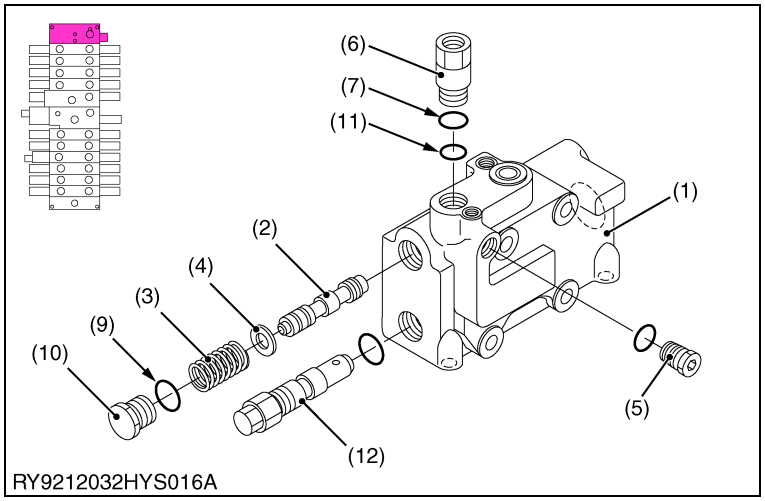
(a) 20 °
(b) 30 °
(c) 45 °
(d) 60 °
(e) 10 °

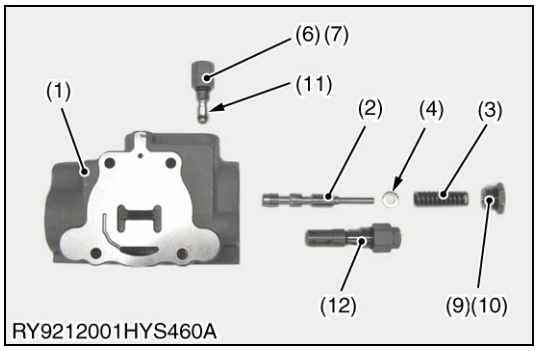
RY9212032HYS0084US0



(A) Outlet
(B) AUX1
(C) Swivel
(D) Bucket
(E) Arm
(F) Boom
(G) Independent travel
(H) Travel right
(I) Travel left
(J) Communication valve
(K) Swing
(L) Blade
(M) AUX2
(N) Inlet
(a) Identification groove for spool assembly orientation

RY9212032HYS0016US0





(A) Spool section (outlet) components

No.	Name of part	Q'ty	Tightening torque
(1)	Outlet housing	1	
(2)	Spool	1	
(3)	Spring	1	
(4)	Metal washer	1	
(5)	Plug assembly	1	28 to 30 N·m 2.9 to 3.0 kgf·m 21 to 22 lbf·ft
(6)	Plug	1	28.4 to 30.4 N·m 2.9 to 3.1 kgf·m 21 to 22.4 lbf·ft
(7)	O-ring (JIS B 2401, 1B, P11)	1	
(8)	Plug	3	
(9)	O-ring (JIS B 2401, 1B, P18)	1	
(10)	Plug	1	67.7 to 73.5 N·m 6.9 to 7.49 kgf·m 50.0 to 54.2 lbf·ft
(11)	O-ring (JIS B 2401, 1B, P7)	1	

No.	Valve assembly (relief) pressure setting	Tightening torque
(12)	27.4 MPa (280 kgf/cm^2, 3970 psi)	49 to 54 N·m 5.0 to 5.5 kgf·m 37 to 39 lbf·ft

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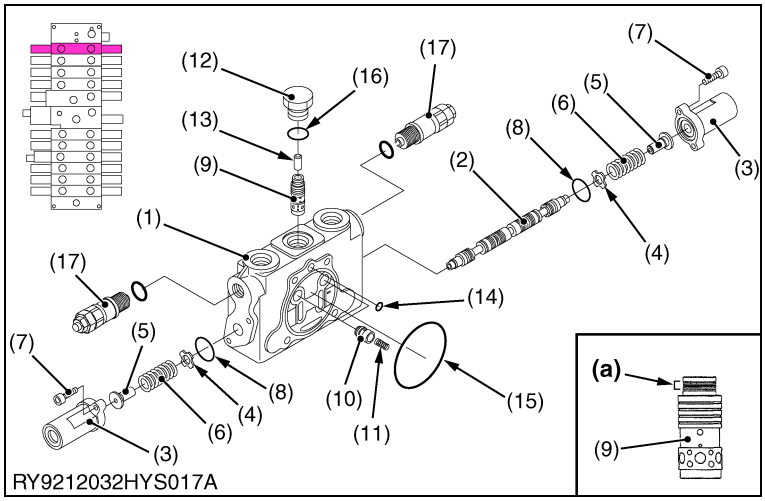
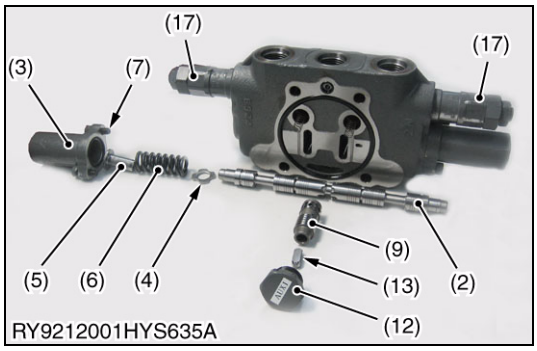




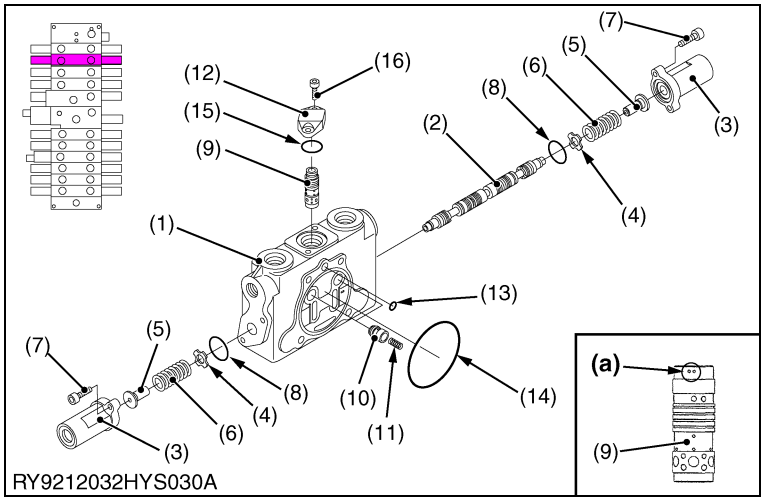
(B) Spool section (AUX1) components

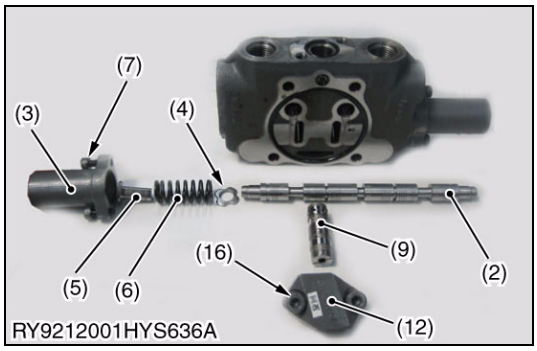
No.	Name of part	Q'ty	Tightening torque
(1)	Valve housing	1	
(2)	Spool	1	
(3)	Cap	2	
(4)	Spring seat	2	
(5)	Spring seat	2	
(6)	Spring	2	
(7)	Socket head bolt	4	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(8)	O-ring (S24, 1A)	2	
(9)	Spool	1	
(10)	Poppet	2	
(11)	Spring	2	
(12)	Plug	1	
(13)	Poppet	1	67.7 to 73.5 N·m 6.9 to 7.49 kgf·m 50.0 to 54.2 lbf·ft
(14)	O-ring (JIS B 2401, 1B, P7)	1	
(15)	O-ring (JIS B 2401, 1A, G75)	1	
(16)	O-ring (JIS B 2401, 1B, P18)	1	

No.	Valve assembly (relief) pressure setting	Tightening torque
(17)	20.6 MPa (210 kgf/cm^2, 2990 psi)	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

(a) Identification groove (x4)

RY9212032HYS0018US0





(C) Spool section (swivel) components

No.	Name of part	Q'ty	Tightening torque
(1)	Valve housing	1	
(2)	Spool	1	
(3)	Cap	2	
(4)	Spring seat	2	
(5)	Spring seat	2	
(6)	Spring	2	
(7)	Socket head bolt	4	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(8)	O-Ring	2	
(9)	Spool ASSY	1	
(10)	Poppet	2	
(11)	Spring	2	
(12)	Flange	1	
(13)	O-ring (JIS B 2401, 1B, P7)	1	
(14)	O-ring (JIS B 2401, 1A, G75)	1	
(15)	O-ring (JIS B 2401, 1B, P22)	1	
(16)	Socket head bolt	2	30.4 to 32.4 N·m 3.1 to 3.3 kgf·m 22.5 to 23.8 lbf·ft

(a) Identification mark (two locations)

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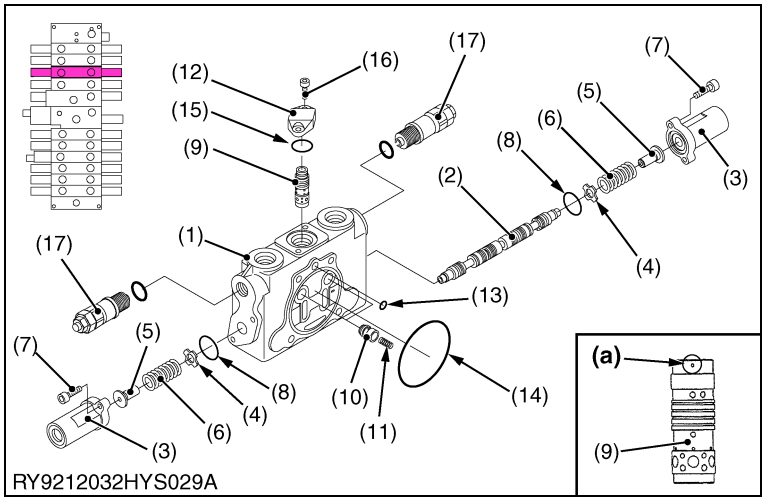
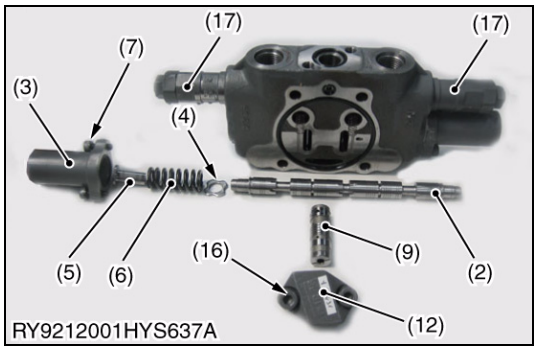




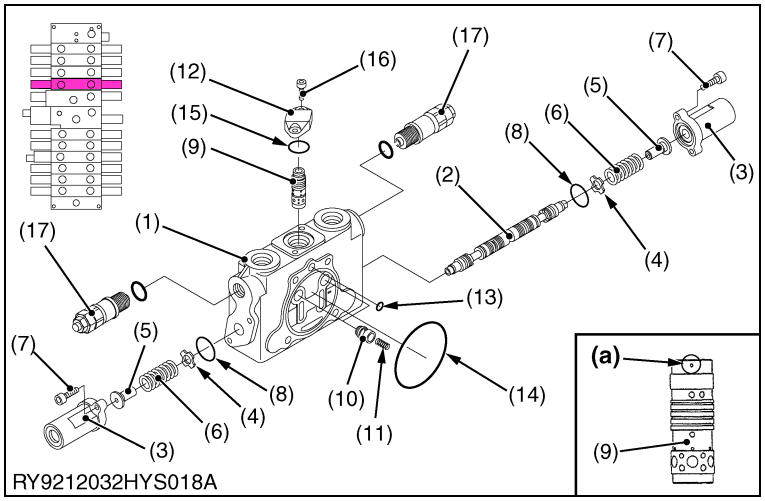
(D) Spool section (bucket) components

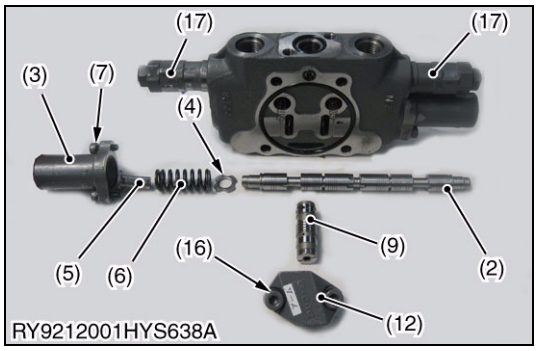
No.	Name of part	Q'ty	Tightening torque
(1)	Valve housing	1	
(2)	Spool	1	
(3)	Cap	2	
(4)	Spring seat	2	
(5)	Spring seat	2	
(6)	Spring	2	
(7)	Socket head bolt	4	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(8)	O-Ring	2	
(9)	Spool	1	
(10)	Poppet	2	
(11)	Spring	2	
(12)	Flange	1	
(13)	O-ring (JIS B 2401, 1B, P7)	1	
(14)	O-ring (JIS B 2401, 1A, G75)	1	
(15)	O-ring (JIS B 2401, 1B, P22)	1	
(16)	Socket head bolt	2	30.4 to 32.4 N·m 3.1 to 3.3 kgf·m 22.5 to 23.8 lbf·ft

No.	Valve assembly (relief) pressure setting	Tightening torque
(17)	31.4 MPa (320 kgf/cm^2, 4550 psi)	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

(a) Identification mark (one location)

RY9212032HYS0020US0





(E) Spool section (arm) components

No.	Name of part	Q'ty	Tightening torque
(1)	Valve housing	1	
(2)	Spool	1	
(3)	Cap	2	
(4)	Spring seat	2	
(5)	Spring seat	2	
(6)	Spring	2	
(7)	Socket head bolt	4	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(8)	O-Ring	2	
(9)	Spool ASSY	1	
(10)	Poppet	2	
(11)	Spring	2	
(12)	Flange	1	
(13)	O-ring (JIS B 2401, 1B, P7)	1	
(14)	O-ring (JIS B 2401, 1A, G75)	1	
(15)	O-ring (JIS B 2401, 1B, P22)	1	
(16)	Socket head bolt	2	30.4 to 32.4 N·m 3.1 to 3.3 kgf·m 22.5 to 23.8 lbf·ft

No.	Valve assembly (relief) pressure setting	Tightening torque
(17)	31.4 MPa (320 kgf/cm^2, 4550 psi)	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

(a) Identification mark (one location)

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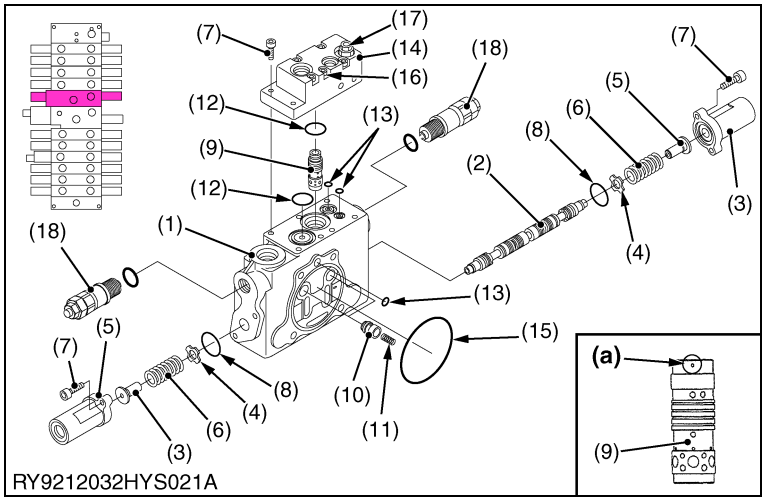
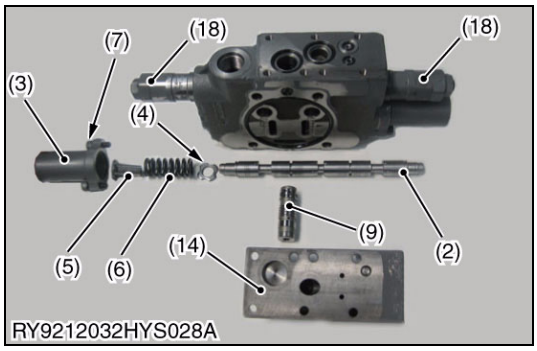




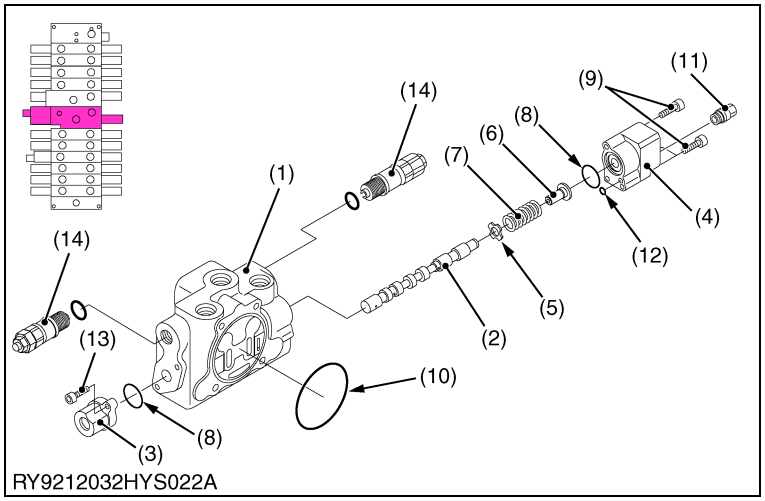
(F) Spool section (boom) components

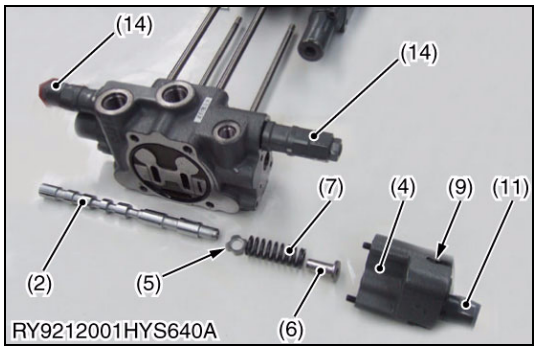
No.	Name of part	Q'ty	Tightening torque
(1)	Valve housing	1	
(2)	Spool	1	
(3)	Cap	2	
(4)	Spring seat	2	
(5)	Spring seat	2	
(6)	Spring	2	
(7)	Socket head bolt	6	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(8)	O-ring (S24, 1A)	2	
(9)	Spool ASSY	1	
(10)	Poppet	2	
(11)	Spring	2	
(12)	O-ring (JIS B 2401, 1B, P22)	2	
(13)	O-ring (JIS B 2401, 1B, P7)	3	
(14)	Anti-drift assembly	1	
(15)	O-ring (JIS B 2401, 1A, G75)	1	
(16)	Socket head bolt	5	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(17)	Valve ASSY	1	28 to 30 N·m 2.9 to 3.0 kgf·m 21 to 22 lbf·ft

No.	Valve assembly (relief) pressure setting	Tightening torque
(18)	31.4 MPa (320 kgf/cm^2, 4550 psi)	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

(a) Identification mark (one location)

RY9212032HYS0022US0





(G) Spool section (independent travel) components

No.	Name of part	Q'ty	Tightening torque
(1)	Valve housing	1	
(2)	Spool	1	
(3)	Cap	1	
(4)	Cap	1	
(5)	Plate (spring)	1	
(6)	Seat (spring)	2	
(7)	Spring	1	
(8)	O-Ring	2	
(9)	Hex socket bolt	3	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(10)	O-Ring	1	
(11)	Plug, assembly	1	21.6 to 23.6 N·m 2.2 to 2.4 kgf·m 16.0 to 17.4 lbf·ft
(12)	O-Ring	1	
(13)	Bolt (socket head)	2	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft

No.	Valve assembly (relief) pressure setting	Tightening torque
(14)	26.5 MPa (270 kgf/cm^2, 3840 psi)	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

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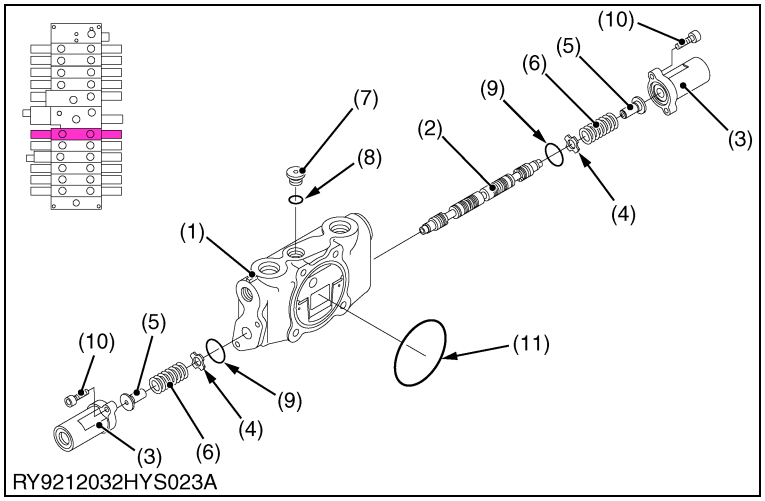

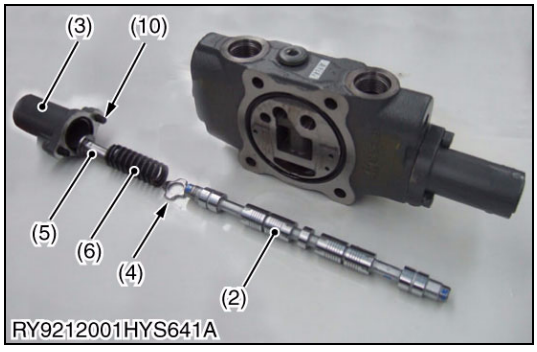

(H) Spool section (travel right) components

No.	Name of part	Q'ty	Tightening torque
(1)	Valve housing	1	
(2)	Spool	1	
(3)	Cap	2	
(4)	Spring seat	2	
(5)	Spring seat	2	
(6)	Spring	2	
(7)	Plug	1	30.4 to 32.4 N·m 3.1 to 3.3 kgf·m 22.5 to 23.8 lbf·ft
(8)	O-Ring	1	
(9)	O-ring (S24, 1A)	2	
(10)	Socket head bolt	4	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(11)	O-ring (JIS B 2401, 1A, G70)	1	

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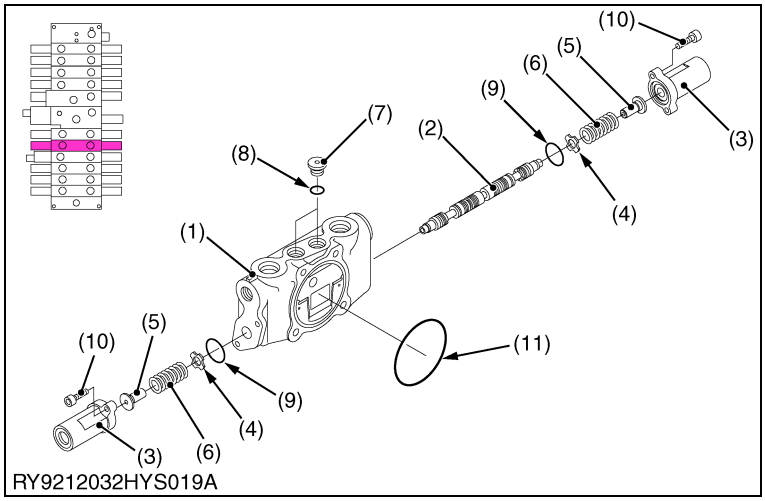

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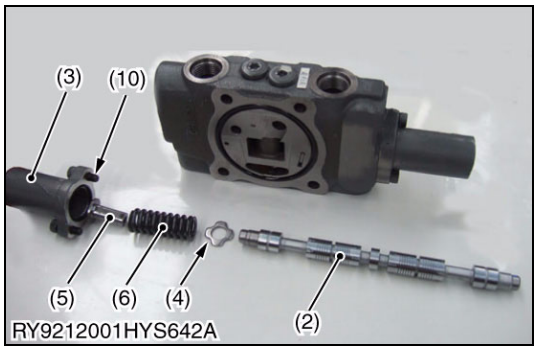

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(I) Spool section (travel left) components

No.	Name of part	Q'ty	Tightening torque
(1)	Valve housing	1	
(2)	Spool	1	
(3)	Cap	2	
(4)	Spring seat	2	
(5)	Spring seat	2	
(6)	Spring	2	
(7)	Plug	2	30.4 to 32.4 N·m 3.1 to 3.3 kgf·m 22.5 to 23.8 lbf·ft
(8)	O-Ring	2	
(9)	O-ring (S24, 1A)	2	
(10)	Socket head bolt	4	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(11)	O-ring (JIS B 2401, 1A, G70)	1	

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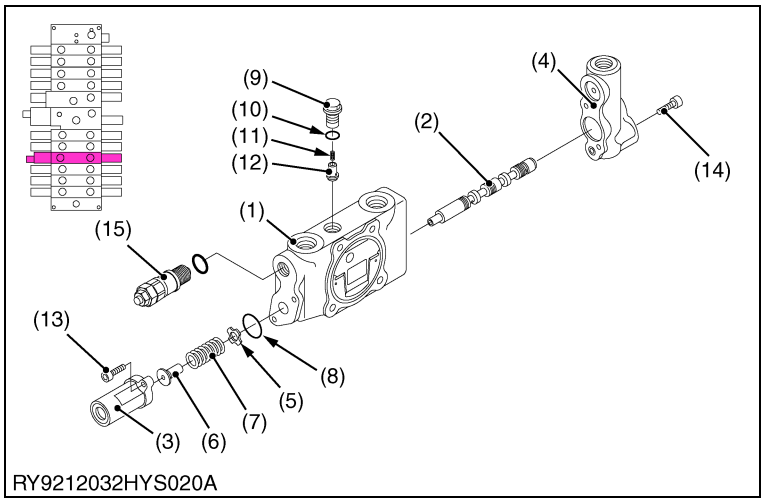

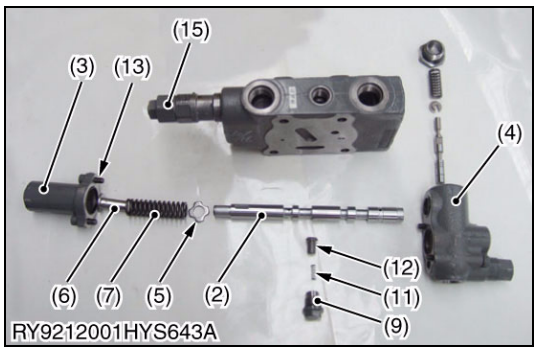

(J) Spool section (communication valve) components

No.	Name of part	Q'ty	Tightening torque
(1)	Valve housing	1	
(2)	Spool	1	
(3)	Cap	1	
(4)	Body assembly	1	
(5)	Spring seat	1	
(6)	Spring seat	1	
(7)	Spring	1	
(8)	O-ring (S24, 1A)	1	
(9)	Plug	1	30.4 to 32.4 N·m 3.1 to 3.3 kgf·m 22.5 to 23.8 lbf·ft
(10)	O-Ring	1	
(11)	Spring	1	
(12)	Poppet	1	
(13)	Socket head bolt	2	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(14)	Socket head bolt	2	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft

No.	Valve assembly (relief) pressure setting	Tightening torque
(15)	19.1 MPa (195 kgf/cm^2, 2770 psi)	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

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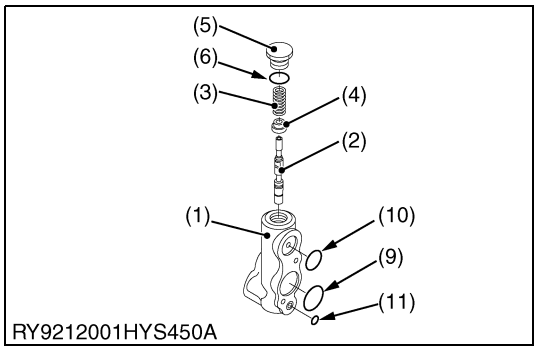

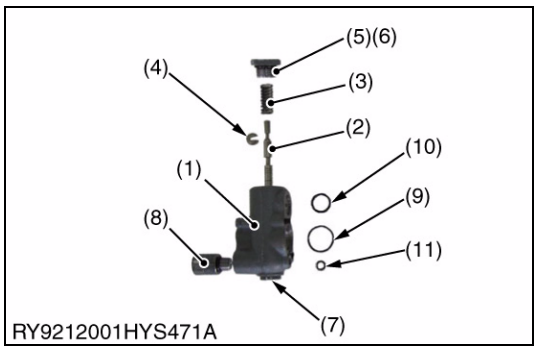

Body (communication valve) components

No.	Name of part	Q'ty	Tightening torque
(1)	Body	1	
(2)	Spool	1	
(3)	Spring	1	
(4)	Spring seat	1	
(5)	Plug	1	28.4 to 30.4 N·m 2.9 to 3.1 kgf·m 21.0 to 22.4 lbf·ft
(6)	O-ring (JIS B 2401, 1B, P18)	1	
(7)	Plug assembly	1	28.4 to 30.4 N·m 2.9 to 3.1 kgf·m 21.0 to 22.4 lbf·ft
(8)	Plug assembly	1	28.4 to 30.4 N·m 2.9 to 3.1 kgf·m 21.0 to 22.4 lbf·ft
(9)	O-ring (S24, 1A)	1	
(10)	O-ring (JIS B 2401, 1A, P16)	1	
(11)	O-ring (JIS B 2401, 1B, P7)	1	

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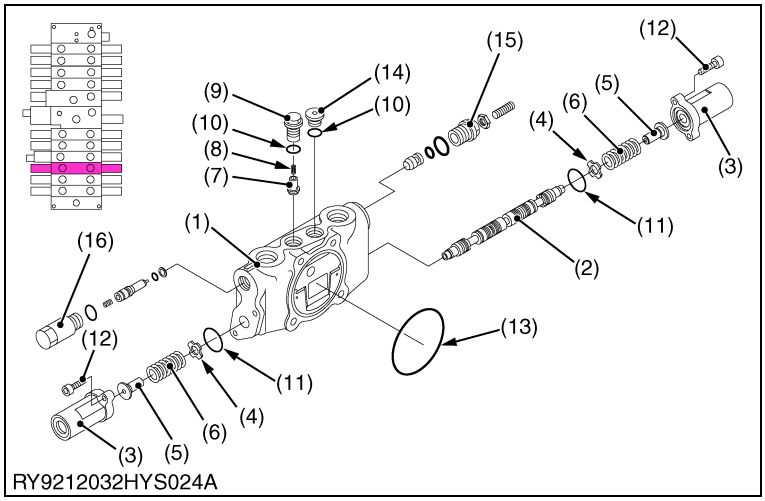

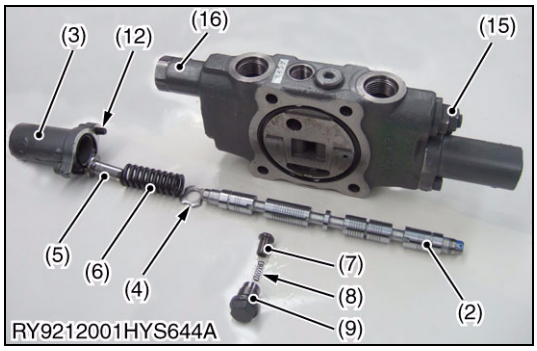

(K) Spool section (swing) components

No.	Name of part	Q'ty	Tightening torque
(1)	Valve housing	1	
(2)	Spool	1	
(3)	Cap	2	
(4)	Spring seat	2	
(5)	Spring seat	2	
(6)	Spring	2	
(7)	Poppet	1	
(8)	Spring	1	
(9)	Plug	1	30.4 to 32.4 N·m 3.1 to 3.3 kgf·m 22.5 to 23.8 lbf·ft
(10)	O-ring (S24, 1A)	2	
(11)	O-Ring	2	
(12)	Socket head bolt	4	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(13)	O-ring (JIS B 2401, 1A, G70)	1	
(14)	Plug	1	30.4 to 32.4 N·m 3.1 to 3.3 kgf·m 22.5 to 23.8 lbf·ft
(15)	Shut-off valve	2	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

No.	Anti-void valve tightening torque
(16)	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

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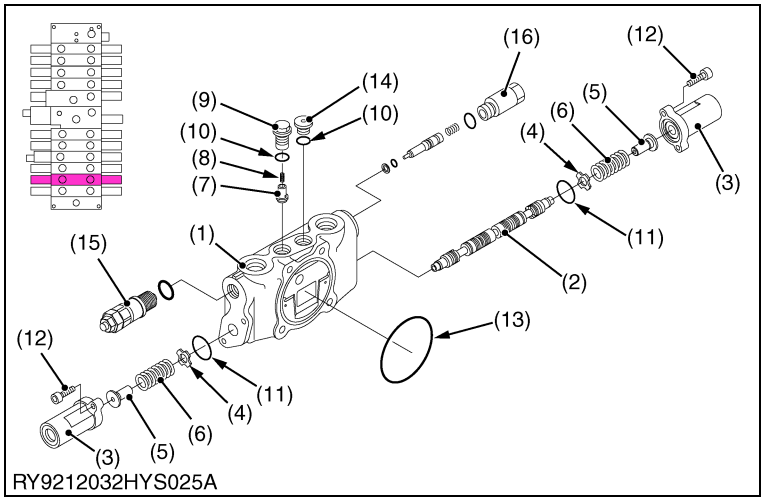

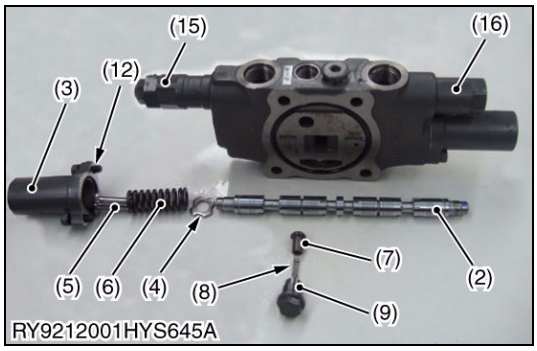

(L) Spool section (blade) components

No.	Name of part	Q'ty	Tightening torque
(1)	Valve housing	1	
(2)	Spool	1	
(3)	Cap	2	
(4)	Spring seat	2	
(5)	Spring seat	2	
(6)	Spring	2	
(7)	Poppet	1	
(8)	Spring	1	
(9)	Plug	1	30.4 to 32.4 N·m 3.1 to 3.3 kgf·m 22.5 to 23.8 lbf·ft
(10)	O-Ring	2	
(11)	O-ring (S24, 1A)	2	
(12)	Socket head bolt	4	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(13)	O-ring (JIS B 2401, 1A, G70)	1	
(14)	Plug	1	30.4 to 32.4 N·m 3.1 to 3.3 kgf·m 22.5 to 23.8 lbf·ft

No.	Valve assembly (relief) pressure setting	Tightening torque
(15)	27.4 MPa (280 kgf/cm^2, 3970 psi)	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

No.	Anti-void valve tightening torque
(16)	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

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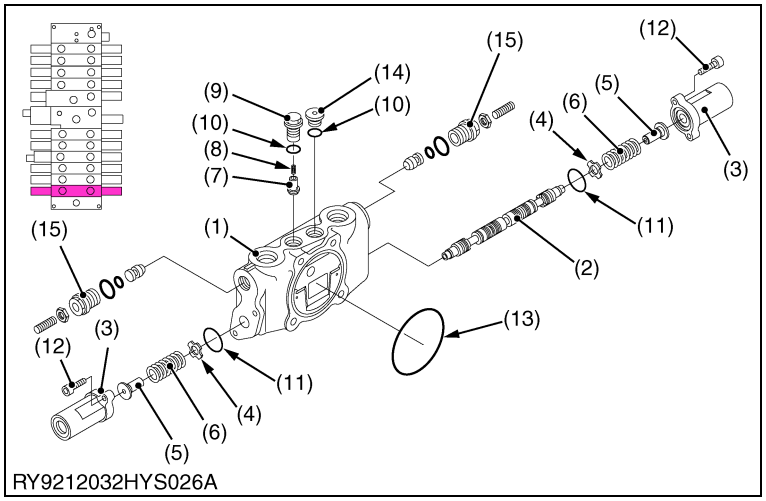

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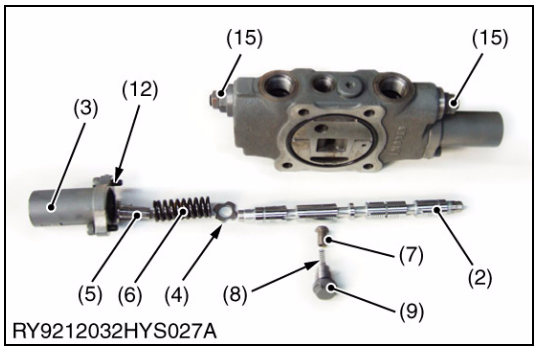

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(M) Spool section (AUX2) components

No.	Name of part	Q'ty	Tightening torque
(1)	Valve housing	1	
(2)	Spool	1	
(3)	Cap	2	
(4)	Spring seat	2	
(5)	Spring seat	2	
(6)	Spring	2	
(7)	Poppet	1	
(8)	Spring	1	
(9)	Plug	1	30.4 to 32.4 N·m 3.1 to 3.3 kgf·m 22.5 to 23.8 lbf·ft
(10)	O-ring (S24, 1A)	2	
(11)	O-Ring	2	
(12)	Socket head bolt	4	8.8 to 10.8 N·m 0.9 to 1.1 kgf·m 6.5 to 7.96 lbf·ft
(13)	O-ring (JIS B 2401, 1A, G70)	1	
(14)	Plug	1	30.4 to 32.4 N·m 3.1 to 3.3 kgf·m 22.5 to 23.8 lbf·ft
(15)	Shut-off valve	2	69 to 78 N·m 7.0 to 8.0 kgf·m 51 to 57 lbf·ft

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3. SWIVEL MOTOR

[1] REMOVAL AND INSTALLATION OF THE SWIVEL MOTOR

CAUTION

- **When removing a hydraulic device after operating the mini-excavator, lower the bucket and blade to the ground and turn off the engine.**
- **Each of the devices and the hydraulic oil are hot and under high pressure immediately after operating the mini-excavator. If the hydraulic oil reached a high operating temperature, it may cause a burn.**
- **Oil gushing out under pressure has enough force to pierce your skin and may cause you injury. Always allow the temperature to drop and relieve any remaining pressure prior to working to remove any hydraulic equipment.**

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Removing the cab

1. Put the bucket on the ground and stop the engine.
   Remove the cab.
   (Refer to the chapter Cab Removal and Installation.)

Tightening torque	Nut (cab)	107.9 to 127.4 N·m 11.0 to 13.0 kgf·m 79.6 to 94.0 lbf·ft

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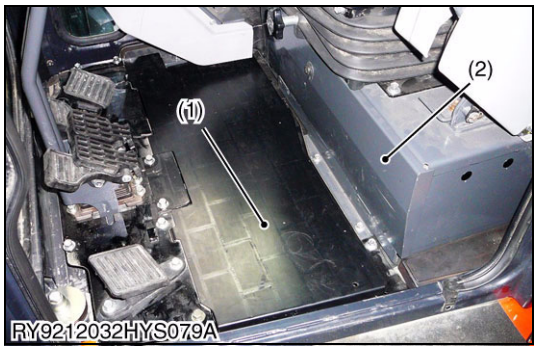

Removing the step

1. Remove the step (1) and the cover (2).

(1) Step (2) Cover

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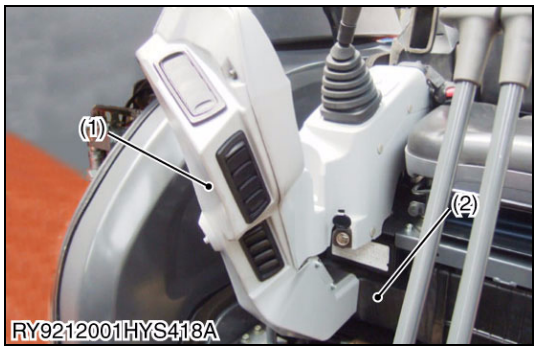

Removing ducts

1. Remove the cover (duct) (1) and the duct ASSY (2).

(1) Cover duct (2) Duct, ASSY

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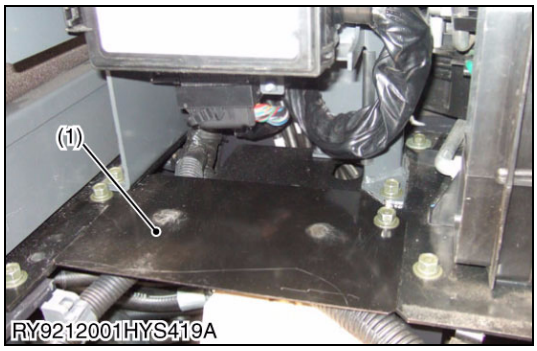

Removing the step

1. Remove the two bolts and then the step (1).

(1) Step

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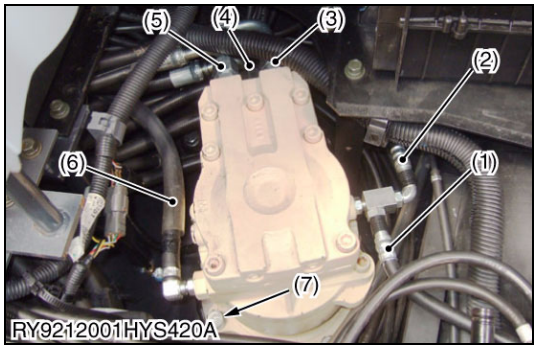

Removing the swivel motor

1. Disconnect the hydraulic hoses (1) to (6) around the motor ASSY (swivel) at the motor.
2. Remove the eight mounting bolts (7) to the motor ASSY (swivel).

■ **IMPORTANT**
- **Apply a threadlock (Loctite #271).**

Tightening torque	Motor ASSY (swivel)	259.9 to 304.0 N·m 26.5 to 31.0 kgf·m 191.7 to 224 lbf·ft

(1) Hydraulic hose
(2) Hydraulic hose
(3) Hydraulic hose
(4) Hydraulic hose
(5) Hydraulic hose
(6) Hydraulic hose
(7) Bolt (M16 × 45)

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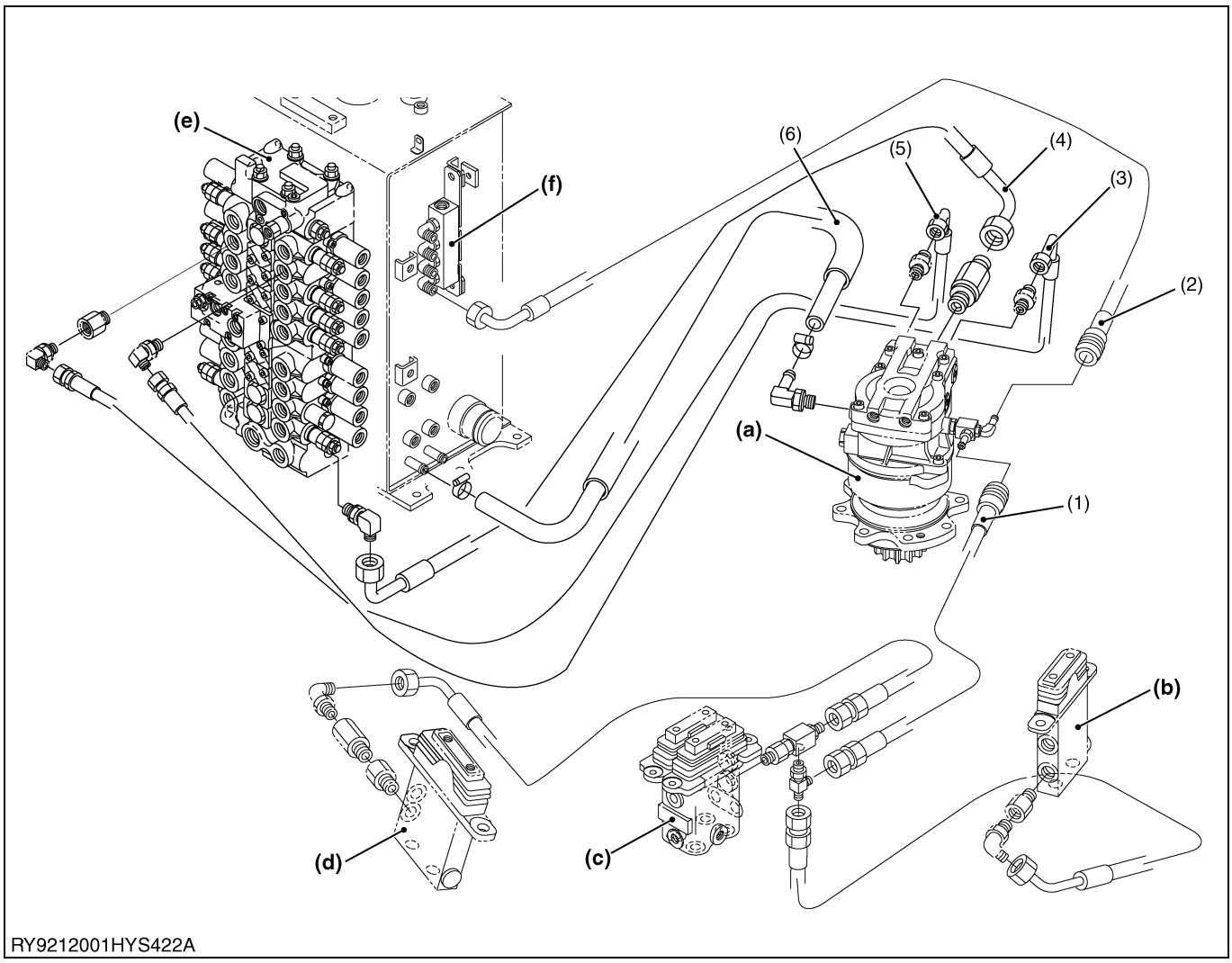
Swivel Motor Hose Circuit



(1) Hydraulic hose (3/8P Travel)
(2) Hydraulic hose (3/8SM-LOCK)
(3) Hydraulic hose (1/2SM-LH)
(4) Hydraulic hose (5/8Makeup)
(5) Hydraulic hose (1/2SM-RH)
(6) Hose (drain, swivel)
(a) Motor ASSY (swivel)
(b) Valve ASSY (PV AUX1)
(c) Valve ASSY (PV Travel)
(d) Valve ASSY (PV swing)
(e) Control Valve
(f) Coupler (Block PP)

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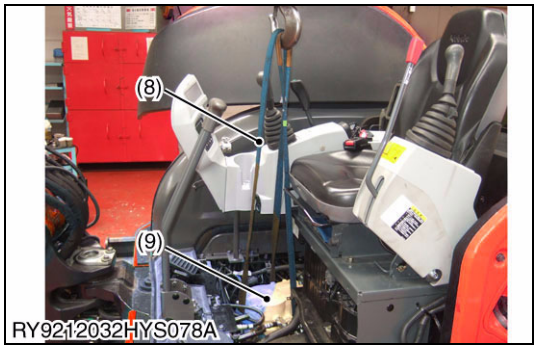

3. Suspend the motor ASSY (swivel) (9) from a nylon sling (8) and hoist it up with a crane.

(8) Nylon sling (9) Motor ASSY (swivel)

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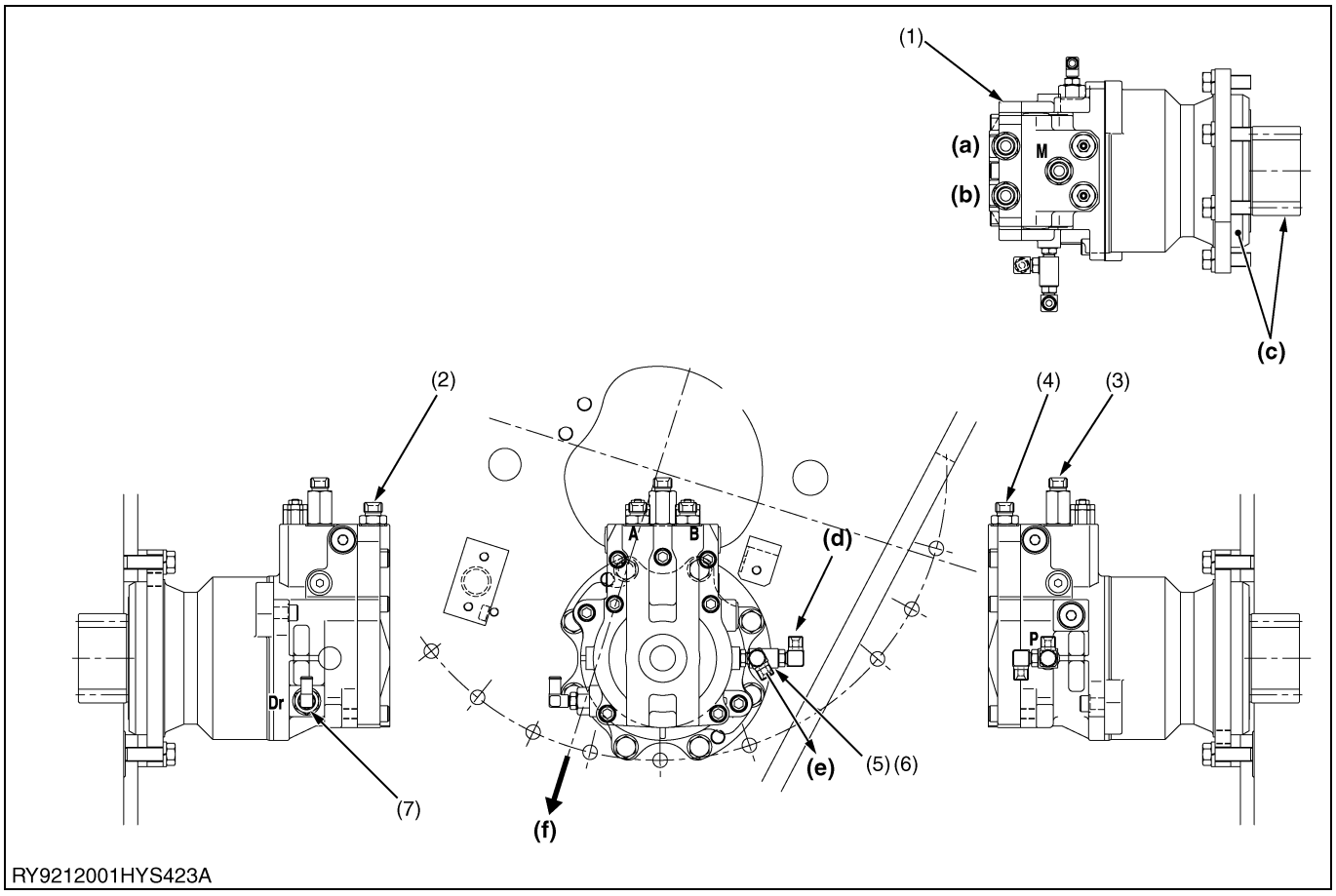
Swivel Motor Adaptor Layout Diagram



(1) Motor, ASSY (swivel)
(2) Pipe joint (S G4, G4)
(3) Pipe joint (S G4, G4)
(4) Pipe joint (S G4, G4)
(5) Pipe joint (T, G2, G2-G2)
(6) Pipe joint (L, G1/4-G3/8)
(7) Pipe joint (L, G2-13)

(a) Swivel right
(b) Swivel left
(c) Apply grease to and install the rabbeted flange and the pinion.
(d) P-block (tank)
(e) Travel pilot V and swing pilot V
(f) Front of machine

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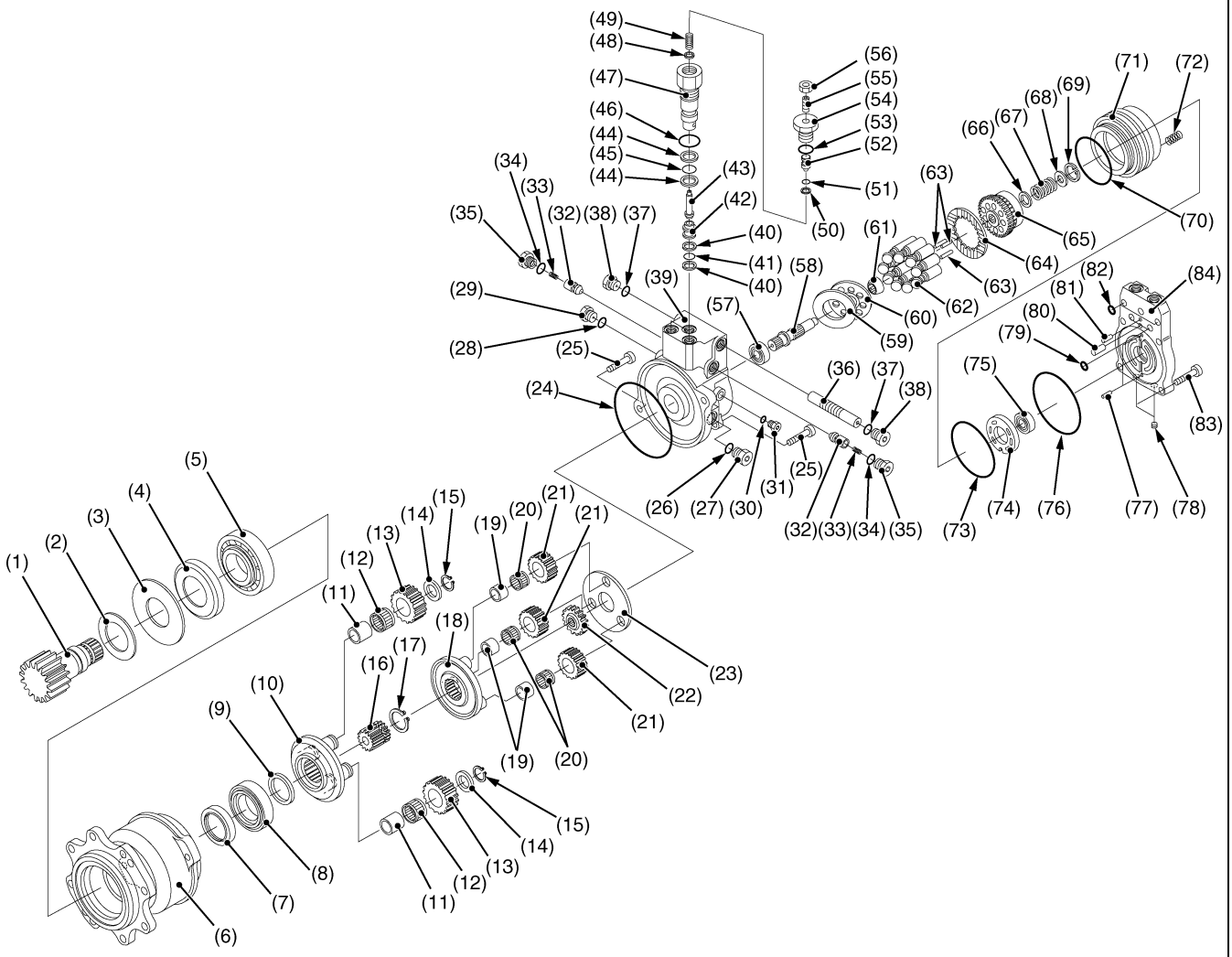
[2] SWIVEL MOTOR ASSEMBLY PROCEDURES



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No.	Part Name	Q'ty	No.	Part Name	Q'ty
(1)	Shaft (pinion)	1	(14)	Plate (thrust 2)	4
(2)	Plate (pinion 2)	1	(15)	External circlip	4
(3)	Plate (pinion)	1	(16)	Gear (sun)	1
(4)	Plate (valve)	1	(17)	External circlip	1
(5)	Tapered roller bearing	1	(18)	Holder (1)	1
(6)	Gear case	1	(19)	Collar (1)	3
(7)	Oil Seal	1	(20)	Needle bearing	3
(8)	Tapered roller bearing	1	(21)	Gear (planetary 1)	3
(9)	Spacer (t = 5.30 mm, 0.21 in.)	2	(22)	Gear (drive)	1
(9)	Spacer (t = 5.45 mm, 0.22 in.)	2	(23)	Plate (thrust) 1.8 mm, 0.07 in.	1
(9)	Spacer (t = 5.60 mm, 0.22 in.)	2	(23)	Plate (thrust) 2.3 mm, 0.09 in.	1
(9)	Spacer (t = 5.75 mm, 0.23 in.)	2	(23)	Plate (thrust) 2.9 mm, 0.11 in.	1
(9)	Spacer (t = 5.90 mm, 0.23 in.)	2	(23)	Plate (thrust) 3.2 mm, 0.13 in.	1
(10)	Holder 2	1	(24)	O-Ring	1
(11)	Collar 2	4	(25)	Hex socket bolt	2
(12)	Needle bearing	4	(26)	O-Ring	1
(13)	Gear (planetary 2)	4	(27)	Filter	1

No.	Part Name	Q'ty	No.	Part Name	Q'ty
(28)	O-Ring	1	(57)	Ball bearing	1
(29)	Plug (G1/2)	1	(58)	Shaft	1
(30)	O-Ring	1	(59)	Thrust plate	1
(31)	Plug (G1/4)	1	(60)	Plate (retainer)	1
(32)	Poppet	2	(61)	Holder (retainer)	1
(33)	Compression spring	2	(62)	Piston, ASSY	9
(34)	O-Ring	2	(63)	Pin	3
(35)	Plug	2	(64)	Plate (friction)	1
(36)	Piston (shockless)	1	(65)	Cylinder block (swivel)	1
(37)	O-Ring	2	(66)	Metal washer (spring 2)	1
(38)	Plug (G1/2)	2	(67)	Spring (CY)	1
(39)	Housing (motor and valves)	1	(68)	Metal washer (spring 2)	1
(40)	Backup ring	4	(69)	Internal circlip	1
(41)	O-Ring	2	(70)	O-Ring	1
(42)	Ring (Poppet seat)	2	(71)	Piston (brake)	1
(43)	Poppet	2	(72)	Spring (NB)	12
(44)	Ring (backup)	4	(73)	O-Ring	1
(45)	O-Ring	2	(74)	Plate (valve)	1
(46)	O-Ring	2	(75)	Ball bearing	1
(47)	Housing (relief)	2	(76)	O-Ring	1
(48)	Ring (spring seat)	2	(77)	Parallel pin	1
(49)	Compression spring	2	(78)	Plug (R1/4)	2
(50)	Ring (backup ring)	2	(79)	O-Ring	2
(51)	O-Ring	2	(80)	Parallel pin	2
(52)	Guide (spring)	2	(81)	Parallel pin	2
(53)	O-Ring	2	(82)	O-Ring	2
(54)	Plug (relief)	2	(83)	Hex socket bolt	7
(55)	Set screw	2	(84)	Cover (motor)	1
(56)	Nut	2			

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(1) Assembly Procedures

1. Use the jig (7) to tap the oil seal into the gear case (6).

■ **IMPORTANT**
- **Apply grease to the lip and circumference of the oil seal.**

(6) Gear case
(7) Oil Seal

(A) Tap in tool
(a) ϕ99 ± 0.05, ϕ3.9 ± 0.002 in.
(b) ϕ89 ± 0.05, ϕ3.5 ± 0.002 in.

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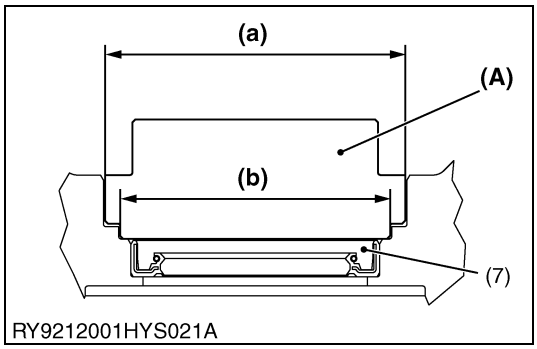

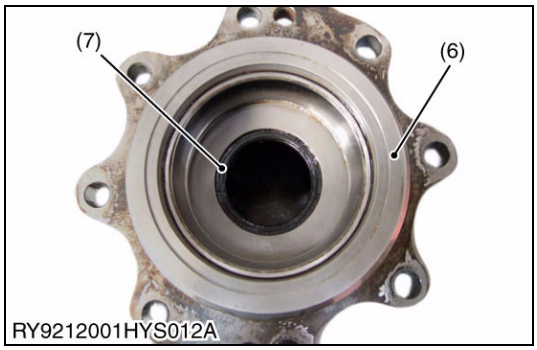

2. Press the outer race of the tapering roller bearing all the way into the gear case (6).

(6) Gear case
(7) Oil Seal

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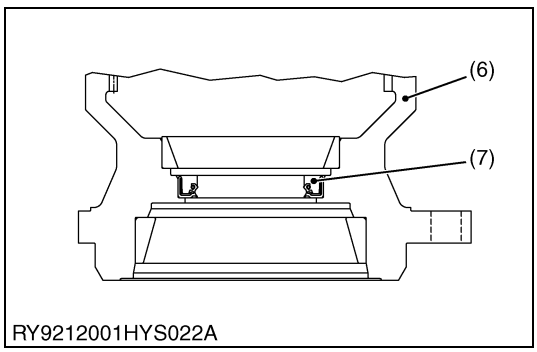

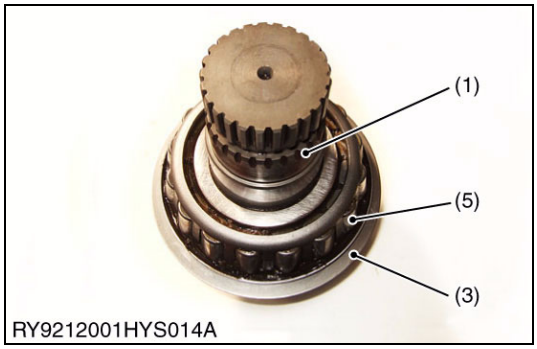

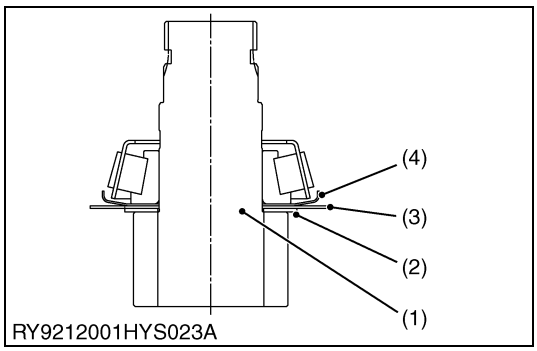

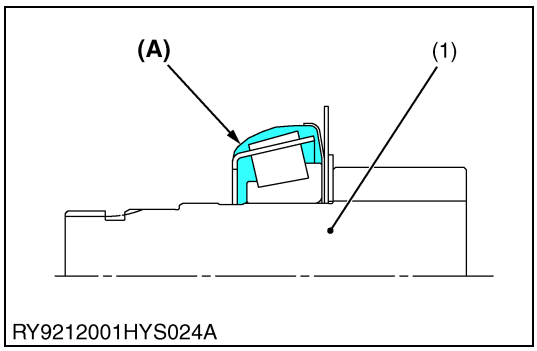

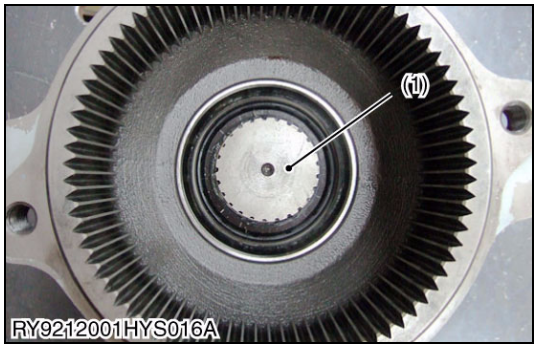

3. Install to the shaft (pinion) (1) in order of plate (pinion 2) (2), plate (pinion) (3) and plate (seal) (4).

■ **IMPORTANT**
- **Be careful of its direction when pressing the inner race of the tapering roller bearing (5) onto the shaft (1).**
- **After installing it, encapsulate the inner race of the tapering roller bearing with grease.**

- Amount of grease : about 50 cc (0.04 U.S.gal)

(1) Shaft (pinion)
(2) Plate (pinion 2)
(3) Plate (pinion)
(4) Plate (valve)
(5) Tapered roller bearing
(A) Grease

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4. Press the shaft (pinion) (1) into the gear case.

■ **IMPORTANT**
- **Do not scratch the oil seal.**

(1) Shaft (pinion)

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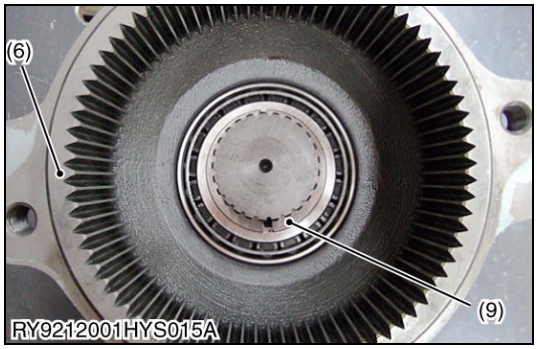

5. Press the inner race of the tapering roller bearing (8) onto the shaft.

■ **IMPORTANT**
- **Be careful to install the inner race facing the right direction.**
- **After installing it, rotate the shaft by hand.**
- **Select and install a spacer (9) so that the gap is between 0 to 0.15 mm (0.006 in.).**

(6) Gear case
(9) Spacer

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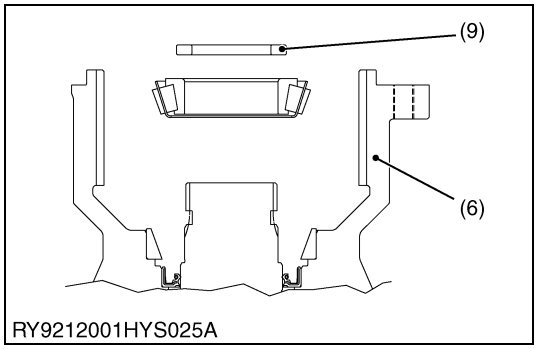
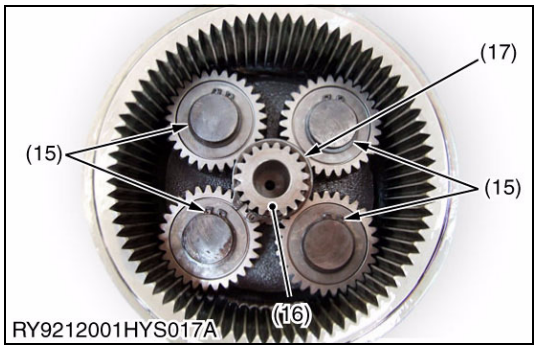
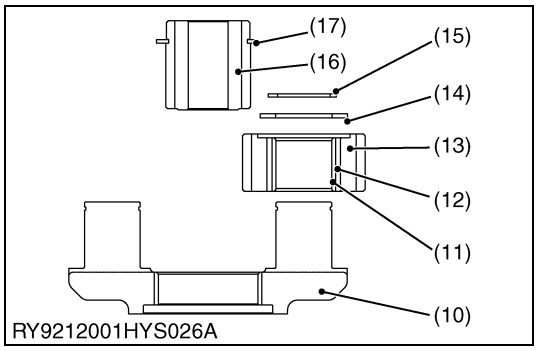


6. Install the collar (11), needle bearing (12), gear (planetary 2) (13) and plate (thrust 2) (14) onto holder 2 (10).
7. Install the gear (sun) (16).

■ **IMPORTANT**
- **Be careful to install the gears (planetary 2) facing the right direction.**
- **Install the gears (planetary 2) so the end without an indentation faces the holder 2.**
- **Install the plates (thrust 2) and external circlips (15) with the R face down.**

- Tool to use : snap ring pliers





(10) Holder 2
(11) Collar 2
(12) Needle bearing
(13) Gear (planetary 2)
(14) Plate (thrust 2)
(15) External circlip
(16) Gear (sun)
(17) External circlip

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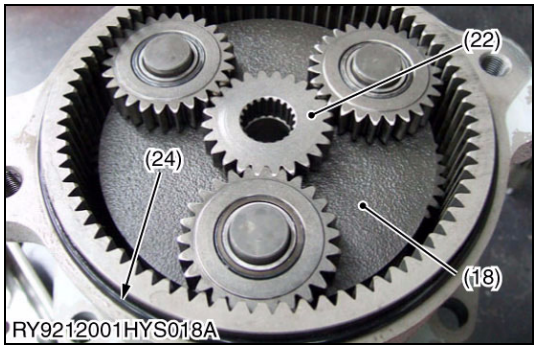

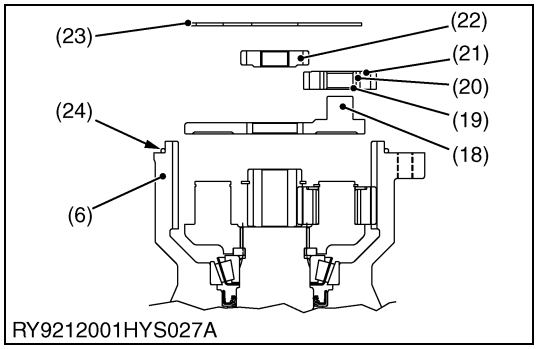

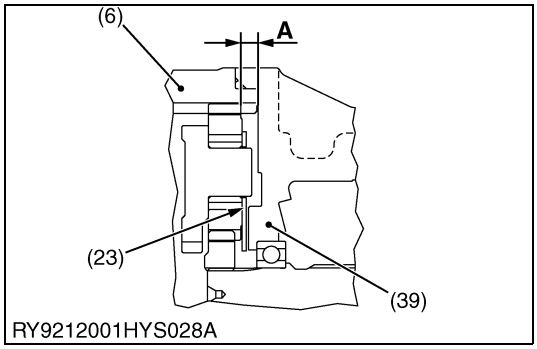

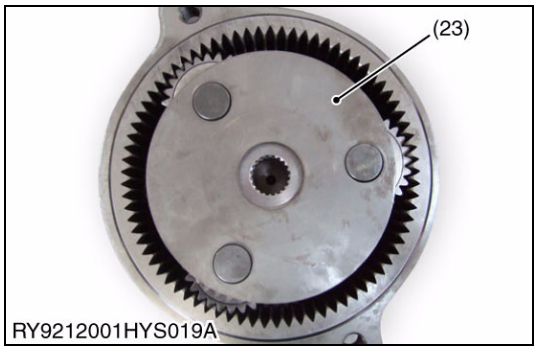

8. Install the collar (19), needle bearing (20) and gear (planetary 1) (21) onto holder 1 (18).
9. Install the gear (drive) (22).
10. Install the O-ring (24) on the gear case(6).

■ **IMPORTANT**
- **Be careful to install the gears (planetary 1) and (drive) facing the right direction.**
- **Install the gear (drive) so the indented face is toward the holder 1.**
- **Install the gear (planetary 1) so the indented face is toward the plate (thrust).**
- **Apply grease to the O-ring.**

(6) Gear case
(18) Holder (1)
(19) Collar (1)
(20) Needle bearing
(21) Gear (planetary 1)
(23) Plate (thrust)
(22) Gear (drive)
(24) O-Ring

RY9212001HYS0184US0

11. Measure the distance **A** between the top of the gear (planetary 1) and the top of the gear case.

■ **IMPORTANT**
- **Select the appropriate plate (thrust) from the table below to suit the measurement of distance A.**

Distance A	Part to Install	Thickness
5.50 to 6.00 mm 0.22 to 0.24 in.	FD411-1727	1.8 mm 0.07 in.
6.00 to 6.60 mm 0.24 to 0.26 in.	FD411-1728	2.3 mm 0.09 in.
6.60 to 6.90 mm 0.26 to 0.27 in.	FD411-1729	2.9 mm 0.11 in.
6.90 to 7.40 mm 0.27 to 0.29 in.	FD411-1730	3.2 mm 0.13 in.

(6) Gear case
(23) Plate (thrust)
(39) Housing (motor and valves)

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12. Install the selected plate (thrust) (23).

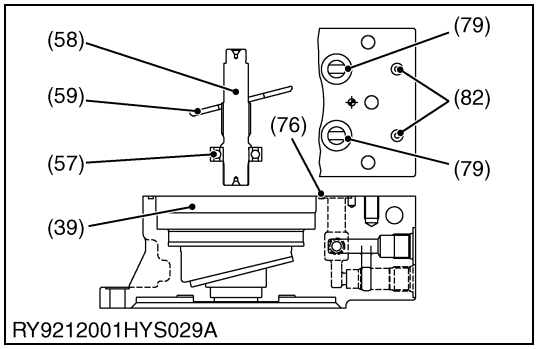
(23) Plate (thrust)

RY9212001HYS0186US0

13. Install the ball bearing (57) on the shaft (58).
14. Install the shaft ASSY into the housing (39).

■ **IMPORTANT**
- **When installing the bearing (57) in the housing (motor, valve), install it so its inscription is visible.**
- **Dip the thrust plate (59) in hydraulic oil and install it so the beveled side faces the housing.**

- Tool to use : plastic hammer



(39) Housing (motor and valves)
(57) Ball bearing
(58) Shaft
(59) Thrust plate
(76) O-Ring
(79) O-Ring
(82) O-Ring

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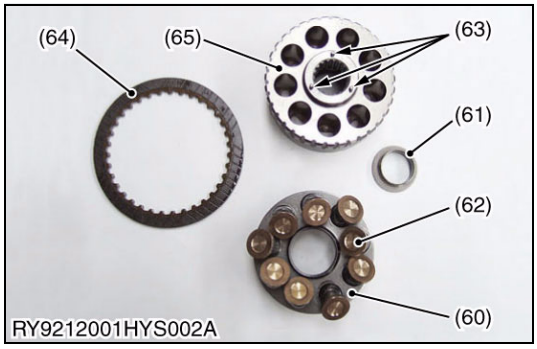
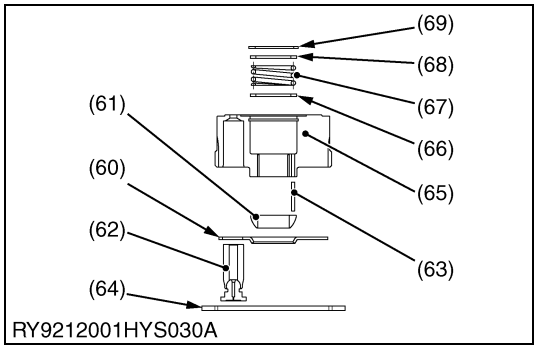


15. Install the metal washer (spring) (66), spring CY (67), metal washer (spring) (68) and internal circlip (69) in the cylinder block (65).

■ **IMPORTANT**
- **Install the internal circlip (69) so its R face is toward the piston.**
- **Apply grease to the pin and install it in the holder (retainer) (61) and the plate (retainer) (60) in order.**



(60) Plate (retainer)
(61) Holder (retainer)
(62) Piston
(63) Pin
(64) Plate (friction)
(65) Cylinder block (swivel)
(66) Metal washer (spring)
(67) Spring CY
(68) Metal washer (spring)
(69) Internal circlip

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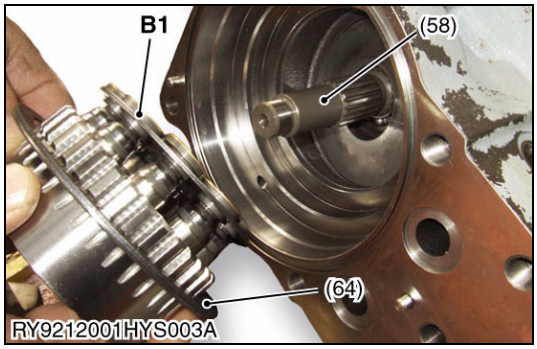

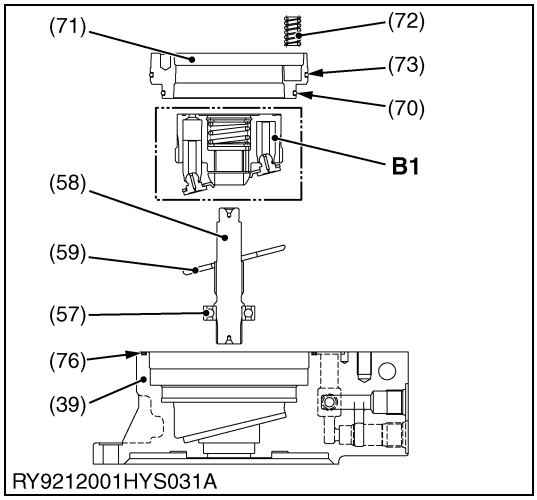

16. Lay the housing on its side.
17. Install the cylinder block sub-assembly **B1**, using the spline of the shaft (58) as a guide.

■ **IMPORTANT**
- **Be careful not to drop the pin.**
- **Dip the whole ASSY in hydraulic oil and then install it.**
- **After installing the ASSY, check and make sure the plate (friction) is not tilted.**
- **Press on the cylinder block sub-assembly B1 and make sure the spring CY is working.**

(57) Ball bearing
(58) Shaft
(59) Thrust plate
(64) Plate (friction)
(70) O-Ring
(71) Piston (brake)
(72) Spring (NB)
(73) O-Ring
(76) O-Ring

B1 : Cylinder block sub-assembly

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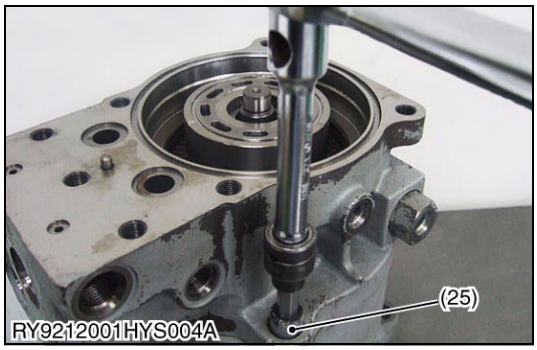

18. Check the O-ring on the gear case side and install the housing (motor, valves) on the gear case.
19. Fasten it with the hex socket bolts (25).

Tightening torque	Hex socket bolt (25)	102.9 to 117.6 N·m 10.5 to 12.0 kgf·m 75.9 to 86.7 lbf·ft

- Tool to use : M10 hex socket

(25) Hex socket bolt (M12)

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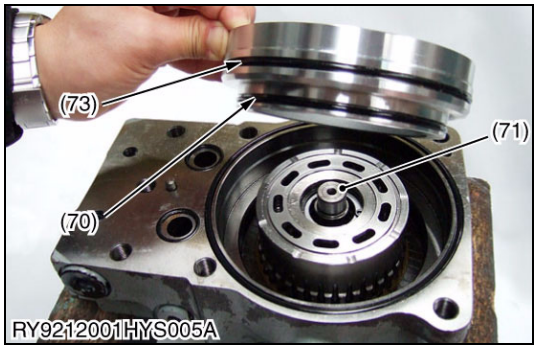

20. Install O-rings (73) and (70) to the piston (brake) (71).

■ **IMPORTANT**
- **Apply grease to the O-ring.**

(70) O-Ring
(71) Piston (brake)
(73) O-Ring

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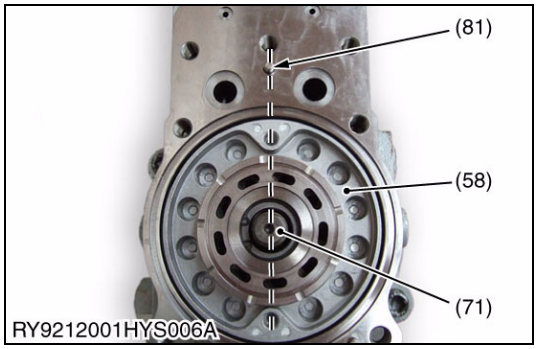

21. Install the piston (brake) (71), keeping it parallel to its mating surface (housing and motor valves) as you do so.

■ **IMPORTANT**
- **Be careful to install the piston (brake) facing the right direction.**
- **Check and make sure that the rotation-checking holes in the piston (brake) line up with the center of the shaft and the center of the pin.**

- Tool to use : plastic hammer

(58) Shaft
(71) Piston (brake)
(81) Pin

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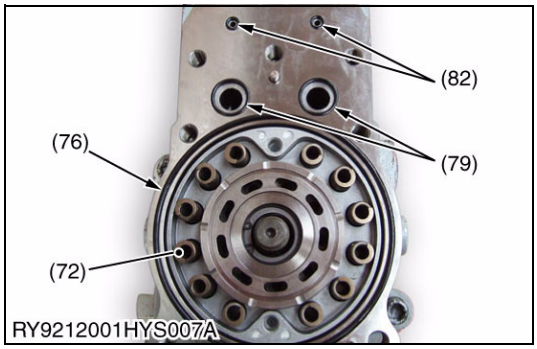

22. Install O-rings (76) and (79).
23. Install the spring (NB) (72) in the piston.

■ **IMPORTANT**
- **Apply grease to the O-ring.**

(72) Spring (NB)
(76) O-Ring
(79) O-Ring
(82) O-Ring

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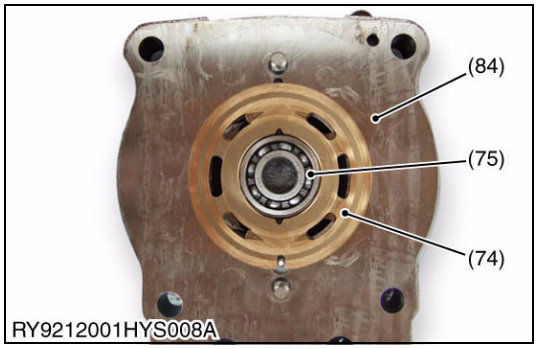

24. Install the ball bearing (75) on the cover (motor) (84).
25. Install the plate (valve) (74) on the cover (84).

■ **IMPORTANT**
- **When installing the ball bearing (75), install it so its inscription is visible.**
- **Apply grease on the plate (74) and stick it to the cover (84).**

- Tool to use : plastic hammer

(74) Plate (valve)
(75) Ball bearing
(84) Cover (motor)

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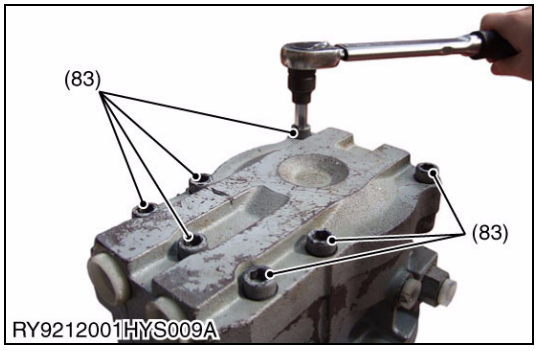

26. Install the cover (ASSY) on the housing (motor, valves).
27. Fasten it with the hex socket bolts (83).

■ **IMPORTANT**
- **Be careful not to drop any valves (plate).**

Tightening torque	Hex socket bolt (83)	102.9 to 117.6 N·m 10.5 to 12.0 kgf·m 75.9 to 86.7 lbf·ft

- Tool to use : M10 hex socket

(83) Hex socket bolt (M12)

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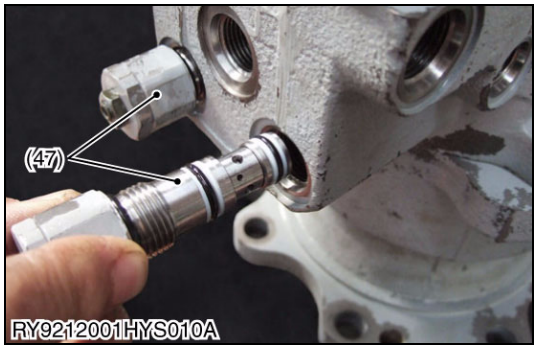
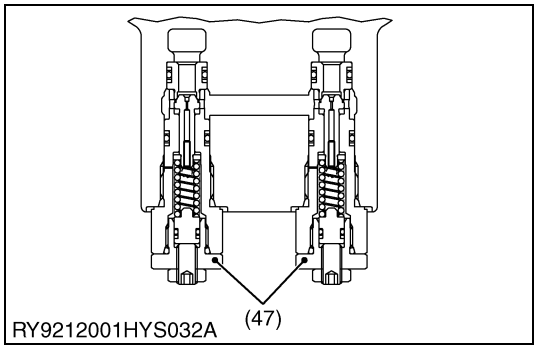


28. Install the valve ASSY (relief) (47).

Tightening torque	Valve ASSY (relief) (47)	58.5 to 68.6 N·m 6.0 to 7.0 kgf·m 43.1 to 50.6 lbf·ft

- Tool to use : wrench (socket) M26



(47) Valve ASSY (relief)

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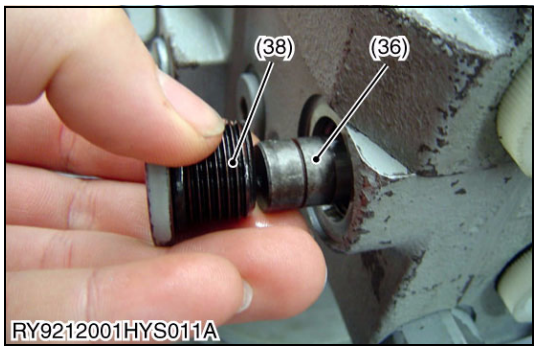
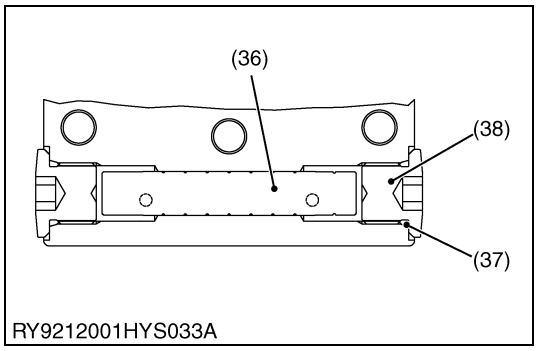


29. Apply hydraulic oil to the piston (shockless) (36) and install it.

Tightening torque	Plug (38)	58.5 to 68.6 N·m 6.0 to 7.0 kgf·m 43.1 to 50.6 lbf·ft

- Tool to use : M10 hex socket



(36) Piston (shockless)
(37) O-Ring
(38) Plug (G1/2)

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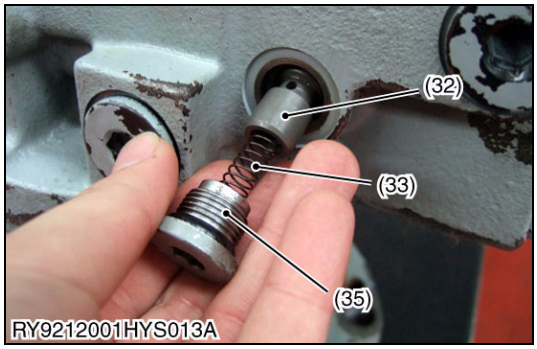
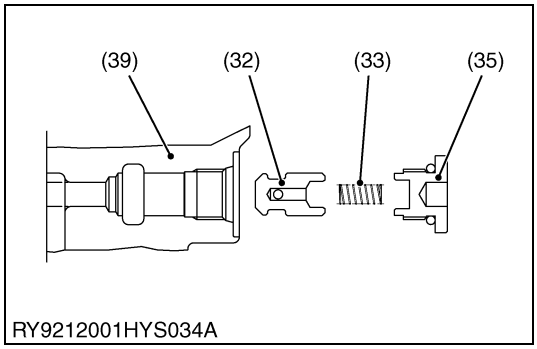


30. Install the poppet (makeup) (32).

Tightening torque	Plug (35)	49.0 to 58.8 N·m 5.0 to 6.0 kgf·m 36.1 to 43.4 lbf·ft

- Tool to use : M8 hex socket



(32) Poppet
(33) Compression spring
(35) Plug
(39) Housing (motor and valves)

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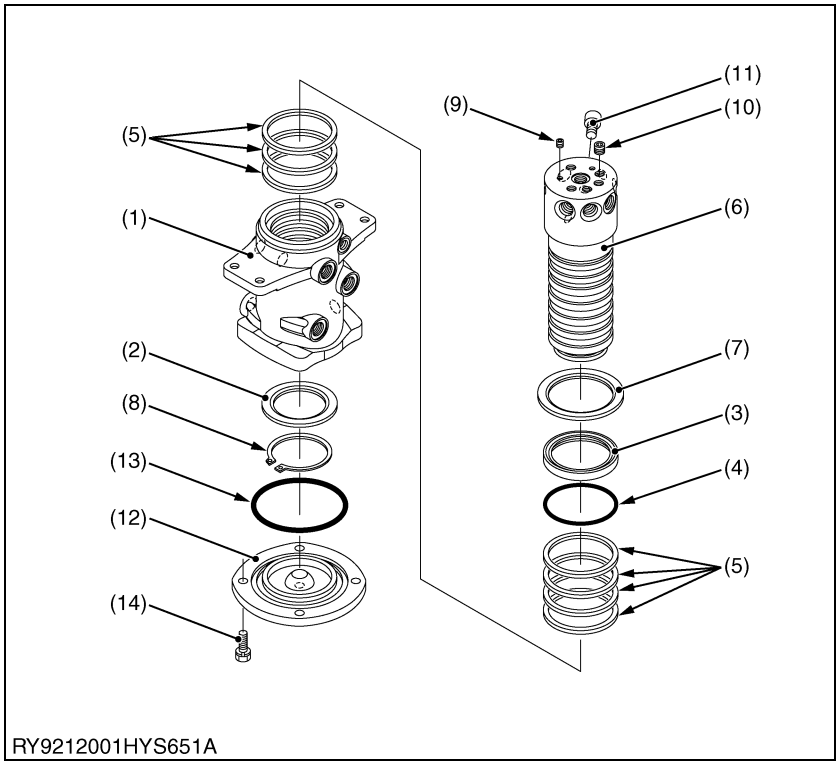
4. SWIVEL JOINT

[1] SWIVEL JOINT

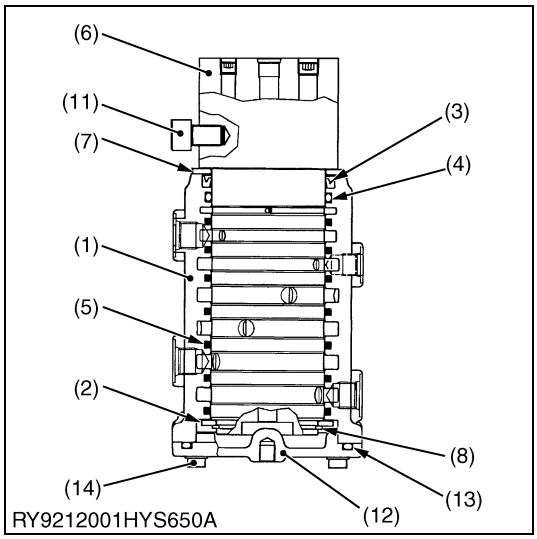
Swivel joint exploded view



RY9212001HYS651A

(1) Body
(2) Collar
(3) Packing (U)
(4) O-Ring
(5) Seal
(6) Shaft
(7) Collar
(8) External circlip
(9) Plug (PT1/4)
(10) Hex socket plug
(11) Hex socket bolt
(12) Cover (bottom, RJ)
(13) O-Ring
(14) Bolt (M10 × 25)

RY9212001HYS0205US0



RY9212001HYS650A

Swivel joint assembly diagram

1. Packing (U) (3) fitting orientation
   Apply grease to the inner and outer surfaces of the packing (U), and install with the seal lip on the outer side.
2. Tightening torque of screw base (11)

■ **IMPORTANT**
- **Apply a threadlock (Loctite #271).**

Tightening torque	Hex socket bolt (11)	196.1 to 225.6 N·m 20.0 to 23.0 kgf·m 144.6 to 166.4 lbf·ft

3. Tightening torque of cover (bottom, RJ) (12) mounting bolt (14)

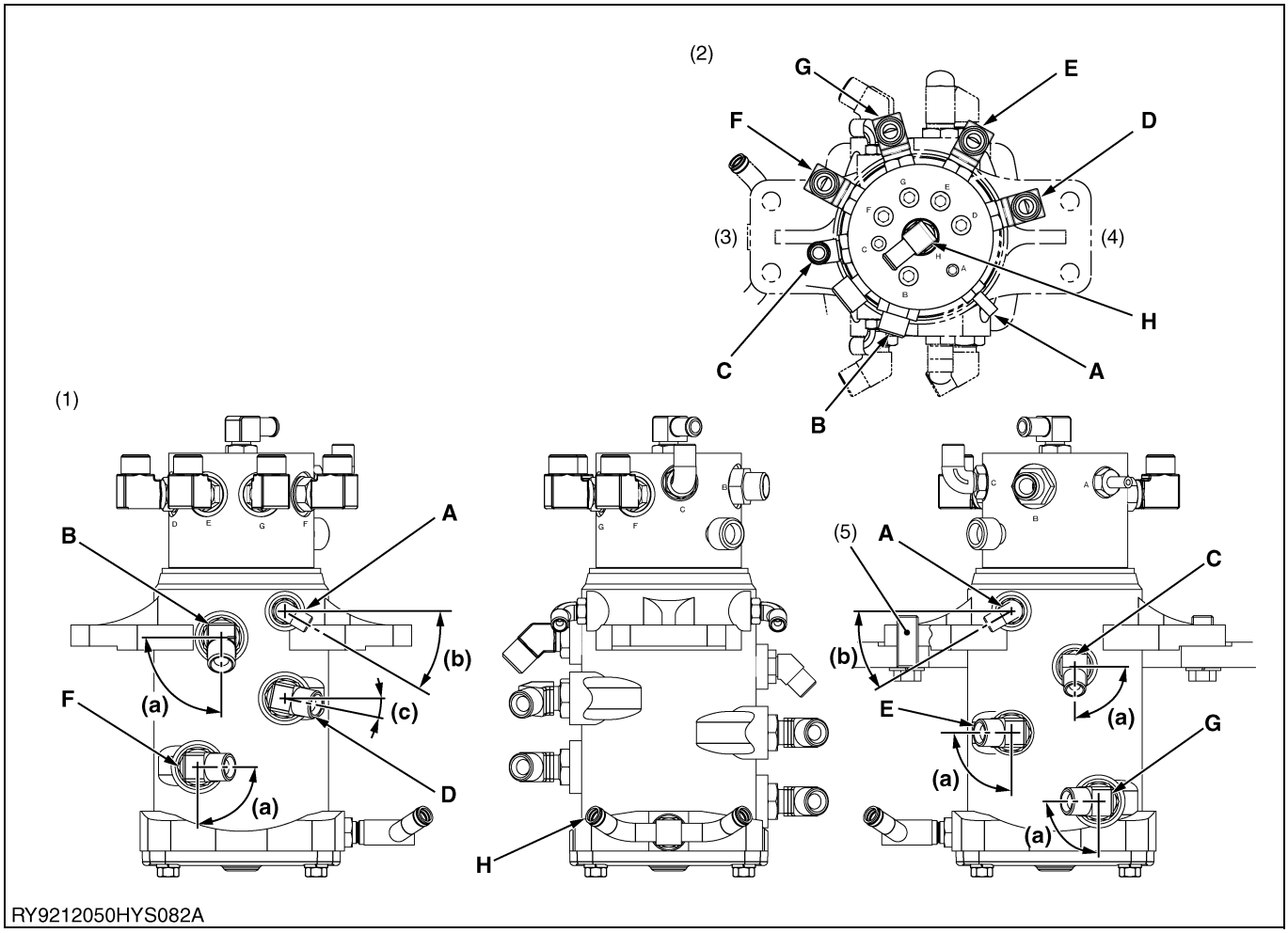
Tightening torque	Bolt (14)	48.1 to 55.9 N·m 4.9 to 5.7 kgf·m 35.5 to 41.2 lbf·ft

Apply threadlock (ThreeBond 1324).

(1) Body
(2) Collar
(3) Packing (U)
(4) O-Ring
(5) Seal
(6) Shaft
(7) Collar
(8) External circlip
(11) Hex socket bolt
(12) Cover (bottom, RJ)
(13) O-Ring
(14) Bolt (M10 × 25)

RY9212001HYS0206US0

Swivel joint adapter angles



RY9212050HYS082A

(1) Body side
(2) Shaft side
(3) Back of machine
(4) Front of machine
(5) Bolt

A : 2-speed pilot
B : Dozer lowering
C : Dozer raising
D : Left forward
E : Right forward
F : Left backward
G : Right backward
H : Drain

(a) 90 °
(b) 45 °
(c) 10 °

■ **IMPORTANT**

- **Apply a threadlock (Locktite #271).**

Tightening torque	Bolt (5)	166.7 to 196.1 N·m 17.0 to 20.0 kgf·m 123.0 to 144.6 lbf·ft

RY9212032HYS0102US0

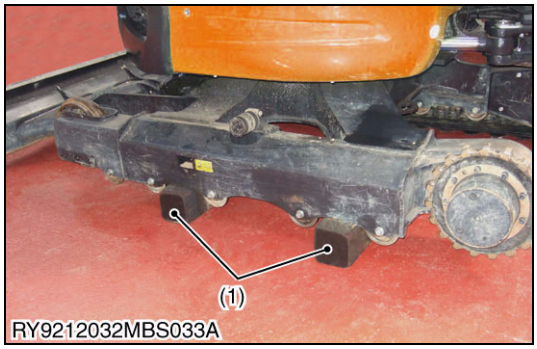
5. TRAVEL MOTOR

[1] REMOVAL AND INSTALLATION OF THE TRAVEL MOTOR

CAUTION

- **When removing a hydraulic device after operating the mini-excavator, lower the bucket and blade to the ground and turn off the engine.**
- **Each of the devices and the hydraulic oil are hot and under high pressure immediately after operating the mini-excavator. If the hydraulic oil reached a high operating temperature, it may cause a burn.**
- **Oil gushing out under pressure has enough force to pierce your skin and may cause you injury. Always allow the temperature to drop and relieve any remaining pressure prior to working to remove any hydraulic equipment.**

RY9212001MBS0004US0



Removing the travel motor

1. Remove the crawler track. Refer to the chapter Crawler Track for the removal and installation of the crawler track.

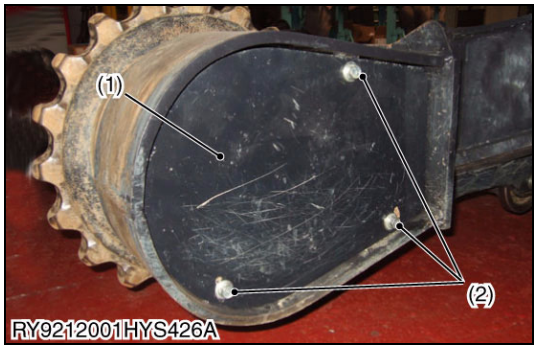
DANGER

- **Jack up the mini-excavator with the front-end and the blade and place timbers under the frame.**

RY9212032HYS0082US0

2. Position the swing and swivel as in the photo at left and lower the bucket and blade to the floor.

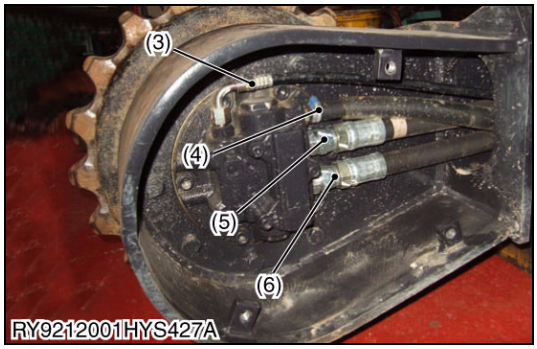
RY9212032HYS0083US0



3. Remove the three cover mounting bolts (2) and take the cover (1) off.

(1) Cover
(2) Bolt (M10 × 20)

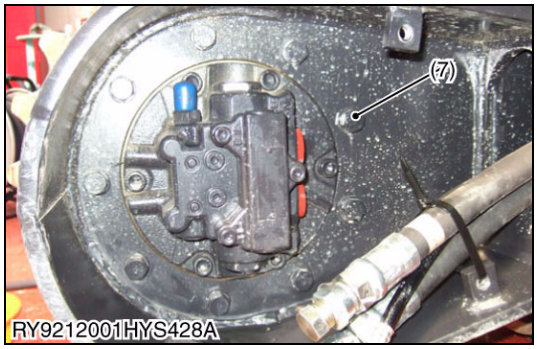
RY9212001HYS0210US0



4. Connect a vacuum pump to the breather hose of the hydraulic oil tank and exert negative pressure inside the tank. Remove the hydraulic hoses (3), (4), (5) and (6).

(3) Hydraulic hose
(4) Hydraulic hose
(5) Hydraulic hose
(6) Hydraulic hose

RY9212001HYS0211US0



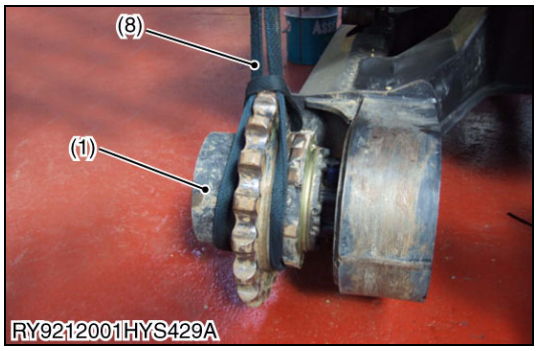
5. Temporarily suspend the travel motor with a nylon sling (8) and remove the nine bolts (7).

■ **IMPORTANT**
- **Apply a threadlock (Loctite #271).**

Tightening torque	Motor, ASSY (wheel) (1)	166.7 to 196.1 N·m 17 to 20 kgf·m 123.0 to 144.6 lbf·ft

(7) Bolt (M14)

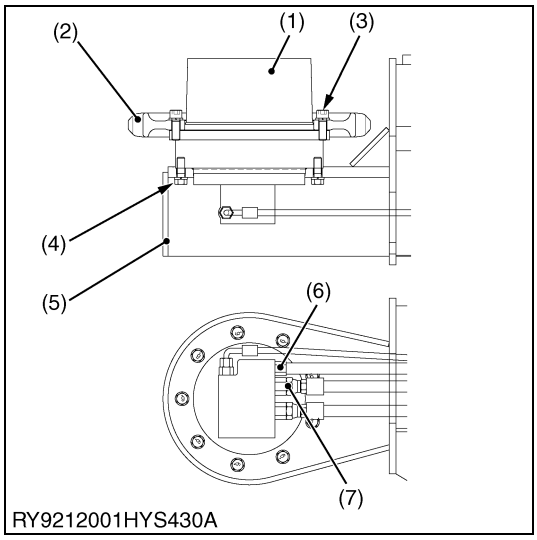
RY9212001HYS0212US0



6. Hoist and remove the motor and ASSY (wheel) (1) with a crane.

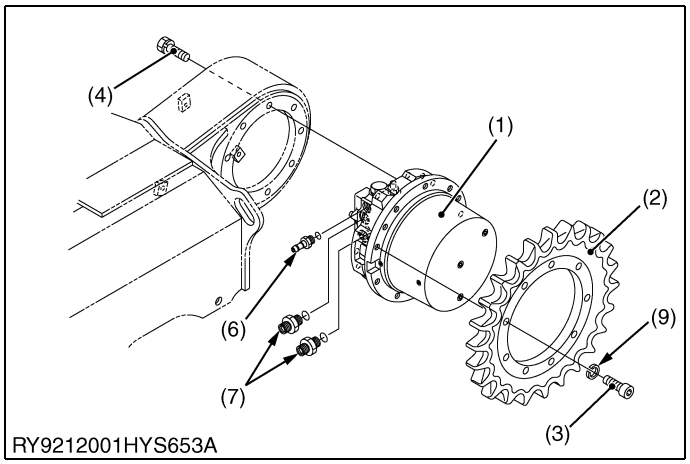
■ **IMPORTANT**
- **Apply a threadlock (Loctite #271).**

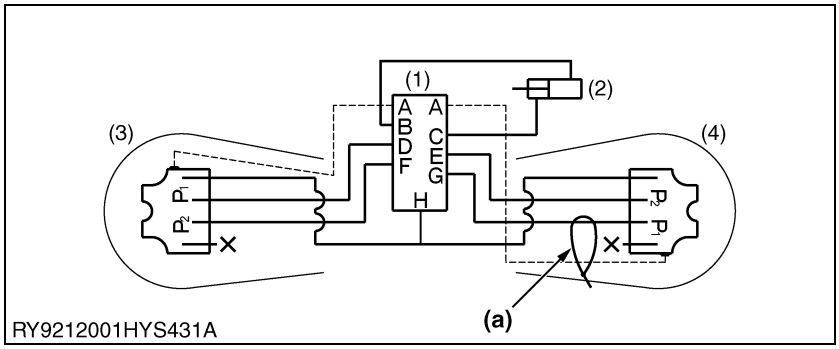
Tightening torque	Sprocket (2)	166.7 to 196.1 N·m 17 to 20 kgf·m 123.0 to 144.6 lbf·ft



(1) Motor, ASSY (wheel)
(2) Sprocket
(3) Bolt (M14)
(4) Bolt (M14)
(5) Track frame
(6) Straight pipe joint
(7) Pipe joint (S G4, G4)
(8) Nylon sling
(9) Spring washer

RY9212001HYS0213US0





RY9212001HYS431A

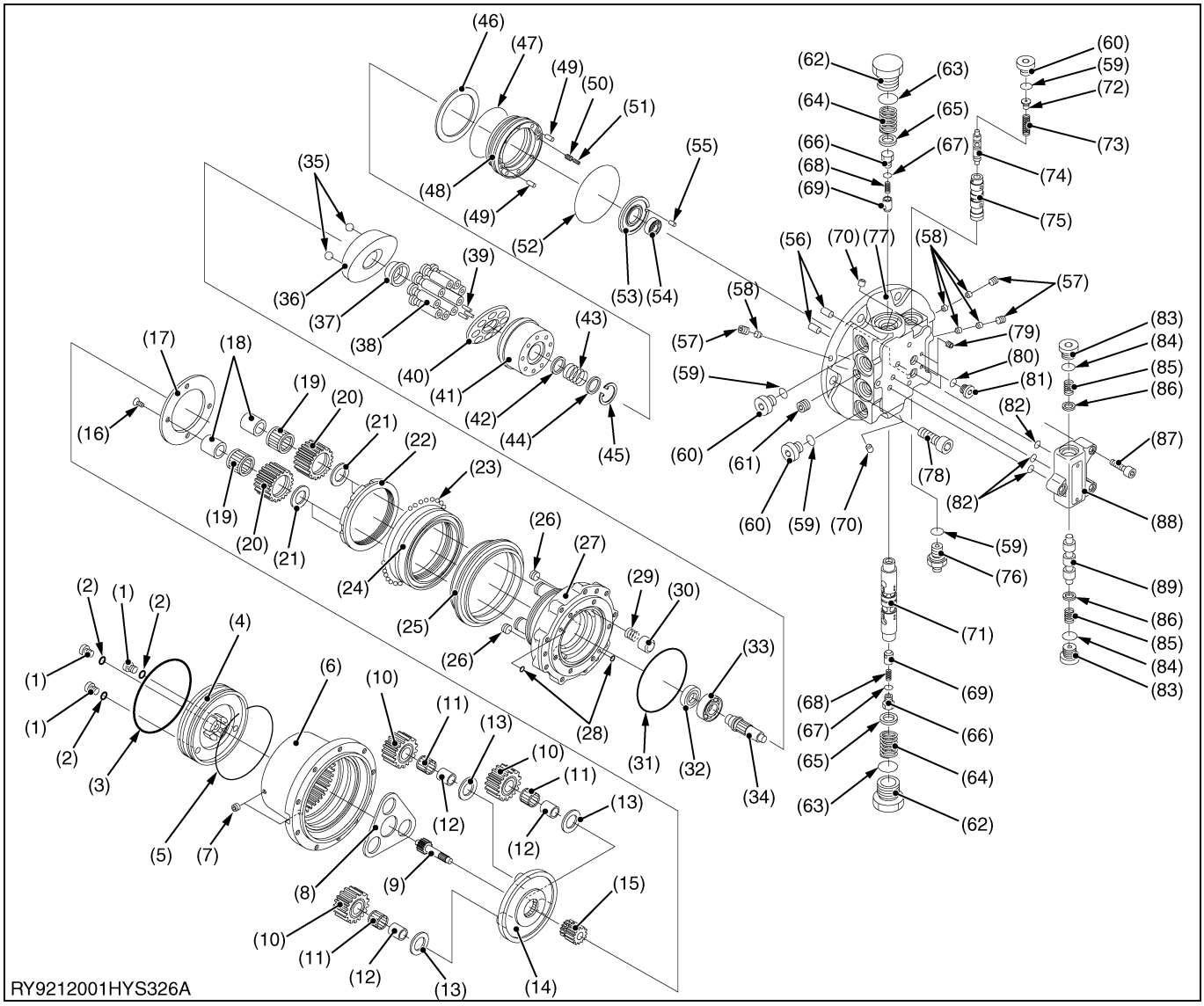
(1) Swivel Joint
(2) Blade Cylinder
(3) Travel Motor L
(4) Travel Motor R

(a) Clamp the 2-speed pressure increase signal hose and the P1 hose (right track only). Do not come in contact with the track frame.

S/J side		Travel motor / cylinder side
A	2-speed pilot	L/R travel 2-speed
B	lower dozer	Cylinder-bottom side
C	lift dozer	Cylinder-rod side
D	left forward	Left P1
E	right forward	right P2
F	left reverse	left P2
G	right reverse	right P1
H	drain	L/R drain port (upper)

RY9212001HYS0214US0

[2] TRAVEL MOTOR DISASSEMBLY / ASSEMBLY PROCEDURES



(To be continued)

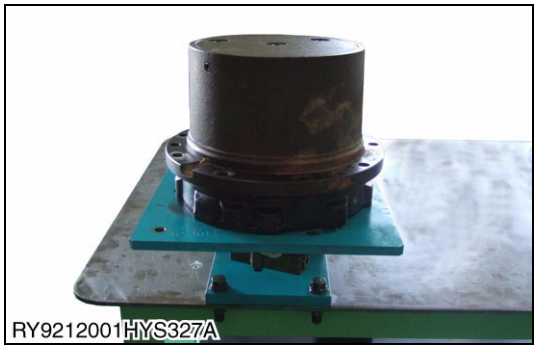
(Continued)

No.	Part Name	Q'ty	No.	Part Name	Q'ty
(1)	Plug	3	(15)	Gear (sun)	1
(2)	O-Ring	3	(16)	Flat head screw	4
(3)	O-Ring	1	(17)	Plate (thrust)	1
(4)	Cover	1	(18)	Bearing (inner)	4
(5)	Wire	1	(19)	Needle bearing	4
(6)	Gear case	1	(20)	Gear (planetary B)	4
(7)	Plug	2	(21)	Metal washer	4
(8)	Plate, kit (thrust) t = 1.8 mm, 0.07 in.	1	(22)	Nut (ring)	1
(8)	Plate, kit (thrust) t = 2.3 mm, 0.09 in.	1	(23)	Steel ball	99
(8)	Plate, kit (thrust) t = 2.8 mm, 0.11 in.	1	(24)	Bearing (angular)	1
(9)	Gear (drive)	1	(25)	Seal	2
(10)	Gear (planetary A)	3	(26)	Plug	2
(11)	Bearing (roller)	3	(27)	Flange holder	1
(12)	Bearing (inner)	3	(28)	O-Ring	3
(13)	Thrust washer	3	(29)	Spring	1
(14)	Holder	1	(30)	2-speed piston	1
(31)	Oil seal	1	(61)	Plug	1
(32)	Ball bearing	1	(62)	Plug	2
(33)	Ball bearing	1	(63)	O-Ring	2
(34)	Shaft	1	(64)	Spring	2
(35)	Ball	2	(65)	Spring seat	2
(36)	Swash-plate	1	(66)	Plug	2
(37)	Retainer holder	1	(67)	O-Ring	2
(38)	Piston ASSY	1	(68)	Spring	2
(39)	Pin	3	(69)	Check valve	2
(40)	Retainer plate	1	(70)	Orifice	2
(41)	Cylinder block	1	(71)	Spool	1
(42)	Spring seat	1	(72)	Spring seat	1
(43)	Spring	1	(73)	Spring	1
(44)	Metal washer	1	(74)	Spool C	1
(45)	Internal circlip	1	(75)	Spool A	1
(46)	Disc	1	(76)	Plug	1
(47)	O-Ring	1	(77)	Baseplate	1
(48)	Brake piston	1	(78)	Hex socket bolt	6
(49)	Pin	2	(79)	Plug	2
(50)	Spring	8	(80)	O-Ring	2
(51)	Spring	4	(81)	Plug	2
(52)	O-Ring	1	(82)	O-Ring	3
(53)	Plate (valve)	1	(83)	Plug	2
(54)	Ball bearing	1	(84)	O-Ring	2
(55)	Parallel pin	1	(85)	Spring	2
(56)	Pin	2	(86)	Spring seat	2
(57)	Plug	3	(87)	Hex socket bolt	3
(58)	Orifice	5	(88)	Valve body	1
(59)	O-Ring	4	(89)	Spool	1
(60)	Plug	3			

RY9212001HYS0310US0

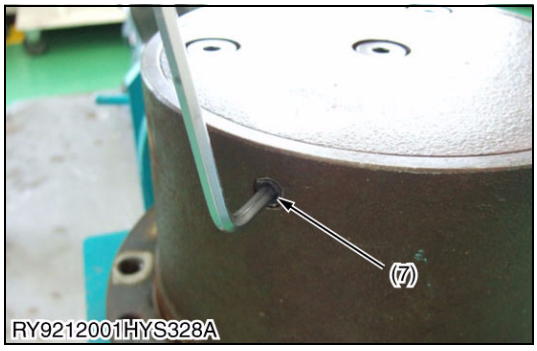
(1) Disassembly Procedures

[A] Gear Case Disassembly


RY9212001HYS327A

1. Attach the travel motor to the special disassembly platform.

RY9212001HYS0311US0



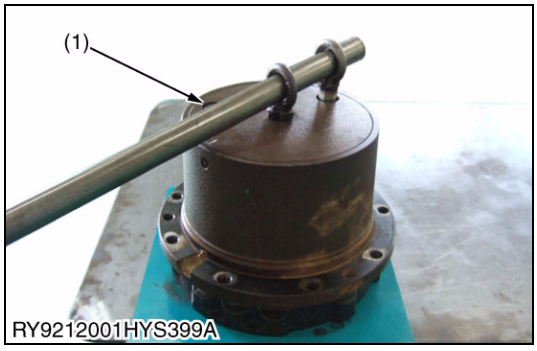
RY9212001HYS328A

2. Remove the plug (7).

- Tool to use : M5 hex socket

(7) Plug

RY9212001HYS0312US0



RY9212001HYS399A

3. Remove the two plugs and replace them with eyebolts, then put the rod through them.

- Tool to use : M8 hex socket, eyebolts (3/8), rod

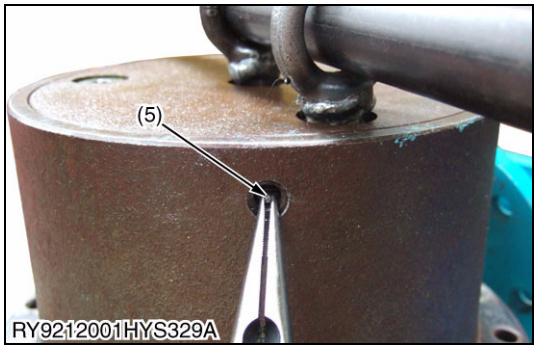
(1) Plug

RY9212001HYS0313US0

RY9212001HYS398A

4. Insert a rod through the housing to keep it from turning.

RY9212001HYS0314US0



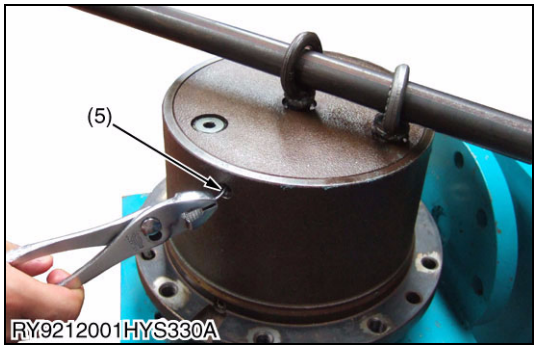
RY9212001HYS329A

5. Turn the eyebolt rod, rotating the cover until you can see the tip of the wire (5) coming from the plug hole.
Use needle-nose pliers to pull the wire out of the plug hole.

- Tool to use : Needle-nose pliers

(5) Wire

RY9212001HYS0315US0



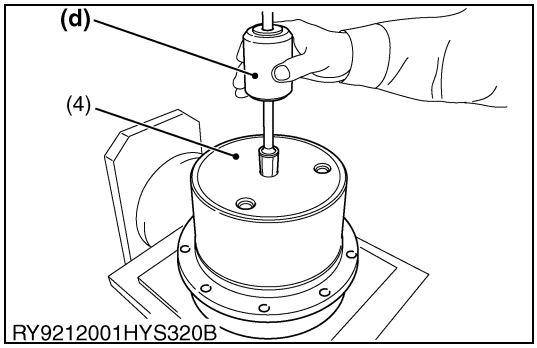
6. Pull on the wire (5) while rotating the cover with the rod.

- Tool to use : Pliers

■ **NOTE**
- **It is easiest to use regular pliers once the wire is out far enough for them to grasp it. (as regular pliers get a better grip than needle-nose pliers)**

(5) Wire

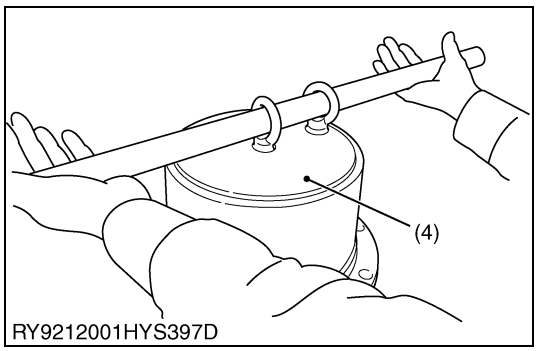
RY9212001HYS0316US0



7. Remove the eyebolts, attach the cover removal tool and knock it up to remove the cover.

If a cover removal tool is not available
- Put the rod through the eyebolt holes.
- Knock upwards on both sides of the rod and remove the cover (4).

- Tool to use : Rod



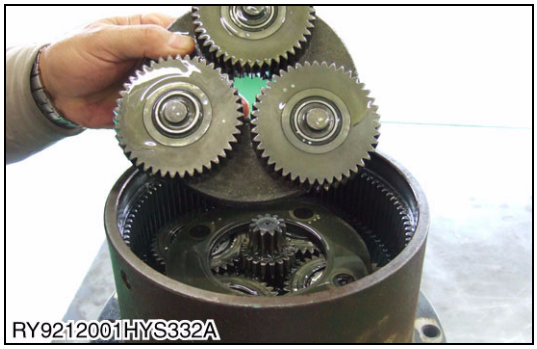
(4) Cover **(d) Cover removal tool**

RY9212001HYS0317US0

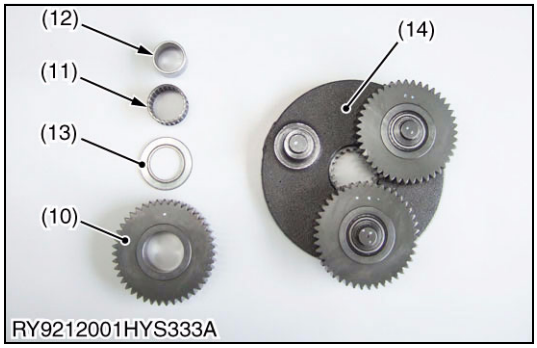
8. Remove the plate and kit (thrust) (8).

(8) Plate, kit (thrust)

RY9212001HYS0318US0


RY9212001HYS332A

9. Remove the holder and sub-assembly.

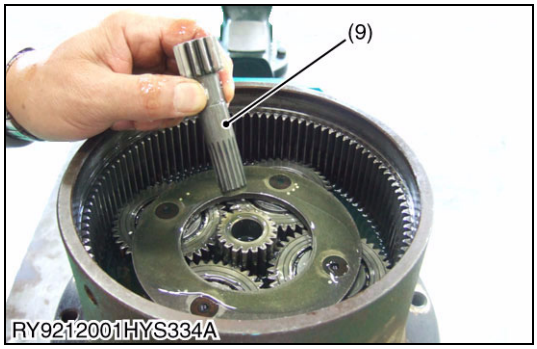


RY9212001HYS333A

Components of the holder and sub-assy

(10) Gear (planetary A)
(11) Bearing (roller)
(12) Bearing (inner)
(13) Thrust washer
(14) Holder

RY9212001HYS0319US0

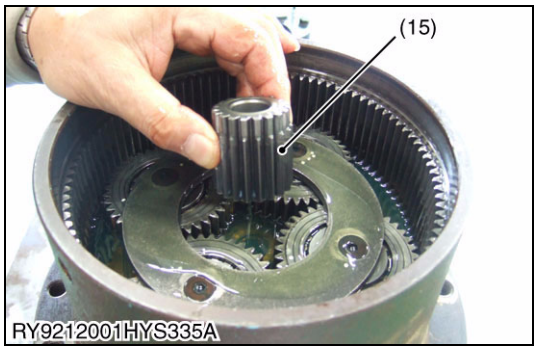


RY9212001HYS334A

10. Remove the gear (drive) (9).

(9) Gear (drive)

RY9212001HYS0320US0

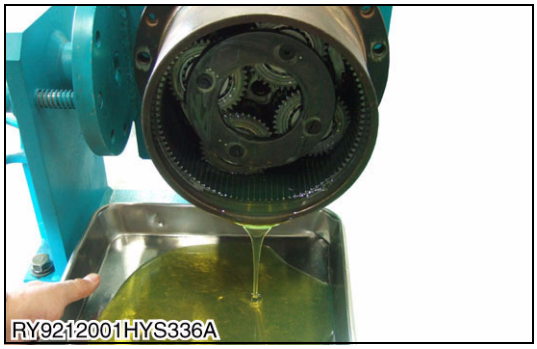


RY9212001HYS335A

11. Remove the gear (sun) (15).

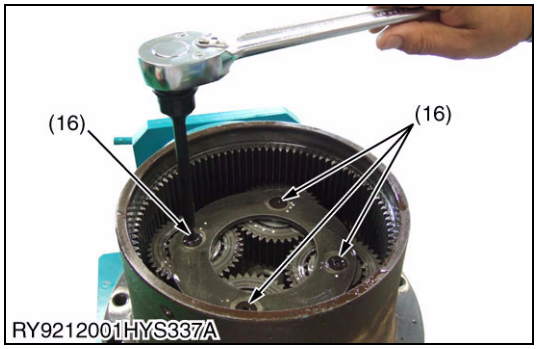
(15) Gear (sun)

RY9212001HYS0321US0


RY9212001HYS336A

12. Drain off any gear oil.
If there is not any gear oil, skip this step.

RY9212001HYS0322US0

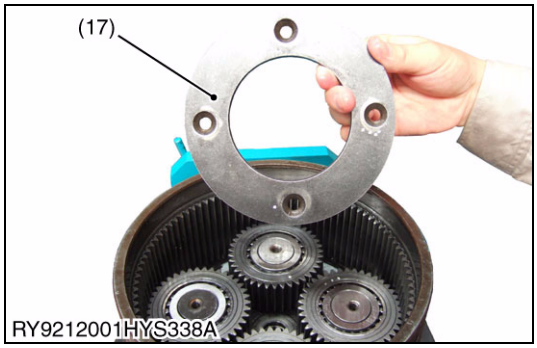


13. Remove the flathead screws (16). (4 places)

■ **IMPORTANT**
- **If the flathead screws are too tight to remove, heat them up with a heat gun or the like.**
- Tool to use : M5 hex socket

(16) Flat head screw

RY9212001HYS0323US0



14. Remove the plate (thrust) (17).

(17) Plate (thrust)

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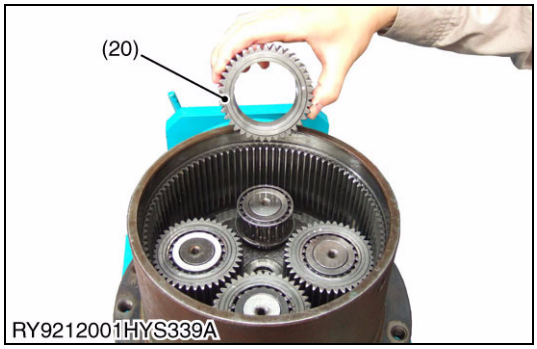
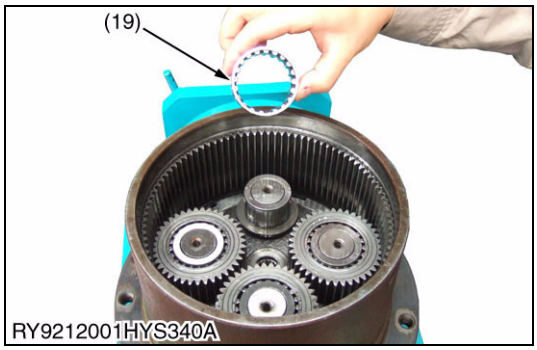


15. Remove the gear (planetary B) (20).

(20) Gear (planetary B)

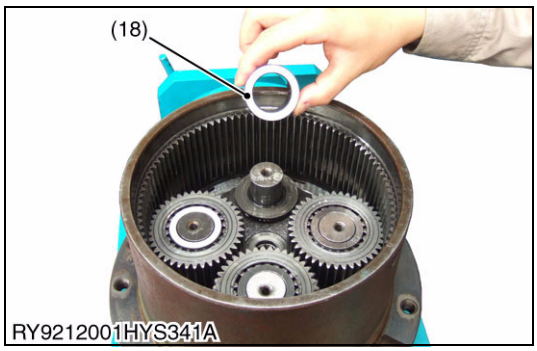
RY9212001HYS0325US0



16. Remove the needle bearing (19).

(19) Needle bearing

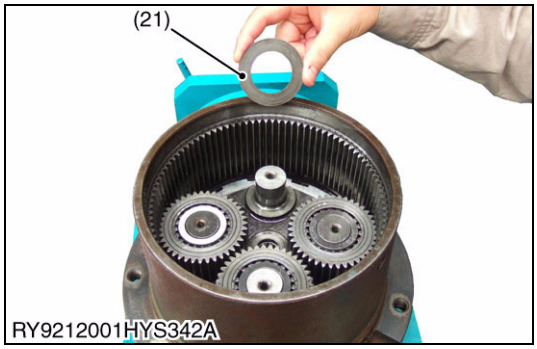
RY9212001HYS0326US0



17. Remove the bearing (inner) (18).

(18) Bearing (inner)

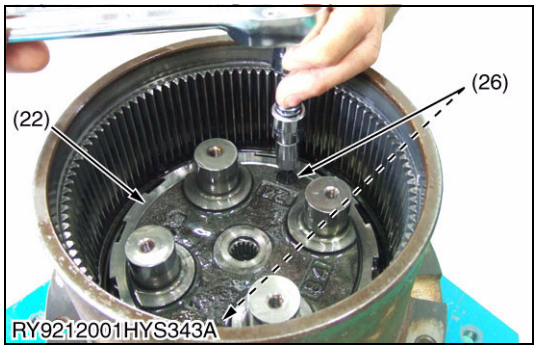
RY9212001HYS0327US0



18. Remove the metal washer (21).

(21) Metal washer

RY9212001HYS0328US0

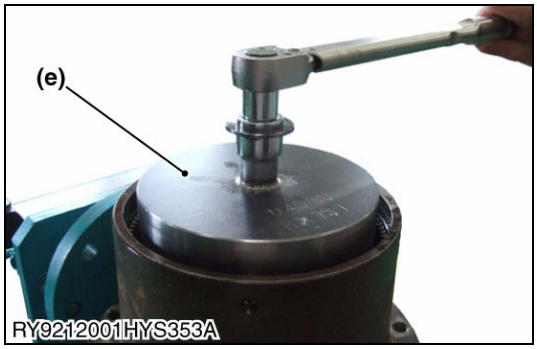


19. Remove the plug (26). (2 places)

- Tool to use : M8 hex socket

(22) Nut (ring) (26) Plug

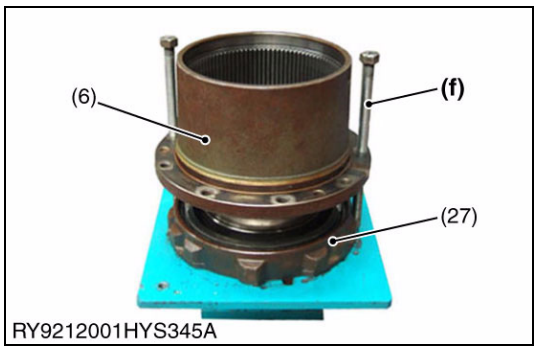
RY9212001HYS0329US0



20. Remove the nut (ring).

(e) Ring nut socket

RY9212001HYS0330US0



21. Use removal bolts to raise the gear case up higher than the flange holder.

■ **IMPORTANT**
- **Tighten the removal bolts equally.**

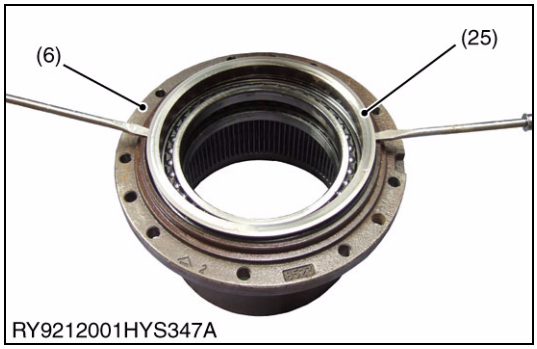
(6) Gear case **(f) Removal bolts (M10 × 2.0)**
(27) Flange holder

RY9212001HYS0331US0

22. Remove the gear case from the flange holder.

■ **NOTE**
- **Refer to [U48-4 TRAVEL MOTOR DISASSEMBLY / ASSEMBLY PROCEDURES] in case removal bolts are not available.**

RY9212001HYS0332US0

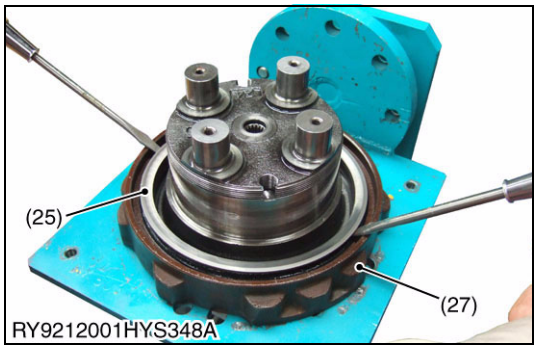


23. Remove the seal (25) from the gear case side.

- Tool to use : Slotted screwdriver

(6) Gear case (25) Seal

RY9212001HYS0333US0

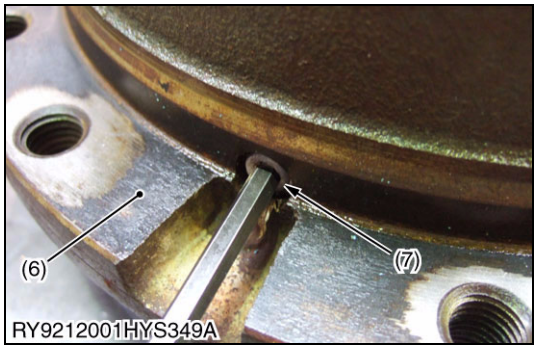


24. Remove the seal (25) from the flange holder side.

- Tool to use : Slotted screwdriver

(25) Seal (27) Flange holder

RY9212001HYS0334US0

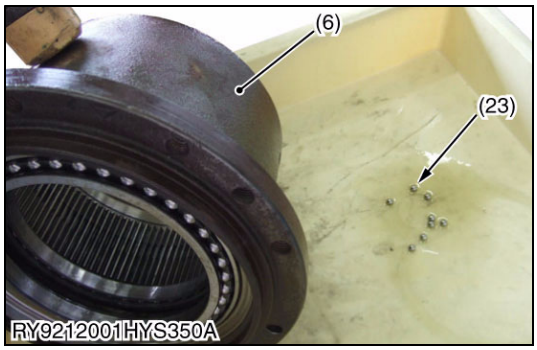


25. Remove the plug.

- Tool to use : M5 hex socket

(6) Gear case (7) Plug

RY9212001HYS0335US0

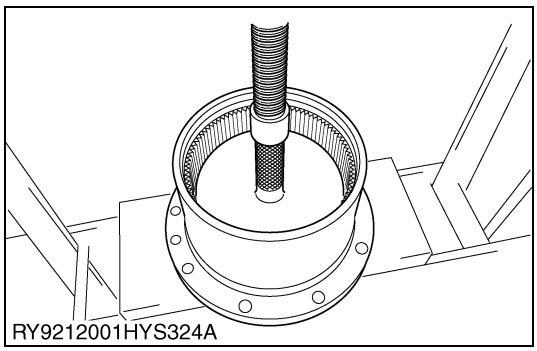


26. Take out the steel balls (23). (99 balls)

■ **IMPORTANT**
- **Do not lose any of the balls.**
- **If you fail to remove even one of the balls, the bearing cannot be removed, so keep close track of the balls.**

(6) Gear case (23) Steel ball

RY9212001HYS0336US0

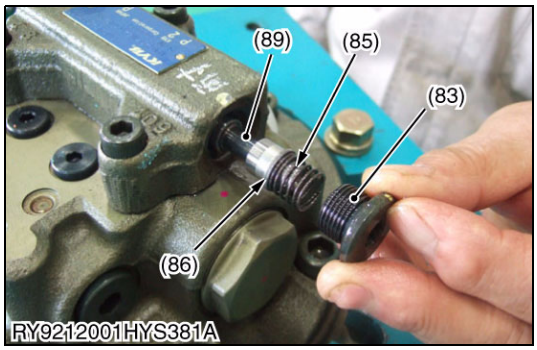


27. Remove the bearing (angular) (24) with a press.

(24) Bearing (angular)

RY9212001HYS0337US0

[B] Motor Disassembly

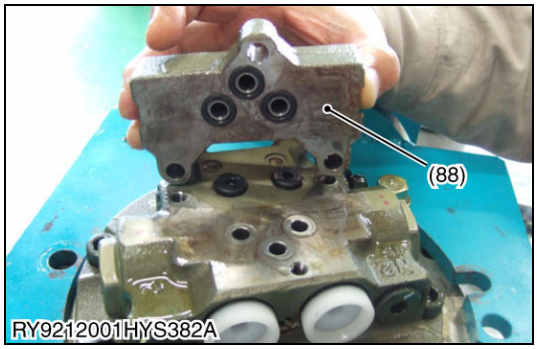


1. Remove the valve body.
   Remove the plug (83), spring (85), spring seat (86) and the spool (89) in that order.

   • Tool to use : M8 hex socket

(83) Plug
(85) Spring
(86) Spring seat
(89) Spool

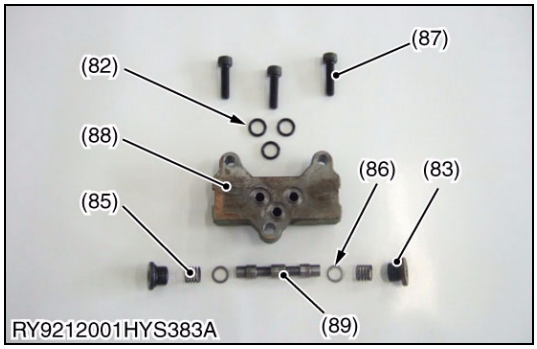
RY9212001HYS0338US0



2. Remove the valve body (88).

■ **IMPORTANT**
- **Replace O-rings with new ones during reassembly.**

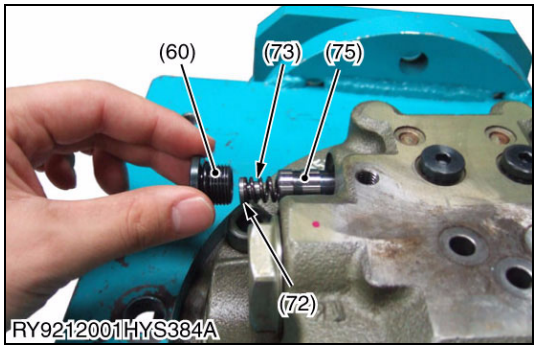
- Tool to use : M6 hex socket



Components of the Valve Body ASSY

(82) O-Ring
(83) Plug
(85) Spring
(86) Spring seat
(87) Socket head bolt
(88) Valve body
(89) Spool

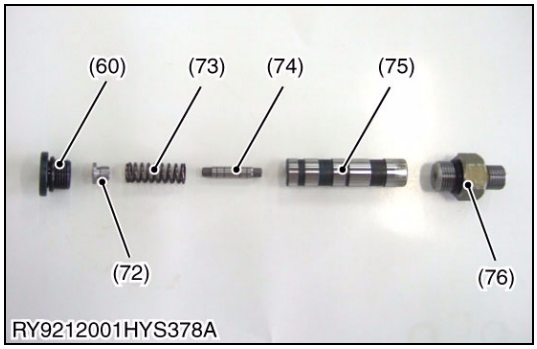
RY9212001HYS0339US0



3. Remove the 2-speed switch.
   Remove the plug (60), spring seat (72), spring (73), spool C (74) and spool A (75) in that order.

■ **IMPORTANT**
- **Check to make sure there are not any scratches around the circumference of the spools.**

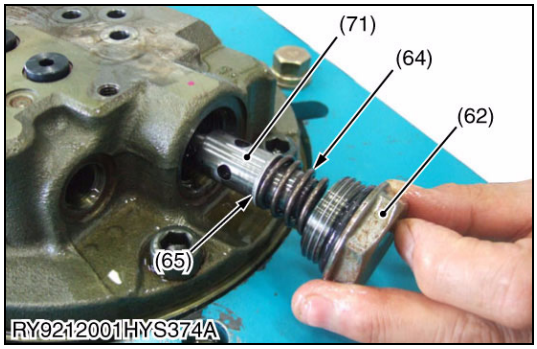
- Tool to use : M8 hex socket, M22 socket wrench



Components of the 2-speed Switch

(60) Plug
(72) Spring seat
(73) Spring
(74) Spool C
(75) Spool A
(76) Plug

RY9212001HYS0340US0



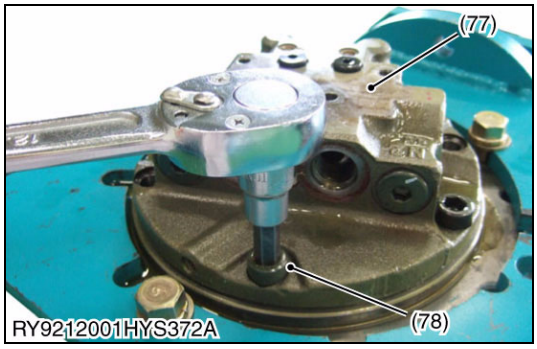
4. Remove the counterbalance valve.
   Remove the plug (62), spring (64), spring seat (65) and the spool (71) in that order.

■ **IMPORTANT**
- **There is little room for the wrench (or socket), so be careful not to let it slip.**
- **Check to make sure there are not any scratches around the circumference of the spools.**

- Tool to use : M36 wrench (socket)

(62) Plug
(64) Spring
(65) Spring seat
(71) Spool

RY9212001HYS0341US0

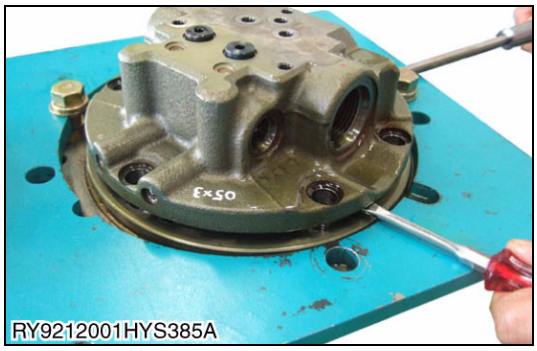


5. Remove the hex socket bolt (78).

- Tool to use : M10 hex socket

(77) Baseplate
(78) Hex socket bolt

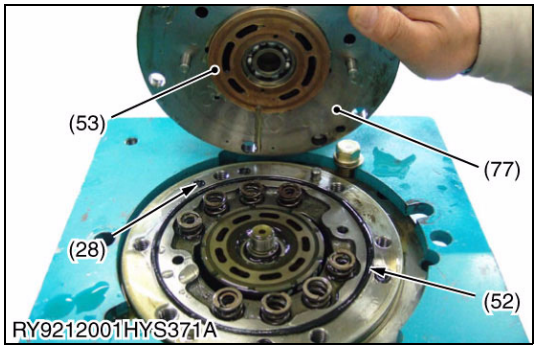
RY9212001HYS0342US0



6. Tap the baseplate with a plastic hammer to loosen it.
   Once the base plate loosens a bit, insert a slotted screwdriver in the crack and strike the baseplate from the opposite side and remove it.

■ **IMPORTANT**
- **Be very careful because using force to insert a slotted screwdriver may scratch the baseplate.**

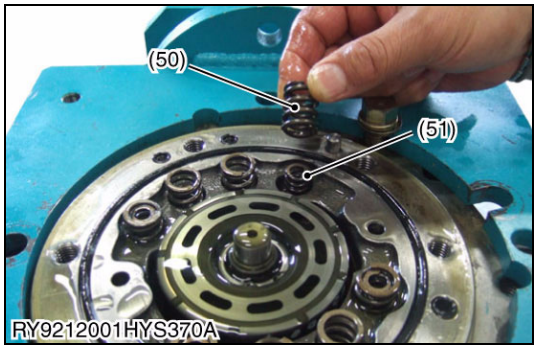
RY9212001HYS0343US0



7. Remove the plate (valve) (53) and O-rings (28) and (52).

(28) O-Ring
(52) O-Ring
(53) Plate (valve)
(77) Baseplate

RY9212001HYS0344US0



8. Remove the springs (12 springs).

(50) Spring (large)
(51) Spring (small)

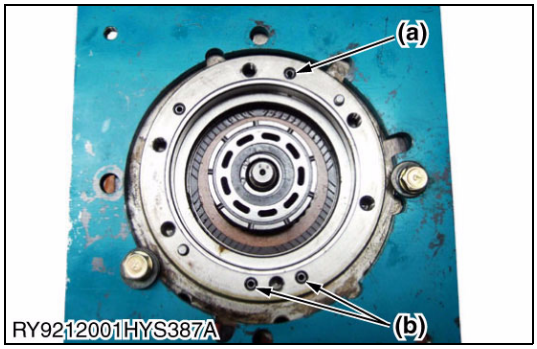
RY9212001HYS0345US0

RY9212001HYS386A

9. While pressing down on the piston brake with a rag, blow air through the brake release oil passage hole **(a)** and remove the piston brake.

CAUTION

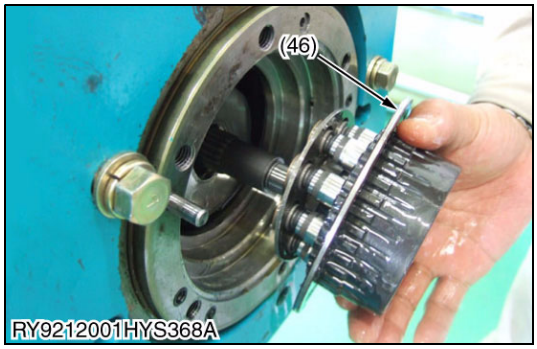
- **Be careful because if you blast air into the passage, the piston brake may come flying off.**



RY9212001HYS387A

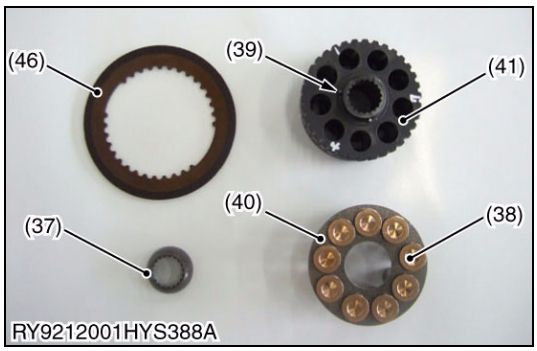
(a) Brake release oil passage hole **(b) 2-speed switch oil passage hole**

RY9212001HYS0346US0



RY9212001HYS368A

10. Rotate the disassembly/assembly platform 90 and remove the disc (46), cylinder block and sub-assembly.

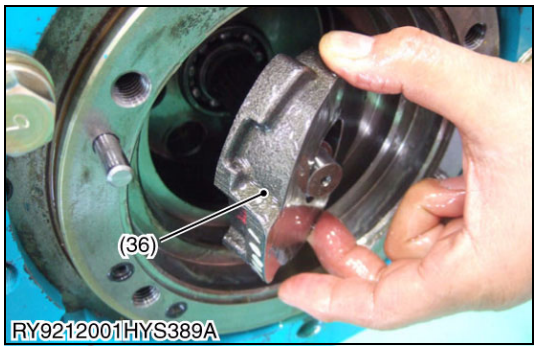


RY9212001HYS388A

Components of the Cylinder Block and Sub-assy

(37) Retainer holder
(38) Piston, ASSY
(39) Pin
(40) Retainer plate
(41) Cylinder block
(46) Disc

RY9212001HYS0347US0

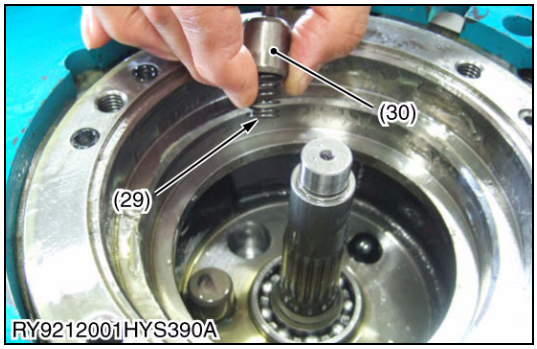


RY9212001HYS389A

11. Remove the swash-plate (36).

(36) Swash-plate

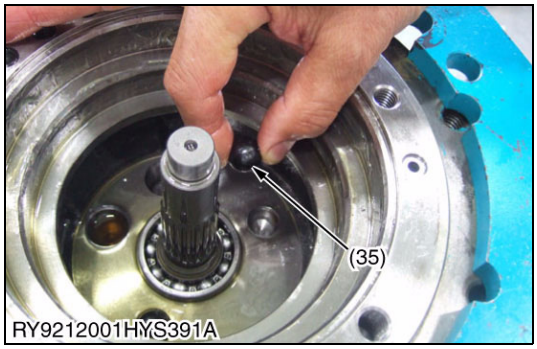
RY9212001HYS0348US0



12. Turn the disassembly/assembly platform back as it was and remove the 2-speed piston (30) and the ASSY.

(29) Spring (30) Piston

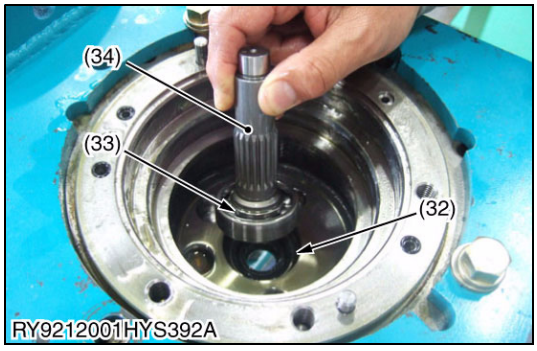
RY9212001HYS0349US0



13. Remove the ball (35).

(35) Ball

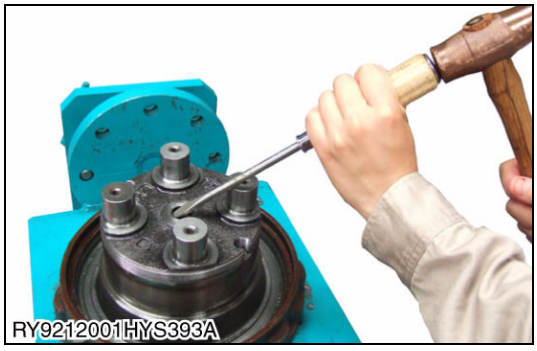
RY9212001HYS0350US0



14. Remove the shaft (34) and ball bearing (33).

(32) Oil Seal (34) Shaft
(33) Ball bearing

RY9212001HYS0351US0

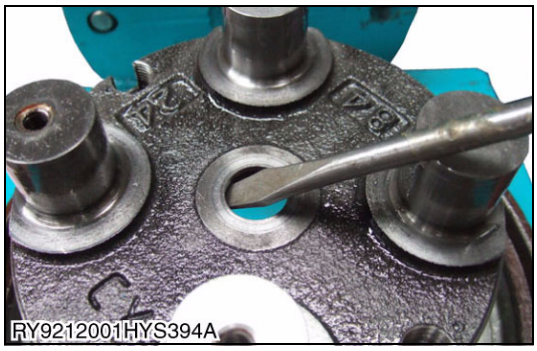


15. Remove the oil seal.

■ **IMPORTANT**

- **When you removed the shaft, if the ball bearing had not been removed, remove them together now.**

- Tool to use : Hammer and slotted screwdriver

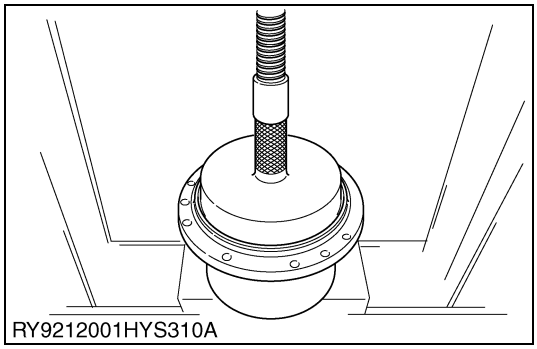


Enlarged view

RY9212001HYS0352US0

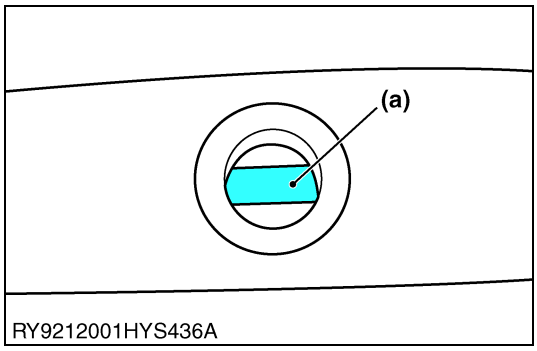
(2) Assembly Procedures

[A] Gear Case Assembly


RY9212001HYS310A

1. Set the bearing (angular) (26) in the gear case and install it with a press.

RY9212001HYS0005US0



RY9212001HYS436A

2. After installing it, check and make sure the groove **(a)** around the circumference of the bearing comes right to the center.

(a) Circumference groove

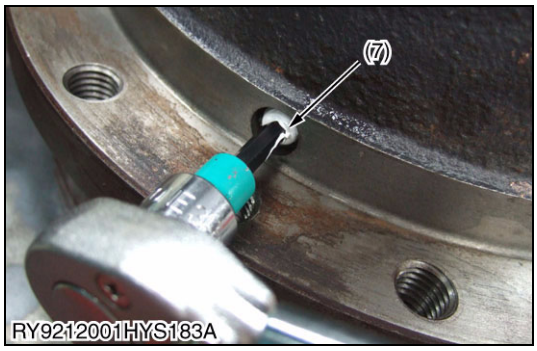
RY9212001HYS0013US0

RY9212001HYS182B

3. Put the 99 steel balls (23) inside.

(23) Steel ball

RY9212001HYS0353US0



RY9212001HYS183A

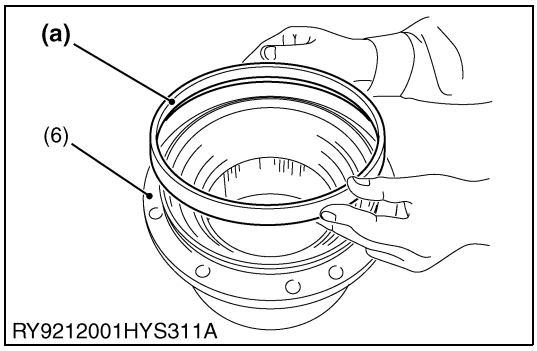
4. Wrap the plug (7) with plumber's tape and install it.

Tightening torque	Plug (7)	6.8 to 8.8 N·m 0.7 to 0.9 kgf·m 5.0 to 6.5 lbf·ft

- Tool to use : M5 hex socket

(7) Plug

RY9212001HYS0354US0



RY9212001HYS311A

5. Set the floating seal installation tool **(a)** on the gear case (6).

(6) Gear case

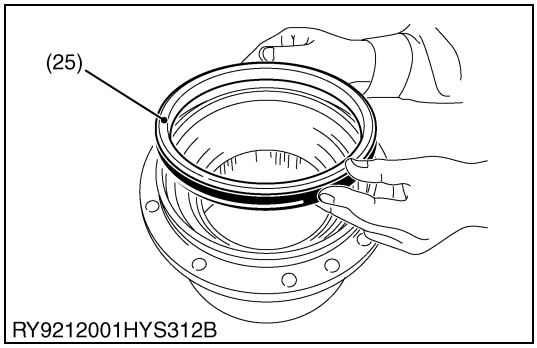
(a) Floating seal installation tool guide (for housing)

RY9212001HYS0006US0

RY9212001HYS184A

6. Apply grease to the O-ring of the seal and install the seal.

RY9212001HYS0007US0

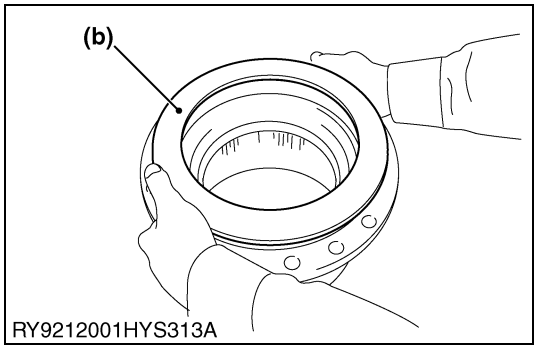


RY9212001HYS312B

7. Set the seal (25) in the gear case.

(25) Seal

RY9212001HYS0355US0

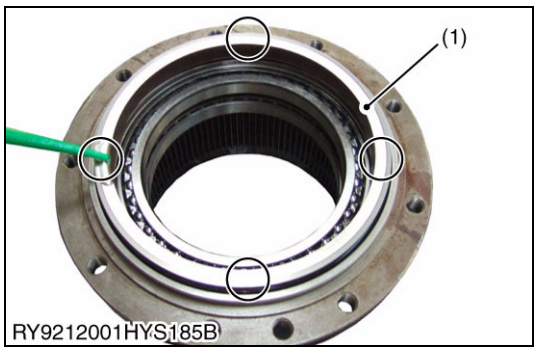


RY9212001HYS313A

8. Install the seal in the gear case with the floating seal installation tool **(b)**.

(b) Floating seal installation tool (pusher)

RY9212001HYS0008US0

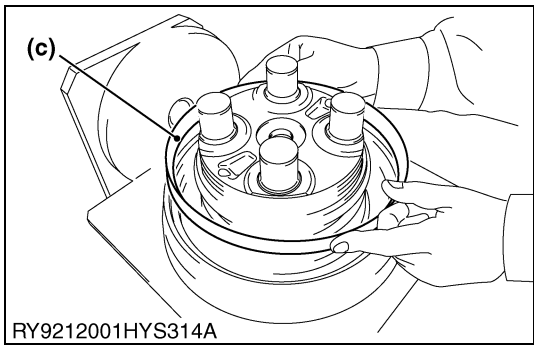


RY9212001HYS185B

9. Apply a little gear oil to the sliding surface of the seal. (4 places, every 90 º)

(6) Gear case (25) Seal

RY9212001HYS0356US0



RY9212001HYS314A

10. Set the holder (flange) on the assembly platform. Set the floating seal installation tool on the holder (flange).

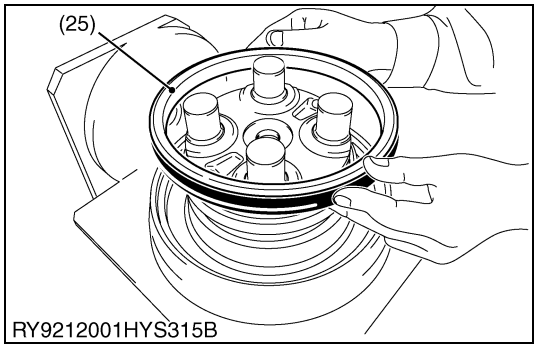
(c) Floating seal installation tool guide (for flange holder)

RY9212001HYS0009US0

RY9212001HYS184A

11. Apply grease to the O-ring of the seal and install the seal.

RY9212001HYS0010US0

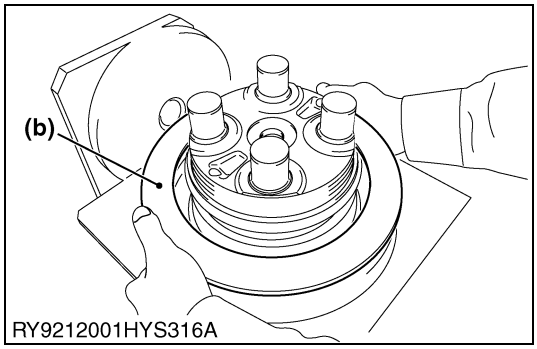


RY9212001HYS315B

12. Set the seal on the flange holder.

(25) Seal

RY9212001HYS0357US0



RY9212001HYS316A

13. Install the seal on the holder (flange) with the floating seal installation tool.

(b) Floating seal installation tool (pusher)

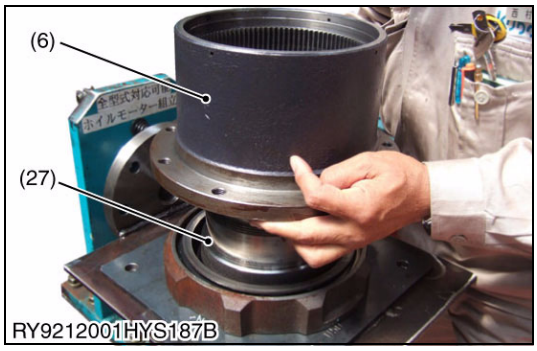
RY9212001HYS0011US0

RY9212001HYS352A

14. Apply a little gear oil on the sliding surface. (4 places, every 90º)

(25) Seal (27) Flange holder

RY9212001HYS0358US0

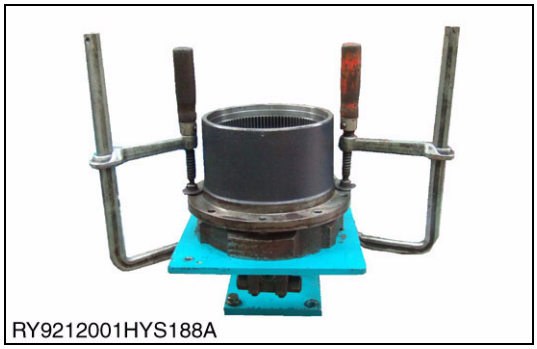


RY9212001HYS187B

15. Install the gear case (6).

(6) Gear case (27) Flange holder

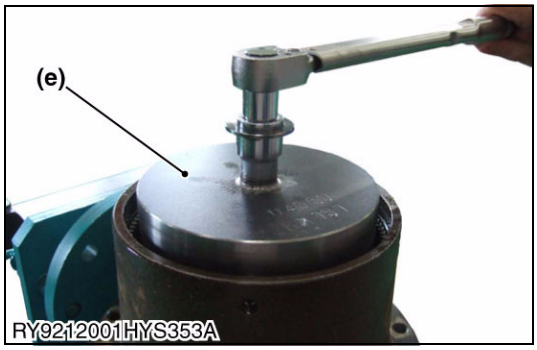
RY9212001HYS0359US0


RY9212001HYS188A

16. Use clamps to press the gear case onto the holder (flange).

- Tool to use : Clamp

RY9212001HYS0012US0



RY9212001HYS353A

17. Install the nut (ring).

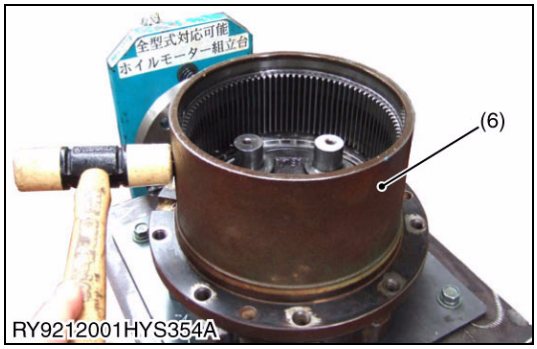
■ **IMPORTANT**

- **Make sure the nut (ring) is securely engaged with the flange holder before removing the clamps.**

Tightening torque	Nut (ring)	225.2 to 244.8 N·m 23.0 to 25.0 kgf·m 166.1 to 180.6 lbf·ft

(e) Ring nut socket

RY9212001HYS0360US0



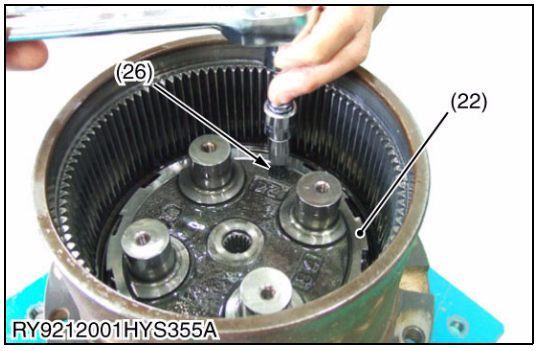
RY9212001HYS354A

18. Tap around the outside of the gear case (6) with a hammer. (4 places, every 90 °)
Rotate the gear case by hand to seat the bearing (angular).

- Tool to use : Plastic hammer

(6) Gear case

RY9212001HYS0361US0



RY9212001HYS355A

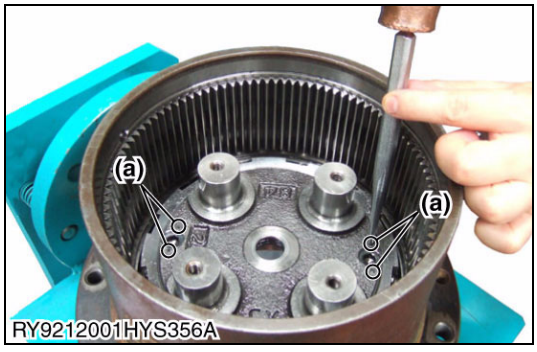
19. Install the plugs (2) for preventing rotation of the nut (ring).

Tightening torque	Plug (26)	29.4 to 39.2 N·m 3.0 to 4.0 kgf·m 21.7 to 28.9 lbf·ft

- Tool to use : M8 hex socket

(22) Nut (ring) (26) Plug

RY9212001HYS0362US0



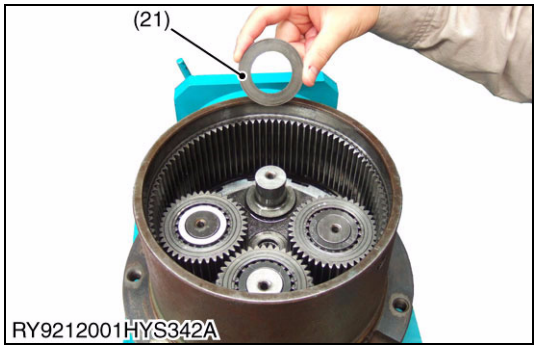
RY9212001HYS356A

20. Swage two places per plug with a punch.

- Tool to use : Hammer and punch

(a) Swage points

RY9212001HYS0363US0

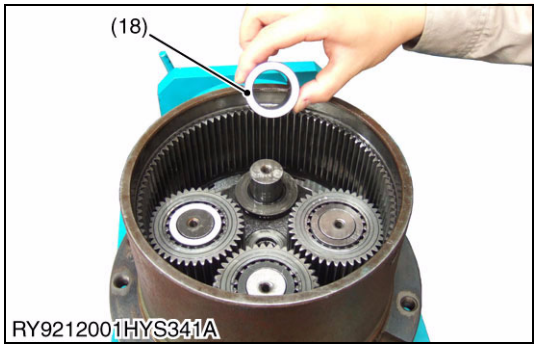


21. Install the metal washer (21).

■ **IMPORTANT**
- **Install with the R face down.**

(21) Metal washer

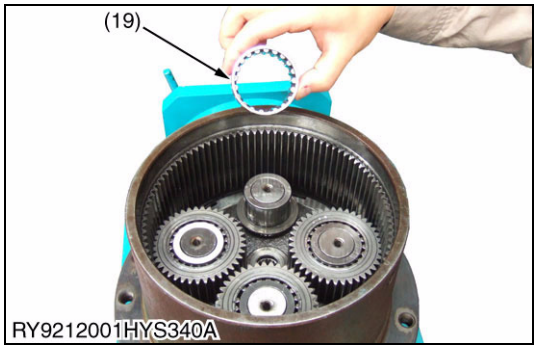
RY9212001HYS0364US0



22. Install the bearing (inner) (18).

(18) Bearing (inner)

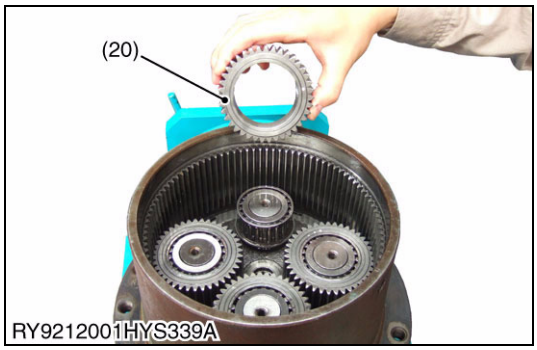
RY9212001HYS0365US0



23. Install the needle bearing (19).

(19) Needle bearing

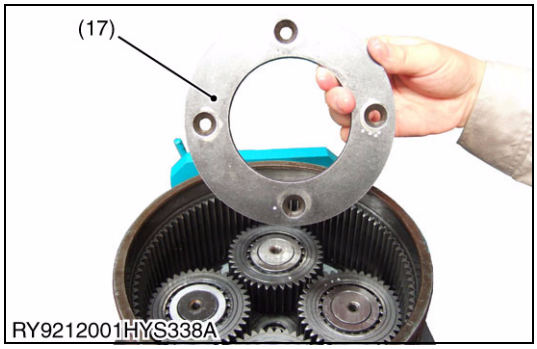
RY9212001HYS0366US0



24. Install the gear (planetary B) (20).

(20) Gear (planetary B)

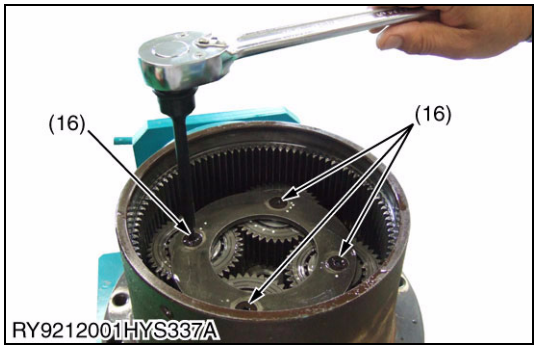
RY9212001HYS0367US0



25. Install the plate (thrust) (17).

(17) Plate (thrust)

RY9212001HYS0368US0



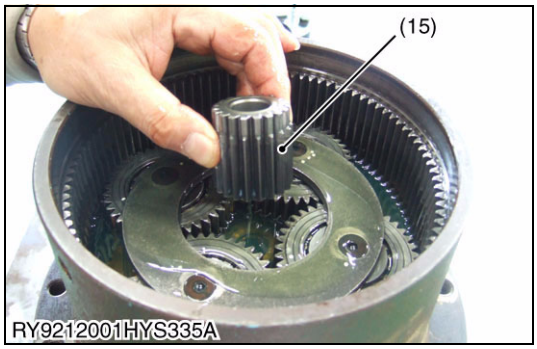
26. Install the flat head screws (16). (4 places)
    Apply loctite to the flat head screws.

Tightening torque	Flat head screws (16)	19.6 to 29.4 N·m 2.0 to 3.0 kgf·m 14.5 to 21.7 lbf·ft

- Tool to use : M5 hex socket, Loctite #262

(16) Flat head screw

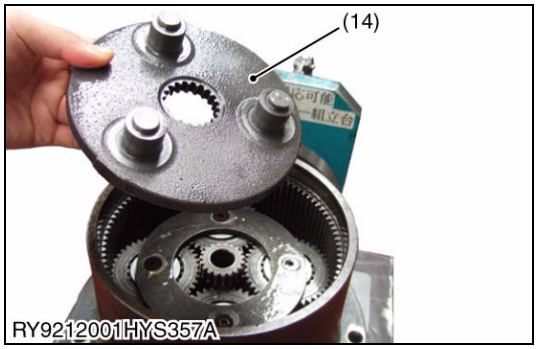
RY9212001HYS0369US0



27. Install the gear (sun) (15).

(15) Gear (sun)

RY9212001HYS0370US0



28. Install the metal holder (14).

(14) Holder

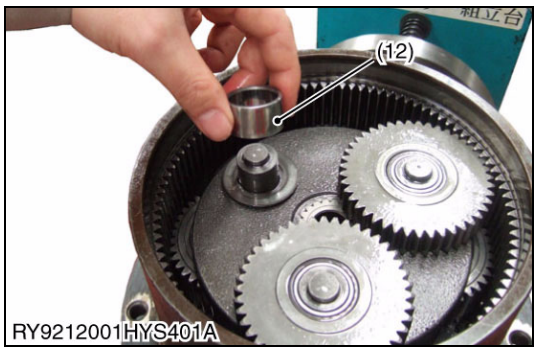
RY9212001HYS0371US0

29. Install the thrust washer (13).

■ **IMPORTANT**
- **Install with the R face down.**

(13) Thrust washer

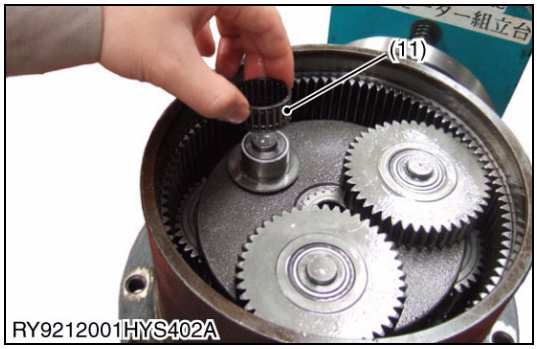
RY9212001HYS0372US0



30. Install the bearing (inner) (12).

(12) Bearing (inner)

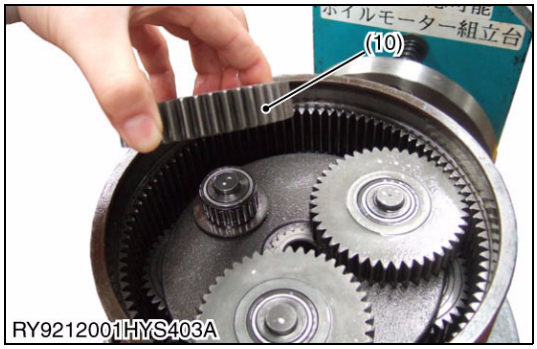
RY9212001HYS0373US0



31. Install the bearing (roller).

(11) Bearing (roller)

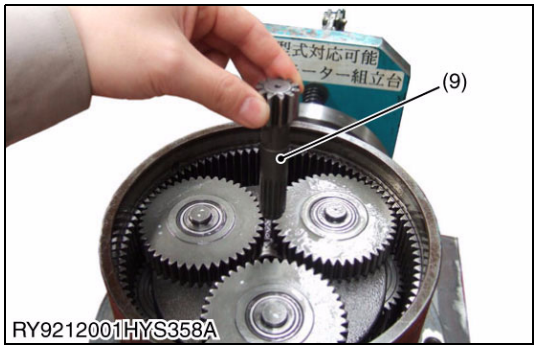
RY9212001HYS0374US0



32. Install the gear (planetary A) (10).

(10) Gear (planetary A)

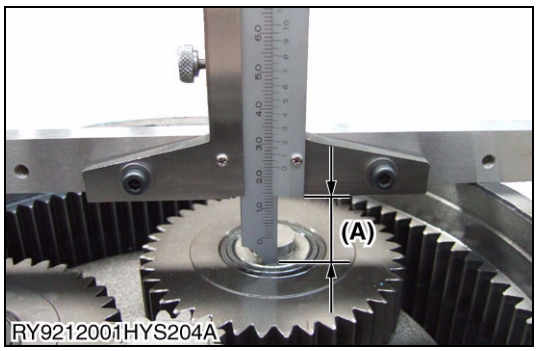
RY9212001HYS0375US0



33. Install the gear (drive) (9).

(9) Gear (drive)

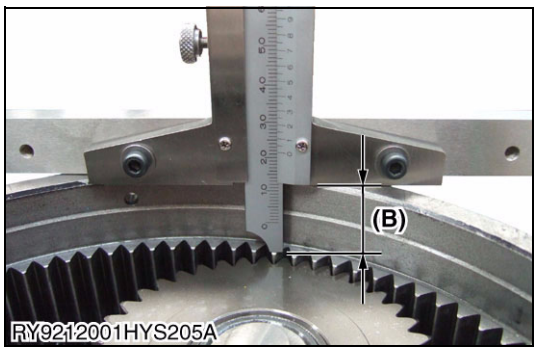
RY9212001HYS0376US0



34. Measure the distance between the edges of the holder and the gear case.
This is measurement A **(A)**.

- Tool to use : Depth gauge

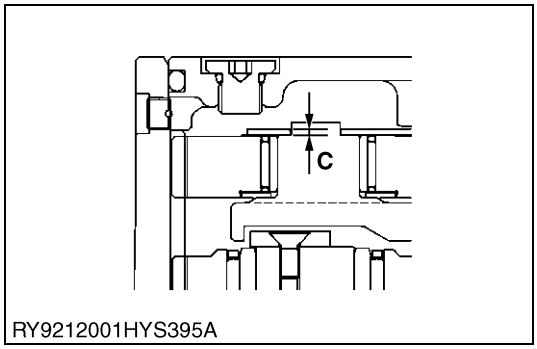
RY9212001HYS0377US0



35. Measure the distance between the gear case tooth surface and the edge of the gear case.
This is measurement B **(B)**.

- Tool to use : Depth gauge

RY9212001HYS0378US0



RY9212001HYS395A

36. Subtract measurement B from measurement A to calculate measurement C.
Select the appropriate plate (thrust, C) to suit measurement C.

Ex.)
23.1 mm (0.909 in.) – 21.5 mm (0.846 in.) = 1.6 mm (0.063 in.)

Measurement C	Plate thickness t
0.6 to 1.1 mm 0.02 to 0.043 in.	1.8 mm 0.071 in.
1.2 to1.7 mm 0.047 to 0.067 in.	2.3 mm 0.091 in.
1.8 to 2.3 mm 0.071 to 0.091 in.	2.8 mm 0.094 in.

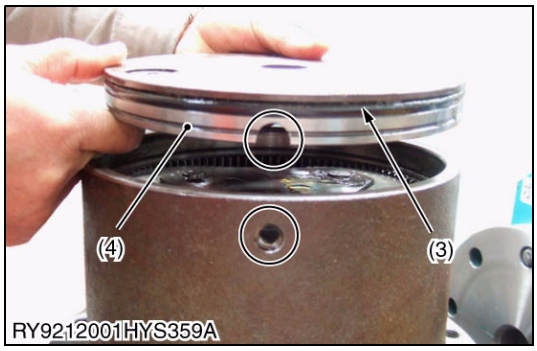
RY9212001HYS0379US0

RY9212001HYS331A

37. Install the selected plate and kit (thrust) (8).

(8) Plate, kit (thrust)

RY9212001HYS0380US0



RY9212001HYS359A

38. Install the O-ring (3) on the cover (4).

■ **IMPORTANT**
- **Apply grease to the O-ring.**
- **Install so the hole in the gear case aligns with the notched groove in the cover.**

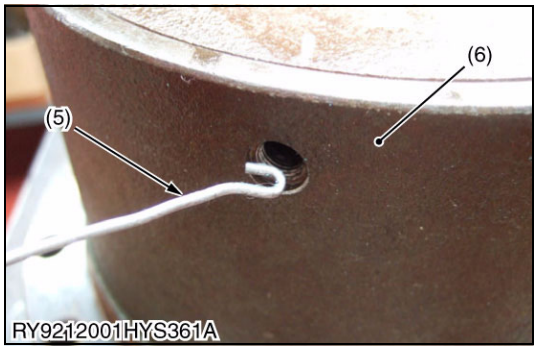
(3) O-Ring (4) Cover

RY9212001HYS0381US0

RY9212001HYS360A

39. Stop the gear case from rotating.

RY9212001HYS0382US0



RY9212001HYS361A

40. Bend the last 6 mm (0.2 in.) of a wire 90° and insert the tip of the wire into the hole in the gear case.

(5) Wire (6) Gear case

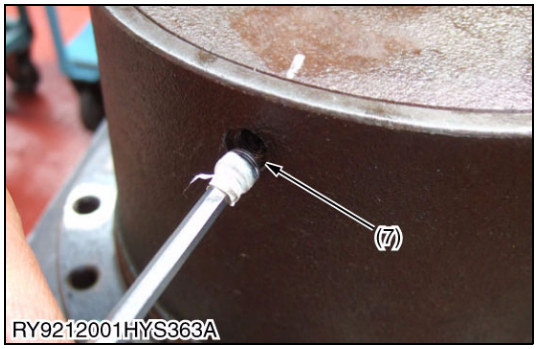
RY9212001HYS0383US0

RY9212001HYS362A

41. Rotate the cover with the rod and feed the wire so it is wrapped all the way around. Cut off any wire protruding from the hole.

- Tool to use : Rod

RY9212001HYS0384US0



RY9212001HYS363A

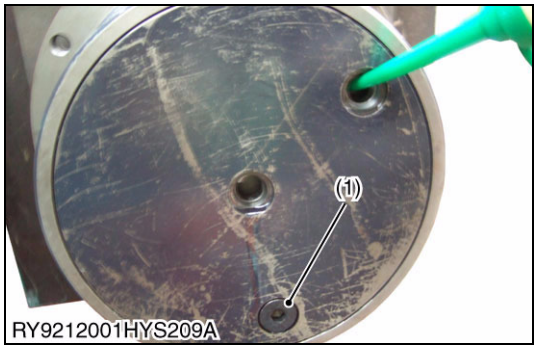
42. Install the plug.

Tightening torque	Plug	6.8 to 8.8 N·m 0.7 to 0.9 kgf·m 5.0 to 6.5 lbf·ft

- Tool to use : M5 hex socket

(7) Plug

RY9212001HYS0385US0



RY9212001HYS209A

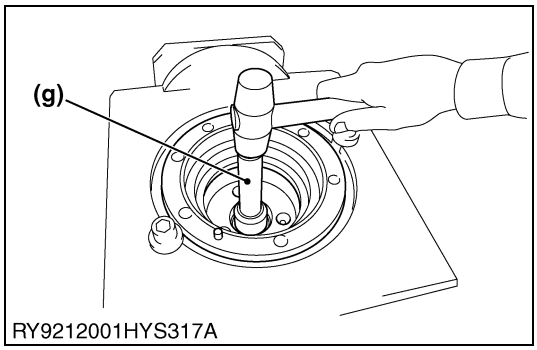
43. After installing the cover, rotate the assembly platform 90 ° and pour in gear oil.
Fill it with gear oil until it flows out of the inspection port and then install the plug.

- Tool to use : M8 hex socket
- Gear oil capacity : 900 cc (2 U.S.gal)

(1) Plug

RY9212001HYS0386US0

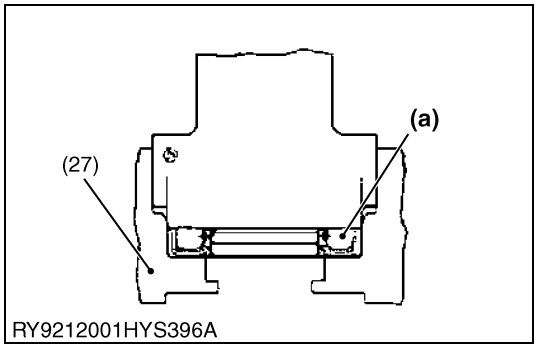
[B] Motor Assembly



RY9212001HYS317A

1. Tap the oil seal in with the oil seal installation tool.

■ **IMPORTANT**
- **Take care to face the oil seal the right direction.**
- **Apply grease to its lip and circumference.**



RY9212001HYS396A

(27) Flange holder

(a) Oil seal lip
(g) Oil seal installation tool

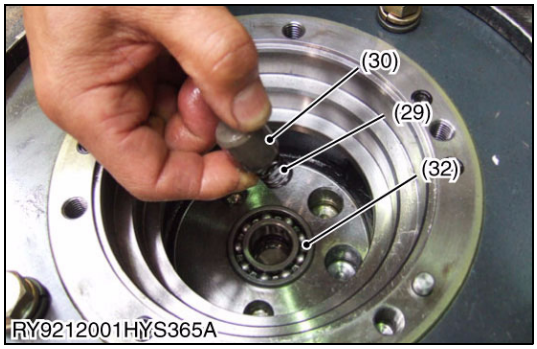
RY9212001HYS0016US0

2. Tap the ball bearing in.

■ **IMPORTANT**
- **Face the ball bearing so the inscription is up.**
- **Apply grease to the circumference of the ball bearing.**

(33) Ball bearing

RY9212001HYS0387US0



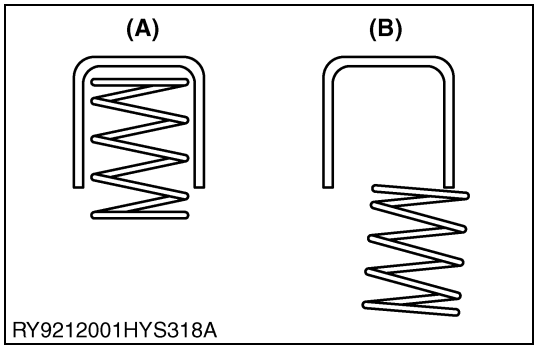
3. Install the two 2-speed pistons (30).

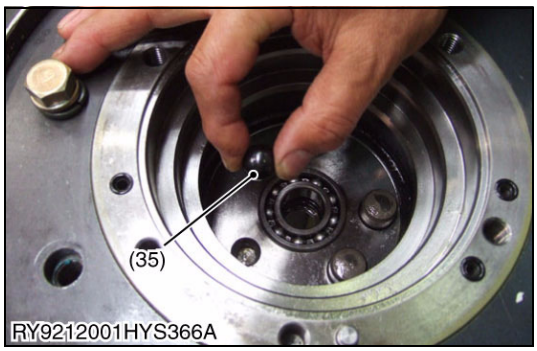
■ **IMPORTANT**
- **The spring comes out easily, so apply some grease to it.**
- **Press the piston down and make sure it moves smoothly.**

(29) Spring
(30) Piston
(32) Ball bearing

(A) Correct
(B) Incorrect

RY9212001HYS0388US0

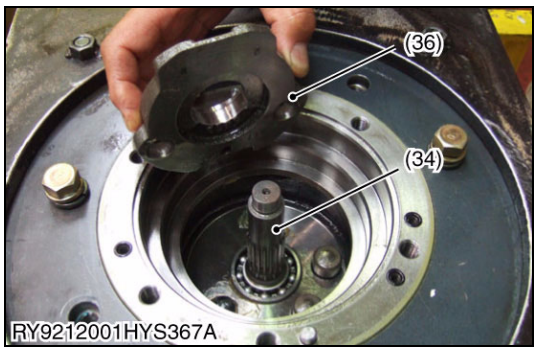




4. Apply grease to the two balls (35) and install them.

(35) Ball

RY9212001HYS0389US0

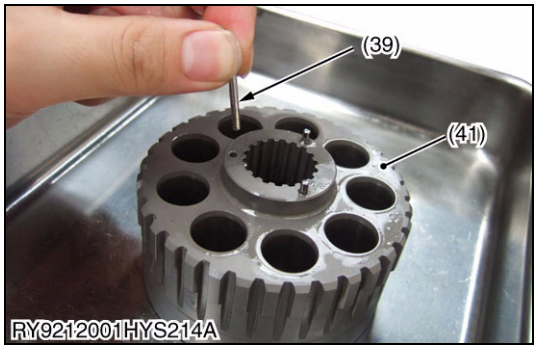


5. Install the shaft (34) and then the swash-plate (36).

■ **IMPORTANT**
- **After installing them, make sure the swash-plate moves smoothly.**

(34) Shaft
(36) Swash-plate

RY9212001HYS0390US0



6. Install the three pins (39) into the cylinder block (41).

■ **IMPORTANT**
- **Apply grease to the pins.**

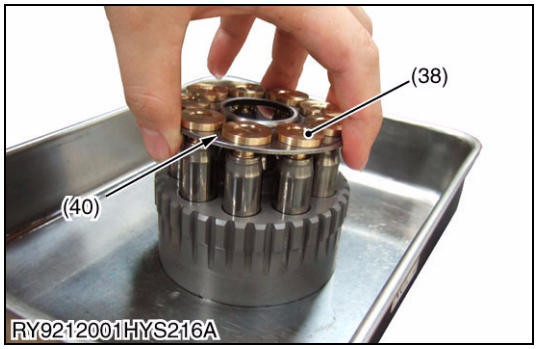
(39) Pin (41) Cylinder block

RY9212001HYS0391US0

7. Install the retainer holder (37).

(37) Retainer holder

RY9212001HYS0392US0

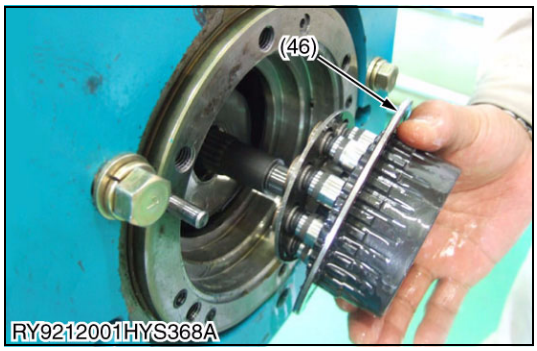


8. Install the piston ASSY (38) into the retainer plate (40) and then install it into the cylinder block.

■ **IMPORTANT**
- **Apply hydraulic oil to the pistons.**
- **Make sure the pistons move smoothly.**

(38) Piston ASSY (40) Retainer plate

RY9212001HYS0393US0

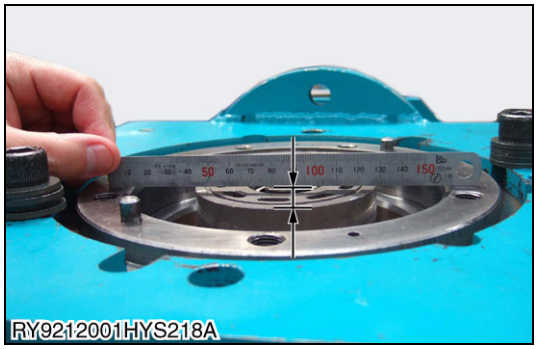


9. Install the sub-assy of the cylinder block and the disc (46) into the flange holder.

■ **IMPORTANT**
- **Turn the disassembly / assembly platform on its side.**

(46) Disc

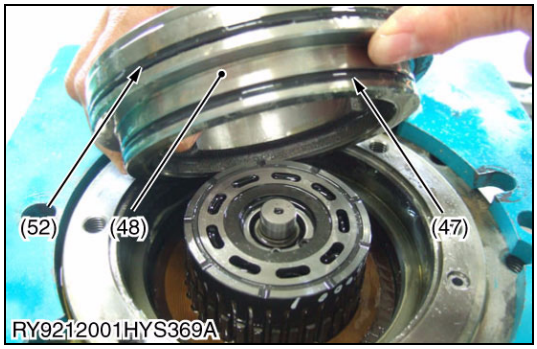
RY9212001HYS0394US0



10. Check and make sure that the cylinder block's sliding surface sinks below the edge of the holder.

■ **IMPORTANT**
- **Turn the disassembly / assembly platform on its side.**

RY9212001HYS0395US0

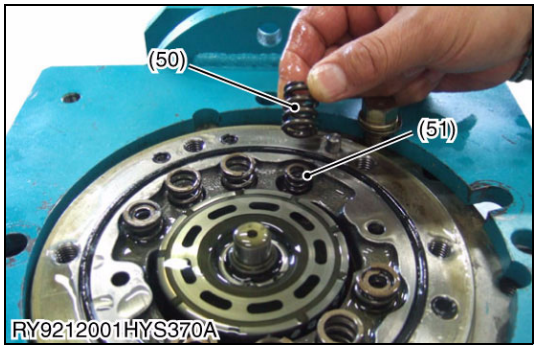


11. Install the brake piston (48).

■ **IMPORTANT**
- **Apply grease to the O-ring.**

(47) O-Ring
(48) Brake piston
(52) O-Ring

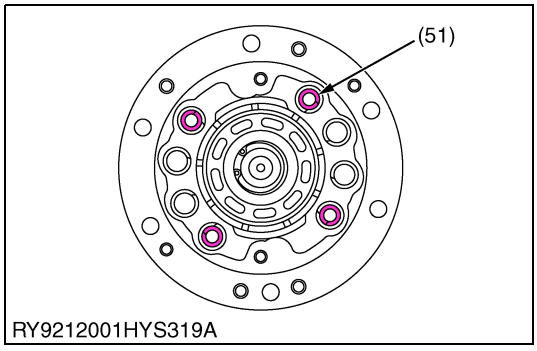
RY9212001HYS0396US0



12. Install the eight springs (50).

(50) Spring (large)
(51) Spring (small)

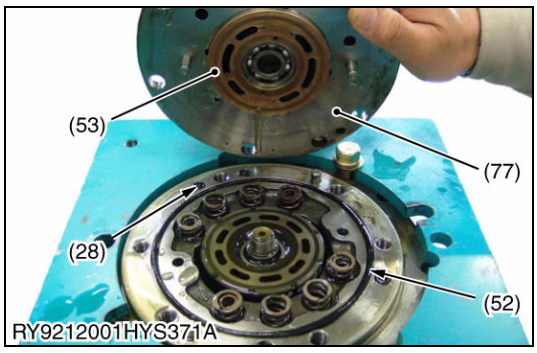
RY9212001HYS0397US0



13. Install the four springs (51).

(51) Spring (small)

RY9212001HYS0398US0

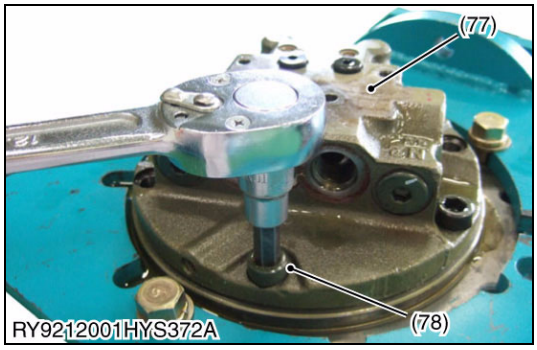


14. Install the plate (valve) and O-ring on the base plate.

■ **IMPORTANT**
- **Take care to install the plate (valve) facing the right direction.**
- **Apply grease on the back of the plate (valve) so it does not fall off the base plate.**
- **Apply grease to the O-ring.**

(28) O-ring
(52) O-ring
(53) Plate (valve)
(77) Baseplate

RY9212001HYS0399US0



15. Install the base plate (77).

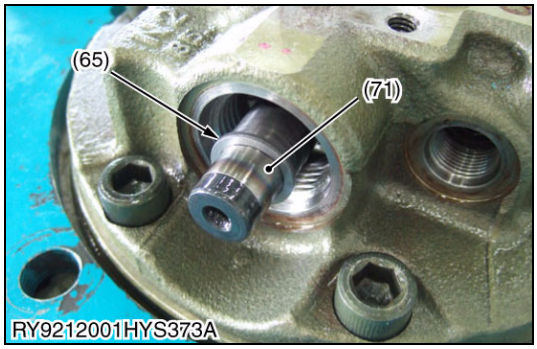
■ **IMPORTANT**
- **Be careful so the plate (valve) does not fall off.**
- **Tighten the hex socket bolts in a criss-cross pattern.**

Tightening torque	Hex socket bolt	121.6 to 135.4 N·m 12.4 to 13.8 kgf·m 89.69 to 99.87 lbf·ft

- Tool to use : M10 hex socket

(77) Baseplate
(78) Hex socket bolt

RY9212001HYS0400US0

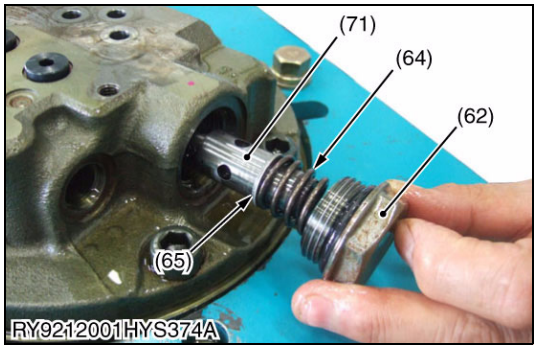


16. Install the counterbalance unit.
Install the spool (71) and then the spring seat (65).

■ **IMPORTANT**
- **The spool itself slides smoothly.**
- **Apply hydraulic oil to the spool.**

(65) Spring seat (71) Spool

RY9212001HYS0401US0



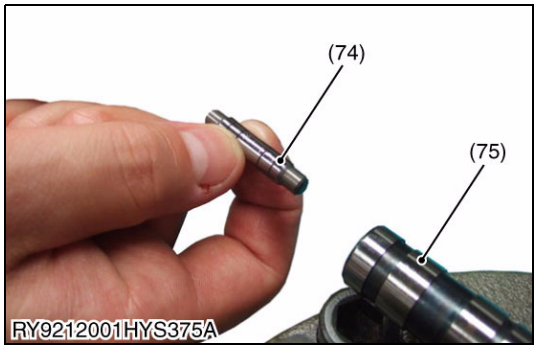
17. Install the two springs (64) and plugs (62).

Tightening torque	Plug (62)	235 to 245 N·m 24.0 to 25.0 kgf·m 173 to 181 lbf·ft

- Tool to use : M36 wrench (socket)

(62) Plug (64) Spring

RY9212001HYS0402US0

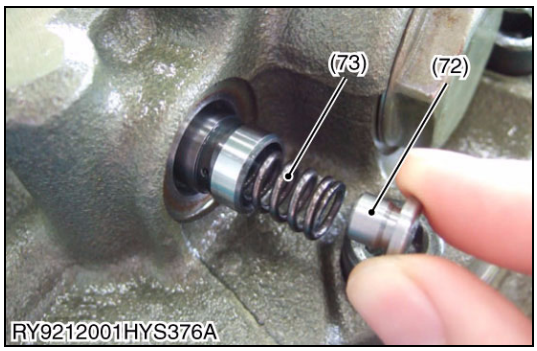


18. Install spool A (75).
Install spool C (74) in spool A.

■ **IMPORTANT**
- **The spool itself slides smoothly.**
- **Apply hydraulic oil to the spool.**

(74) Spool C (75) Spool A

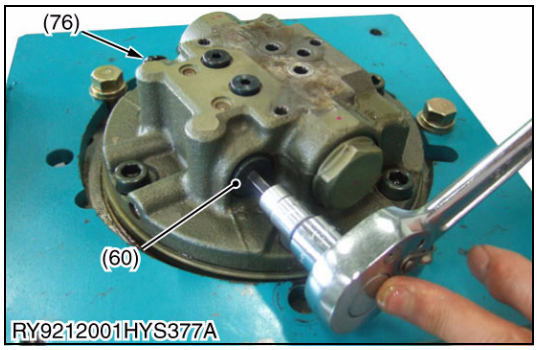
RY9212001HYS0403US0



19. Install the spring (73) and spring seat (72).

(72) Spring seat (73) Spring

RY9212001HYS0404US0



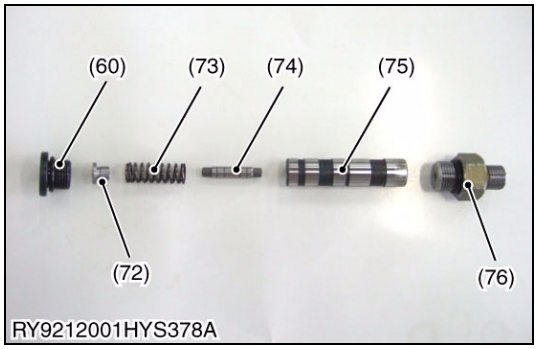
20. Install the two plugs.

Tightening torque	Plug	49 to 58.8 N·m 5.0 to 6.0 kgf·m 36.0 to 43.4 lbf·ft

- Tool to use : M8 hex socket, M22 socket wrench

(60) Plug (76) Plug

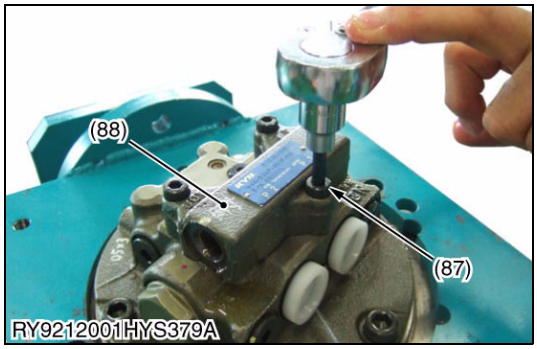
RY9212001HYS0405US0



21. Components of the 2-speed Switch

(60) Plug
(72) Spring seat
(73) Spring
(74) Spool C
(75) Spool A
(76) Plug

RY9212001HYS0406US0



22. Install the valve body (88).

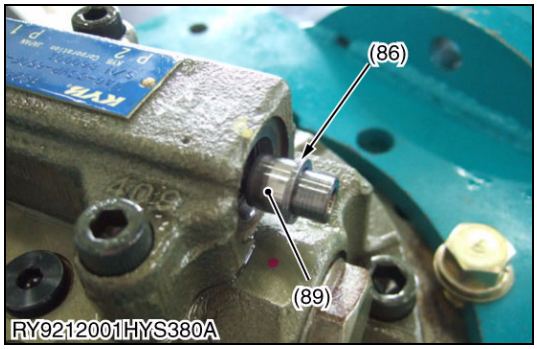
■ **IMPORTANT**
- **Be careful not to forget to install the O-ring.**
- **Apply grease to the O-ring.**

Tightening torque	Hex socket bolt	35 to 38.8 N·m 3.6 to 4.0 kgf·m 25.8 to 28.6 lbf·ft

- Tool to use : M6 hex socket

(87) Hex socket bolt
(88) Valve body

RY9212001HYS0407US0

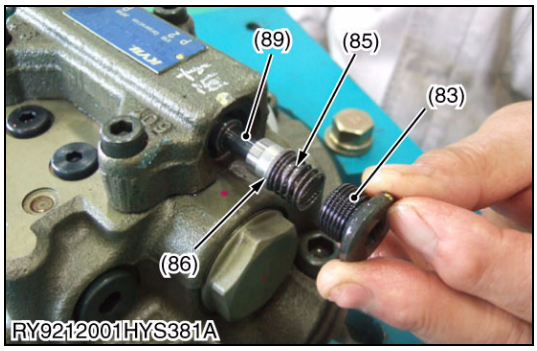


23. Install the spool (89) and the spring seat (86).

■ **IMPORTANT**
- **The spool itself slides smoothly.**
- **Apply hydraulic oil to the spool.**

(86) Spring seat
(89) Spool

RY9212001HYS0408US0



24. Install the two springs (85) and plugs (83).

Tightening torque	Plug (83)	49 to 58.8 N·m 5.0 to 6.0 kgf·m 36.0 to 43.4 lbf·ft

- Tool to use : M8 hex socket

(83) Plug
(85) Spring
(86) Spring seat
(89) Spool

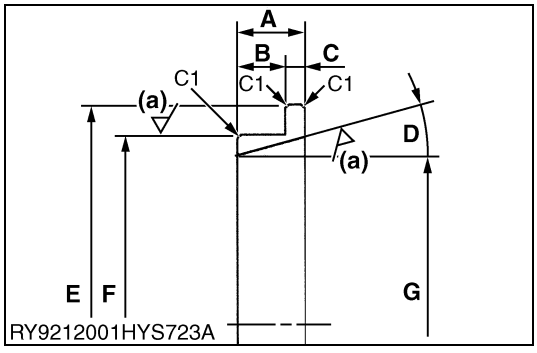
RY9212001HYS0409US0

[3] SPECIAL TOOLS

RY9212001HYS722A

No. in Figure	Name of part
(a)	Floating seal installation tool [Guide (for housing)]
(b)	Floating seal installation tool (pusher)
(c)	Floating seal installation tool [Guide (for flange holder)]
(d)	Cover removal tool
(e)	Ring nut socket
(f)	Removal bolts (M10 × 2.0)
(g)	Oil seal installation tool

RY9212001HYS0410US0

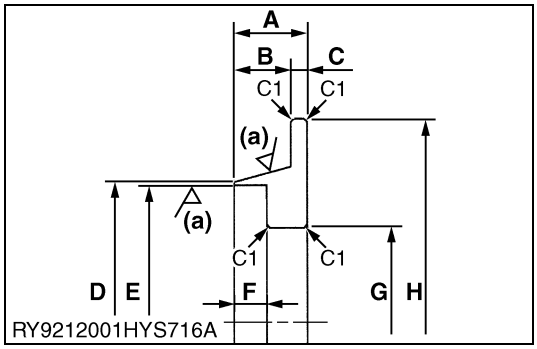


RY9212001HYS723A

(a) Floating seal installation tool [Guide (housing)]

A	17 mm, 0.67 in.
B	12 mm, 0.47 in.
C	5 mm, 0.2 in.
D	15 °
E	ϕ245 mm, 9.65 in.
F	ϕ230 mm, 9.06 in.
G	ϕ219.8 mm, 8.654 in.
H	255 mm, 10.0 in.
C1	1 mm, 0.04 in. bevel
a	Ra=6.3a

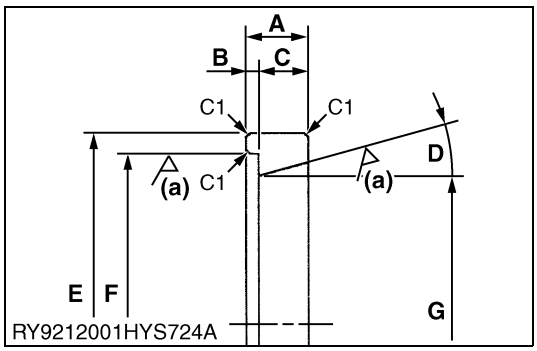
RY9212001HYS0415US0



(b) Floating seal installation tool (pusher)

A	22 mm, 0.87 in.
B	17 mm, 0.67 in.
C	5 mm, 0.2 in.
D	ϕ217.5 mm, 8.563 in.
E	ϕ215.5 mm, 8.484 in.
F	9.8 mm, 0.39 in.
G	ϕ190 mm, 7.48 in.
H	ϕ255 mm, 10.0 in.
C1	1 mm, 0.04 in. bevel
a	Ra=6.3a

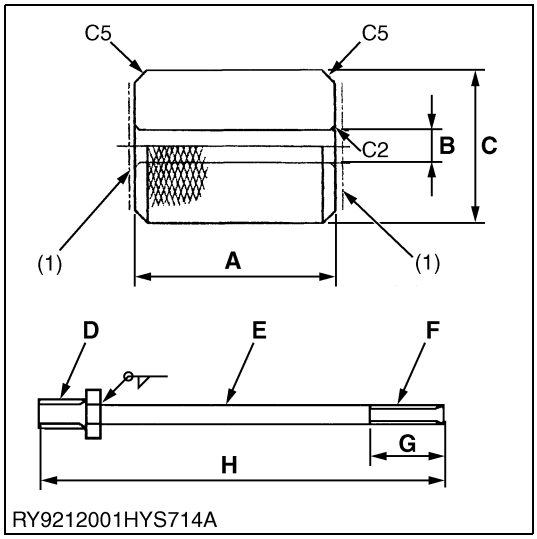
RY9212001HYS0414US0



(c) Floating seal installation tool [Guide (for flange holder)]

A	15 mm, 0.59 in.
B	3 mm, 0.1 in.
C	12 mm, 0.47 in.
D	15 °
E	ϕ240 mm, 9.45 in.
F	ϕ230.3 mm, 9.067 in.
G	ϕ219.8 mm, 8.654 in.
C1	1 mm, 0.04 in. bevel
a	Ra=6.3a

RY9212001HYS0416US0

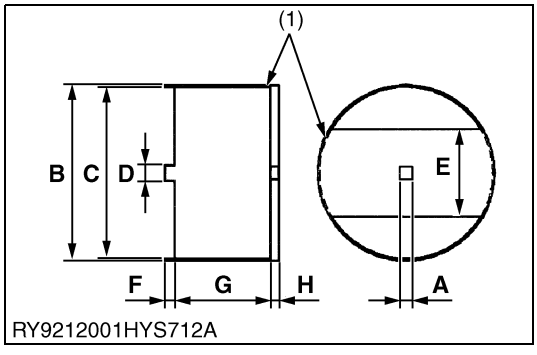


(d) Cover removal tool

A	80 mm, 3.1 in.
B	ϕ13 mm, 0.51 in.
C	ϕ60 mm, 2.4 in.
D	R3/8
E	ϕ12.5 mm, 0.492 in.
F	M12 × P1.25
G	25 mm, 0.98 in.
H	315 mm, 12.4 in.
C2	2 mm, 0.08 in. bevel
C5	5 mm, 0.2 in. bevel

(1) Tempered

RY9212001HYS0411US0

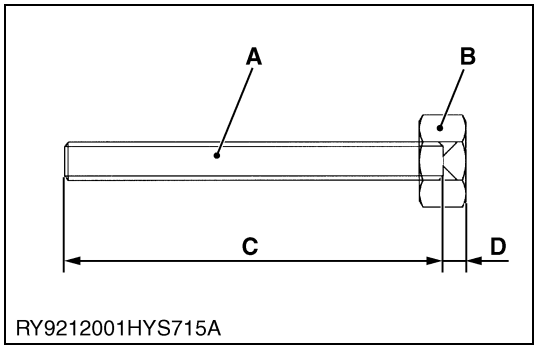


(e) Ring nut installation tool

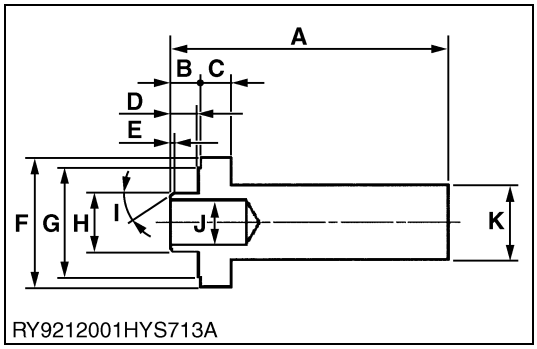
A	12.7 mm, 0.50 in.
B	ϕ180 mm, 7.09 in.
C	ϕ176 mm, 6.93 in.
D	4 to 16 mm, 0.2 to 0.63 in.
E	90 mm, 3.5 in.
F	10 mm, 0.39 in.
G	107 mm, 4.21 in.
H	9 mm, 0.4 in.

(1) Weld

RY9212001HYS0412US0



RY9212001HYS715A



RY9212001HYS713A

(f) Removal bolt (M10 × 2.0)

A	M14 × P2.0
B	M14 nut
C	250 mm, 9.84 in.
D	5 mm, 0.2 in.

RY9212001HYS0413US0

(g) Oil seal installation tool

A	110 mm, 4.33 in.
B	12 mm, 0.47 in.
C	12 mm, 0.47 in.
D	11 mm, 0.43 in.
E	2 mm, 0.08 in.
F	ϕ52 mm, 2.0 in.
G	ϕ44 mm, 1.7 in.
H	23.8 mm, 0.937 in.
I	30 °
J	ϕ18 mm, 0.71 in.
K	ϕ30 mm, 1.2 in.

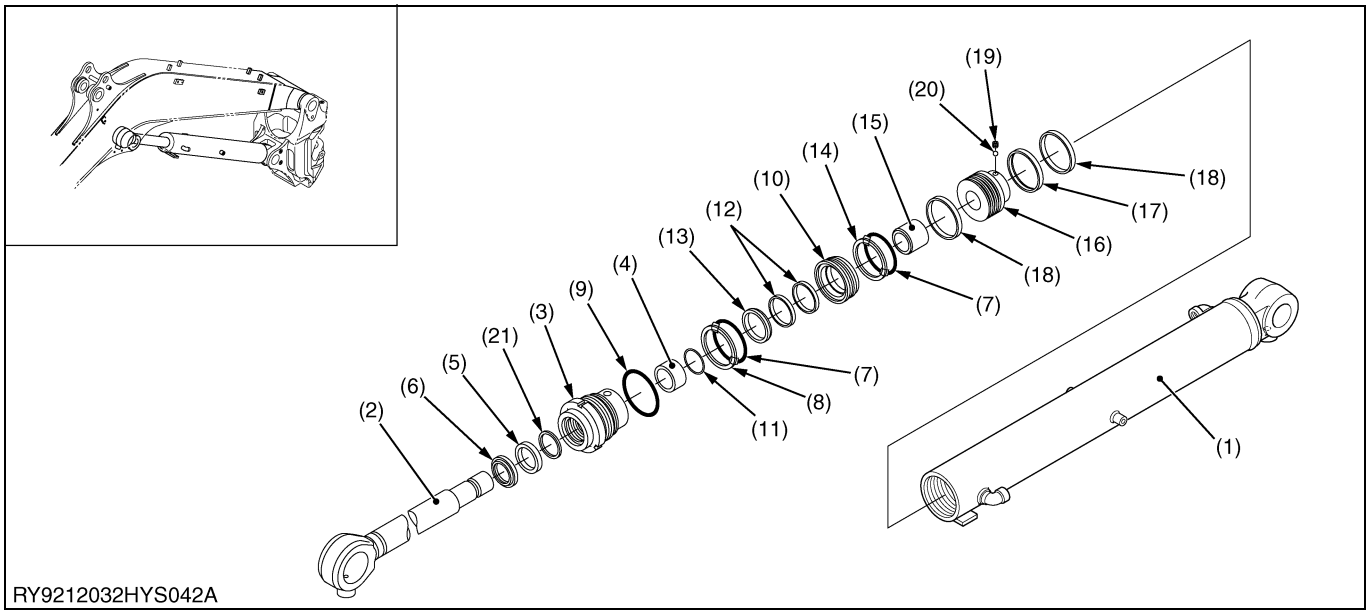
RY9212001HYS0417US0

6. HYDRAULIC CYLINDER

[1] HYDRAULIC CYLINDER DISASSEMBLY / ASSEMBLY PROCEDURES

(1) Cylinder Components

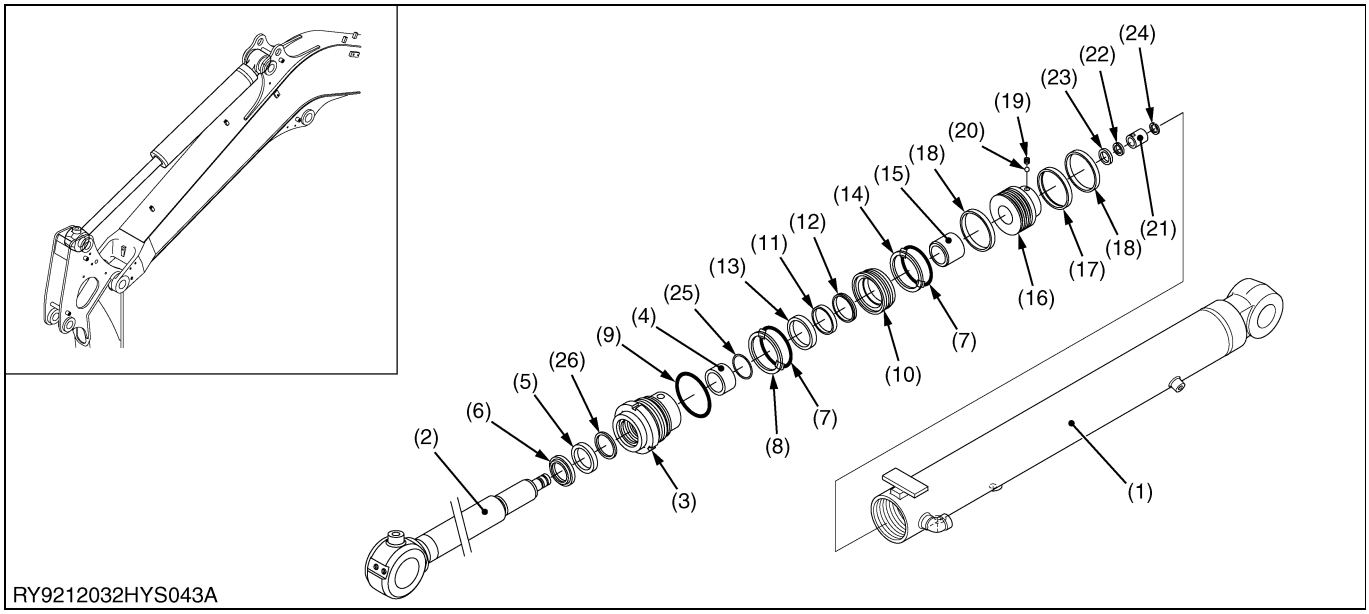
Boom Cylinder



No.	Part Name	Q'ty	No.	Part Name	Q'ty
(1)	Cylinder tube ASSY	1	(12)	Cushion seal	1
(2)	Piston rod ASSY	1	(13)	Collar	1
(3)	Cylinder head	1	(14)	Backup ring	1
(4)	Bushing	1	(15)	Cushion bearing	1
(5)	U-ring	1	(16)	Piston	1
(6)	Wiper ring	1	(17)	Seal ring ASSY	1
(7)	O-Ring	2	(18)	Slide ring	2
(8)	Backup ring	1	(19)	Set screw	1
(9)	O-Ring	1	(20)	Steel ball	1
(10)	Holder	1	(21)	Buffer ring	1
(11)	Cushion seal	1			

RY9212032HYS0030US0

Arm Cylinder

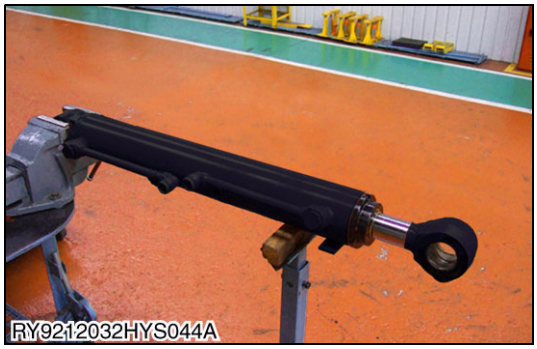


RY9212032HYS043A

No.	Part Name	Q'ty	No.	Part Name	Q'ty
(1)	Cylinder tube ASSY	1	(14)	Backup ring	1
(2)	Piston rod ASSY	1	(15)	Cushion bearing	1
(3)	Cylinder head	1	(16)	Piston	1
(4)	Bushing	1	(17)	Seal ring ASSY	1
(5)	U-ring	1	(18)	Slide ring	2
(6)	Wiper ring	1	(19)	Set screw	1
(7)	O-Ring	2	(20)	Steel ball	1
(8)	Backup ring	1	(21)	Cushion bearing	1
(9)	O-Ring	1	(22)	Cushion seal	1
(10)	Holder	1	(23)	Snap ring	1
(11)	Cushion seal	1	(24)	Stopper	2
(12)	Spacer	1	(25)	Snap ring	1
(13)	Collar	1	(26)	Buffer ring	1

RY9212032HYS0031US0

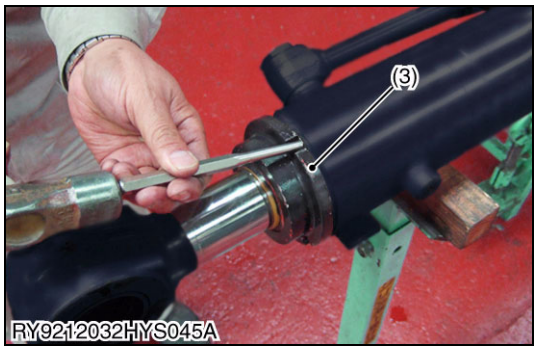
(2) Disassembly Procedures



Cylinder Disassembly

1. Drain the oil from inside the cylinder, and fasten the cylinder bottom in a vice across the bolt width.

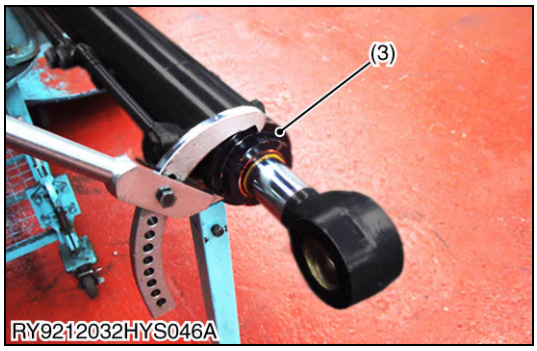
RY9212032HYS0032US0



2. Place an anti-rotation device in one position of the cylinder head (3).

(3) Cylinder head

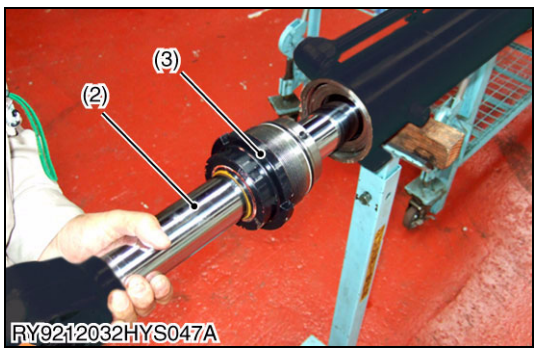
RY9212032HYS0033US0



3. Use a wrench (hook) or wrench (key) to loosen the cylinder head (3).
   While loosening the cylinder head (3) screw, remove the cylinder head.

(3) Cylinder head

RY9212032HYS0034US0

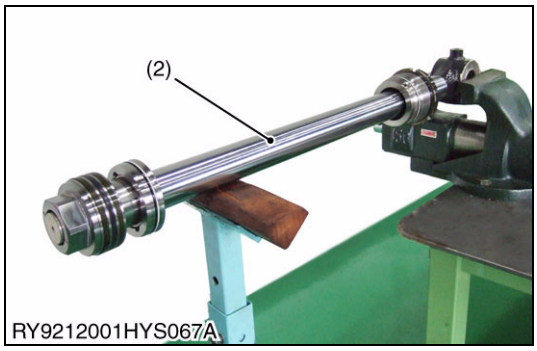


4. Pull out the piston rod assembly (2) together with the cylinder head (3), and place on a board.

■ **IMPORTANT**
- **Check whether or not the pipe cap has been removed.**
- **Provide the port on the cylinder head side with an oil receptacle.**
- **Draw the piston rod assembly (2) out horizontally while keeping it held, to avoid dropping it and causing damage to parts immediately after it is withdrawn.**

(2) Piston rod ASSY (3) Cylinder head

RY9212032HYS0035US0



5. Fasten the piston rod assembly (2) in a vice across the bolt width and use a cushioning material.

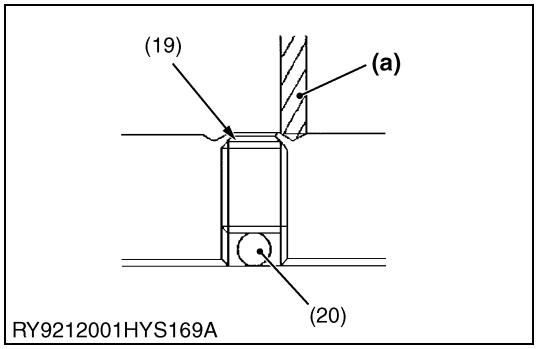
■ **IMPORTANT**
- **Place the rod on a block of wood.**

(2) Piston rod ASSY

RY9212001HYS0431US0

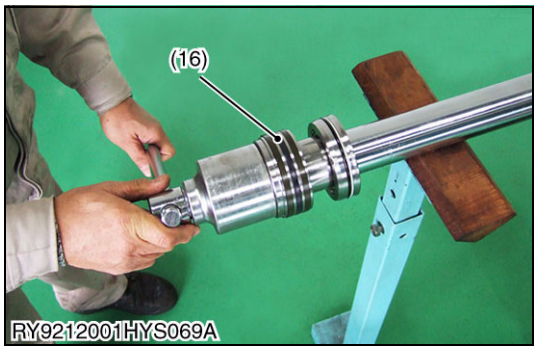
6. Remove the set screw (19), and remove the steel ball (20).

■ **IMPORTANT**
- **The set screw (19) is caulked in two locations. Use a hand drill or similar device to remove the caulking, then loosen the set screw (19).**
- **After removing, use a hand tap (M8 × 1.25) to carry off the piston side.**
- **If the set screw (19) is damaged on removal, replace it with a new one.**



(19) Set screw
(20) Steel ball
(a) Drill

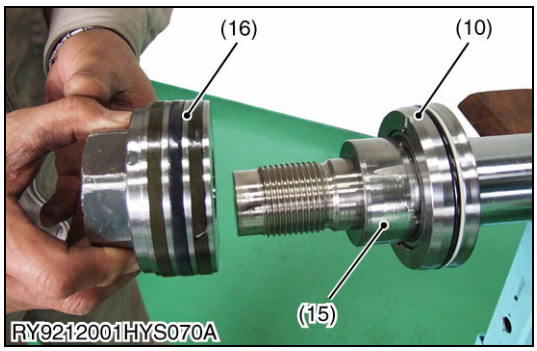
RY9212001HYS0432US0



7. Use a wrench (socket wrench) on the hexagonal nut section of the piston (16), and loosen it.
   If a large amount of torque is required, prepare a dynamic wrench with hydraulic jack - hydraulic cylinder.

(16) Piston

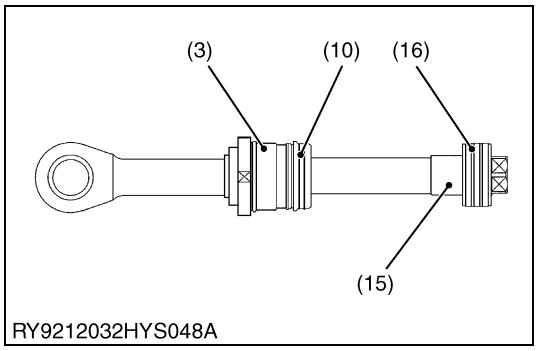
RY9212001HYS0433US0

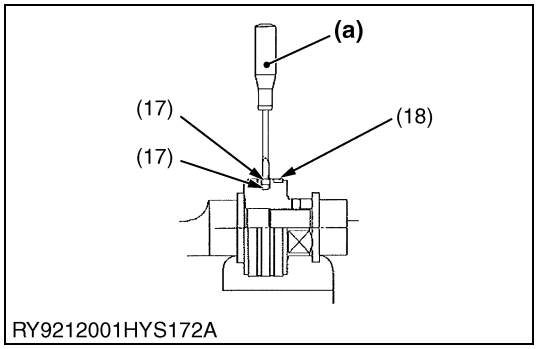


8. Remove the piston (16), cushion bearing (15) and cylinder head (3) in that order.

(3) Cylinder head
(10) Holder
(15) Cushion bearing
(16) Piston

RY9212032HYS0036US0





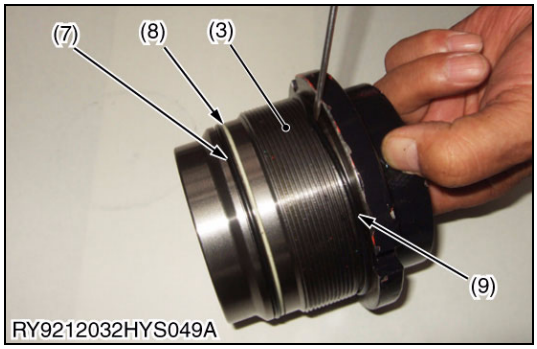
RY9212001HYS172A

9. Remove the slide ring (18) by hand, split the seal ring (17) by tapping it with a flat tip screwdriver **(a)**, and remove.
Remove the O-ring (17) with a spatula.

■ **IMPORTANT**
- **Do not use seals once removed.**

(17) Seal ring, O-ring
(18) Slide ring
(a) Slotted screwdriver

RY9212001HYS0439US0



RY9212032HYS049A

10. Remove the O-rings (7) (9) and backup ring (8) of the cylinder head (3).

■ **IMPORTANT**
- **If removal is difficult, use a screwdriver, taking care not to damage the cylinder head.**
- **Do not use seals once removed.**

(3) Cylinder head
(7) O-Ring
(8) Backup ring
(9) O-Ring

RY9212032HYS0037US0

RY9212032HYS051A

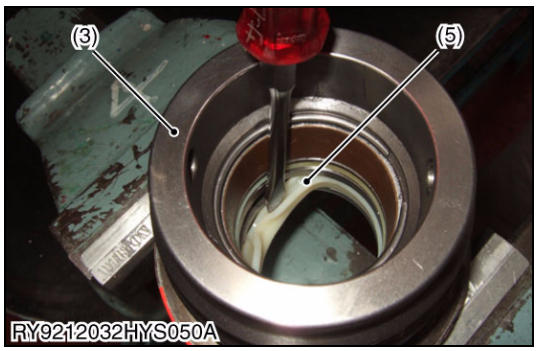
11. Remove the wiper ring (6).

The wiper ring (6) is press-fitted.
Use a tool such as a driver, and tap using rubber cushioning.

■ **IMPORTANT**
- **Do not use seals once removed.**

(6) Wiper ring

RY9212032HYS0038US0



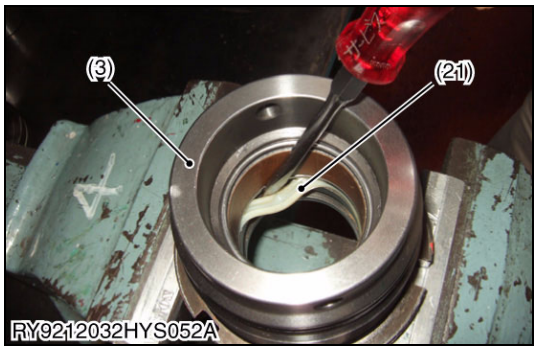
RY9212032HYS050A

12. Lift the U-ring (5) using a screwdriver, and remove it from the cylinder head (3).

■ **IMPORTANT**
- **Do not use seals once removed.**

(3) Cylinder head
(5) U-ring

RY9212032HYS0039US0



RY9212032HYS052A

13. Lift the buffer ring (21) with a screwdriver, and remove it from the cylinder head (3).

■ **IMPORTANT**
- **Do not use seals once removed.**

(3) Cylinder head
(21) Buffer ring

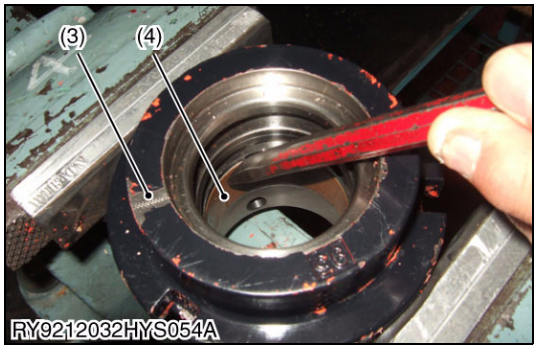
RY9212032HYS0040US0

14. Lift the snap ring (11) with a screwdriver, and remove it from the cylinder head (3).

■ **IMPORTANT**
- **Do not use seals once removed.**

(11) Snap ring

RY9212032HYS0041US0



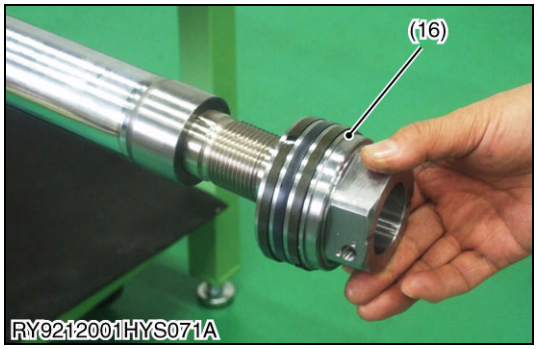
15. Lightly tap out the bushing (4) with a hammer and chisel, taking care not to damage the cylinder head (3).

■ **IMPORTANT**
- **Do not use seals once removed.**

(3) Cylinder head (4) Bushing

RY9212032HYS0042US0

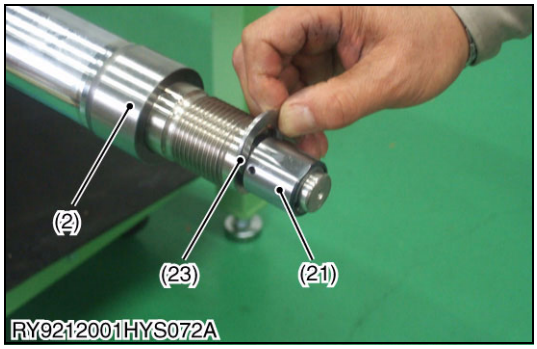
Compression side cushion bearing disassembly (arm cylinder only)



1. Remove the piston (16).
   Disassembly is not possible when the piston (16) is fitted.

(16) Piston

RY9212001HYS0435US0

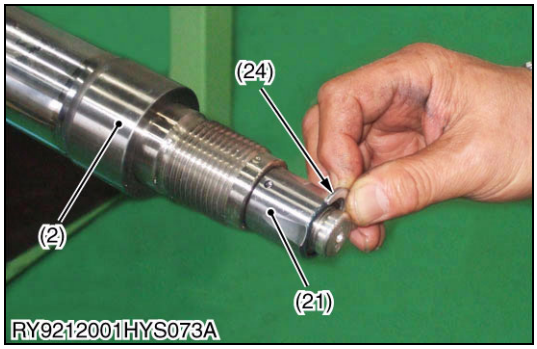


2. Remove the snap ring (23).

■ **IMPORTANT**
- **Lightly tap out with a plastic hammer to avoid damaging the piston rod (2) and cushion bearing (21).**

(2) Piston rod (23) Snap ring
(21) Cushion bearing

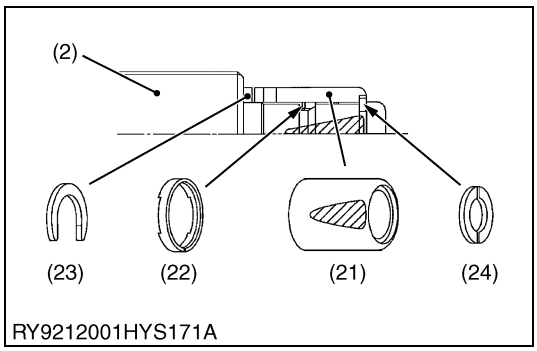
RY9212001HYS0436US0



3. Slide the cushion bearing (21) to the thread side of the piston rod (2), and remove the stopper (24) (splits into two).

(2) Piston rod (24) Stopper
(21) Cushion bearing

RY9212001HYS0437US0



4. Remove the cushion bearing (21), and remove the cushion seal (22).
   The cushion seal (22) has a split opening in one location, so widen the split to remove.

(2) Piston rod
(21) Cushion bearing
(22) Cushion seal
(23) Snap ring
(24) Stopper

RY9212001HYS0438US0

(3) Assembly Procedures

Precautions on Assembly

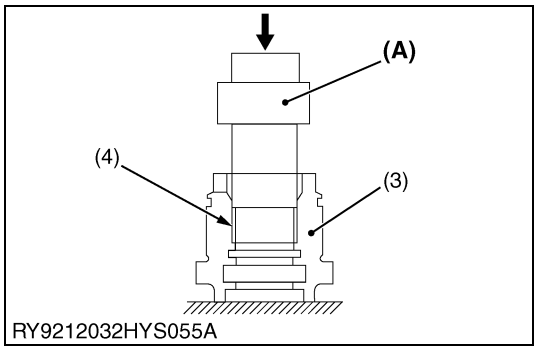
Replacing Seals

All seals must be replaced when disassembling the cylinder.

Replacing O-rings

Thoroughly clean the mounting groove before fitting the backup ring and O-ring.
Take care over the backup ring location.
Apply grease or hydraulic fluid to the backup ring and O-ring, for smoothness of assembly.
If not sufficiently lubricated, O-rings may become twisted during assembly, resulting in oil leakage.

RY9212001HYS0444US0



Cylinder Head Assembly

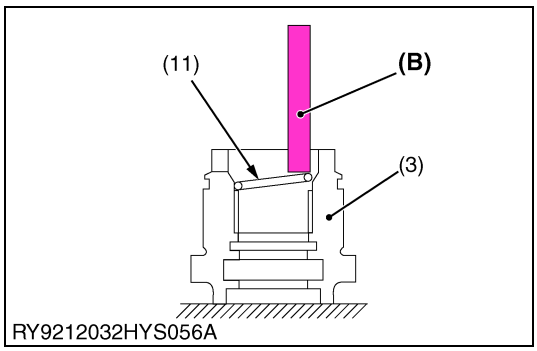
1. Use press-fitting tool **(A)** to press-fit the bushing (4).

■ **IMPORTANT**

- **Apply hydraulic fluid beforehand to the cylinder head inner surface.**
  Also check that there is no unevenness due to scratching, etc., of the bushing after press fitting.

(3) Cylinder head
(4) Bushing
(A) Tool

RY9212032HYS0043US0

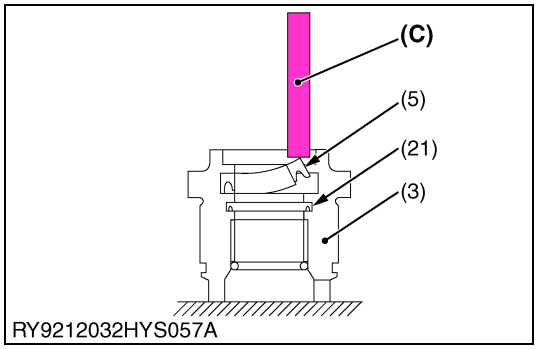


Snap ring assembly

1. Insert the snap ring (11) as far as the cylinder head (3) mounting groove using the press-fitting tool **(B)**.

(3) Cylinder head
(11) Snap ring
(B) Tool (spatula, etc.)

RY9212032HYS0044US0



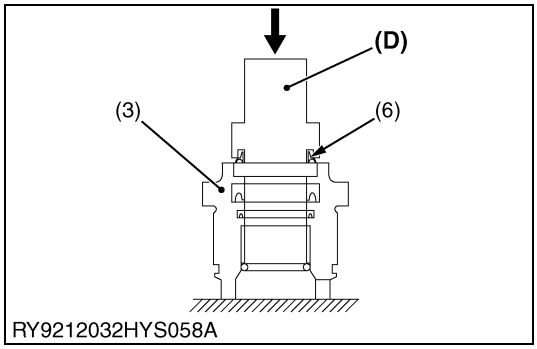
U-ring and buffer ring assembly

1. Apply hydraulic fluid to the buffer ring (21) and U-ring (5), install in the cylinder head (3), and use assembly tool **(C)** to insert as far as the used mounting groove.

■ **IMPORTANT**
- **Make sure the buffer ring (21) and U-ring (5) are installed with the correct orientation.**
- **Place the buffer ring (21) and U-ring (5) in hot water (approx. 90 °C, 194 °F) for about five to ten minutes to soften them prior to installation.**

(3) Cylinder head
(5) U-ring
(21) Buffer ring
(C) Tool

RY9212032HYS0045US0

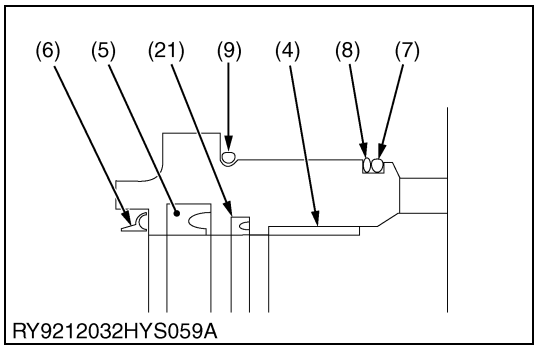


Wiper ring assembly

1. Apply hydraulic fluid to the wiper ring (6).
   Place the tool **(D)** on the wiper ring (6), and use a press to insert it.

(3) Cylinder head
(6) Wiper ring
(D) Tool

RY9212032HYS0046US0

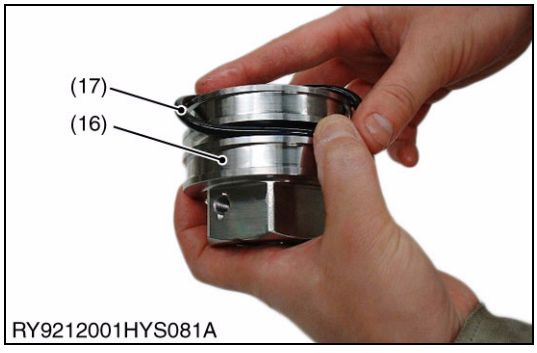


Seal assembly

1. Apply hydraulic fluid to the O-rings (7) (9) and backup ring (8) and install in the cylinder head (3).

(4) Bushing
(5) U-ring
(6) Wiper ring
(7) O-Ring
(8) Backup ring
(9) O-Ring
(21) Buffer ring

RY9212032HYS0047US0

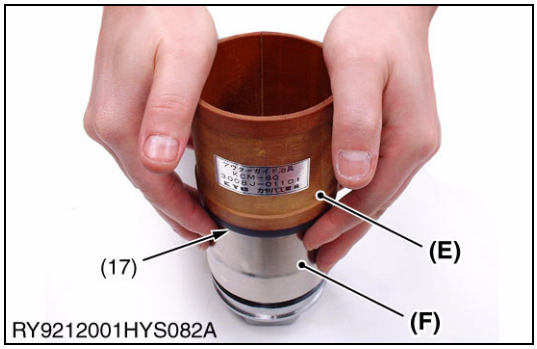


Piston assembly

1. Install the O-ring (17) for the seal ring assembly.
   Apply hydraulic fluid to the O-ring (17).

(16) Piston
(17) O-Ring

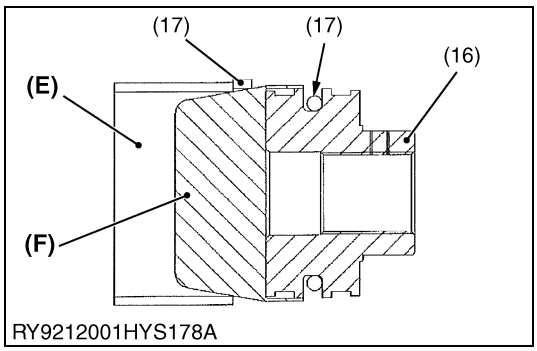
RY9212001HYS0450US0

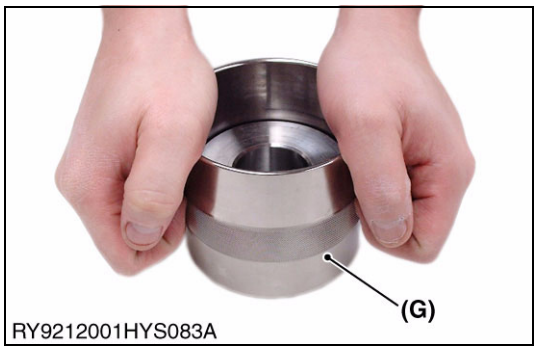


2. Quickly install the seal ring (17) for the sealing assembly using the tools **(E) (F)**.

(16) Piston
(17) Seal ring, O-ring
(E) Tool
(F) Tool

RY9212001HYS0451US0

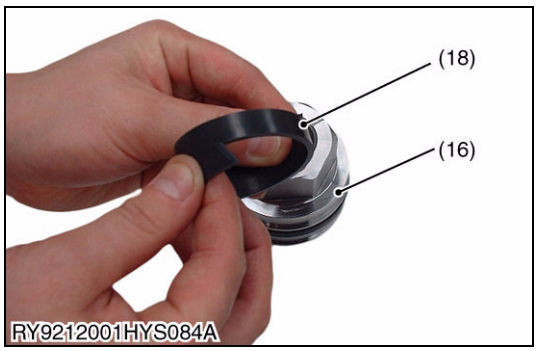




3. After installing the seal ring assembly, quickly pass through the correcting tool **(G)** for correction.

(G) Tool

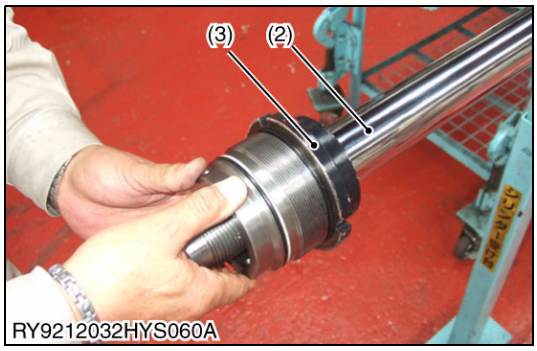
RY9212001HYS0452US0



4. To facilitate installation of the two slide rings (18), first roll them tight (see photo) before installing.

(16) Piston
(18) Slide ring

RY9212001HYS0453US0



Piston rod assembly

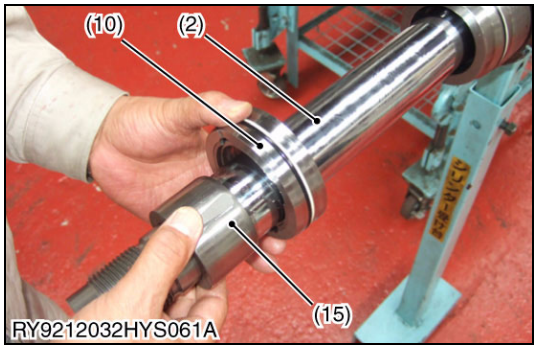
1. Fasten the piston rod (2) in a vice, apply hydraulic fluid to the seal section of the cylinder head (3), and install the piston rod.

■ **IMPORTANT**

- **Take care so that the lip of the wiper ring and U-ring does not catch on the stepped section.**

(2) Piston rod
(3) Cylinder head

RY9212032HYS0048US0

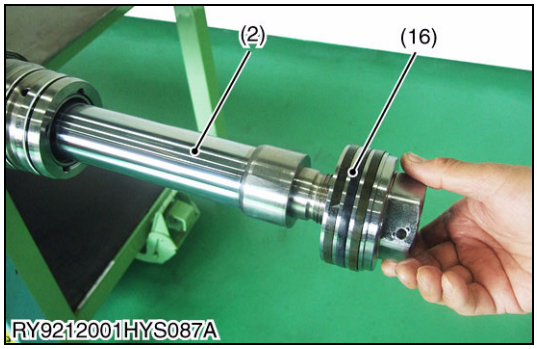


2. Fit the holder (10) and cushion bearing (15), to which hydraulic fluid has been applied, to the piston rod (2). (In the case of the boom cylinder)

■ **IMPORTANT**
- **Take care over the installation orientation of the cushion bearing (15).**

(2) Piston rod
(10) Holder
(15) Cushion bearing

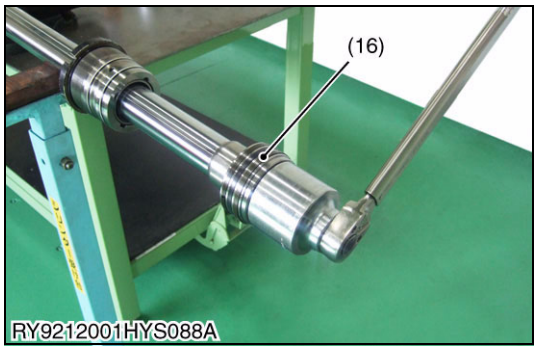
RY9212032HYS0049US0



3. Fit the piston (16) to the piston rod (2).

(2) Piston rod
(16) Piston

RY9212001HYS0456US0

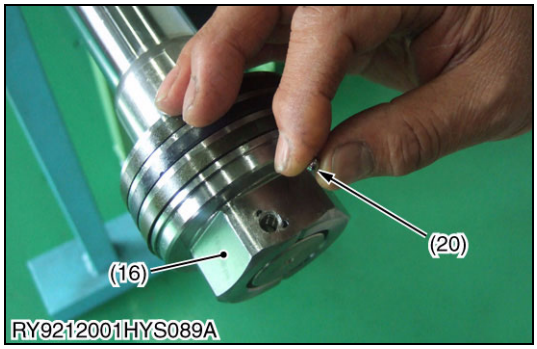


4. Tighten the piston (16).

■ **IMPORTANT**
- **Tighten the piston to the specified torque.**

(16) Piston

RY9212001HYS0461US0



5. Insert the steel ball (20) in the piston (16).

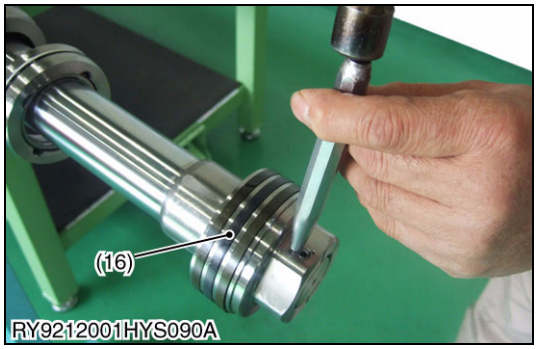
(16) Piston
(20) Steel ball

RY9212001HYS0462US0

6. Tighten the set screw (19).

(19) Set screw

RY9212001HYS0463US0

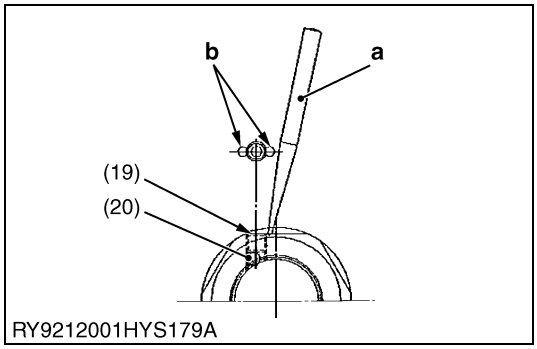


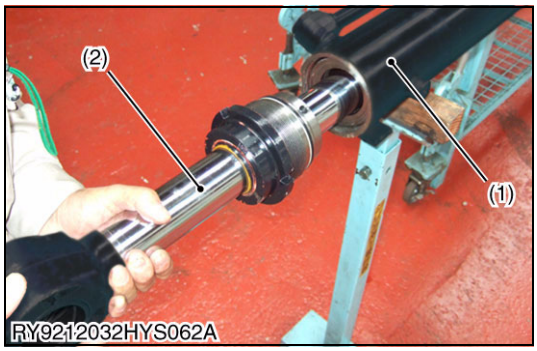
7. Use a punch to caulk in two locations on the circumference of the piston (16).

(16) Piston
(19) Set screw
(20) Steel ball

a : Punch
b : Caulking

RY9212001HYS0464US0

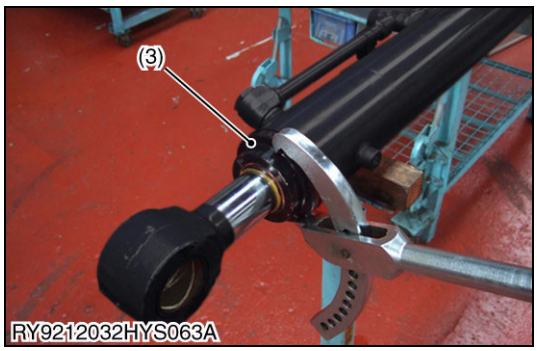




8. Hold the cylinder tube (1) horizontally in a vice, and insert the piston rod (2) to which hydraulic fluid has been applied.

(1) Cylinder tube (2) Piston rod

RY9212032HYS0050US0



9. Use a wrench (hook) or wrench (key) to tighten the cylinder head (3).

(3) Cylinder head

RY9212032HYS0051US0

10. Firmly bend the lock washer into the cylinder head groove.

RY9212032HYS0052US0

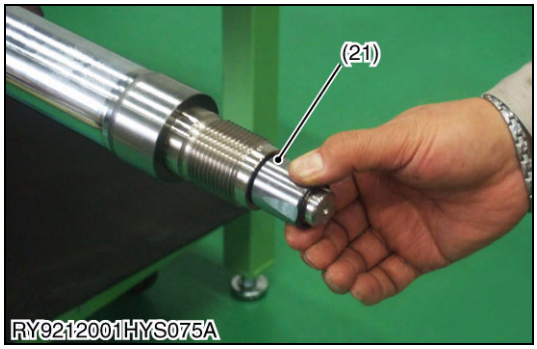
Compression side cushion bearing disassembly (arm cylinder only)

Fit the cushion bearing before fitting the piston nut. Assembly is not possible if the nut is already fitted.

1. Insert the cushion seal (22) in the groove with the slit towards the thread side.

(22) Cushion seal

RY9212001HYS0457US0



2. Assemble the cushion bearing (21) paying attention to the machined flat part.

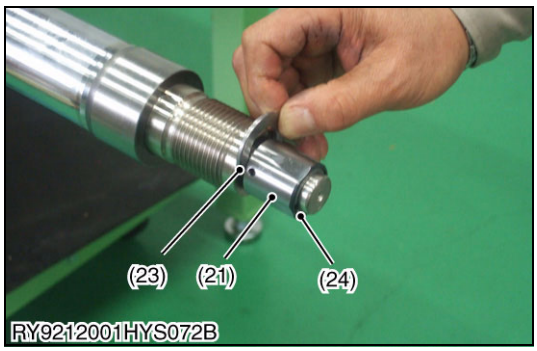
(21) Cushion bearing

RY9212001HYS0458US0

3. Insert the stopper (24) in the groove.

(24) Stopper

RY9212001HYS0459US0



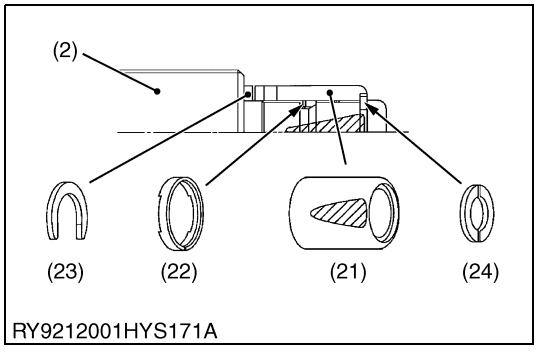
4. Push the cushion bearing (21) fully in the direction of the stopper (24), and tap in the snap ring (23).

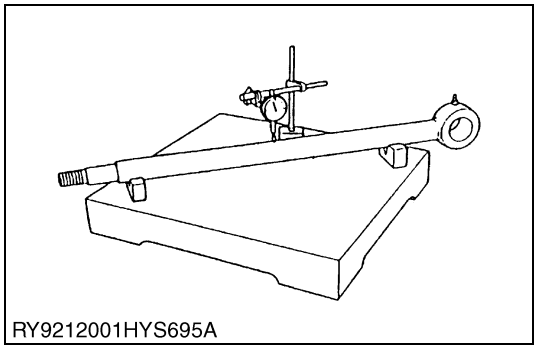
■ **IMPORTANT**

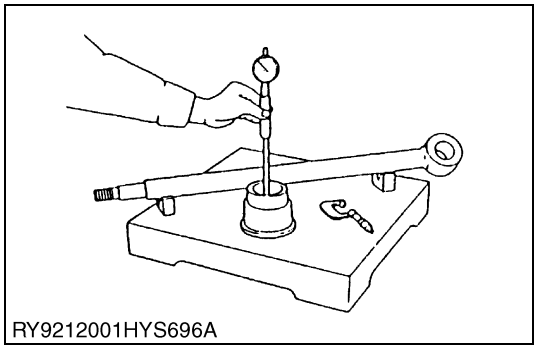
- **Lightly tap the rod and cushion bearing with a plastic hammer.**

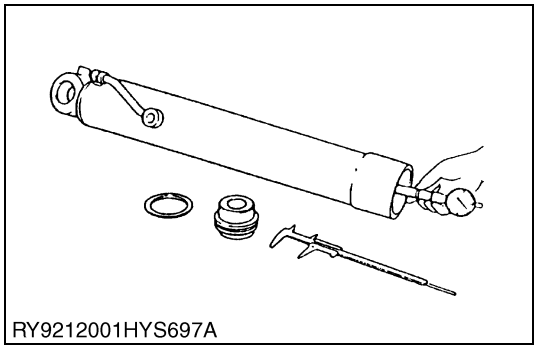
(2) Piston rod
(21) Cushion bearing
(22) Cushion seal
(23) Snap ring
(24) Stopper

RY9212001HYS0460US0




RY9212001HYS695A


RY9212001HYS696A


RY9212001HYS697A

Cylinder Inspection

1. Warping of the piston rod

1. Put the piston rod by itself on the V blocks.
2. Set a dial gauge on the center of the rod.
3. Rotate the piston rod and read the measurements on the dial gauge. Warpage equals 1/2 the difference in the readings.
4. Replace any rod that exceeds its usage limit.
   - Factory spec for warpage : 0.05 mm (0.002 in.) ≥
   - Usage limit for warpage : 0.5 mm (0.02 in.)

2. Wear in the rod and bushings

1. Measure the diameter of the outside of the piston rod and that of the inside of the bushing in the cylinder head and calculate the gap.

	Rod size	Gap
Factory specification	ϕ25 to 40 mm ϕ0.99 to 1.5 in.	0.25 mm ≥ 0.01 in. ≥
	ϕ45 to 75mm ϕ1.8 to 3.0 in.	0.30 mm ≥ 0.01 in. ≥
Allowable limits	ϕ25 to 40 mm ϕ0.99 to 1.5 in.	0.4 mm 0.02 in.
	ϕ45 to 75mm ϕ1.8 to 3.0 in.	0.5 mm 0.02 in.

3. Wear in the tube and piston ring

1. Measure the inside diameter of the cylinder tube.
2. Measure the outside diameter of the piston ring and calculate the clearance.

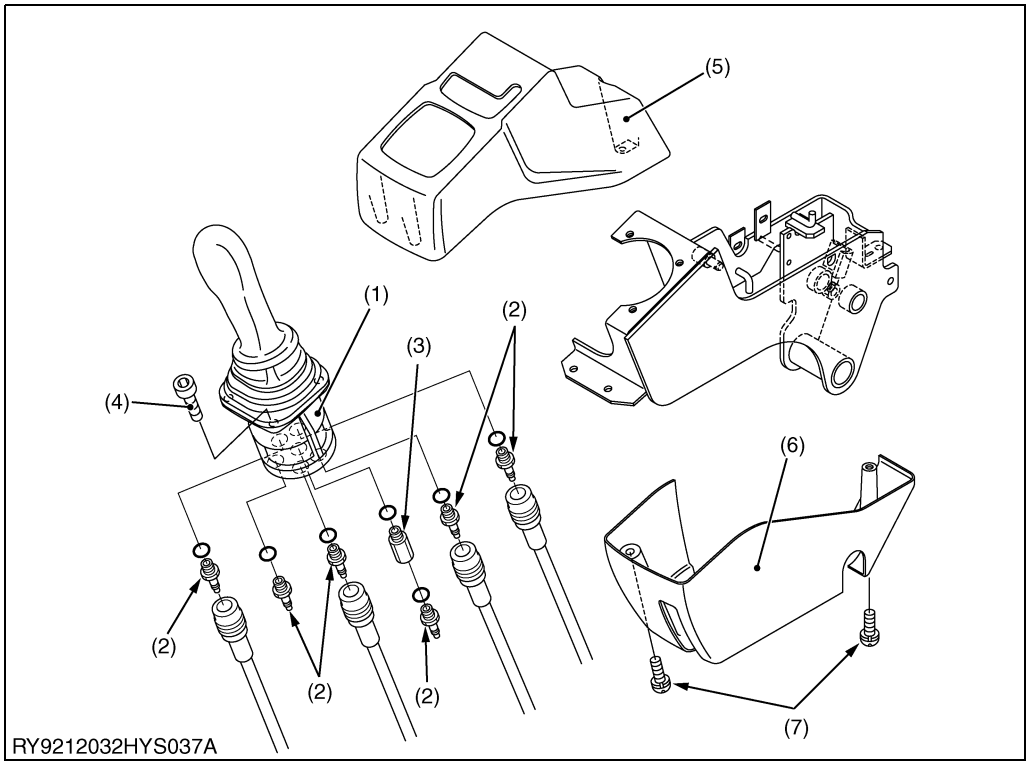
	Rod size	Gap
Factory specification	ϕ60 mm ≥ ϕ2.4 in. ≥	0.05 to 0.30 mm 0.002 to 0.01 in.
	ϕ65 to 115 mm ϕ2.6 to 4.53 in.	0.05 to 0.35 mm 0.002 to 0.01 in.
	ϕ120 mm ≤ ϕ4.72 in. ≤	0.05 to 0.40 mm 0.002 to 0.02 in.
Allowable limits	ϕ60 mm ≥ ϕ2.4 in. ≥	0.60 mm 0.02 in.
	ϕ65 to 115 mm ϕ2.6 to 4.53 in.	0.70 mm 0.03 in.
	ϕ120 mm ≤ ϕ4.72 in. ≤	0.80 mm 0.03 in.

RY9212001HYS0469US0

7. PILOT VALVE (CONTROL)

[1] PILOT VALVE (CONTROL) ASSEMBLY

Exploded view of pilot valve left (control)

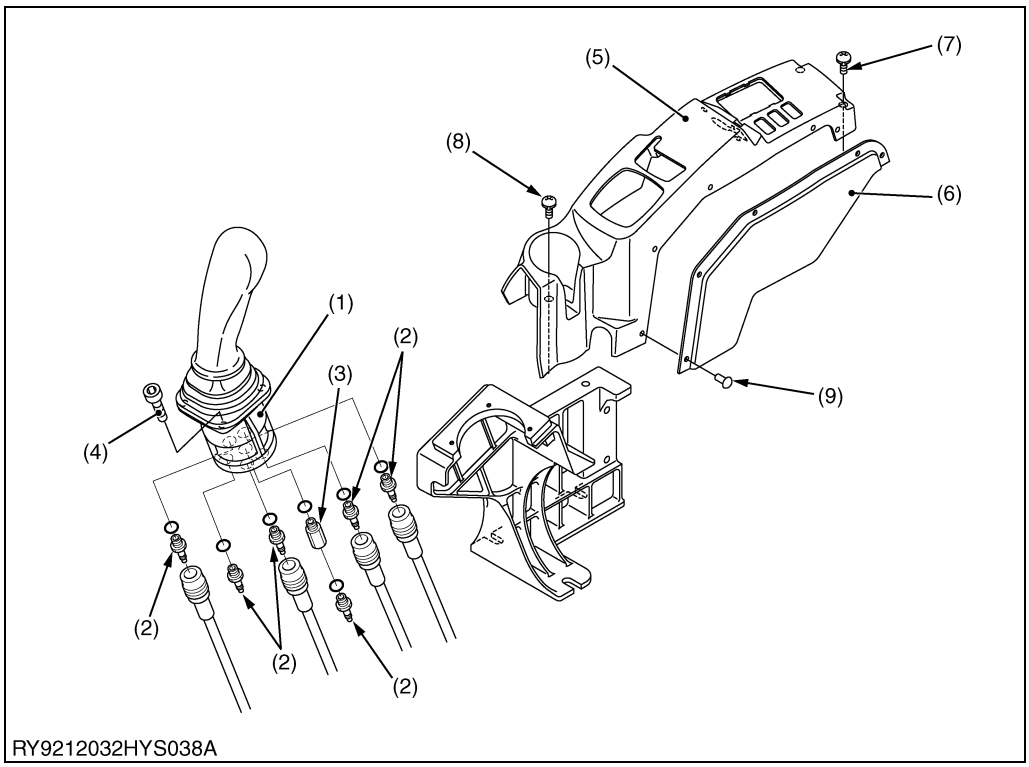


RY9212032HYS037A

(1) Valve assembly (pilot)
(2) Pipe joint (S, G1/4-8.14)
(3) Filter
(4) Hex socket bolt
(5) Cover (left, top)
(6) Cover (left, bottom)
(7) Machine screw and washer

RY9212032HYS0053US0

Exploded view of pilot valve right (control)

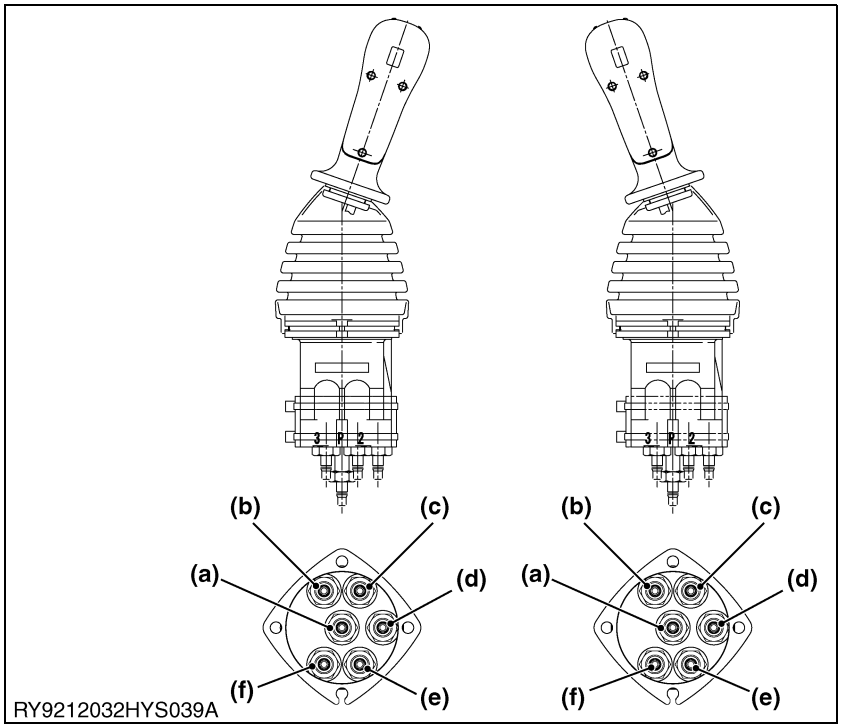


RY9212032HYS038A

(1) Valve assembly (pilot)
(2) Pipe joint (S, G1/4-8.14)
(3) Filter
(4) Hex socket bolt
(5) Cover (right, back)
(6) Cover (right, bottom)
(7) Machine screw and washer
(8) Bolt
(9) Rivet (31E4)

RY9212032HYS0054US0

Used parts of pilot valve hydraulic hose



Left P/V

	Used part	Hose tape color
1	Swivel left	Gray
2	Arm dump	Black
3	Swivel right	Light blue
4	Arm crowd	Blue
P	P port	66666666
T	T port	55555555

Right P/V

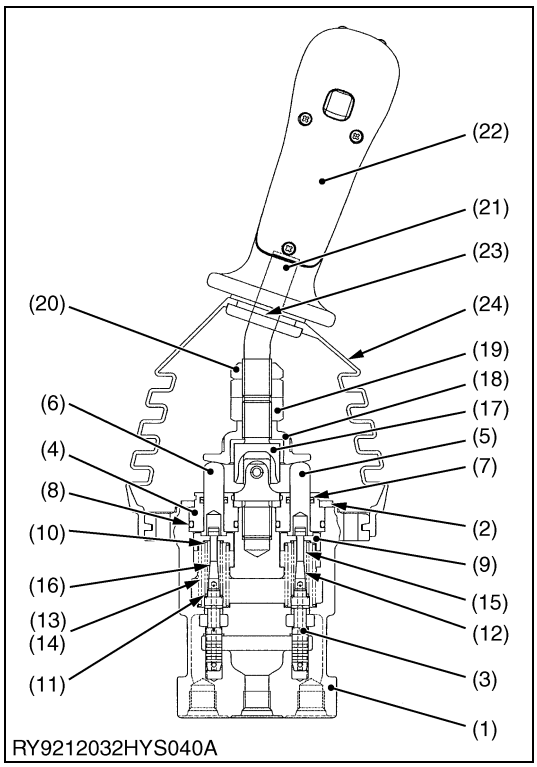
	Used part	Hose tape color
1	Bucket crowd	White
2	Boom down	Yellow
3	Bucket dump	Red
4	Boom up	Green
P	P port	44444444
T	T port	33333333

(a) P port
(b) Port 3
(c) Port 2
(d) T port
(e) Port 1
(f) Port 4

RY9212032HYS0055US0

[2] PILOT VALVE (CONTROL) DISASSEMBLY / ASSEMBLY PROCEDURES

(1) Pilot valve components



No.	Part Name	Q'ty
(1)	Casing	1
(2)	Plate	1
(3)	Spool	4
(4)	Plug	4
(5)	Pushrod	2
(6)	Pushrod	2
(7)	Seal	4
(8)	O-Ring	4
(9)	Spring seat	2
(10)	Spring seat	2
(11)	Washer 2	4
(12)	Spring (Ports 1 and 3)	2
(13)	Spring (Port 2)	1
(14)	Spring (Port 4)	1
(15)	Spring	2
(16)	Spring	2
(17)	Joint	1
(18)	Round plate	1
(19)	Adjusting nut	1
(20)	Lock nut	1
(21)	Lever	1
(22)	Handle	1
(23)	Spring Pins	1
(24)	Boot	1

RY9212032HYS0056US0

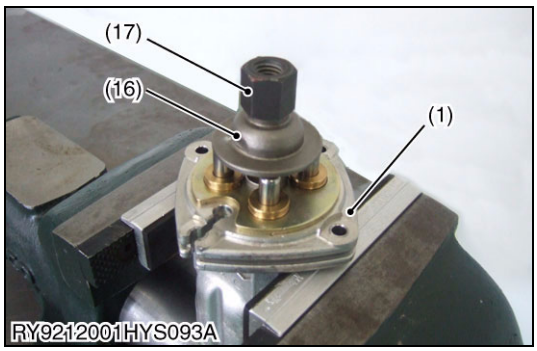
(2) Disassembly

Disassembly Procedures

CAUTION

- **All of the parts are precisely made, so be very careful in handling them and taking care not to drop or hit parts against each other.**
- **If you hit a part too hard while working on it, it may result in burrs or other damage, thus preventing installation as well as oil leaks and/or compromised performance, so be careful when handling parts.**
- **If parts are left disassembled or left partway disassembled, humidity or foreign matter may cause rust, so if interrupting the work is unavoidable, take precautions to protect the parts from rust and dust.**

RY9212001HYS0476US0



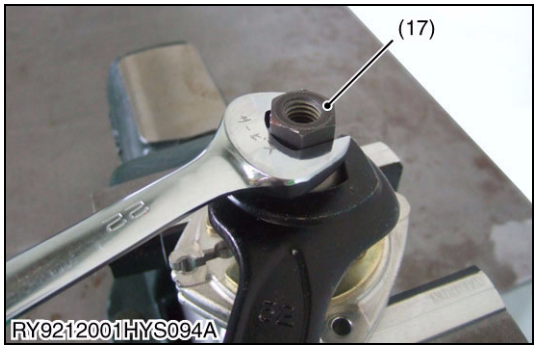
1. Clamp the pilot valve in a vise.

IMPORTANT

- **When clamping it in a vise, use a sheet of copper to prevent scratching the pilot valve.**

(1) Casing
(16) Nut (disc)
(17) Nut (adjustment)

RY9212001HYS0477US0

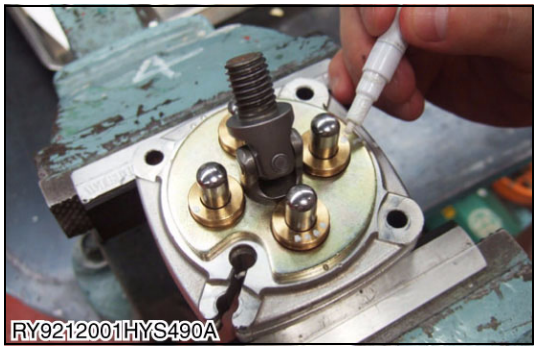


2. Use two wrenches on the nuts (adjustment 16 and disc 17) to remove them.

- Tools to use : 22 mm and 32 mm (0.87 in. and 1.3 in.) wrenches

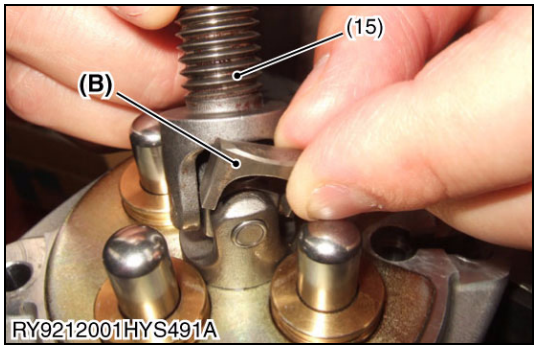
(17) Nut (adjustment)

RY9212001HYS0478US0

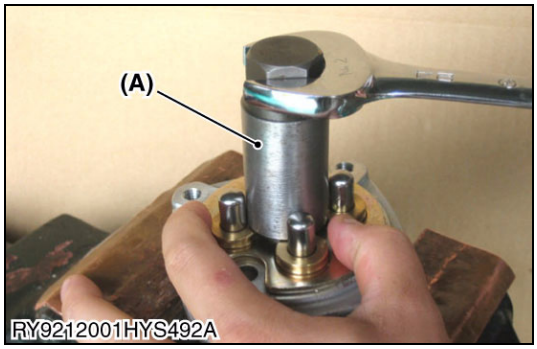


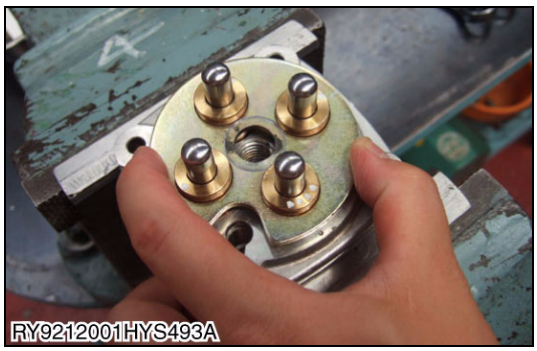
3. Mark the relationship of holes to the casing.

RY9212001HYS0479US0



4. After mounting tool **(B)** on the U-joint (15), use tool **(A)** to turn the U-joint counterclockwise and loosen it.



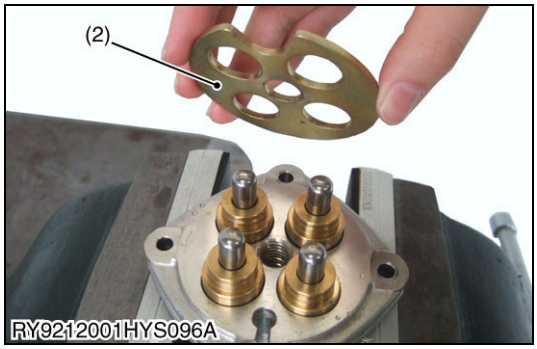


CAUTION

- **When removing the U-joint, take care that it does not pop off.**

(A) Tool **(B) Tools (2)**

RY9212001HYS0480US0



5. Remove the plate (2).

(2) Plate

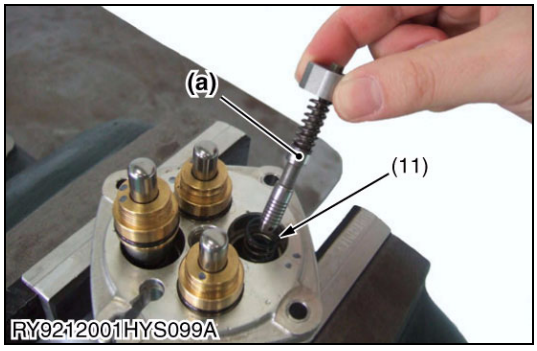
RY9212001HYS0481US0

6. Slip a slotted screwdriver in the groove in the plug (3) to remove the plug.

CAUTION
- **Take care so the plug does not go flying.**
- **Take care not to damage it by exerting force unevenly.**
- **If a burr is formed, use a whetstone to remove it.**

(3) Plug

RY9212001HYS0482US0



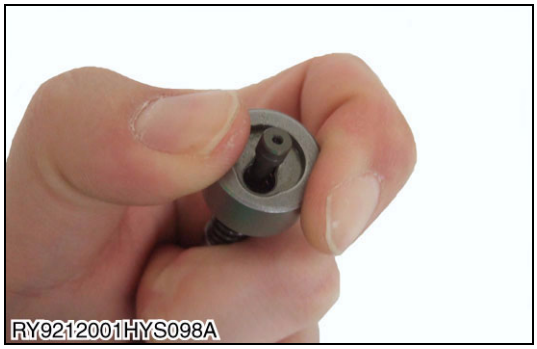
7. Remove the reducing valve ASSY **(a)** and the return spring (11).

IMPORTANT
- **Tag the springs to positively ID which port they go to.**

(11) Spring

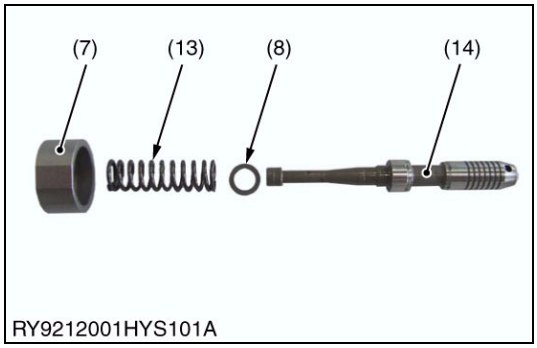
(a) Reducing valve ASSY

RY9212001HYS0483US0


RY9212001HYS098A

8. To disassemble the reducing valve, press the spring seat in and while compressing the secondary pressure spring, shift the spring seat to the side and remove it from the spool via the larger hole.

■ **IMPORTANT**
- **Be careful not to scratch the surface of the spool.**
- **Do not depress the spring seat 6 mm (0.2 in.) ≤.**
- **Do not disassemble the reducing valve unless there is a problem with it.**

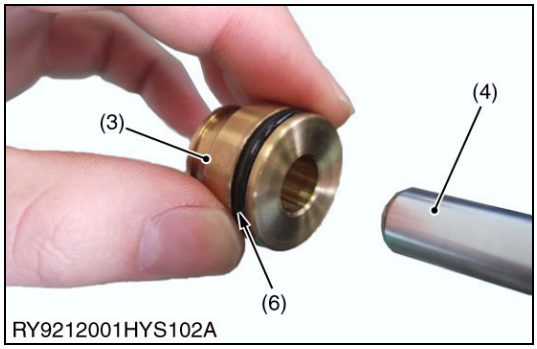


RY9212001HYS101A

Components of the Reducing Valve

(7) Spring seat
(8) Metal washer 2
(13) Spring
(14) Spool

RY9212001HYS0484US0

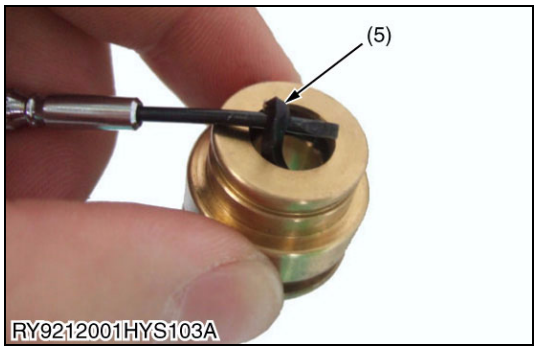


RY9212001HYS102A

9. Remove the plug (3) from the pushrod (4).

(3) Plug
(4) Pushrod
(6) O-Ring

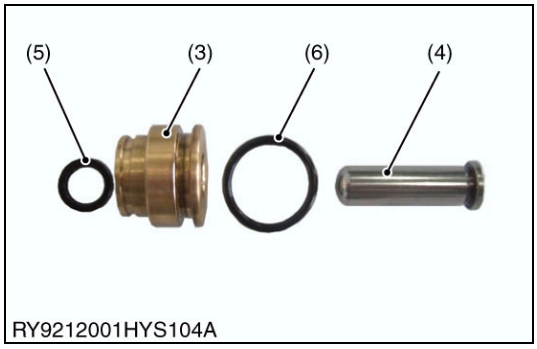
RY9212001HYS0485US0



RY9212001HYS103A

10. Remove the O-ring (6) and seal (5) from the plug (3).

■ **IMPORTANT**
- **Use a mini slotted screwdriver.**
- **Be careful not to scratch the inside surface of the plug.**



RY9212001HYS104A

Components of the Plug

(3) Plug
(4) Pushrod
(5) Seal
(6) O-Ring

RY9212001HYS0486US0

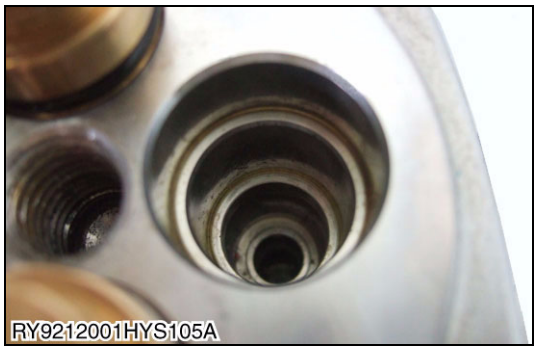
(3) Assembly

Assembly Procedures

CAUTION

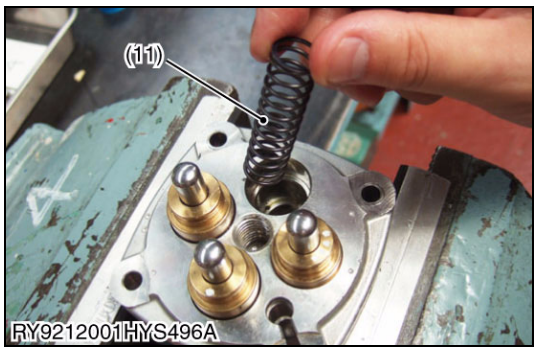
- **Prepare your workbench in the same way as for disassembly.**
- **Follow the same general precautions as in the disassembly.**
- **When assembling the parts, remove all bits of metal or foreign matter from all the parts and make sure there aren't any burrs or dings on the parts.**
- **Replace used O-rings with new ones.**
- **Take care not to damage the O-rings when installing them.**

RY9212001HYS0001US0



1. Make sure there aren't any burrs or scratches inside the casing.

RY9212001HYS0487US0



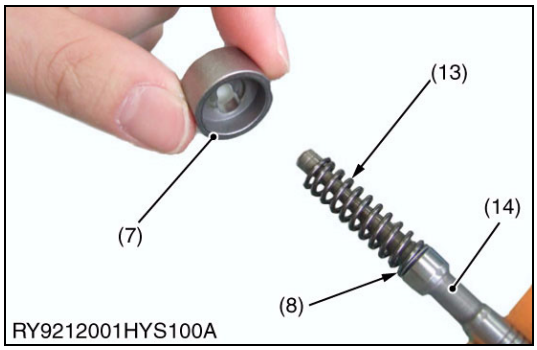
2. Install the return spring (11) in the casing.

■ **IMPORTANT**

- **Install it in the same position as before disassembly.**

(11) Spring

RY9212001HYS0488US0



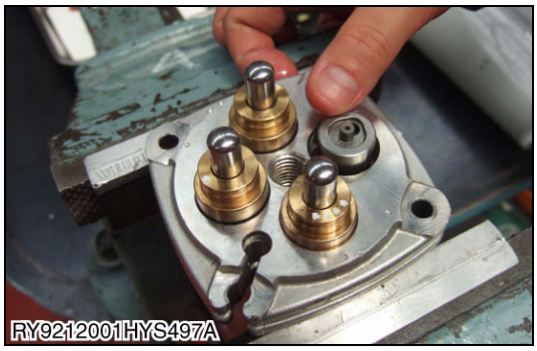
3. Install the metal washer (8), spring (13) and spring seat (7) in order to the spool (14).

■ **IMPORTANT**

- **Do not depress the spring seat 6mm (0.2 in.) or more.**
- **Be careful not to scratch the spool.**

(7) Spring seat
(8) Metal washer 2
(13) Spring
(14) Spool

RY9212001HYS0489US0

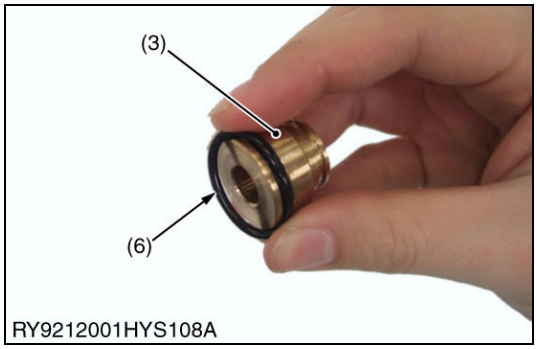


4. Install the reducing valve ASSY.
   After installing it, make sure the spool moves smoothly.

■ **IMPORTANT**

- **Install it in the same position as before disassembly.**

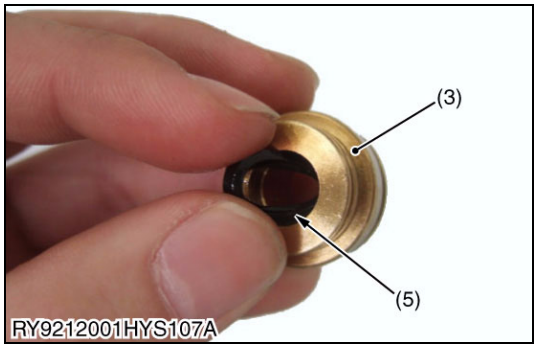
RY9212001HYS0490US0



5. Install the O-ring (6) on the plug (3).

(3) Plug
(6) O-Ring

RY9212001HYS0491US0

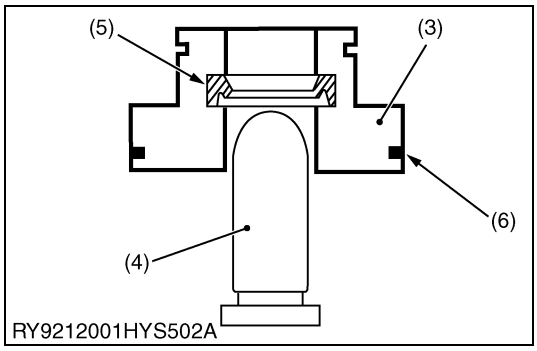


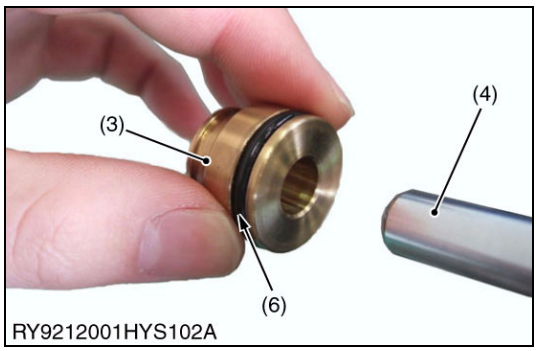
6. Install the seal (5) on the plug (3).

■ **IMPORTANT**
- **Be careful that the seal faces the right direction.**
- **Apply hydraulic oil on the circumference and lip of the seal.**

(3) Plug
(4) Pushrod
(5) Seal
(6) O-Ring

RY9212001HYS0492US0





7. Install the plug (3) on the pushrod (4).

■ **IMPORTANT**
- **Apply hydraulic oil to the pushrod.**

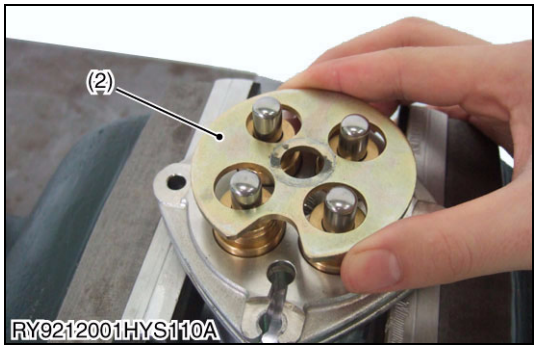
(3) Plug
(4) Pushrod
(6) O-Ring

RY9212001HYS0493US0

8. Install the plug ASSY into the case.
If the return spring is too stiff, use the plate to install the ASSY.

■ **IMPORTANT**
- **Be careful not to scratch the hole of the casing by prying on the spool.**
- **Take care so the plug ASSY does not go flying.**

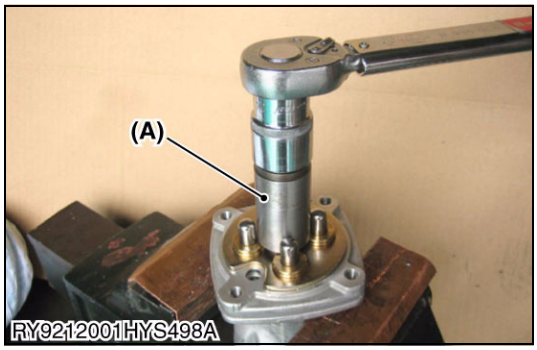
RY9212001HYS0494US0



9. Install the plate (2).

(2) Plate

RY9212001HYS0495US0

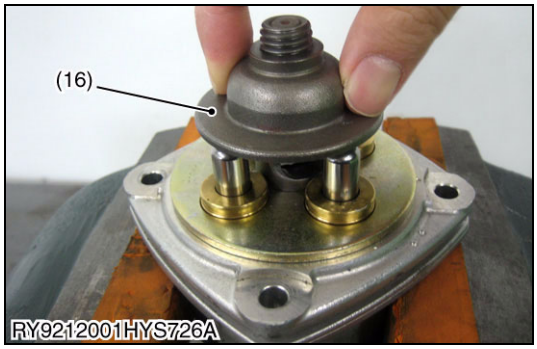


10. Install the U-joint.

Tightening torque	U-joint	44 to 50 N·m 4.5 to 5.1 kgf·m 32 to 37 lbf·ft

(A) Tool

RY9212001HYS0496US0



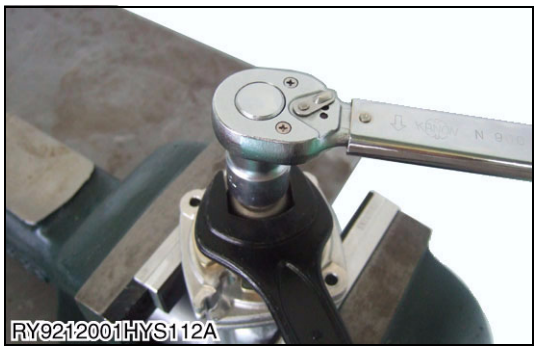
11. Install the nut (disc) (16) on the universal joint.
Tighten it until it touches all four pushrods equally.

CAUTION

- **If you tighten it too far, the mechanism will not function properly when the lever is in neutral, so be careful to adjust the nut to the correct position.**

(16) Nut (disc)

RY9212001HYS0497US0

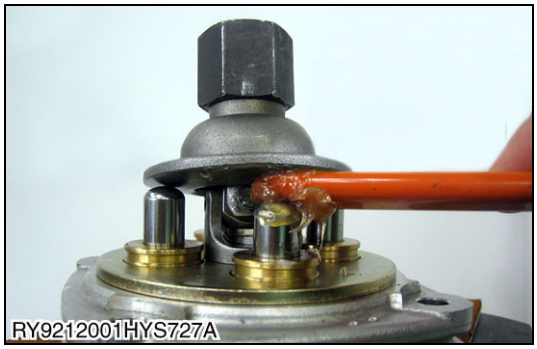


12. Tighten the nut (adjustment).
Put the wrench on the bolt width of the disc and tighten the nut.

- Tools to use : 22 mm (0.87 in.) wrench (or socket), 32 mm (1.3 in.) wrench

Tightening torque	Nut (adjustment)	63.7 to 73.5 N·m 6.5 to 7.5 kgf·m 47.0 to 54.2 lbf·ft

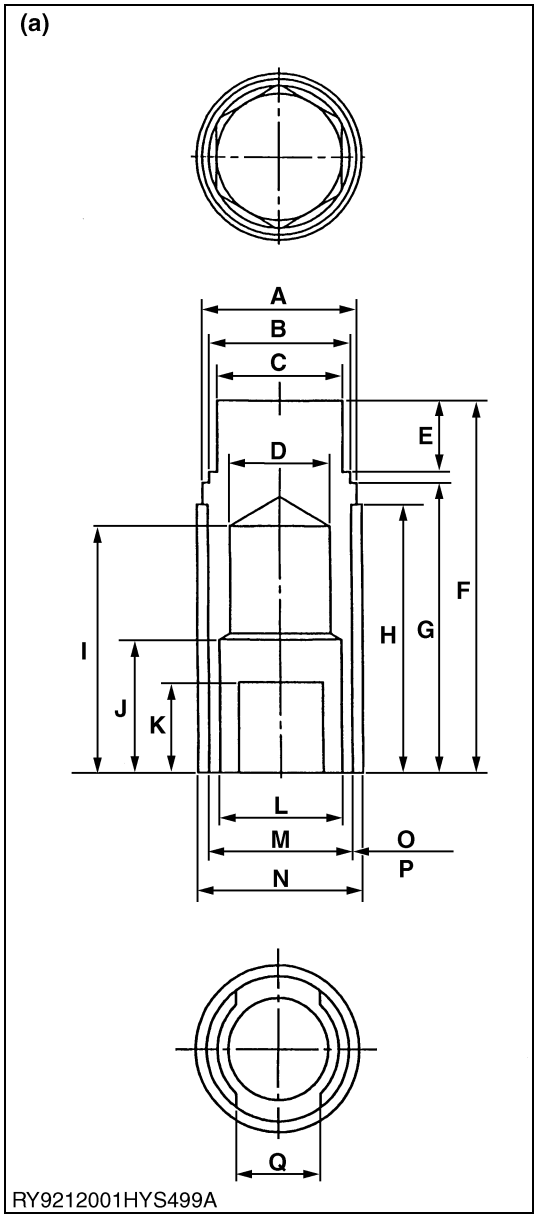
RY9212001HYS0498US0



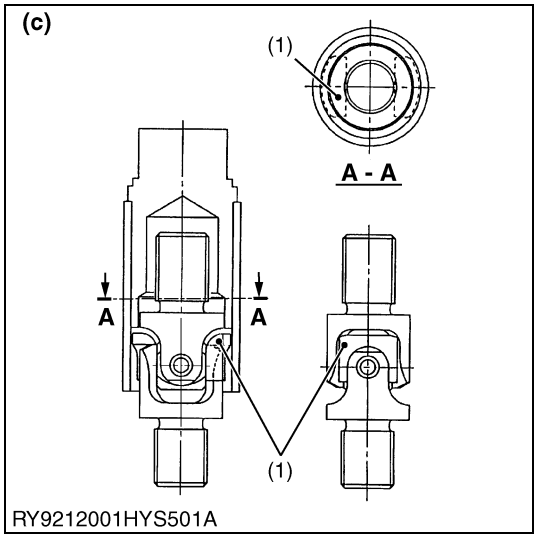
13. Apply grease to the rotating parts of the universal joint and to the ends of the pushrods.

RY9212001HYS0499US0

(4) U-joint Tightening Tool

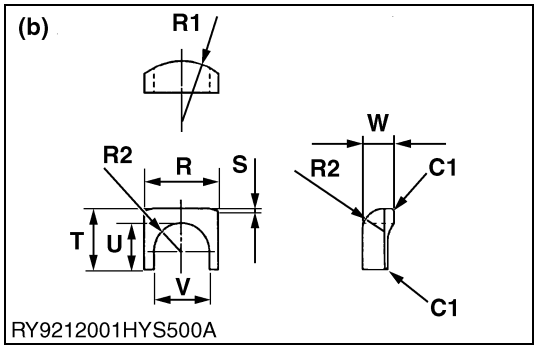


RY9212001HYS499A



RY9212001HYS501A

A	ϕ29 mm (ϕ1.142 in.)
B	ϕ26.5 mm (ϕ1.043 in.)
C	23.5 mm (0.925 in.) (nut width)
D	ϕ19 mm (ϕ0.748 in.)
E	13 mm (0.512 in.)
F	69 mm (2.717 in.)
G	54 mm (2.126 in.)
H	50 mm (1.968 in.)
I	46 mm (1.811 in.)
J	25 mm (0.984 in.)
K	17 mm (0.669 in.)
L	ϕ23 mm (ϕ0.906 in.)
M	ϕ27 mm (ϕ1.063 in.)
N	ϕ31 mm (ϕ1.220 in.)
O	Hole H 6 mm (0.236 in.)
P	Axle n 6 mm (0.236 in.)
Q	ϕ16 mm (ϕ0.6299 in.)
R	15.5 mm (0.6102 in.)
S	0.5 mm × 15 mm (0.0197 in. × 0.591 in.)
T	12.5 mm (0.492 in.)
U	9.5 mm (0.374 in.)
V	11.6 mm (0.457 in.)
W	6.5 mm (0.256 in.)
C1	0.5 mm (0.0197 in.) bevel
R1	R 13 mm (0.512 in.)
R2	R 5.8 mm (0.228 in.)
R3	R 4.5 mm (0.177 in.)



RY9212001HYS500A

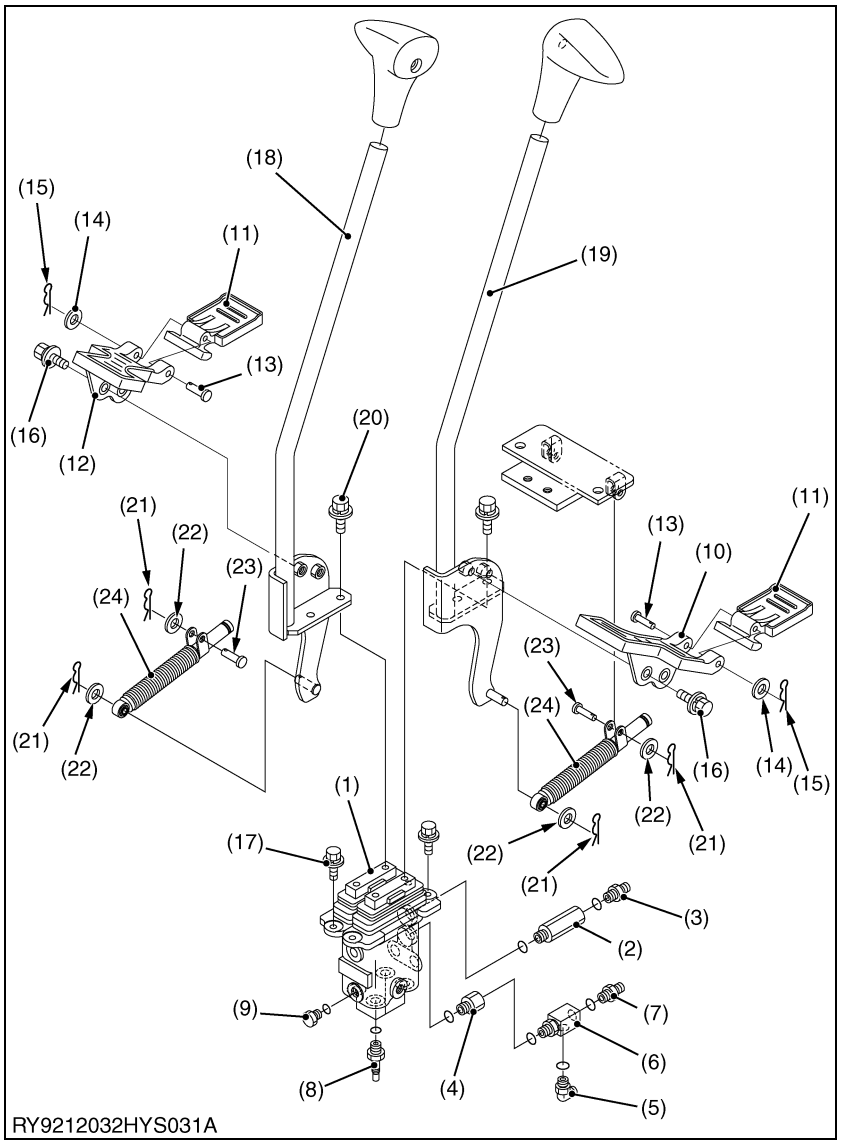
(1) Bushing

(a) U-joint tightening tool, detailed schematic
(b) Bushing, detailed schematic
(c) Assembled U-Joint

RY9212001HYS0500US0

8. PILOT VALVE (TRAVEL)

Pilot Valve (Travel) Exploded View

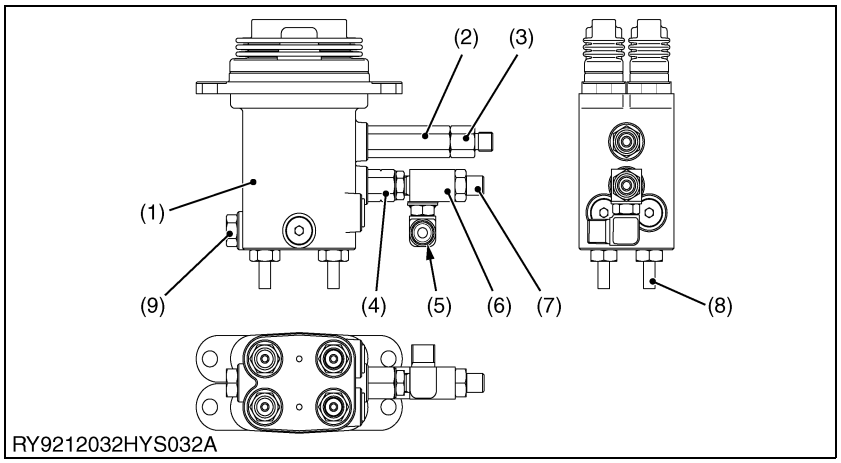


RY9212032HYS031A

(1) Valve assembly (PV, travel)
(2) Pipe joint (S, G2, G2)
(3) Straight pipe joint (G2-G2)
(4) Filter
(5) Pipe joint (L, G1/4-G3/8)
(6) Pipe joint (T, G2, G2-G2)
(7) Adapter
(8) Pipe joint (L, G1/4-8.4)
(9) Plug (G1/4)
(10) Pedal assembly (travel left)
(11) Pedal (travel 2)
(12) Pedal assembly (travel right)
(13) Headed pin
(14) Flat metal washer
(15) Snap pin
(16) Bolt (M10 × 25)
(17) Bolt (M10 × 25)
(18) Lever (travel, right)
(19) Lever (travel, left)
(20) Bolt (M8 × 20)
(21) Snap pin 8
(22) Flat metal washer
(23) Headed pin
(24) Damper (HST)

Tightening torque	Bolt (17)	48.1 to 55.9 N·m 4.9 to 5.7 kgf·m 35.5 to 41.2 lbf·ft
	Bolt (20)	17.7 to 20.6 N·m 1.8 to 2.1 kgf·m 13.0 to 15.2 lbf·ft

RY9212032HYS0057US0

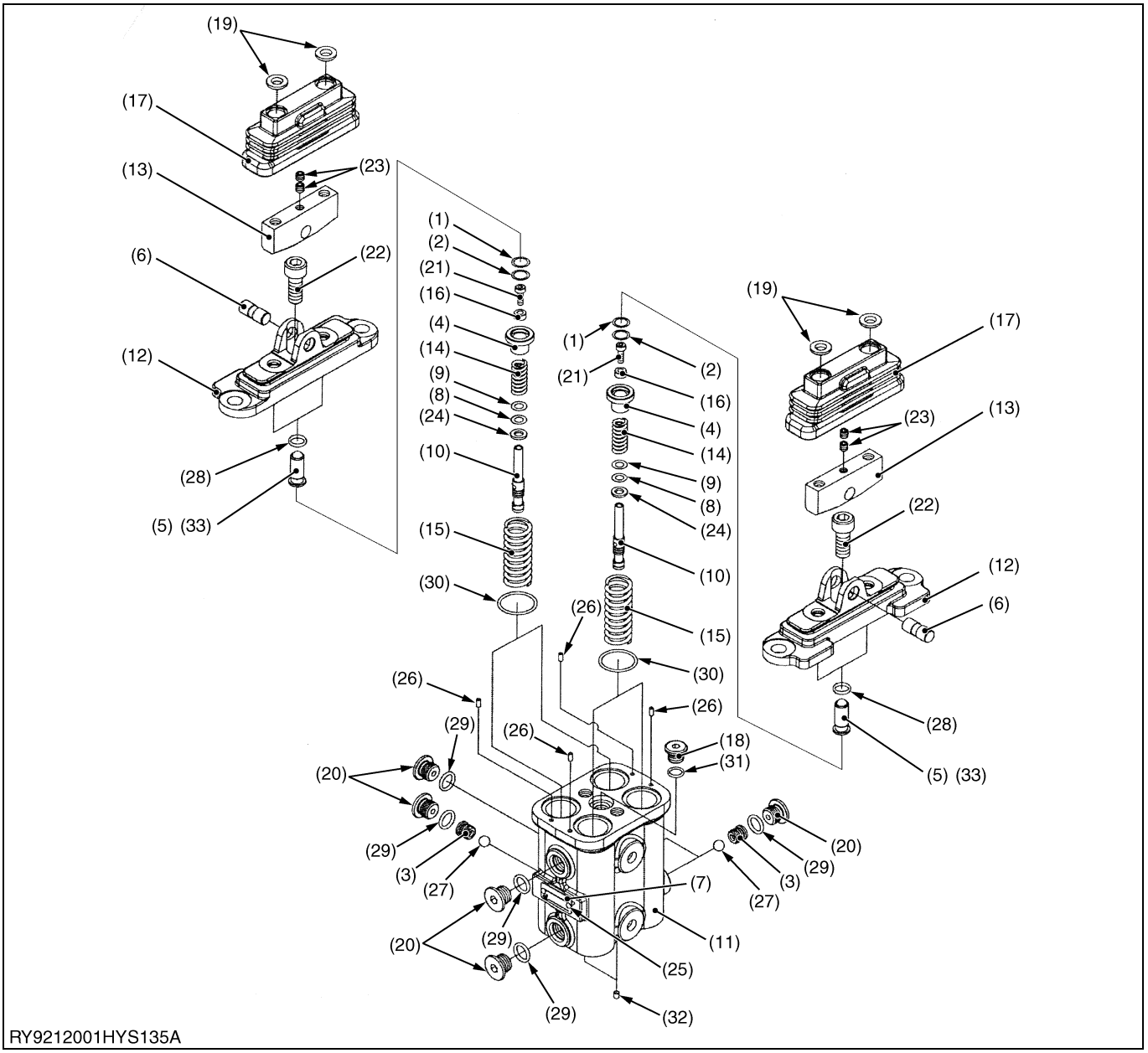


RY9212032HYS032A

(1) Valve assembly (PV, travel)
(2) Pipe joint (S, G2, G2)
(3) Straight pipe joint (G2-G2)
(4) Filter
(5) Pipe joint (L, G1/4-G3/8)
(6) Pipe joint (T, G2, G2-G2)
(7) Adapter
(8) Pipe joint (L, G1/4-8.4)
(9) Plug

RY9212032HYS0058US0

[1] PILOT VALVE (TRAVEL) ASSEMBLY



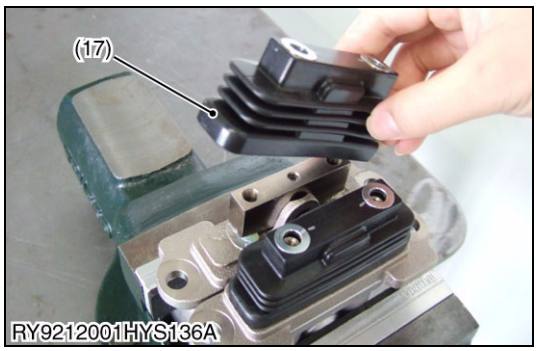
RY9212001HYS135A

No.	Name of part	No.	Name of part	No.	Name of part
(1)	Shim (t = 0.1 mm, 0.04 in.)	(12)	Cover	(23)	Hex set screw
(2)	Shim (t = 0.2 mm, 0.08 in.)	(13)	Cam	(24)	Flat metal washer
(3)	Seat	(14)	Spring	(25)	Rivet screw
(4)	Sleeve	(15)	Spring	(26)	Parallel pin
(5)	Pusher	(16)	Collar	(27)	Ball
(6)	Pin	(17)	Bushing	(28)	O-Ring
(7)	Nameplate	(18)	Plug	(29)	O-Ring
(8)	Shim (t = 0.2 mm, 0.08 in.)	(19)	Collar	(30)	O-Ring
(9)	Shim (t = 0.1 mm, 0.04 in.)	(20)	Flanged plug	(31)	O-Ring
(10)	Spool	(21)	Hex socket bolt	(32)	Expander
(11)	Body	(22)	Hex socket bolt	(33)	Pusher ASSY

RY9212001HYS0503US0

[2] PILOT VALVE (TRAVEL) DISASSEMBLY / ASSEMBLY PROCEDURES

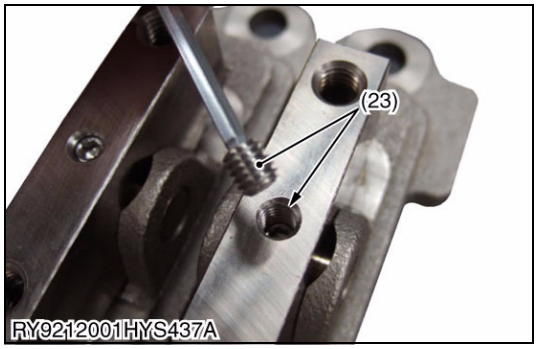
(1) Disassembly Procedures



1. Remove the boot (17).

(17) Bushing

RY9212001HYS0504US0



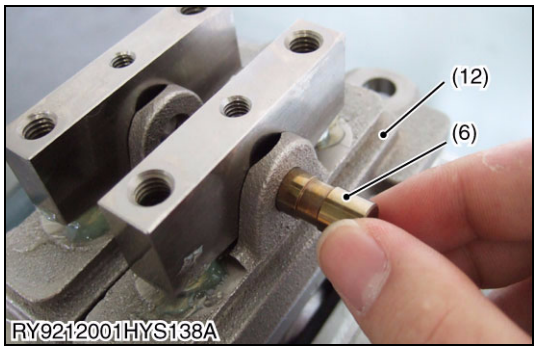
2. Remove the two hex socket set screws (23).

CAUTION

- **Note that there are two hex set screws per hole.**
- Tool to use : M3 hex socket

(23) Hex set screw

RY9212001HYS0505US0

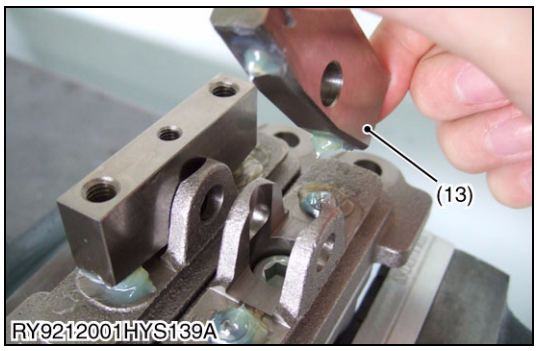


3. Remove the pin (6).

- Tool to use : Hammer and pin punch

(6) Pin (12) Cover

RY9212001HYS0506US0



4. Remove the cam (13).

(13) Cam

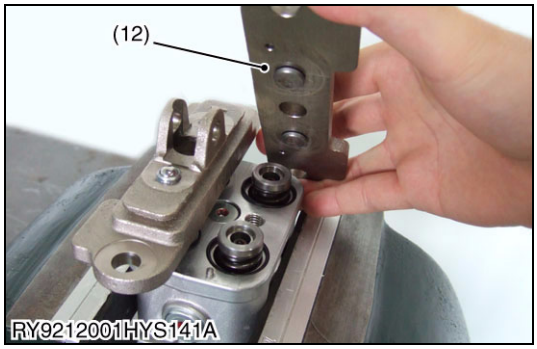
RY9212001HYS0507US0

5. Remove the hex socket bolt (23).

- Tool to use : M8 hex socket

(23) Hex socket bolt

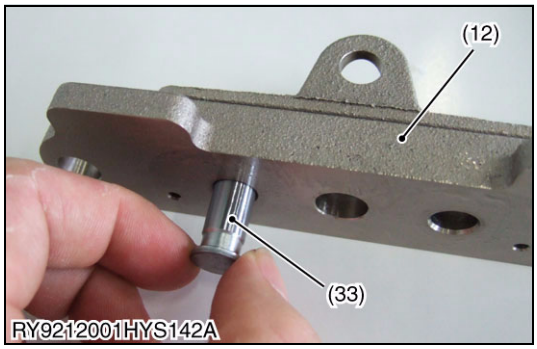
RY9212001HYS0508US0



6. Remove the cover (12).

(12) Cover

RY9212001HYS0509US0

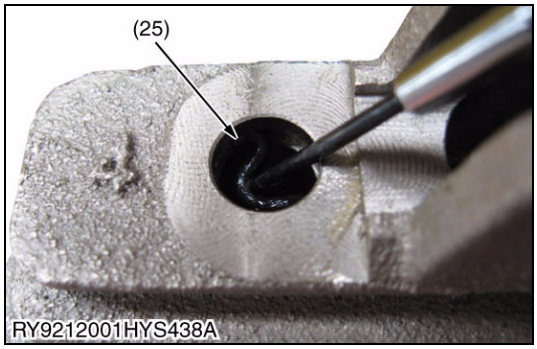


7. Remove the pusher ASSY (33).

■ **IMPORTANT**
- **There is a shim on the edge of the pusher ASSY.**
- **If it comes off, return it to the top of the sleeve.**

(12) Cover (33) Pusher ASSY

RY9212001HYS0510US0



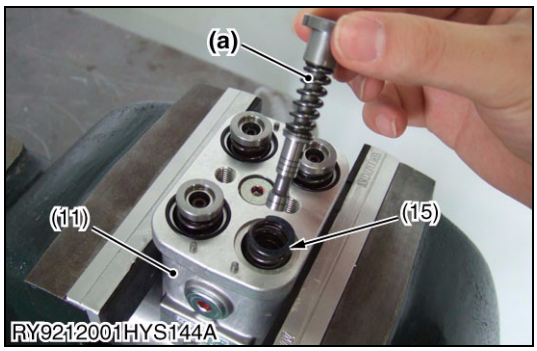
8. Remove the O-rings (25).
- Tool to use : Slotted screwdriver

(25) O-Ring

RY9212001HYS0511US0

9. Mark the positioning of the body hole and the spool ASSY.

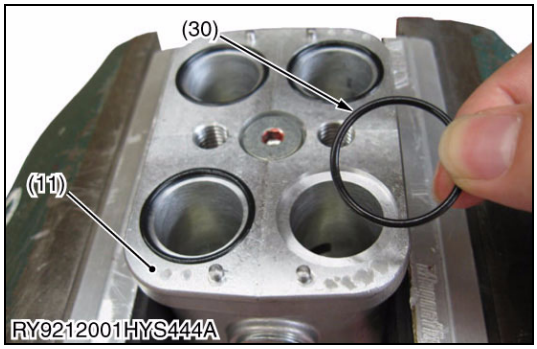
RY9212001HYS0512US0



10. Spool ASSY from the body (11) **(a)** Remove the spring (15).

(11) Body
(15) Spring
(a) Spool ASSY

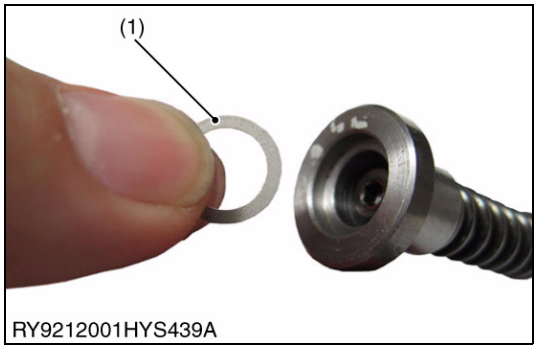
RY9212001HYS0513US0



11. Remove the O-ring (30) from the body (11).

(11) Body
(30) O-Ring

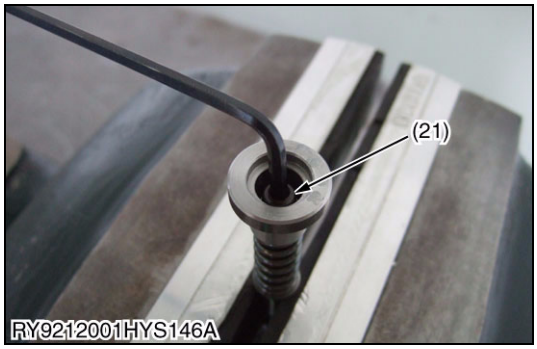
RY9212001HYS0514US0



12. Remove the shim (1).

(1) Shim

RY9212001HYS0515US0



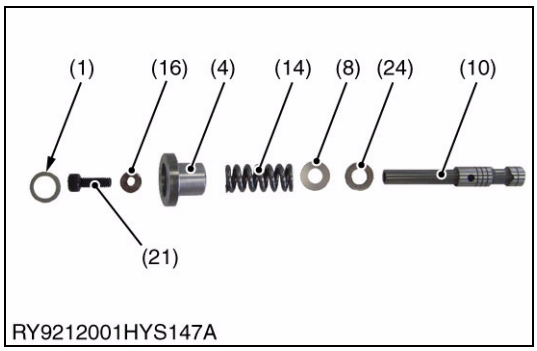
13. Clamp the spool in a vice and remove the hex socket bolt (21).

■ **IMPORTANT**
- **Use a copper plate in the vice to prevent it from scratching the spool.**
- **Be careful not to overtighten the vice as this will deform the spool.**

- Tool to use : M3 hex socket

(21) Hex socket bolt

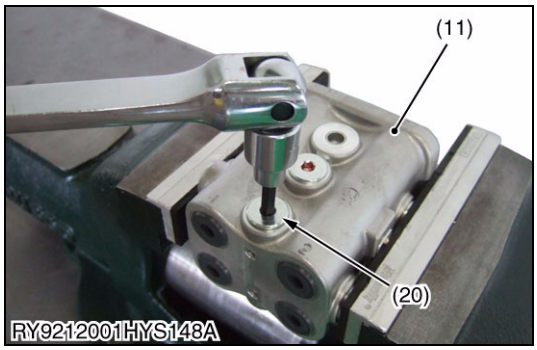
RY9212001HYS0516US0



Components of the Spool ASSY

(1) Shim
(4) Sleeve
(8) Shim
(10) Spool
(14) Spring
(16) Collar
(21) Hex socket bolt
(24) Flat metal washer

RY9212001HYS0517US0

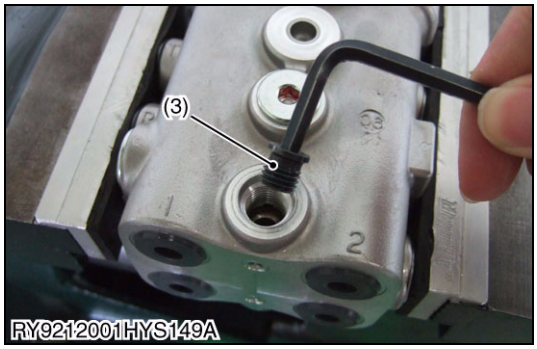


14. Remove the flanged plug (20).

- Tool to use : M6 hex socket

(11) Body
(20) Flanged plug

RY9212001HYS0518US0

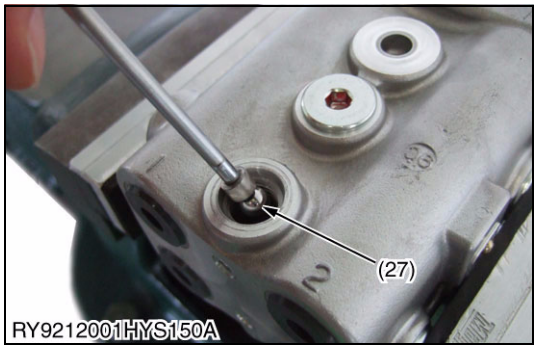


15. Remove the seat (3).

- Tool to use : M5 hex socket

(3) Seat

RY9212001HYS0519US0



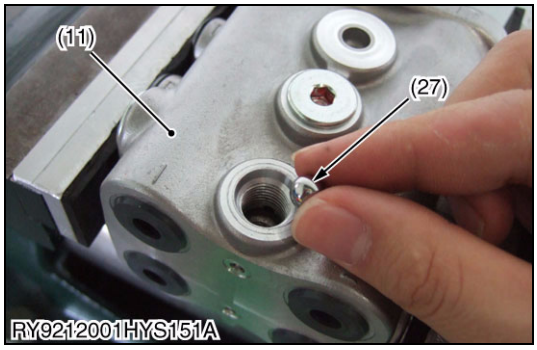
16. Remove the ball (27).

- Tool to use : Magnet

(27) Ball

RY9212001HYS0520US0

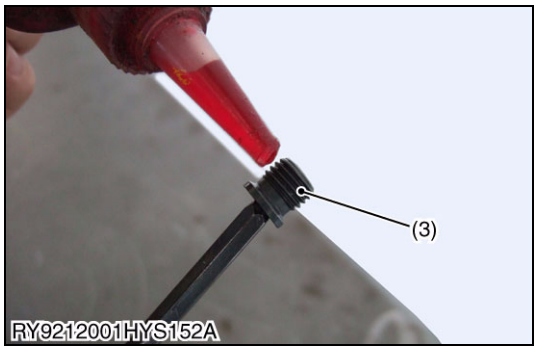
(2) Assembly Procedures



1. Insert the ball (27) in the body (11).

(11) Body (27) Ball

RY9212001HYS0521US0

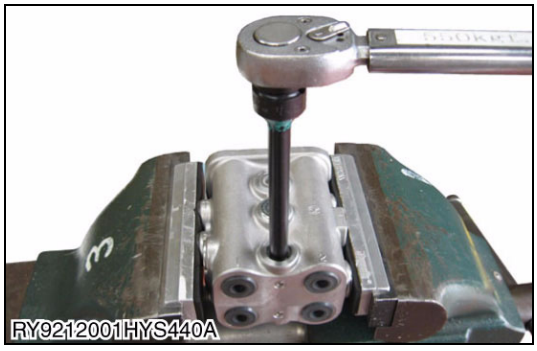


2. Apply Loctite to the threads of the seat.

- Tool to use : Loctite #262

(3) Seat

RY9212001HYS0522US0

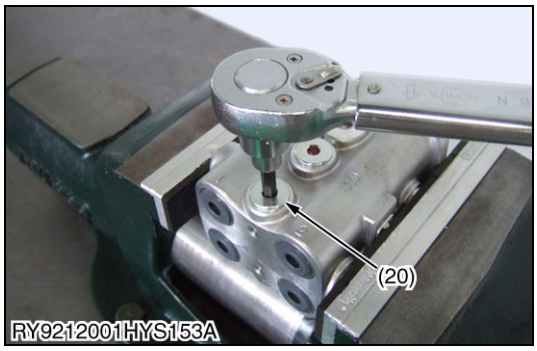


3. Install the seat.

Tightening torque	Seat (3)	14.7 N·m 1.5 kgf·m 10.8 lbf·ft

- Tool to use : M5 hex socket

RY9212001HYS0523US0



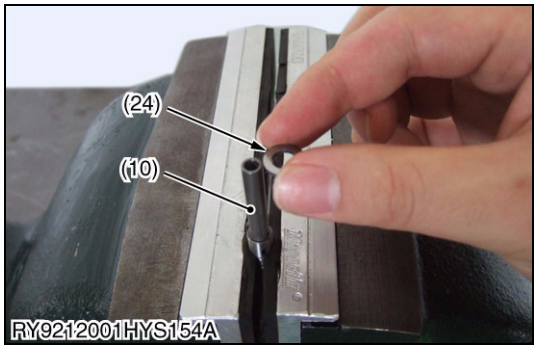
4. Install the flanged plug (20).

Tightening torque	Flanged plug (20)	24.5 N·m 2.5 kgf·m 18.1 lbf·ft

- Tool to use : M6 hex socket

(20) Flanged plug

RY9212001HYS0524US0

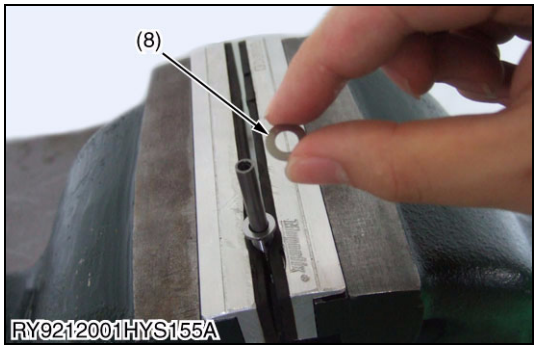


5. Clamp the spool (10) in a vice and install the flat metal washer (24).

■ **IMPORTANT**
- **Be careful to follow the order of installation.**
- **Use a copper plate in the vice to prevent it from scratching the spool.**
- **Be careful not to overtighten the vice as this will deform the spool.**

(10) Spool (24) Flat metal washer

RY9212001HYS0525US0

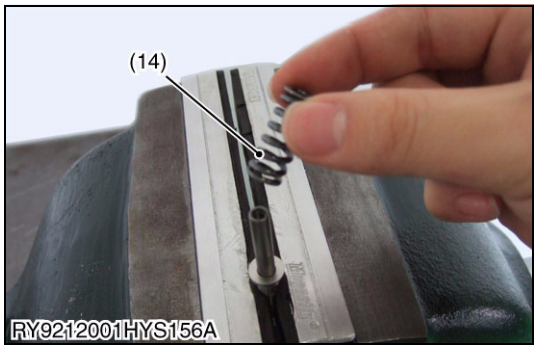


6. Install the shim (8).

■ **IMPORTANT**
- **Be careful to follow the order of installation.**

(8) Shim

RY9212001HYS0526US0

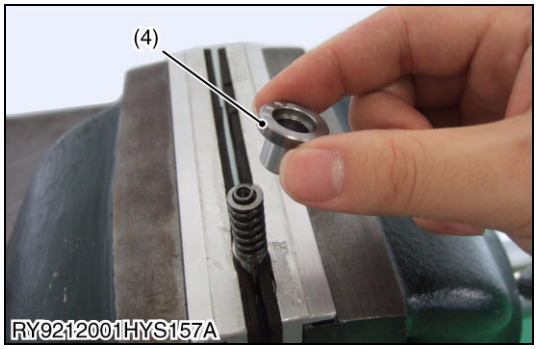


7. Install the spring (14).

■ **IMPORTANT**
- **Be careful to follow the order of installation.**

(14) Spring

RY9212001HYS0527US0

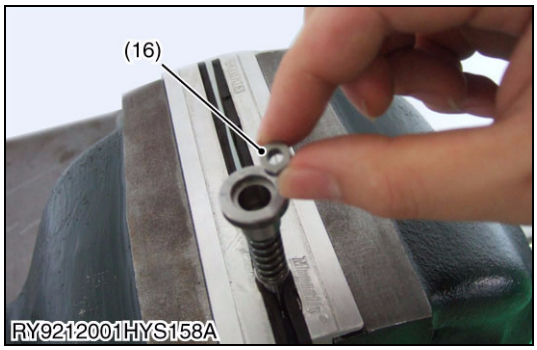


8. Install the sleeve (4).

■ **IMPORTANT**
- **Be careful to follow the order of installation.**

(4) Sleeve

RY9212001HYS0528US0

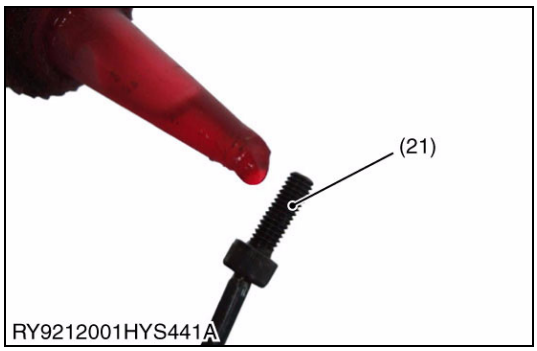


9. Install the collar (16).

■ **IMPORTANT**
- **Be careful to follow the order of installation.**

(16) Collar

RY9212001HYS0529US0

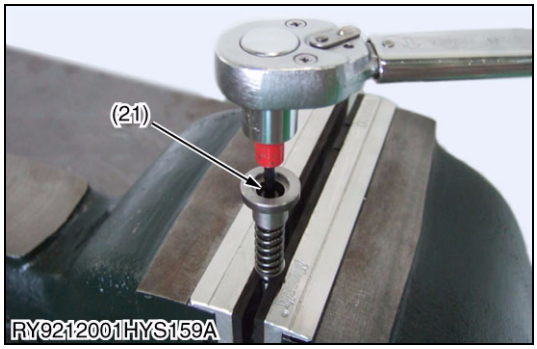


10. Apply Loctite to the threads of hex socket bolt.

- Loctite #242

(21) Hex socket bolt

RY9212001HYS0530US0



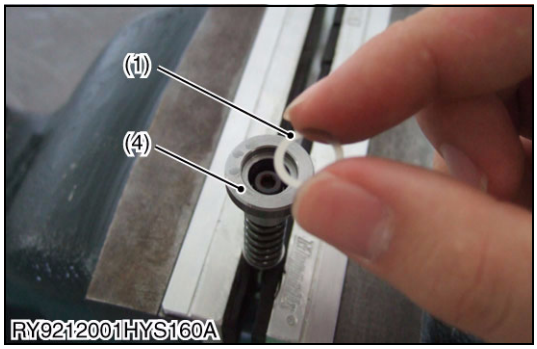
11. Install the hex socket bolt (21).

Tightening torque	Hex socket bolt (21)	4.9 N·m 0.5 kgf·m 3.6 lbf·ft

- Tool to use : M3 hex socket

(21) Hex socket bolt

RY9212001HYS0531US0

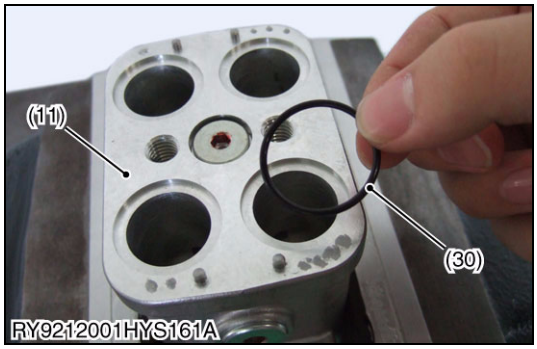


12. Install the shim (1).

■ **IMPORTANT**
- **Install the same number of shims as were disassembled.**

(1) Shim (4) Sleeve

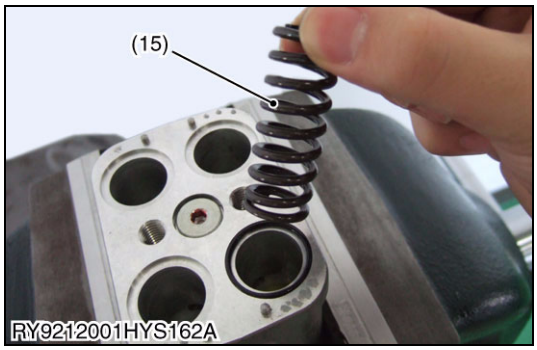
RY9212001HYS0532US0



13. Install the O-ring (30).

(11) Body (30) O-Ring

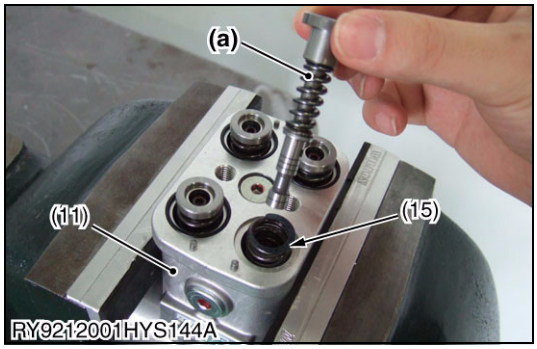
RY9212001HYS0533US0



14. Install the spring (15).

(15) Spring

RY9212001HYS0534US0

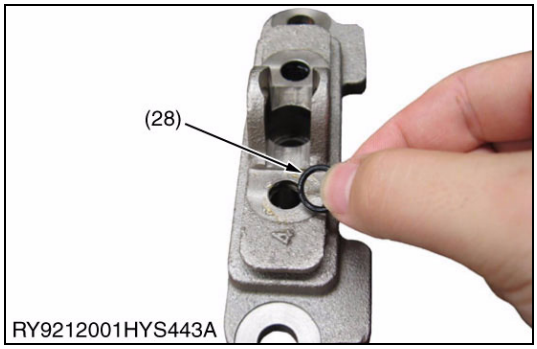


15. Install the spool ASSY **(a)**.

■ **IMPORTANT**
- **Install in the same holes in the body as during disassembly.**

(11) Body **(a) Spool ASSY**
(15) Spring

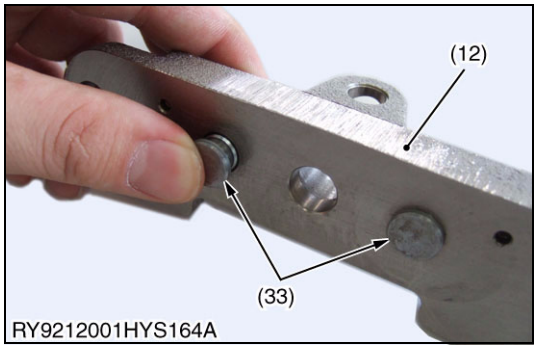
RY9212001HYS0535US0



16. Install the O-ring (28) in the cover.

(28) O-Ring

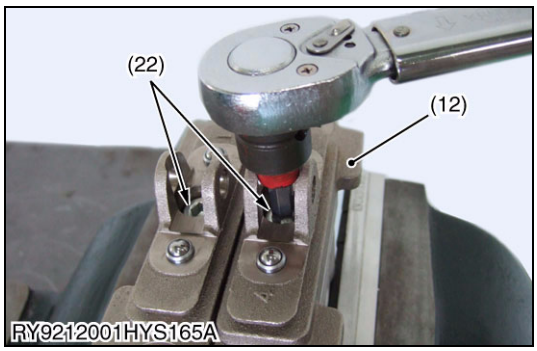
RY9212001HYS0536US0



17. Install the pusher ASSY (33).

(12) Cover (33) Pusher ASSY

RY9212001HYS0537US0



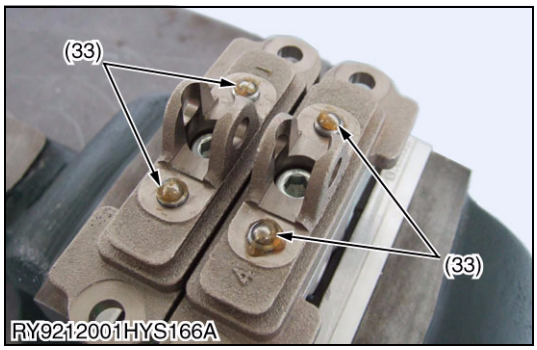
18. Install the cover (12).

Tightening torque	Cover (12)	22.6 N·m 2.3 kgf·m 16.7 lbf·ft

- Tool to use : M8 hex socket

(12) Cover (22) Hex socket bolt

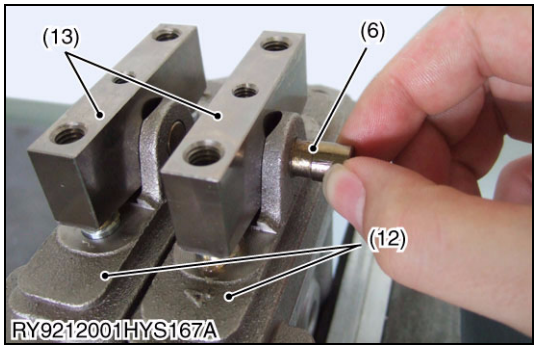
RY9212001HYS0538US0



19. Apply grease to the pusher ASSY balls.

(33) Pusher ASSY

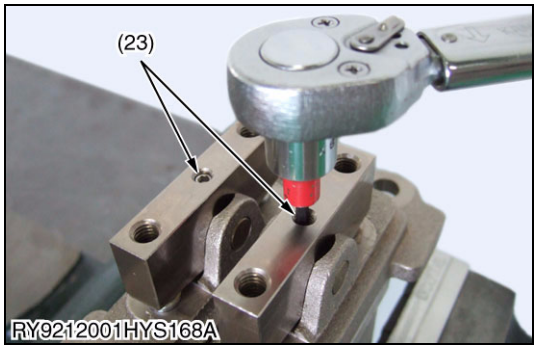
RY9212001HYS0539US0



20. Apply grease to the sliding part of the pin and install it.

(6) Pin (13) Cam
(12) Cover

RY9212001HYS0540US0



21. Install the hex socket set screws (23).

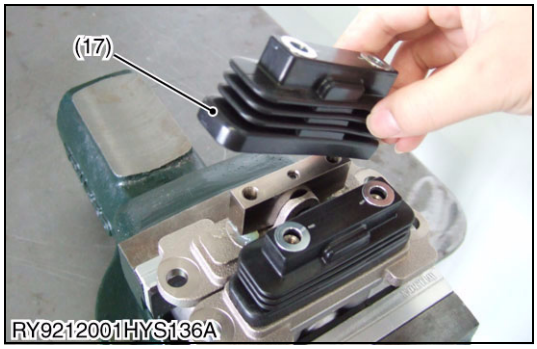
■ **IMPORTANT**
- **Note that each one has two hex socket set screws (23).**

Tightening torque	Hex set screw (23)	9.8 N·m 1.0 kgf·m 7.2 lbf·ft

- Tool to use : M3 hex socket

(23) Hex set screw

RY9212001HYS0541US0



22. Install the boot (17).

(17) Bushing

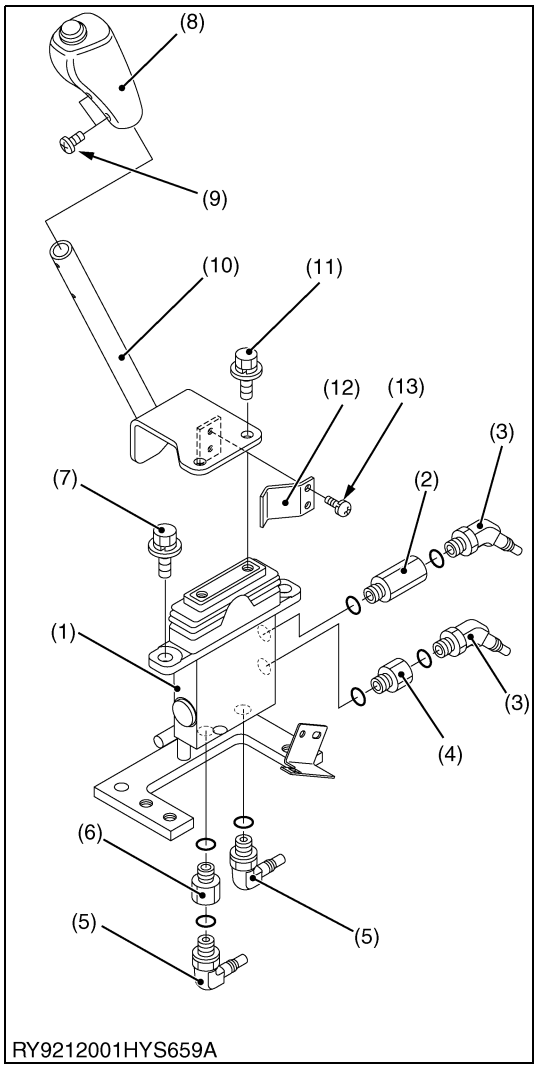
RY9212001HYS0542US0

■ **NOTE**
- **Use shims (1), (2), (8) or (9) as needed.**
  It is not a problem if there are no shims at all or a lot of shims.
- **Shims are used as needed, so be sure to install them where there were used before.**

RY9212001HYS0543US0

9. PILOT VALVE (BLADE, SWING)

[1] PILOT VALVE (BLADE, SWING) ASSEMBLY



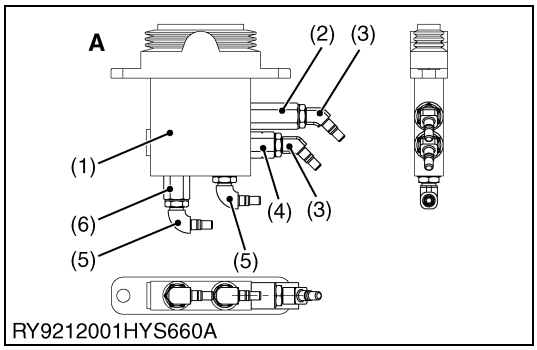
RY9212001HYS659A

Pilot Valve (Blade) Exploded View

Tightening torque	Bolt (M10 × 20) (7)	48.1 to 55.9 N·m 4.9 to 5.7 kgf·m 35.5 to 41.2 lbf·ft
	Bolt (M8 × 16) (11)	23.5 to 27.5 N·m 5.4 to 2.8 kgf·m 17.4 to 20.2 lbf·ft

(1) Valve assembly (PV, blade)
(2) Straight pipe joint (G2-G2)
(3) Pipe joint (to Q, G1/4-8.4)
(4) Filter
(5) Pipe joint (QL, G1/4-8.4)
(6) Straight pipe joint (G2-G2)
(7) Bolt (M10 × 20)
(8) Grip (2-speed)
(9) Pan head machine screw
(10) Lever (blade)
(11) Bolt (M8 × 16)
(12) Flat spring (condenser)
(13) Machine screw and washer

RY9212001HYS0544US0



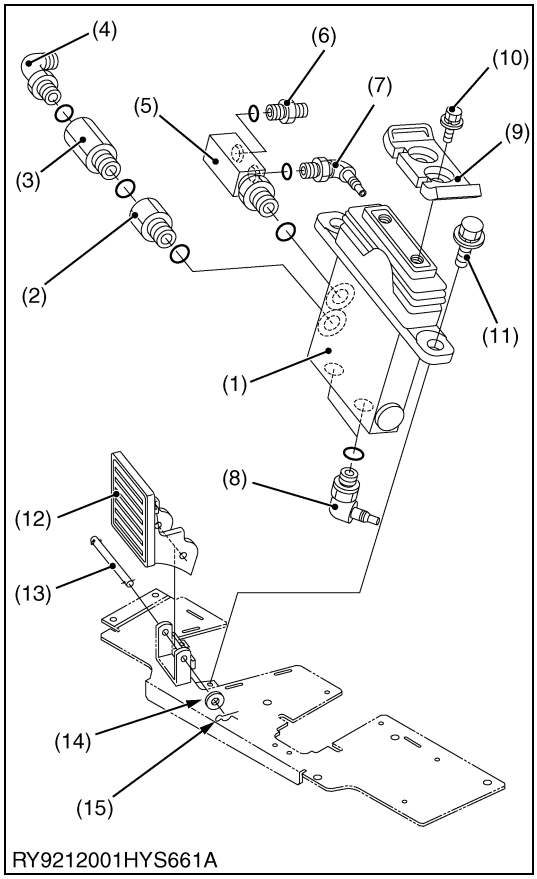
RY9212001HYS660A

Pilot Valve (Blade) Adapter Installation

(1) Valve assembly (PV, blade)
(2) Straight pipe joint (G2-G2)
(3) Pipe joint (to Q, G1/4-8.4)
(4) Filter
(5) Pipe joint (QL, G1/4-8.4)
(6) Straight pipe joint (G2-G2)

A : Front of machine

RY9212001HYS0545US0



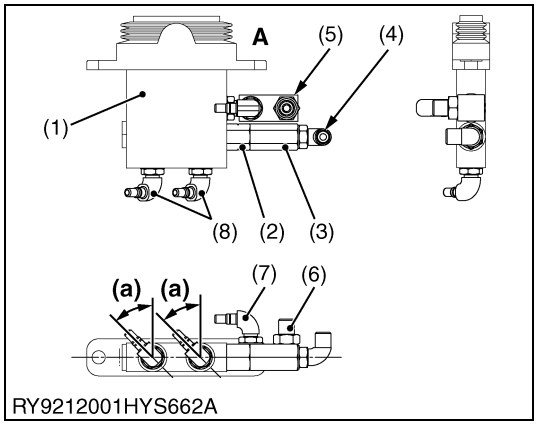
RY9212001HYS661A

Pilot Valve (Swing) Exploded View

Tightening torque	Bolt (M8 × 20) (10)	23.5 to 27.5 N·m 5.4 to 2.8 kgf·m 17.4 to 20.2 lbf·ft
	Bolt (M10 × 25) (11)	48.1 to 55.9 N·m 4.9 to 5.7 kgf·m 35.5 to 41.2 lbf·ft

(1) Valve assembly
(2) Filter
(3) Straight pipe joint (G2-G2)
(4) Pipe joint (L, G1/4-G1/4)
(5) Pipe joint (L, G2-G2)
(6) Adapter
(7) Pipe joint (QL, G1/4-8.4)
(8) Pipe joint (QL, G1/4-8.4)
(9) Pedal (swing)
(10) Bolt (M8 × 20)
(11) Bolt (M10 × 25)
(12) Pedal (swing)
(13) Pin (swing cover)
(14) Flat metal washer
(15) Snap pin

RY9212001HYS0546US0



RY9212001HYS662A

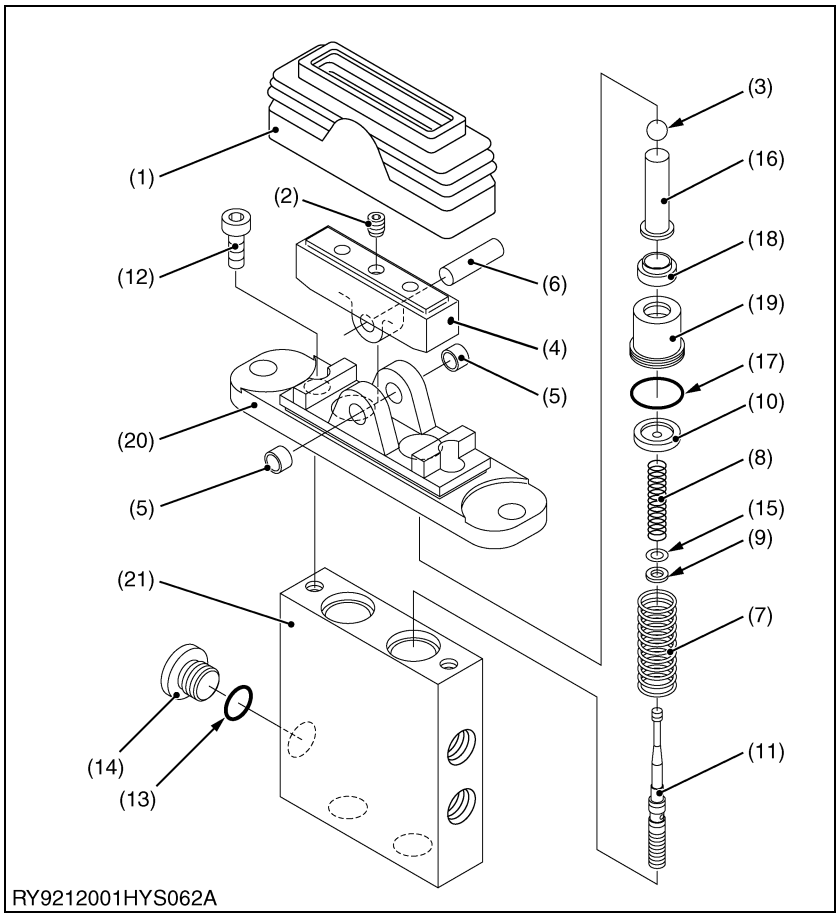
Pilot Valve (Swing) Adapter Installation

(1) Valve assembly
(2) Filter
(3) Straight pipe joint (G2-G2)
(4) Pipe joint (L, G1/4-G1/4)
(5) Pipe joint (L, G2-G2)
(6) Adapter
(7) Pipe joint (QL, G1/4-8.4)
(8) Pipe joint (QL, G1/4-8.4)

(a) 45 °
A : Machine right direction

RY9212001HYS0547US0

[2] PILOT VALVE (BLADE, SWING) DISASSEMBLY / ASSEMBLY PROCEDURES

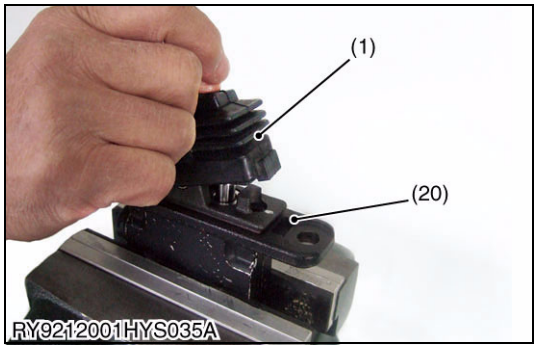


RY9212001HYS062A

No.	Part Name	Q'ty
(1)	Bellows	1
(2)	Hex socket bolt	1
(3)	Ball	2
(4)	Cam	1
(5)	Bushing	2
(6)	Cam shaft	1
(7)	Spring (return)	2
(8)	Spring (secondary pressure)	2
(9)	Metal washer	2
(10)	Spring seat	2
(11)	Spool	2
(12)	Hex socket bolt	2
(13)	O-Ring	1
(14)	RO plug	1
(15)	Shim	2
(16)	Pushrod	2
(17)	O-Ring	2
(18)	Gasket	2
(19)	Plug	2
(20)	Cover	1
(21)	Casing	1

RY9212001HYS0550US0

(1) Disassembly



RY9212001HYS035A

1. Clamp the blade valve in a vise.
2. Remove the bellows (1) from the cover (20).

■ **IMPORTANT**
- **Use a copper plate when clamping the part.**

(1) Bellows (20) Cover

RY9212001HYS0551US0

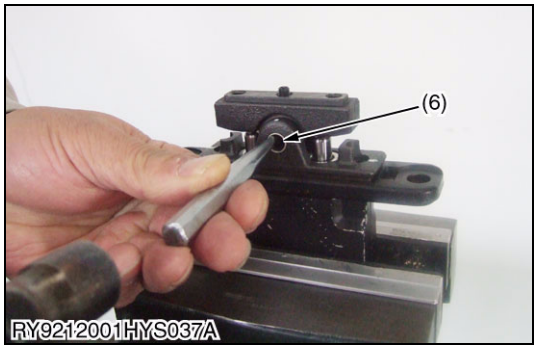
RY9212001HYS036A

3. Remove the hex socket bolt (2).

■ **IMPORTANT**
- **Note that Loctite was used so loosening will require a lot of force.**

- Tool to use : M3 hex socket

RY9212001HYS0552US0

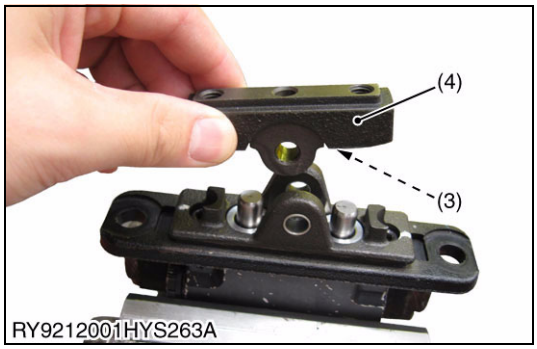


4. Put a pin punch against the edge of the cam shaft (6) and tap it lightly with a hammer to remove it.

- Tool to use : Hammer and pin punch (ϕ7 mm, ϕ0.3 in. ≥)

(6) Cam shaft

RY9212001HYS0553US0

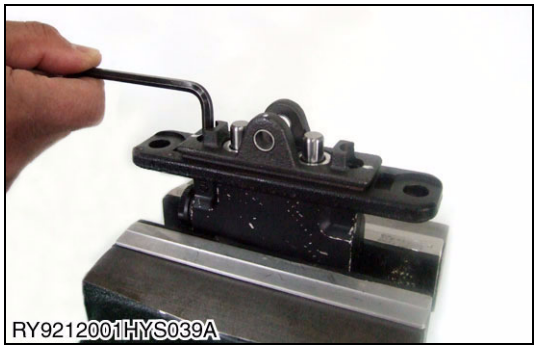


5. Remove the cam (4).

■ **IMPORTANT**
- **Handle the cam (4) and the ball (3) as an assembly. (Cannot be disassembled)**
- **Mark the relationship between the cam (4) and the cover.**

(3) Ball (4) Cam

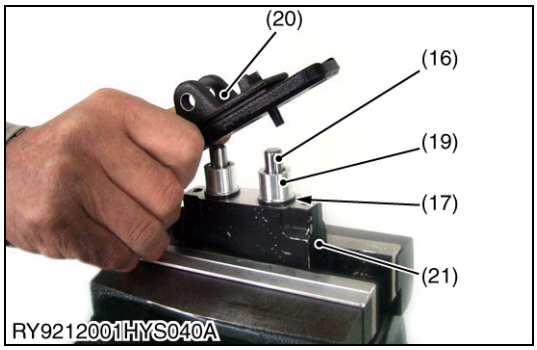
RY9212001HYS0554US0



6. Remove the hex socket bolt.

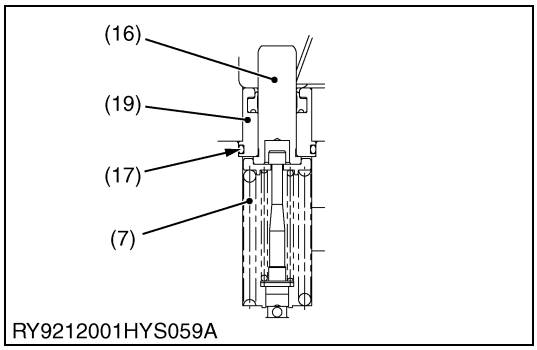
- Tool to use : M5 hex socket

RY9212001HYS0555US0



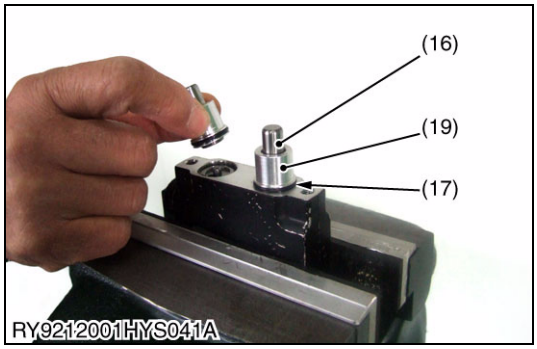
7. Remove the cover (20).

CAUTION
- **Mark the relationship between the cover (20) and the casing (21).**
- **Be careful so the pushrod (16) and the plug (19) don't pop out.**



(7) Spring (return)
(16) Pushrod
(17) O-Ring
(19) Plug
(20) Cover
(21) Casing

RY9212001HYS0556US0

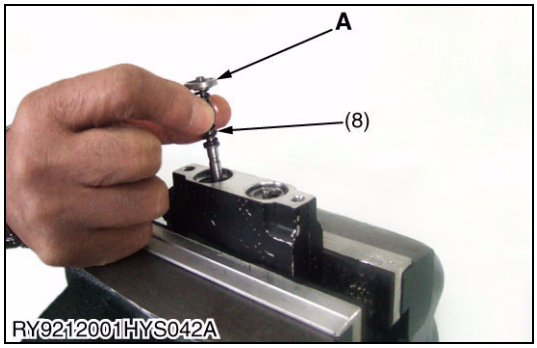


8. Remove the plug (19).

■ **IMPORTANT**
- **Mark the relationship between the plug (19) and the casing (21).**

(16) Pushrod
(17) O-Ring
(19) Plug

RY9212001HYS0557US0

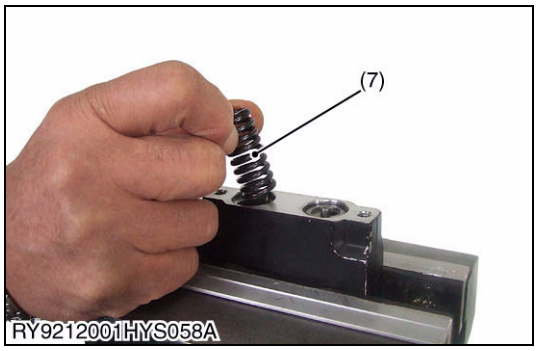


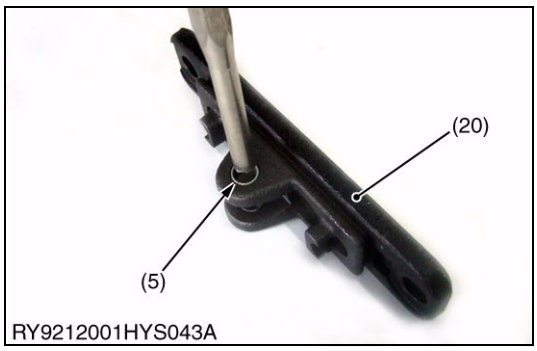
9. Remove the reducing valve ASSY **A** and the spring (7) from the casing.

■ **IMPORTANT**
- **Mark the relationship of the casing holes.**

(7) Spring (return)
(8) Spring (secondary pressure)
A : Reducing valve ASSY

RY9212001HYS0558US0

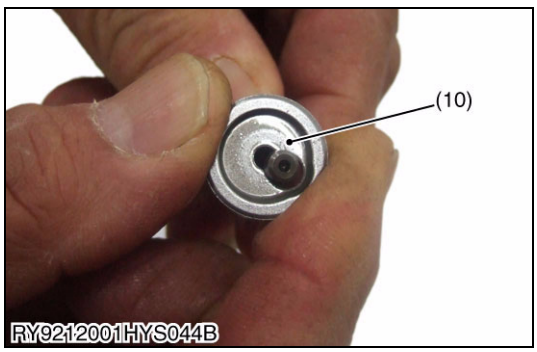




10. Put the cover (20) on its side, put a pin punch against the bushing (5) and lightly tap it with a hammer to remove it.
- Tools to use : Hammer and pin punch (ϕ10 mm, ϕ0.39 in. ≥)

(5) Bushing
(20) Cover

RY9212001HYS0559US0

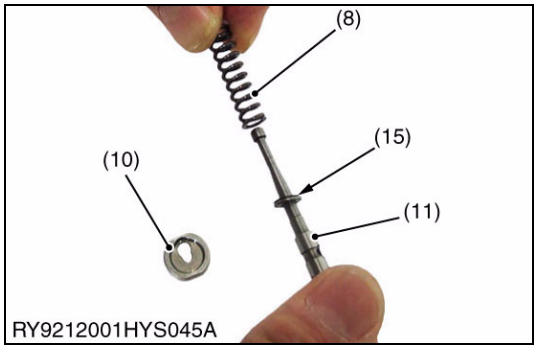


11. To disassemble the reducing valve, compress the spring, shift the spring seat (10) to the side and remove the spool via the large hole.

■ **IMPORTANT**
- **Be careful not to scratch the spool.**
- **Do not depress the spring seat 4 mm (0.2 in.) ≤**
- **Do not disassemble the reducing valve unless there is a problem with it.**

(10) Spring seat

RY9212001HYS0560US0

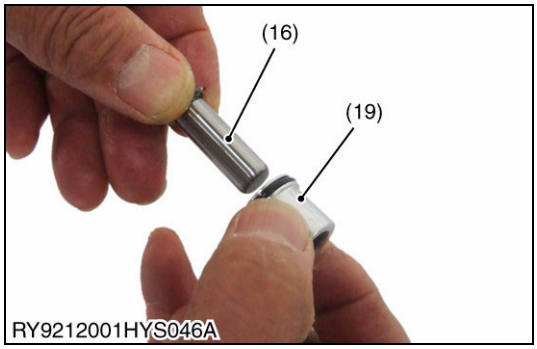


12. Remove the spool (11), secondary pressure setting spring (8), shims (15) and metal washer (9).

■ **IMPORTANT**
- **Treat as an assembly until reassembly.**
- **The thickness of the metal washers is different for each spool ASSY due to the preset adjustment of the secondary pressure setting spring (8).**
- **A metal washer (9) is not used in the figure.**

(8) Spring (secondary pressure) (11) Spool
(10) Spring seat (15) Shim

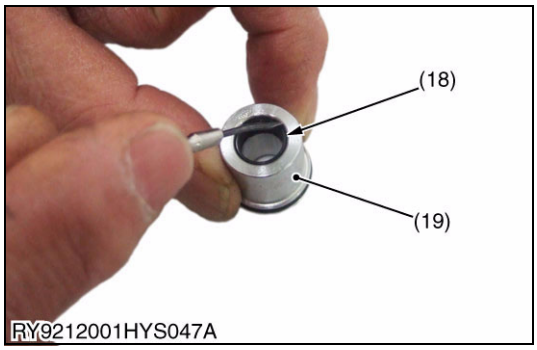
RY9212001HYS0561US0



13. Remove the plug (19) from the pushrod (16).

(16) Pushrod (19) Plug

RY9212001HYS0562US0



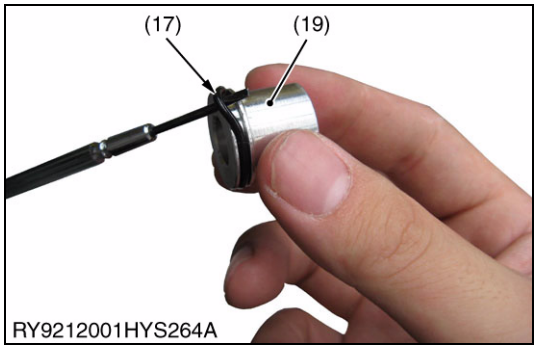
14. Remove the gasket (18) from the plug (19).

CAUTION
- **Use a mini slotted screwdriver to remove it.**
- **Be careful not to scratch the inside surface of the plug.**

- Tool to use : Slotted screwdriver

(18) Gasket (19) Plug

RY9212001HYS0563US0

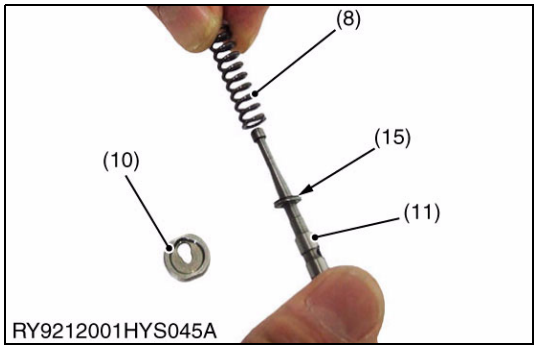


15. Remove the O-ring (17) from the plug (19).

(17) O-Ring (19) Plug

RY9212001HYS0564US0

(2) Assembly

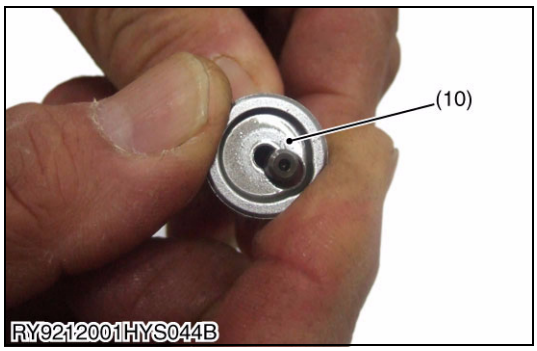


1. Install the metal washer, shim (15), secondary pressure setting spring (8) and spring seat (10) in order to the spool (11).

■ **IMPORTANT**
- **The thickness of the metal washers is different for each spool ASSY due to the preset adjustment of the secondary pressure setting spring (8).**

(8) Spring (secondary pressure)
(10) Spring seat
(11) Spool
(15) Shim

RY9212001HYS0565US0

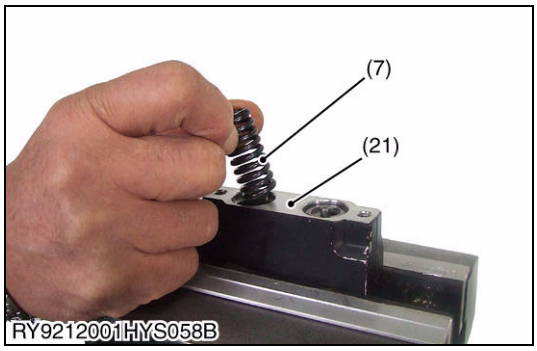


2. Pass the end of the spool through the larger part of the hole in the spring seat (10), compressing the spring and shifting the spring seat to the side to install it.

■ **IMPORTANT**
- **Be careful not to scratch the spool.**
- **Do not depress the spring seat 4 mm (0.2 in.) ≤**

(10) Spring seat

RY9212001HYS0566US0

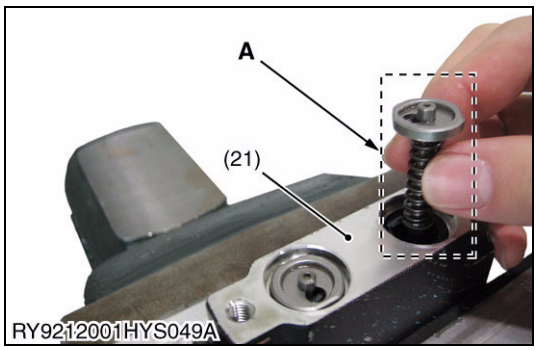


3. Clamp the casing (21) in a vise. Install the spring (7) in the casing (21).

■ **IMPORTANT**
- **Install it in the same position as before disassembly.**

(7) Spring (return)
(21) Casing

RY9212001HYS0567US0



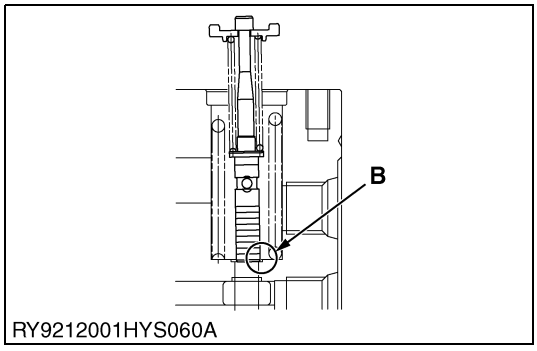
4. Install the reducing valve ASSY **A** to the casing (21).

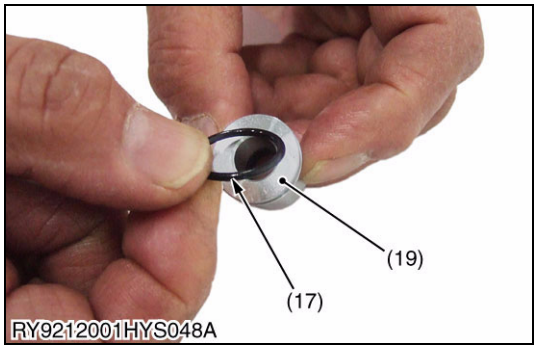
■ **IMPORTANT**
- **Install it in the same position as before disassembly.**
- **When installing the reducing valve ASSY, take care not to hit the bottom edge of the spool hard against the corner B or the casing.**

(21) Casing

A : Reducing valve ASSY
B : Corner of casing

RY9212001HYS0568US0



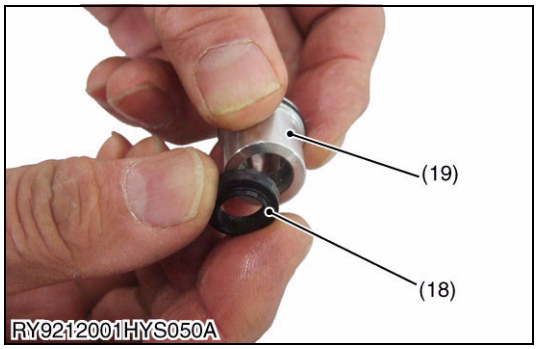


5. Install the O-ring (19) on the plug (17).

■ **IMPORTANT**
- **Apply hydraulic oil to the O-ring.**

(17) O-Ring (19) Plug

RY9212001HYS0569US0

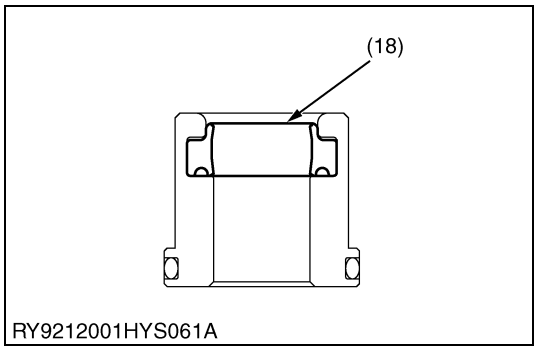


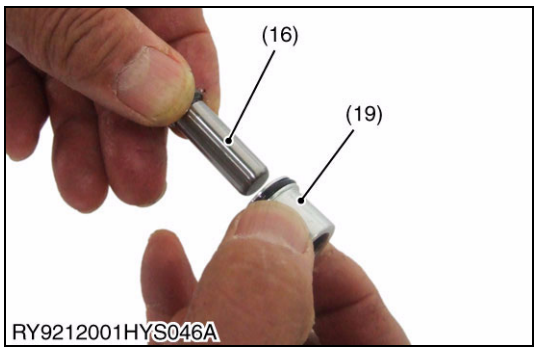
6. Install the gasket (18) on the plug (19).

■ **IMPORTANT**
- **Be careful that the gasket faces the right direction. (The gasket (18) has an uneven shape ; put the end with a larger diameter in first.)**
- **Apply hydraulic oil on the circumference and lip of the gasket.**

(18) Gasket (19) Plug

RY9212001HYS0570US0



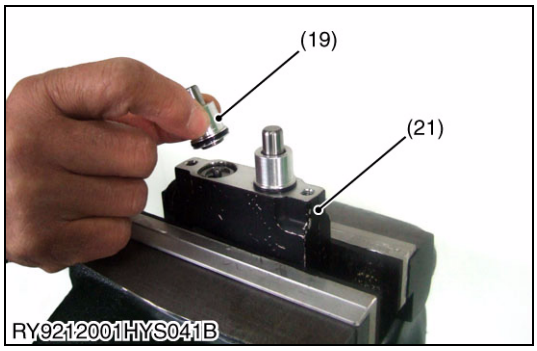


7. Install the pushrod (16) into the plug (19).

■ **IMPORTANT**
- **Apply hydraulic oil to the pushrod (16).**
- **Do not force the gasket (18) in as it may damage its lip.**

(16) Pushrod (19) Plug

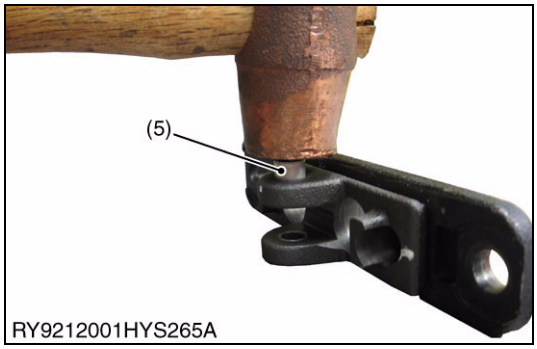
RY9212001HYS0571US0



8. Install the pushrod and plug ASSY in the casing (21).

(19) Plug (21) Casing

RY9212001HYS0572US0



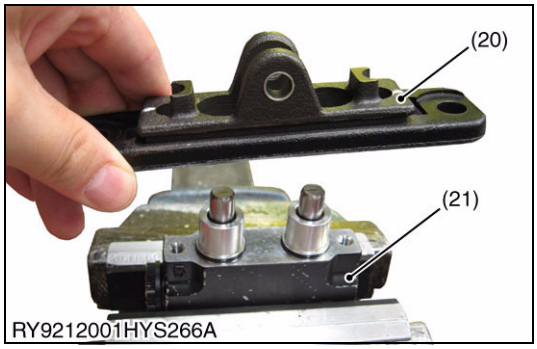
9. Turn the cover on its side and tap lightly on the bushing (5) with a hammer to install it.

■ **IMPORTANT**
- **Take care not to knock the bushing so it sticks out from the inside of the cover.**

- Tool to use : hammer

(5) Bushing

RY9212001HYS0573US0

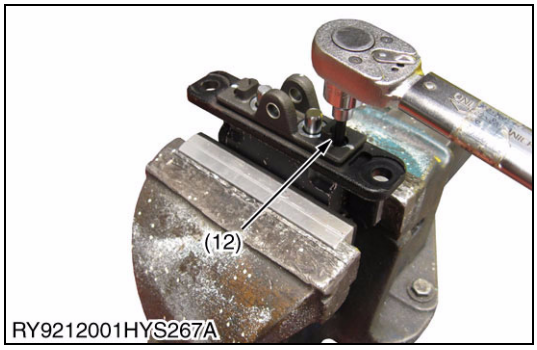


10. Install the cover (20) on the casing (21).

■ **IMPORTANT**
- **Install it in the same position as before disassembly.**
- **Note that the cover will ride up due to the springs.**

(20) Cover (21) Casing

RY9212001HYS0574US0



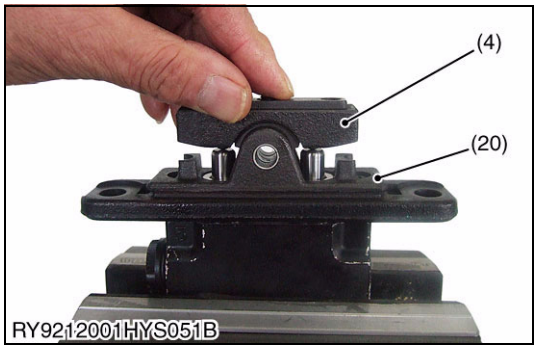
11. Install the hex socket bolts (12).

■ **IMPORTANT**
- **Install them so the cover sits flat.**

Tightening torque	Cover (20)	8.8 N·m 0.9 kgf·m 6.5 lbf·ft

- Tool to use : hex socket

RY9212001HYS0575US0

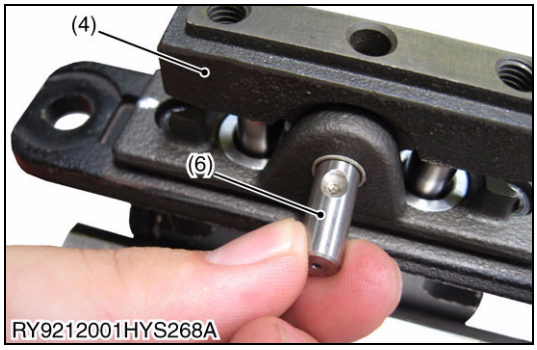


12. Install the cam (4) on the cover (20).

■ **IMPORTANT**
- **Install it in the same position as before disassembly.**

(4) Cam (20) Cover

RY9212001HYS0576US0



13. Install the camshaft (6).

■ **IMPORTANT**
- **Grease the sliding part that holds the camshaft.**
- **Install the indentation in the cam faces up.**

(4) Cam (6) Cam shaft

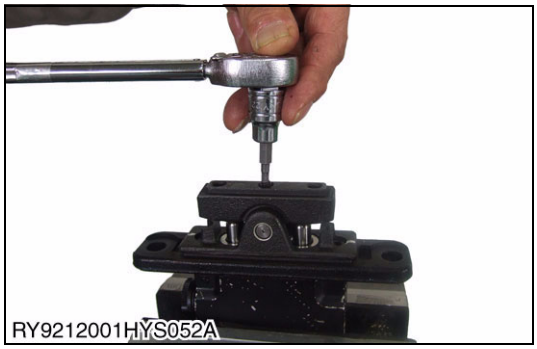
RY9212001HYS0577US0

RY9212001HYS054A

14. Apply Loctite to the threads of the hex socket bolt.

- Loctite #241

RY9212001HYS0578US0

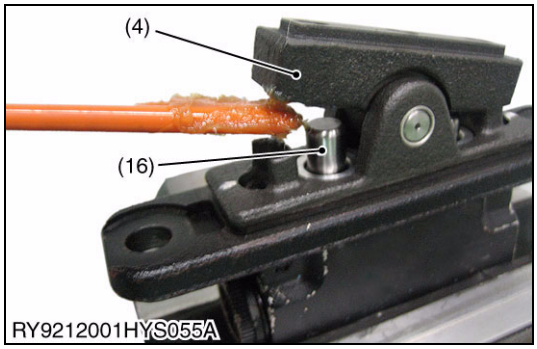

RY9212001HYS052A

15. Install the hex socket bolt.

Tightening torque	Cam (4)	6.9 ± 1.0 N·m 0.7 ± 0.1 kgf·m 5.1 ± 0.7 lbf·ft

- Tool to use : M3 hex socket

RY9212001HYS0579US0



RY9212001HYS055A

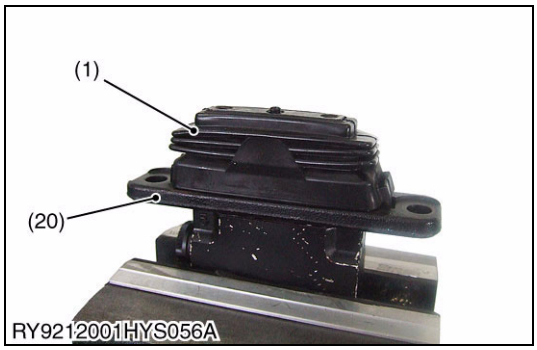
16. Apply grease to the ends of the pushrods (16).

■ **IMPORTANT**

- **Use a soft spatula to apply the grease so you don't scratch the surfaces of the pushrods or the plugs.**

(4) Cam (16) Pushrod

RY9212001HYS0580US0



RY9212001HYS056A

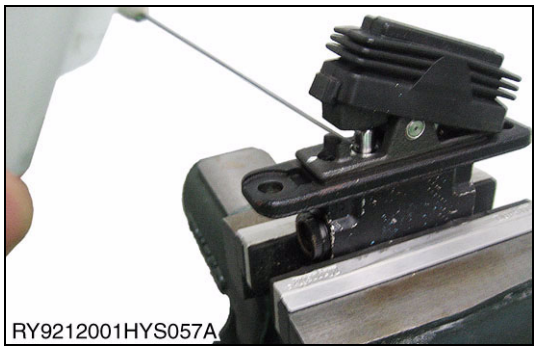
17. After fitting the top of the bellows (1) onto the cam, fit the bottom edge into the groove in the cover (20).

■ **IMPORTANT**

- **Before fitting the bottom edge of the bellows into the groove of the cover, apply an anti-rust oil to the parts inside the bellows.**

(1) Bellows (20) Cover

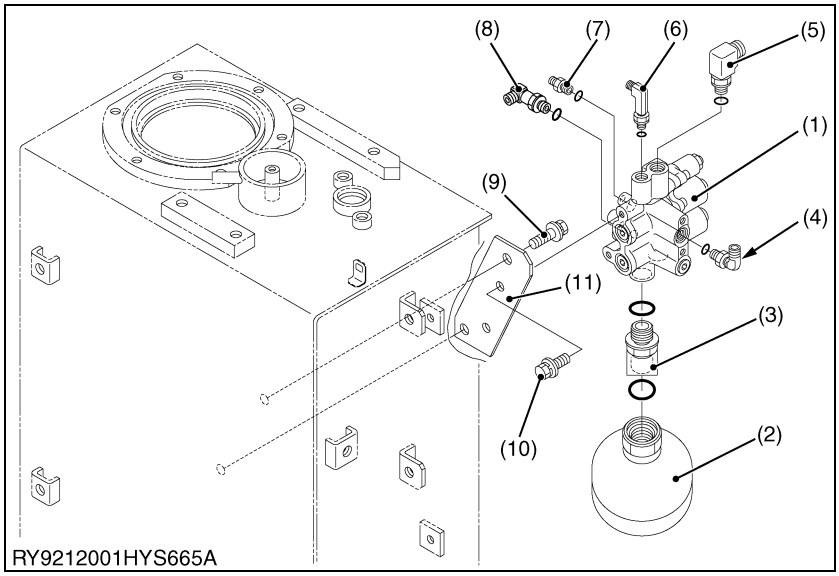
RY9212001HYS0581US0


RY9212001HYS057A

10. UNLOAD VALVE

[1] UNLOAD VALVE ASSEMBLY

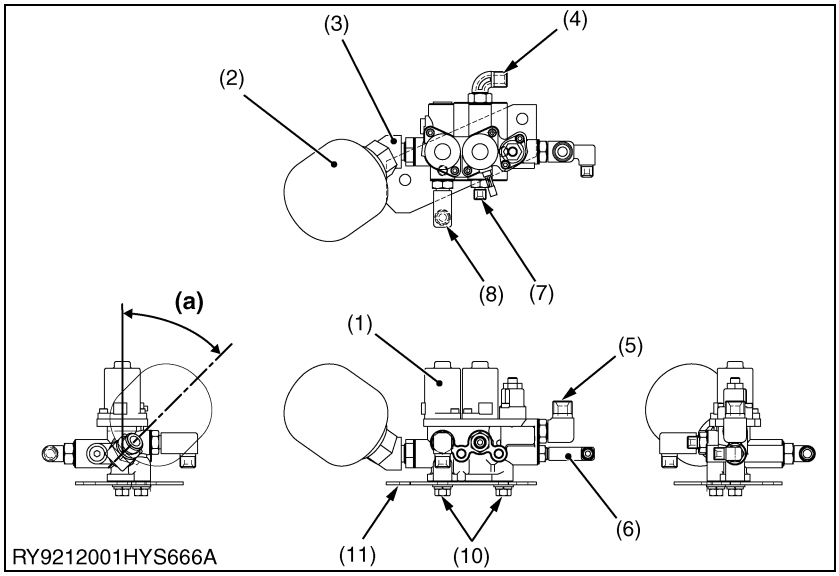
Unload Valve Disassembly Schematic



(1) Unload Valve
(2) Accumulator
(3) Pipe joint (L45, G4-G4)
(4) Elbow pipe joint (G3-G3)
(5) Pipe joint (L, G3/8-G1/2)
(6) Pipe joint (L, G1/4-G1-4)
(7) Adapter
(8) Pipe joint (L, G3/8-G3/8)
(9) Bolt (M10 × 20)
(10) Bolt (M10 × 20)
(11) Bracket (switch)

RY9212001HYS0582US0

Unload Valve Adapter Installation

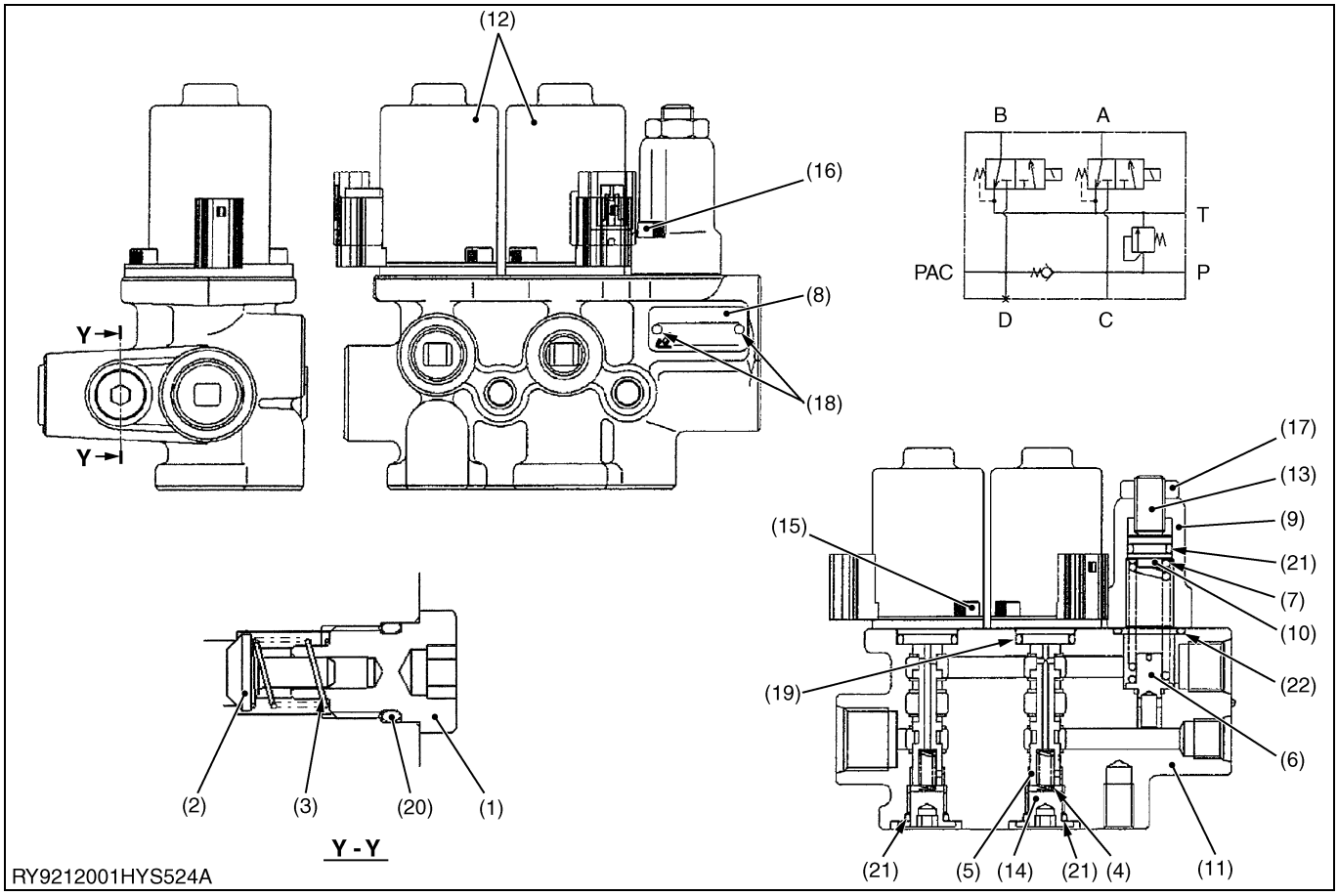


(1) Unload Valve
(2) Accumulator
(3) Pipe joint (L45, G4-G4)
(4) Elbow pipe joint (G3-G3)
(5) Pipe joint (L, G3/8-G1/2)
(6) Pipe joint (L, G1/4-G1-4)
(7) Adapter
(8) Pipe joint (L, G3/8-G3/8)
(10) Bolt (M10 × 20)
(11) Bracket (switch)

(a) 45 °

RY9212001HYS0583US0

[2] UNLOAD VALVE DISASSEMBLY / ASSEMBLY PROCEDURES



RY9212001HYS524A

No.	Name of part	Q'ty	Notes	No.	Name of part	Q'ty	Notes
(1)	Plug	1		(12)	Solenoid	2	
(2)	Plunger	1		(13)	Screw adjustment	1	
(3)	Spring	1		(14)	Flanged plug	2	
(4)	Spring	2		(15)	Hex socket bolt	4	
(5)	Spool	2		(16)	Hex socket bolt	2	
(6)	Plunger	1		(17)	Hex nut	1	
(7)	Spring	1		(18)	Rivet screw	2	
(8)	Nameplate	1		(19)	O-Ring	2	
(9)	Cover	1		(20)	O-Ring	1	
(10)	Plug	1		(21)	O-Ring	4	
(11)	Body	1		(22)	O-Ring	1	

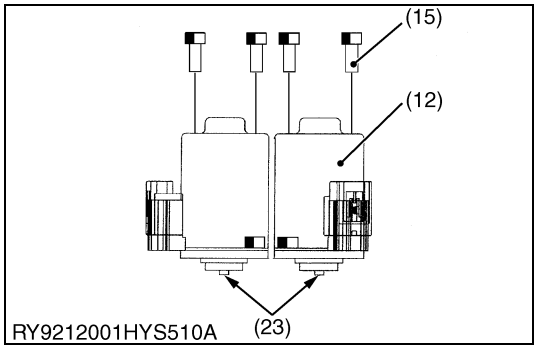
RY9212001HYS0584US0

(1) Disassembly / Assembly Procedures

Precautions during Disassembly / Assembly

The clearances of the body and spool are calculated to fit.
Be sure to check their positions during disassembly and re-install them in the same positions during assembly.
The same with the solenoid, reinstall it in the same position and orientation.

RY9212001HYS0585US0



RY9212001HYS510A

Solenoid Valve Disassembly

1. Remove the two hex socket nuts (15) per solenoid and remove the solenoid (12).

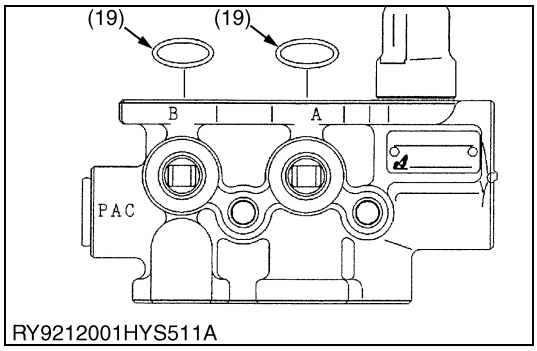
■ **IMPORTANT**
- **Take care that the pushrods (23) do not fall out of the solenoids (12).**

Tightening torque	Hex socket bolt (15)	3.92 N·m 0.4 kgf·m 2.89 lbf·ft

- Tool to use : M4 hex socket

(12) Solenoid (23) Pushrod
(15) Hex socket bolt

RY9212001HYS0586US0



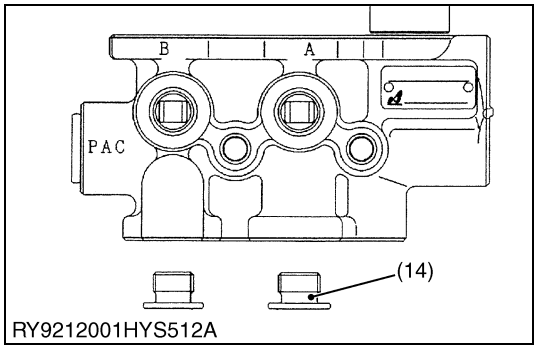
RY9212001HYS511A

2. Remove the O-rings (19).

■ **IMPORTANT**
- **During assembly, install the O-rings (19) to the solenoids (12) and then install them to the body (11).**
- **Apply grease to the O-rings.**

(19) O-Ring

RY9212001HYS0587US0



RY9212001HYS512A

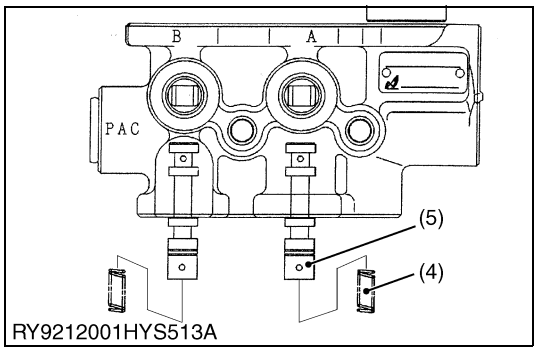
3. Remove the flanged plug (14).

Tightening torque	Flanged plug (14)	26.5 N·m 2.7 kgf·m 19.5 lbf·ft

- Tool to use : M6 hex socket

(14) Flanged plug

RY9212001HYS0588US0



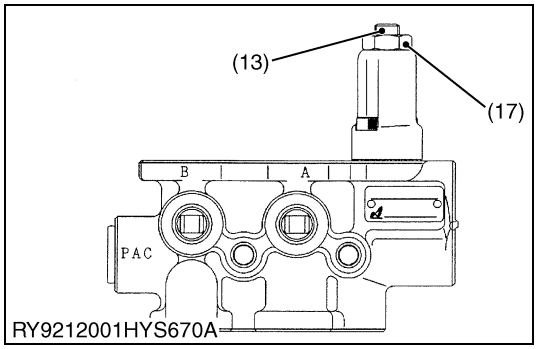
RY9212001HYS513A

4. Remove the springs (4) and spools (5).

■ **IMPORTANT**
- **During assembly, apply hydraulic oil to the spool (5).**

(4) Spring (5) Spool

RY9212001HYS0589US0



RY9212001HYS670A

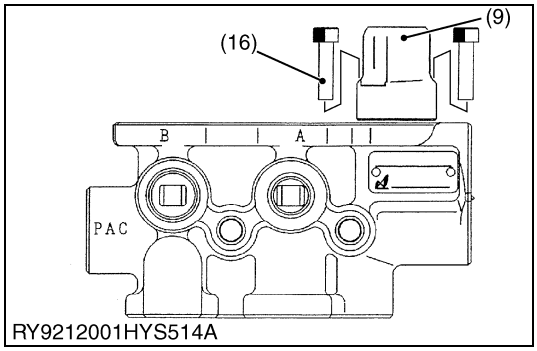
5. Remove the hex nut (17) and the adjustment screw (13).

Tightening torque	Hex nut (17)	15.7 N·m 1.6 kgf·m 11.6 lbf·ft

- Tool to use : M17 wrench

(13) Screw adjustment (17) Lock nut

RY9212001HYS0590US0



RY9212001HYS514A

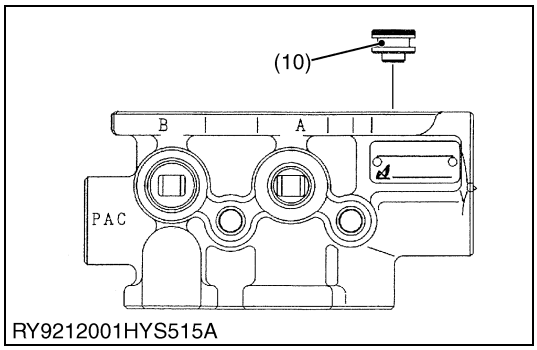
6. Remove the cover (9).

Tightening torque	Hex socket bolt (16)	3.92 N·m 0.4 kgf·m 2.89 lbf·ft

- Tool to use : M4 hex socket

(9) Cover (16) Hex socket bolt

RY9212001HYS0591US0

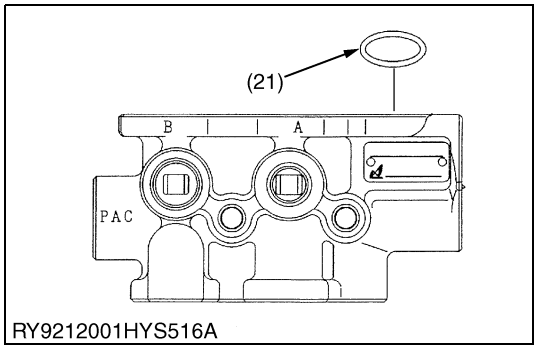


RY9212001HYS515A

7. Remove the plug (10).

(10) Plug

RY9212001HYS0592US0

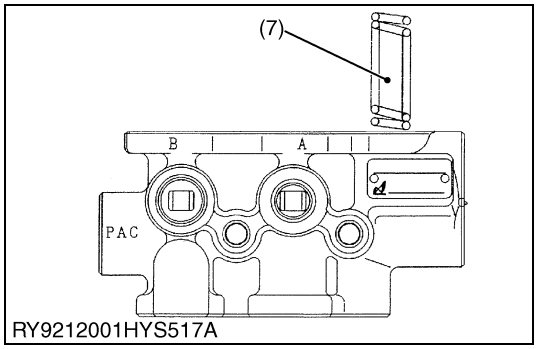


RY9212001HYS516A

8. Remove the O-ring (21).

(21) O-Ring

RY9212001HYS0593US0

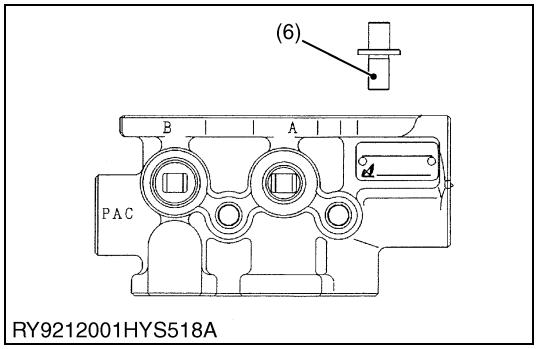


RY9212001HYS517A

9. Remove the spring (7).

(7) Spring

RY9212001HYS0594US0



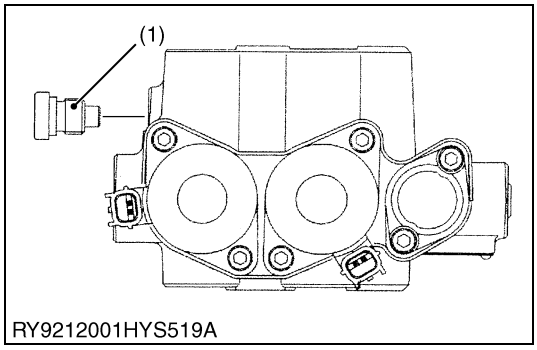
RY9212001HYS518A

10. Remove the plunger (6).

■ **IMPORTANT**
- **During assembly, apply hydraulic oil to the plunger (6).**
- Tool to use : Magnet

(6) Plunger

RY9212001HYS0595US0



RY9212001HYS519A

Check Valve Disassembly

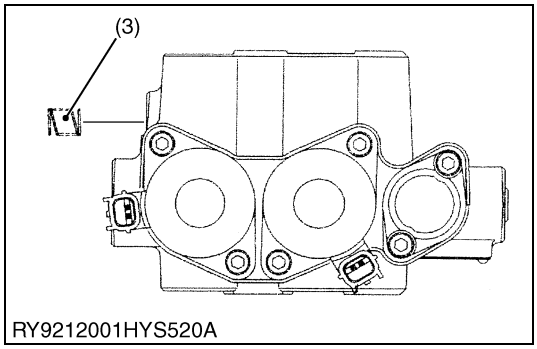
11. Remove the plug (1).

Tightening torque	Plug (1)	21.0 N·m 2.1 kgf·m 15 lbf·ft

- Tool to use : M6 hex socket

(1) Plug

RY9212001HYS0596US0

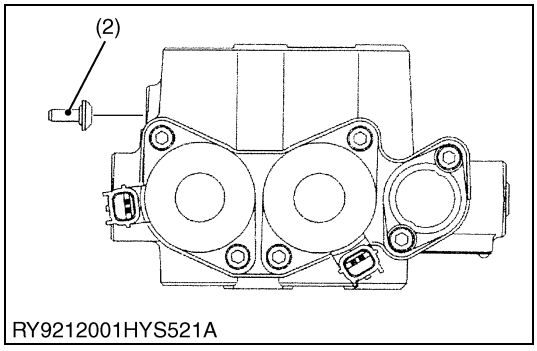


RY9212001HYS520A

12. Remove the spring (3).

(3) Spring

RY9212001HYS0597US0



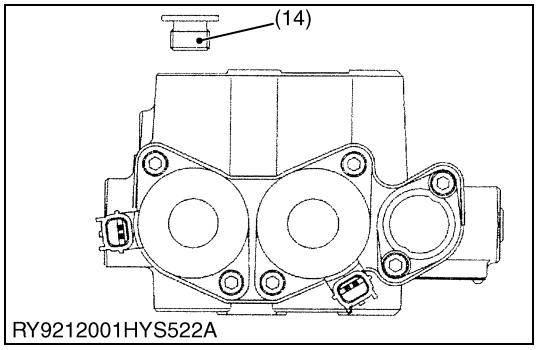
RY9212001HYS521A

13. Remove the plunger (2).

■ **IMPORTANT**
- **During assembly, apply hydraulic oil to the plunger (2).**

(2) Plunger

RY9212001HYS0598US0



RY9212001HYS522A

14. Remove the flanged plug (14).

Tightening torque	Flanged plug (14)	26.5 N·m 2.7 kgf·m 19.5 lbf·ft

- Tool to use : M6 hex socket

(14) Flanged plug

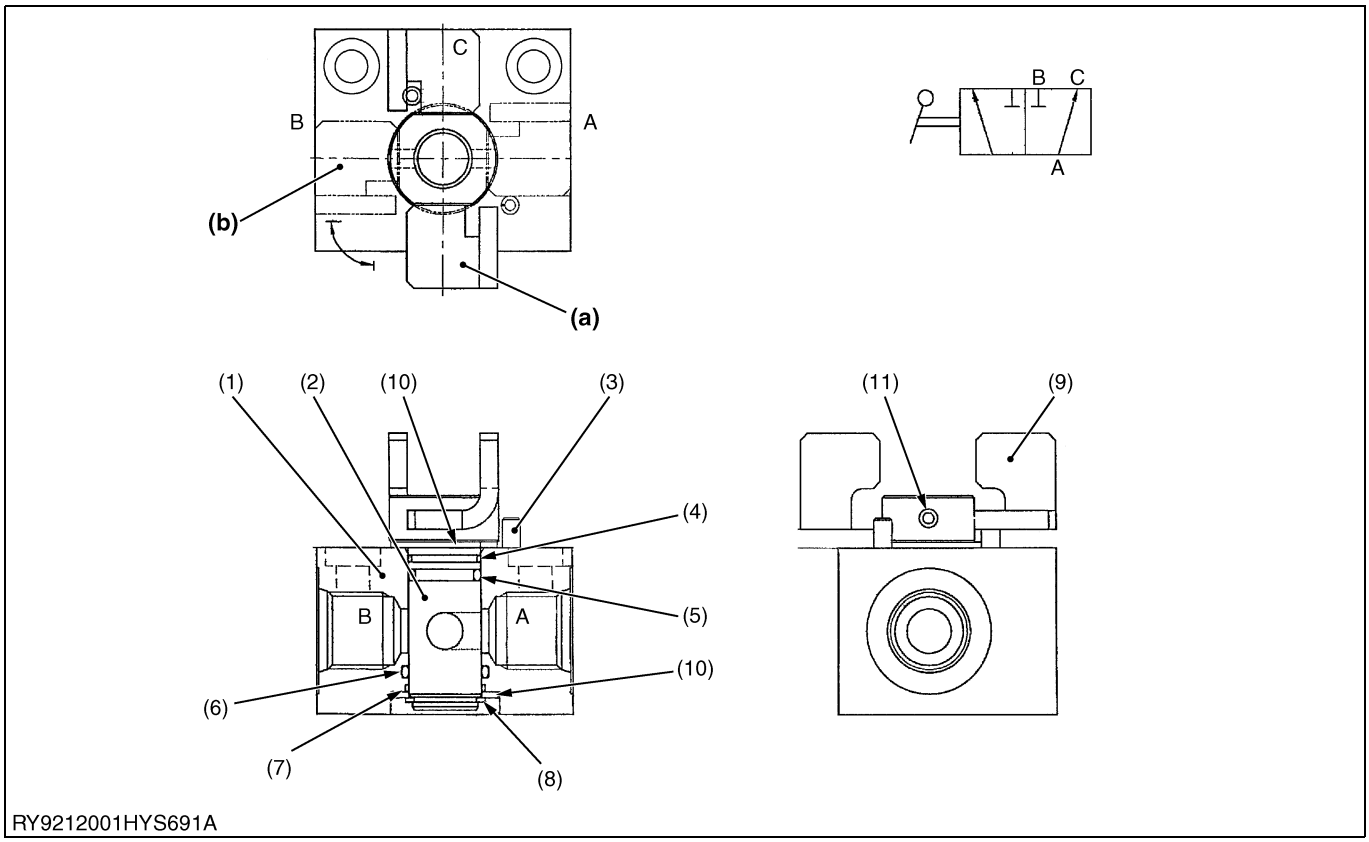
RY9212001HYS0599US0

Perform the procedures in reverse to assemble the parts.

RY9212001HYS0017US0

11. THIRD LINE VALVE ASSEMBLY

[1] THIRD LINE VALVE ASSEMBLY COMPONENTS



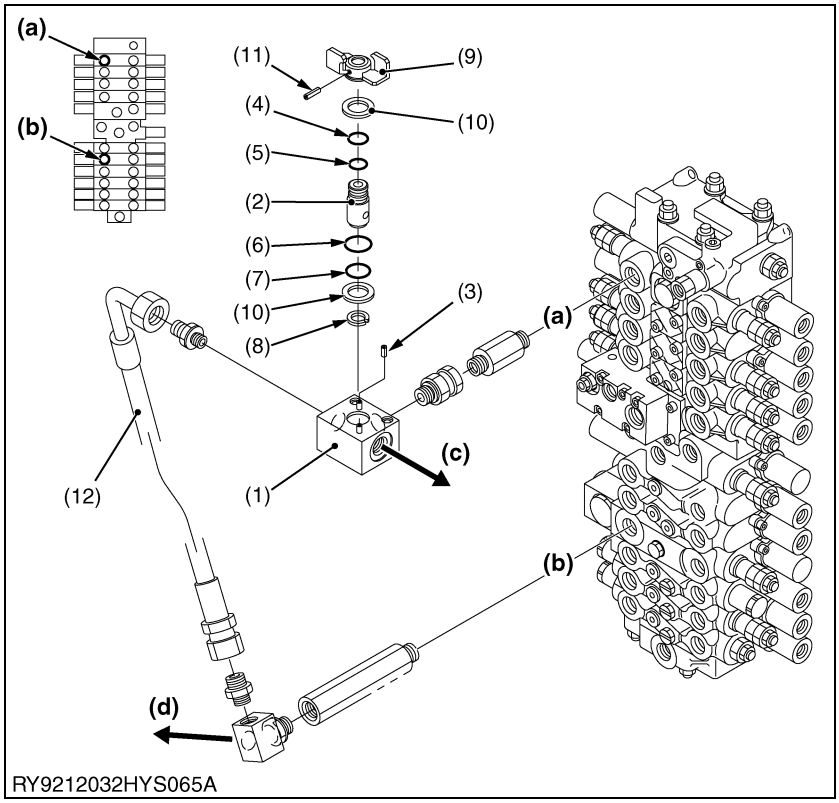
RY9212001HYS691A

(1) Body
(2) Spool
(3) Spring Pins
(4) O-ring (04811-10180)
(5) O-ring (04810-00160)
(6) O-ring (04810-00200)
(7) O-ring (04811-10200)
(8) O-ring (04612-50180)
(9) Lever
(10) Washer
(11) Spring Pins

(a) A-C port oil passage lever position
(b) A-B port oil passage lever position

RY9212001HYS0609US0

[2] THIRD LINE HOSE ROUTE



RY9212032HYS065A

(1) Body
(2) Spool
(3) Spring Pins
(4) O-ring (04811-10180)
(5) O-ring (04810-00160)
(6) O-ring (04810-10200)
(7) O-ring (04811-10200)
(8) O-ring (04612-50180)
(9) Lever
(10) Washer
(11) Spring Pins

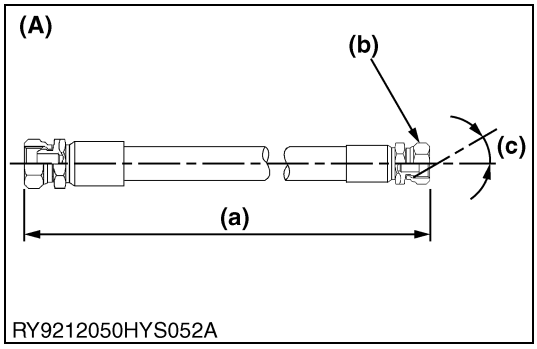
(a) AUX1low pressure port
(b) Tank port
(c) To boom base pipe (AUX1 low pressure side)
(d) To oil cooler

RY9212032HYS0059US0

12. ROUTING OF HYDRAULIC HOSES

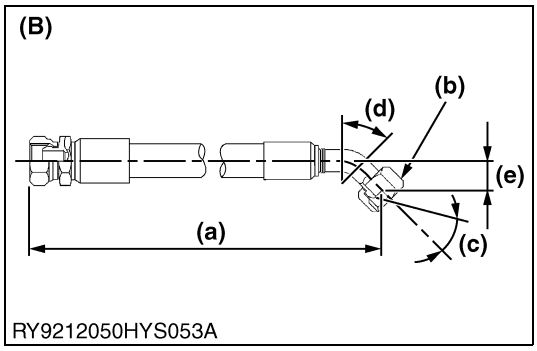
[1] TABLE OF HYDRAULIC HOSES

(1) Hydraulic Hoses



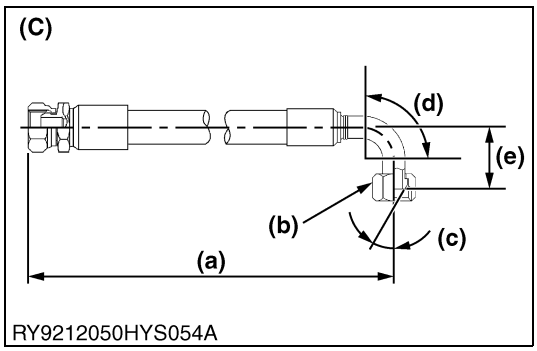
RY9212050HYS052A

(A) Type C, Parallel female thread for pipe (male 30 ° seat)
(a) Total length
(b) Metal fitting size
(c) 30 °



RY9212050HYS053A

(B) Type CR4, Parallel female thread 45 ° for pipe (male 30 ° seat)
(a) Total length
(b) Metal fitting size
(c) 30 °
(d) 45 °
(e) Fitting Dimensions



RY9212050HYS054A

(C) Type CR9, Parallel female thread 90 ° for pipe (male 30 ° seat)
(a) Total length
(b) Metal fitting size
(c) 30 °
(d) 90 °
(e) Fitting Dimensions

RY9212050HYS0074US0

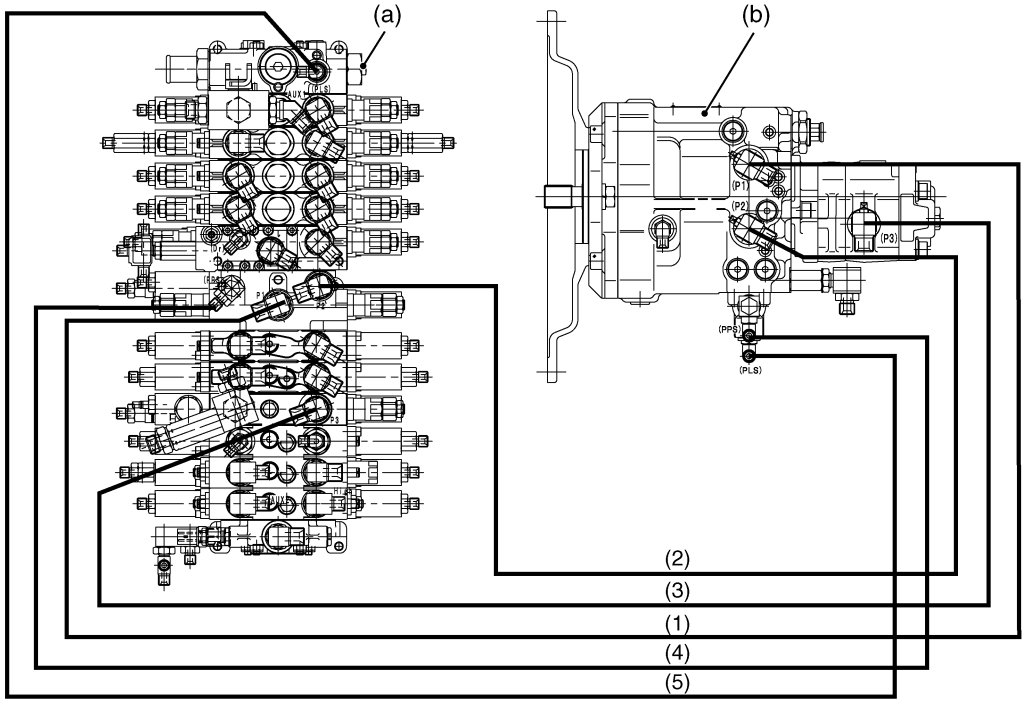
(2) Table of High-Pressure Hoses

No.	Part number	Hose			Metal fitting			Guard	Position Used
		Total length mm (in.)	Size	Tape color	Type	Size	Length mm (in.)		
(1)	RD551-63213	3050 (120.1)	1/2	White	C~C	G1/2	–	Resin-spirals	Pump - C/V (P1 Delivery)
(2)	RD551-63223	3080 (121.3)	1/2	Green	C~C	G1/2	–	Resin-spirals	Pump - C/V (P2 Delivery)
(3)	RD551-63232	2730 (107.5)	1/2	Pink	C~C	G1/2	–	Resin-spirals	Pump - C/V (P3 Delivery)
(4)	RD551-63264	2665 (104.9)	1/4		C~C	G1/4	–	Resin-spirals	Pump - C/V (PPS)
(5)	RD551-63275	2930 (115.4)	1/4		C~C	G1/4	–	Resin-spirals	Pump - C/V (PLS)
(6)	RD551-63713	1110 (43.7)	5/8	White	C~C	G1/2	–		R/J - Travel motor [L-FWD and R-FWD]
(7)	RD551-63722	1150 (45.3)	5/8		C~C	G1/2	–		R/J - Travel motor [L-REV and R-REV]
(8)	RD551-63761	580 (22.8)	3/8		C~CR9	G3/8	37 (1.5)		R/J Pipe (Blade allocation) [Lifting blade]
(9)	RD551-63771	560 (22.0)	1/2		C~CR9	G1/2	47 (1.9)		R/J Pipe (Blade allocation) [Lowering blade]
(10)	RD551-63781	605 (23.8)	3/8		CR4~C	G3/8	26 (1.0)	Spring	Pipe (Blade allocation) - Blade CYL [Lifting blade]
(11)	RD551-63791	656 (25.8)	1/2		CR4~C	G1/2	29.5 (1.2)	Spring	Pipe (Blade allocation) - Blade CYL [Lowering blade]
(12)	RD451-64114	2180 (85.8)	1/2	Green	C~C	G1/2	–	Resin-spirals	C/V - Boom CYL [Lifting boom]
(13)	RD551-64125	2450 (96.5)	1/2	Yellow	C~C	G1/2	–	Resin-spirals , Cover	C/V - Boom CYL [Lowering boom]
(14)	RD451-64134	2240 (88.2)	1/2	Black	C~C	G1/2	–	Resin-spirals , Cover	C/V - Boom base pipe [Arm dump]
(15)	RD358-64141	2270 (88.2)	1/2	Blue	C~C	G1/2	–	Resin-spirals , Cover	C/V - Boom base pipe [Crowd arm]
(16)	RD358-64151	2220 (86.6)	1/2	Red	C~C	G1/2	–	Resin-spirals , Cover	C/V - Boom base pipe [Dump bucket]
(17)	RD451-64164	605 (23.8)	1/2	White	C~C	G1/2	–	Resin-spirals , Cover	C/V - Boom base pipe [Crowd bucket]
(18)	RD551-64811	1420 (55.9)	1/2		C~C	G1/2	–	Resin-spirals	Boom end pipe - Bucket CYL [Dump and crowd bucket]
(19)	RD551-64343	1560 (61.4)	1/2		C~C	G1/2	–	Cover	Boom mid-pipe - Arm CYL [Dump arm]
(20)	RD551-64353	780 (30.7)	1/2		C~C	G1/2	–	Cover	Boom mid-pipe - Arm CYL [Crowd arm]
(21)	RD358-64411	680 (26.8)	1/2	Blue	C~CR9	G1/2	74.5 (2.9)		C/V - R/J(D) [Travel L-FWD]]
(22)	RD358-64421	640 (25.2)	1/2	Red	C~CR9	G1/2	46 (1.8)		C/V - R/J(F) [Travel L-FWD]
(23)	RD358-64431	730 (28.7)	1/2	Green	C~CR9	G1/2	74.5 (2.9)		C/V - R/J(E) [Travel L-FWD]
(24)	RD358-64441	700 (27.6)	1/2	Yellow	C~CR9	G1/2	74.5 (2.9)		C/V - R/J(G) [Travel R-REV]
(25)	RD358-64511	750 (29.5)	1/2	Gray	C~CR4	G1/2	22 (0.9)		C/V - Swivel motor [Swivel left]
(26)	RD358-64521	780 (30.7)	1/2	Aqua	C~CR4	G1/2	22 (0.9)		C/V - Swivel motor [Swivel right]

No.	Part number	Hose			Metal fitting			Guard	Position Used
		Total length mm (in.)	Size	Tape color	Type	Size	Length mm (in.)		
(27)	RD551-64613	470 (18.5)	1/4	Green -ish yellow	C~CR9	G1/4	24 (0.9)		C/V - Swing CYL [Swing left]
(28)	RD551-64622	750 (29.5)	1/4	Or- ange	C~CR9	G1/4	24 (0.9)		C/V - Swing CYL [Swing right]
(29)	RD358-64711	590 (23.2)	3/8	Pink	C~CR9	G3/8	70 (2.8)		C/V - R/J(C) [Lift blade]
(30)	RD358-64721	490 (19.3)	1/2	Brown	C~CR4	G1/2	22 (0.9)		C/V - R/J(B) [Lift blade]
(31)	RD358-92311	2220 (87.4)	1/2	Pink	C~C	G1/2	–	Resin-spirals , Cover	C/V - Boom base pipe [AUX1 Hi]
(32)	RD358-92321	2220 (87.4)	1/2	Brown	C~C	G1/2	–	Resin-spirals , Cover	C/V - Boom base pipe [AUX1 Low] <AUX1 spec>
(33)	RD551-92413	740 (29.1)	5/8		C~C	G1/2	–	Cover	Boom mid-pipe - Pipe [AUX1 Hi and Low] <AUX1 spec>
(34)	RD451-92512	890 (35.0)	5/8		C~C	G1/2	–	Spring	Boom end pipe - Arm side block [AUX1 Hi and Low]]
(35)	RD551-92611	2680 (105.5)	3/8	Gray	C~C	G1/2	–	Resin-spirals , Cover	C/V - Boom mid-pipe [AUX2 Hi]
(36)	RD551-92621	2760 (108.7)	3/8	Aqua	C~C	G3/8	–	Resin-spirals , Cover	C/V - Boom mid-pipe [AUX2 Low]
(37)	RD551-92652	790 (31.1)	3/8		C~C	G3/8	–	Cover	Boom mid-pipe - Pipe [AUX2 Hi and Low]
(38)	RD451-92681	750 (29.5)	3/8		C~C	G3/8	–	Spring	Boom end pipe - Arm side block [AUX2 Hi and Low]

RY9212032HYS0085US0

(3) Deliver Hose Routing

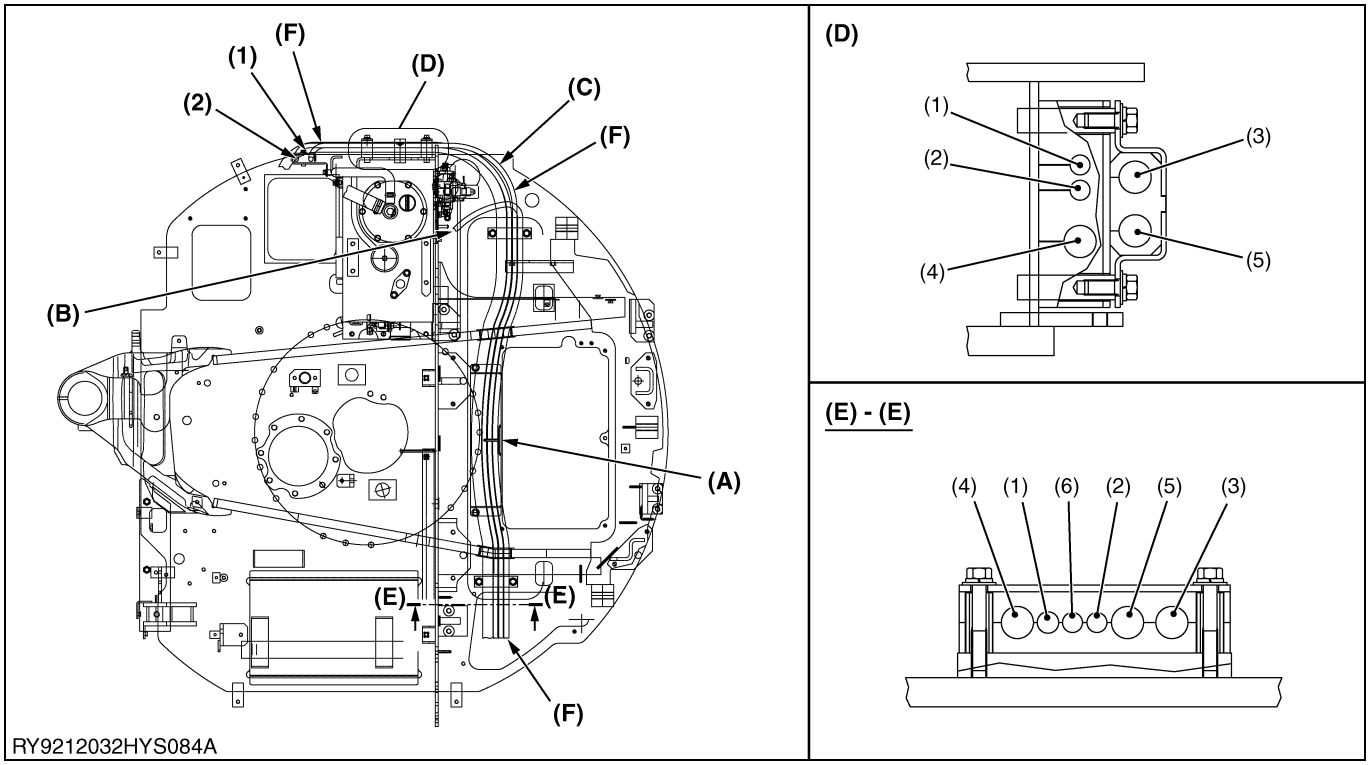


RY9212050HYS011A

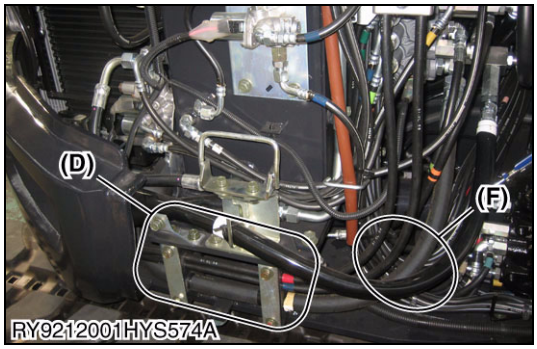
(a) Control valve assembly (b) Pump assembly (piston)

RY9212050HYS0076US0

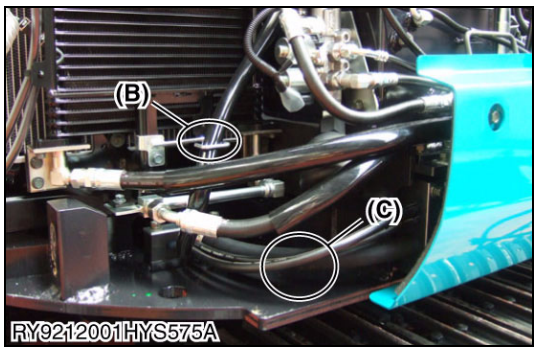
(4) Delivery Hose Clamp Positions



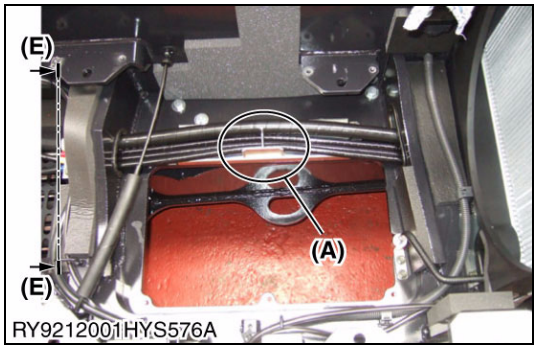
RY9212032HYS084A



RY9212001HYS574A



RY9212001HYS575A



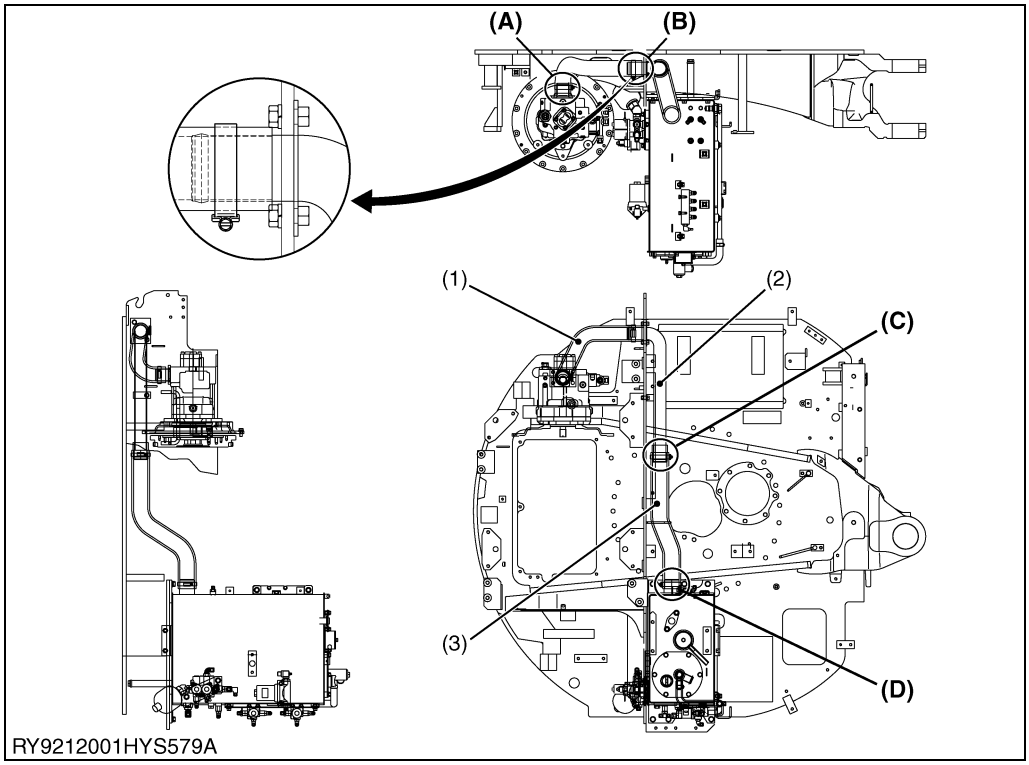
RY9212001HYS576A

(1) Red
(2) Blue
(3) White
(4) Pink
(5) Green
(6) Yellow

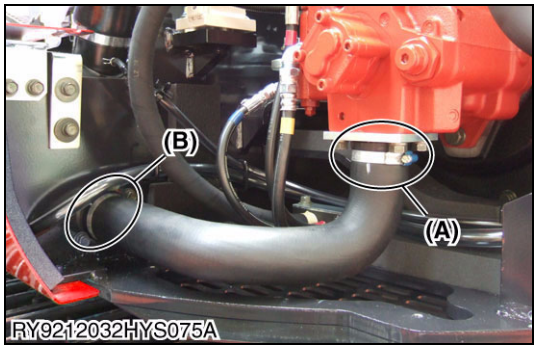
(A) Pass the hose under the rod. Do not overlap hoses.
(B) Hang the plastic tube-wrapped hose on the round rod of the guide (Hose PP).
(C) Must not touch the weight.
(D) Clamps (2 places)
(E) Clamps (2 places)
(F) No hoses touching.

RY9212032HYS0086US0

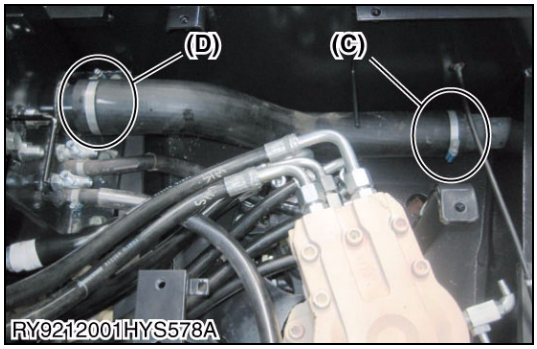
(5) Suction Pipe and Hose Routing



RY9212001HYS579A



RY9212032HYS075A



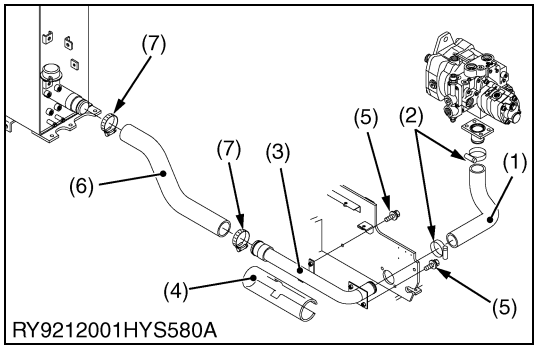
RY9212001HYS578A

(1) Hose (suction 1)
(2) Pipe (suction pipe)
(3) Hose (suction 2)

(A) Hose clamp (50-65)
(B) Hose clamp (50-65)
(C) Hose clamp (58-75)
(D) Hose clamp (58-75)

RY9212050HYS0113US0

(6) Installation of Pipes (suction)



RY9212001HYS580A

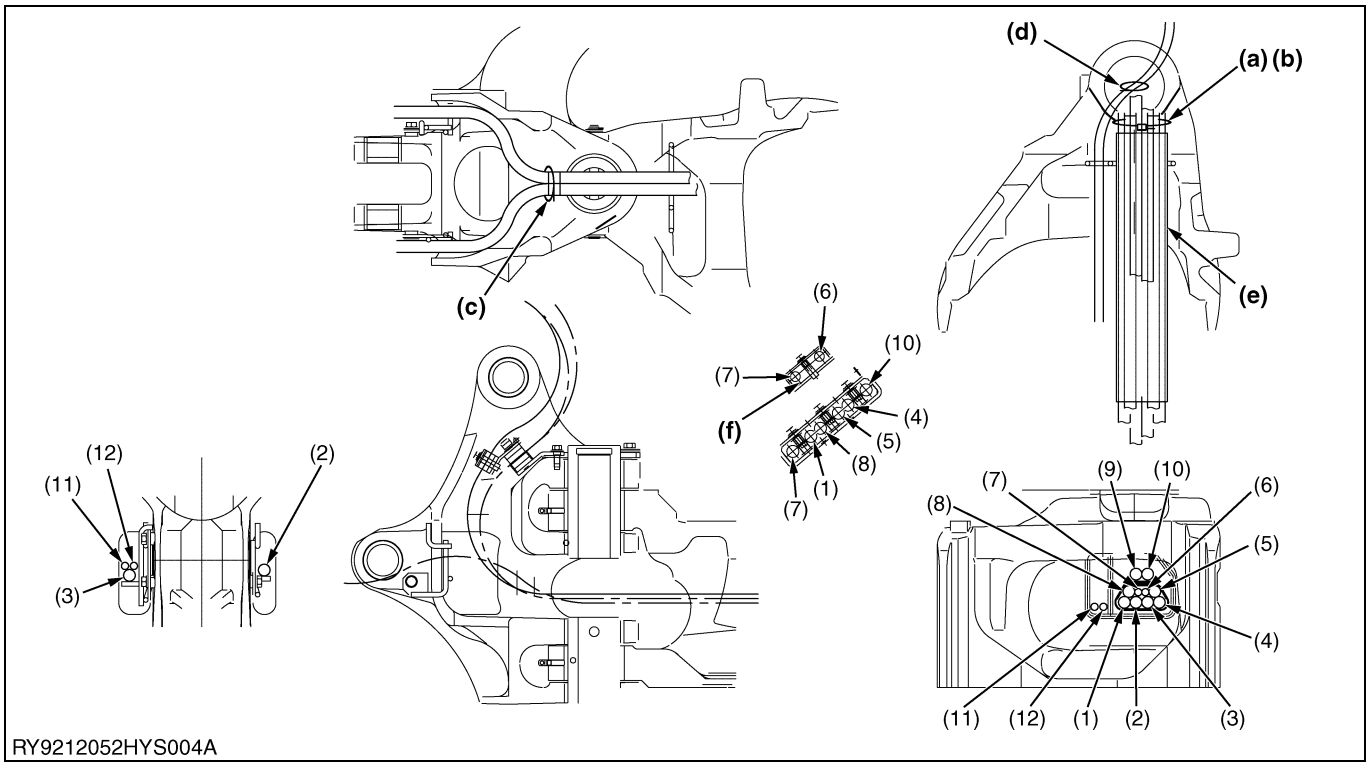
Apply thread compound (Loctite 271) on the pipe (suction) (3) and attach to the frame with the torque indicated below.

Tightening torque	Pipe (suction) (3)	48.1 to 55.9 N·m 4.9 to 5.7 kgf·m 35.5 to 41.2 lbf·ft

(1) Hose (suction 1)
(2) Hose clamp (50-65)
(3) Pipe (suction)
(4) Insulation (suction pipe)
(5) Bolt (M6)
(6) Hose (suction 2)
(7) Hose clip (58-75)

RY9212001HYS0618US0

(7) Front Hose Routing



RY9212052HYS004A

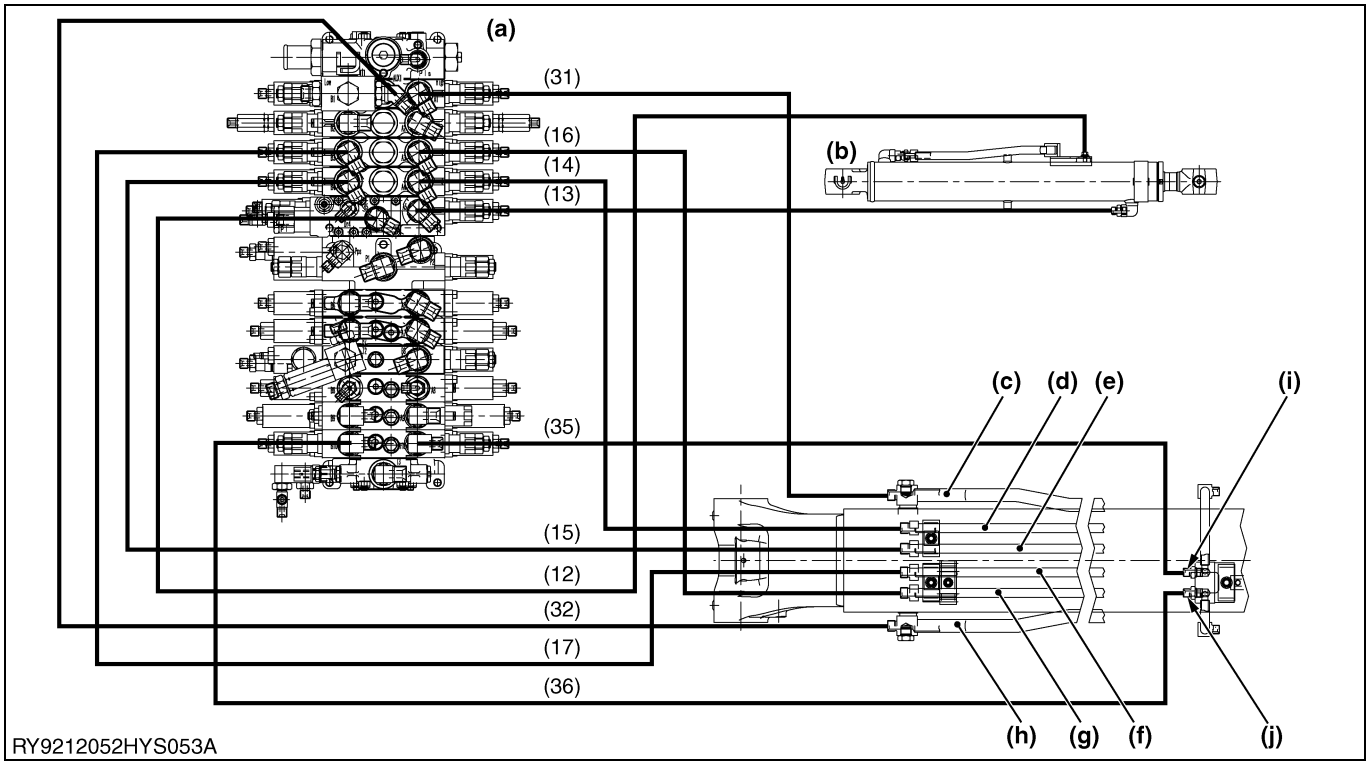
(1) Black
(2) Yellow
(3) Green
(4) Red
(5) White
(6) Aqua blue (AUX2 spec)
(7) Gray (AUX2 spec)
(8) Blue
(9) Pink
(10) Green
(11) Red (H/V spec)
(12) Blue (H/V spec)

■ **NOTE**

- **(a) : AUX 1 Spec. Route the six hoses according to color of tape and clamp them with a plastic tie, then put the two AUX1 hoses on top and clamp all eight hoses with a plastic tie.**
- **(b) : AUX 2 Spec. Route the eight hoses according to color of tape and clamp them with a plastic tie, then put the two AUX1 hoses on top and clamp all ten hoses with a plastic tie.**
- **(c) : Gather the hoses with green tape (lift boom) and yellow tape (lower boom) and clamp with plastic tie.**
- **(d) : Route the boom H/V hoses according to tape and clamp.**
- **(e) : Wrap the cover from just after the colored tape and face the Velcro side up.**
- **(f) : Install so the slit is at the bottom.**

RY9212052HYS0047US0

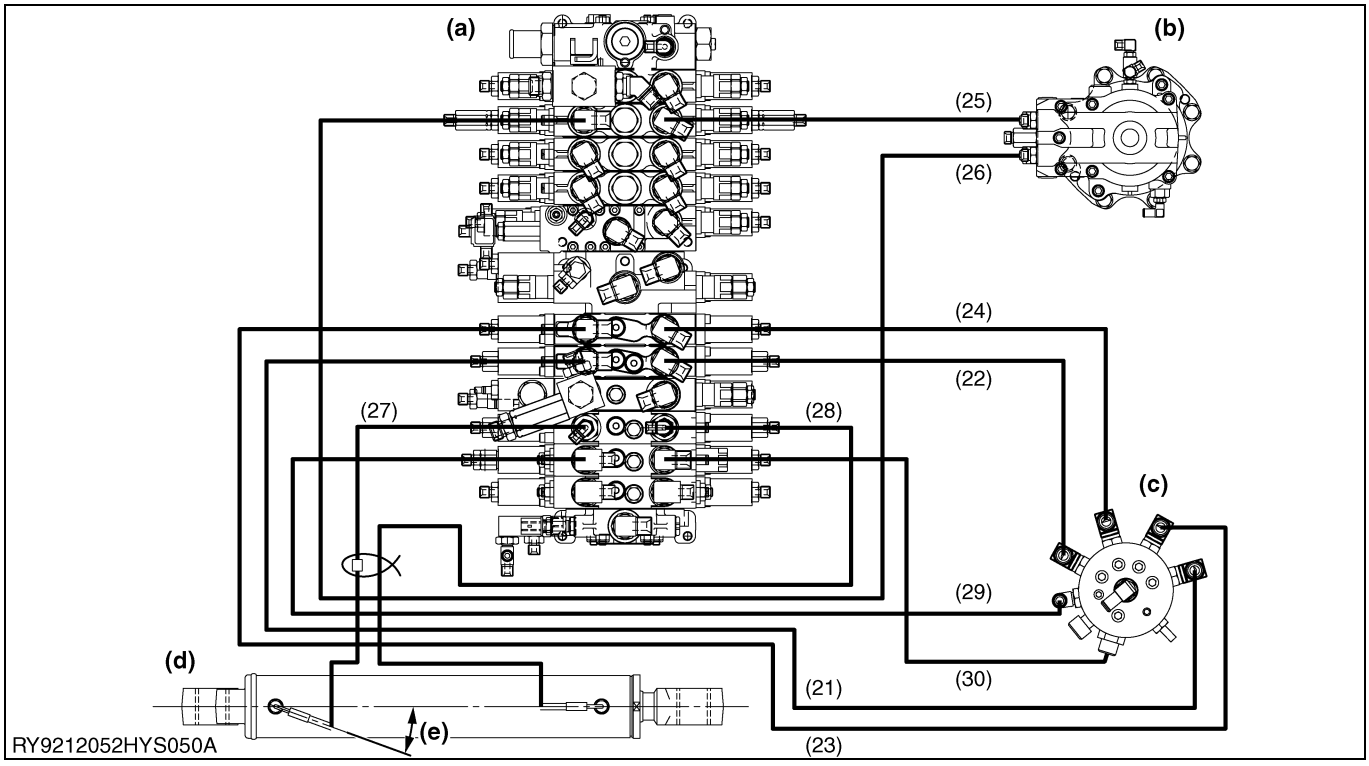
(8) High-pressure Hydraulic Hose Routing (Front)



(a) Control Valve
(b) Cylinder, ASSY (Boom)
(c) AUX1 (High)
(d) Arm (Rod)
(e) Arm (Bottom)
(f) Bucket (Bottom)
(g) Bucket (Rod)
(h) AUX1 (Low)
(i) AUX2 / Thumb (Bottom)
(j) AUX2 / Thumb (Rod)

RY9212032HYS0105US0

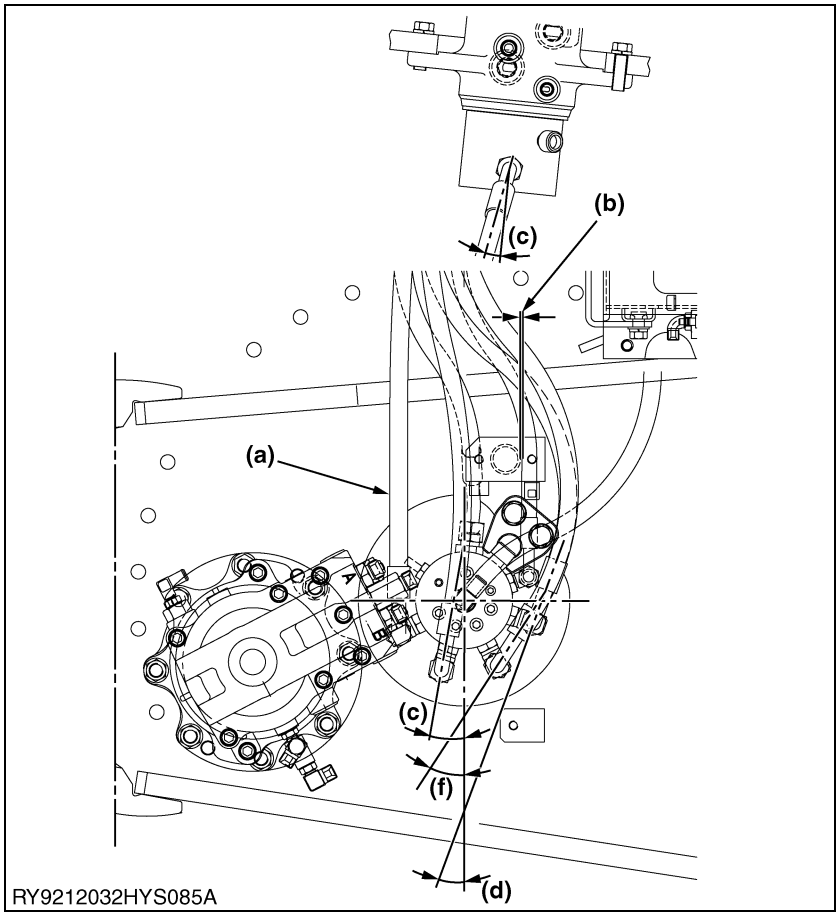
(9) High-pressure Hydraulic Hose Routing (Travel, Swivel, Blade, Swing)



(a) Control valve
(b) Motor, ASSY (swivel)
(c) Swivel Joint
(d) Cylinder, ASSY (swing)
(e) 20 °

RY9212052HYS0051US0

(10) Swivel Hose Routing (KX057-4)

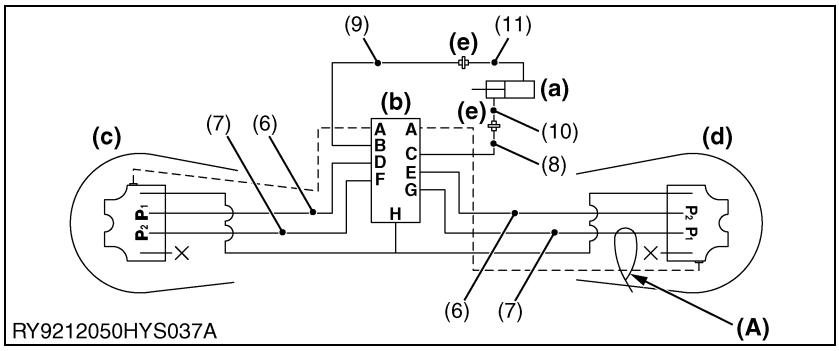


RY9212032HYS085A

(a) Install directly toward the C/V (travel left fwd)
(b) Install the hose in the gap so it just misses other pipes and hoses. (Lift dozer)
(c) 10 °
(d) 20 °
(e) 30 °
(f) 33 °

RY9212032HYS0087US0

(11) High-pressure Hydraulic Hose Routing (Travel, Blade Swivel)



RY9212050HYS037A

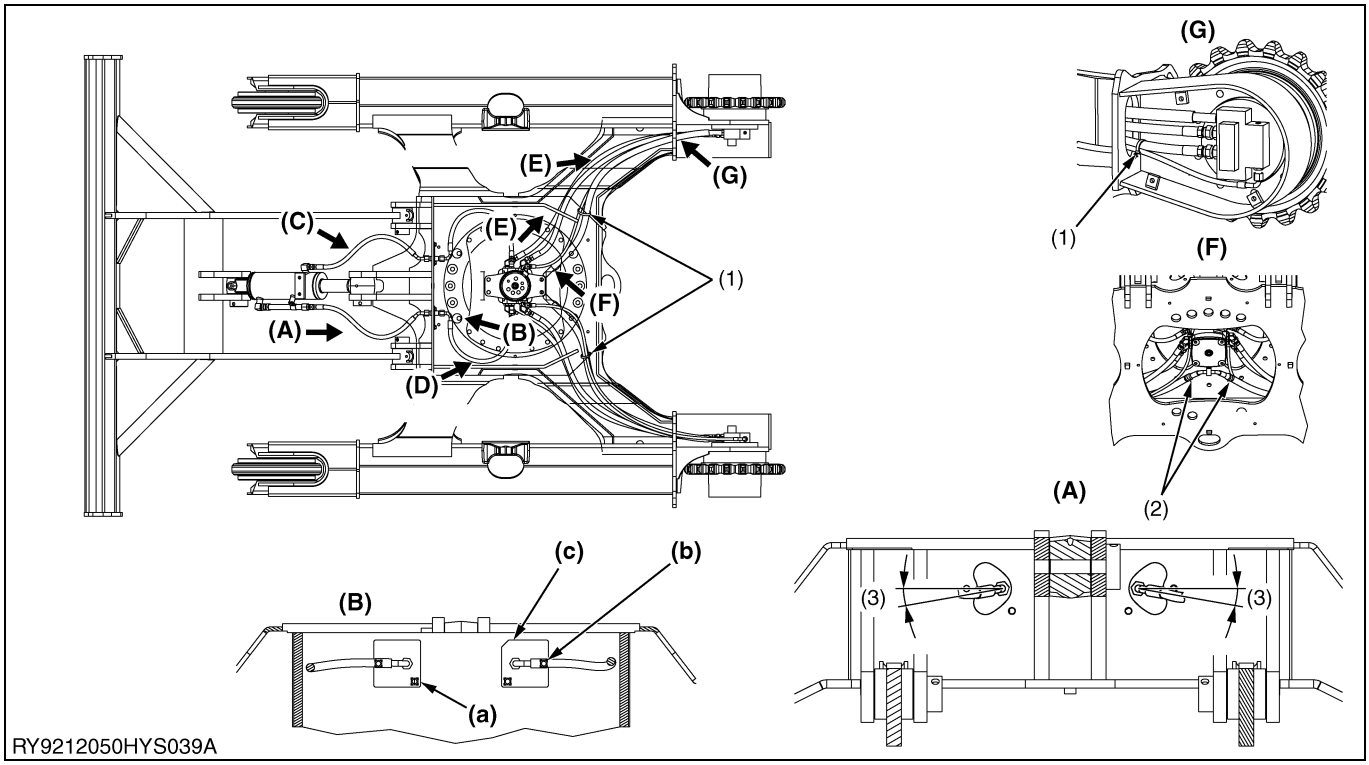
	S/J side	Travel motor / cylinder side
A	2-speed pilot	L/R travel 2-speed
B	Lower blade	Cylinder-bottom side
C	Lift blade	Cylinder-rod side
D	Left forward	Left P1
E	Right forward	right P2
F	Left backward	left P2
G	Right backward	right P1
H	Drain	L/R drain port (upper)

(a) Blade Cylinder
(b) Swivel Joint
(c) Wheel motor left side
(d) Wheel motor right side
(e) Bracket

(A) Clamp the 2-speed pressure increase signal hose and the P1 hose (right track). (Do not come in contact with the track frame.)

RY9212050HYS0082US0

(12) Hose Routing Inside the Track Frame



(1) Clamp
(2) Protective tubing fastening tape
(3) 10 °

■ **NOTE**

- **(A) : When connecting the blade hose bracket and cylinder side hose, angle the connector down 10 °.**
- **(B) : Connection of blade hose bracket and swivel side hose.**
- **(C) : So hoses do not kink when blade moves up/down. (left/right same)**
- **(D) : Hoses not to touch track frame. (left/right same)**
- **(E) : Hoses not to come in strong contact with track frame or each other.**
- **(F) : Install tape on the swivel joint side.**
- **(G) : Clamp the 2-speed signal hose with the high-pressure hose at this point. (right side only)**
- **(a) : Install the left/right brackets so the welded nut comes forward.**
- **(b) : Hoses to take a horizontal path. (align with the horizontal position of the welded nut, same right/left)**
- **(c) : The corner of the right side bracket has a bevel to identify it.**

RY9212052HYS0094US0

[2] TABLE OF HYDRAULIC HOSES (LOW-PRESSURE HOSES)

(1) Table of Low-Pressure Hoses

No.	Part number	Hose			Fitting			Guard	Position Used
		Total length mm (in.)	Size	Tape color	Type	Size	Dimen-sions mm (in.)		
(1)	RD451-63512	410 (16.1)	1/2		CR9~C	G1/2	46 (1.8)		Unload valve - O/T [T]
(2)	RD551-63612	1230 (48.4)	5/8	White	C~C	G1/2	–	Tube	C/V (T2) - O/C
(3)	RD451-63623	600 (23.6)	5/8	White	C~CR4	G1/2	–	Tube	O/C - Return pipe
(4)	RD451-63741	1110 (43.7)	–		–	–	–		R/J - Travel motor [Drain (left and right)]
(5)	RD551-64551	510 (20.1)	–		–	–	–		R/J - O/T [Travel motor drain]
(6)	RD358-64531	630 (24.8)	5/8	White	C~C	G1/2	–	Tube	C/V - Swivel motor [Makeup]
(7)	RD358-64551	780 (30.7)	–		–	–	–		Travel motor - O/T [Drain]
(8)	RD551-92522	340 (13.4)	5/8		C~CR9	G1/2	46 (1.8)		Third line valve - C/V (T2)

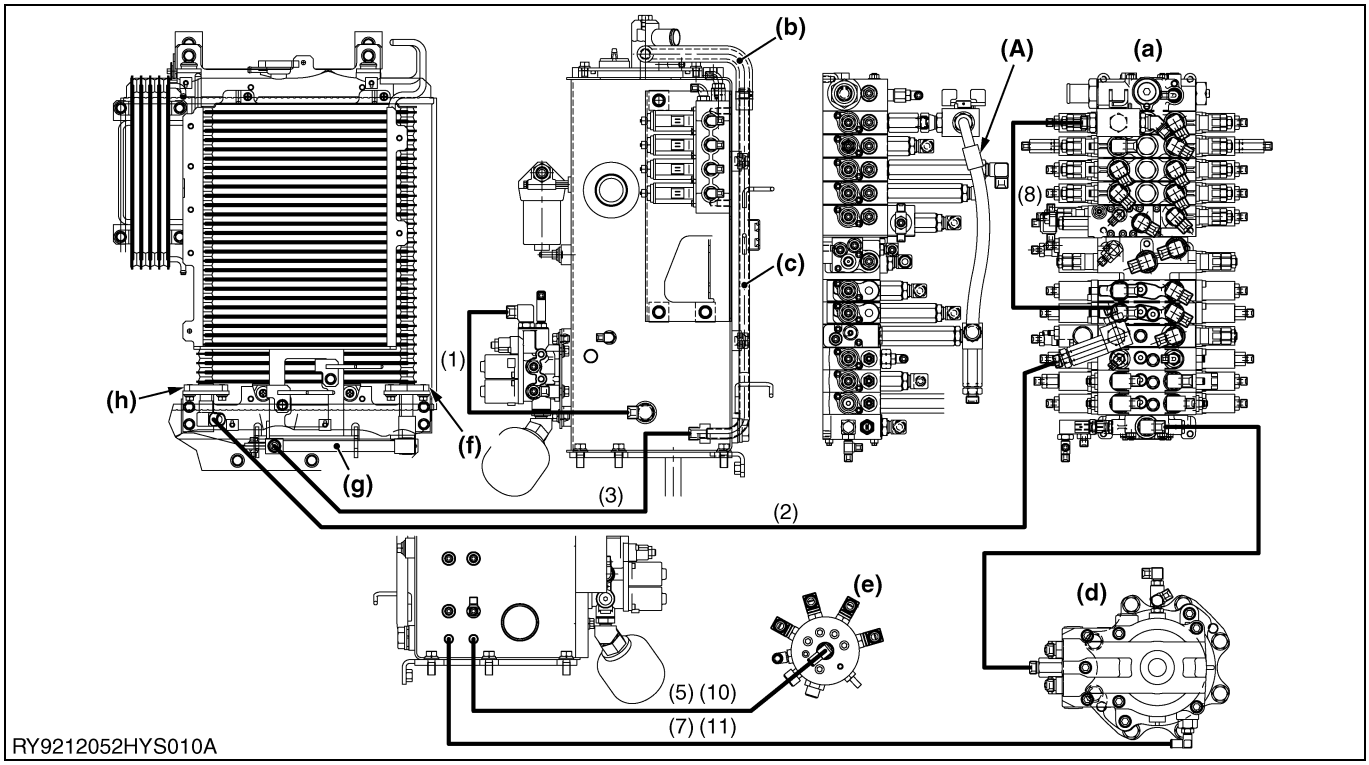
RY9212032HYS0088US0

(2) Table of Protective Tubing

No.	Part number	Hose					Guard	Position Used
		Total length mm (in.)	Tape color					
(9)	RC411-43051	1000 (39.4)		–	–	–	–	Use for low - pressure hose No.4
(10)	68191-63451	400 (15.7)		–	–	–	–	Use for low - pressure hose No.5
(11)	RD358-64561	650 (25.6)		–	–	–	–	Use for low - pressure hose No.7

RY9212032HYS0089US0

(3) Drain Hose Routing



(a) Control valve
(b) Hose (return, cooler)
(c) Pipe (return, cooler)
(d) Motor, ASSY (swivel)
(e) Swivel joint
(f) Bracket (R, oil cooler)
(g) Pipe (oil cooler)
(h) Bracket (L, oil cooler)

■ **NOTE**

- **(A) : Install so the hose will not kink.**

Note) The number in parentheses that appears after the hose number is the (protective tube number). Hose No. (Protective tube no.)

RY9212052HYS0056US0

[3] TABLE OF HYDRAULIC HOSES (PILOT HOSES)

(1) Table of Pilot Hoses

No.	Part number	Hose			Fitting			Guard	Position Used
		Total Length mm (in.)	Size	Tape color	Type	Size	Di-mensions mm (in.)		
(1)	RD359-62511	2280 (89.8)	1/4	Green	Quick - CR9	G1/4	44.5 (1.8)		Steering P/V- C/V [Lift boom]
(2)	RD359-62521	2370 (93.3)	1/4	Yellow	Quick - CR9	G1/4	24 (0.9)		Steering P/V- C/V [Lower boom]
(3)	RD359-62531	2050 (80.7)	1/4	Black	Quick - CR9	G1/4	44.5 (1.8)		Steering P/V- C/V [Dump arm]
(4)	RD359-62541	2810 (110.6)	1/4	Blue	Quick - CR9	G1/4	44.5 (1.8)		Steering P/V- C/V [Crowd arm]
(5)	RD358-62551	1540 (60.6)	1/4	Red	Quick - CR9	G1/4	44.5 (1.8)		Steering P/V- C/V [Dump bucket]
(6)	RD358-62561	2180 (85.8)	1/4	White	Quick - CR9	G1/4	24 (0.9)		Steering P/V- C/V [Crowd bucket]
(7)	RD358-62571	2160 (85.0)	1/4	Gray	Quick - CR9	G1/4	24 (0.9)		Steering P/V- C/V [Swivel left]
(8)	RD358-62581	2820 (111.0)	1/4	Aqua	Quick - CR9	G1/4	24 (0.9)		Steering P/V- C/V [Swivel right]
(9)	RD358-62611	2280 (89.8)	1/4	Pink	Quick - CR9	G1/4	44.5 (1.8)		Steering P/V- C/V [Lift blade]
(10)	RD358-6262	1710 (67.3)	1/4	Brown	Quick - CR9	G1/4	44.5 (1.8)		Steering P/V- C/V [Lower blade]
(11)	RD358-62632	2610 (102.8)	1/4	Green -ish yellow	Quick - CR9	G1/4	44.5 (1.8)		Swing P/V - C/V [Swing left]
(12)	RD358-62642	1940 (76.4)	1/4	Or-ange	Quick - CR9	G1/4	44.5 (1.8)		Swing P/V - C/V [Swing right]
(13)	RD358-62652	2570 (101.2)	1/4	Blue	Quick - CR9	G1/4	24 (0.9)		Travel P/V - C/V [left fwd]
(14)	RD358-62662	1890 (74.4)	1/4	Red	Quick - CR9	G1/4	32 (1.3)		Travel P/V - C/V [left bwd]
(15)	RD358-62672	2570 (101.2)	1/4	Green	Quick - CR9	G1/4	24 (0.9)		Travel P/V - C/V [right fwd]
(16)	RD358-62682	1890 (74.4)	1/4	Yellow	Quick - CR9	G1/4	44.5 (1.8)		Travel P/V - C/V [right bwd]
(21)	RD458-62711	760 (29.9)	1/4	Pink	C - CR9	G1/4	24 (0.9)		Four-way proportioning valve or AUX1 proportioning valve - C/V [AUX1 Hi]
(22)	RD458-62721	290 (11.4)	1/4	Brown	C - C	G1/4	–		Four-way proportioning valve or AUX1 proportioning valve - C/V [AUX1 Low]
(23)	RD451-63151	1050 (41.3)	3/16		C - Quick	G1/4	–	Colgate tube	Pump (drain) - nothing [Air bleed]
(24)	RD551-63245	2040 (80.3)	3/8		C - C	G1/4	–	Resin-spirals, tube	Pump (P4) - Line filter
(25)	RD451-63252	430 (16.9)	3/8		CR9 - C	G1/4	38 (1.5)		Line filter - Unload valve [P]
(26)	RD358-63283	1520 (59.8)	3/8		C - CR9	G1/4	38 (1.5)		Swivel motor - P collector block 5 [Swivel brake release]
(27)	RD551-63293	670 (26.4)	1/4		CR9 - C	G1/4	44.5 (1.8)		Unload valve - C/V [AI]
(28)	RD451-63313	1980 (78.0)	1/4		Quick - CR9	G1/4	24 (0.9)		Steering P/V (left) - P collector block 3 [P]

No.	Part number	Hose			Fitting			Guard	Position Used
		Total Length mm (in.)	Size	Tape color	Type	Size	Di-mensions mm (in.)		
(29)	RD451-63324	1450 (157.1)	1/4		Quick - CR9	G1/4	24 (0.9)		Steering P/V (right) - P collector block 2 [P]
(30)	RD451-63334	1200 (47.2)	1/4		Quick - CR9	G1/4	24 (0.9)		Blade P/V (left) - P collector block 4[P]
(31)	RD358-63341	620 (24.4)	1/4		CR9 - C	G1/4	24 (0.9)	Resin-spirals, tube	Swing P/V - Travel PV [P]
(32)	RD358-63352	300 (11.8)	3/8		CR9 - C	G3/8	38 (1.5)		Travel PV - Swivel motor [P]
(33)	RD458-63361	670 (26.4)	1/4		C - CR9	G1/4	24 (0.9)		Four-way proportioning valve or AUX1 proportioning valve - Unload valve [P]
(34)	RD451-63385	1480 (58.3)	3/8		C - C	G3/8	–		Unload valve - P collector block 1 [P base pressure]
(35)	RD451-63413	1760 (69.3)	1/4		Quick - C	G1/4	–		Steering P/V (left) - O/T left bottom [T]
(36)	RD451-63423	1180 (46.5)	1/4		Quick - C	G1/4	–		Steering P/V (right) - O/T right bottom [T]
(37)	RD451-63433	950 (37.4)	1/4		Quick - CR4	G1/4	24 (0.9)		Blade P/V - O/T [T]
(38)	RD358-63442	1470 (57.9)	1/4		Quick - CR4	G1/4	24 (0.9)		Swing P/V - O/T [T]
(39)	RD358-63451	540 (21.3)	1/4		CR9 - C	G1/4	24 (0.9)	Resin-spirals	Swing P/V - Travel PV [T]
(40)	RD458-63461	530 (20.9)	1/4		C - CR9	G1/4	24 (0.9)		Four-way proportioning valve or AUX1 P/V - O/T [Proportioning valve T]
(41)	RD451-63552	860 (33.9)	1/4	Yellow	C - CR9	G1/4	24 (0.9)		C/V (Pi) - C/V (Pa5) [Boom lock valve release]
(42)	RD451-63584	720 (268.3)	1/4		C - C	G1/4	–		C/V(DR) - O/T [Boom lock valve drain]
(43)	RD451-63731	1250 (49.2)	1/4		C - CR9	G1/4	24 (0.9)		R/J - Travel motor (2-speed L and R)
(44)	RD551-63911	470 (18.5)	1/4		C - CR9	G1/4	24 (0.9)		C/V(PP1) - C/V(PP2)
(45)	RD551-63922	600 (23.6)	1/4		C - CR9	G1/4	24 (0.9)		C/V(PP1) - C/V(PP3)
(46)	RD551-63933	300 (11.8)	1/4		C - Quick	G1/4	–		C/V(PF1) - C/V(PF2)
(47)	RD358-64461	2580 (101.6)	1/4		CR9 - Quick	G1/4	24 (0.9)	Resin-spirals	Unload valve - R/J [2-speed]
(48)	RD359-79811	2150 (84.6)	1/4	Yellow	CR9 - C	G1/4	24 (0.9)	Resin-spirals	C/V - Boom HV [Boom HV P]
(49)	RD359-79822	2640 (103.9)	1/4	Red	CR9 - C	G1/4	24 (0.9)	Resin-spirals	O/T - Boom HV [Boom HV T]
(50)	RD358-62731	1210 (47.6)	1/4	Gray	C - CR9	G1/4	24 (0.9)		Four-way proportioning valve - C/V [AUX2 Hi]
(51)	RD558-62741	520 (20.5)	1/4	Aqua	C - C	G1/4	–		Four-way proportioning valve - C/V [AUX2 Low]

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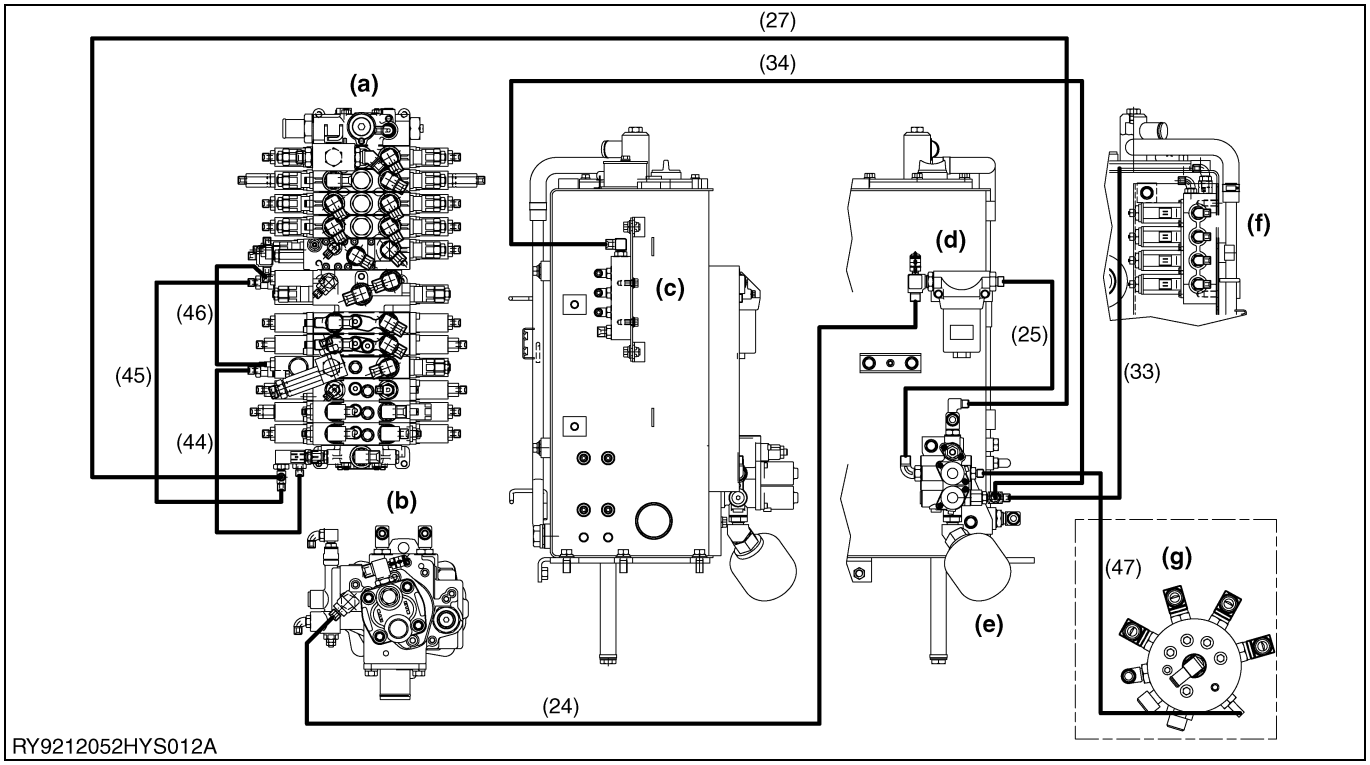
(2) Pilot Hose Routing 1 (P)



(a) Control valve
(b) Pump assembly (piston)
(c) Coupler (Block PP)
(d) Filter, assy (pressure)
(e) Valve ASSY (unload)
(f) Valve ASSY (proportional, 4)
(g) Swivel joint, ASSY

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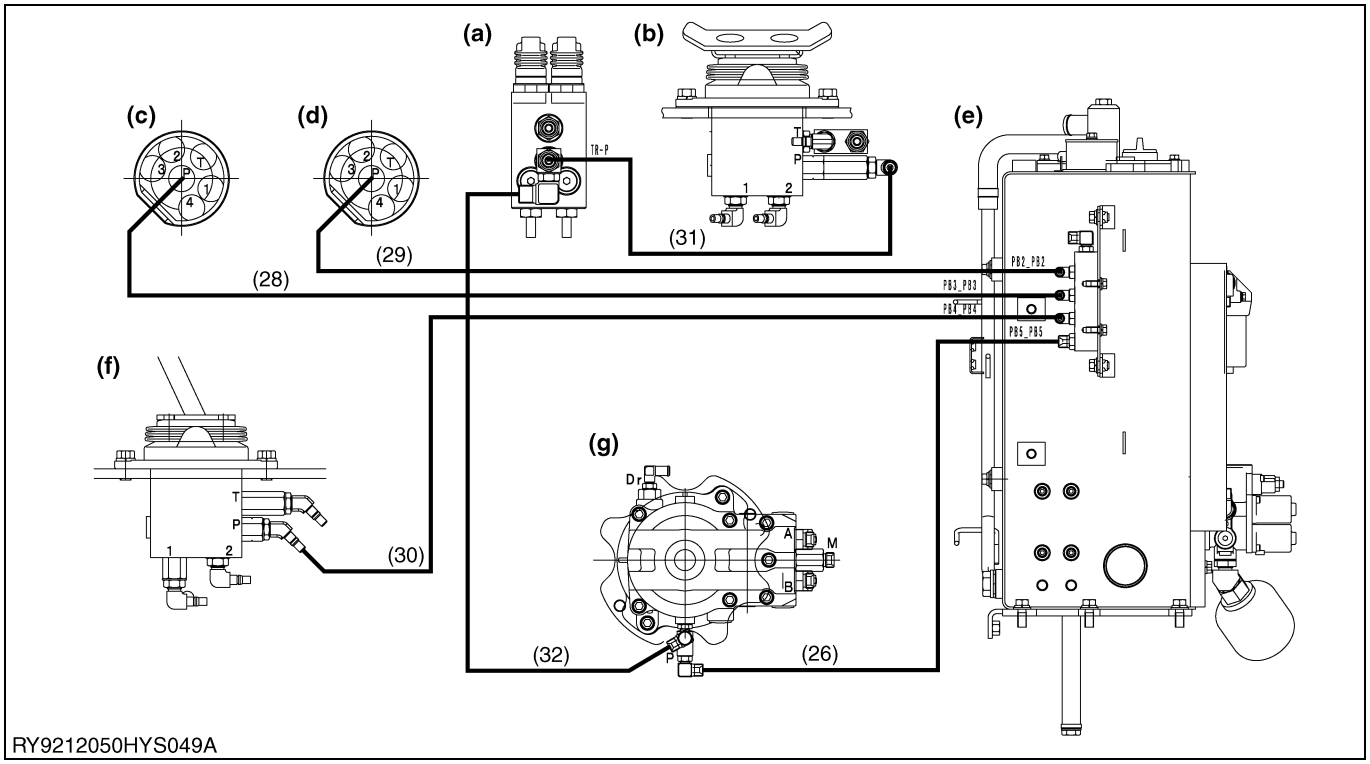
(3) Pilot Hose Routing 2 (P)



(a) Valve assembly (PV travel)
(b) Valve, ASSY (PV swing)
(c) Pilot Valve (left)
(d) Pilot Valve (right)
(e) Coupler (Block PP)
(f) Valve ASSY (PV, Blade)
(g) Motor, ASSY (swivel)

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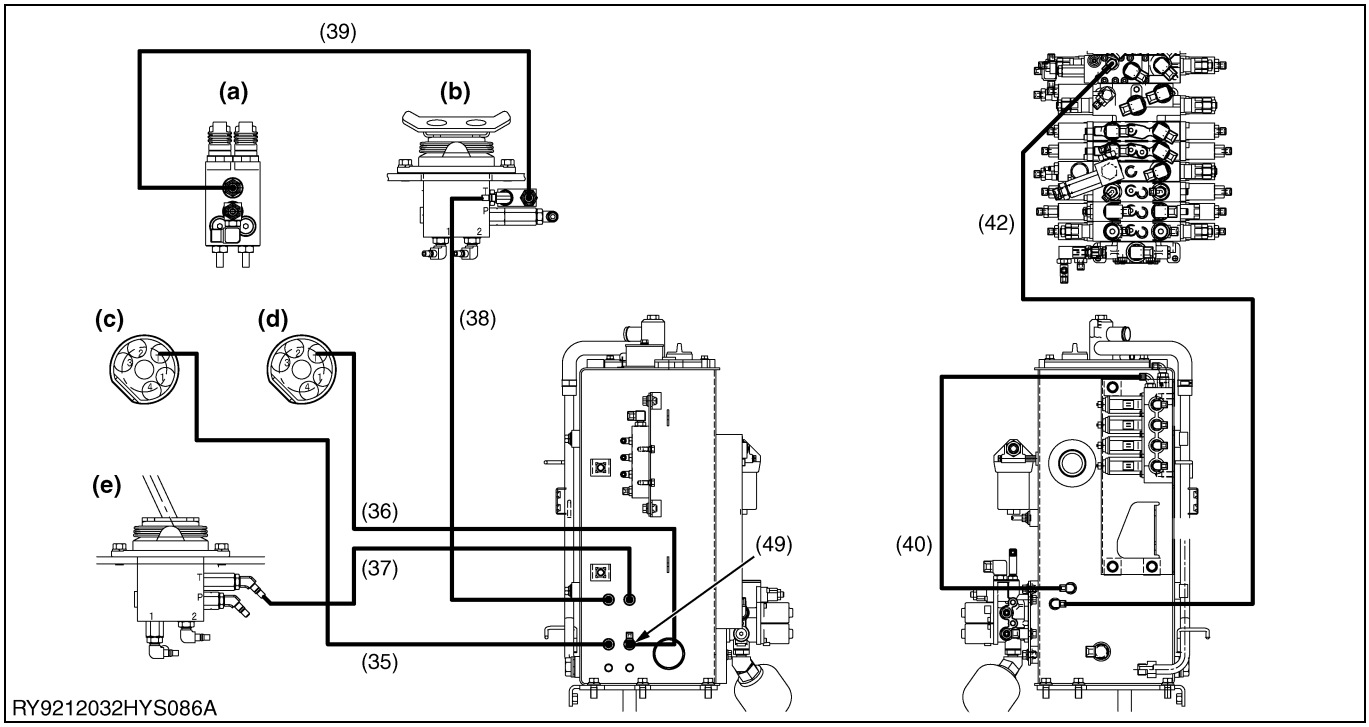
(4) Pilot Hose Routing (T)



(a) Valve assembly (PV travel) **(b) Valve, ASSY (PV swing)** **(c) Pilot Valve (left)** **(d) Pilot Valve (right)** **(e) Valve ASSY (PV, Blade)**

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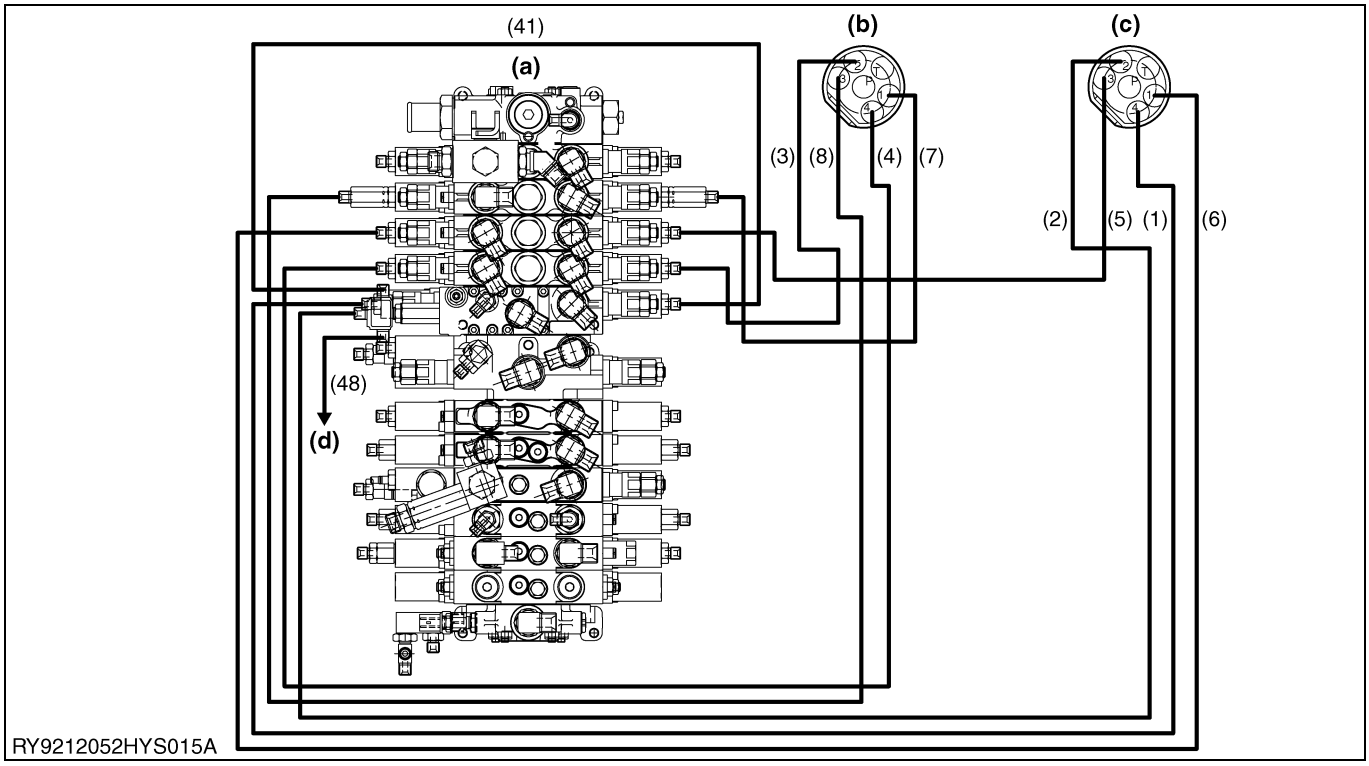
(5) Pilot Hose Routing (Front)



(a) Control valve **(b) Pilot Valve (left)** **(c) Pilot Valve (right)** **(d) To boom holding valve**

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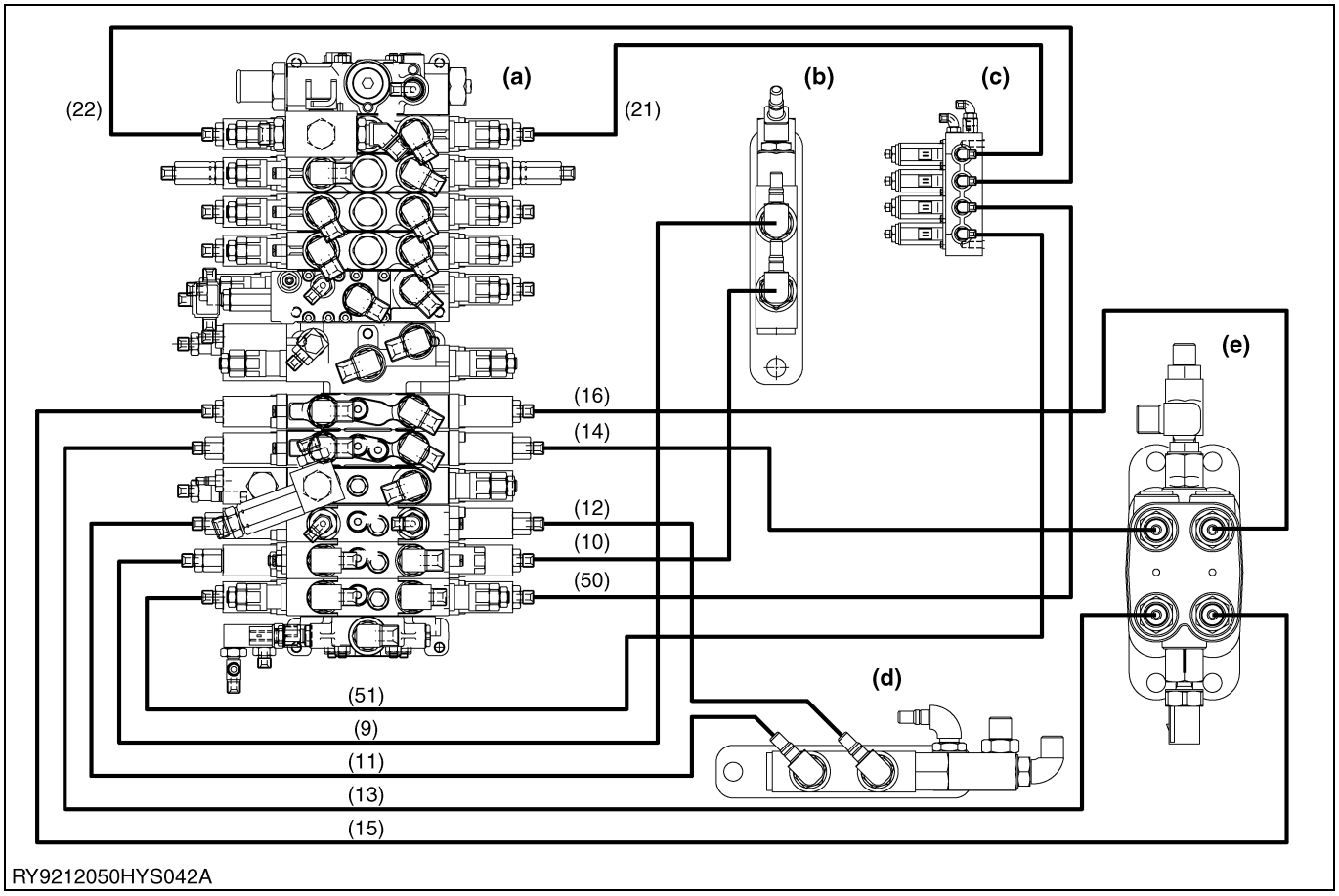
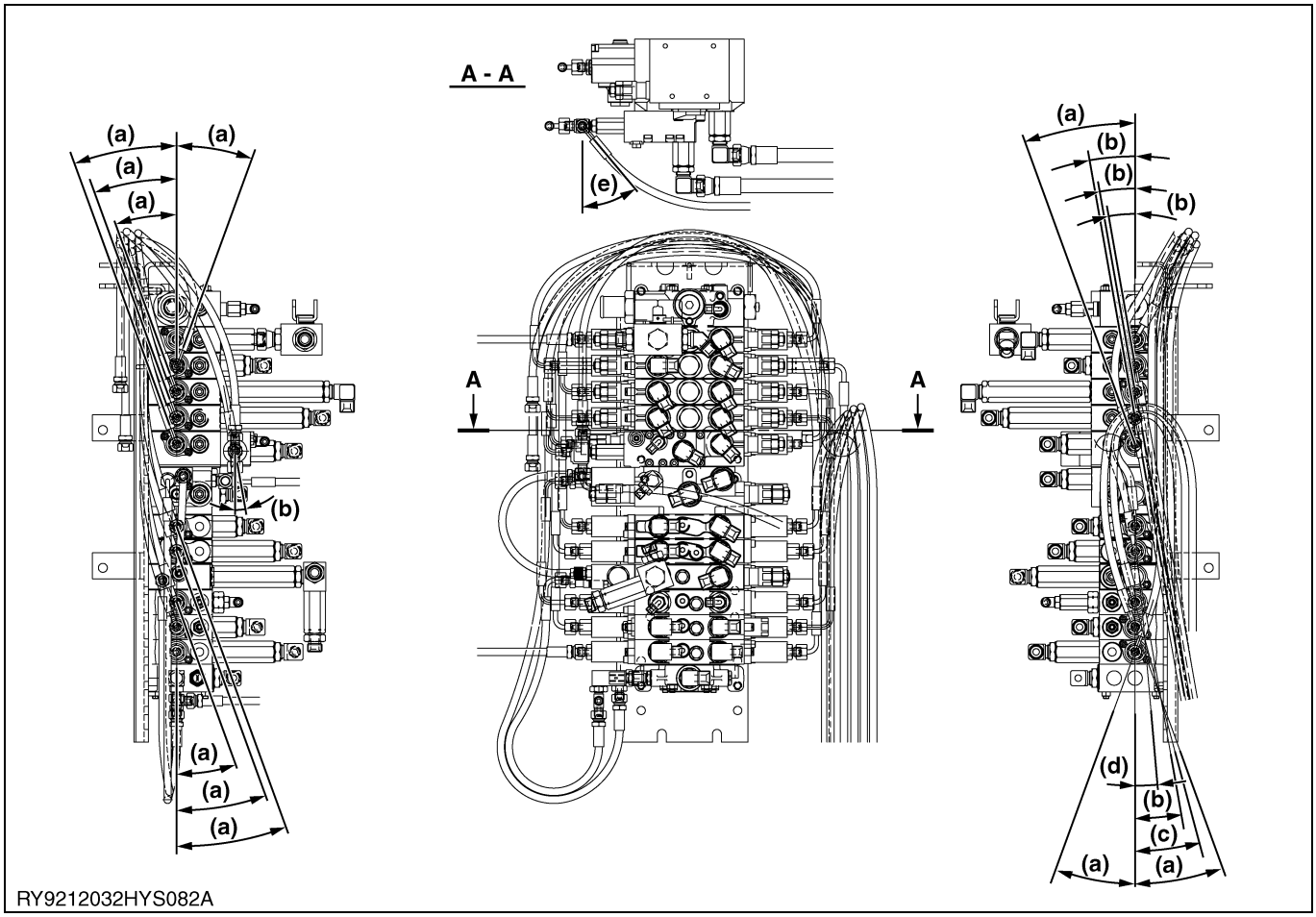
(6) Pilot Hose Routing (Travel, Blade, Swing, AUX1, AUX2)



(a) Control valve
(b) Valve assembly (PV, blade)
(c) Valve ASSY (proportional, 4)
(d) Valve, ASSY (PV swing)
(e) Valve assembly (PV travel)

RY9212052HYS0065US0

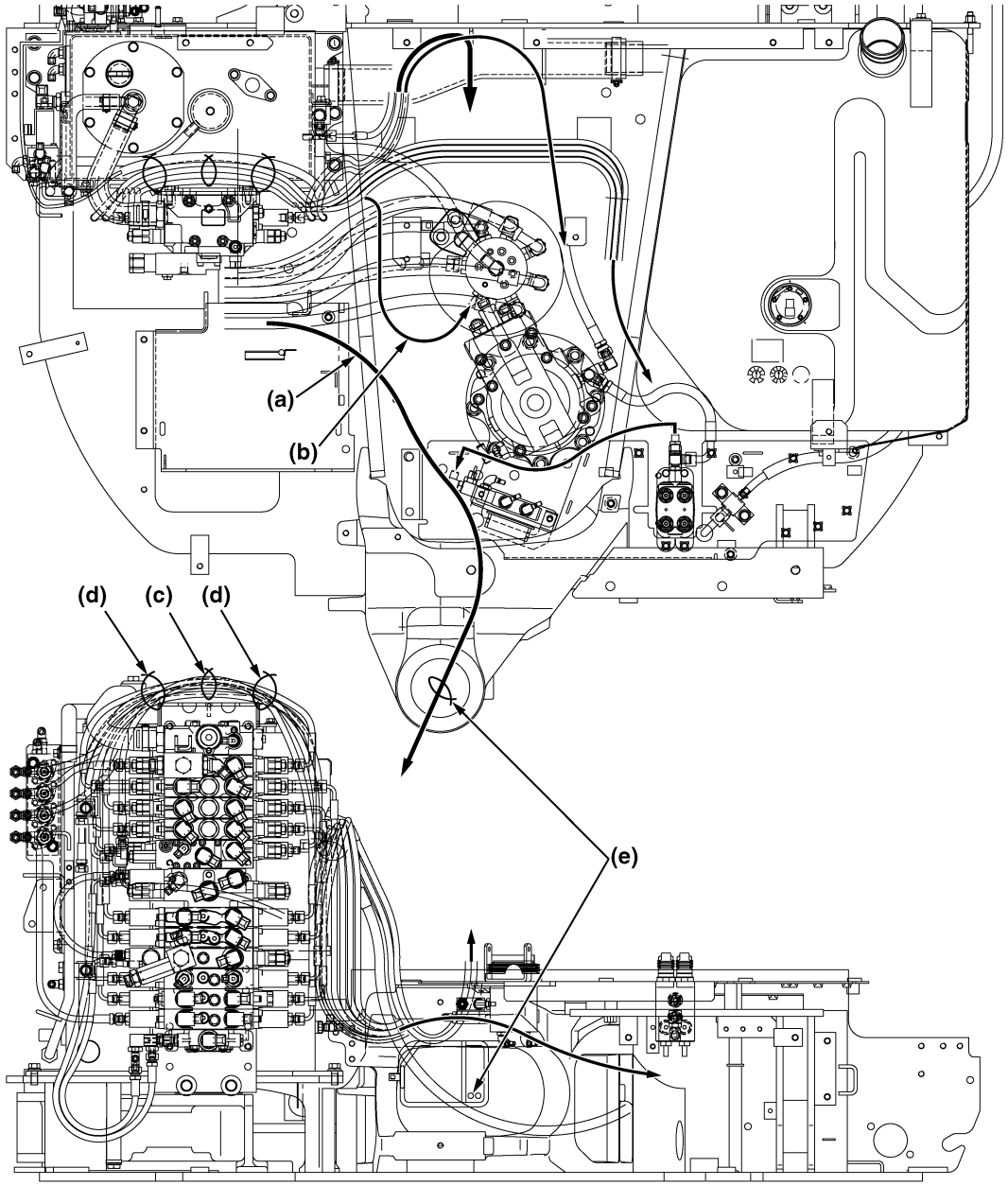
(7) Pilot Hose Routing (Control Valve)



(a) 20 ° **(c) 15 °** **(d) 5 °** **(e) 40 °**
(b) 10 °

RY9212032HYS0092US0

(8) Overall Routing of Pilot Hoses (Front of Machine)



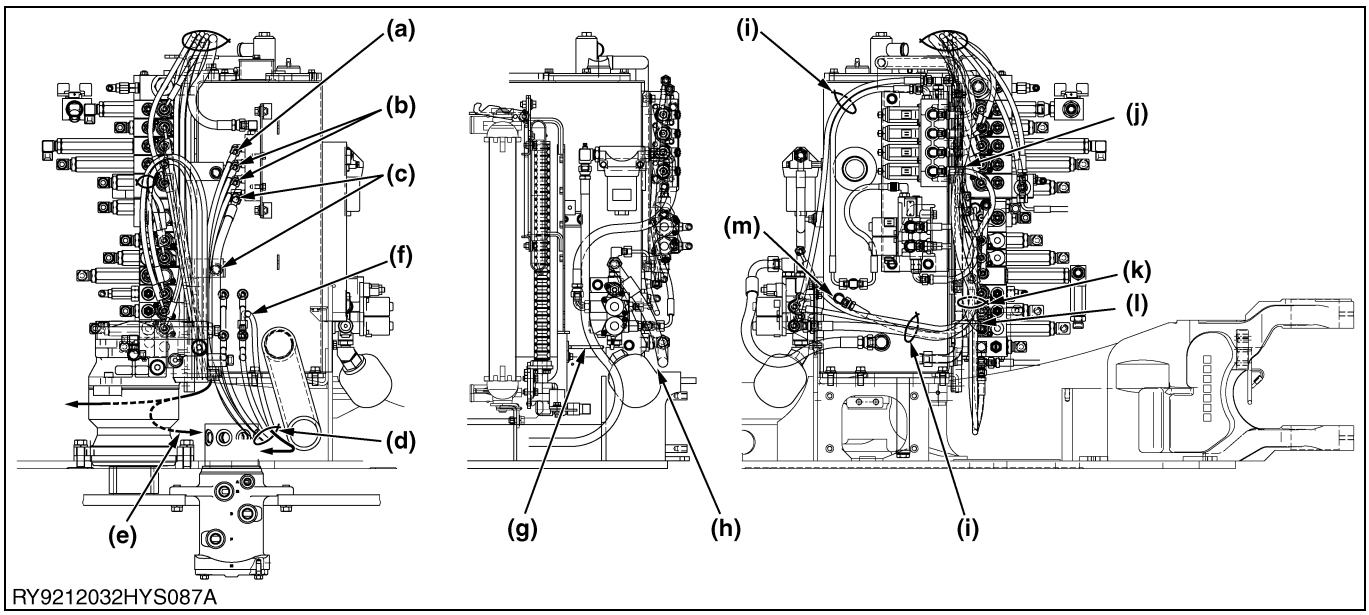
RY9212032HYS083A

■ **NOTE**

- **(a) : Pass the boom H/V hoses along the front hoses.**
- **(b) : Pass the 2-speed travel hose between the round pipe and the vertical rib of the swivel frame and then behind the makeup hose of the swivel motor.**
- **(c) : Clamp with a speed clamp.**
- **(d) : After gathering the unload V and CV pilot hoses together, clamp them together with a speed clamp.**
- **(e) : Gather the boom H/V pilot hoses together where the hoses are taped and clamp them at the taped position.**

RY9212032HYS0093US0

(9) Overall Routing of Pilot Hoses (Right of Machine)



RY9212032HYS087A

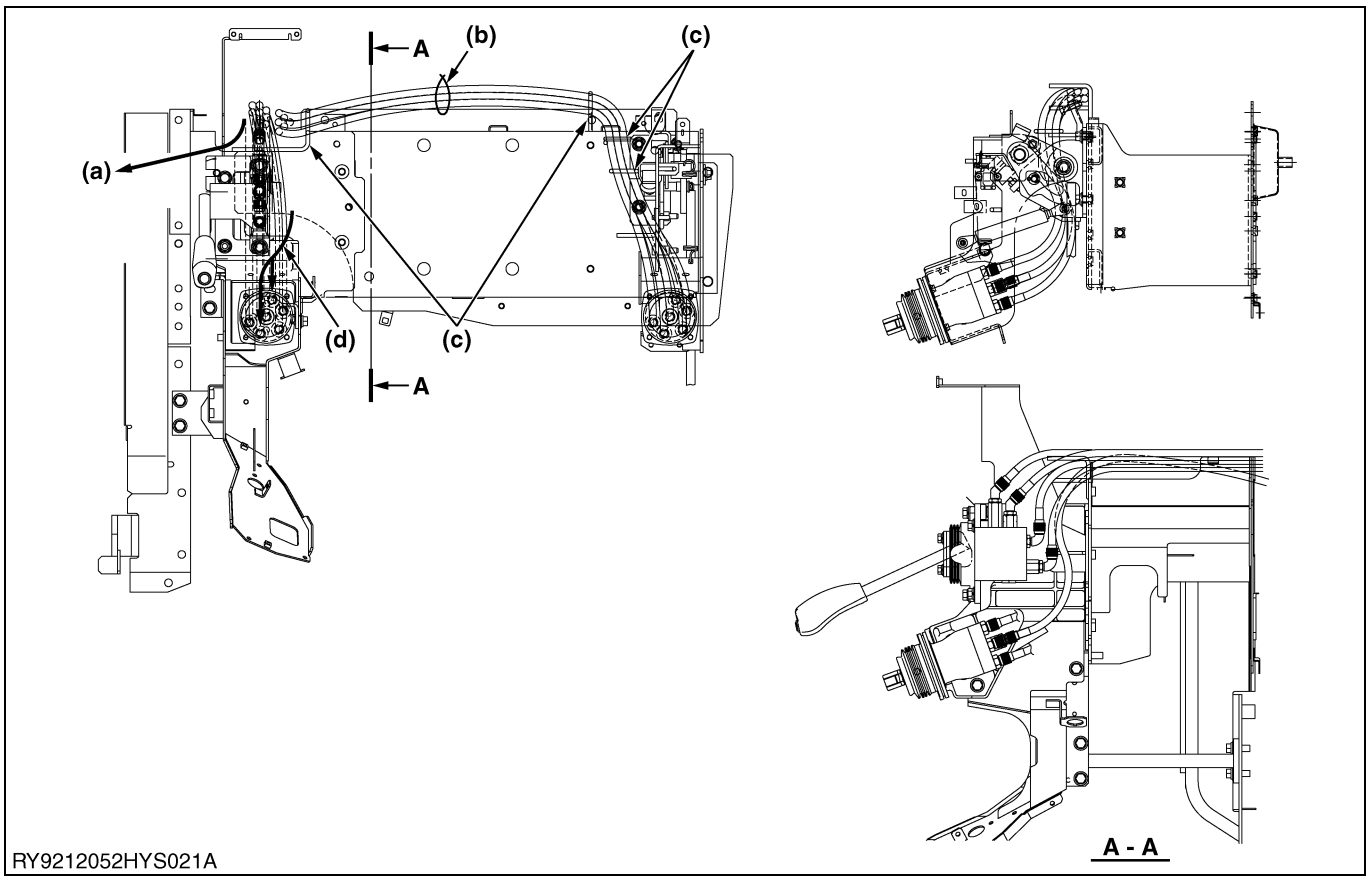
(1) Clamp

■ **NOTE**

- **(a) : Aim for directly above PB3.**
- **(b) : Hoses not to touch each other.**
- **(c) : Aim for CV block mounting bolts.**
- **(d) : Clamp. Aim for the white tape and the middle of the base of the hose.**
- **(e) : To R/J 2-speed travel port.**
- **(f) : Pass the boom H/V Dr hose between the suction hose and the pilot valve (Right, T) hose.**
- **(g) : Hang from the round rod.**
- **(h) : Install with a gap of at least 20mm (0.79 in.) from solenoid parts.**
- **(i) : Clamp.**
- **(j) : Clamp the 2-speed travel and pilot base pressure hoses to the round rod welded to the return pipe.**
- **(k) : Gather the boom lock Dr & 2-speed travel pilot base pressure hoses at the white tape and clamp them. (AUX2 spec) Gather the AUX2 Low hose too and clamp together at the white tape.**
- **(l) : Hang from the round rod welded to the return pipe.**
- **(m) : Install so hoses do not touch the boom lock (Dr) adapter or hoses.**

RY9212032HYS0094US0

(10) Pilot Hose Routing (around the driver's seat)



RY9212052HYS021A

■ **NOTE**

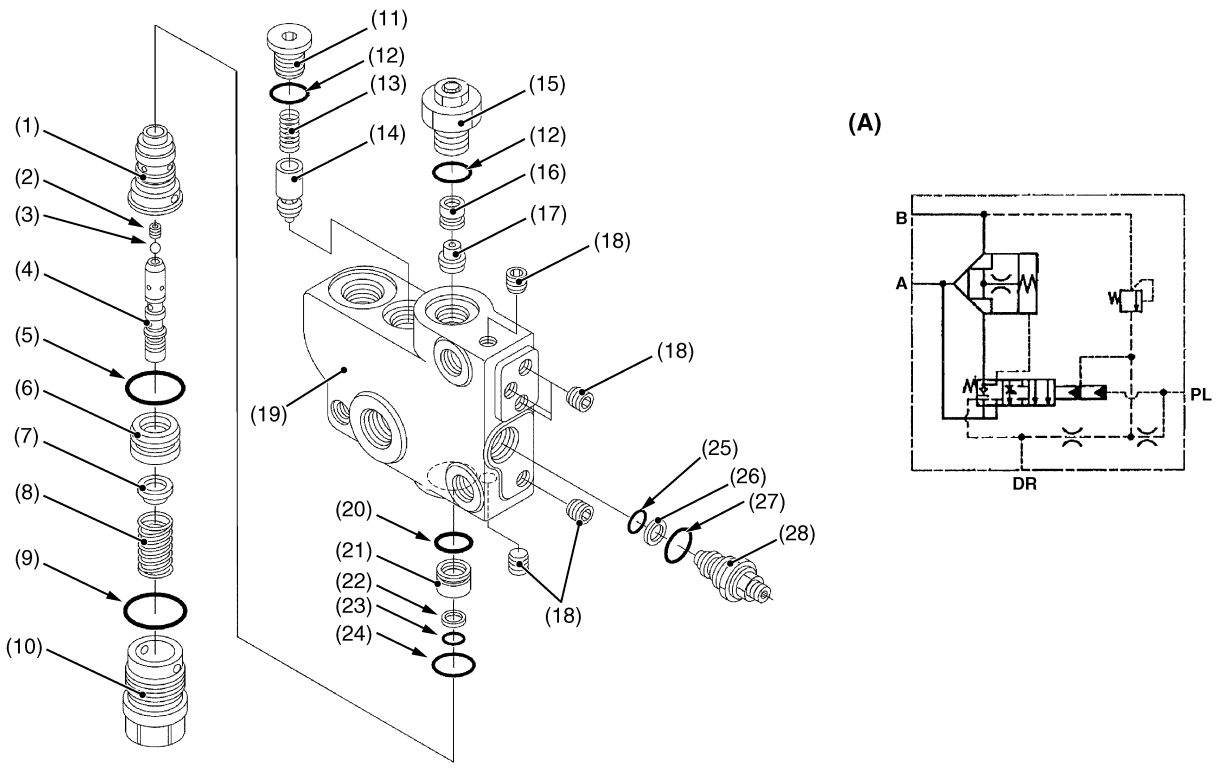
- **(a) : To oil tank, P block (P, T hoses) To control valves (Hoses other than P, T).**
- **(b) : Clamp.**
- **(c) : Route the bundle of pilot hoses so they hang on the guides (round rod).**
- **(d) : Boom Hose Routing.**

RY9212052HYS0070US0

13. BOOM HOLDING VALVE

[1] BOOM HOLDING VALVE DISASSEMBLY / ASSEMBLY PROCEDURES

(1) Boom Holding Valve Components



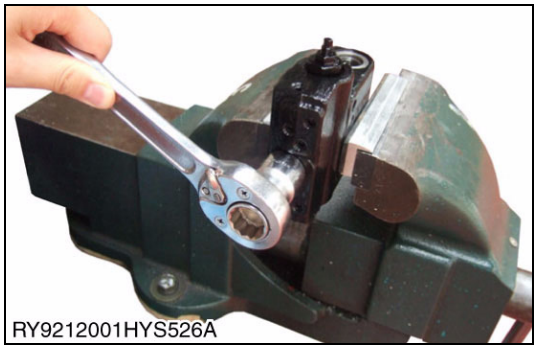
RY9212001HYS525A

(A) Hydraulic diagram

No.	Name of part	Q'ty	No.	Name of part	Q'ty
(1)	Bushing 2	1	(15)	Plug	1
(2)	Hex set screw	1	(16)	Piston 2	1
(3)	Steel ball	1	(17)	Piston 1	1
(4)	Spool	1	(18)	Plug	6
(5)	O-ring	1	(19)	Casing	1
(6)	Bushing 3	1	(20)	O-ring	1
(7)	Spring seat	1	(21)	Bushing 1	1
(8)	Spring	1	(22)	Backup ring	1
(9)	O-ring	1	(23)	Cap seal	1
(10)	Plug	1	(24)	O-ring	1
(11)	Plug	1	(25)	O-ring	1
(12)	O-ring	2	(26)	Backup ring	1
(13)	Spring	1	(27)	O-ring	1
(14)	Poppet	1	(28)	Relief valve	1

RY9212001CVS0006US0

(2) Disassembly Procedures


RY9212001HYS526A

1. Remove the relief valve.

■ **IMPORTANT**
- **Since the purchase area of the box is minimal, take care so that it does not come off.**

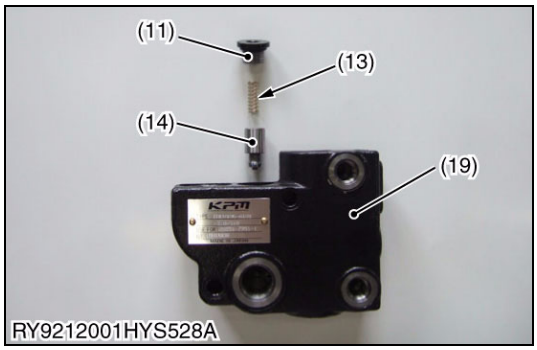
- Tool to use : wrench (socket) M22

RY9212001CVS0007US0

RY9212001HYS527A

2. Remove the poppet valve.

- Tool to use : M8 hex socket



RY9212001HYS528A

Poppet Section Components

(11) Plug
(13) Spring
(14) Poppet
(19) Casing

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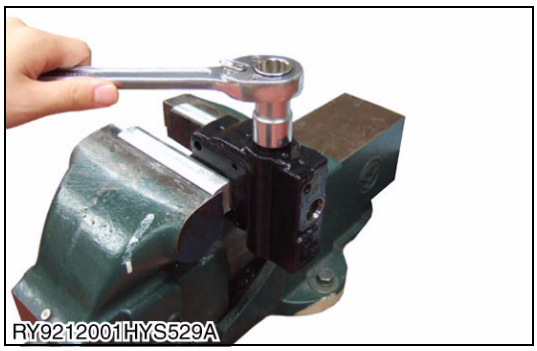
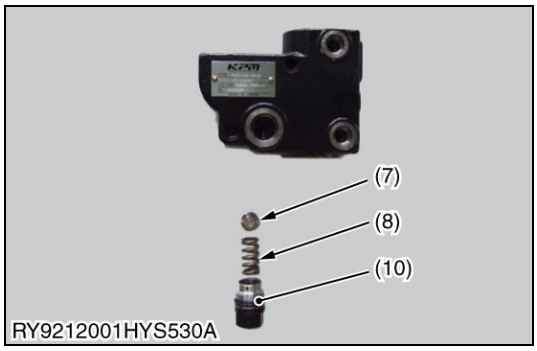

RY9212001HYS529A

3. Remove the spool section plug.

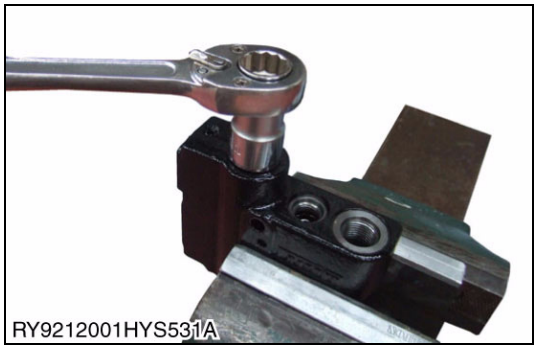


RY9212001HYS530A

Spool Section Components

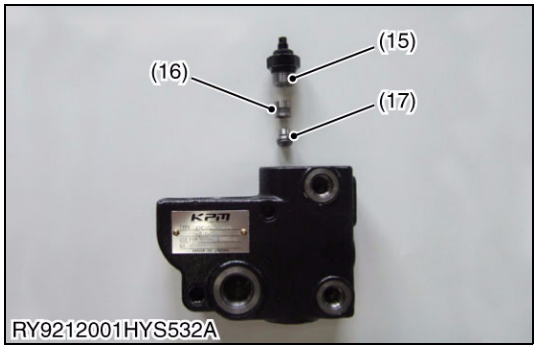
(7) Spring seat
(8) Spring
(10) Plug

RY9212001CVS0009US0


RY9212001HYS531A

4. Remove the piston section.

- Tool to use : wrench (socket) M22

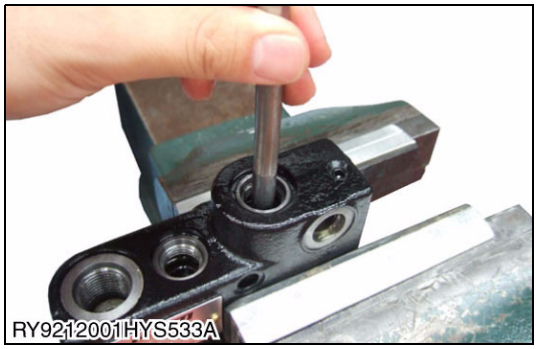


RY9212001HYS532A

Piston Section Components

(15) Plug
(16) Piston 2
(17) Piston 1

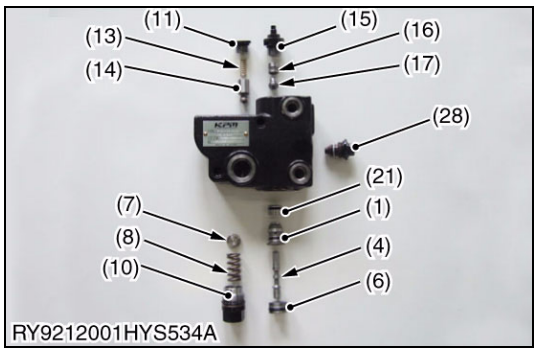
RY9212001CVS0010US0


RY9212001HYS533A

5. Remove the spool assembly.

■ **IMPORTANT**
- **Since the O-ring is difficult to remove by hand, use a punch pin to punch out from the piston side.**
- **Tap lightly to avoid damaging the spool.**
- **Place an oil pan or other receptacle underneath to avoid dropping the spool.**

- Tool to use :Hammer and M9-to-M10 punch pin



RY9212001HYS534A

Boom Holding Valve Components

(1) Bushing 2
(4) Spool
(6) Bushing 3
(7) Spring seat
(8) Spring
(10) Plug
(11) Plug
(13) Spring
(14) Poppet
(15) Plug
(16) Piston 2
(17) Piston 1
(21) Bushing 1
(28) Relief valve

RY9212001CVS0011US0

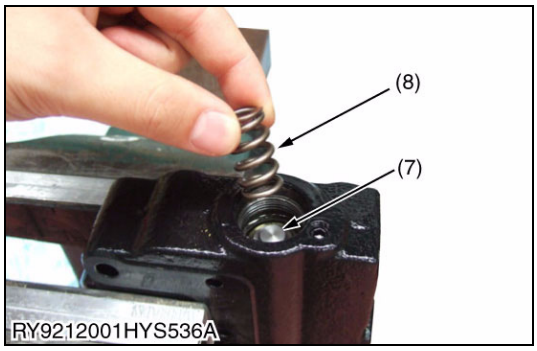
(3) Assembly Procedures

1. Install the spool assembly.

■ **IMPORTANT**
- **Apply hydraulic fluid to the spool.**

- Spool assembly : Bushing 1, bushing 2, bushing 3 and spool

RY9212001CVS0012US0



2. Install the spring seat (7) and spring (8).

(7) Spring seat (8) Spring

RY9212001CVS0013US0

3. Install the plug.

Tightening torque	Plug (10)	55 to 65 N·m 5.6 to 6.6 kgf·m 41 to 48 lbf·ft

- Tool to use : wrench (socket) 22 mm

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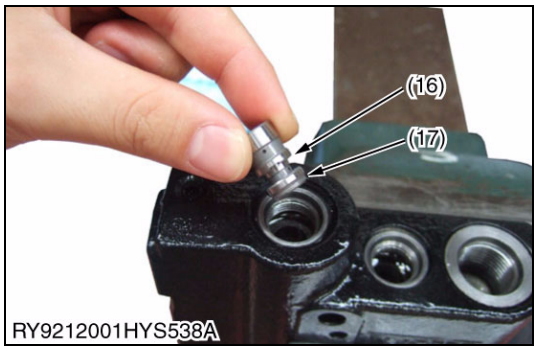
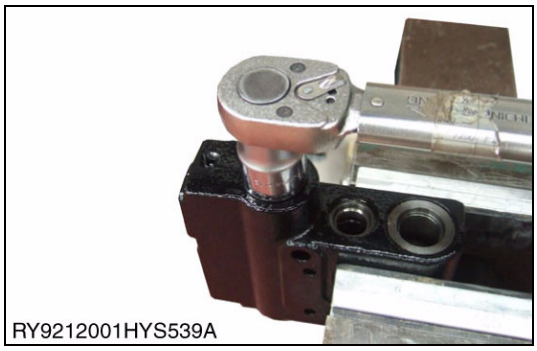


4. Install the pistons.

■ **IMPORTANT**
- **Apply hydraulic fluid to the pistons.**

(16) Piston 2 (17) Piston 1

RY9212001CVS0015US0

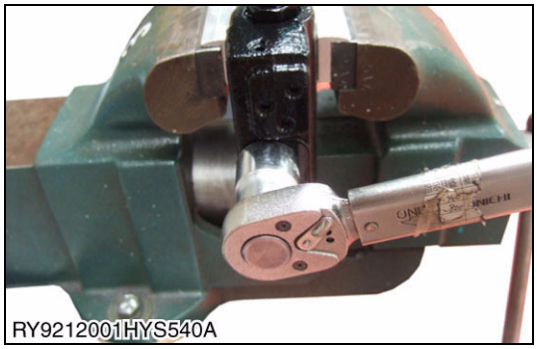


5. Install the plug.

Tightening torque	Plug (15)	34 to 39 N·m 3.5 to 4.0 kgf·m 25 to 29 lbf·ft

- Tool to use : wrench (socket) 22 mm

RY9212001CVS0016US0


RY9212001HYS540A

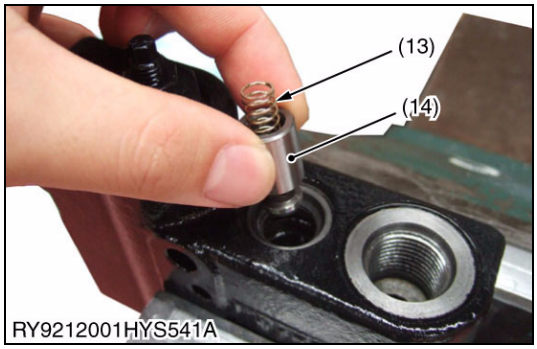
6. Install the relief valve.

■ **IMPORTANT**
- **Since the purchase area of the box is minimal, take care so that it does not come off.**

Tightening torque	(28) Relief valve	29 to 39 N·m 3.0 to 4.0 kgf·m 21 to 29 lbf·ft

- Tool to use : wrench (socket) M22

RY9212001CVS0017US0



RY9212001HYS541A

7. Install the poppet (14) and spring (13).

■ **IMPORTANT**
- **Apply hydraulic fluid to the spool.**

(13) Spring (14) Poppet

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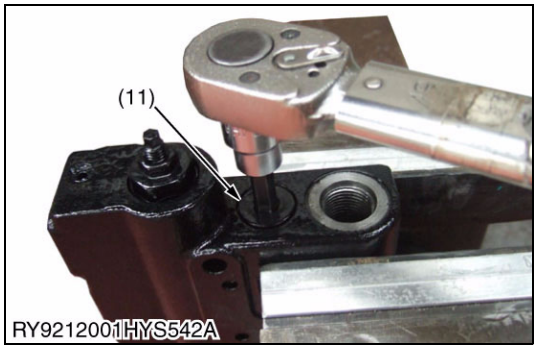


RY9212001HYS542A

8. Install the plug (11).

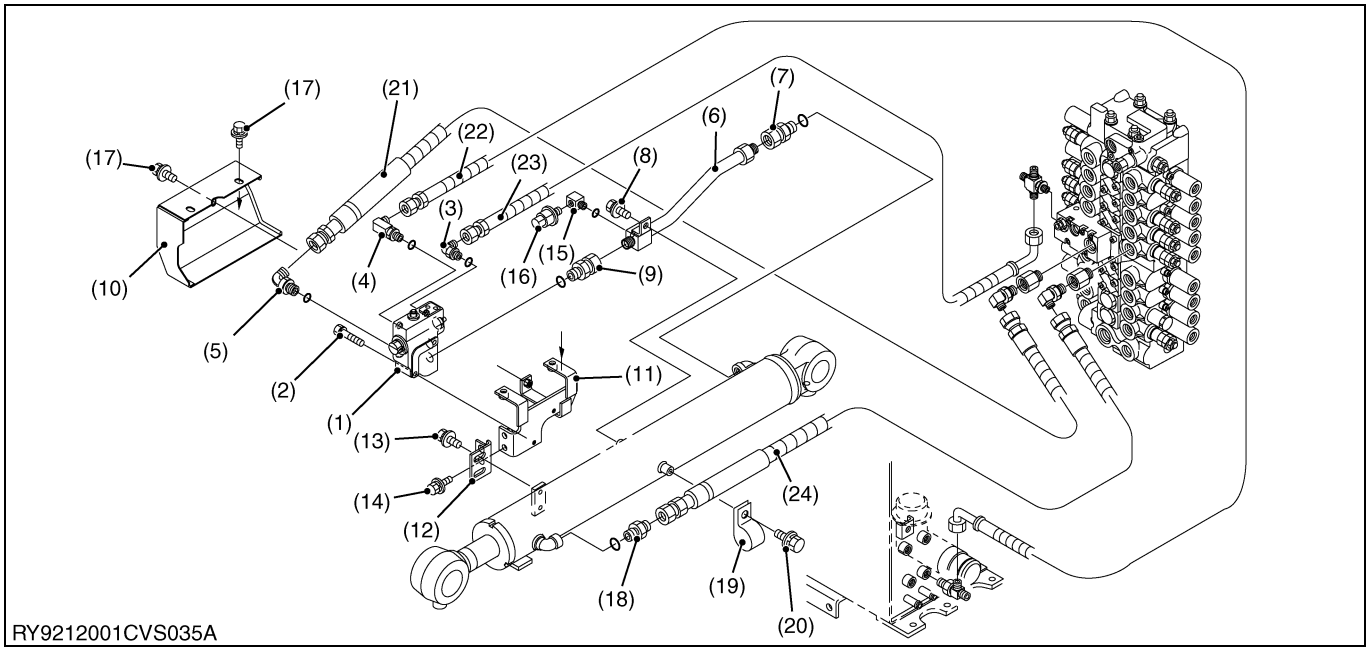
Tightening torque	Plug (11)	39 to 49 N·m 4.0 to 5.0 kgf·m 29 to 36 lbf·ft

- Tool to use: M8 hex socket

(11) Plug

RY9212001CVS0019US0

(4) Valve Assy Components



(1) Boom Holding Valve
(2) Bolt (M8×50)
(3) Pipe Joint (L, G1/4-G1/4)
(4) Pipe Joint (L, G1/4-G1/4)
(5) Pipe Joint
(6) Pipe
(7) Pipe Joint (S, G4-G4)
(8) Bolt (M8×20)
(9) Pipe Joint (S, G4-G4)
(10) Cover
(11) Bracket
(12) Bracket (L)
(13) Bolt (M10×20)
(14) Bolt (M10×25)
(15) Pipe Joint
(16) Sensor (Pressure 35MPA)
(17) Bolt (M10×20)
(18) Pipe Joint (S, G4-G4)
(19) Clamp
(20) Bolt (M8×16)
(21) Hydraulic Hose (1/2)
(22) Hydraulic Hose (1/4)
(23) Hydraulic Hose (1/4)
(24) Hydraulic Hose (1/2)

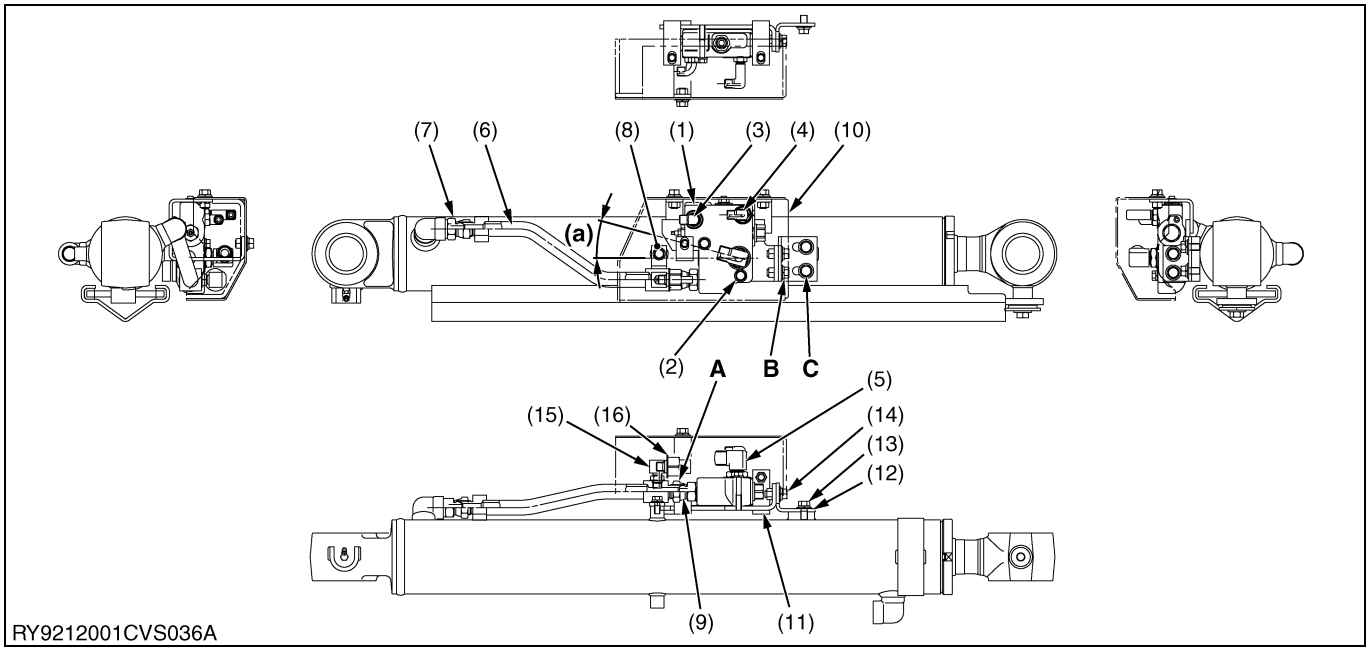
RY9212001CVS0003US0

■ Table of Hydraulic Hoses

No.	Part Number	Hose		Metal Fitting		Guard	Position Used
		Total Length mm (in.)	Tape Color	Left	Right		
(21)	RD451-6411-4	2180 (85.8)	Green	G1/2·C	G1/2·C	Resin-spirals, Cover	C/V ~ Boom CYL [Boom Raise]
(22)	RD451-7982-2	2560 (100.8)	Red	G1/4·C	G1/4·CR9	Resin-spirals	O/T ~ Boom H/V[T]
(23)	RD451-7981-2	2790 (109.8)	Yellow	G1/4·CR4	G1/4·C	Resin-spirals	C/V ~ Boom H/V[P]
(24)	RD551-6412-5	2450 (96.5)	Yellow	G1/2·C	G1/2·C	Resin-spirals, Cover	C/V ~ Boom CYL [Boom Lower]

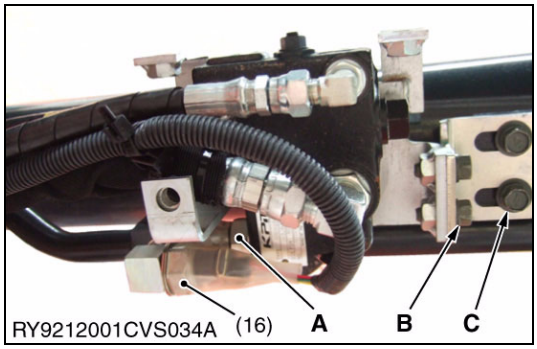
RY9212052HYS0121US0

(5) Assembling Valve Assy



(1) Boom Holding Valve
(2) Bolt (M8×50)
(3) Pipe Joint (L, G1/4-G1/4)
(4) Pipe Joint (L, G1/4-G1/4)
(5) Pipe Joint
(6) Pipe
(7) Pipe Joint (S, G4-G4)
(8) Bolt (M8×20)
(9) Pipe Joint (S, G4-G4)
(10) Cover
(11) Bracket
(12) Bracket (L)
(13) Bolt (M10×20)
(14) Bolt (M10×25)
(15) Pipe Joint
(16) Sensor (Pressure 35MPA)

(a) 15 °



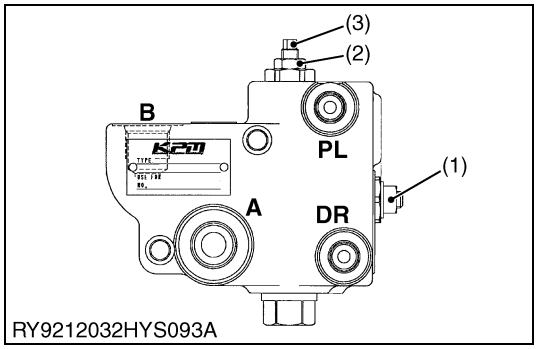
Assembly Procedures

1. Lightly tighten bolts **"A"**, **"B"** and **"C"** together with the assembly of their associated components.
2. Tighten in the order of **"A"** → **"B"** → **"C"**.

Tightening torque	Bolt **"B"**, **"C"**	48.1 to 55.9 N·m 4.9 to 5.7 kgf·m 35.4 to 41.2 lbf·ft
	Sensor (Pressure 35MPA) (16)	18.6 to 28.4 N·m 1.9 to 2.9 kgf·m 13.7 to 21 lbf·ft

RY9212052HYS0122US0

[2] GUIDE TO RELEASING THE HOLDING VALVE



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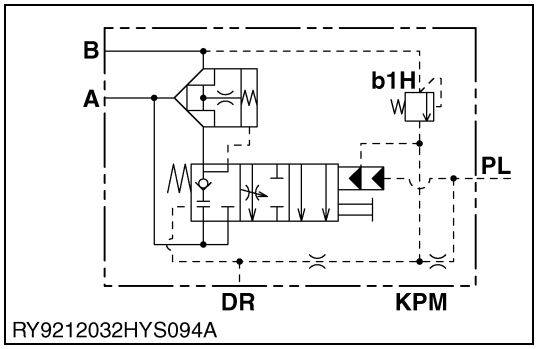
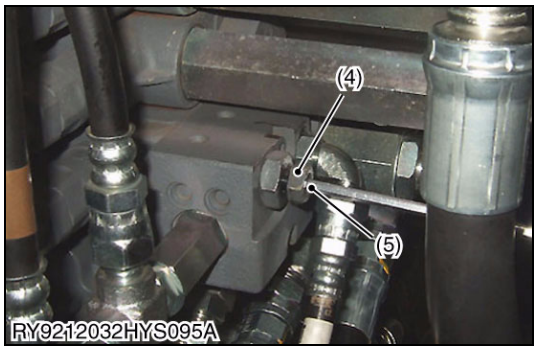


RY9212032HYS094A



RY9212032HYS095A

- Use this guide if the accumulator fails to operate and there is an urgent need to lower the boom.

Operating Procedures

1. Make sure the engine is stopped.
2. Remove the cover of the holding valve.
3. Loosen the nut (2) on the holding valve.
4. Tighten the needle valve (3) of the holding valve three turns.
5. Loosen the nut (4) and screw (5) of the shut-off valve on the boom block.

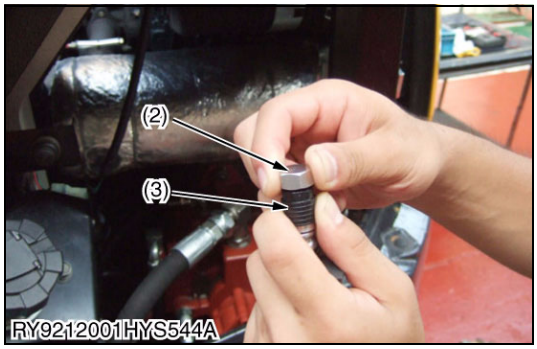
CAUTION

- **Do not loosen the shut-off valve screw quickly.**
- **Do not get under the boom.**

(1) Relief valve
(2) Nut
(3) Needle valve
(4) Nut
(5) Screw

RY9212032HYS0101US0

14. MEASURING HYDRAULIC DEVICE PERFORMANCE



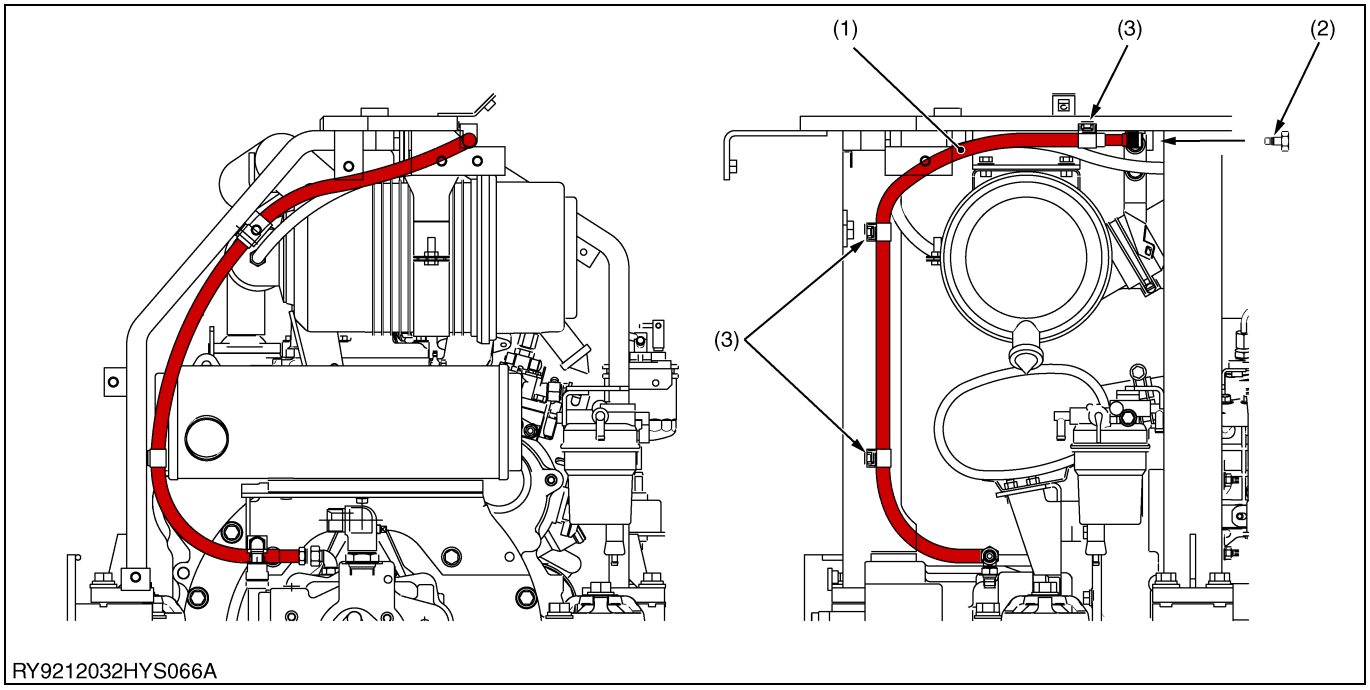
Piston Pump Air Bleeding Procedure

When disassembling hydraulic equipment and replacing hoses, etc., or after changing the hydraulic fluid and using the vacuum pump, before operating the machine, be sure to carry out air bleeding to prevent pump scorching and cavitation.

1. After operating, with the engine stopped, remove the hose at the top of the pump from its clamp.
2. Press in the hexagonal plug and the black plastic lock section as well. Then hold the black plastic lock section and pull out the hexagonal plug.
3. Drape the hose on the front of the weight, and leave for 30 seconds.
4. Fit a hexagonal plug to the hose, start and idle the engine, and check whether there is any cavitation noise from the pump.
5. Repeat operations in 2. 3. 4 until pump cavitation noise disappears.
6. When cavitation noise disappears, raise the engine speed to 1500 rpm, slowly operated the arm and check whether cavitation noise is emitted. (Make sure there is no relief when operating the arm.)
7. If there is no cavitation noise, raise the engine speed to 2000 rpm, slowly operate the arm, and check again for cavitation noise. If cavitation noise is emitted, stop the engine and carry out 2. 3.
8. If there is no cavitation noise in step 7, raise the engine speed to maximum rpm, slowly operate the aim, and check again for cavitation noise. If cavitation noise is emitted, stop the engine and carry out 2. 3. (Make sure there is no relief when operating the arm.)
9. If there was no cavitation noise when performing step 8, air bleeding is finished. Clamp the air bleed hose in its original position.

(1) Air bleed hose
(2) Hexagonal plug
(3) Lock section

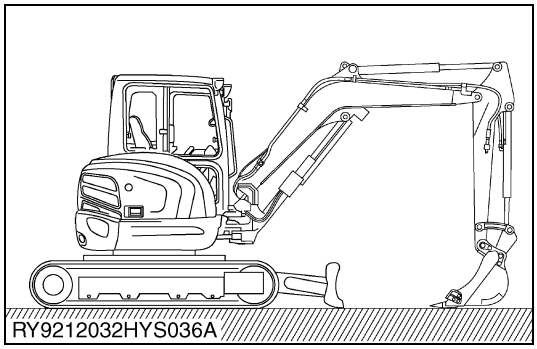
RY9212050HYS0114US0



RY9212032HYS066A

(1) Air bleed hose (2) Hexagonal plug (3) Clamp

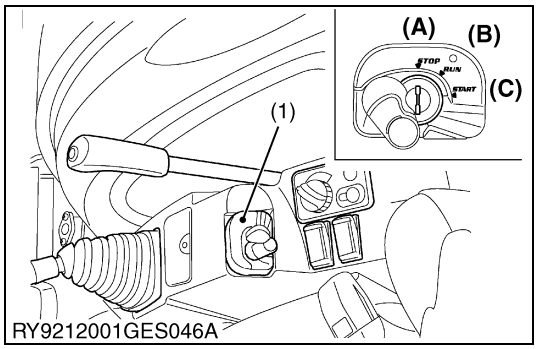
RY9212032HYS0075US0


RY9212032HYS036A

Hydraulic System Pressure Release Procedure

1. Place the machine on firm, level ground, lower the bucket and blade to ground level, and stop the engine.

RY9212032HYS0060US0

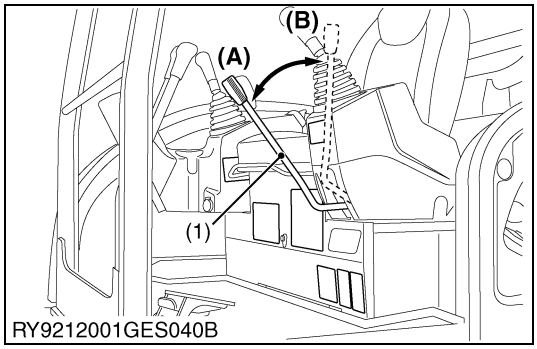


RY9212001GES046A

2. Without starting the engine, place the engine starter switch in the "RUN" **(B)** position.

(1) Starter switch
(A) STOP
(B) RUN
(C) START

RY9212001HYS0648US0

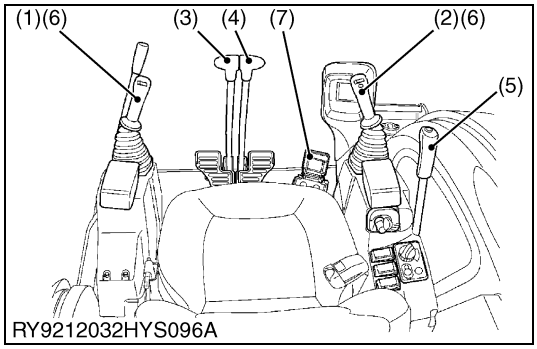


RY9212001GES040B

3. Place the machine lock lever in the release position.

(1) Machine lock lever
(A) Release
(B) Lock

RY9212001HYS0649US0



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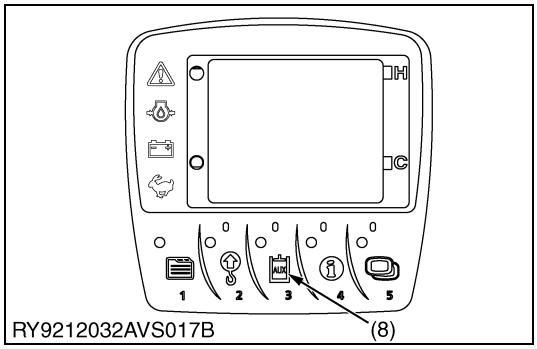

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4. Operate each control lever for the boom, arm, bucket and swivel to full stroke.

5. Operate the travel lever, blade lever, swing pedal each to full stroke.

6. Switch on the AUX port using the AUX port enable switch (switch3), and operate AUX port knob switches each to full stroke.

7. Place the machine's lock lever in the "Lock" position, and the engine starter switch to the "STOP" position.

(1) Left machine control lever
(2) Right machine control lever
(3) Travel lever left
(4) Travel lever right
(5) Blade control lever
(6) AUX port knob switch
(7) Swing pedal
(8) AUX port enable switch (switch3)

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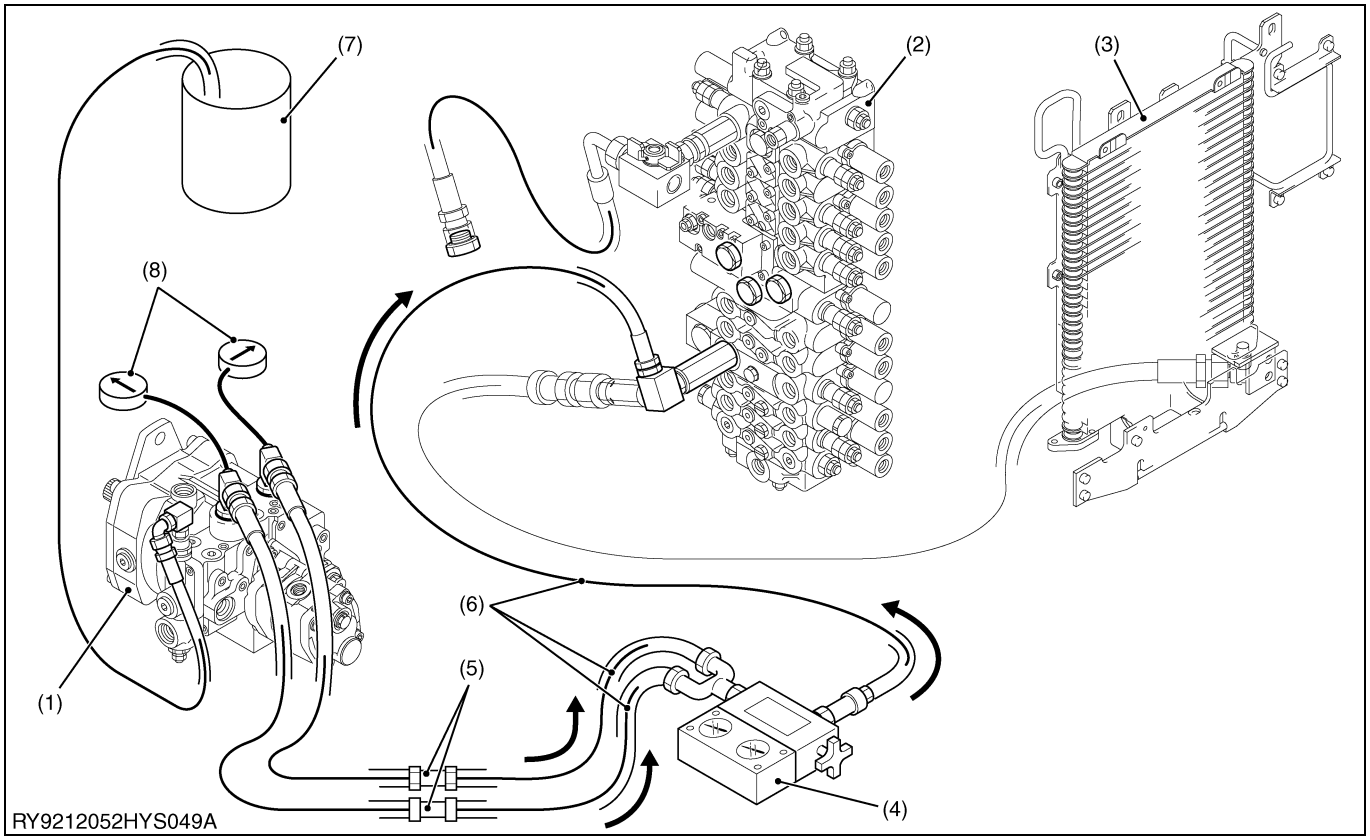
Measuring Main Pump Flow (3 pumps)



(1) Pump
(2) Control valve
(3) Oil cooler
(4) Flow meter
(5) Joint
(6) Test hose
(7) Oil catcher
(8) Pressure gauge

Measurement preparation

1. Place the mini excavator on flat, hard ground, lower the bucket and the blade, and stop the engine.
2. Follow the chapter "Releasing Hydraulic System Pressure" and release pressure in the hydraulic lines.
3. Use a vacuum pump and attach a pressure gauge to the pressure measurement port.

If measuring P1 and P2 flow (combined flow)

1. Disconnect the control valve side of the P1 & P2 hoses and plug the control valve's P1 and P2 ports.
2. Connect the P1 & P2 hoses and the test hoses and connect them to the IN side of the flow meter. (Combine the flows with an adapter.)
3. Disconnect the hose connecting the 2-way valve and the control valve (T2) on the control valve (T2) side and plug the disconnected hose.
4. Connect the control valve (T2) and the OUT side of the flow meter with a test hose.
5. Disconnect the control valve side of the PPS hose and plug the control valve's PPS port.
6. Place the PPS hose in an oil catcher.
7. Remove the vacuum pump.
8. Bleed the pump of air and make sure there are no oil leaks in any of the pipes.

If measuring P3 flow

1. Disconnect the control valve side of the P3 delivery hose and plug port P3 of the control valve.
2. Connect the P3 delivery hose and the test hose and connect it to the IN side of the flow meter.
3. Disconnect the hose connecting the 2-way valve and the control valve (T2) on the control valve (T2) side and plug the disconnected hose.
4. Connect the control valve (T2) and the OUT side of the flow meter with a test hose.
5. Disconnect the control valve side of the PPS hose and plug the control valve's PPS port.
6. Place the PPS hose in an oil catcher.
7. Remove the vacuum pump.
8. Bleed the pump of air and make sure there are no oil leaks in any of the pipes.

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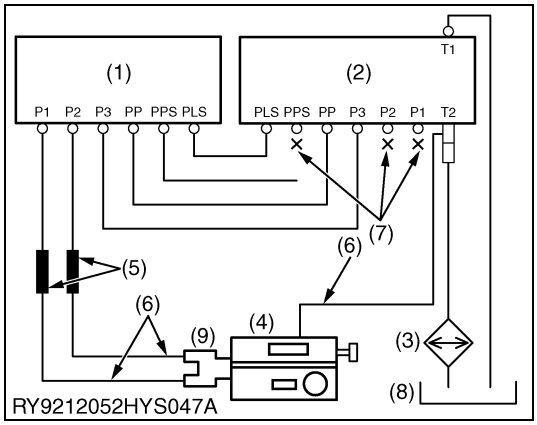

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Measurement

1. Hydraulic oil temperature of 50 ± 5 °C (122 ± 9 °F).
2. Open the loading valve of the flow meter and start the engine. Set the engine speed to maximum, gradually close the loading valve of the flow meter, and measure the flow and engine speed at each pressure level.
3. Perform the measurement 3 times, take the average and use this as the measurement value.

(Pump performance inspection procedure)

The pump performance inspection is placing a specified pressure load on the pump discharge and performing measurement at a specified engine speed to check the volumetric efficiency.

$$\text{Volumetric efficiency} = \frac{\text{Rated load discharge rate}}{\text{Logical discharge value (Calculated value)}} \times 100\,(\%)$$

RY9212032HYS074A

1. The pump volumetric efficiency is proportional to pump rotational speed and inverse proportional to load pressure so set the engine speed at maximum speed for the test.
2. Volumetric efficiency is the ratio of the discharge amount per revolution (cc/rev) at a specified load and the theoretical discharge amount (calculated value). The specified load is the main relief set pressure.
3. The measurement value of the discharge flow at the specified load must be corrected to one pump revolution because the rotational speed of the pump is reduced from its normal speed.

$$\text{Rated load discharge rate} = \frac{\text{Rated load discharge rate (L/min)} \times 1000}{\text{Rated load pump (rpm)}}$$

RY9212032HYS073A

(1) Pump
(2) Control valve
(3) Oil cooler
(4) Flow meter
(5) Joint
(6) Test hose
(7) Plug
(8) Tank
(9) Adapter

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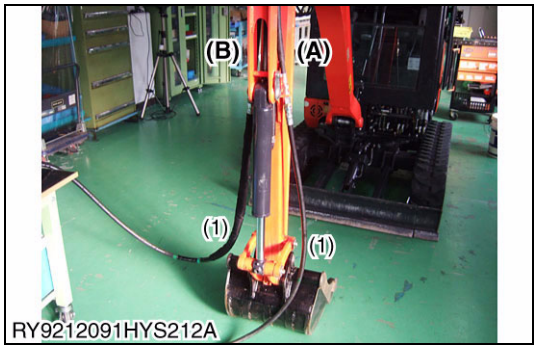

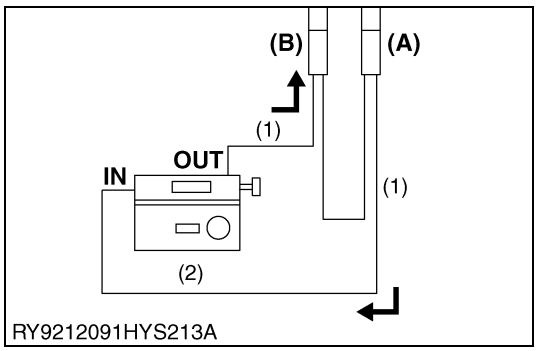

Actual AUX PQ Value Measurement

Measurement preparation

1. Place the mini excavator on flat, hard ground, lower the bucket and the blade and stop the engine.
2. Follow the chapter on "Releasing Pressure in the Hydraulic System" and release pressure in the hydraulic lines.
3. Connect a vacuum pump.
4. Connect the AUX discharge (high pressure side) and the IN side of the flow meter with a test hose.
5. Connect the OUT side of the flow meter and the AUX discharge (low pressure side) with a test hose.
6. Remove the vacuum pump.

Measurement

1. Hydraulic oil temperature of 50 ± 5 °C (122 ± 9 °F).
2. Open the loading valve of the flow meter and start the engine.
3. After bringing the engine to maximum RPM, operate the AUX.
4. Gradually close down the loading valve of the flow meter and measure the flow at each pressure level.
5. Perform the measurement 3 times; take the average and use this as the measurement value.

■ **IMPORTANT**

- **Take care not to make an error in the direction of oil flow and the IN direction of the flow meter.**

(1) Test Hose
(2) Flow Meter
(A) AUX High Pressure Side
(B) AUX Low Pressure Side

RY9212091HYS0282US0

Actual Measured Values

Port	AUX1	AUX2
Port Relief	20.6 MPa (210 kgf/cm^2, 3000 psi)	19.1 MPa (195 kgf/cm^2, 2770 psi)
Load (10 MPa)	75 L/min 19.8 USGPM	37 L/min 9.8 USGPM
Load (15 MPa)	57 L/min 15.1 USGPM	36 L/min 9.5 USGPM
Load (19 MPa)	37 L/min 9.8 USGPM	20 L/min 5.3 USGPM

CAUTION

- **Actual measured values may vary with the machine.**

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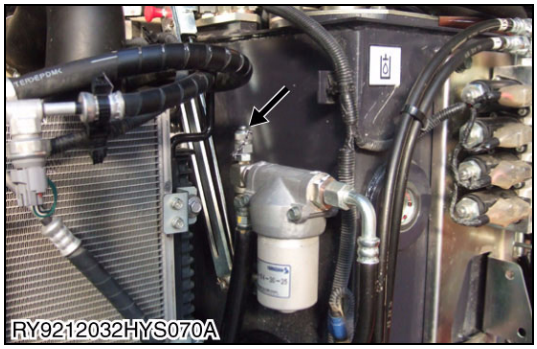
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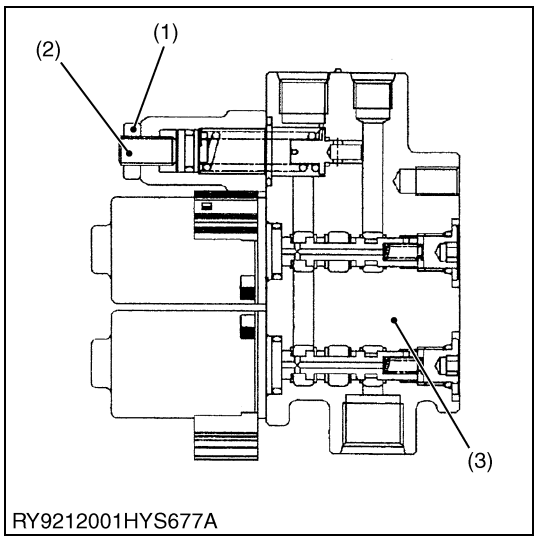

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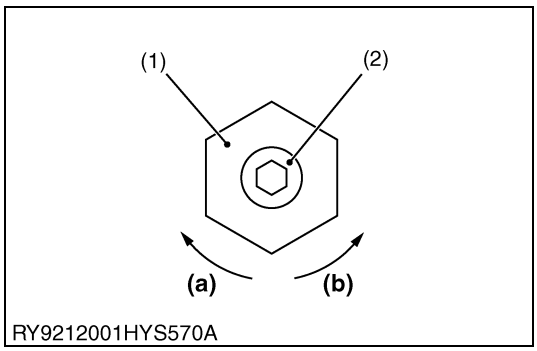

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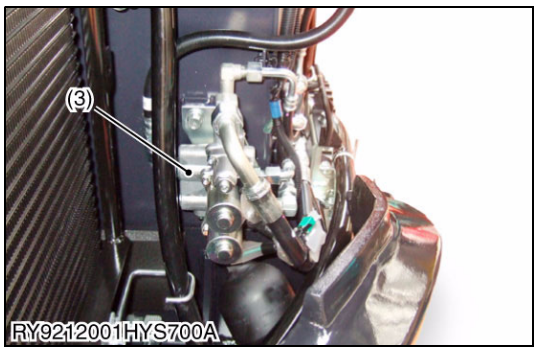

RY9212001HYS700A

Pilot pressure

Pilot Primary Pressure Measuring Procedure

1. Place the machine on firm, level ground, lower the bucket and blade to ground level, and stop the engine.
2. In accordance with "Releasing Residual Hydraulic System Pressure" in this manual, release pressure from the hydraulic line.
3. Remove the plug from the adapter on the pilot filter inlet side, and attach a pressure gage.
4. Start and idle the engine, and check that there is no oil leakage when the machine's lock lever is released.
5. Raise engine speed to maximum rpm, and measure pilot pressure under no load. Perform the measurement three times, determine the average value, and take this as the measured value. Conduct at oil temperature 50 ± 5 °C (122 ± 9 °F).

Pilot Primary Pressure Adjustment Method

1. Loosen the relief valve lock nut (1) or the unload valve (3). Use a hexagonal wrench to turn the adjuster screw (2), and tighten the lock nut.
2. After adjusting, check the set pressure.

Tightening torque	Lock-nut (1)	15.7 N·m 1.6 kgf·m 11.6 lbf·ft

(1) Lock nut
(2) Adjuster screw
(3) Unload Valve

(a) Pressure increase
(b) Pressure decrease

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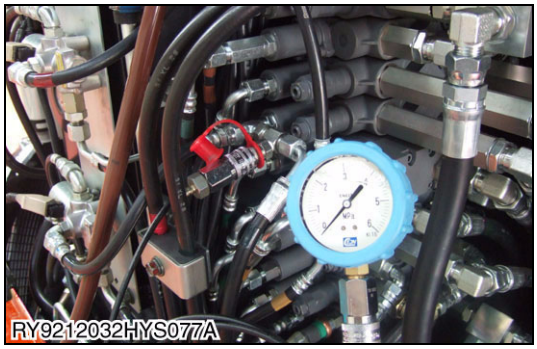

Pilot Secondary Pressure Measuring Procedure

1. Place the mini excavator on flat hard ground, lower the bucket and the blade, and stop the engine.
2. In accordance with "Releasing Residual Hydraulic System Pressure" in this manual, release pressure from the hydraulic line.
3. Fit a T-joint to the pilot port on the control valve side to be measured, and attach a pressure gage.
4. Start and idle the engine, and after checking that there is no oil leakage.
5. Operate the measuring lever after raise engine speed to maximum rpm, and take the pilot pressure reading at full throttle.
6. Perform the measurement 3 times, take the average and use this as the measurement value. Conduct at oil temperature 50 ± 5 °C (122 ± 9 °F).

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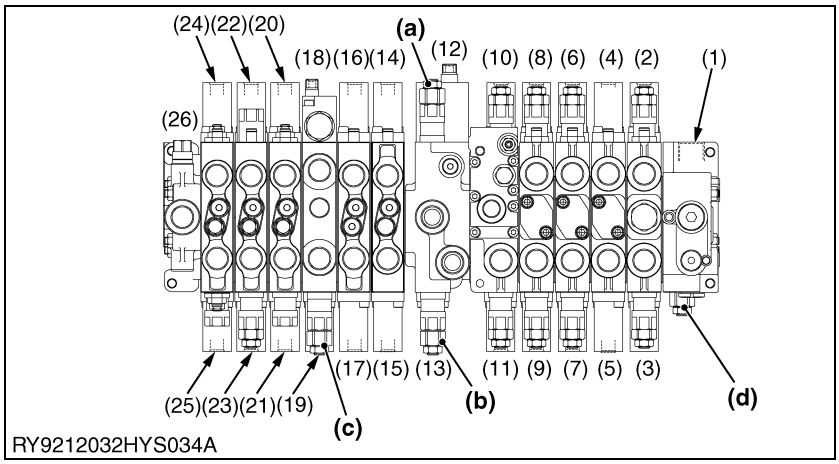

(1) T1
(2) AUX1 (Low)
(3) AUX1 (High)
(4) Swivel right
(5) Swivel left
(6) Bucket, bottom
(7) Bucket, rod
(8) Arm, bottom
(9) Arm, rod
(10) Boom, bottom
(11) Boom, rod
(12) Independent travel valve (P1)
(13) Independent travel valve (P2)
(14) Travel right forward
(15) Travel right rear
(16) Travel left forward
(17) Travel left rear
(18) T2
(19) Communication valve (P3)
(20) Swing, bottom
(21) Swing, rod
(22) Blade, rod
(23) Blade, bottom
(24) AUX2 (Low)
(25) AUX2 (High)
(26) T3

(a) Main Travel Right relief valve
(b) Main Travel Left relief valve
(c) Main P3 relief valve
(d) Main LS relief valve

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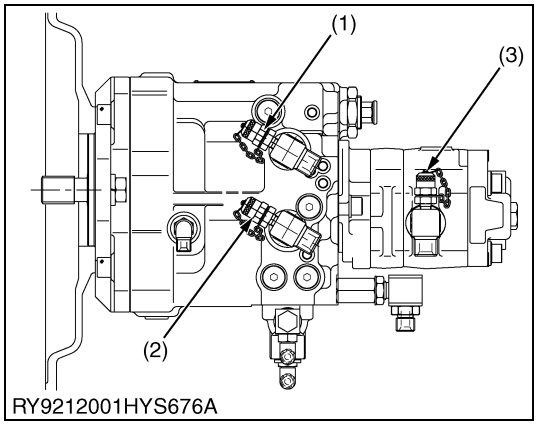

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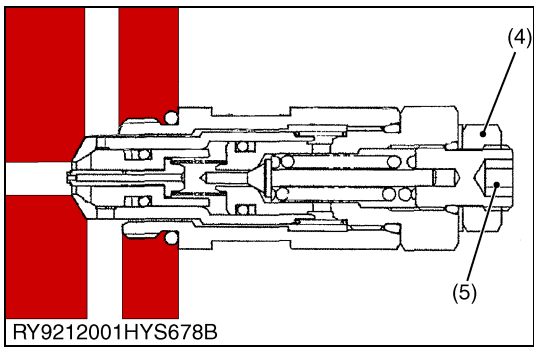

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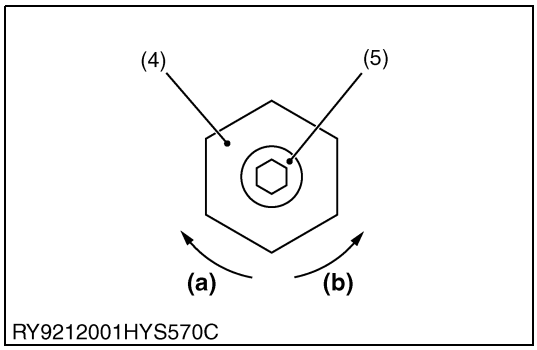

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Main relief valve pressure

Main relief valve measuring procedure

1. Place the machine on firm, level ground, lower the bucket and blade to ground level, and stop the engine.
2. In accordance with "Releasing Hydraulic System Pressure" in this manual, release pressure from the hydraulic line.
3. Remove the plug from the adapter's inspection port on the discharge side of the pump to be measured, and attach a pressure gage.
4. Start and idle the engine, and check that there is no oil leakage.
5. Slowly operate the control lever of the front operation to be measured, operate until the cylinder reaches the end of its stroke, then relieve.
6. In the case of travel, lock the travel section, gradually operate the travel lever, then relieve.
7. Measure three times at maximum engine speed, and take the average value as the measurement.
8. Conduct at oil temperature 50 ± 5 °C (122 ± 9 °F).

Main Relief Valve Adjustment Procedure

1. Loosen the relief valve lock nut (4). Use a hexagonal wrench to turn the adjuster screw (5), and tighten the lock nut.
2. Operate the lever at maximum engine speed, and check the pressure setting.

Tightening torque	Lock-nut (4)	27 to 31 N·m 2.8 to 3.2 kgf·m 20 to 23 lbf·ft

(1) Pump 1 pressure check port plug
(2) Pump 2 pressure check port plug
(3) Pump 3 pressure check port plug
(4) Lock nut
(5) Adjuster screw

(a) Pressure increase
(b) Pressure decrease

RY9212032HYS0063US0

Refer also to the previous topic of main relief valve pressure

RY9212032HYS0064US0

Model	Valve location	Bench data	Measured value
KX057-4	Main travel right (aTR)	26.5 MPa 270 kgf/cm^2 3840 psi	27.0 ± 0.5 MPa 280 ± 5 kgf/cm^2 3900 ± 70 psi
	Main travel left (aTL)	26.5 MPa 270 kgf/cm^2 3840 psi	27.0 ± 0.5 MPa 280 ± 5 kgf/cm^2 3900 ± 70 psi
	Main LS (aLS)	27.4 MPa 280 kgf/cm^2 3990 psi	28.0 ± 0.5 MPa 290 ± 5 kgf/cm^2 4100 ± 70 psi
	Main P3 (aP3)	19.1 MPa 195 kgf/cm^2 2770 psi	19.4 ± 0.5 MPa 198 ± 5 kgf/cm^2 2810 ± 70 psi
	Pilot primary (aPP)	3.9 MPa 40 kgf/cm^2 570 psi	4.2 ± 0.2 MPa 43 ± 2 kgf/cm^2 610 ± 30 psi

CAUTION

- **Measured values in the above table are the average values calculated from the actual ten measurements.**

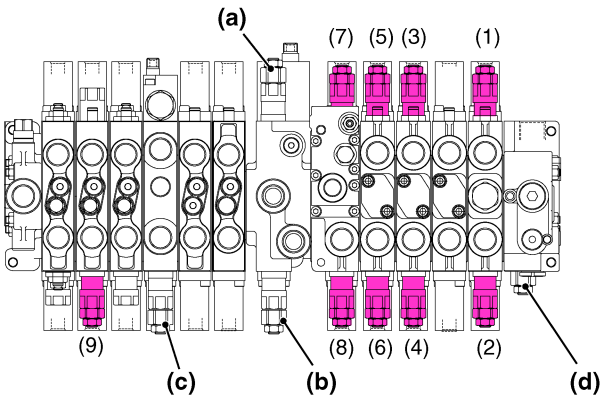
RY9212032HYS0078US0

Overload relief valve pressure

Measuring with the main relief valve setting pressure of the machine greater than the setting pressure of the overload relief valve is not desirable from the viewpoint of safety.

When it is necessary to check the overload relief valve pressure on the actual machine, measure the main relief pressure of each circuit (boom, arm, bucket and blade), and judge normal if the main relief pressure is standard; and if abnormal the overload relief valve must be replaced as an assembly.

Overload Relief Valve Layout Diagram



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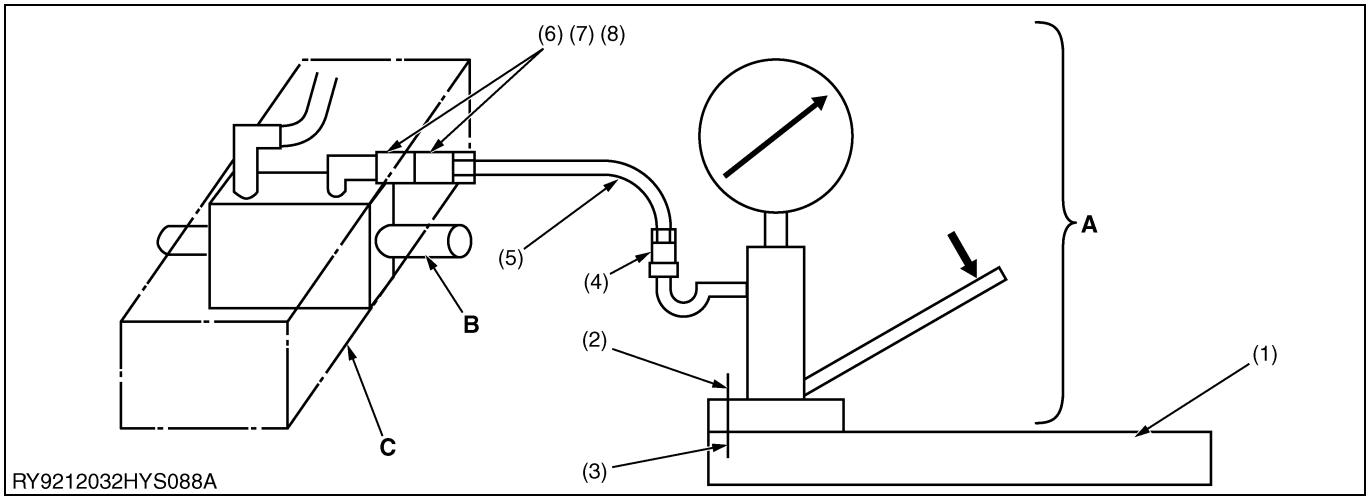
(1) AUX1 (Low)
(2) AUX1 (High)
(3) Bucket, bottom
(4) Bucket, rod
(5) Arm, bottom
(6) Arm, rod
(7) Boom, bottom
(8) Boom, rod
(9) Blade, rod

(a) Main Travel Right relief valve
(b) Main Travel Left relief valve
(c) Main P3 relief valve
(d) Main LS relief valve

RY9212032HYS0065US0

Procedure for Measuring the Overload Relief Valve Pressure



A : Injection pressure gauge B : Overload relief valve to be measured C : Control valve

No.	Name of part	Qty	Notes
(1)	Support	1	When using the gauge, fasten it to this support with the bolt (2) and nut (3) to give it a stable base.
(2)	Bolt (M10 × 35)	2	
(3)	Nut (M12)	2	
(4)	Pipe joint (M12-G2)	1	Connect the hose to the gauge.
(5)	Test hose (1/4)	1	
(6)	Straight pipe joint (G3-G2)	1	If the size of the port is G3/8, use this part to connect the hose and the port. [straight pipe joint (7) not required]
(7)	Straight pipe joint (G4-G3)	1	If the size of the port is G1/2, connect this part to the straight pipe joint (6) to connect the port.
(8)	Plug (PT1/8)	2	Plugs the hole of the pressure measurement port of straight pipe joints (6), (7).

Measurement preparation

1. Place the mini excavator on flat, hard ground, lower the bucket and the blade, and stop the engine.
2. Follow the chapter "Releasing Hydraulic System Pressure" and release pressure in the hydraulic lines.
3. Using a vacuum pump, disconnect the high-pressure hose on the valve section port attached to the overload relief valve to be measured and plug the removed hose.
   - When measuring the boom holding valve
     Remove the hose from port A and connect the test hose to port A.
     Disconnect the hose on the boom rod side and block it with a plug.
4. Connect to the free port with a pipe joint, test hose and injection pressure gauge.
5. Remove the vacuum pump.

Testing the Overload Relief Valve

1. Add pressure until the overload relief valve opens and read the pressure at that point.
2. Perform the measurement 3 times; take the average and use this as the measurement value.

CAUTION

- **Use a test hose that is rated to at least the pressure setting to be tested.**
- **Take care not to misconnect or twist the hose.**
- **When disconnecting the hose after testing the pressure, loosen the pipe joint (4) and the injection pressure gauge slightly and make sure the pressure bleeds off before disconnecting them.**
- **When testing the boom holding function, the boom may rise due to air getting into the lines. If the boom does rise, after finishing testing, follow the section Guide to Releasing the Boom Holding Valve and lower the boom.**

RY9212032HYS0095US0

Model	Point to Measure		Bench Data	Measured Values
KX057-4	Boom	Bottom (b1B)	31.4 MPa 320 kgf/cm^2 4554 psi	31.5 ± 1 MPa 320 ± 10 kgf/cm^2 4569 ± 145 psi
		Rod (b1R)	31.4 MPa 320 kgf/cm^2 4554 psi	31.5 ± 1 MPa 320 ± 10 kgf/cm^2 4569 ± 145 psi
		H/V (b1H)	30.4 Mpa 310 kgf/cm^2 4409 psi	30.5 ± 1 MPa 311 ± 10 kgf/cm^2 4424 ± 145 psi
	Arm	Bottom (b2B)	31.4 MPa 320 kgf/cm^2 4554 psi	31.5 ± 1 MPa 320 ± 10 kgf/cm^2 4569 ± 145 psi
		Rod (b2R)	31.4 MPa 320 kgf/cm^2 4554 psi	31.5 ± 1 MPa 320 ± 10 kgf/cm^2 4569 ± 145 psi
	Bucket	Bottom (b3B)	31.4 MPa 320 kgf/cm^2 4554 psi	31.5 ± 1 MPa 320 ± 10 kgf/cm^2 4569 ± 145 psi
		Rod (b3R)	31.4 MPa 320 kgf/cm^2 4554 psi	31.5 ± 1 MPa 320 ± 10 kgf/cm^2 4569 ± 145 psi
	Blade	Bottom (b4B)	27.4 Mpa 279 kgf/cm^2 3974 psi	27.4 ± 1 MPa 279 ± 10 kgf/cm^2 3974 ± 145 psi
	AUX1	LH (b6L)	20.6 Mpa 210 kgf/cm^2 2988 psi	21.0 ± 1 MPa 214 ± 10 kgf/cm^2 3046 ± 145 psi
		RH (b6R)	20.6 Mpa 210 kgf/cm^2 2988 psi	21.0 ± 1 MPa 214 ± 10 kgf/cm^2 3046 ± 145 psi

CAUTION

- **Measured values in the above table are the actual one measurement.**

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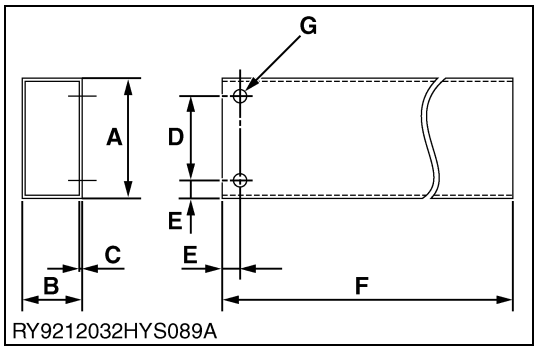
Jig for Measuring



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(1) Support

A	100 mm, 3.94 in.
B	50 mm, 2.0 in.
C	t = 2.3 mm, 0.09 in.
D	70 mm, 2.8 in.
E	15 mm, 0.59 in.
F	600 mm, 23.6 in.
G	2-11 mm, 2-0.43 in.

Material grade: STKR400

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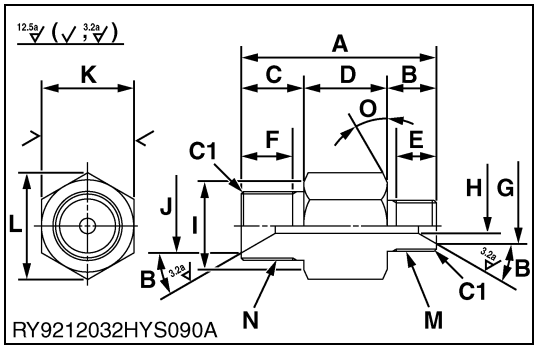

(4) Pipe joint (M12-G2)

A	47 mm, 1.8 in.
B	12 mm, 0.47 in.
C	15 mm, 0.59 in.
D	20 mm, 0.79 in.
E	10 mm, 0.39 in. ≤
F	12 mm, 0.47 in. ≤
G	ϕ8 mm, 0.3 in.
H	ϕ3 mm, 0.1 in.
I	ϕ18 mm, 0.71 in.
J	ϕ9.5 ± 0.2 mm, 0.37 ± 0.01 in.
K	19 +0, –0.35 mm, 0.75 +0, –0.01 in.
L	21.9 mm, 0.86 in.
M	M12 × 1.5
N	G1/4
O	30 °

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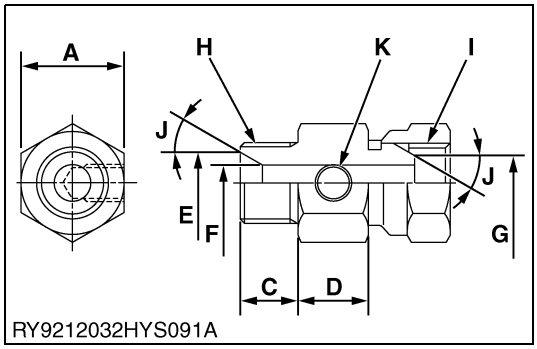
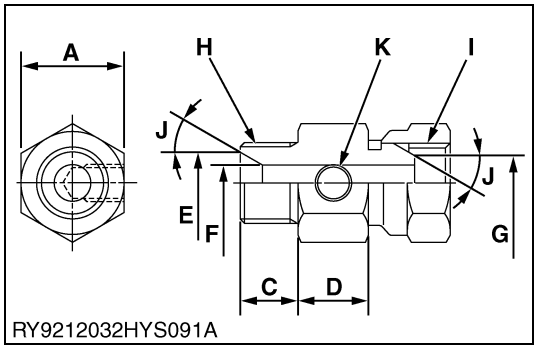


(6) Straight pipe joint (G3-G2)

A	22 mm, 0.87 in.
B	54 mm, 2.1 in.
C	15 mm, 0.59 in.
D	18 mm, 0.71 in.
E	ϕ9.5 ± 0.3 mm, 0.37 ± 0.01 in.
F	ϕ5.5 mm, 0.22 in.
G	ϕ10 mm, 0.39 in.
H	G1/4
I	G3/8
J	30 °
K	R1/8

RY9212032HYS0099US0



(7) Straight pipe joint (G4-G3)

A	27 mm, 1.1 in.
B	54 mm, 2.1 in.
C	15 mm, 0.59 in.
D	18 mm, 0.71 in.
E	ϕ12.5 ± 0.3 mm, 0.49 ± 0.01 in.
F	ϕ8 mm, 0.3 in.
G	ϕ13.9 mm, 0.55 in.
H	G3/8
I	G1/2
J	30 °
K	R1/8

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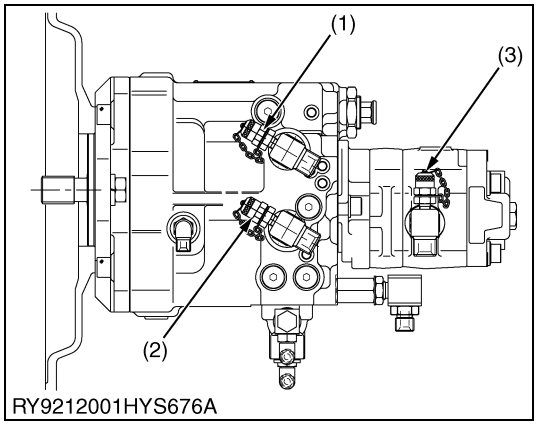

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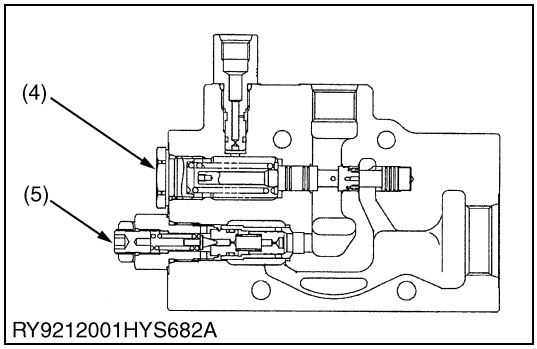

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Unload LS valve pressure

1. Place the machine on firm, level ground, lower the bucket and blade to ground level, and stop the engine.
2. In accordance with "Releasing Hydraulic System Pressure" in this manual, release pressure from the hydraulic line.
3. Remove the plug from the adapter's inspection port on the discharge side of the pump to be measured, and attach a pressure gage.
4. Start and idle the engine, and check that there is no oil leakage.
5. Raise engine speed to maximum rpm, and measure the pressure during load-free operation (control lever in neutral).
6. Measure three times at maximum engine speed, and take the average value as the measurement.
7. Conduct at oil temperature 50 ± 5 °C (122 ± 9 °F).

(1) Pump 1 pressure check port plug
(2) Pump 2 pressure check port plug
(3) Pump 3 pressure check port plug
(4) Unload LS valve
(5) Main LS relief valve

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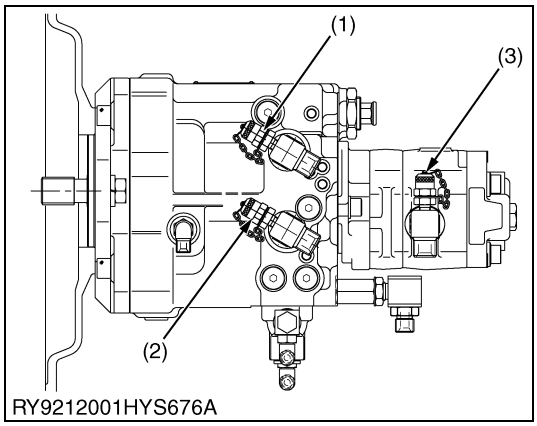

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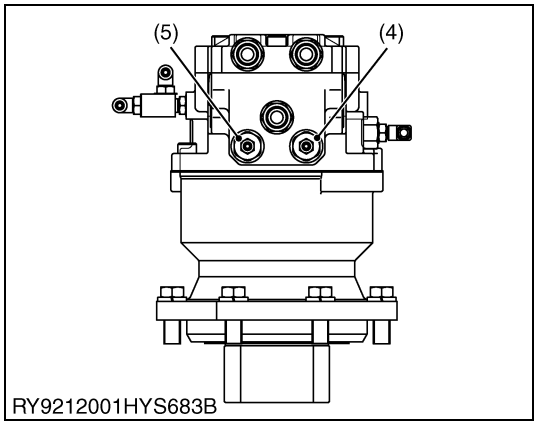

RY9212001HYS683B

Swivel relief valve pressure

1. Place the machine on firm, level ground, lower the bucket and blade to ground level, and stop the engine.
2. In accordance with "Releasing Residual Hydraulic System Pressure" in this manual, release pressure from the hydraulic line.
3. Remove the plug (1) or (2) from the adapter's inspection port on the discharge side of the pump to be measured, and attach a pressure gage.
4. Start and idle the engine, and check that there is no oil leakage.
5. Place the bucket against something robust, lock the machine so that it does not move, slowly operate the swivel lever from left to right and from right to left, and take the relief pressure reading at maximum engine speed.
   Perform the measurement three times, determine the average value, and take this as the measured value. Conduct at oil temperature 50 ± 5 °C (122 ± 9 °F).

■ **NOTE**

- **When measuring at the relief valve pressure inspection port side of the swivel motor, the pressure rises by about 10 % of the relief valve pressure setting. For more accurate measurement, attach the pressure gauge to the swivel motor.**

(1) Pump 1 pressure check port plug
(2) Pump 2 pressure check port plug
(3) Pump 3 pressure check port plug
(4) Swivel right relief valve
(5) Swivel left relief valve

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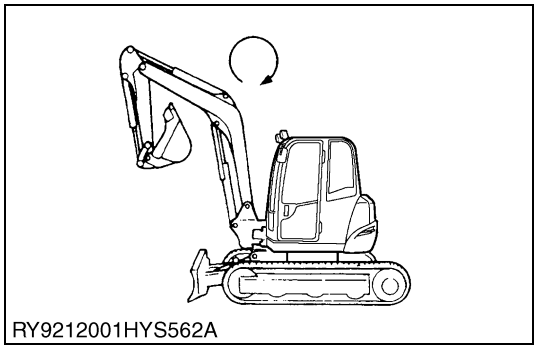
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LS Control Pressure

The actual measurement of LS control differential pressure requires special equipment such as a differential pressure instrument. General maintenance shops do not have such a expertise measuring device. This section introduces a simple method that makes use of one of the LS functions, such as the swivel motion of an actual machine.

1. Place the machine on hard ground.
2. Warm up the machine to the oil temperature of 50 ± 5 °C (122 ± 9 °F).
3. Raise up the engine speed at Max. rpm.
4. Measure the time for three turns constant swivel

Swivel function	KX057-4	U55-4	U48-4
Reference value [three turns]	17.6 - 21.7 sec.	17.6 - 21.7 sec.	18.2 - 22.2 sec.
Actual measurement			

- Machine condition:
  Boom raised, arm and bucket crowd
  Dozer-down on ground.

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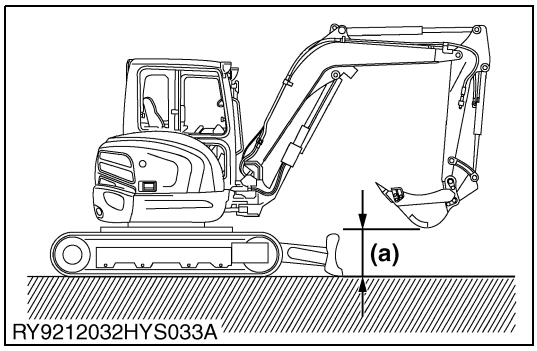

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RY9212001HYS552A

Swivel motor drain volume

1. Before measuring, repeat swivel left and right operations to sufficiently warm up the swivel motor. Hydraulic oil temperature of 50 ± 5 °C (122 ± 9 °F).
2. Place the mini excavator on flat hard ground, lower the bucket and the blade, and stop the engine.
3. In accordance with "Releasing Residual Hydraulic System Pressure" in this manual, release pressure from the hydraulic line.
4. Connect a vacuum pump.
5. Disconnect the swivel motor's drain hose from the swivel motor side, and insert a plug in the disconnected hose.
6. Connect the measuring use hose (eg., low-pressure use polyvinyl hose) to the drain port on the swivel motor side.
7. Remove the vacuum pump.
8. Operate the swivel lever at full stroke for one minute with the engine at maximum rpm, and while maintaining the swivel status at the same speed, collect hydraulic fluid from the drain hose in a receptacle and take the measurement.
9. Take the measurement from right to left and left to right two to three times, and determine the average value.

CAUTION

- **Before commencing measurement, make sure there are no persons or obstacles within the swivel range.**

(a) 1 m, 40 in.

RY9212032HYS0068US0

RY9212032HYS035A

RY9212001HYS554A

Travel motor drain volume

1. Before measuring turn on the travel motor and give it a thorough warm up. Set the hydraulic fluid temperature to 50 ± 5 °C (122 ± 9 °F).
2. Place the mini excavator on flat hard ground, lower the bucket and the blade, and stop the engine.
3. In accordance with "Releasing Residual Hydraulic System Pressure" in this manual, release pressure from the hydraulic line.
4. Connect a vacuum pump.
5. Disconnect the travel motor's drain hose from the travel motor side, and insert a plug in the disconnected hose.
6. Connect the measuring use hose (eg., low-pressure use polyvinyl hose) to the drain port on the travel motor side.
7. After disconnecting the vacuum pump, start the engine, jack up the machine and raise the crawler above ground level.

CAUTION
- **Place safety blocks and supports under the jacked up machine to prevent it from dropping.**

8. Rotate the crawler on the measuring side for one minute with the engine at maximum rpm, collect hydraulic fluid from the measuring use hose in a receptacle, and take the measurement. Take the measurement from right to left and left to right two to three times, and determine the average value.

CAUTION
- For safety's sake, keep hands and feet out from under the crawler.

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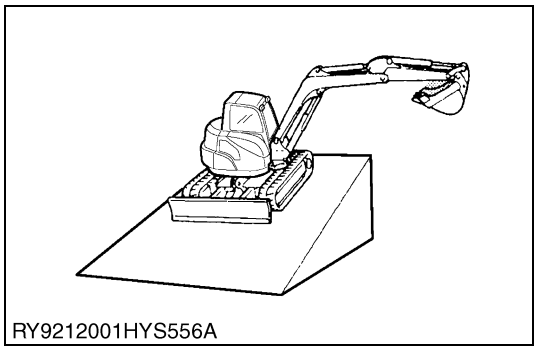
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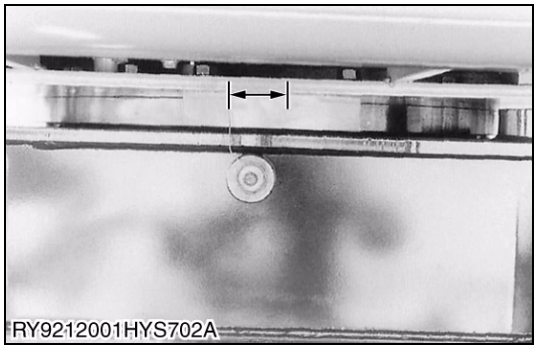
RY9212001HYS702A

Swivel Block Performance

1. Before measuring, repeat swivel left and right operations to sufficiently warm up the swivel motor. Set the hydraulic fluid temperature to 50 ± 5 °C (122 ± 9 °F).
2. Place dirt or a weight of the specified weight (JIS heap x specific gravity 1.8) in the bucket.
3. For this measurement, set the machine on a slope angle of 20 ° with the front perpendicular to the sloping surface.
4. The front attitude should be with the arm cylinder fully compressed and bucket cylinder fully extended, holding the boom on a straight line between the boom base pin and bucket pin.
5. Place markers on the circumference of the swivel bearing and track frame.
6. Start the engine, release the safety lock lever at idling rpm (lever down), and measure the slippage over one minute.
7. Take the measurement from right to left and left to right two to three times, and determine the average value.

CAUTION
- **Before commencing measurement, make sure there are no persons or obstacles within the swivel range.**

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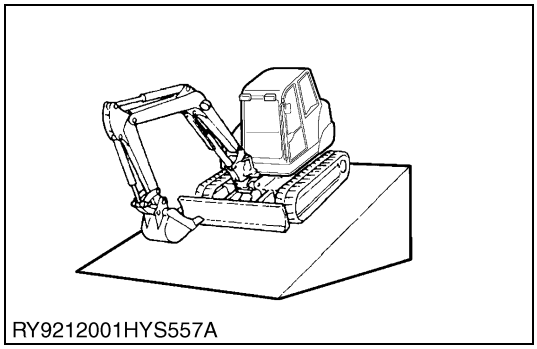
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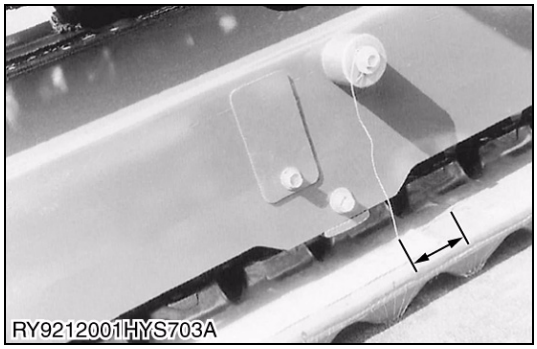
RY9212001HYS703A

Travel Block Performance

1. Before measuring turn on the travel motor and give it a thorough warm up. Set the hydraulic fluid temperature to 50 ± 5 °C (122 ± 9 °F).
2. For this measurement, set the machine on a slope angle of 20 °.
3. Stop the machine on the slope, and set the front to travel attitude.
4. Place the travel lever in neutral and stop the engine.
5. Make marks in the track frame and crawler, and measure the slippage of ten minutes.

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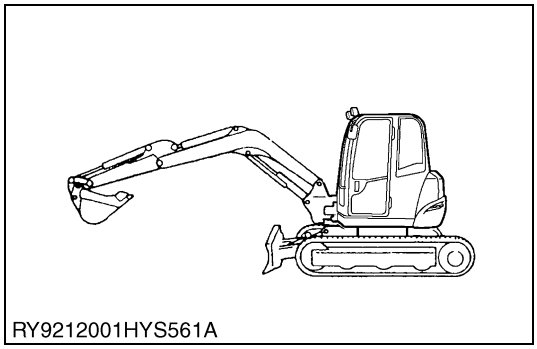
RY9212001HYS561A

Gravity fall amount of hydraulic cylinder

1. Before measuring, repeat front operations and fully warm up each cylinder. Set the hydraulic fluid temperature to 50 ± 5 °C (122 ± 9 °F).
2. Place dirt or a weight of the specified weight (JIS heap x specific gravity 1.8) in the bucket.
3. The front attitude should be with arm cylinder fully compressed, bucket cylinder fully extended, and bucket bottom approximately 1 m (40 in.) above ground level. Note that the arm cylinder should return about 50 mm (2.0 in.) from the stroke end, and be outside the cushion range.
4. Stop the engine, and place marks on the boom, arm and bucket cylinder rods.
5. After ten minutes has elapsed, measure the boom cylinder compression, arm cylinder extension and bucket cylinder compression.

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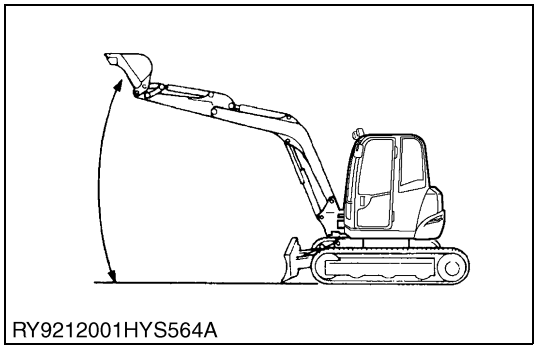
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Hydraulic Cylinder Operating Time

Boom cylinder measurement

1. Before measuring, repeat front operations and fully warm up each cylinder. Set the hydraulic fluid temperature to 50 ± 5 °C (122 ± 9 °F).
2. The attitude for measurement should be with maximum compressed length of the arm cylinder and bucket cylinder.
3. Raise the engine speed to maximum rpm, operate the boom control lever to full stroke, and measure the time required from the bucket ground contact position (maximum down position) to maximum up position (position above ground). (Do not include cushion operating time.)

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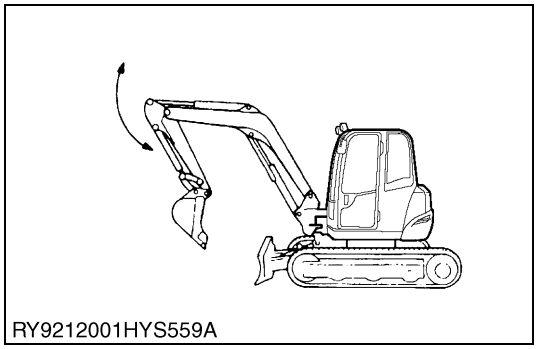
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Arm cylinder measurement

1. Before measuring, repeat front operations and fully warm up each cylinder. Set the hydraulic fluid temperature to 50 ± 5 °C (122 ± 9 °F).
2. With the engine at maximum rpm, operate the arm control lever to full stroke, and measure the time required for arm in and out.

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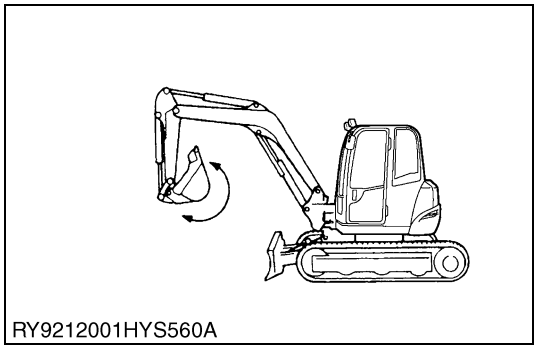
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Bucket cylinder measurement

1. Before measuring, repeat front operations and fully warm up each cylinder. Set the hydraulic fluid temperature to 50 ± 5 °C (122 ± 9 °F).
2. With the engine at maximum rpm, operate the bucket control lever to full stroke, and measure the time required for bucket crowd and dump.

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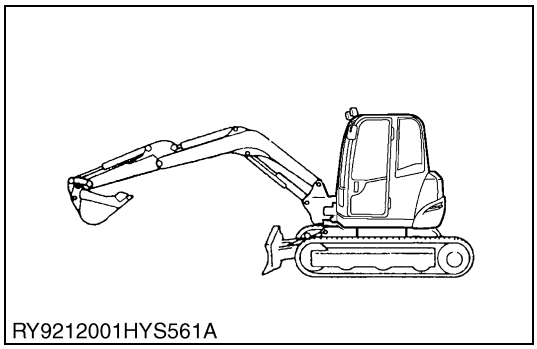
RY9212001HYS561A

Swing cylinder measurement

1. Before measuring, repeat front operations and fully warm up each cylinder. Set the hydraulic fluid temperature to 50 ± 5 °C (122 ± 9 °F).
2. The front attitude should be with arm cylinder fully compressed, bucket cylinder fully extended, and bucket bottom approximately 1 m (40 in.) above ground level.
3. At maximum engine rpm, perform a full throttle stroke swing from left to right and right to left, and measure the time required to achieve this.

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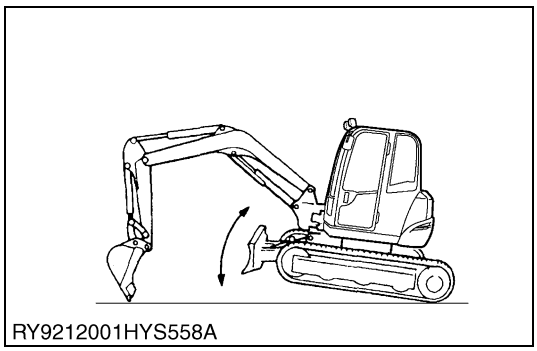
RY9212001HYS558A

Blade cylinder measurement

1. Before measuring, repeat front operations and fully warm up each cylinder. Set the hydraulic fluid temperature to 50 ± 5 °C (122 ± 9 °F).
2. The vehicle attitude for measurement should be jacked up by the front, assuring full stroke of cylinder, top to bottom.
3. With the engine at maximum rpm, operate the blade control lever to full stroke, and measure the time required for blade up and down operation.

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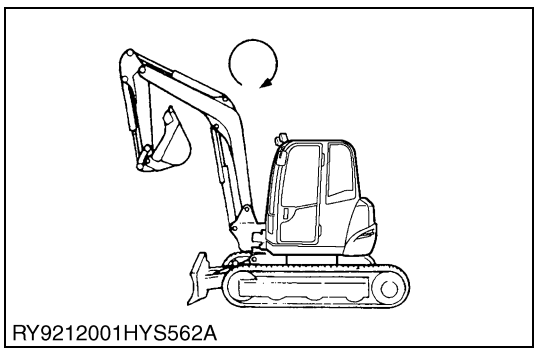
RY9212001HYS562A

Measurement of required swivel time

1. Before measuring, repeat left-right swivel operation to thoroughly warm up the swivel motor. Set the hydraulic fluid temperature to 50 ± 5 °C (122 ± 9 °F).
2. The attitude for measurement should be with maximum extension of the boom cylinder, arm cylinder and bucket cylinder.
3. At maximum engine rpm, operate the swivel control lever at full stroke, and measure the time taken for three turns of the swivel unit.

⚠ CAUTION

- **Before commencing measurement, make sure there are no persons or obstacles within the swivel range.**

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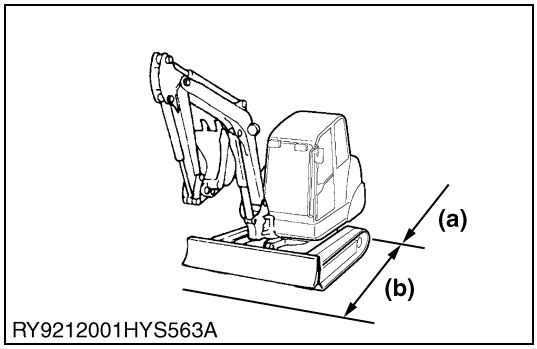

RY9212001HYS563A

Travel Speed

1. Before measuring, adjust the left and right crawlers to even tension, and operate the travel motor to thoroughly warm it up. Set the hydraulic fluid temperature to 50 ± 5 °C (122 ± 9 °F).
2. The measuring attitude should be travel attitude.
3. At maximum engine rpm, perform a 5 m (200 in.) run-up and 10 m (390 in.) forward run, and measure the time required.

(a) Run-up (5 m, 200 in.) **(b) Measuring area (10 m, 390 in.)**

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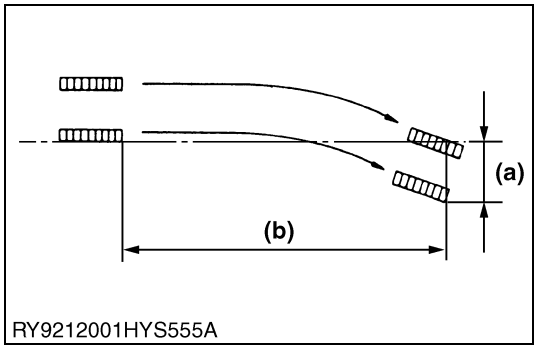

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Amount of travel drift

1. Before measuring, adjust the left and right crawlers to even tension, and operate the travel motor to thoroughly warm it up. Set the hydraulic fluid temperature to 50 ± 5 °C (122 ± 9 °F).
2. Determine a 10 m travel course on firm, flat ground, and set the measuring attitude to travel attitude.
3. At maximum engine rpm, travel for 10 m (390 in.), and measure the amount of drift **(a)**.
4. Perform the measurement three times, backwards and forwards; determine the average value, and take this as the measured value.

(a) Travel drift **(b) 10 m, 390 in.**

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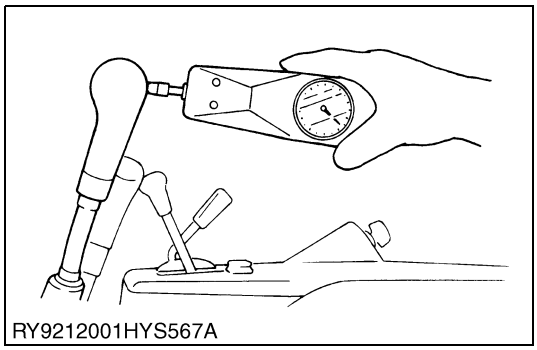
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Lever operating force

1. Measurements on left and right control levers.
2. At maximum engine rpm, operate a control lever to full stroke, and take the value just before the stroke end as the measured value.
3. Take three measurements, determine the average and take that as the measured value.

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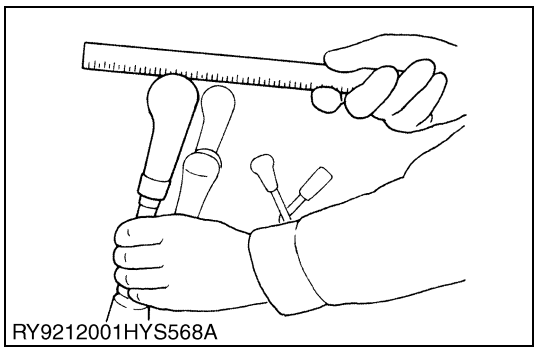
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Lever stroke

1. Stop the engine.
2. Move each control lever (travel, arm, bucket, blade and swivel) from neutral to stroke end, and measure at the top center of the grip.
3. If there is backlash in neutral, take two measurements.
4. Measurement is by linear dimensions.
5. Perform the measurement three times, determine the average value, and take this as the measured value.

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15. TROUBLESHOOTING

Front System Troubleshooting

All front operations slow or not moving

Cause	Inspection point	Remedy	Reference page
Defect of the engine itself	Engine speed measurement	Adjust each engine part	
Insufficient hydraulic fluid volume or oil degradation	Check hydraulic tank oil level and oil quality	Replenish the hydraulic fluid supply or change the oil	
Suction line (suction filter) blockage	Inspect the suction line (suction filter)	Wash the suction line Replace the suction line	
Pilot filter blockage	Pilot filter blockage inspection	Replace pilot filter	
Pilot relief valve faulty operation or poor pilot pump performance	Pilot primary pressure measurement	Adjust, wash or replace pilot relief valve Replace pilot pump	
Poor main relief valve operation or seating	Main relief valve pressure measurement	Adjust, wash or replace main relief valve	
Poor unload valve operation or seating	Control valve unload pressure measurement	Wash unload valve seat surface or replace	
Drop in control differential pressure due to LS regulator spool stick	Pump LS regulator spool inspection	Wash LS regulator spool Replace LS regulator spool	
Defective pump installation coupling	Pump installation coupling inspection	Replace pump coupling	
Pump drive shaft breakage	Pump drive shaft inspection	Replace shaft	
Pump internal parts wear or damage	Pump inspection	Repair or replace pump	

Either pilot valve right or left front does not move or is slow

Cause	Inspection point	Remedy	Reference page
Pilot valve line filter blockage	Pilot valve line filter blockage inspection	Clean pilot filter line filter	
Defective pilot valve	Pilot secondary pressure measurement of applicable cylinder	Pilot valve disassembly, cleaning or replacement	

Low power of entire hydraulic system

Cause	Inspection point	Remedy	Reference page
Pilot relief valve faulty operation or poor pilot pump performance	Pilot primary pressure measurement	Adjust, wash or replace pilot relief valve Replace pilot pump	
Poor main relief valve operation or seating	Main relief valve pressure measurement	Adjust, wash or replace main relief valve	
Defective control differential pressure due to LS regulator spool stick	Pump LS regulator spool inspection	Wash LS regulator spool Replace LS regulator spool	

A certain cylinder only does not move or is slow

Cause	Inspection point	Remedy	Reference page
Applicable pilot valve defect	Pilot secondary pressure measurement of applicable cylinder	Pilot valve disassembly, cleaning or replacement	
Defective specified pressure of overload relief valve	Inspection of overload relief valve of applicable cylinder	Wash overload relief valve seat surface or replace	
Control valve spool stick	Inspection of control valve spool of applicable cylinder	Control valve spool disassembly and washing	
Defective seal of cylinder internal parts	Inspection of applicable cylinder	Cylinder disassembly and seal replacement	

Low power of certain implement

Cause	Inspection point	Remedy	Reference page
Pilot relief valve faulty operation or poor pilot pump performance	Pilot primary pressure measurement	Adjust, wash or replace pilot relief valve Replace pilot pump	
Defective specified pressure of overload relief valve	Inspection of overload relief valve of applicable cylinder	Wash overload relief valve seat surface or replace	
Drop in control differential pressure due to LS regulator spool stick	Pump LS regulator spool inspection	Disassemble and wash LS regulator spool Replace LS regulator spool	

Major front leak (drift) volume

Cause	Inspection point	Remedy	Reference page
Defective specified pressure of overload relief valve	Inspection of overload relief valve of applicable cylinder	Wash overload relief valve seat surface or replace	
Control valve spool stick	Inspection of control valve spool of applicable cylinder	Control valve spool disassembly and washing	
Defective seal of cylinder internal parts	Inspection of applicable cylinder	Cylinder disassembly and seal replacement	

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Travel System Troubleshooting

No travel on one side. Slow Meandering

Cause	Inspection point	Remedy	Reference page
Crawler tension trouble or earth blockage around crawler	Crawler tension and blockage inspection	Earth removal around crawler and crawler tension adjustment	
Defective travel pilot valve operation	Travel pilot valve secondary pressure measurement	Travel pilot valve disassembly, cleaning or replacement	
Defective travel relief specified pressure of control valve	Slow side travel relief pressure measurement	Travel relief valve washing or replacement	
Control valve spool stick	Control valve spool stick inspection	Control valve spool disassembly and washing	
Control valve spool stick	Travel motor counterbalance spool inspection	Travel motor counterbalance valve disassembly, cleaning or replacement	
Defective travel motor	Travel motor drain volume measurement	Travel motor disassembly, replacement	
Internal leak of swivel joint	Remove the travel outlet hose of the swivel joint, plug it and measure the relief pressure	Swivel joint seal replacement	

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Swivel System Troubleshooting

Swivel speed low or no swivel

Cause	Inspection point	Remedy	Reference page
Defective pilot valve	Travel pilot valve secondary pressure measurement	Pilot valve disassembly, cleaning or replacement	
Swivel section spool stick	Control valve swivel section spool inspection	Clean spool	
Defective swivel relief specified pressure	Swivel relief pressure measurement	Swivel relief valve washing or replacement	
Internal defect of swivel motor	Swivel motor drain volume measurement	Swivel motor disassembly, replacement	
Snagging or sticking of friction plate for swivel motor parking brake	Inspection for snagging or sticking of friction plate for swivel motor parking brake	Replace friction plate	

Swivel drift

Cause	Inspection point	Remedy	Reference page
Pilot valve spool stick	Check that the pilot valve spool has returned to neutral	Pilot valve disassembly, cleaning or replacement	
Swivel section spool stick	Control valve swivel section spool inspection	Control valve spool disassembly and washing	
Defective swivel relief specified pressure	Swivel relief pressure measurement	Swivel relief valve washing or replacement	
Swivel motor make-up poppet stick or defective seat surface	Swivel motor make-up poppet inspection	Make-up poppet disassembly and washing	
Internal defect of swivel motor	Swivel motor drain volume measurement	Swivel motor disassembly, replacement	

RY9212032HYS0074US0

4 ELECTRICAL SYSTEM

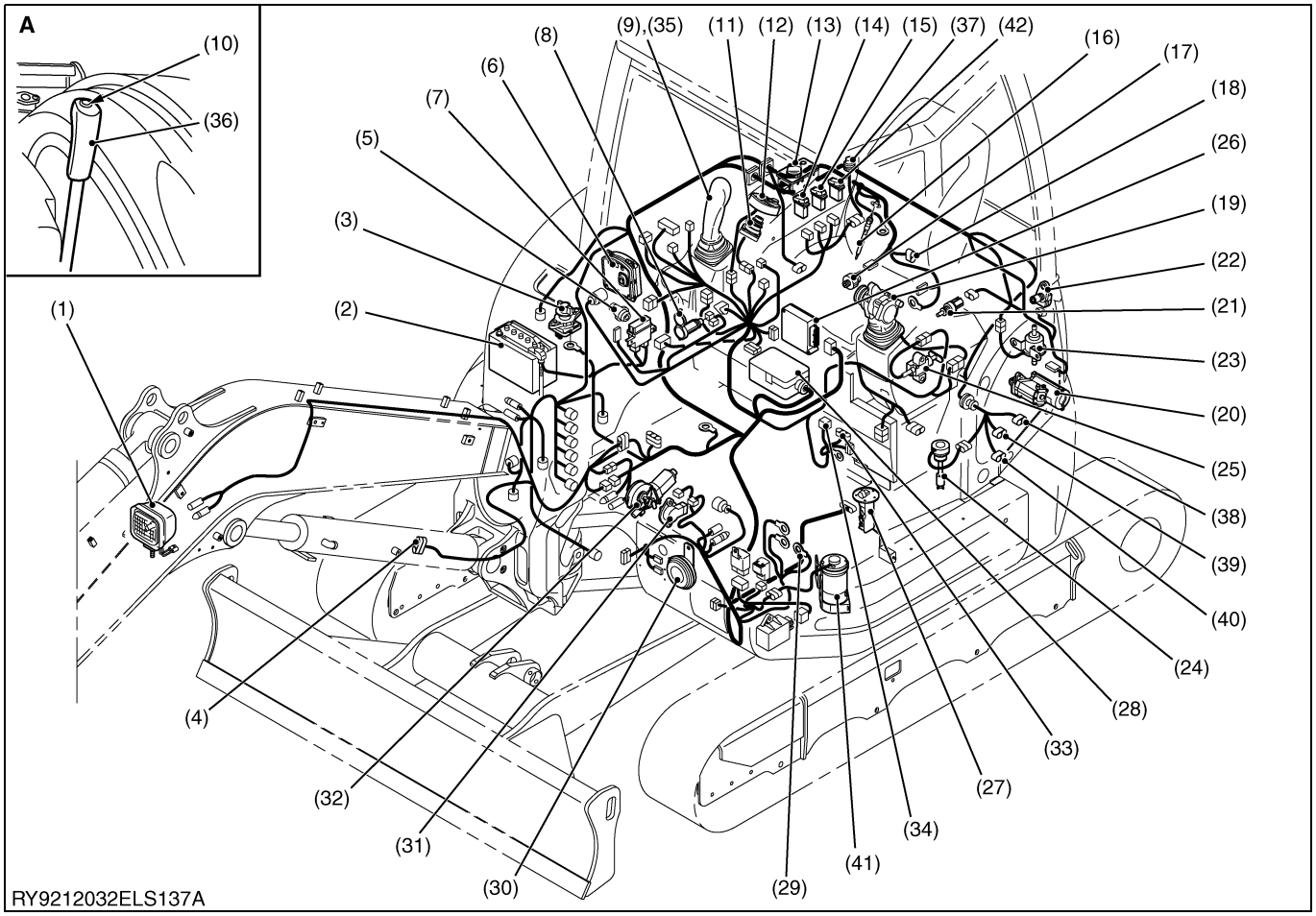
SERVICING

CONTENTS

1. ELECTRONIC DEVICE LAYOUT 4-S1
2. WIRING CIRCUIT 4-S2
   [1] PRECAUTIONS ON HOW TO CLAMP THE ELECTRICAL WIRING 4-S2
   [2] PRECAUTIONS ON HANDLING ELECTRICAL CONNECTORS 4-S2
   [3] UNPLUGING ELECTRICAL CONNECTORS AND WIRING LAYOUT 4-S3
3. TROUBLESHOOTING (START-UP EQUIPMENT VERSION) 4-S13
4. INSPECTIONS 4-S15
   [1] POWER AND GROUND 4-S15
   [2] STARTING AND STOPPING DEVICE 4-S18
5. INSTRUMENT PANEL OPERATING GUIDE 4-S22
   [1] METER CONSOLE 4-S22
      (1) Names and Functions of Each Meter and Switch 4-S22
   [2] DETAILS OF OPERATIONAL PROCEDURES TABLE 4-S22
   [3] DETAILS OF THE OPERATIONAL PROCEDURES 4-S23
      (1) Refer to the Hour Meter, Clock, Engine rpm, Water Temperature, and Fuel 4-S23
      (2) Refer to the Operational Information 4-S23
      (3) Periodical-check-item Confirmation and Operation after the Periodical Check Execution 4-S24
      (4) How to set the Clock 4-S25
      (5) Switching-over of the items of “AM/PM · 24 hours” 4-S26
      (6) Language Selection 4-S26
      (7) Beep the Buzzer while Fueling 4-S27
   [4] AUXILIARY PORT OPERATION 4-S28
      (1) Selecting the Action Modes 4-S28
      (2) AUX Port Handling Procedure 4-S30
      (3) Setting the Maximum Flow Volume 4-S31
   [5] SERVICE DEALER SETTINGS 4-S36
      (1) Diagnosis 4-S37
      (2) Setting 4-S44
   [6] LIST OF WARNING ALARM DISPLAYS 4-S84
6. TROUBLESHOOTING (METER PANEL EDITION) 4-S88
   [1] ENGINE RELATED SYSTEMS 4-S88
      (1) Engine Oil Pressure Errors 4-S88
      (2) Charging System Errors 4-S91
      (3) Fuel Sensor Errors 4-S94
      (4) Water Temperature Sensor Errors 4-S98
   [2] MACHINE RELATED SYSTEM 4-S101
      (1) Lever Lock System Errors 4-S101
      (2) Travel 2-speed System Error 4-S107
   [3] AUTO IDLING (AI) SYSTEM 4-S112
      (1) Governor Sensor Errors 4-S112
      (2) Accelerator Sensor Errors 4-S116
      (3) AI Motor Errors 4-S120
      (4) Testing the AI Pressure Switch 4-S125
      (5) Testing the AI Switch 4-S129
   [4] ANTI-THEFT (AT) SYSTEM 4-S133
      (1) Anti-Theft System Errors 4-S133

[5] POWER SUPPLY SYSTEM 4-S138
(1) Over voltage 4-S138
(2) 5V Short System Error 4-S139
(3) 12V Short System Error 4-S140
[6] COMMUNICATION SYSTEM 4-S141
(1) CAN Communication Errors 4-S141
[7] AUX SYSTEM 4-S144
(1) AUX1 / AUX2/Thumb System Errors 4-S144
[8] HOLDING VALVE 4-S149
[9] BATTERY ISOLATOR 4-S151
[10] FUEL SUPPLY PUMP 4-S152
(1) Inspecting each Device Visually and Physically 4-S152
(2) Testing with a Circuit Tester 4-S154
(3) Testing the Equipment Itself 4-S157

1. ELECTRONIC DEVICE LAYOUT



No.	Part Name	No.	Part Name
(1)	Worklight	(22)	Engine rotation sensor
(2)	Battery	(23)	Fuel pump
(3)	Battery isolator	(24)	Fuel gauge
(4)	Boom pressure sensor	(25)	Lock lever switch
(5)	AI pressure switch	(26)	Main ECU
(6)	Meter panel	(27)	Fuel sensor
(7)	Slow-blow fuse	(28)	Fuse box
(8)	Power outlet	(29)	GND
(9)	Horn switch	(30)	Horn
(10)	Travel 2-speed switch	(31)	Governor sensor
(11)	Key switch	(32)	AI motor
(12)	Anti-theft antenna	(33)	CAN comm connector (2P)
(13)	Accelerator dial	(34)	Function extension connector (4P)
(14)	Worklight switch	(35)	Attachment control lever
(15)	CAB worklight switch	(36)	Blade control lever
(16)	Glow plug	(37)	Engine stop button
(17)	Engine oil switch	(38)	Fuel level audible indication switch
(18)	Engine stop solenoid	(39)	Fuel supply ON switch
(19)	Alternator	(40)	Fuel supply OFF switch
(20)	Starter	(41)	Fuel supply pump
(21)	Water temperature sensor	(42)	Rotary beacon switch

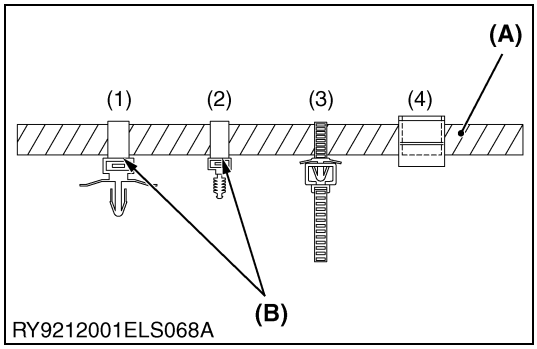
RY9212032ELS0058US0

2. WIRING CIRCUIT

[1] PRECAUTIONS ON HOW TO CLAMP THE ELECTRICAL WIRING

1. Do not touch the wiring or the area around it.
   Do not touch where uncovered.
2. Do not clamp to fuel hoses.
3. Connect connectors and terminals securely so they do not come unplugged when pulled on gently.
4. Be sure to clamp the harness at the clamp position.

5. Clamps for securing harnesses



RY9212001ELS068A

(1) Anchor type
(Insert firmly until it catches.)
(2) Screw type
(Insert to the end of the screw.)
(3) and (4) Insert type : Insert until it locks.

(A) Harness
(B) Clamp the harness so it stays in position and does not move. Insert the end of the cable tie into the hole on the other side to clamp the harness.

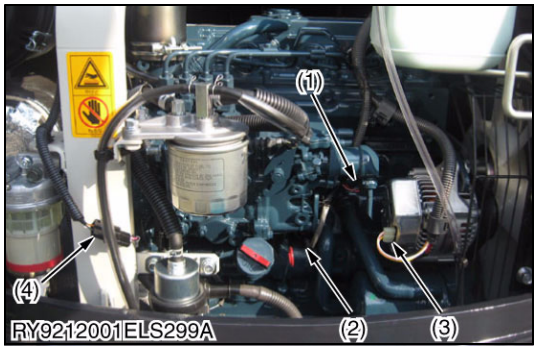
RY9212001ELS0025US0

[2] PRECAUTIONS ON HANDLING ELECTRICAL CONNECTORS

1. When disconnecting connectors, grasp the body of the connector and pull it out; do not pull on the wiring harness. If the connector is the locking type, release the lock and then pull to disconnect.
2. When removing a connector's plastic cover (for water protection) to inspect it, be careful not to let any water get in the connector. If water does get in, dry it thoroughly before reassembling the connector and putting its plastic cover securely in place.
3. Straighten any bent connector terminals and make sure none are sticking out or missing. Also make sure there is no corrosion on the connector's terminals before connecting it.
4. When connecting a locking connector, be sure to press it in until you hear it click and then pull gently on the harness close to the connector and make sure the harness does not come out.

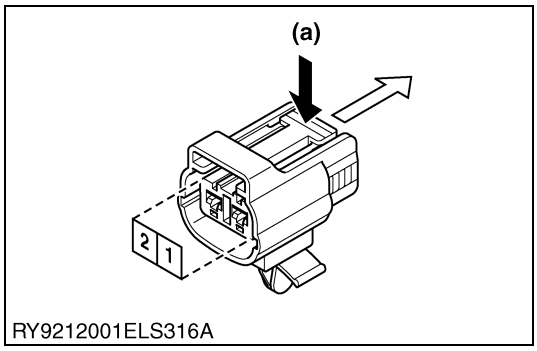
RY9212001ELS0224US0

[3] UNPLUGING ELECTRICAL CONNECTORS AND WIRING LAYOUT



(1) Engine stop solenoid connector
(2) Engine oil switch connector
(3) Alternator connector
(4) Fuel pump connector

RY9212001ELS0225US0

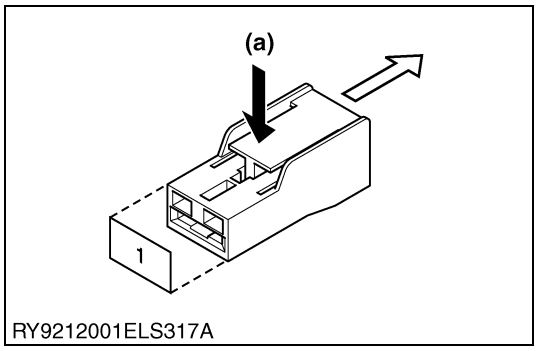


(1) Engine stop solenoid connector

Connector No.	Place Used	No. of Terminals
CN36	Inside engine compartment	2

(a) Press lock and unplug

RY9212001ELS0226US0

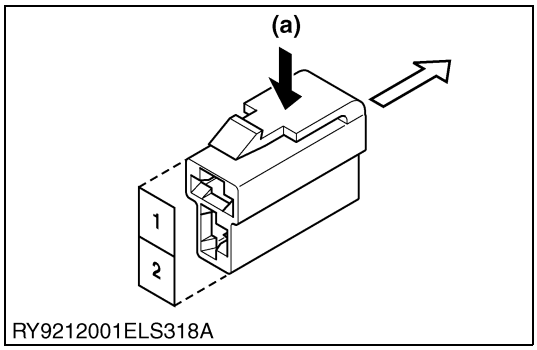


(2) Oil switch connector

Connector No.	Place Used	No. of Terminals
CN28	Inside engine compartment	1

(a) Press lock and unplug

RY9212001ELS0227US0

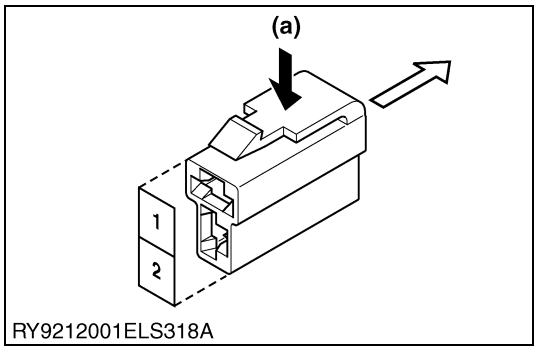


(3) Alternator connector

Connector No.	Place Used	No. of Terminals
CN25	Inside engine compartment	2

(a) Press lock and unplug

RY9212001ELS0228US0

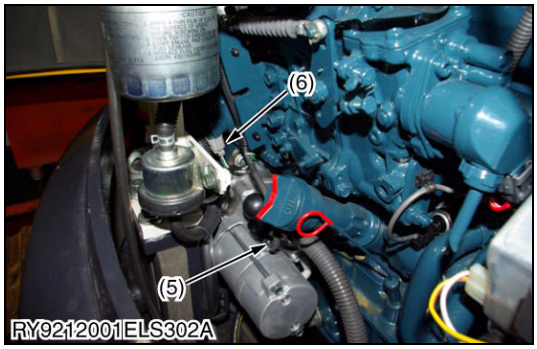


(4) Fuel pump connector

Connector No.	Place Used	No. of Terminals
CN24	Inside engine compartment	2

(a) Press lock and unplug

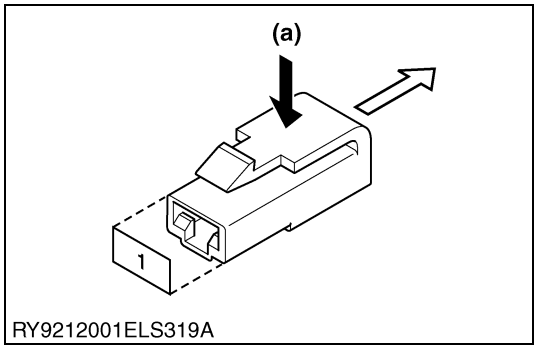
RY9212001ELS0229US0



(5) Starter connector

(6) Engine rotation sensor connector

RY9212001ELS0230US0

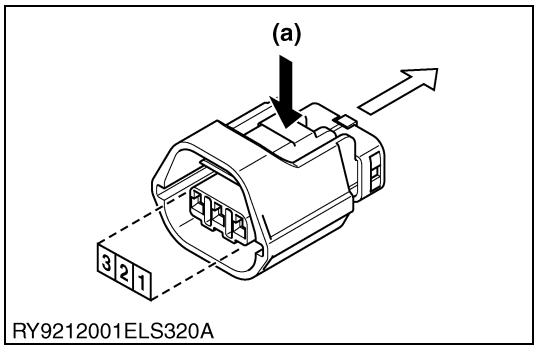


(5) Starter S-terminal connector

Connector No.	Place Used	No. of Terminals
CN37	Inside engine compartment	1

(a) Press lock and unplug

RY9212001ELS0231US0

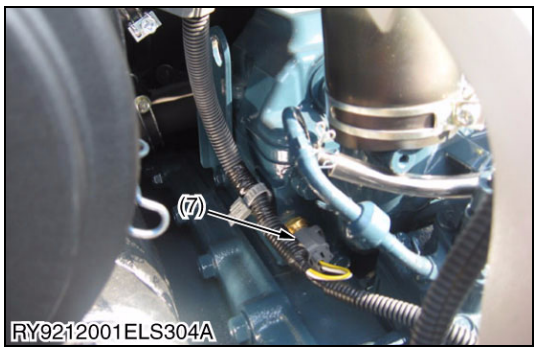


(6) Rotation sensor connector

Connector No.	Place Used	No. of Terminals
CN33	Inside engine compartment	3

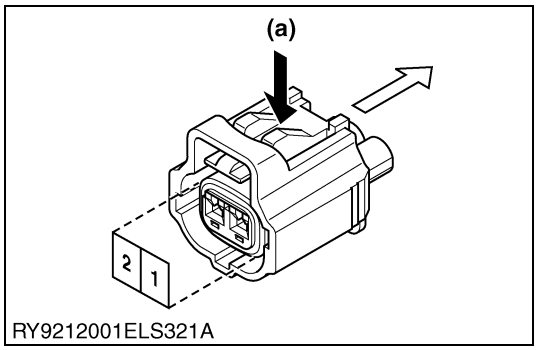
(a) Press lock and unplug

RY9212001ELS0232US0



(7) Water temperature sensor connector

RY9212001ELS0233US0

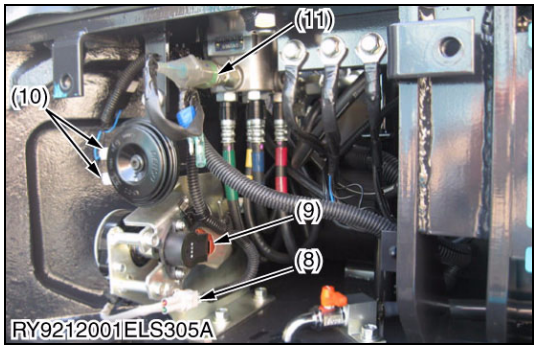


(7) Water temperature sensor connector

Connector No.	Place Used	No. of Terminals
CN32	Inside engine compartment	2

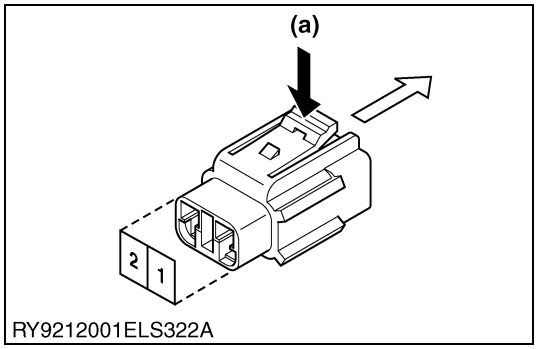
(a) Press lock and unplug

RY9212001ELS0234US0



(8) AI motor connector
(9) Governor sensor connector
(10) Horn connector
(11) Travel pressure switch connector

RY9212001ELS0235US0

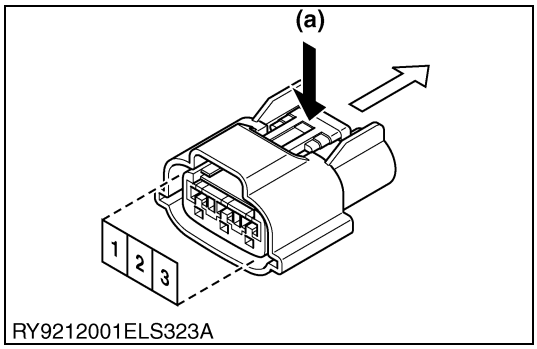


(8) AI motor connector

Connector No.	Place Used	No. of Terminals
CN5	In front of the swivel frame	2

(a) Press lock and unplug

RY9212001ELS0236US0

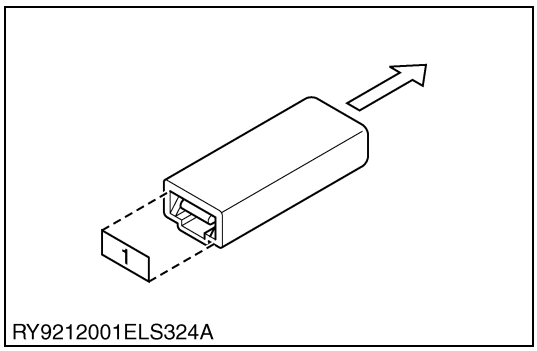


(9) Governor sensor connector

Connector No.	Place Used	No. of Terminals
CN4	In front of the swivel frame	3

(a) Press lock and unplug

RY9212001ELS0237US0

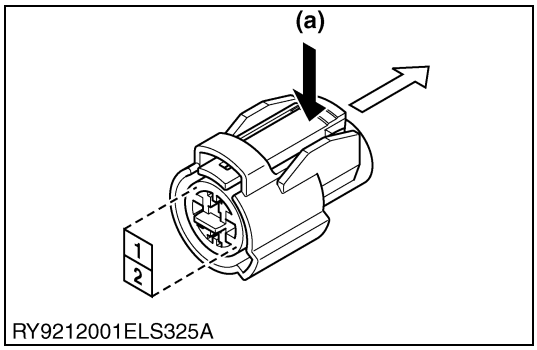


(10) Horn connector

Connector No.	Place Used	No. of Terminals
CN45, CN46	In front of the swivel frame	1

Squeeze the connector and pull

RY9212001ELS0238US0

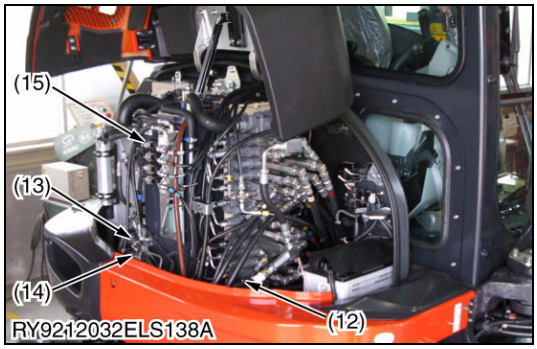


(11) Travel pressure switch connector

Connector No.	Place Used	No. of Terminals
CN454	In front of the swivel frame	2

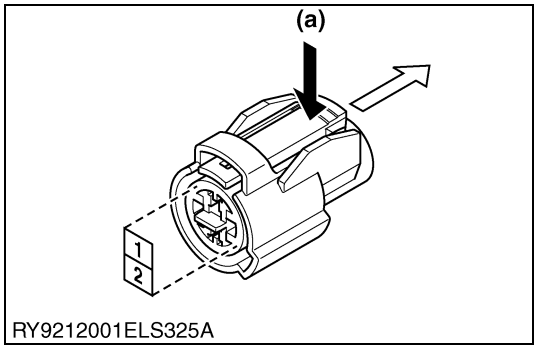
(a) Press lock and unplug

RY9212001ELS0239US0



(12) AI pressure switch connector
(13) 2-speed solenoid connector
(14) Lever lock solenoid connector
(15) AUX1, AUX2 solenoid connector

RY9212032ELS0086US0

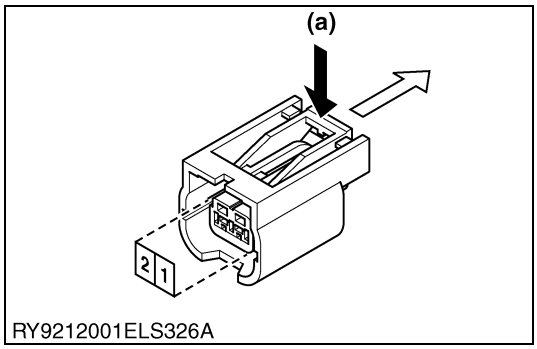


(12) AI pressure switch connector

Connector No.	Place Used	No. of Terminals
CN8	Inside right of hood	2

(a) Press lock and unplug

RY9212001ELS0241US0



(13) 2-speed solenoid connector

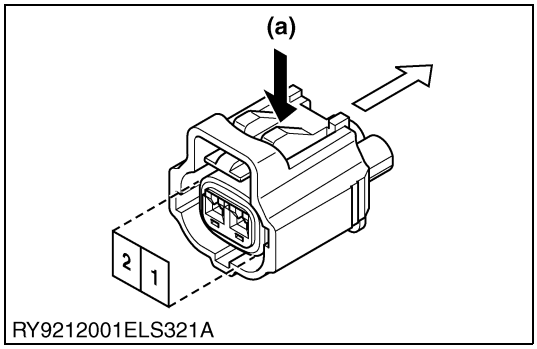
Connector No.	Place Used	No. of Terminals
CN13	Inside right of hood	2

(14) Lever lock solenoid connector

Connector No.	Place Used	No. of Terminals
CN12	Inside right of hood	2

(a) Press lock and unplug

RY9212001ELS0242US0

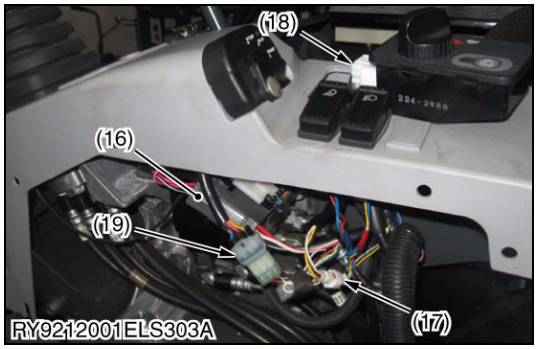


(15) AUX1, AUX2 solenoid connector

Connector No.	Place Used	No. of Terminals
CN427	Inside right of hood	2

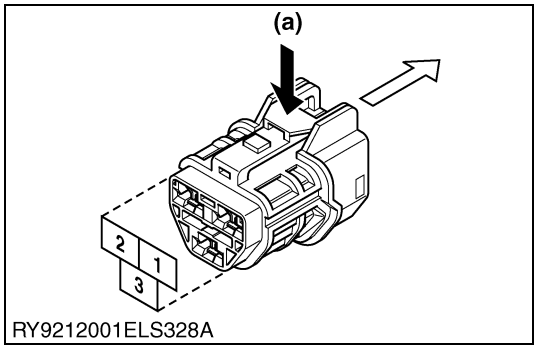
(a) Press lock and unplug

RY9212032ELS0059US0



(16) Key switch connector
(17) 2-speed switch connector
(18) AI console connector
(19) Anti-theft antenna connector

RY9212001ELS0244US0



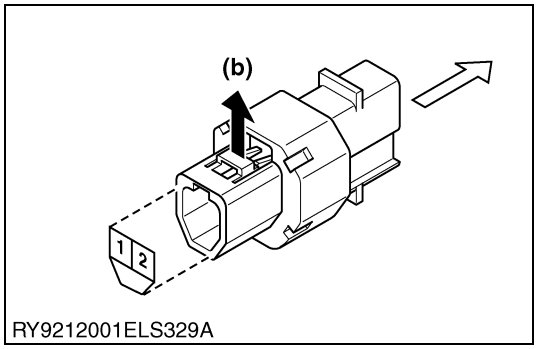
RY9212001ELS328A

(16) Key switch connector

Connector No.	Place Used	No. of Terminals
CN14	Inside right control cover	3

(a) Press lock and unplug

RY9212001ELS0245US0



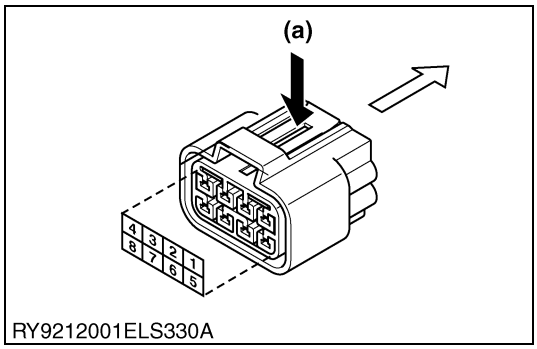
RY9212001ELS329A

(17) 2-speed switch connector

Connector No.	Place Used	No. of Terminals
CN15	Inside right control cover	2

(b) Lift up on the lock and then unplug

RY9212001ELS0246US0



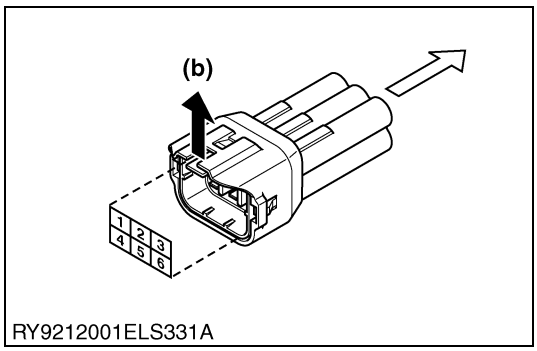
RY9212001ELS330A

(18) AI console connector

Connector No.	Place Used	No. of Terminals
CN421	Inside right control cover	8

(a) Press lock and unplug

RY9212001ELS0247US0



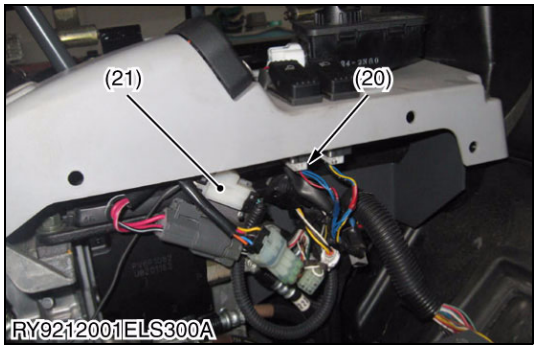
RY9212001ELS331A

(19) Anti-theft antenna connector

Connector No.	Place Used	No. of Terminals
CN441	Inside right control cover	6

(b) Lift up on the lock and then unplug

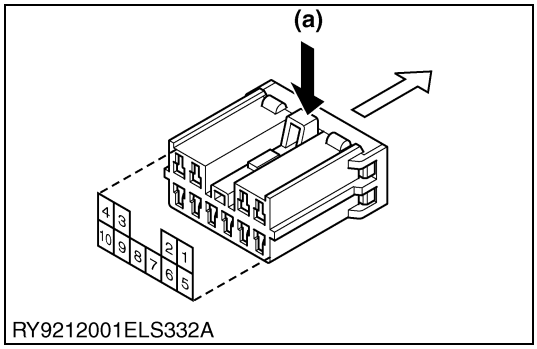
RY9212001ELS0248US0



RY9212001ELS300A

(20) Worklight switch connector (21) Horn switch connector

RY9212001ELS0249US0



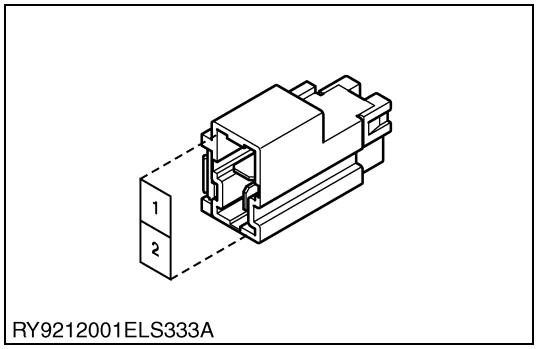
RY9212001ELS332A

(20) Worklight switch connector

Connector No.	Place Used	No. of Terminals
CN830	Inside right control cover	10

(a) Press lock and unplug

RY9212001ELS0250US0



RY9212001ELS333A

(21) Horn switch connector

Connector No.	Place Used	No. of Terminals
CN21	Inside right control cover	2

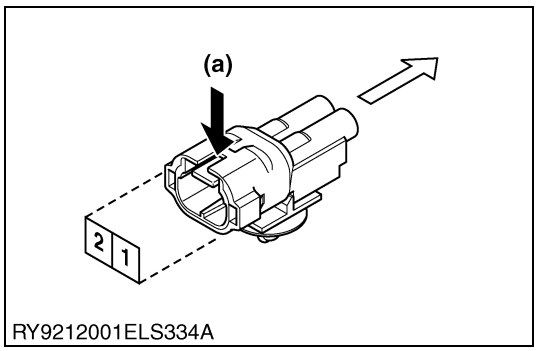
Unplug after pressing the lock of the connector on the switch side.

RY9212001ELS0251US0

RY9212001ELS307A

(22) Full tank signal switch connector

RY9212001ELS0252US0



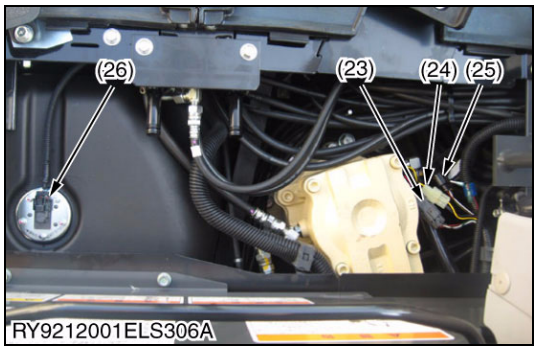
RY9212001ELS334A

(22) Full tank signal switch connector

Connector No.	Place Used	No. of Terminals
CN515	Above the fuel filler	2

(a) Press lock and unplug

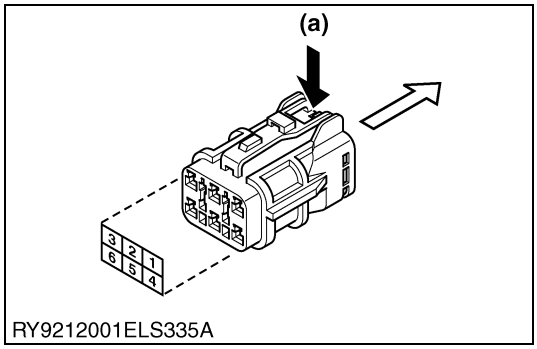
RY9212001ELS0253US0



RY9212001ELS306A

(23) Crane main connector
(24) Worklight harness connector
(25) Arm main connector
(26) Fuel sensor connector

RY9212001ELS0254US0



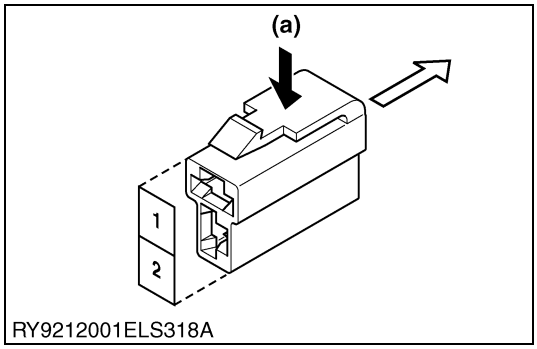
RY9212001ELS335A

(23) Crane main connector

Connector No.	Place Used	No. of Terminals
CN82	Swivel frame center	6

(a) Press lock and unplug

RY9212001ELS0255US0



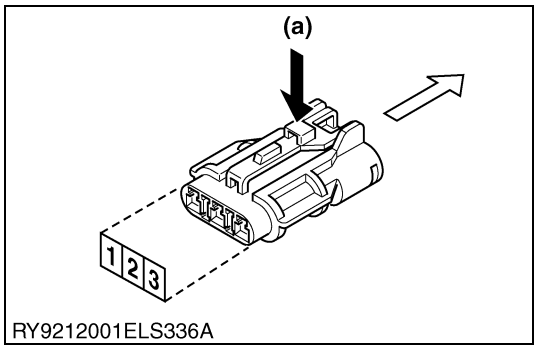
RY9212001ELS318A

(24) Worklight harness connector

Connector No.	Place Used	No. of Terminals
CN18	Swivel frame center	2

(a) Press lock and unplug

RY9212001ELS0256US0



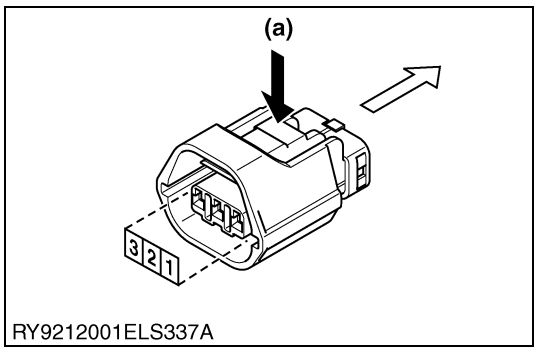
RY9212001ELS336A

(25) Arm main connector

Connector No.	Place Used	No. of Terminals
CN54	Swivel frame center	3

(a) Press lock and unplug

RY9212001ELS0257US0



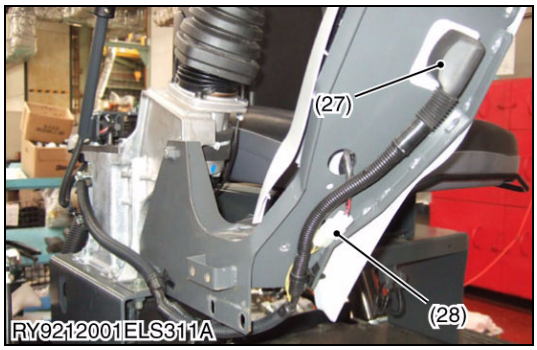
RY9212001ELS337A

(26) Fuel sensor connector

Connector No.	Place Used	No. of Terminals
CN23	Swivel frame center	3

(a) Press lock and unplug

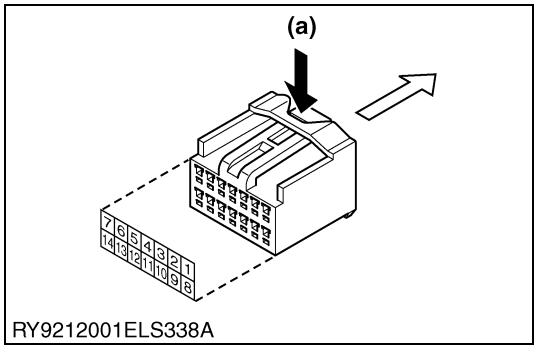
RY9212001ELS0258US0



RY9212001ELS311A

(27) LCD meter connector (28) LCD meter buzzer connector

RY9212001ELS0259US0



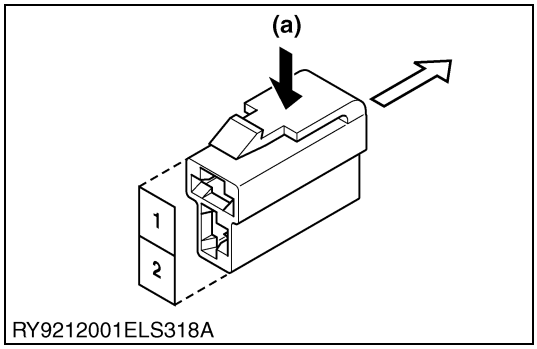
RY9212001ELS338A

(27) LCD meter connector

Connector No.	Place Used	No. of Terminals
CN2	Inside meter panel box	14

(a) Press lock and unplug

RY9212001ELS0260US0



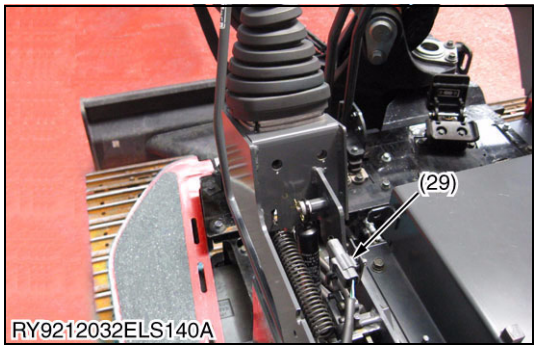
RY9212001ELS318A

(28) LCD meter buzzer connector

Connector No.	Place Used	No. of Terminals
CN250	Inside meter panel box	2

(a) Press lock and unplug

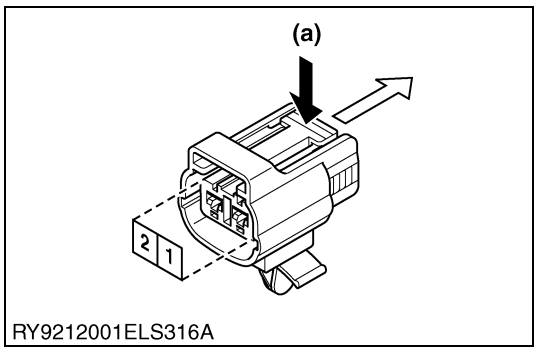
RY9212001ELS0261US0



RY9212032ELS140A

(29) Lever lock switch connector

RY9212050ELS0032US0



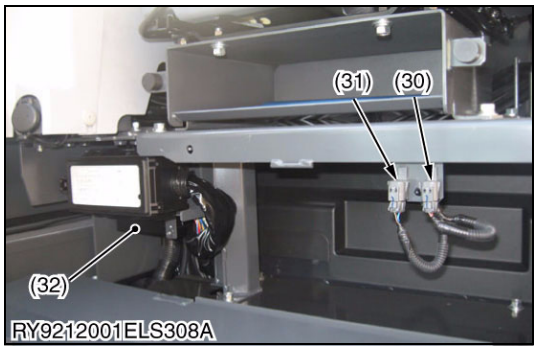
RY9212001ELS316A

(29) Lever lock switch connector

Connector No.	Place Used	No. of Terminals
CN11	Inside left control cover	2

(a) Press lock and unplug

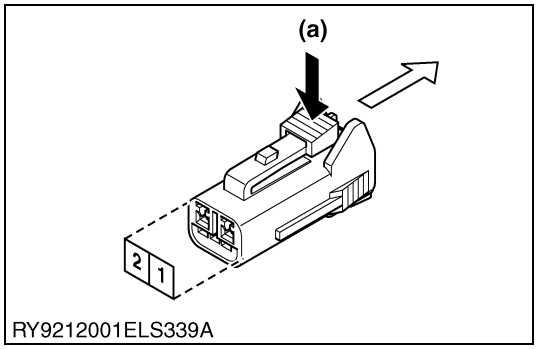
RY9212001ELS0263US0



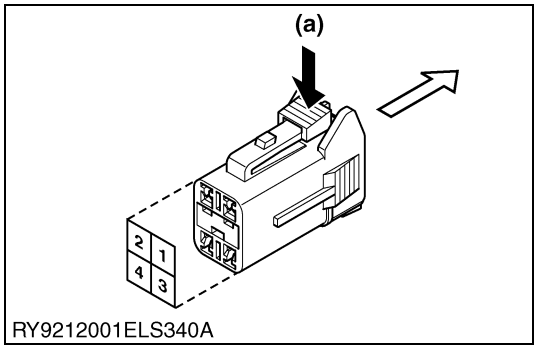
RY9212001ELS308A

(30) CAN comm connector
(31) Function extension connector
(32) Main ECU connector

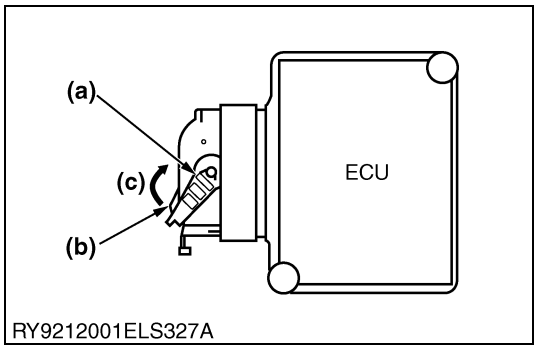
RY9212001ELS0264US0



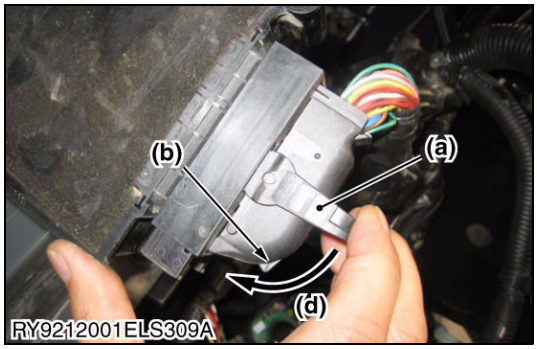
RY9212001ELS339A



RY9212001ELS340A



RY9212001ELS327A



RY9212001ELS309A

(30) CAN comm connector

Connector No.	Place Used	No. of Terminals
CN6	Under the seat	2

(a) Press lock and unplug

RY9212001ELS0265US0

(31) Function extension connector

Connector No.	Place Used	No. of Terminals
CN850	Under the seat	4

(a) Press lock and unplug

RY9212001ELS0266US0

(32) Main ECU connector

Connector No.	Place Used	No. of Terminals
CN1	Under the seat	81

1. Connecting and disconnecting connectors

(When disconnecting)

- Press the lock button, releasing the lever and unplug the connector.

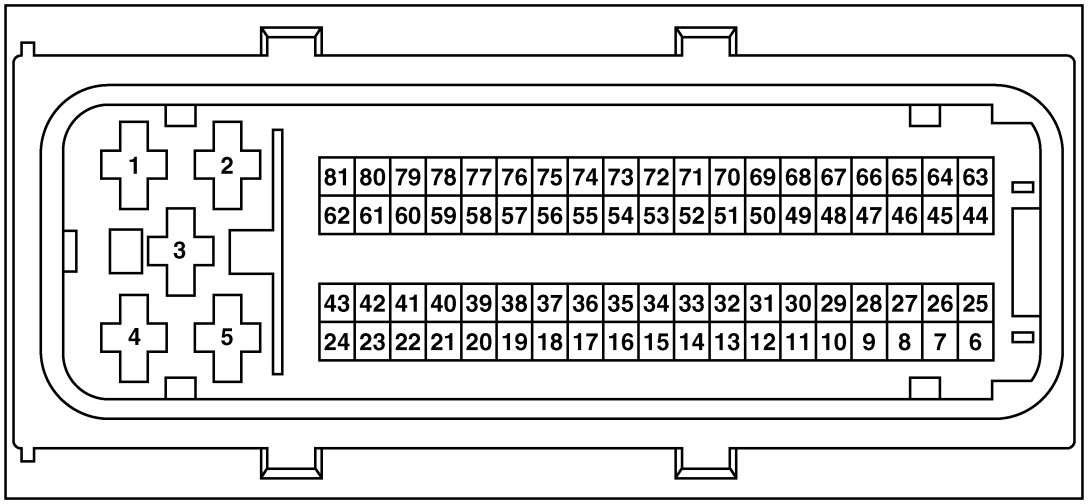
(When connecting)

- Press the connector all the way in, close the lever and make sure it is securely locked.

(a) Lever
(b) Lock button
(c) Release
(d) Lock

RY9212001ELS0267US0

2. Names of the Terminal Signals of the Main ECU Connector (Harness Side)



RY9212001ELS341A

Connector		Connector		Connector	
Terminal	Signal Name	Terminal	Signal Name	Terminal	Signal Name
1	GND (AI motor)	28	Accelerator angle sensor	55	–
2	GND	29	Boom bottom side pressure sensor	56	Lever lock switch
3	+12V Power (AI motor)	30	AUX2 control knob sensor	57	Starter switch
4	Motor (+, FWD rotation)	31	TXD (anti-theft antenna)	58	Start signal input
5	Motor (-, BWD rotation)	32	Buzzer	59	AUX1 holding switch
6	–	33	GND (sensor)	60	Compressor clutch signal input
7	Boom angle sensor	34	–	61	AI self-holding relay
8	Motor angle sensor	35	+5V Power output (sensor)	62	Right AUX1 solenoid
9	Boom rod side pressure sensor	36	–	63	–
10	AUX1 control knob sensor	37	–	64	–
11	+12V Power output	38	LED (anti-theft)	65	Travel pressure switch
12	–	39	Bucket lock solenoid relay	66	AI mode-switching switch
13	RXD (anti-theft antenna)	40	AC SW (Sol Power Supply)	67	Multipurpose SW (console)
14	–	41	AC SW (Sol Power Supply)	68	TXD (check connector)
15	AUX1 solenoid (–)	42	AC SW (Sol Power Supply)	69	Multipurpose switch (lever)
16	AUX2 solenoid (–)	43	Left AUX1 solenoid	70	–
17	AUX2 solenoid (–)	44	AUX2 holding switch	71	–
18	–	45	AI pressure switch	72	Engine rotation input
19	+B power (supplied directly)	46	–	73	–
20	Left AUX2 solenoid	47	Travel 2-speed switch	74	–
21	–	48	–	75	–
22	Travel 2-speed solenoid	49	RXD (check connector)	76	Glow relay
23	Right AUX2 solenoid	50	CAN (H-0)	77	Rotating light relay
24	Anti-theft horn relay	51	CAN (L-0)	78	LED (multi-purpose)
25	–	52	CAN (H-1)	79	LED (AI mode)
26	–	53	CAN (L-1)	80	Lever lock solenoid
27	Arm angle sensor	54	–	81	Multipurpose Sol

RY9212032ELS0060US0

3. TROUBLESHOOTING (START-UP EQUIPMENT VERSION)

Engine does not start

Checkpoint	Cause	Solution
Check whether "Wrong Key" is displayed when it is in the start position. Determine whether it is the registered key or not in the tester mode.	The engine was not started with the registered key.	Start the engine with the registered key.
Is the unload lever up or not? Is the message "Lift the lever" displayed?	The lever lock switch (limit) is pressed in.	Lift the unload lever and then start the engine.
Check slow-blow and other fuses.	Slow-blow and/or other fuses are blown.	After determining the cause of slow-blow and/or other fuses blowing, replace them.
Check whether GND wire(s) are securely connected to the body.	Ground defective	Tighten GND wire bolt(s).
Check battery voltage and specific gravity.	Battery fault	Recharge or replace the battery.
Check continuity between key switch terminals.	Key switch faulty	Replace the key switch.
Measure the voltage at terminal B of the starter.	Break in continuity of the harness or starter relay.	Repair the harness. Replace the harness, starter relay and/or fuses.
Measure the voltage at terminal S of the starter.	Break in continuity in the harness, starter relay and/or fuses.	Repair the harness. Replace the harness, starter relay and/or fuses.
Disconnect the engine stop solenoid connector and measure the voltage at the connector terminals on the harness side.	Break in continuity in the harness or engine stop solenoid relay.	Repair the harness. Replace the harness and/or the engine stop solenoid relay.
Disconnect the lever lock switch (limit) connector and measure the voltage at the connector terminals on the harness side.	Break in continuity in the harness or lever lock switch (limit) fuses.	Repair the harness. Replace the harness and/or fuses. Replace the lever lock switch (limit).

The engine fails to start sometimes.

Checkpoint	Cause	Solution
Is the key on a metal keyring or have a metal fob?	The fob and/or keyring are interfering with communication between the key and the antenna.	Get rid of the fob and/or ring.

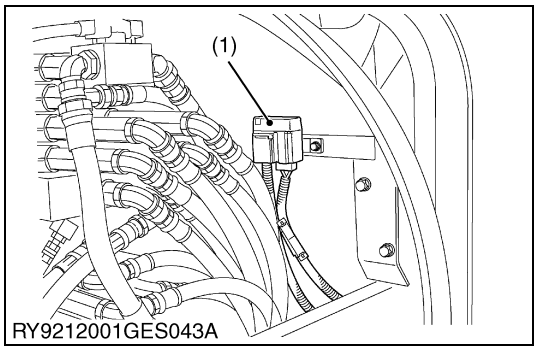
Engine starts even with unregistered keys

Checkpoint	Cause	Solution
Check whether the anti-theft system is "OFF" or not initialized.	As the anti-theft function is not working, even unregistered keys can start the engine.	Make the anti-theft settings and register the key.

RY9212050ELS0031US0

4. INSPECTIONS

[1] POWER AND GROUND



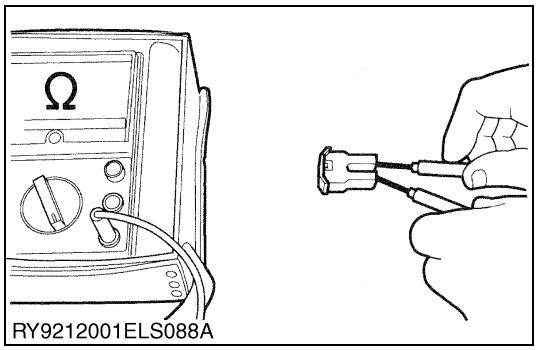
RY9212001GES043A

Slow-blow fuses

■ **IMPORTANT**
- **When replacing a slow-blow fuse, always use the same capacity fuse and replace it after determining why it blew.**

(1) Slow-blow fuses

RY9212001ELS0027US0

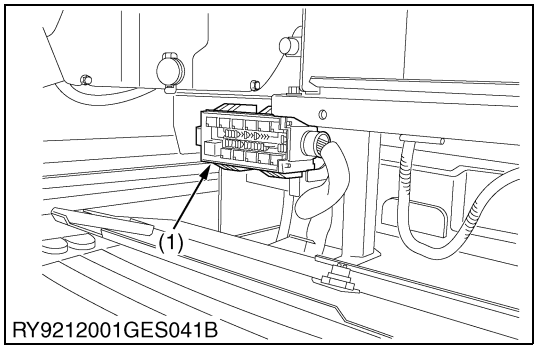


RY9212001ELS088A

Inspecting slow-blow fuses

- Measurement parameter : check continuity across its terminals

RY9212001ELS0028US0



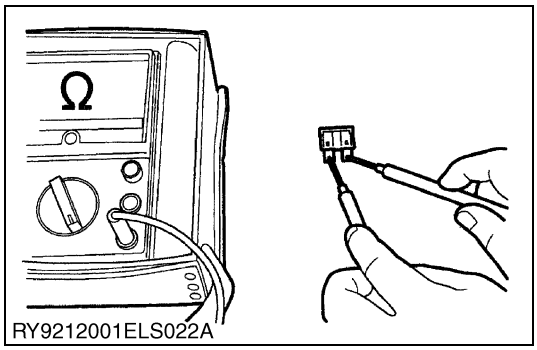
RY9212001GES041B

Fuses

■ **IMPORTANT**
- **When replacing a fuse, always use the same capacity fuse and replace it after determining why it blew.**

(1) Fuse box

RY9212001ELS0029US0

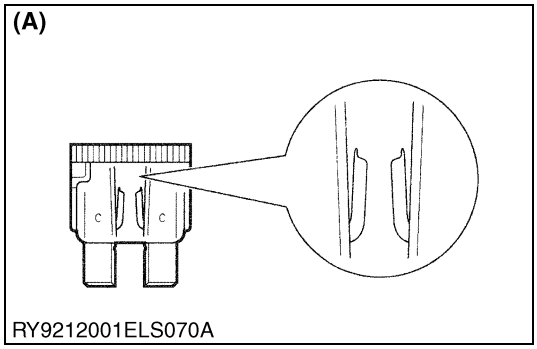


RY9212001ELS022A

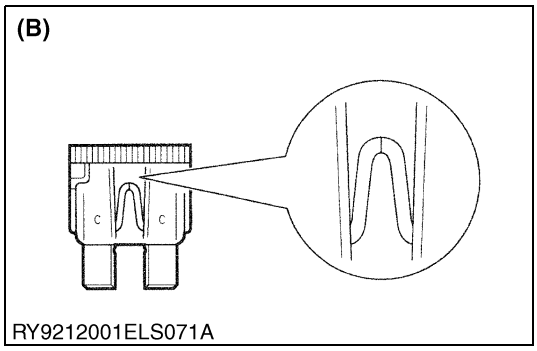
Inspecting fuses

- Measurement parameter : check continuity across its terminals

RY9212001ELS0031US0



RY9212001ELS070A



RY9212001ELS071A

Precautions when a fuse blows

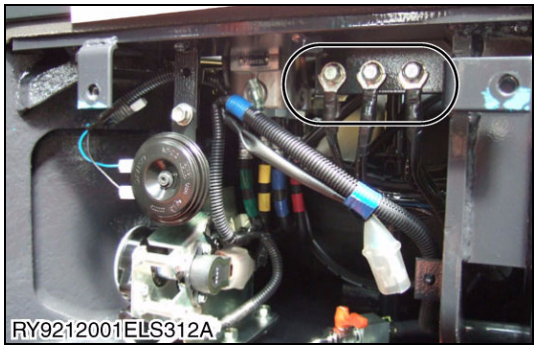
When a fuse blows, there are 2 potential causes. The first is when an overload of current exceeds the rated amperage of the fuse, blowing it; the other is when it blows due to a repetitive, intermittent current.

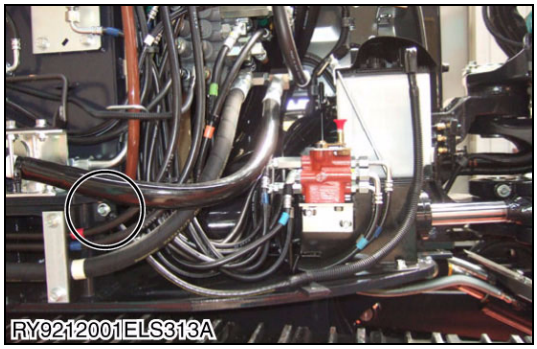
These two cases can be readily recognized visually, so when a fuses blows, take note of the following points.

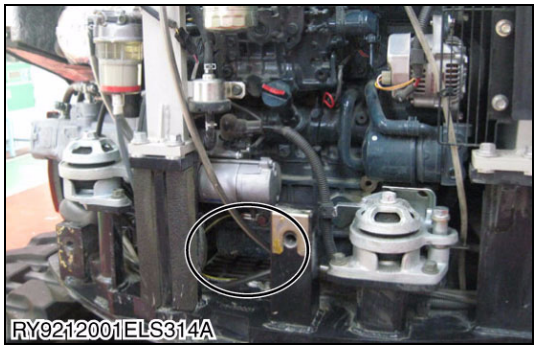
1. When a fuse blows due to an overload of current exceeding its rated capacity.
   An overload current produces a blown fuse such as shown at left **(A)**.
   You should not immediately replace a fuse that blows in this way with a new one.
   The fuse will just blow again when subjected to the overload current, so first inspect the circuit for a short or a problem with a device, then after fixing the problem, install a fuse of the same capacity.
   The purpose of the original fuse is to provide a margin of safety, so never replace a fuse with one of a higher capacity.
   If you replace a fuse with one of a higher capacity, it presents the danger of a current overload damaging the electrical device(s) and/or the wiring in the circuit before blowing the fuse.
2. When a fuse blows due to a repetitive, intermittent current.
   A repetitive, intermittent current produces a blown fuse such as shown at left **(B)**. In general, this kind of blown fuse occurs after a relatively long period of time, so it does not happen very often. With this kind of blown fuse, it is OK to replace it with a fuse of the same capacity.

(A) Fuse blown by current overload (B) Fuse blown by thermal fatigue

RY9212001ELS0032US0


RY9212001ELS312A

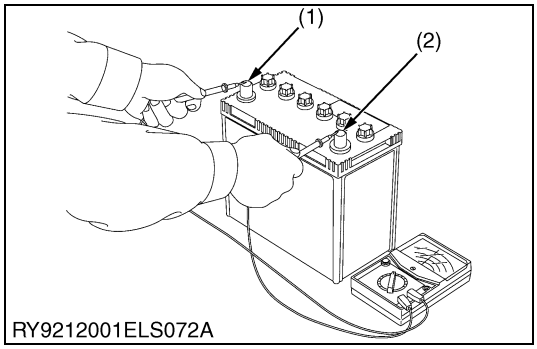

RY9212001ELS313A


RY9212001ELS314A

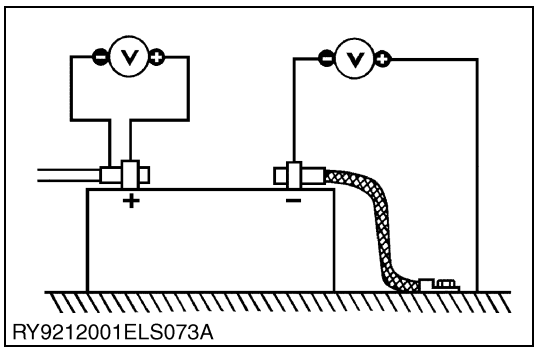
Ground

Check whether GND wire(s) are securely connected to the body.

RY9212001ELS0033US0



RY9212001ELS072A



RY9212001ELS073A

Battery

Check the voltage between the terminals

1. Connect a circuit tester between the (+) and (-) terminals of the battery and measure the voltage across the terminals.
2. If the measurement is below factory specs, check the specific gravity of the electrolyte.

Voltage between terminals	Factory specification	At least DC 12V

Check the condition of terminal connections

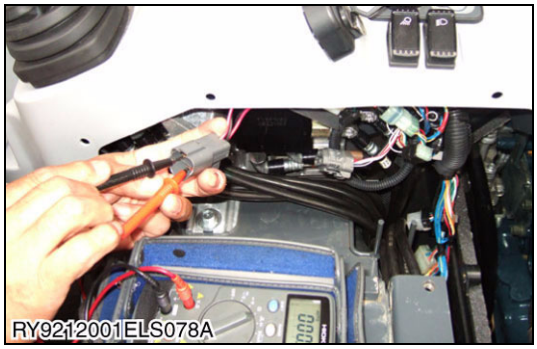
1. Put an electrical load on the battery. (E.g.: Turn the key switch to RUN and turn a worklight on.
2. Connect the (+) side if the circuit tester to the (+) terminal of the battery and the (-) side of the circuit tester to the (+) battery cable. Measure the voltage.
3. Connect the (-) side if the circuit tester to the (-) terminal of the battery and the (+) side of the circuit tester to the (-) battery cable. Measure that voltage.
4. If the measurements are greater than factory specs, check the condition of the contacts at the terminals.

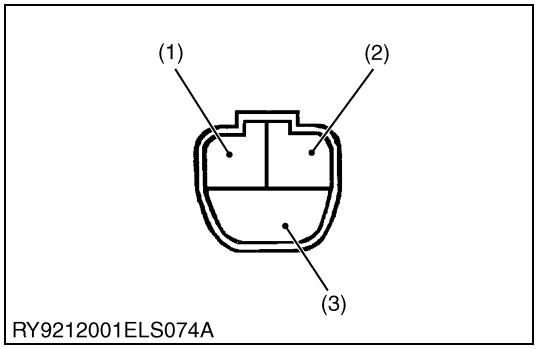
Voltage between terminals	Factory specification	At least DC 0.1 V

(1) (-) Terminal (2) (+) Terminal

RY9212001ELS0034US0

[2] STARTING AND STOPPING DEVICE





Key switch

Checks

1. Remove the key switch's 3P connector.
2. Turn the key switch to the RUN position and then check the continuity between the red / white wire terminal of the connector on the key switch side and the red wire terminal on the connector.
3. Turn the key switch to the START position and then check the continuity between the black/white wire terminal of the connector on the key switch side and the red wire terminal on the connector.

Key switch circuit table

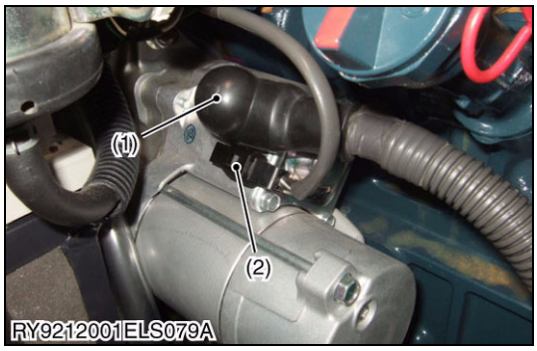
(●—● : Continuity)

Position	(3)	(1)	(2)
STOP			
RUN	●	●	
START	●	●	●

RY9212050ELS011A

(1) Red / white
(2) Black / white
(3) Red

RY9212050ELS0027US0



Starter

1. Power supply to terminal B

■ **IMPORTANT**

- **The battery voltage always exists at terminal B of the starter, so do not short it during inspection.**

1. Connect the (+) side of the circuit tester to terminal B of the starter and the (–) side to the body and measure the voltage.
2. If the measurement meets the factory spec, the harness between the battery and terminal B is OK.
3. If the measurement is outside of factory specs, check the condition of the battery cable (+) contact and that of the GND (–) cable and the body.

Measured voltage	Factory Specification	11 to 14 V (battery voltage)

2. Power supply to starter's pull-in and holding coils

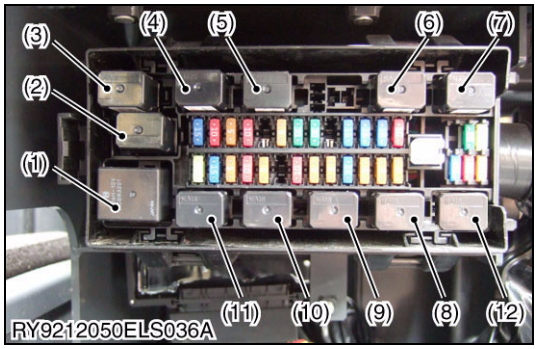
1. Remove the connector from the starter's S terminal.
2. Connect the (+) of the circuit tester to the connector on the harness side and the (–) to the body.
3. Put the machinery operation lock lever in the lock position and measure the voltage with the key switch held in the START position.

If the measurement meets factory specs, the circuit from the battery to the S terminal is OK (harness, key switch, auto-release relay).

Measured voltage	Factory Specification	11 to 14 V (battery voltage)

(1) Terminal B
(2) Terminal S

RY9212001ELS0036US0



Relay capacity and their circuits

(1) Glow (40A)
(2) Compressor (20A)
(3) Crane (20A)
(4) Blower (20A)
(5) Engine stop (20A)
(6) Cab worklight (20A)
(7) Horn (20A)
(8) Worklight (20A)
(9) AI motor (20A)
(10) Cab (20A)
(11) Starter (20A)
(12) Rotary beacon (20A)

RY9212050ELS0056US0

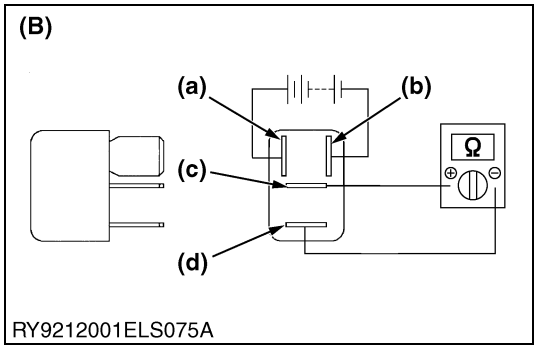
Starter relay

Harness-side voltage

1. Turn the key switch OFF and remove the starter relay.
2. Turn the key switch to RUN and measure the voltage between connector terminal 3 on the fuse box side and the body.
3. If the measurement meets factory specs, it is OK.

Measured voltage	Factory Spec	11 to 14 V (battery voltage)

RY9212001ELS0038US0



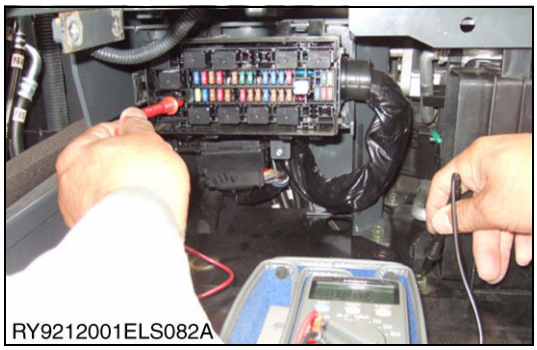
Starter relay test

1. Turn the key switch OFF and remove the starter relay.
2. Impress the battery voltage between relay terminals 3 and 5 and check for continuity between relay terminals 1 and 2.
3. If the measurement meets factory specs, it is OK.

Between terminals	Factory Spec	Continuity

(a) Relay terminal 5
(b) Relay terminal 3
(c) Relay terminal 2
(d) Relay terminal 1

RY9212001ELS0039US0



Glow relay

Harness-side voltage

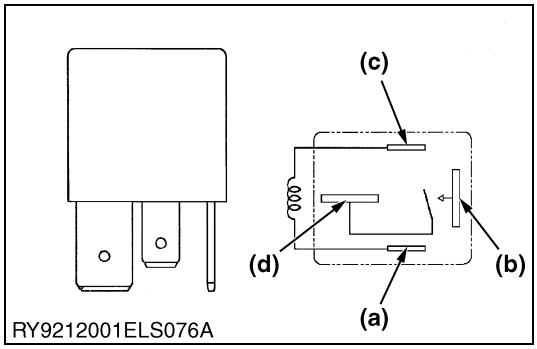
1. Turn the key switch OFF and remove the glow relay.
2. Turn the key switch to OFF and measure the voltage between connector terminal 3 on the fuse box side and the body.
3. If the measurement meets factory specs, it is OK.

Measured voltage	Factory Spec	11 to 14V (battery voltage)

4. Turn the key switch to RUN and measure the voltage between connector terminal 1 on the fuse box side and the body.
5. If the measurement meets factory specs, it is OK.

Measured voltage	Factory Spec	11 to 14 V (battery voltage)

RY9212001ELS0040US0



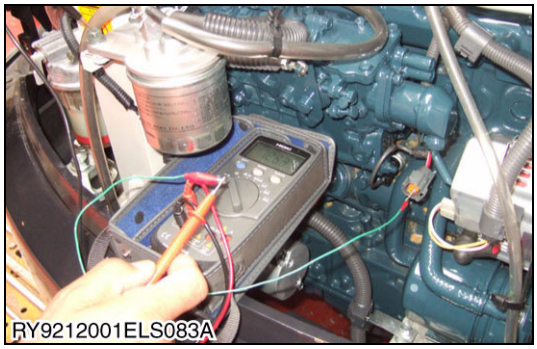
Glow relay test

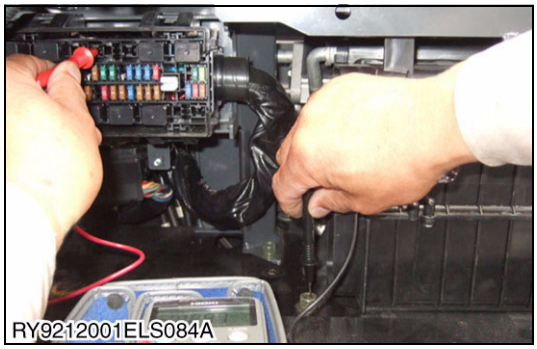
1. Turn the key switch OFF and remove the glow relay.
2. Measure the resistance between terminals 1 and 4.
3. Check for continuity between terminals 2 and 3.

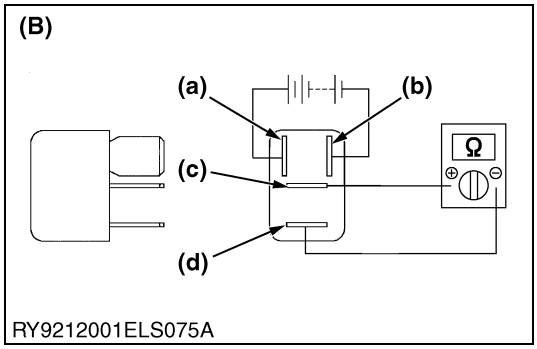
Measured items	(+)	(–)	Factory Spec
Coil	Terminal 1	Terminal 4	72 to 88 Ω
Contact	Terminal 2	Terminal 3	No continuity

(a) Terminal 1
(b) Terminal 3
(c) Terminal 4
(d) Terminal 2

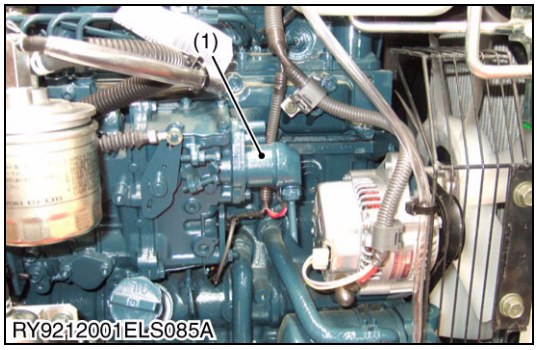
RY9212001ELS0041US0


RY9212001ELS083A

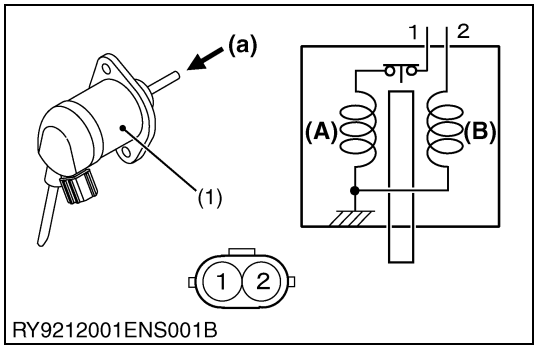

RY9212001ELS084A



RY9212001ELS075A



RY9212001ELS085A



RY9212001ENS001B

Engine stop solenoid connector voltage

1. Remove the engine stop solenoid's 2P connector.
2. Turn the key switch to RUN and measure the voltage between connector terminal 1 on the wire harness side and the body. Turn the key switch to START and measure the voltage between connector terminal (2) on the wire harness side and the body.
3. If the measurement meets factory specs, it is OK.

Measured voltage	Factory specification	11 to 14 V (battery voltage)

RY9212001ELS0042US0

Engine stop solenoid relay

Harness-side voltage

1. Turn the key switch OFF and remove the engine stop solenoid relay.
2. Turn the key switch to OFF and measure the voltage between connector terminal 1 on the fuse box side and the body.
3. If the measurement meets factory specs, it is OK.

Measured voltage	Factory Spec	11 to 14 V (battery voltage)

4. Turn the key switch to RUN and measure the voltage between connector terminal 3 on the fuse box side and the body.
5. If the measurement meets factory specs, it is OK.

Measured voltage	Factory Spec	11 to 14 V (battery voltage)

Engine stop solenoid relay test

1. Turn the key switch OFF and remove the engine stop solenoid relay.
2. Impress the battery voltage between relay terminals 3 and 5 and check for continuity between relay terminals 1 and 2.
3. If the measurement meets factory specs, it is OK.

Between terminals	Factory Spec	Continuity

(a) Relay terminal 5
(b) Relay terminal 3
(c) Relay terminal 2
(d) Relay terminal 1

RY9212001ELS0043US0

Engine stop solenoid

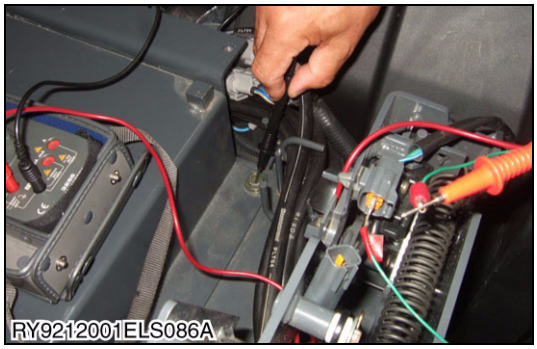
1. Remove the engine stop solenoid.
   Measure the resistance between connector terminal 1 (holding coil) and connector 2 (pull-in coil).
2. Push the plunger in and check for no continuity.
3. If the resistance is 0 Ω, it is shorted, so replace it. Alternatively, if the resistance is infinite, the coil is open, so replace it.

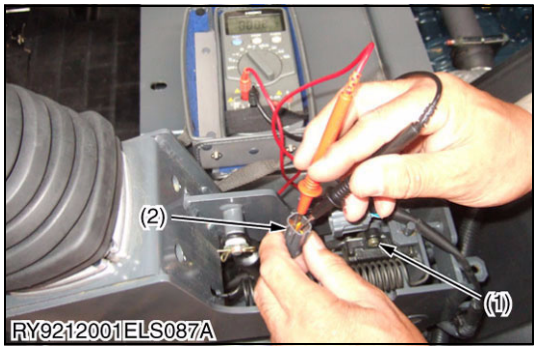
Measured items	(+)	(–)	Factory specification
Holding coil	Terminal 2	Body (Frame)	14 to 18 Ω
Pull-in coil	Terminal 1	Body (Frame)	0.1 to 0.5 Ω (state: free)
			No continuity (state: plunger pressed)

(1) Engine stop solenoid

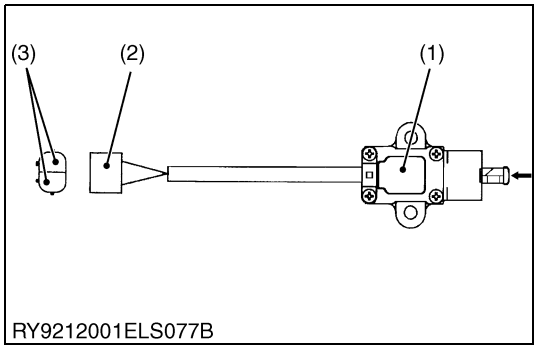
(A) Pull-in coil
(B) Holding coil
(a) Press in

RY9212001ELS0044US0


RY9212001ELS086A



RY9212001ELS087A



RY9212001ELS077B

Switch (limit) connector voltage

1. Remove the 2P connector of the lever lock switch (limit).
2. Turn the key switch to RUN and measure the voltage between the connector terminal (blue/white) on the wire harness side and the body.
3. If the measurement meets factory specs, it is OK.

Measured voltage	Factory specification	11 to 14V (battery voltage)

RY9212001ELS0045US0

Switch (limit)

1. Remove the 2P connector of the limit switch.
2. Move the equipment lock lever up and down and check for continuity between the connector terminals when the limit switch is pressed and when it is free.
   Key switch circuit table

Position	Black	Black	
FREE (Lever up)			No continuity
PUSH (Lever down)	●	●	Continuity

RY9212050ELS012A

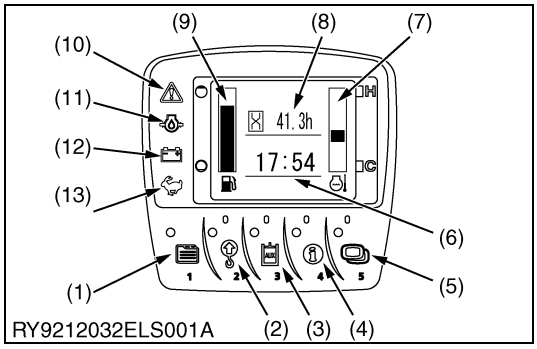
(1) Limit switch
(2) Connector
(3) Terminals (black wire)

RY9212050ELS0028US0

5. INSTRUMENT PANEL OPERATING GUIDE

[1] METER CONSOLE

(1) Names and Functions of Each Meter and Switch

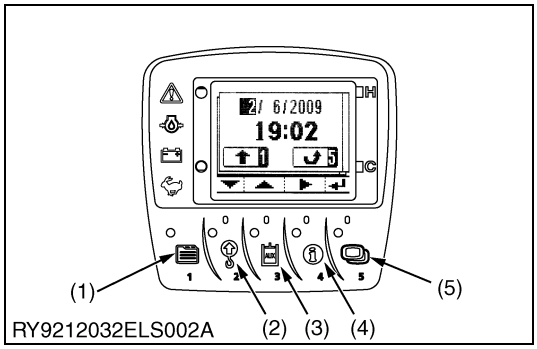


RY9212032ELS001A

Normal display

(1) User setting switch (Switch 1)
(2) Overload warning switch (Switch 2)
(3) AUX port enable switch (Switch 3)
(4) Information switch (Switch 4)
(5) Display selector switch (Switch 5)
(6) Clock display
(7) Water temperature gauge
(8) Hour meter - Engine tachometer
(9) Fuel gauge
(10) Warning lamp (red, yellow)
(11) Oil lamp
(12) Charge lamp
(13) Speed indicator light

RY9212007ELS0001US0



RY9212032ELS002A

Display at menu-selection

(1) Direction cursor switch (Switch 1)
Stop each setting and return to the original screen.
(2) Cursor move switches (Switch 2)
Move down the selection item.
Move down the menu-selection position.
(3) Cursor move switches (Switch 3)
Move up the selection item.
Move up the menu-selection position.
(4) Cursor move switch (Switch 4)
(5) Save switch (Switch 5)
Decision of the selection item.
Selecting the item at the menu-selection position.

RY9212007ELS0002US0

[2] DETAILS OF OPERATIONAL PROCEDURES TABLE

	Operation items	Operational procedures	Reference page
(1)	Refer to the Hour Meter, Clock, Engine rpm, Water Temperature and Fuel.	Turn the key from OFF to ON. (Pressing SW5 will change the display.)	4-S23
(2)	Refer to the Operational Information.	Turn the key from OFF to ON and press SW1. Select "Operation control".	4-S23
(3)	Periodical-check-item Confirmation and Operation after the Periodical Check Execution.	Turn the key from OFF to ON and press SW1. Select "Periodical check".	4-S24
(4)	How to set the Clock.	Turn the key from OFF to ON and press SW1. Select "Clock setting".	4-S25
(5)	Switching-over of the items of "AM/PM·24 hours".	Turn the key from OFF to ON and press SW1. Select "Various setting" and select "Setting of calendar clock display".	4-S26
(6)	Language Selection.	Turn the key from OFF to ON and press SW1. Select "Language Selection".	4-S26
(7)	Beep the Buzzer while Fueling.	Press the fuel button at the time of key OFF. Or press SW1 or SW5 at the time of key OFF.	4-S27

RY9212007ELS0003US0

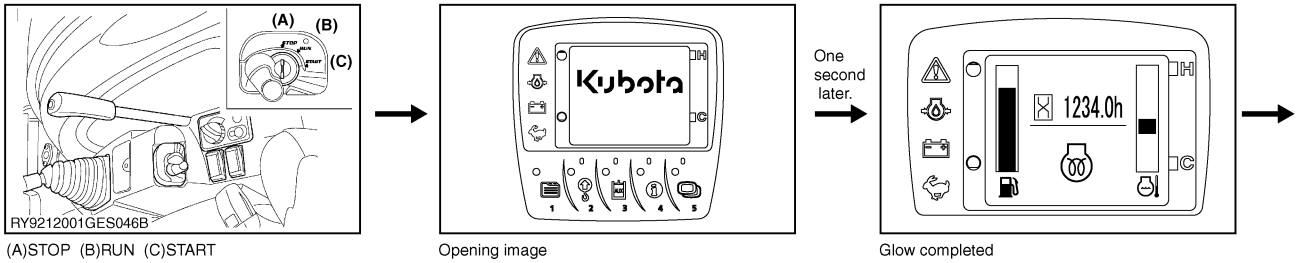
[3] DETAILS OF THE OPERATIONAL PROCEDURES

(1) Refer to the Hour Meter, Clock, Engine rpm, Water Temperature, and Fuel

The display of the electronic console will change into the three kinds of image at each pressing of the display-switch-over switch.

[Operation 1]

Turn the starter key to [RUN] position.



(A)STOP (B)RUN (C)START — Opening image — Glow completed

[Operation 2]

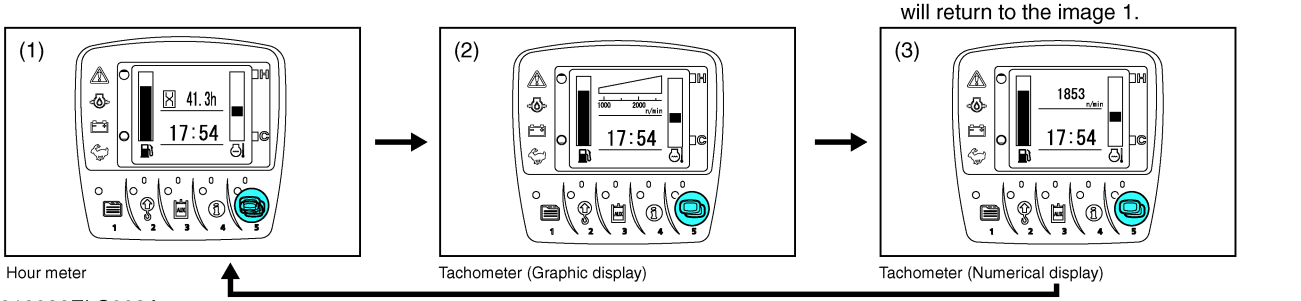
Press SW5.

[Operation 3]

Press SW5.

[Operation 4]

Press SW5 and the display will return to the image 1.



Hour meter — Tachometer (Graphic display) — Tachometer (Numerical display)

RY9212032ELS003A

RY9212007ELS0004US0

(2) Refer to the Operational Information

In "Operation control", the operational information of the machine can be confirmed up to 3 months ago.

[Operation 1]

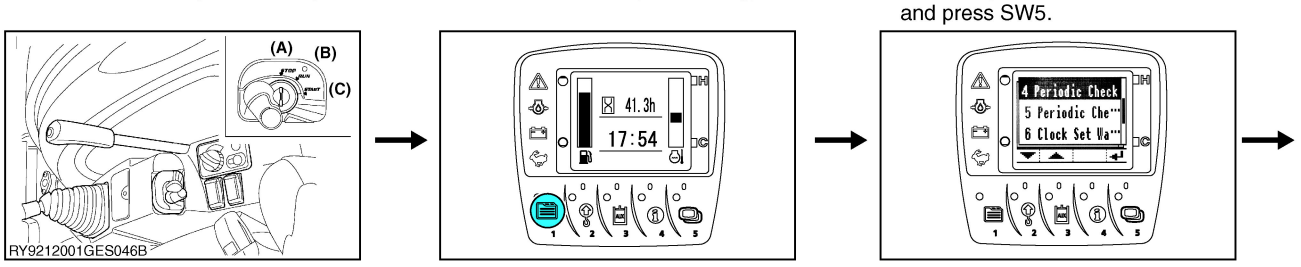
Turn the starter key to [RUN] position.

[Operation 2]

Press the switch1 (user setting).

[Operation 3]

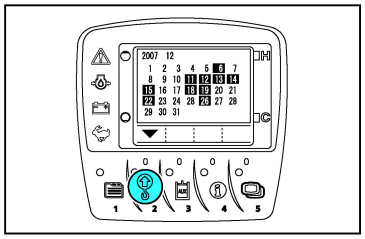
Select "Operationcontrol" and press SW5.



(A)STOP (B)RUN (C)START

[Operation 4]

By pressing SW2, operation control information (machine working days)of the last month and the month before that (up to 90 days record) can be seen.



- Press the save switch (Switch 5) to make the calendar appear on screen.
- The highlighted days indicate when the machine was operated.

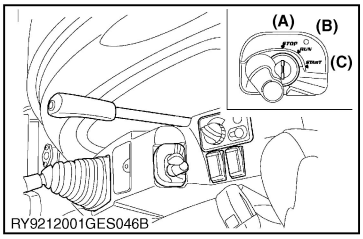
RY9212032ELS004A

RY9212007ELS0005US0

(3) Periodical-check-item Confirmation and Operation after the Periodical Check Execution

[Operation 1]

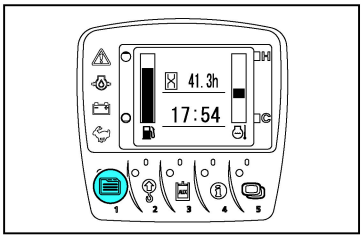
Turn the starter key to [RUN] position.



(A)STOP (B)RUN (C)START

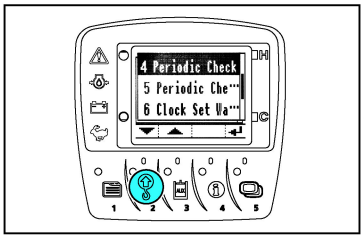
[Operation 2]

Press SW1 (user setting).



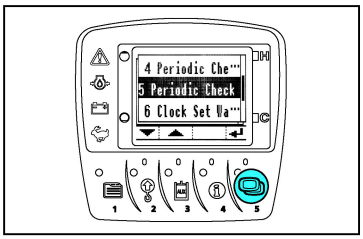
[Operation 3]

Press SW2 and select "Periodical check".



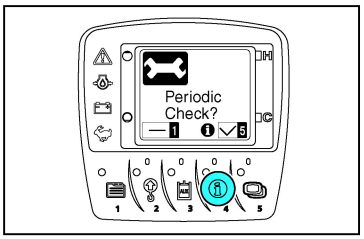
[Operation 4]

Select "Periodical check" and press SW5.



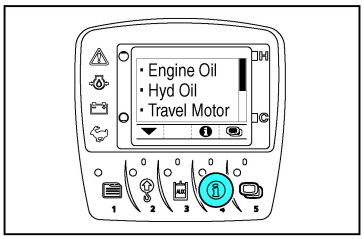
[Operation 5]

At the time of confirming the check items, press SW4.



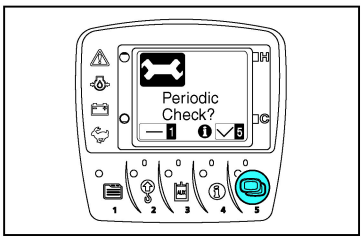
[Operation 6]

Confirm the displayed maintenance items, press SW4 again, and the screen will return to the original image.

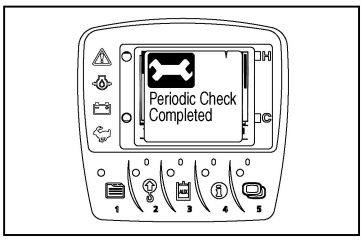


[Operation 7]

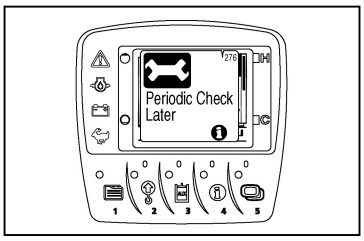
After completion of the periodical check, press SW5.



[Periodical check completed]



※ Pressing SW5 except during the periodical check time will display the following image.

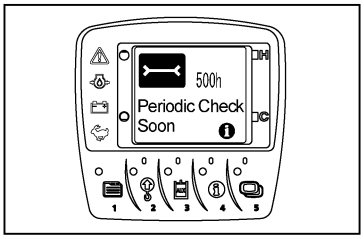


RY9212032ELS005A

In the case of display of the periodical check notices on the meter console.

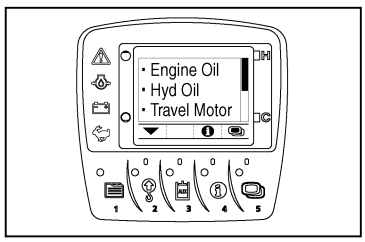
[Operation 1]

At 10 hours before the periodical check, the following imagewill be displayed. When the check items need to be confirmed, press SW4.

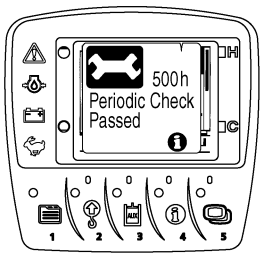


[Operation 2]

Execute the maintenance work indicated in the display.



RY9212032ELS006A



RY9212032ELS028A

■ **IMPORTANT**

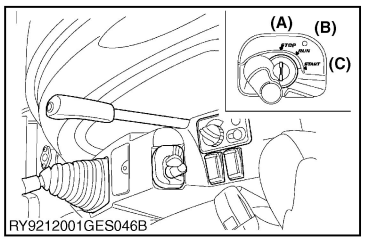
- **The periodic check can be preset to be made disappear automatically after the key switch is turned ON and Off 10 times or more.**
  (this is standard for non-EU version.)
- **The periodic check screen can be preset to be made disappear manually only.**
  (this is standard for EU version.)
- **When the periodical check interval has passed, the massage "Periodic Check Passed" is displayed.**

RY9212007ELS0006US0

(4) How to set the Clock

[Operation 1]

Turn the starter key to [RUN] position.

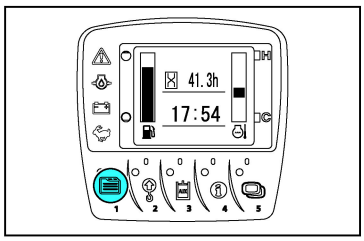


RY9212001GES046B

(A)STOP (B)RUN (C)START

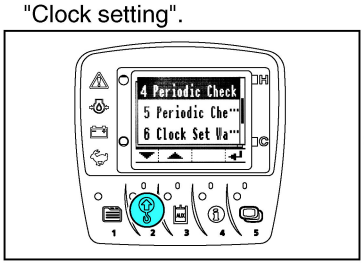
[Operation 2]

Press SW1 (user setting).



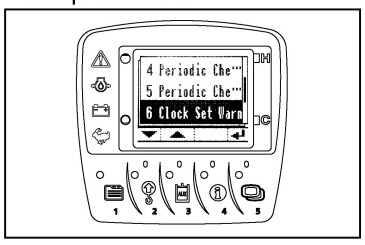
[Operation 3]

Press SW2 and select "Clock setting".



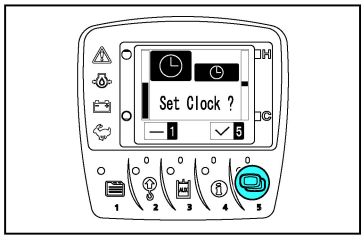
[Operation 4]

Select "Clock setting" and press SW5.

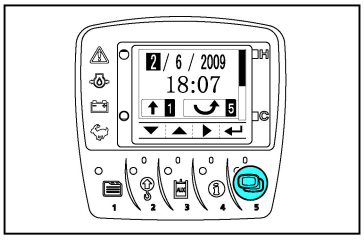


[Operation 5]

Set the clock and press SW5.



[Setting completed]



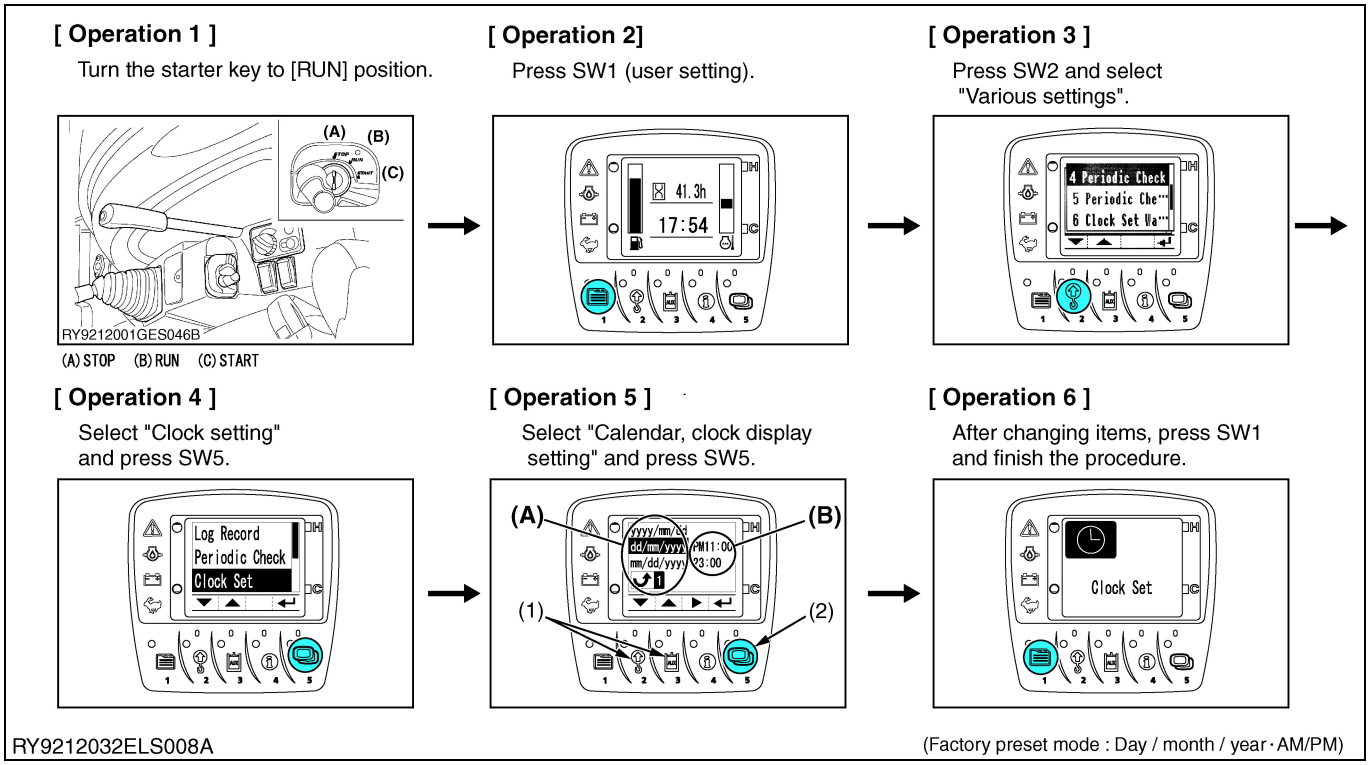
[Clock setting procedures]

Pressing SW4 (▶) will change the items in such a way as"year → month → day → hour → minute → year".
Pressing SW2 (▲) will reduce the number.
Pressing SW3 (▼) will increase the number.
Pressing SW1 on the clock setting screen will return the screen to the original image without changing the set time.

RY9212032ELS007A

RY9212007ELS0007US0

(5) Switching-over of the items of “AM/PM · 24 hours”

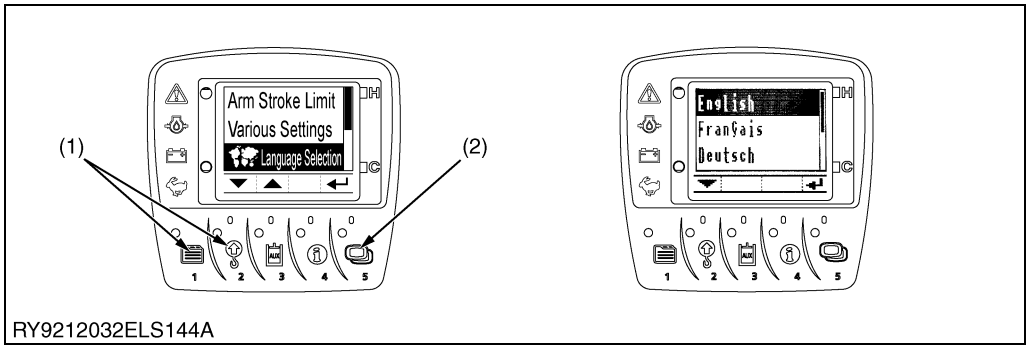


(1) Cursor move switch (Switch 2 and 3)
(2) Item move switch (Switch 5)
(A) Date/Month/Year display
(B) Clock display

1. Using the cursor move switchs (SW2 and 3), move up and down the times.
   The date / month / year on side **(A)** will be recorded.
2. Using the item move switch (SW4), move the cursor to side **(B)**. Select the "AM / PM" system or the "24-hour" system.
3. Press the save switch (SW5), and the new settings will be made.
   If the direction cursor switch (SW1) is pressed, the previous settings will remain.

RY9212007ELS0008US0

(6) Language Selection



(1) Cursor move switch (Switch 2 and 3)
(2) Save switch (Switch 5)

1. Select "Language Selection" on the user setting scree.
2. Select your desired "Language".
3. Press the cursor move switch to move the cursor up or down and to select your desired language.

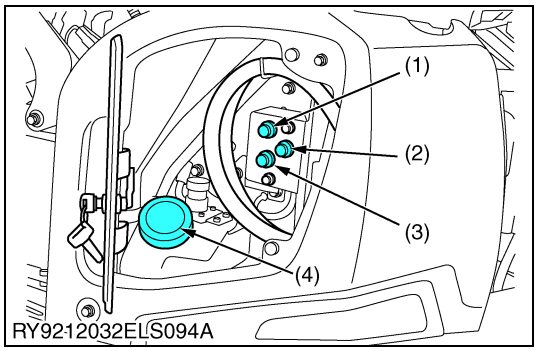
■ **NOTE**

- **There are the following 11 different languages to choose from.**
  (English, French, German, Spanish, Italian, Portuguese, Dutch, Danish, Swedish, Finnish and Norwegian)

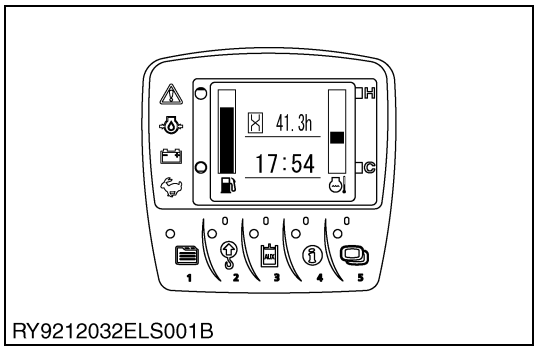
RY9212032ELS0088US0

(7) Beep the Buzzer while Fueling

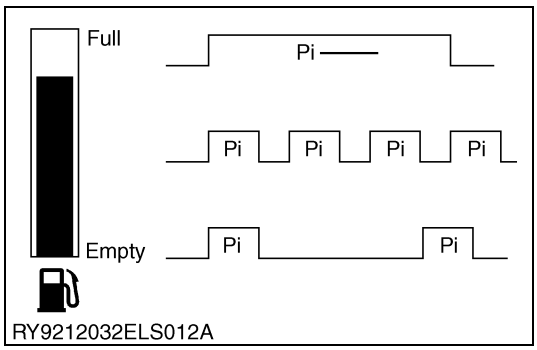
By pressing the fill-up announcing buzzer switch while keeping the starter key at [STOP] position, fueling condition can be confirmed by the buzzer sound.



RY9212032ELS094A



RY9212032ELS001B



RY9212032ELS012A

[Operation 1]

Press the fuel level audible indication switch (2) while keeping the starter key at [STOP] position.

Or press SW1 or SW5 while keeping the key switch at [STOP] position.

Pressing the fuel level audible indication switch will start the screen display and the buzzer beep.

Pressing SW1 or SW5 will start only the screen display and the following fueling-start will start the buzzer beep.

(1) Switch (black button)
(2) Fuel level audible indication switch
(3) Switch (red button)
(4) Fuel tank cap

RY9212007ELS0010US0

[Operation 2]

Feed the fuel. The beeping interval varies in response to the quantity of the fuel in the tank.

When reaching near the fill-up condition, the beeping sound will become near the continuous sound. Therefore, confirm the conditions until the fill-up by hearing the beeping sounds during fueling.

When the fueling need to be stopped halfway (before full fill-up), beeping can be stopped by pressing the fill-up announcing buzzer or by leaving the system as it is for a moment (10 minutes).

RY9212007ELS0011US0

[4] AUXILIARY PORT OPERATION

The auxiliary port enable switch is used to operate hydraulic attachment such as hammers.

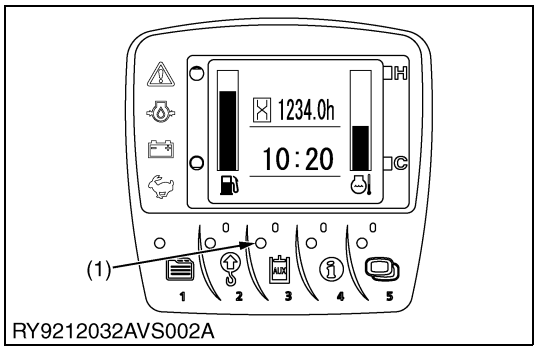
RY9212032ELS0061US0

(1) Selecting the Action Modes

The AUX port has been factory-set to four action modes. You can select one of them.
Up to six action modes can be preset. Each time the AUX port enable switch (switch 3) is pressed, the action modes change over one after another. And the icon and action mode number on the screen change accordingly.

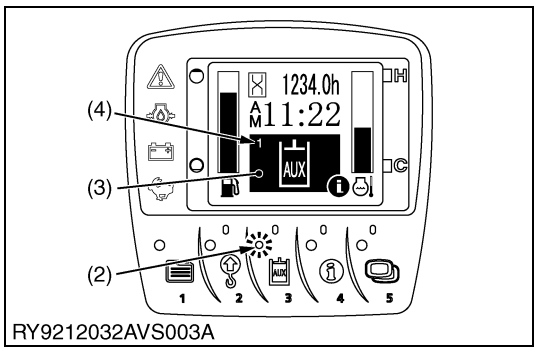
RY9212032ELS0062US0

AUX 1 mode only



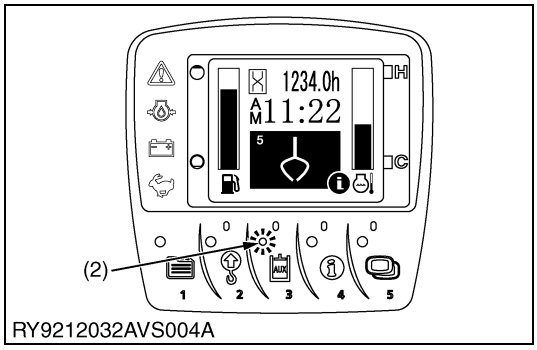
RY9212032AVS002A

[Mode 0] AUX disable (normal screen)
AUX 1 port : No activation



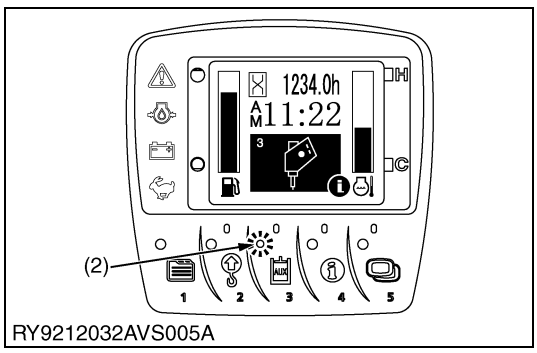
RY9212032AVS003A

[Mode 1]
AUX 1 port : Max. flow volume



RY9212032AVS004A

[Mode 2]
AUX 1 port : Limited flow volume



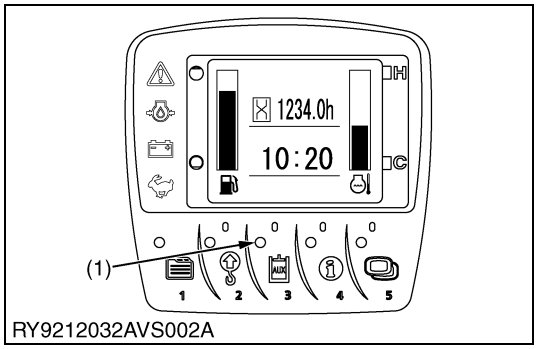
RY9212032AVS005A

[Mode 3]
AUX 1 port : One way flow (Send oil to the port 2 only)

(1) No lighting
(2) Blinking
(3) Icon
(4) Action mode No.

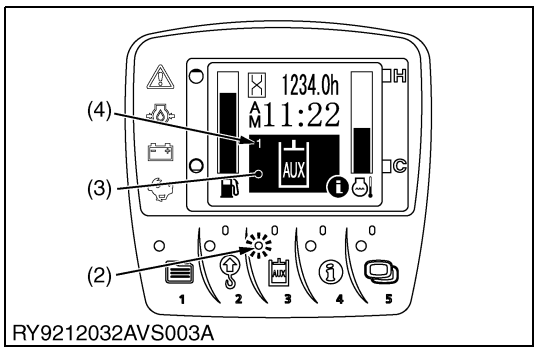
RY9212032ELS0063US0

AUX 1 and 2 modes



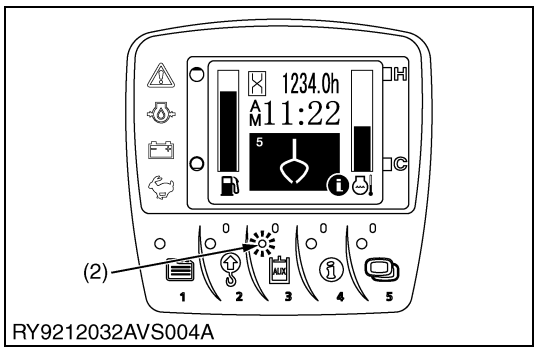
RY9212032AVS002A

[Mode 0] AUX disable (normal screen)
AUX 1 port : No activation
AUX 2 port : No activation



RY9212032AVS003A

[Mode 1]
AUX 1 port : MAX. flow volume
AUX 2 port : MAX. flow volume



RY9212032AVS004A

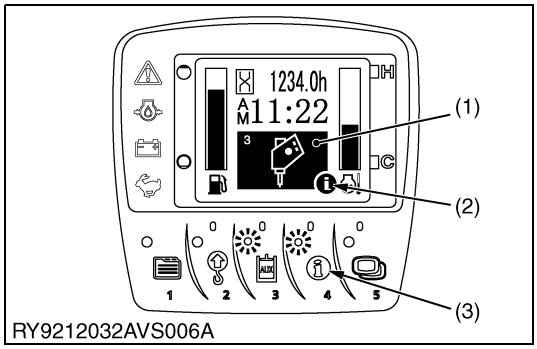
[Mode 2]
AUX 1 port : One way flow (Send oil to the port 2 only)
AUX 2 port : MAX. flow volume

(1) No lighting
(2) Blinking
(3) Icon
(4) Action mode No.

RY9212032ELS0064US0

■ **NOTE**
- **When turning the starter key to the "RUN" position, the action mode will return to the last action mode used.**

RY9212032ELS0065US0



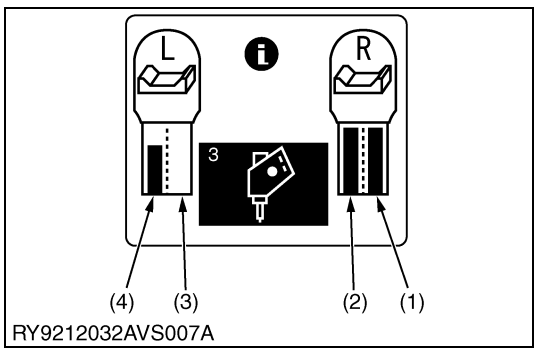
RY9212032AVS006A

Checking the settings of each action mode

When an action mode is selected and the Information mark (2) appears at the lower right of the icon, the flow volume setting gets displayed by pressing the switch 4.

(1) Icon
(2) Information mark
(3) Information switch (switch 4)

RY9212032ELS0066US0



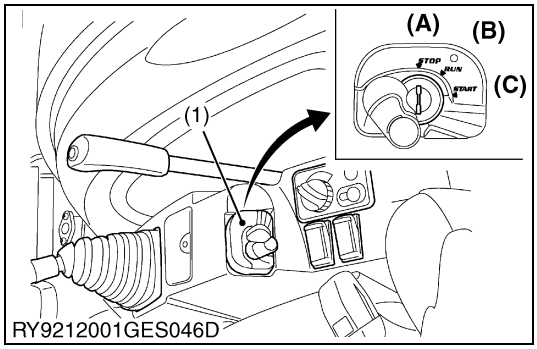
RY9212032AVS007A

Display in AUX 1 and 2 modes

(1) Port 1
(2) Port 2
(3) Port 3
(4) Port 4

RY9212032ELS0067US0

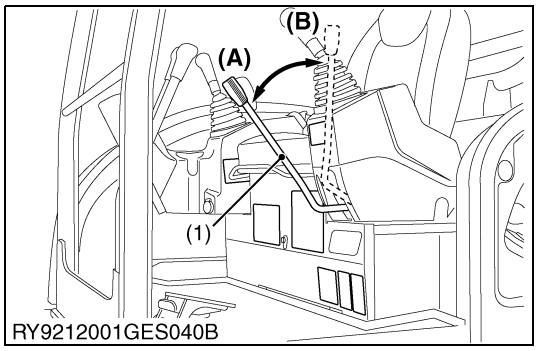
(2) AUX Port Handling Procedure



1. Turn the starter key to the "RUN" position.
   Let the engine warm up after start-up for approx. 10 minutes under no load conditions.

(1) Starter switch
(A) "STOP"
(B) "RUN"
(C) "START"

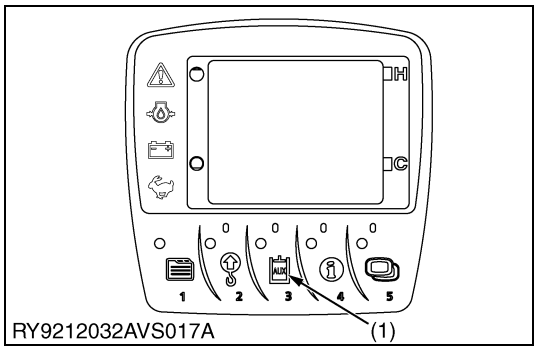
RY9212032ELS0068US0



2. Lower the pilot control lock lever (UNLOCK).

(1) Pilot control lever
(A) "Unlock"
(B) "Locked"

RY9212032ELS0069US0



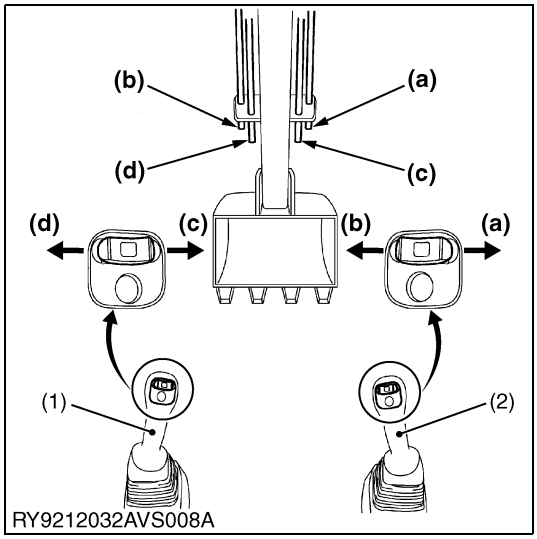
3. Push the AUX port enable switch (switch 3).

■ **NOTE**
- **If the pilot control lock lever is not at the "UNLOCK" position, the following message appears on the screen. Down this lever to the "UNLOCK" position first and then press the AUX port enable switch (switch 3).**

RY9212032ELS126A

(1) AUX port enable switch (switch 3)

RY9212050ELS0022US0

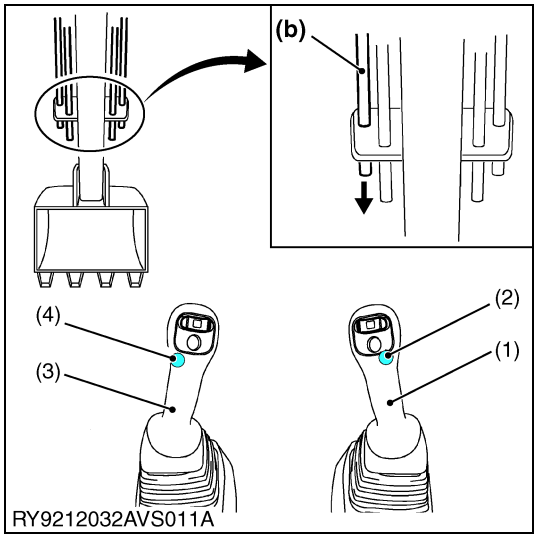


4. Move the AUX port knob of the right attachment control lever to the right to send oil to the AUX port 1.
   Move the AUX port knob to the left to send oil to the AUX port 2.
   If the machine is equipped with the AUX 2 port, move the AUX port knob of the left attachment control lever to the right to send oil to the AUX port 3.
   Move the AUX port knob of the left attachment control lever to the left to send oil to the AUX port 4.

■ **IMPORTANT**
- **Proportional control of the AUX port knob allows for slow-to-fast movement of attachment.**
  Example : If you move the AUX port knob halfway, the attachment will move at approximately one-half speed.

(1) Attachment control lever (left)
(2) Attachment control lever (right)
(a) "Port 1"
(b) "Port 2"
(c) "Port 3"
(d) "Port 4"

RY9212032ELS0071US0

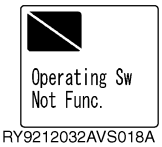


RY9212032AVS011A

One way hold

Press the one way hold switch of the right attachment control lever, and the oil continues to flow through the port **(b)**.
Press this switch again or move the AUX port knob, and the oil flow is interrupted.

■ **NOTE**
- **Even if the one way hold switch of the left attachment control lever is pressed, no function is assigned.**
  In this case, the following message appears on the screen.



RY9212032AVS018A

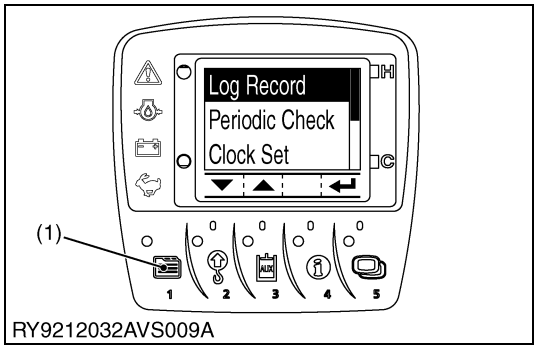
(1) Attachment control lever (right)
(2) One way hold switch (right)
(3) Attachment control lever (left)
(4) One way hold switch (left)
(b) Port 2

RY9212032ELS0072US0

(3) Setting the Maximum Flow Volume

The AUX port has been factory-set to three action modes 1, 2 and 3. The action modes 4 and 5 can also be preset.

RY9212032ELS0073US0



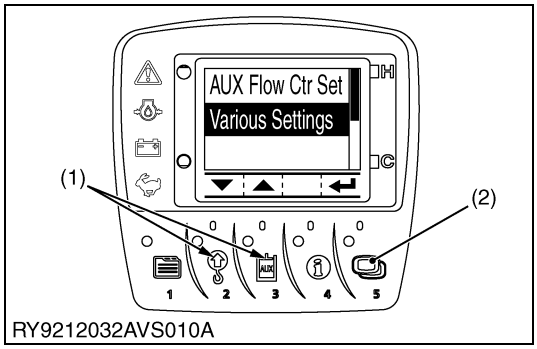
RY9212032AVS009A

How to make the settings

1. With the starter key at the "RUN" position, press the user setting switch (switch 1), and the following display appears on the screen.

(1) User setting switch (switch 1)

RY9212032ELS0074US0

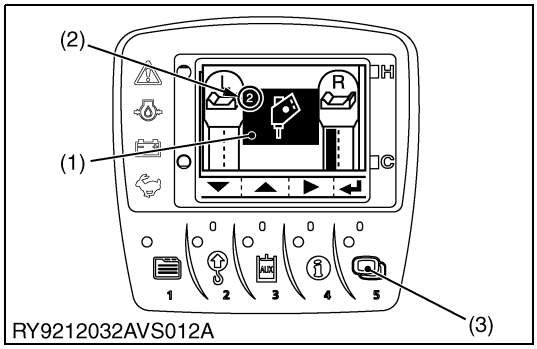


RY9212032AVS010A

2. Press the switch 2 or 3 to select "AUX Flow Ctr Set", and then press the save switch (switch 5).

(1) Cursor move switch (switch 2 and 3) (2) Save switch (switch 5)

RY9212032ELS0075US0

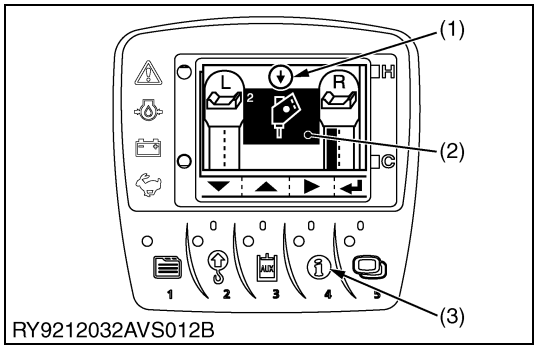


RY9212032AVS012A

3. Each time the switch 5 is pressed, the mode number changes. Select your desired setting mode number.

(1) Icon
(2) Mode No.
(3) Switch 5

RY9212032ELS0076US0

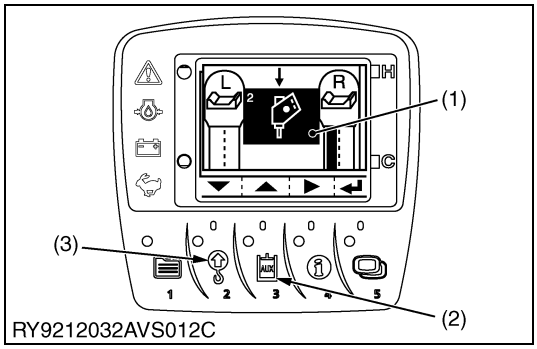


RY9212032AVS012B

4. Take the following steps to set the icons. Each time the switch 4 is pressed, the setting cursor (arrow mark) shifts position. Move the cursor above the icon.

(1) Setting curcor (arrow mark)
(2) Icon
(3) Switch 4

RY9212032ELS0077US0

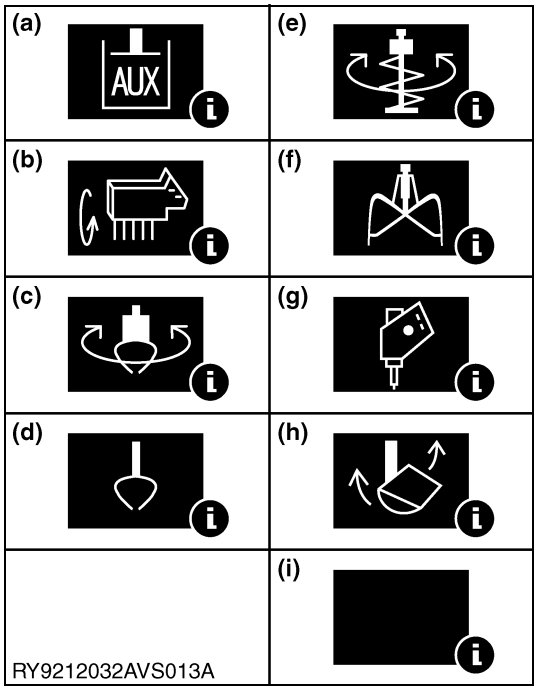


RY9212032AVS012C

5. Each time the switch 2 or 3 is pressed, the icon changes. Select your desired icons.

(1) Icon
(2) Switch 3
(3) Switch 2

RY9212032ELS0078US0



RY9212032AVS013A

Types of AUX icons

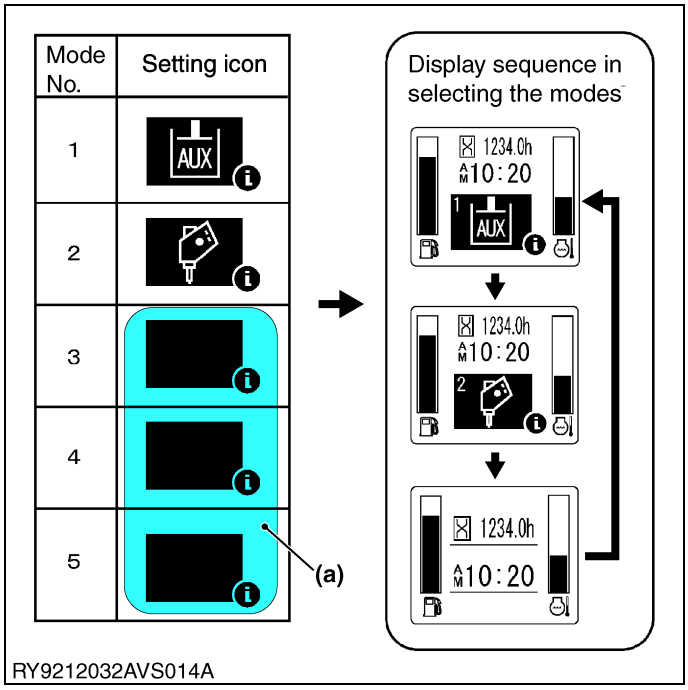
■ **NOTE**
- **There is no relationship between the icons and the flow control settings. Select icons to suit the images of attachments to be connected.**
- **In an action mode with the disable icon preset, such action mode is skipped even if selected.**

- Take an example of the following settings :
  AUX (standard) icon for action mode 1,
  Breaker icon for action mode 2,
  Disable icon for actions modes 3, 4 and 5.

Each time the AUX port enable switch (switch 3) is pressed, the display changes from action mode 1, action mode 2 to normal mode in this order.

(a) AUX (Standard)
(b) Brush cutter
(c) Rotary grapple
(d) Grapple
(e) Auger
(f) Clamshell
(g) Breaker
(h) Tilt bucket
(i) Blank (disable)

RY9212032ELS0079US0

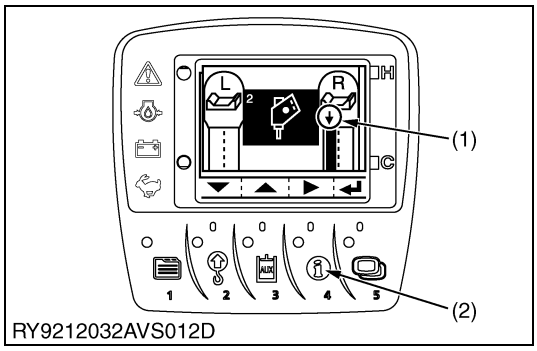


RY9212032AVS014A

[Setting example]

(a) Blank (disable) icon

RY9212032ELS0080US0

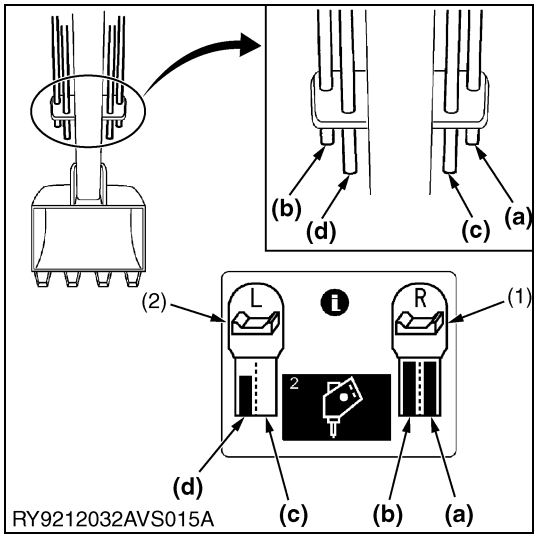


RY9212032AVS012D

6. Set the maximum flow volume for each AUX port. Press the switch 4 to move the setting cursor (arrow mark) to the port 2 position of AUX1 at the right.

(1) Setting, cursor (arrow) (2) Switch 4

RY9212032ELS0081US0

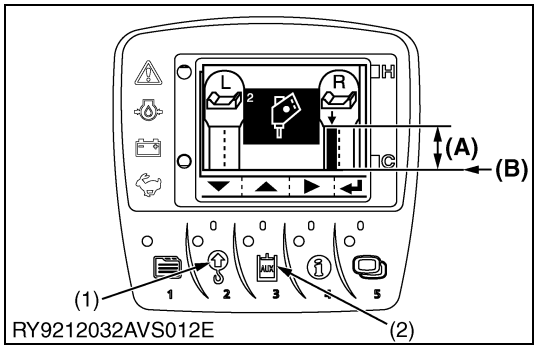


RY9212032AVS015A

(1) AUX 1
(2) AUX 2

(a) "Port 1"
(b) "Port 2"
(c) "Port 3"
(d) "Port 4"

RY9212032ELS0082US0



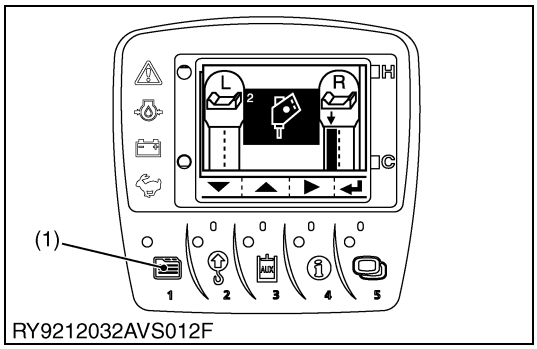
RY9212032AVS012E

7. Press the switch 2 or 3 to preset the maximum flow volume. Set the bar to the highest level, and the flow volume will be maximized.
   Set the bar to the lowest level (no bar displayed), and there will be no oil flow.
   Then press the switch 4 to go to the next port, and make the settings for the all the other ports.

■ **NOTE**
- **Some attachments might not be activated even when the bar level is still somewhat above the lowest position. Or even when the bars of ports 1 and 2 (or of ports 3 and 4) are at the same level, the same speed might not be achieved. Those cases are not a machine failure, however. Readjust the bar to the optimum level according to your attachments.**
- **Suppose that the same attachment is mounted on another machine. Even if the flow control setting is made, the same speed cannot be achieved. Make an optimum setting on each machine.**

(1) Switch 2 (Lower flow volume) **(A) "MAX. flow volume"**
(2) Switch 3 (Higher flow volume) **(B) "Output interrupted"**

RY9212032ELS0083US0



RY9212032AVS012F

8. Go back to Step 3 to make settings for the next action mode. When all the settings of all the action modes have been made, press the switch 1 to return to the normal screen.

AUX port MAX. Flow volume

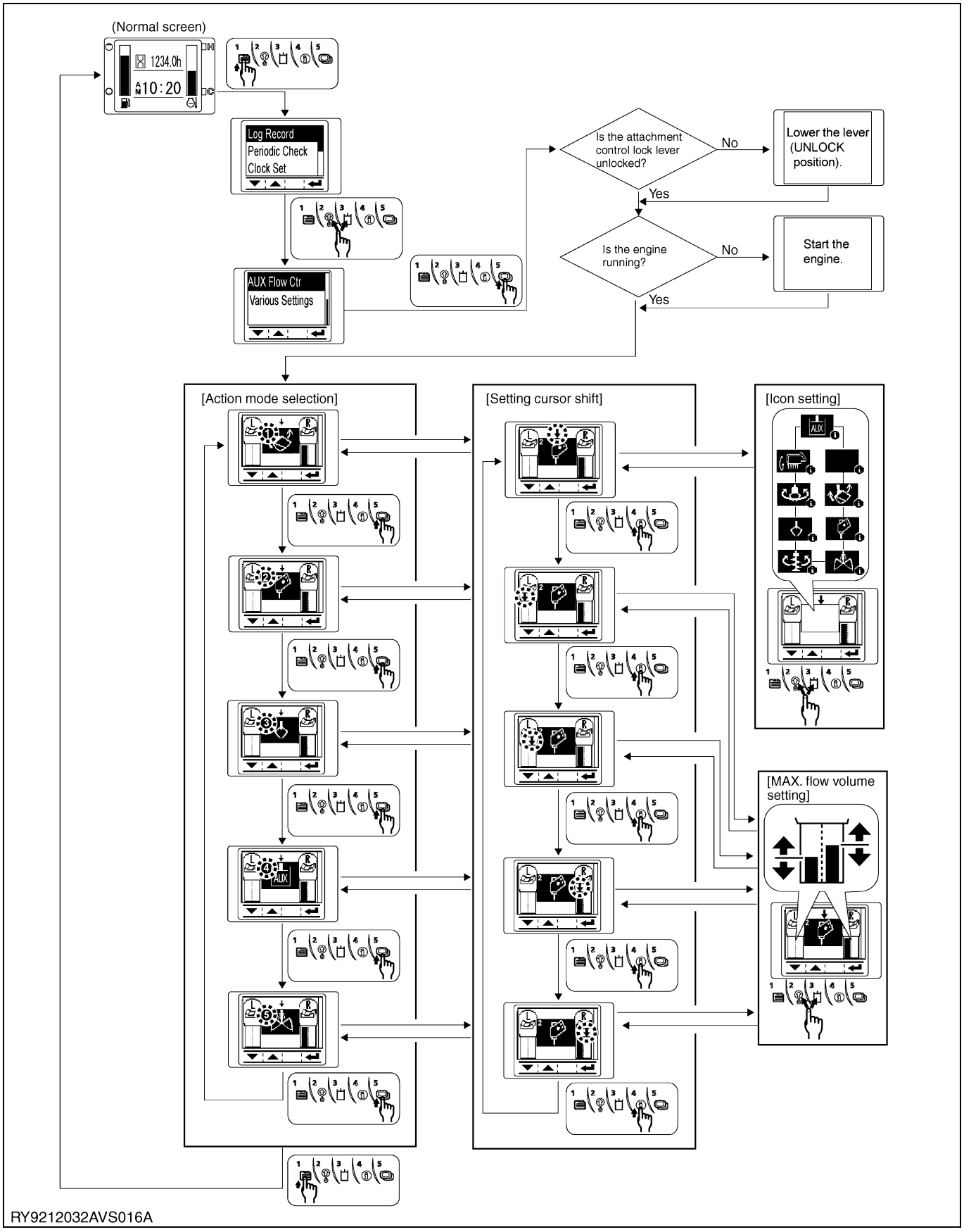
	AUX2 port	AUX1 port
MAX. flow volume (Theoretical) L/min (U.S.gal/min)	37 (9.87)	75 (20)
MAX. pressure MPa (kgf/cm^2) [psi]	19.1 (195) [2770]	20.6 (210) [3000]

■ **IMPORTANT**
- **When the AUX port is not used for a long period, dirt particles can settle in the lower part of the AUX port lines. When the plugs on the AUX port lines are removed to connect attachments, drain approx. 100 cc (3.4 oz) of oil before making connections.**

(1) Switch 1

RY9212050ELS0023US0

AUX port maximum flow volume setting flowchart



RY9212032ELS0085US0

[5] SERVICE DEALER SETTINGS

Mode	Operation items		Operational procedures
(1) Diagnosis	[A] Tester		While setting "SW5", for the main key from OFF to ON. Tester mode appears on the screen.
	[B] Check the Failure Record that Occurred in the Past		Press "SW5", turn the main key from OFF to ON, and select "Retrieve Fail Record".
	[C] Cancel of Failure Record		While pressing "SW5", turn the main key from OFF to ON, and select "Delete Fail Record".
(2) Setting	[A] AI (Motor, cable, governor sensor adjusted)		While pressing "SW5", turn the main key from OFF to ON, and select "AI set".
	AUX1	[B] Knob exchanged	While pressing "SW5", turn the main key from OFF to ON, and select "AUX1 setting".
		[C] with attachment	(With attachment) Setting of the start point, start the engine or lift up the lock lever.
		[D] pressure rise of header	(Without attachment) Setting of the start point.
		[E] Feeling adjustment	While pressing "SW5", turn the main key from OFF to ON, and select "Feeling adjustment".
	AUX2 / Thumb	[F] Knob exchanged	While pressing "SW5", turn the main key from OFF to ON, and select "AUX2 / Thumb setting".
		[G] with attachment	(With attachment) Setting of the start point, start the engine or lift up the lock lever.
		[H] pressure rise of header	(Without attachment) Setting of the start point.
		[I] Feeling adjustment	While pressing "SW5", turn the main key from OFF to ON, and select "Feeling adjustment".
	[J] Overload warning		While pressing "SW5", turn the main key from OFF to ON, and select "Overload warning".
	[K] Model (ECU and digital panel replaced)		While pressing "SW5", turn the main key from OFF to ON, and select "Model Set".
	[L] Others		1. AI motor drive
			2. Periodical check guidance cancellation method.
			3. Need/non-need of periodic check guidance display.
			4. Periodical check offset time.
			5. Request for clock adjusting guidance display.
	[M] Operate AUX2 by AUX1 knob (Or operate AUX1 by AUX2 knob)		While pressing "SW5", turn the main key from OFF to ON, and select "Exchang (AUX1, AUX2/thumb)".
	[N] Changed condition of Multipurpose switch.		While pressing "SW5", turn the main key from OFF to ON, and select "Multipurpose".
	[O] At the time of Replacing the Meters and ECU's		In the case of confirming whether or not.
	[P] Resetting of the Clock after Removing the Battery		In the case of resetting of the clock.
	[Q] Anti-Theft Device		Register a black key with the machine (When a black key is lost).
	[R] Overheat Caution		Setting valves of the water temperatures.

RY9212050ELS0007US0

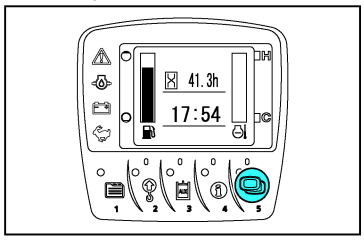
(1) Diagnosis

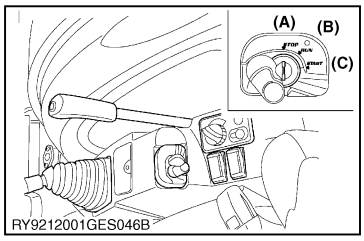
[A] Tester

Using the tester mode, check to see the conditions of the various sensors and the information of switches.

[Operation 1]

Turn the starter key to [RUN] position while pressing SW5.

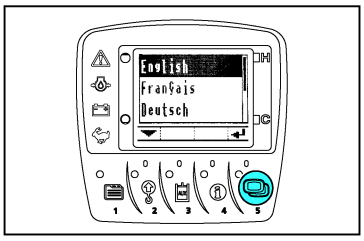




(A)STOP (B)RUN (C)START

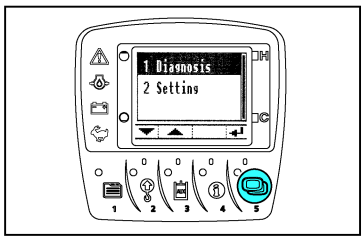
[Operation 2]

Select "English" and press SW5.



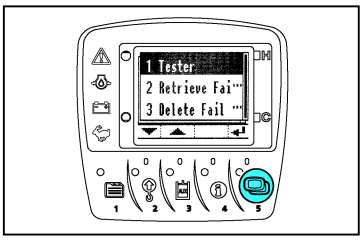
[Operation 3]

Select "Diagnosis" and press SW5.



[Operation 4]

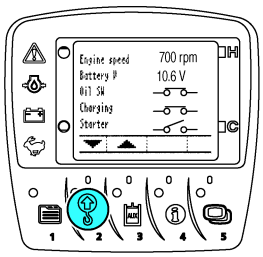
Select "Tester" and press SW5.



[Image 1]

RY9212032ELS025A

RY9212007ELS0013US0

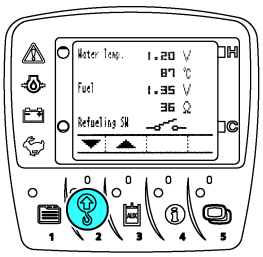


RY9212032ELS030A

[Image 1]

Contents	Instruction, Set Value
Engine RPM	During engine stop : 0 rpm During engine rotation : 1050 rpm
Voltage (Battery)	Battery voltage : ±0.5 V
Oil	Before engine Start : ON After engine Start : OFF
Charge	Before engine Start : ON After engine Start : OFF
Starter	The key at the START position : ON The key at other positions : OFF

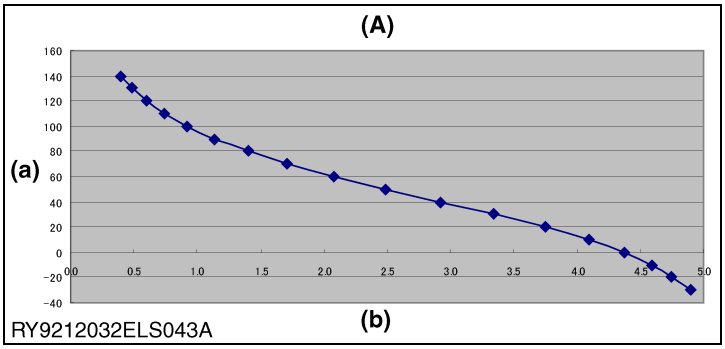
RY9212007ELS0014US0



RY9212032ELS031A

[Image 2]

Contents	Instruction, Set Value
Voltage (Water temperature)	Voltage and temperature are displayed. 0 °C (32 °F)→ 4.38 V, 100 °C (212 °F) → 0.91 V (Details are shown in the following table.)
Water temperature	
Voltage (Fuel)	E : Higher, F : Lower
Resistance (Fuel)	Full-up (F) : 5 Ω and below Empty (E) : 101.0 Ω and above



RY9212032ELS043A

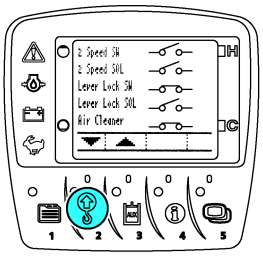
(A) Water temperature vs Voltage
(a) Water temperature (°C)
(b) Voltage (V)

Fuel dot number

Design value	KX057-4	U55-4
Full	5 Ω and below	5 Ω and below
1/2 view	33.64 Ω	33.64 Ω
Remainder 3dot *	92.5 Ω	92.5 Ω
Empty	101.0 Ω and above	101.0 Ω and above

* Fuel caution

RY9212007ELS0015US0

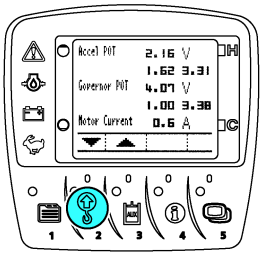


RY9212032ELS032A

[Image 3]

Contents	Instruction, Set Value
Travel 2 speed SW	Press the switch : ON
Travel 2 speed SOL	Solenoid : ON/OFF
Lever Lock SW	Press the switch : ON
Lever lock SOL	Solenoid : ON/OFF
Air Cleaner	Electric sensor is not installed.

RY9212007ELS0016US0

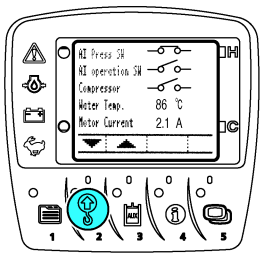


RY9212032ELS033A

[Image 4]

Contents	Instruction, Set Value
Accelerator POT	Actual value : (0.25 to 4.75 V)
	Designed value : Idling (Lower), MAX (Higher)
Governor POT	Actual value : (0.25 to 4.75 V)
	Designed value : Idling (Lower), MAX (Higher)
Motor Current	During AI motor operation : 0.0 to 15.0 A During AI motor stop : 0.0 to 2.0 A

RY9212007ELS0017US0

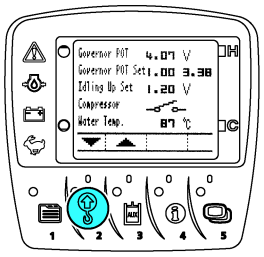


RY9212032ELS034A

[Image 5]

Contents	Instruction, Set Value
AI pressure SW	During idling Operation : ON During Operation : OFF
AI operating SW	Press the switch : ON
Compressor	During Operation : ON
Water temperature	Voltage and temperature are indicated. 0 °C (32 °F)→ 4.38 V, 100 °C (212 °F) → 0.91 V
Motor Current	During AI motor operation : 0.0 to 15.0 A During AI motor stop : 0.0 to 2.0 A

RY9212007ELS0018US0



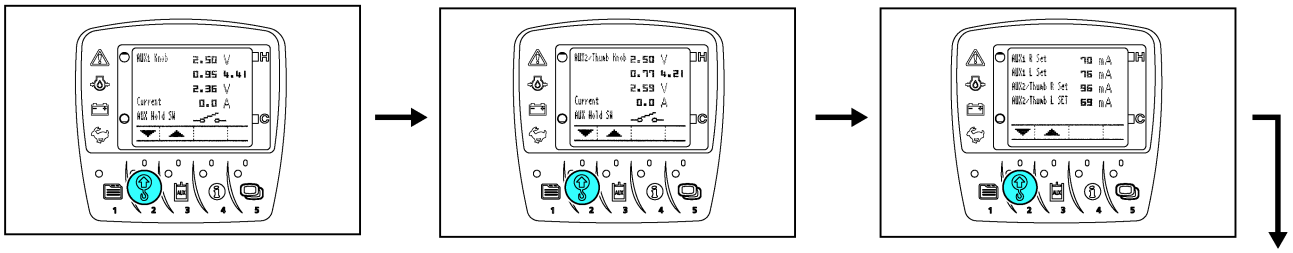
RY9212032ELS035A

[Image 6]

Contents	Instruction, Set Value
Governor POT	Actual value : (0.25 to 4.75 V)
Governor POT setting	Designed value : Idling (Lower), MAX (Higher)
Idle up	Idle up setting values
Compressor	During Operation : ON
Water temperature	Voltage and temperature are indicated. 0 °C (32 °F)→ 4.38 V, 100 °C (212 °F) → 0.91 V

RY9212007ELS0019US0

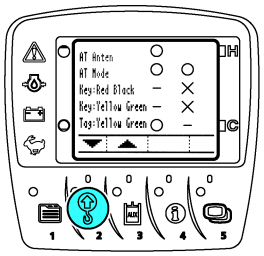
[Image 7] (Only for overseas specification) **[Image 8]** (Only for overseas specification) **[Image 9]** (Only for overseas specification)



RY9212032ELS026A

[Image 10]

RY9212007ELS0020US0



RY9212032ELS095A

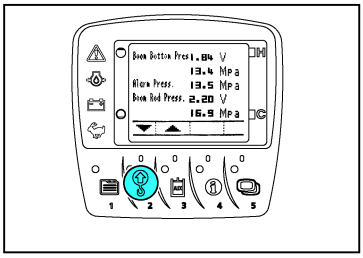
[Image 10]

Contents	Instruction, Set Value
Antenna for anti-theft	Antenna normal : ❍ Antenna abnormal : ×
Present-absent, valid-invalid	Key present : ❍, Anti-theft mode : ❍ Key absent : ×, Anti-theft canceled : ×
Red key, black key	Identified as the red key : ❍, identified as the black key : ❍ Not identified as the red key: ×, not identified as the black key : ×
Yellow key, green key	Identified as the yellow key : ❍, identified as the green key : ❍ Not identified as the yellow key : ×, not identified as the green key : ×

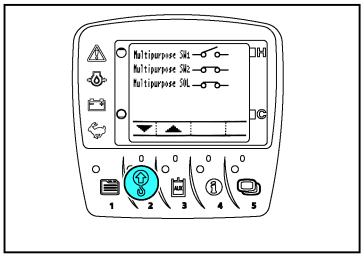
- Yellow key and Green key are equipped with North American Versions.

RY9212007ELS0021US0

[Image 12] (Only for overseas specification)



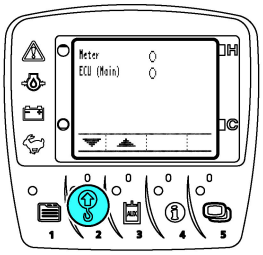
[Image 13] (Only for overseas specification)



[Image 14]

RY9212032ELS027A

RY9212007ELS0022US0

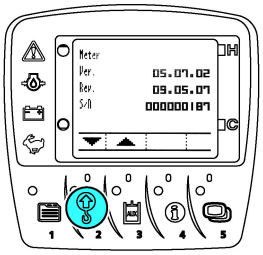


RY9212032ELS038A

[Image 13]

Contents	Instruction, Set Value
Meter	At the normal condition : ❍ (❍ when the meter exists.)
ECU (Main)	At the normal condition : ❍ (❍ when the ECU (Main) exists.)

RY9212007ELS0023US0

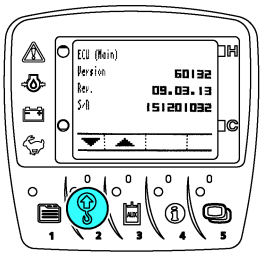


RY9212032ELS039A

[Image 14]

Contents	Instruction, Set Value
Ver	Version of the program
Rev	Program preparation date (Year, month, day)
Serial number	Serial number (Different number for each machine.)

RY9212007ELS0024US0

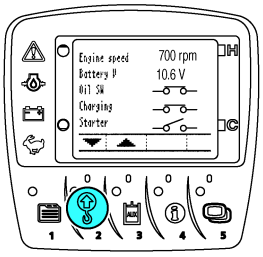


RY9212032ELS042A

[Image 15]

Contents	Instruction, Set Value
Ver	Version of the program
Rev	Program preparation date (Year, month, day)
Serial number	Serial number (Different number for each machine.)

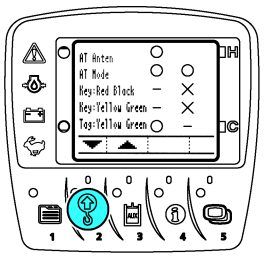
RY9212007ELS0025US0



RY9212032ELS030A

Return to the original Image.

RY9212007ELS0026US0



RY9212032ELS095A

CAUTION

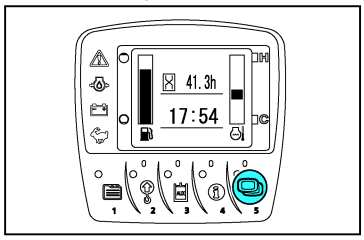
- **Indication does not disappear even if you turn off the key in the tester mode.**
  When it is completed, press SW1, and get out of tester mode.
  (When you turn off the key and leave if as tester mode, indication disappears three minutes later.)

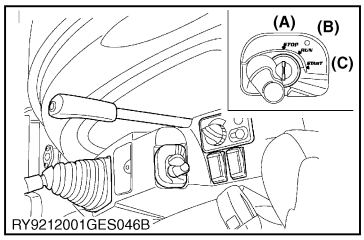
RY9212007ELS0027US0

[B] Check the Failure Record that Occurred in the Past

[Operation 1]

Turn the starter key to [RUN] position while pressing SW5.



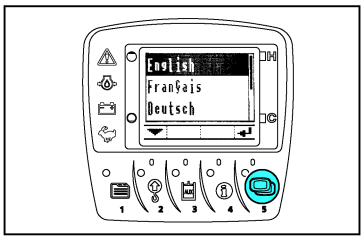


RY9212001GES046B

(A)STOP (B)RUN (C)START

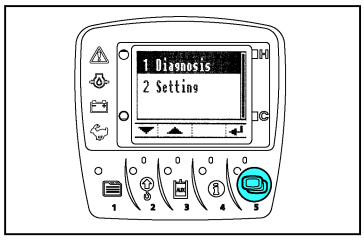
[Operation 2]

Select "Engish" and press SW5.



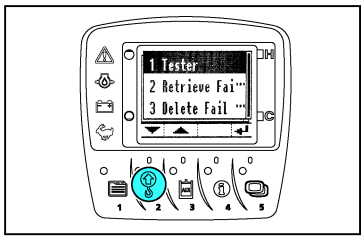
[Operation 3]

Select "Diagnosis" and press SW5.



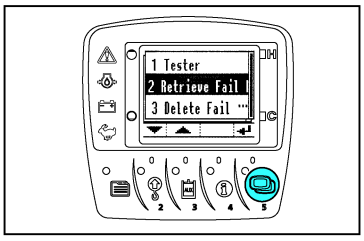
[Operation 4]

Press SW2 and select "Retrieve failure record".

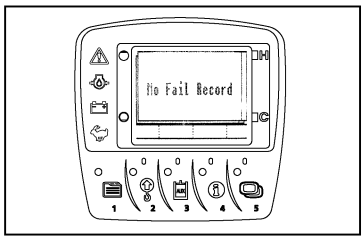


[Operation 5]

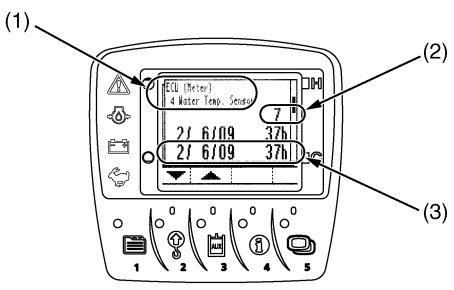
Select "Retrieve failure record"and press SW5.



Displayed image at the time of no fail record.



RY9212032ELS013A



RY9212032ELS091A

(1) The ECU that detected the failure is indicated. (Main) (Meter)
(2) Number of occurrences (1-255 times)
(3) The first date of occurrence (Date/Month/Year) and hour meter.
The last date of occurrence (Date/Month/Year) and hour meter.

RY9212007ELS0028US0

List of Failure Codes

Failure codes		Cause of generation and the measures
ECU (Meter)	0 Engine Oil Err	Detect the decrease in the engine oil pressure. The oil switch is in trouble or defect in harness, repair or replace it.
ECU (Meter)	1 Charging Sys Err	Detect the power generation decrease. The alternator is in trouble or the fan belt came off or defect in harness, repair or replace it.
ECU (Meter)	2 Overheat	The machine is overheated and must cool off by idling.Refill the radiator with coolant by its boiled-over amount. Unclog the radiator and other components before use again.Check also the hydraulic system for oil leak and other troubles.
ECU (Meter)	3 Fuel Sensor	The fuel sensor is in trouble or defect in harness, repair or replace it.
ECU (Meter)	4 Water Temperature Sensor	The water temperature sensor is in trouble or defect in harness, repair or replace it.
ECU (Meter)	5 CAN Sys (Main)	Defect in harness or defect in ECU (main), repair or replace it.
ECU (Meter)	6 CAN Sys (AS)	Defect in harness or defect in ECU(AS), repair or replace it.
ECU (Meter)	7 Setting Data Err	Set the model again. It is defective in the meter when still not repaired.
ECU (Main)	0 Lever Lock Sol	The lever lock Sol is in trouble or defect in harness, repair or replace it.
ECU (Main)	1 2-Speed Sol	The travel 2-speed Sol is in trouble or defect in harness, repair or replace it.
ECU (Main)	2 Multipurpose Sol	The multipurpose Sol is in trouble or defect in harness, repair or replace it.
ECU (Main)	3 AUX1 Knob	The AUX1 port knob is in trouble or defect in harness, repair or replace it.
ECU (Main)	4 AUX1 R Sol	The AUX1 Sol (right) is in trouble or defect in harness, repair or replace it.
ECU (Main)	5 AUX1 L Sol	The AUX1 Sol (left) is in trouble or defect in harness, repair or replace it.
ECU (Main)	6 AUX2/thumb Knob	The AUX2 port knob is in trouble or defect in harness, repair or replace it.
ECU (Main)	7 AUX2/Thumb R Sol	The AUX2 Sol (right) is in trouble or defect in harness, repair or replace it.
ECU (Main)	8 AUX2/Thumb L Sol	The AUX2 Sol (left) is in trouble or defect in harness, repair or replace it.
ECU (Main)	9 External 5V	The sensor's 5V power supply is short-circuited, repair or replace it.
ECU (Main)	10 External 12V	The sensor's or switch's 12V line (travel 2-speed SW and AI pressure SW, angles SW, etc.) is short-circuited, repair or replace it.
ECU (Main)	11 Overvoltage	A jimper cable is connected to a 24V battery or improper device to get the engine started or the alternator is in trouble, repair or replace it.
ECU (Main)	–	–
ECU (Main)	–	–
ECU (Main)	–	–
ECU (Main)	–	–
ECU (Main)	–	–
ECU (Main)	17 Boom Bottom Press.	Press the overload warning switch and release the warning.The load being lifted is too heavy.Place it on the ground to lessen the lifting load.
ECU (Main)	–	–
ECU (Main)	–	–
ECU (Main)	20 Governor Sensor	The governor sensor is in trouble or defect in harness, repair or replace it.
ECU (Main)	21 Accel Sensor	The accelerator sensor is in trouble or defect in harness, repair or replace it.
ECU (Main)	22 AI Motor	The AI motor is in trouble or defect in harness, repair or replace it.
ECU (Main)	–	–
ECU (Main)	24 Antenna	The antenna for anti-theft is in trouble or defect in harness, repair or replace it.

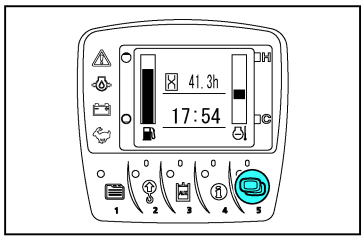
RY9212032ELS0114US0

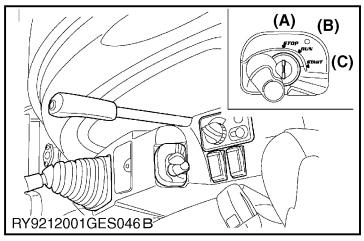
[C] Cancel of Failure Record

Setting procedures necessary to cancel the failure record that occurred in the past.

[Operation1]

Turn the starter key to [RUN] position while pressing SW5.

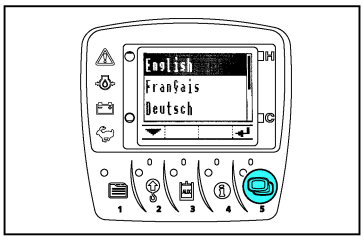




(A)STOP (B)RUN (C)START

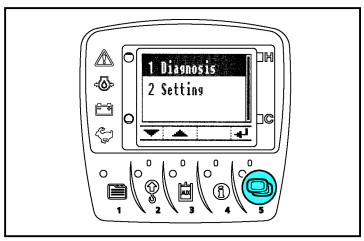
[Operation2]

Select "English" and press SW5.



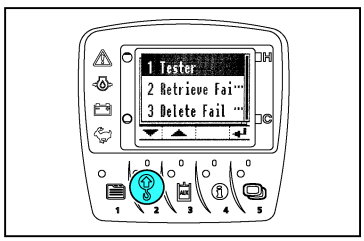
[Operation3]

Select "Diagnosis" and press SW5.



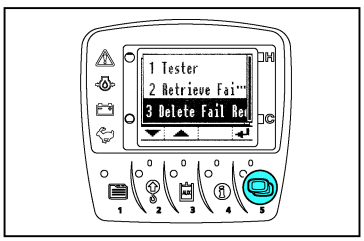
[Operation4]

Press SW2 and select "Delete fail record".

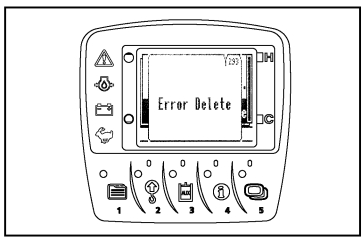


[Operation5]

Select "Delete fail record" and press SW5.



[Completed of delete fail record]



RY9212032ELS014A

RY9212007ELS0029US0

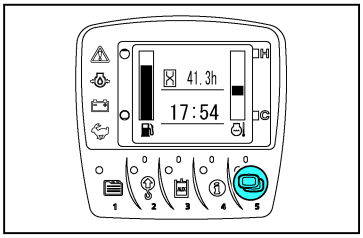
(2) Setting

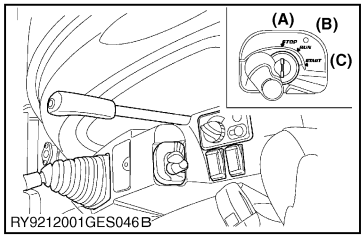
[A] AI Setting

Setting procedures that are necessary when the AI motor, AI motor cable, or governor sensor have been adjusted.

[Operation 1]

Turn the starter key to [RUN] position while pressing SW5.

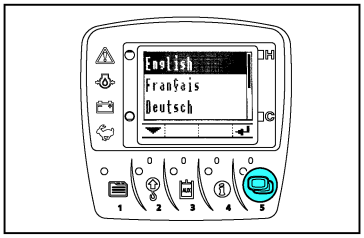




(A)STOP (B)RUN (C)START

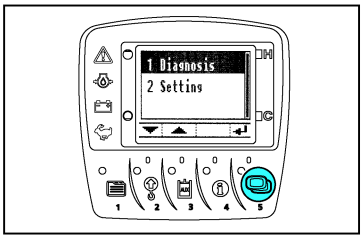
[Operation 2]

Select "English" and press SW5.



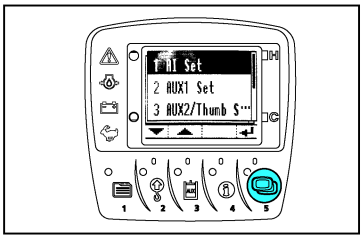
[Operation 3]

Press SW2, select "Setting", and press SW5.

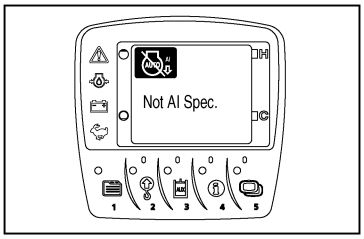


[Operation 4]

Select "AI Set" and press SW5.



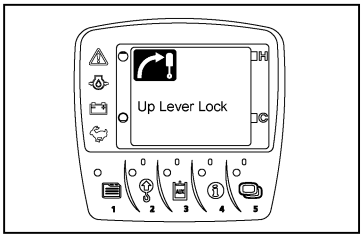
When AI has been set as "Not AI Spec." in "Model setting", the following image will be displayed.

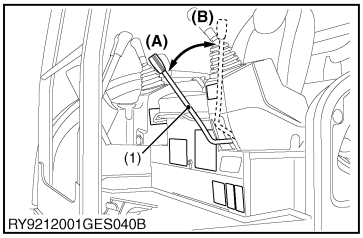


[From here the setting shall be conducted according to the indications of the meter panel.]

[Operation 5]

Up Lock Lever for attachment control

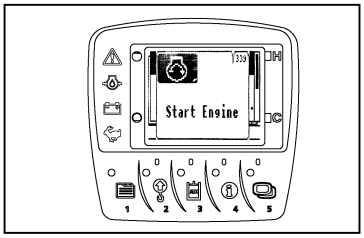




(1) Lock lever for attachment control (A) Unlock (B) Lock

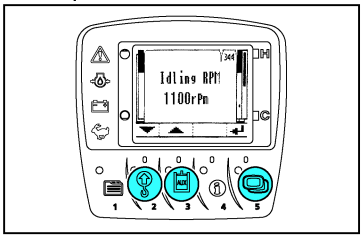
[Operation 6]

Start the engine.



[Operation 7]

Set idling rotating number and press SW5.

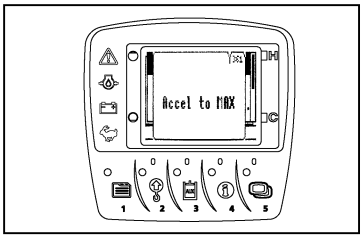


Pressing SW2 or SW3 can set up idling RPM, adjusting number by 50 rpm.

Pressing SW2 (▼) will decrease the number.
Pressing SW3 (▲) will increase the number.
KX057-4 → 1050 rpm (Default), 1300rpm (Max)

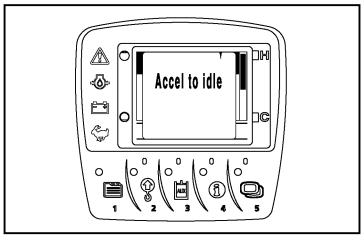
[Operation 8]

Put the accelerator at [MAX] position.

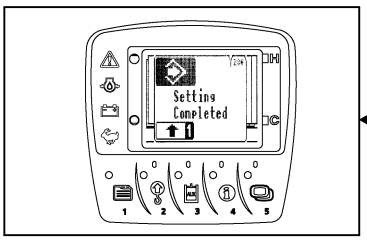


[Operation 9]

Put the accelerator at the idling position.



[Setting completed]



The setting will be finished in about one minute 20 seconds.

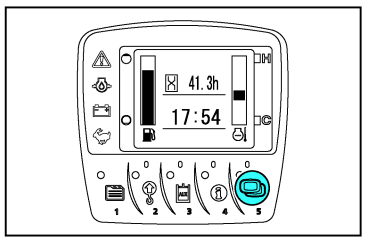
RY9212032ELS015A

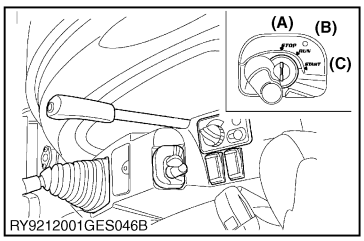
RY9212007ELS0030US0

[B] AUX1 Setting (Knob exchanged)

Set up the knob (AUX1) when the knob of AUX1 to be changed.

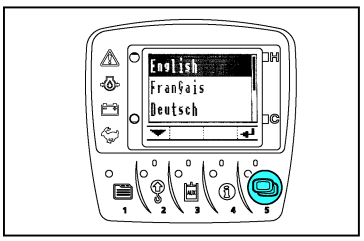
[Operation 1]
Turn the starter key to [RUN] position while pressing SW5.



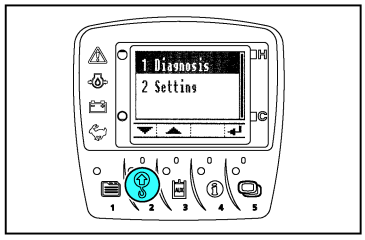


(A)STOP (B)RUN (C)START

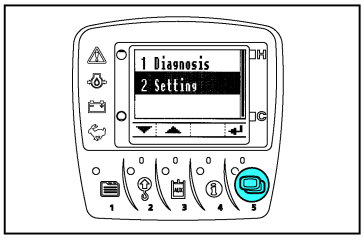
[Operation 2]
Select "English" and press SW5.



[Operation 3]
Press SW2.



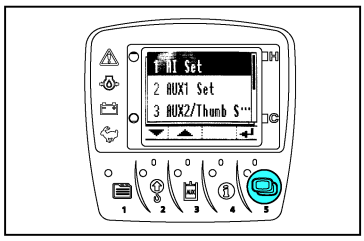
[Operation 4]
Select "Setting", and press SW5.



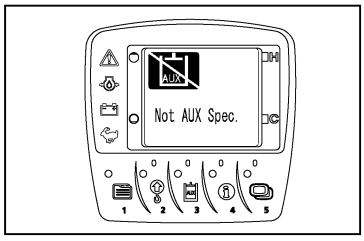
[Operation 5]

RY9212032ELS096A

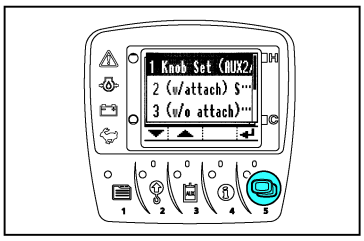
[Operation 5]
Select "AUX1 Set" and press SW5.



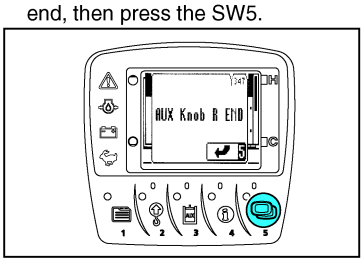
If "AUX1" has been set "None";



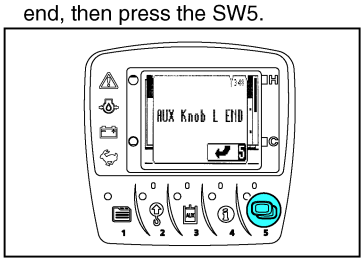
[Operation 6]
Select "Knob set (AUX1)" and press SW5.



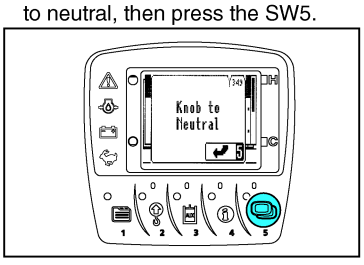
[Operation 7]
Shift the AUX1 knob SW to the right end, then press the SW5.



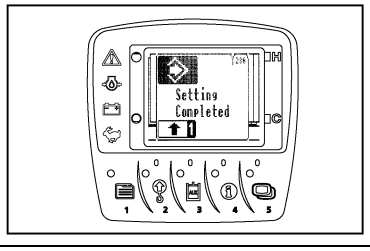
[Operation 8]
Shift the AUX1 knob SW to the left end, then press the SW5.



[Operation 9]
Release the AUX1 knob SW to neutral, then press the SW5.



[Setting completed]



RY9212032ELS097A

RY9212007ELS0031US0

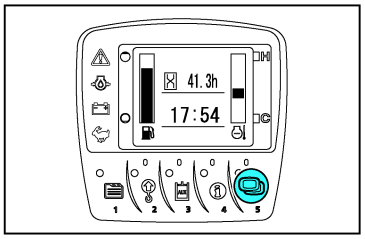
[C] AUX1 Setting (with attachment)

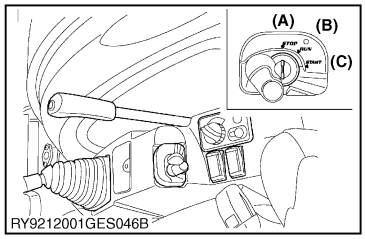
If AUX1 proportional valve or spool has been replaced;

This is the setting mode using a light load attachment like thumbs. If a thumb is not available, use a bucket.

[Operation 1]

Turn the starter key to [RUN] position while pressing SW5.

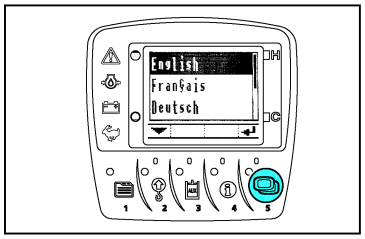




(A)STOP (B)RUN (C)START

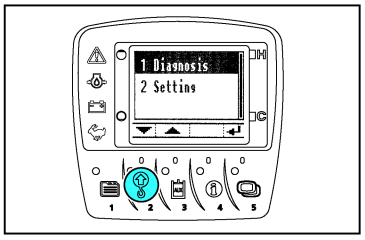
[Operation 2]

Select "English" and press SW5.



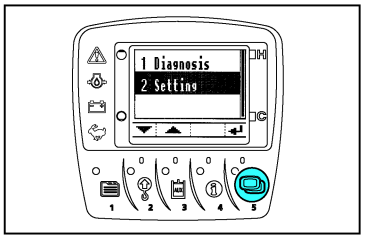
[Operation 3]

Press SW2.



[Operation 4]

Select "Setting", and press SW5.

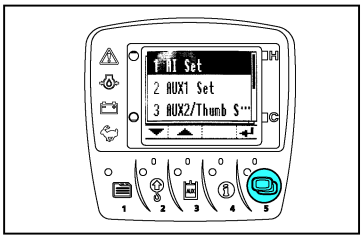


[Operation 5]

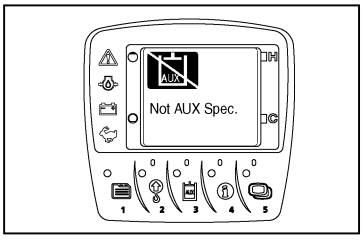
RY9212032ELS096A

[Operation 5]

Select "AUX1 Set" and press SW5.

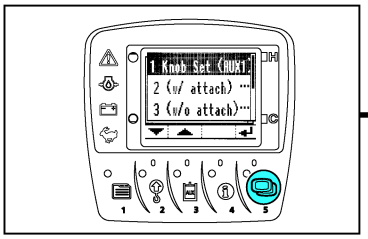


If "AUX1" has been set "None";



[Operation 6]

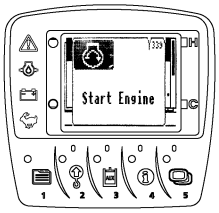
Select " (with attach) set up" and press SW5.



[If the following messages were given, follows the direction.]

Lift up the lock lever.

Start the engine.



Get the lock lever down.

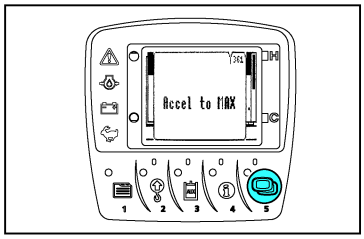
Start the engine. Now this message disappers. or Lift up (down) the lock lever.
This message disappears by lifting up (down) the lock lever.

[Operation 7]

RY9212032ELS164A

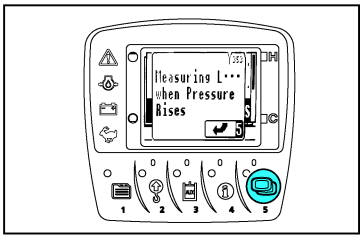
[Operation 7]

Turn the accel dial to Max. position. Set the attachment at the designated position and press the SW5.



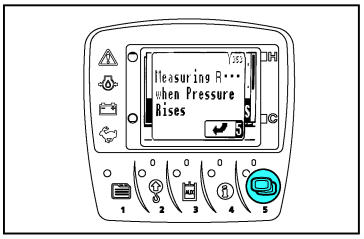
[Operation 8]

When the attachment starts moving to the left, press SW5.

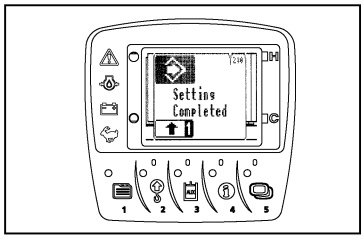


[Operation 9]

When the attachment starts moving to the right, press SW5.



[Setting completed]



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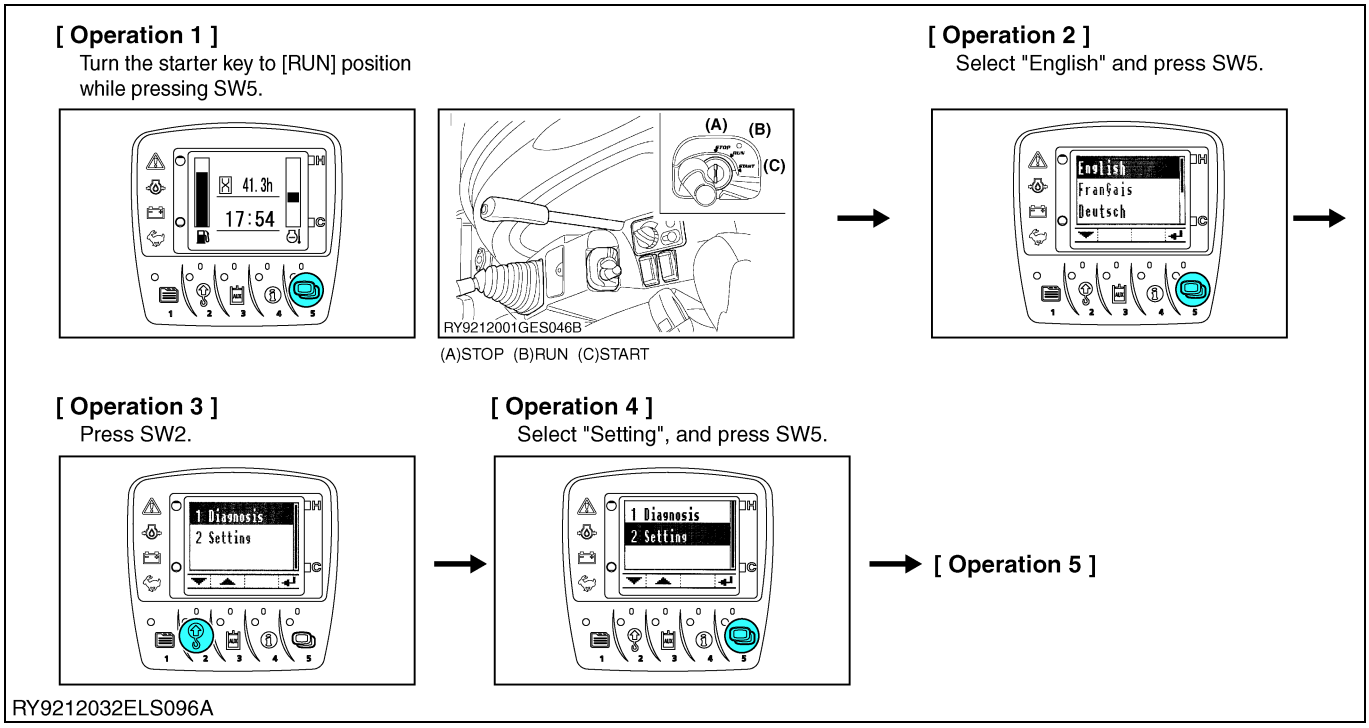
RY9212007ELS0032US0

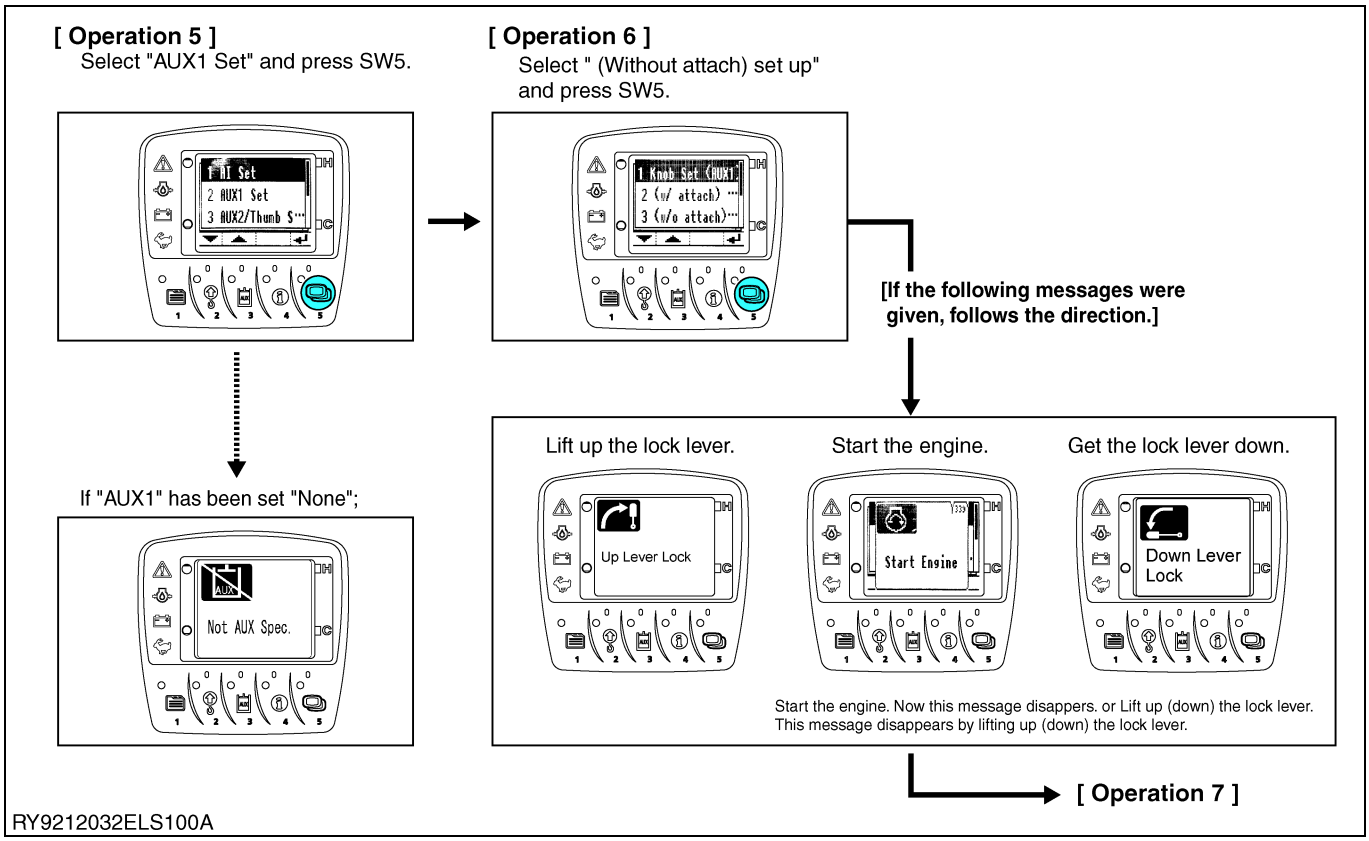
[D] AUX1 Setting (pressure rise of header)

If AUX1 proportional valve or spool has been replaced; set up the pressure rise of pressure header.

This is the fine adjustment in case of the attachment is unable to prepare.

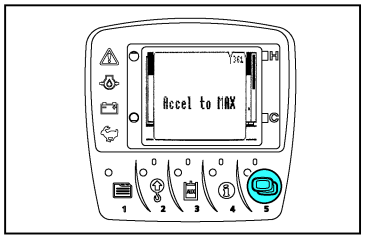
1. Cover both service port exits and connect pressure gauges.
2. Adjust them one by one and press SW5 to set it when each pressure rapidly increase.





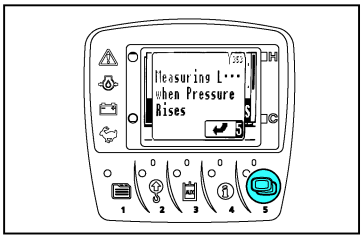
[Operation 7]

Turn the accel dial to Max. position and press the SW5.



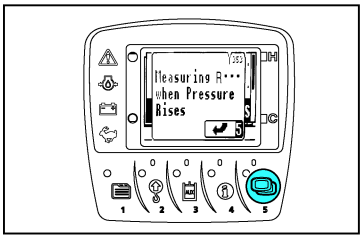
[Operation 8]

When Service Port (left) pressure rise up, press SW5.

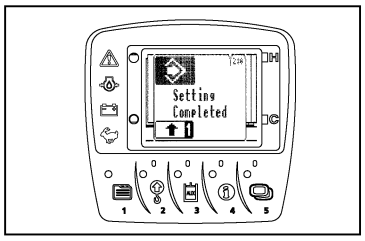


[Operation 9]

When Service Port (right) pressure rise up, press SW5.



[Setting completed]



RY9212032ELS101A

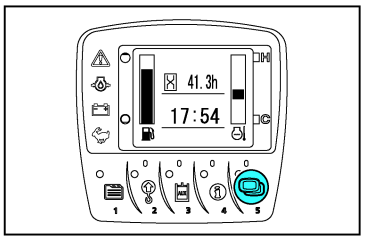
RY9212007ELS0033US0

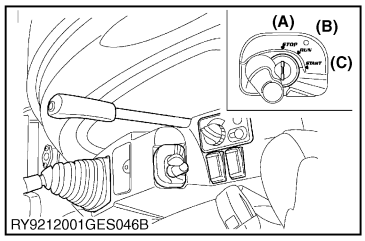
[E] AUX1 Setting (Feeling adjustment)

Set up when the feeling of AUX1 to be changed.

This is the setting mode for unexpected cases such as the adjustments with attachment and without attachment do not work and some manual correction is needed.
The current setting value can be changed directly by pressing a button.

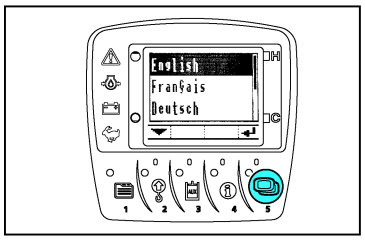
[Operation 1]
Turn the starter key to [RUN] position while pressing SW5.



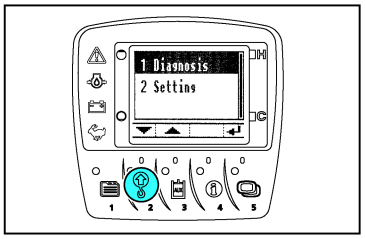


(A)STOP (B)RUN (C)START

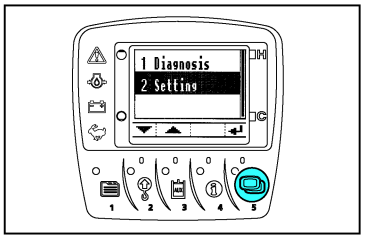
[Operation 2]
Select "English" and press SW5.



[Operation 3]
Press SW2.



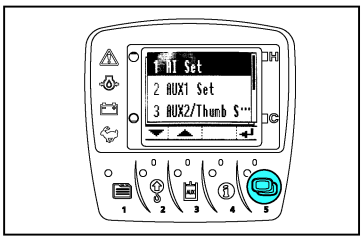
[Operation 4]
Select "Setting", and press SW5.



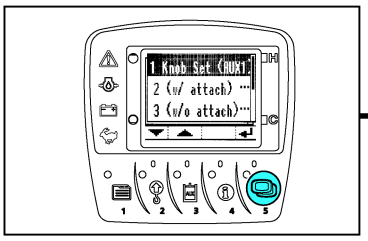
→ **[Operation 5]**

RY9212032ELS096A

[Operation 5]
Select "AUX1 Set" and press SW5.

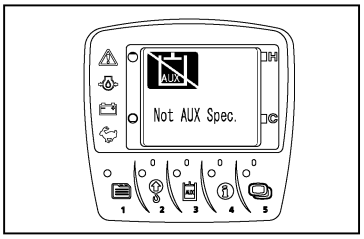


[Operation 6]
Select "Feeling adjustment" and press SW5.

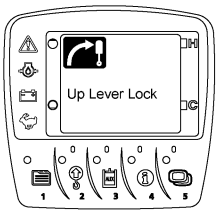


[If the following messages were given, follows the direction.]

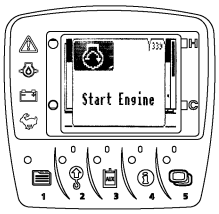
If "AUX1" has been set "None";



Lift up the lock lever.



Start the engine.



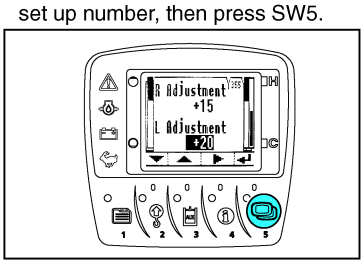
Get the lock lever down.

Start the engine. Now this message disappers. or Lift up (down) the lock lever.
This message disappears by lifting up (down) the lock lever.

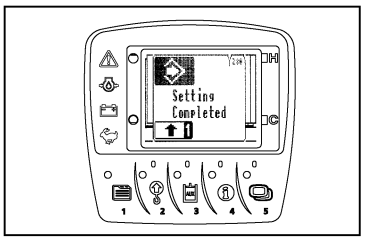
→ **[Operation 7]**

RY9212032ELS102A

[Operation 7]
While the feeling adjust, change the set up number, then press SW5.



[Setting completed]



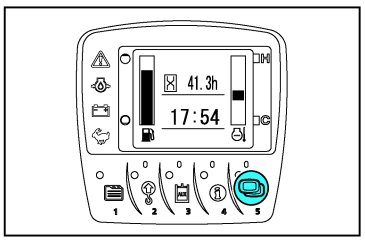
RY9212032ELS106A

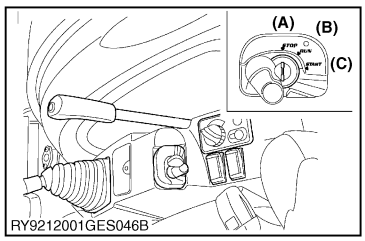
RY9212007ELS0034US0

[F] AUX2 / Thumb Setting (Knob exchanged)

Set up the knob (AUX2 / Thumb) when the knob of AUX2 / Thumb to be changed.

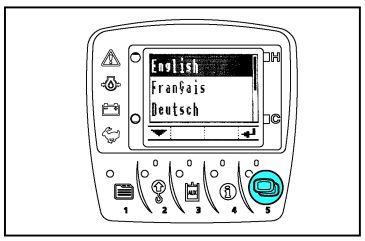
[Operation 1]
Turn the starter key to [RUN] position while pressing SW5.



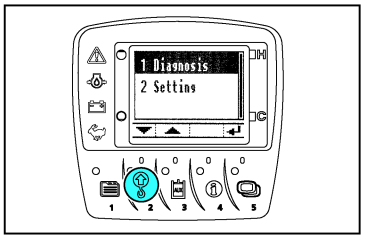


(A)STOP (B)RUN (C)START

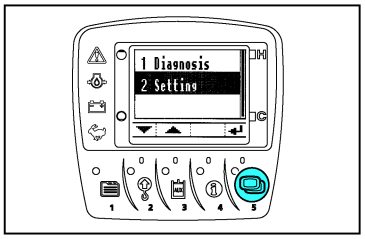
[Operation 2]
Select "English" and press SW5.



[Operation 3]
Press SW2.



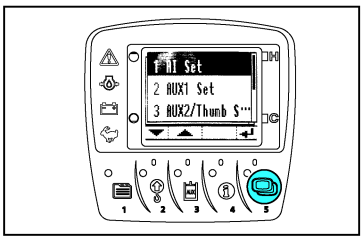
[Operation 4]
Select "Setting", and press SW5.



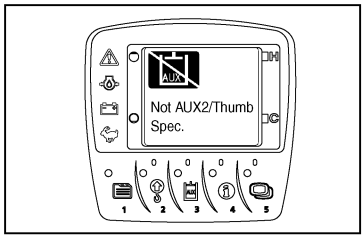
[Operation 5]

RY9212032ELS096A

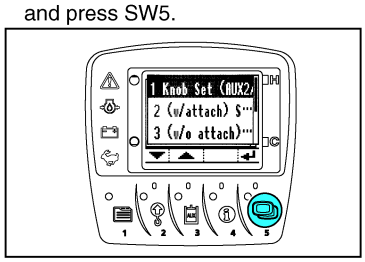
[Operation 5]
Select "AUX2 / Thumb Set" and press SW5.



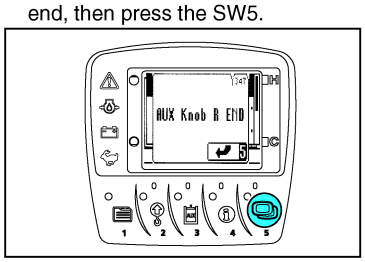
When AUX has been set as "Not AUX2 / Thumb" in "Model setting", the following image will be displayed.



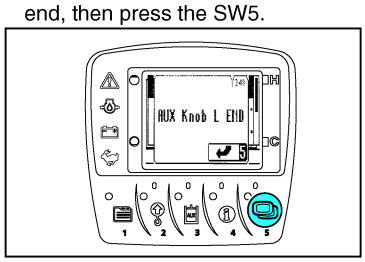
[Operation 6]
Select "Knob set (AUX2 / Thumb)" and press SW5.



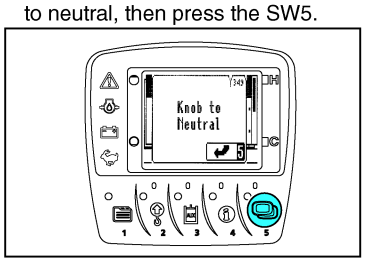
[Operation 7]
Shift the AUX2 knob SW to the right end, then press the SW5.



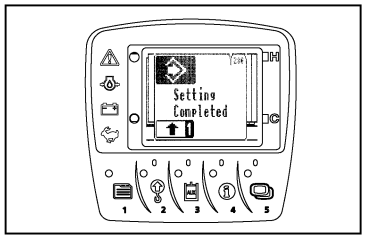
[Operation 8]
Shift the AUX2 knob SW to the left end, then press the SW5.



[Operation 9]
Release the AUX2 knob SW to neutral, then press the SW5.



[Setting completed]



RY9212032ELS103A

RY9212007ELS0035US0

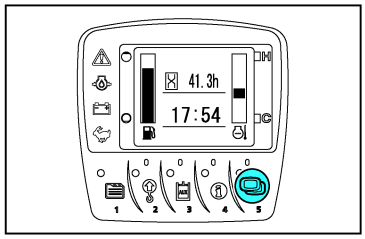
[G] AUX2 Setting (with attachment)

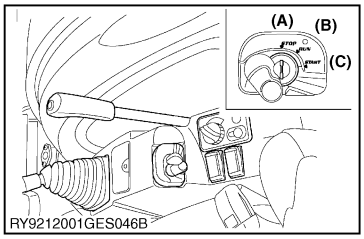
If AUX2 / Thumb proportional valve or spool has been replaced;

This is the setting mode using a light load attachment like thumbs. If a thumb is not available, use a bucket.

[Operation 1]

Turn the starter key to [RUN] position while pressing SW5.

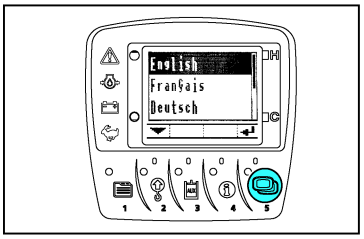




(A)STOP (B)RUN (C)START

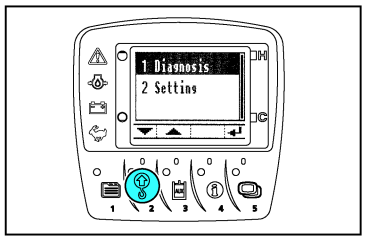
[Operation 2]

Select "English" and press SW5.



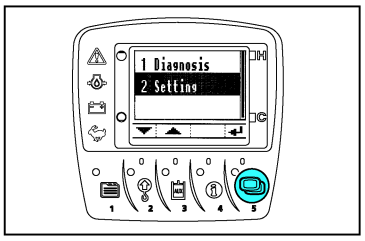
[Operation 3]

Press SW2.



[Operation 4]

Select "Setting", and press SW5.

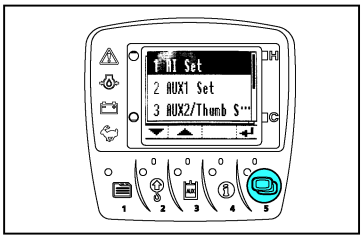


[Operation 5]

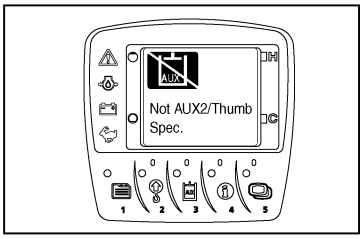
RY9212032ELS096A

[Operation 5]

Select "AUX2 / Thumb Set" and press SW5.

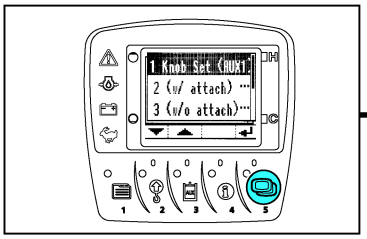


If "AUX2 / Thumb" has been set "None";



[Operation 6]

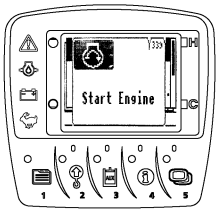
Select " (with attach) set up" and press SW5.



[If the following messages were given, follows the direction.]

Lift up the lock lever.

Start the engine.



Get the lock lever down.

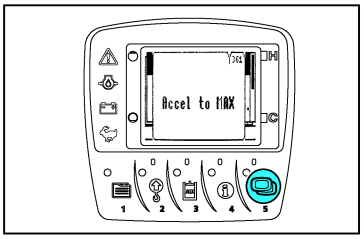
Start the engine. Now this message disappers. or Lift up (down) the lock lever.
This message disappears by lifting up (down) the lock lever.

[Operation 7]

RY9212032ELS098A

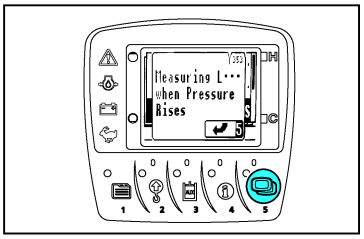
[Operation 7]

Turn the accel dial to Max. position. Set the attachment at the designated position and press the SW5.



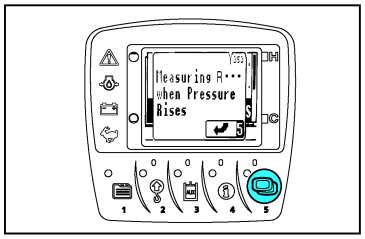
[Operation 8]

When the attachment starts moving to the left, press SW5.

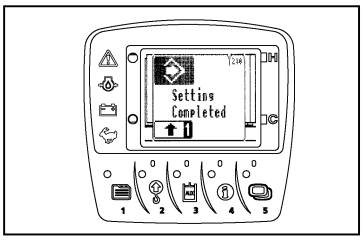


[Operation 9]

When the attachment starts moving to the right, press SW5.



[Setting completed]



RY9212032ELS099A

RY9212032ELS0112US0

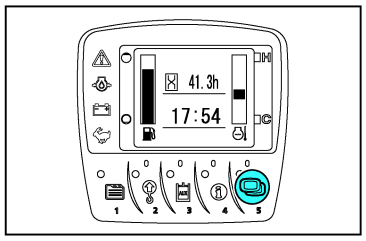
[H] AUX2 / Thumb Setting (pressure rise of header)

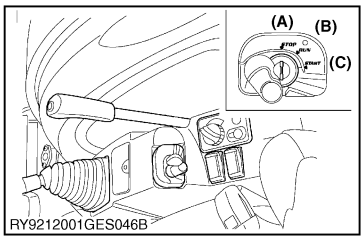
If AUX2 / Thumb proportional valve or spool has been replaced; set up the pressure rise of pressure header.

This is the fine adjustment in case of the attachment is unable to prepare.

1. Cover both service port exits and connect pressure gauges.
2. Adjust them one by one and press SW5 to set it when each pressure rapidly increase.

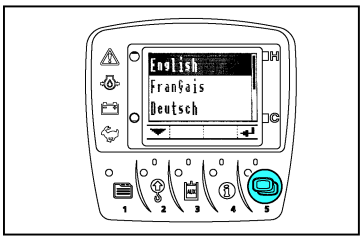
[Operation 1]
Turn the starter key to [RUN] position while pressing SW5.



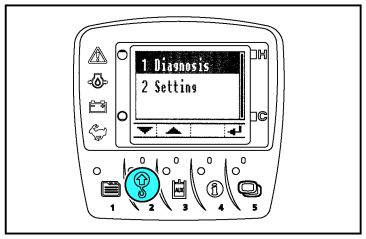


(A)STOP (B)RUN (C)START

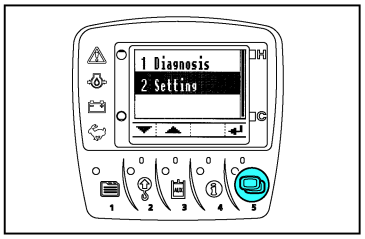
[Operation 2]
Select "English" and press SW5.



[Operation 3]
Press SW2.



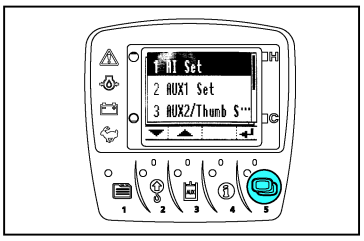
[Operation 4]
Select "Setting", and press SW5.



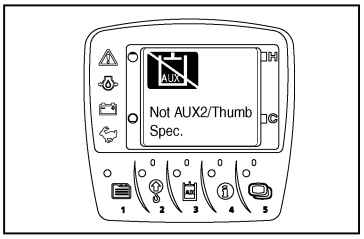
[Operation 5]

RY9212032ELS096A

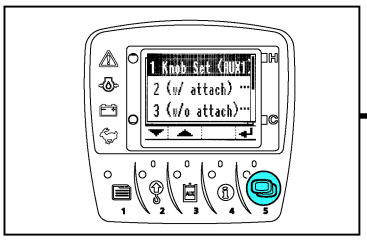
[Operation 5]
Select "AUX2 / Thumb Set" and press SW5.



If "AUX2 / Thumb" has been set "None";

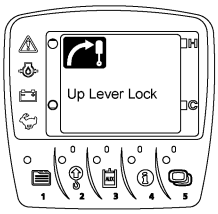


[Operation 6]
Select "(Without attach) AUX set " and press SW5.

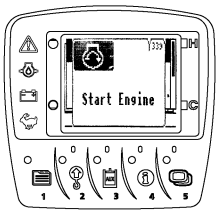


[If the following messages were given, follows the direction.]

Lift up the lock lever.



Start the engine.



Get the lock lever down.

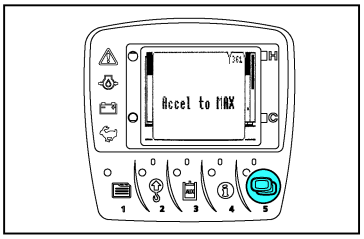
Start the engine. Now this message disappers. or Lift up (down) the lock lever.
This message disappears by lifting up (down) the lock lever.

[Operation 7]

RY9212032ELS104A

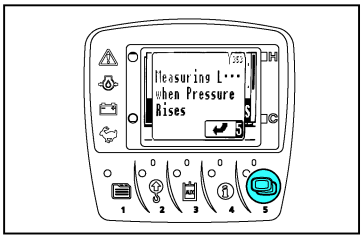
[Operation 7]

Turn the accel dial to Max. position and press the SW5.



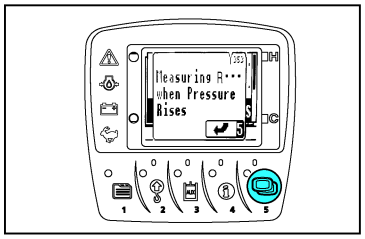
[Operation 8]

When Service Port (left) pressure rise up, press SW5.

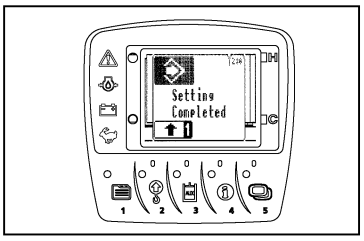


[Operation 9]

When Service Port (right) pressure rise up, press SW5.



[Setting completed]



RY9212032ELS101A

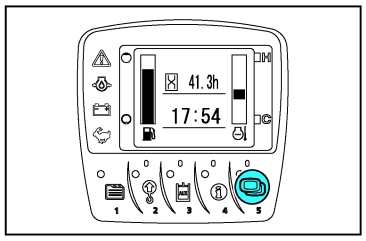
RY9212007ELS0036US0

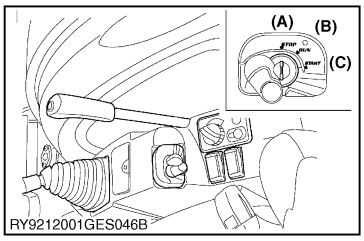
[I] AUX2 / Thumb Setting (Feeling adjustment)

Set up when the feeling of AUX2 / Thumb to be changed.

This is the setting mode for unexpected cases such as the adjustments with attachment and without attachment do not work and some manual correction is needed.
The current setting value can be changed directly by pressing a button.

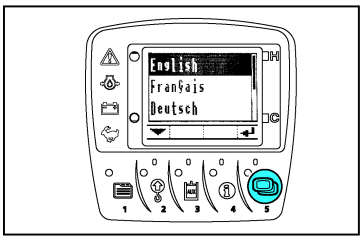
[Operation 1]
Turn the starter key to [RUN] position while pressing SW5.



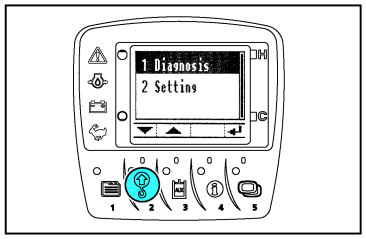


(A)STOP (B)RUN (C)START

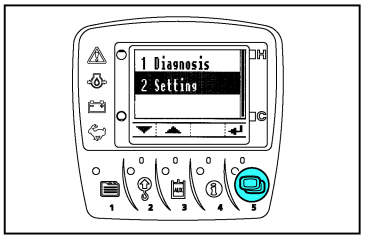
[Operation 2]
Select "English" and press SW5.



[Operation 3]
Press SW2.



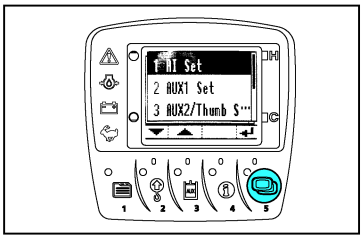
[Operation 4]
Select "Setting", and press SW5.



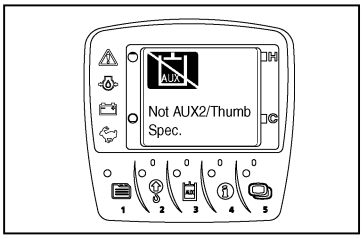
→ **[Operation 5]**

RY9212032ELS096A

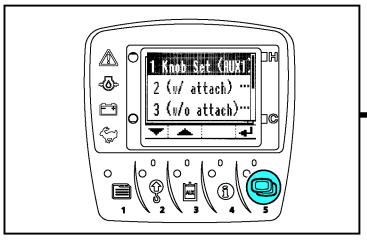
[Operation 5]
Select "AUX2 / Thumb Set" and press SW5.



If "AUX2 / Thumb" has been set "None";



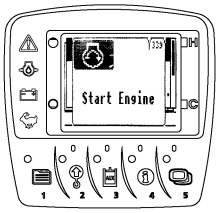
[Operation 6]
Select "Feeling adjustment" and press SW5.



[If the following messages were given, follows the direction.]

Lift up the lock lever.

Start the engine.



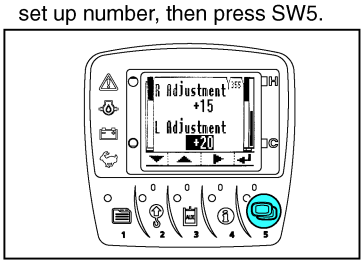
Get the lock lever down.

Start the engine. Now this message disappers. or Lift up (down) the lock lever.
This message disappears by lifting up (down) the lock lever.

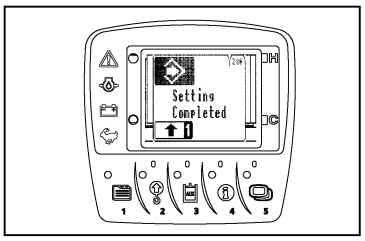
→ **[Operation 7]**

RY9212032ELS105A

[Operation 7]
While the feeling adjust, change the set up number, then press SW5.



[Setting completed]



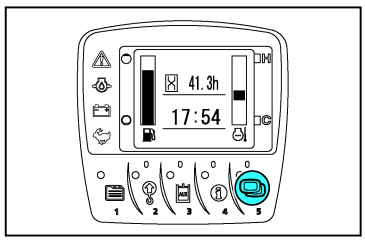
RY9212032ELS106A

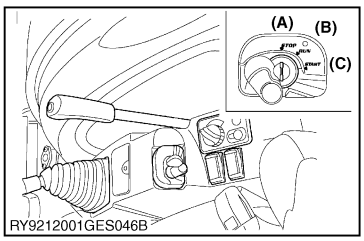
RY9212007ELS0037US0

[J] Overload Warning Setting

Set up the "overload warning pressure (European version)".

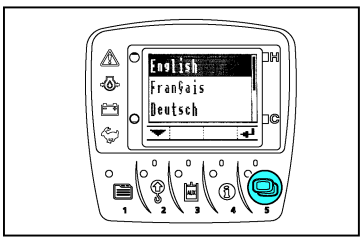
[Operation 1]
Turn the starter key to [RUN] position while pressing SW5.



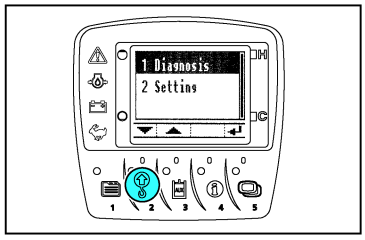


(A)STOP (B)RUN (C)START

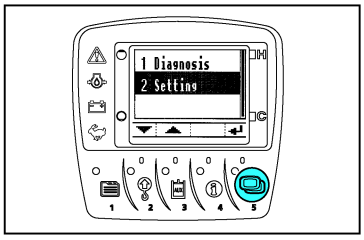
[Operation 2]
Select "English" and press SW5.



[Operation 3]
Press SW2.



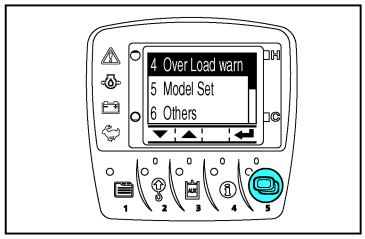
[Operation 4]
Select "Setting", and press SW5.



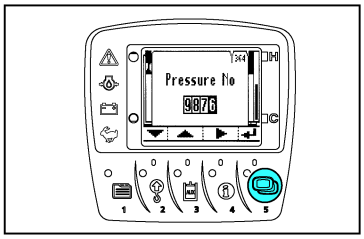
[Operation 5]

RY9212032ELS096A

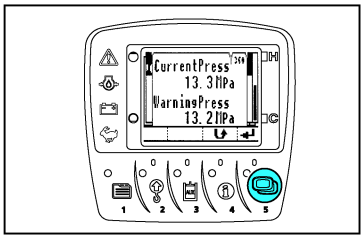
[Operation 5]
Select "Overload warning" and press SW5.



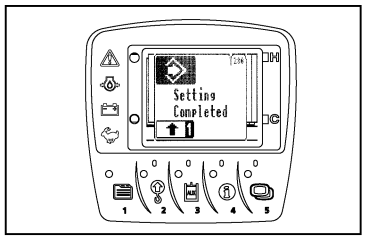
[Operation 6]
Input the pre-set code number and press SW5. (Refer to below table)



[Operation 7]
Press SW5.

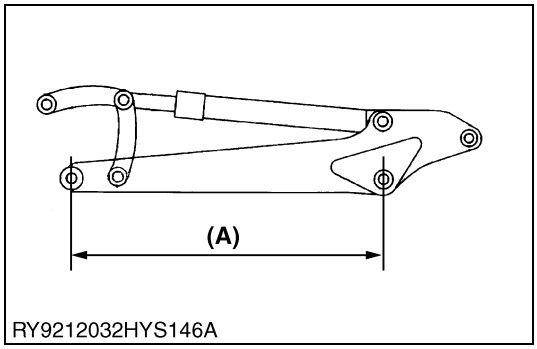


[Setting completed]



RY9212032ELS107A

RY9212007ELS0038US0



RY9212032HYS146A

Pre-set code number list for Overload Warning Setting

Model	Arm Length (A)	Type of Track	Pre-set code number
KX057-4	1820 mm (71.65 in.)	Iron track	4840
		Rubber track or Wide iron track	0744
	1570 mm (61.81 in.)	Rubber track	0744
U55-4	1570 mm (61.81 in.)	Iron track	7253
		Rubber track	7281
		Wide iron track	3189
U48-4	1450 mm (57.09 in.)	Iron track	2357
		Rubber track	6455

RY9212032ELS0091US0

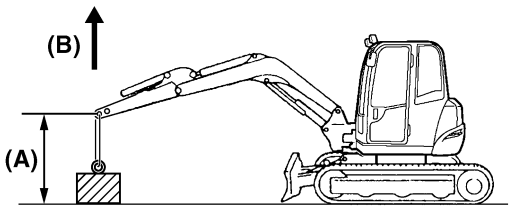
Boom Overload Alarm Check Method

Set pressure list

Spec.	KX057-4	U55-4	U48-4
Iron track	12.8 MPa 131 kgf/cm^2 1710 psi	11.5 MPa 117 kgf/cm^2 1670 psi	11.9 MPa 121 kgf/cm^2 1730 psi
Rubber track	13.2 MPa 135 kgf/cm^2 1910 psi	11.2 MPa 114 kgf/cm^2 1620 psi	12.2 MPa 124 kgf/cm^2 1770 psi
Wide iron track	13.2 MPa 135 kgf/cm^2 1910 psi	11.8 MPa 120 kgf/cm^2 1710 psi	–

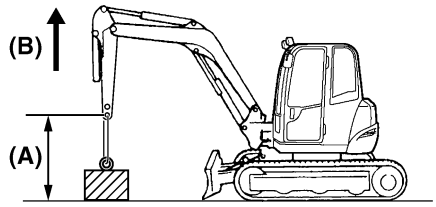
RY9212032ELS0089US0

a)



RY9212032ELS148A

b)



RY9212032ELS147A

[Testing Method]

1. Weight of suspended weight: 500 ~ 600 kg (1110 ~ 1320 lbs) (No bucket, includes weight of rigging)
2. No-load height **(A)**: Approx. 1300 mm (51.18 in.) (Height from bottom of weight to rigging point)
3. Hoisting Posture
   a) Max digging radius posture
      The arm cylinder fully compressed, the excavator facing forward, dozer lowered and in a central swing position.
   b) Vertical arm posture
      The arm vertical, the excavator facing forward, dozer lowered and in a central swing position.
4. Test procedure (lifting the weight off the ground)
   - Press the overload warning button on the instrument panel and put the excavator in the **a)** Max digging radius posture.
   - With the engine idling, slow raise the boom.
   - Lift the weight to a height of approx. 300 mm (11.8 in.) and if the warning sounds, it is operating normally.
   - Put the excavator in the **b)** Arm vertical posture, and lift the weight slowly with the engine idling.
   - Lift the weight to a height of approx. 300 mm (11.8 in.) and if the warning does not sound, it is operating normally.

[Evaluation Standard]

Hoisting Posture	Criteria
a) Max digging radius posture	Warning sounds (OK)
b) Vertical arm posture	Warning does not sound (OK)

(A) 1300 mm (51.18 in.) **(B) Lift 300 mm (11.8 in.)**

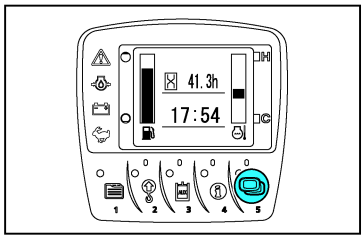
RY9212032ELS0090US0

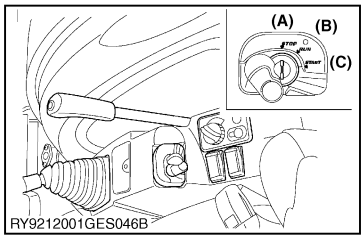
[K] Model Setting

Setting procedures that is necessary when ECU's and digital panel have been replaced.

[Operation 1]

Turn the starter key to [RUN] position while pressing SW5.

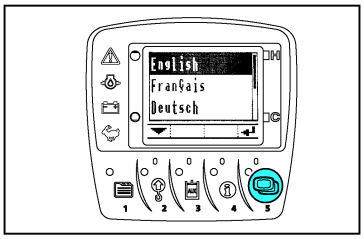




(A)STOP (B)RUN (C)START

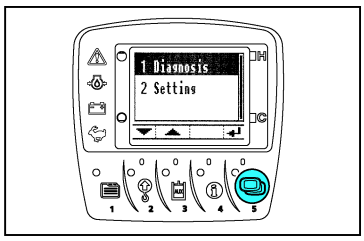
[Operation 2]

Select "English" and press SW5.



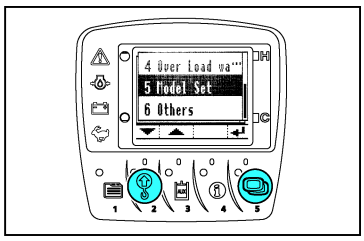
[Operation 3]

Press SW2, select "Setting", and press SW5.



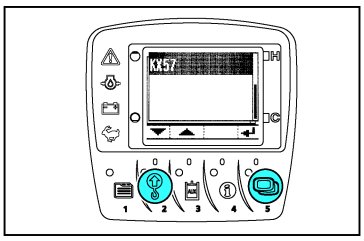
[Operation 4]

Press SW2, select "Model set", and press SW5.



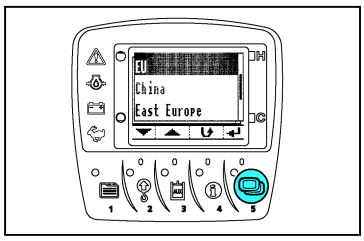
[Operation 5]

Press SW2, select the model "KX57", and press SW5.



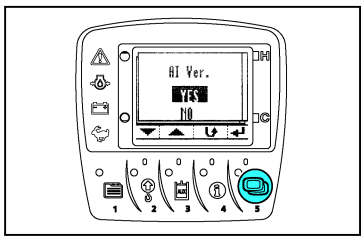
[Operation 6]

Select "EU" and press SW5.



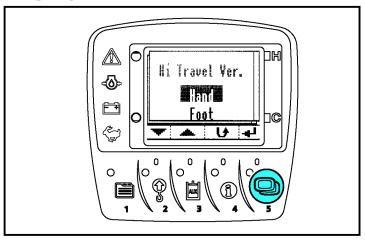
[Operation 7]

Select "YES" and press SW5.



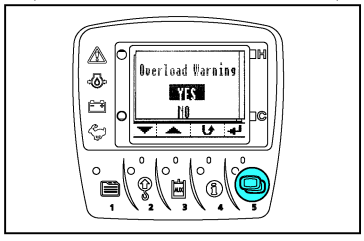
[Operation 8]

Choose having Hi travel version controlled by "Hand", and press SW5.



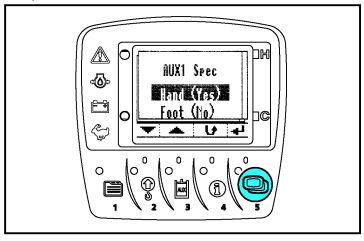
[Operation 9]

Choose having Overload Warning "YES", and press SW5.
(Select the "YES" for EU version.)



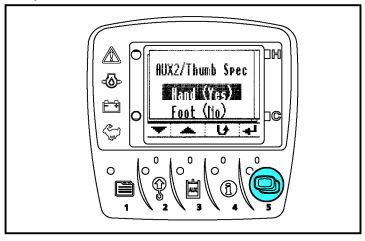
[Operation 10]

Choose having AUX1 spec. controlled by hand. Select "Hand(Yes)" and press SW5.



[Operation 11]

Select "AUX2/Thumb Spec" controlled by hand. Select "Hand(Yes)" and press SW5.



RY9212032ELS017A

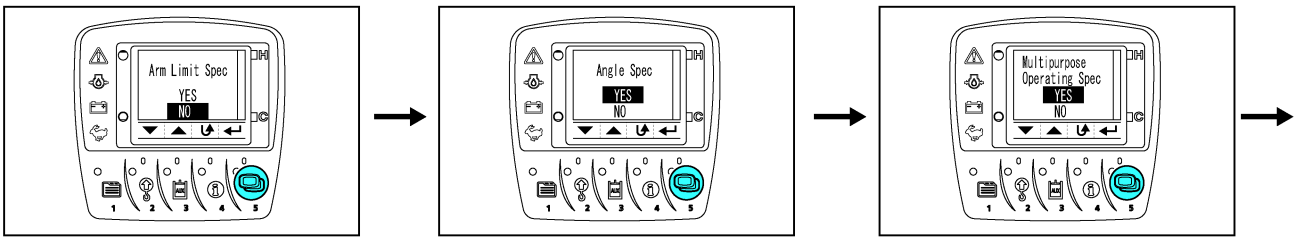
(To be continued)

(Continued)

[Operation 12]
Choose " NO" on the "Arm Limit Spec" and press SW5.

[Operation 13]
With Angle blade "YES", Without Angle blade "NO" and press SW5.

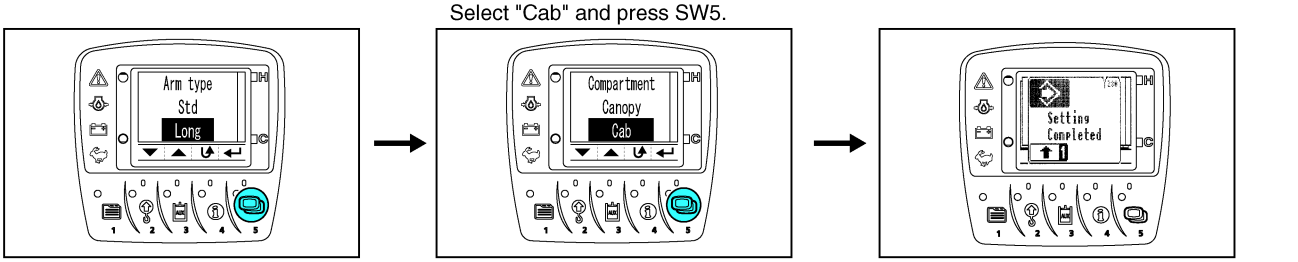
[Operation 14]
Choose "YES" on the "Multipurpose Operating Spec" and press SW5.



[Operation 15]
Choose the specifications of the Arm type. As for the KX057-4 specifications, long arm is standard equipment.
Select "Long" and press SW5.

[Operation 16]
Choose the Specifications of the Compartment (Canopy or Cab).
As for the KX057-4 specifications, cab is the standard equipment.
Select "Cab" and press SW5.

[Setting completed]



RY9212032ELS145A

■ **NOTE**

- **After selecting the correct machine settings, you have to recalibrate the AUX port knob of the levers, initialize the auto-idle function, and set the overload warning code.**

RY9212007ELS0039US0

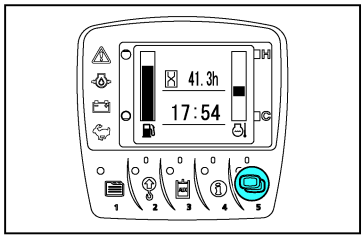
[L] Others

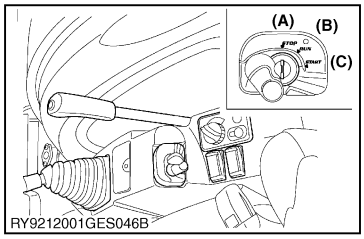
1. AI motor drive

Setting procedures when AI motor lever position is to be moved.

[Operation 1]

Put the starter key to [RUN] position while pressing SW5.

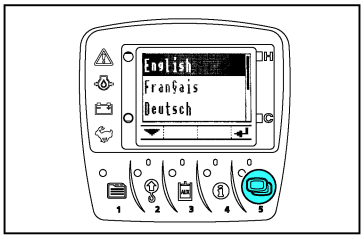




(A)STOP (B)RUN (C)START

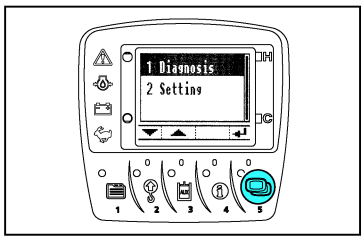
[Operation 2]

Select "English" and press SW5.



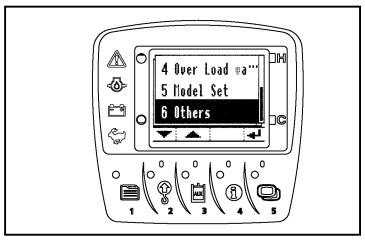
[Operation 3]

Press SW2, select "Setting", and press SW5.



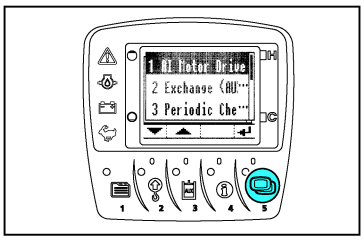
[Operation 4]

Press SW2, select "Others", and press SW5.



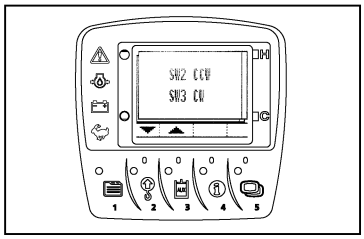
[Operation 5]

Select "AI motor drive" and press SW5.



[Operation 6]

Pressing SW2 will move AI motor to the idling side.
Pressing SW3 will move AI motor to the [MAX] side.



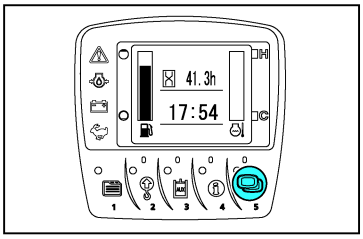
RY9212032ELS018A

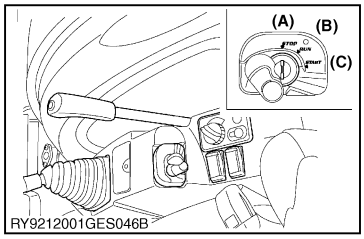
RY9212007ELS0040US0

2. Periodic check guidance cancellation method

Setting procedures when the periodical check guidance cancellation method is to be changed.

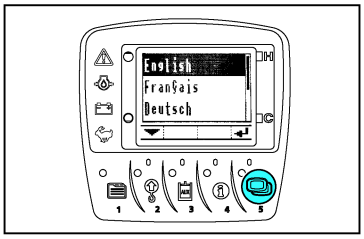
[Operation 1]
Put the starter key to [RUN] position while pressing SW5.





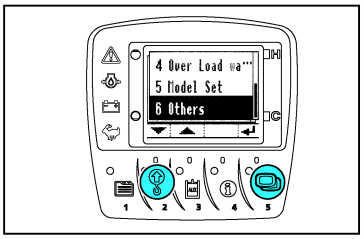
(A)STOP (B)RUN (C)START

[Operation 2]
Select "English" and press SW5.

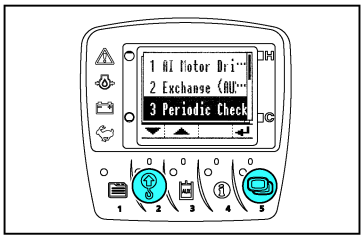


[Operation 3]
Press SW2, select "Setting", and press SW5.

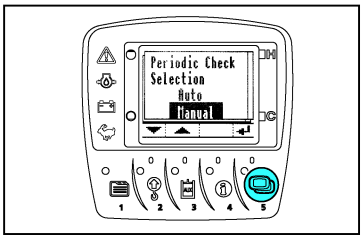
[Operation 4]
Press SW2, select "Others", and press SW5.



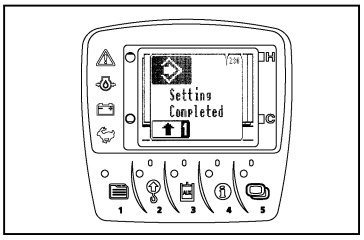
[Operation 5]
Press SW2, select "Periodic check guidance cancellation", and press SW5.



[Operation 6]
Select auto/manual and press SW5.
(Factory preset mode: Auto)



[Setting completed]



RY9212032ELS019A

Periodical check guidance cancelation method
[Automatic]
- Turn the key ON/OFF ten times.
- Press "Yes" on the periodical check screen, "Have you finished the periodical check ?".

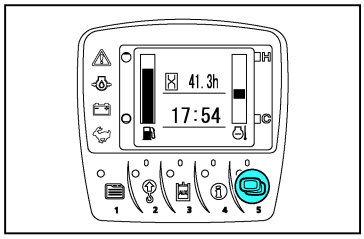
[Manual]
- Press "Yes" on the periodical check screen, "Have you finished the periodical check ?".
- (Turning the key ON/OFF will not cancel the image.)

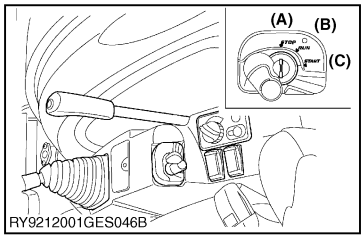
RY9212007ELS0041US0

3. Need/non-need of periodic check guidance display.

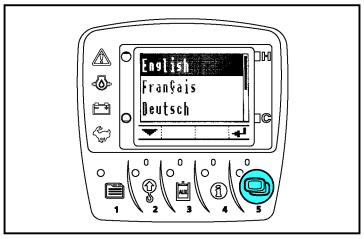
Setting procedures when "Need or non-need of the periodical check guidance display" is to be changed.

[Operation 1]
Put the starter key to [RUN] position while pressing SW5.

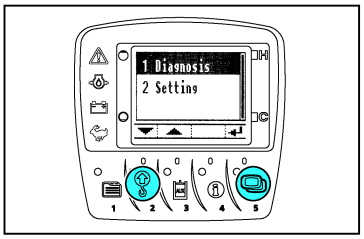




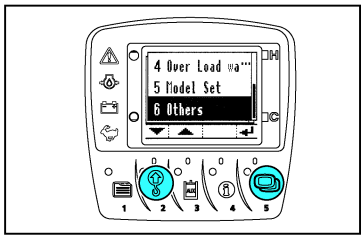
[Operation 2]
Select "English" and press SW5.



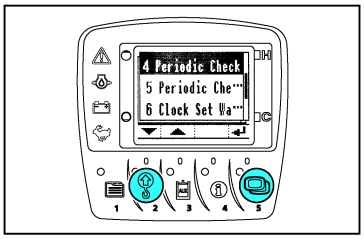
[Operation 3]
Press SW2, select "Setting", and press SW5.



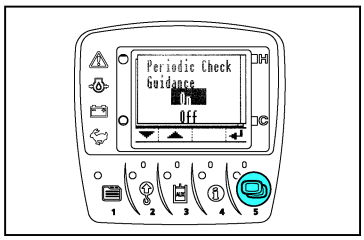
[Operation 4]
Press SW2, select "Others", and press SW5.



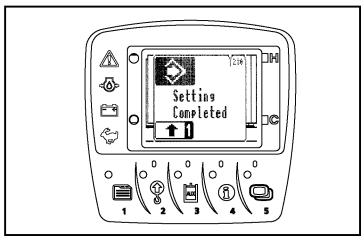
[Operation 5]
Press SW2, select "Periodical check guidance display", and press SW5.



[Operation 6]
Select "Display" or "Not", and press SW5. (Factory preset mode: Display.)



[Setting completed]



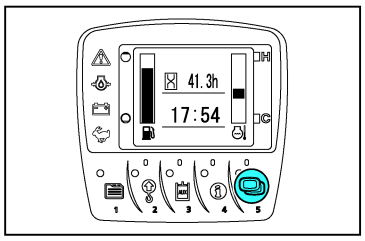
RY9212032ELS020A

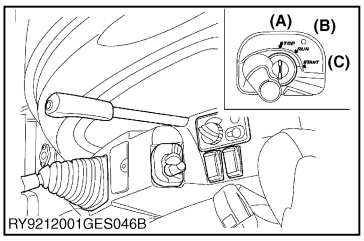
RY9212007ELS0042US0

4. Periodical check offset time

Procedures when the operation time before replacement is to be put into the replaced new meter.

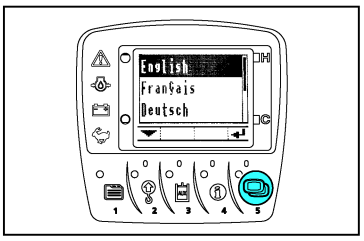
[Operation 1]
Turn the starter key to [RUN] position while pressing SW5.



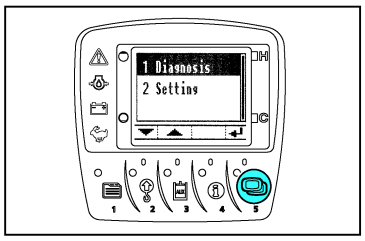


(A)STOP (B)RUN (C)START

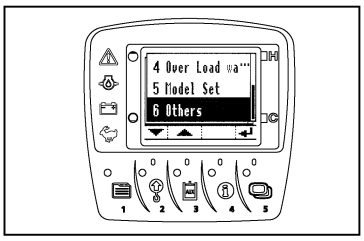
[Operation 2]
Select "English" and press SW5.



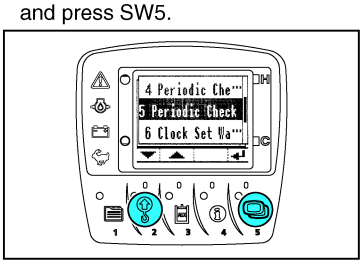
[Operation 3]
Press SW2, select "Setting", and press SW5.



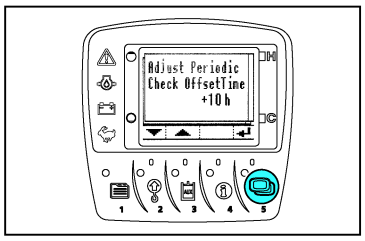
[Operation 4]
Press SW2, select "Others", and press SW5.



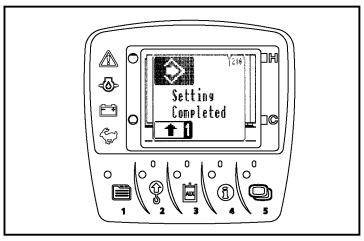
[Operation 5]
Press SW2, select "Offset time adjustment of the periodic check", and press SW5.



[Operation 6]
Set the before-the-replacement hour meter and press SW5.



[Setting completed]



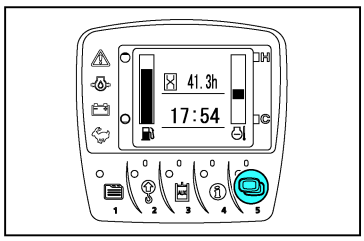
RY9212032ELS021A

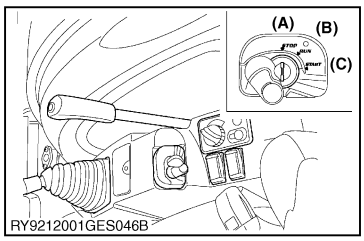
RY9212007ELS0043US0

5. Request for clock adjusting guidance display

Setting procedures how to make the clock setting warning not to be displayed.

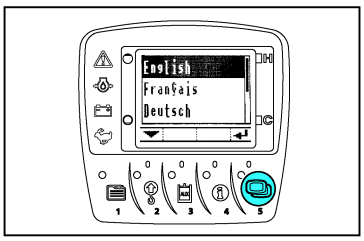
[Operation 1]
While pressing the "SW5", turn the main key SW from OFF to ON.



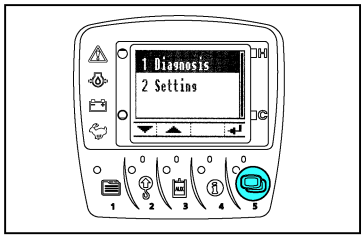


(A)STOP (B)RUN (C)START

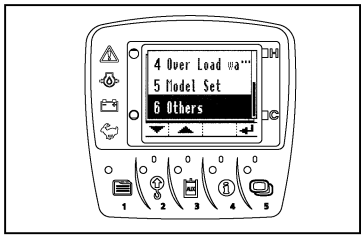
[Operation 2]
Select "English" and press SW5.



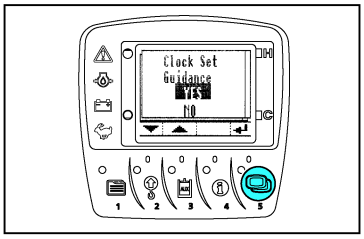
[Operation 3]
Press SW2, select "Setting", and press SW5.



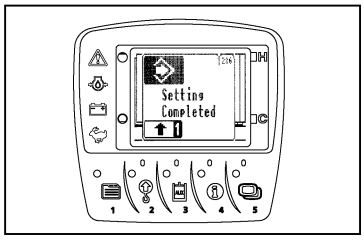
[Operation 4]
Press SW2, select "Others", and press SW5.



[Operation 5]
Select "Require clock adjusting guidance display" or "Not require" and press SW5.
(Factory preset mode : Require)



[Setting completed]

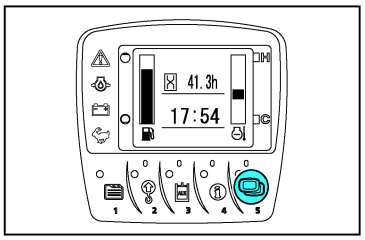


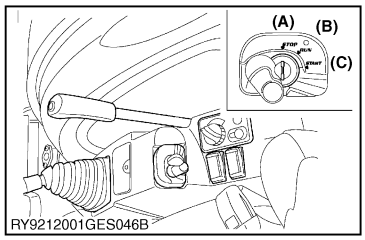
RY9212032ELS022A

RY9212007ELS0044US0

[M] Operate AUX2 / Thumb by AUX1 knob (Or operate AUX1 by AUX2 / Thumb knob)

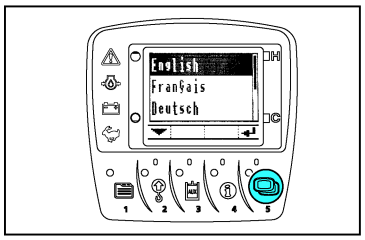
[Operation 1]
Turn the starter key to [RUN] position while pressing SW5.



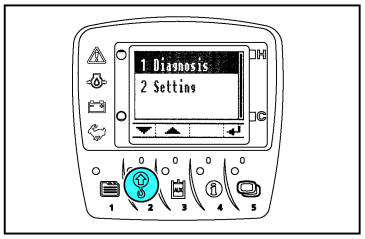


(A)STOP (B)RUN (C)START

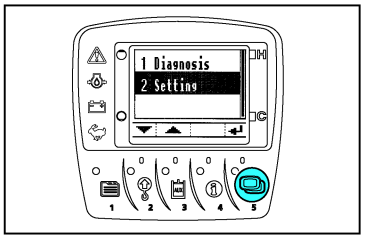
[Operation 2]
Select "English" and press SW5.



[Operation 3]
Press SW2.



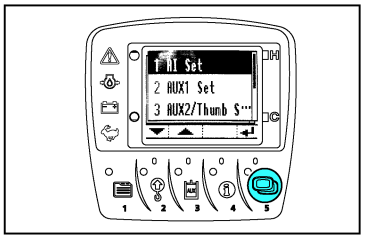
[Operation 4]
Select "Setting", and press SW5.



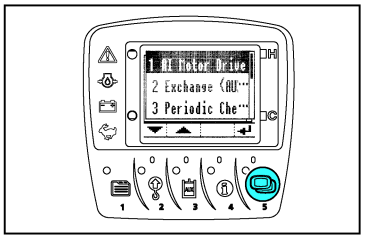
[Operation 5]

RY9212032ELS096A

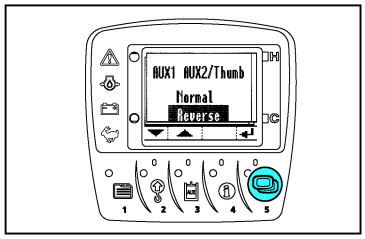
[Operation 5]
Select "Others" and press SW5.



[Operation 6]
Select "Exchange (AUX1 AUX2 / thumb)" and press SW5.

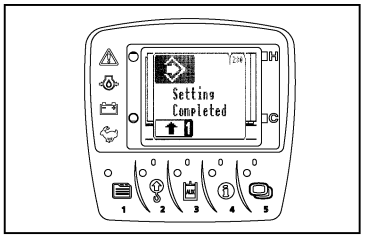


[Operation 7]
Press SW5.



Normal → Standard Setting
Reverse → Exchange

[Setting completed]

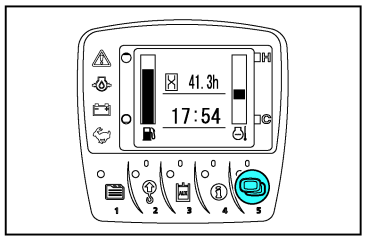


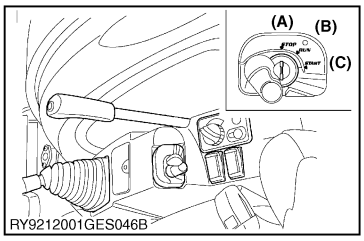
RY9212032ELS108A

RY9212007ELS0045US0

[N] Set up changed condition of Multipurpose switch.

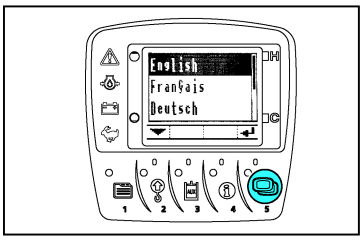
[Operation 1]
Turn the starter key to [RUN] position while pressing SW5.



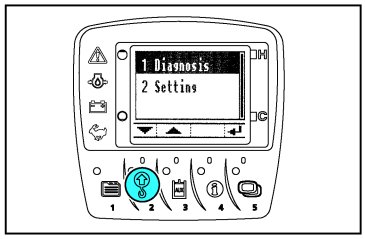


(A)STOP (B)RUN (C)START

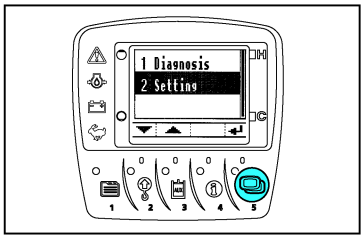
[Operation 2]
Select "English" and press SW5.



[Operation 3]
Press SW2.



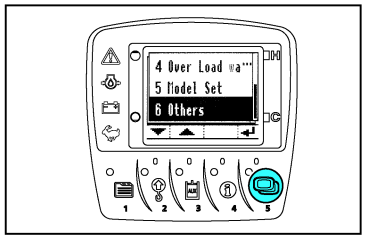
[Operation 4]
Select "Setting", and press SW5.



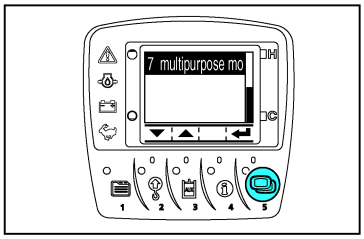
→ **[Operation 5]**

RY9212032ELS096A

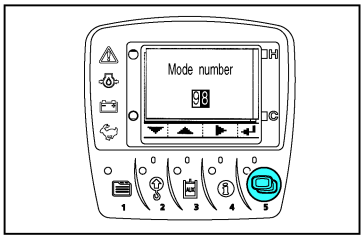
[Operation 5]
Select "Others" and press SW5.



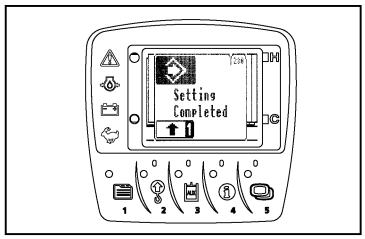
[Operation 6]
Select "multipurpose mode" and press SW5.



[Operation 7]
Install the mode number and press the SW5.
(Available number from "01" to "10".)



[Setting completed]



■ NOTE

- For the method of "multipurpose mode", refer to "Multipurpose Function".

RY9212032ELS109A

RY9212007ELS0046US0

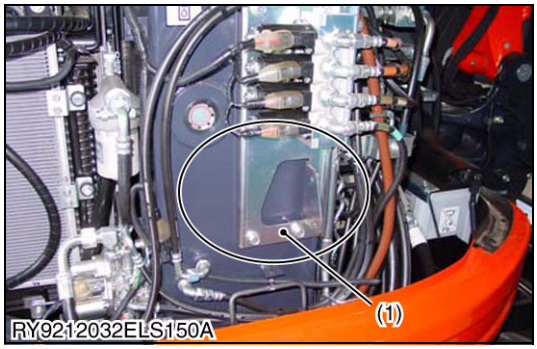
(A) Multipurpose Function

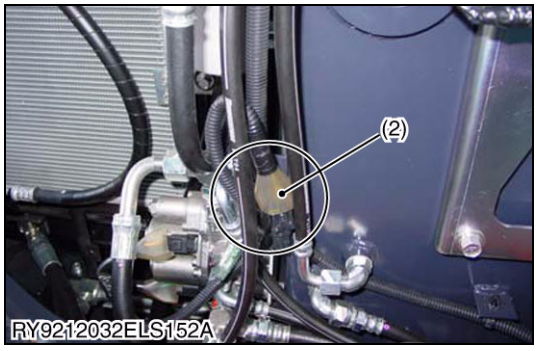
Every machines equipped with 2 Service Ports, can activate the "multipurpose switch" function. With this multipurpose switch function it is possible to use 10 different modes for controlling an additional solenoid valve, or various other hydraulic functions.
The following instructions will show you how to use this multipurpose function.

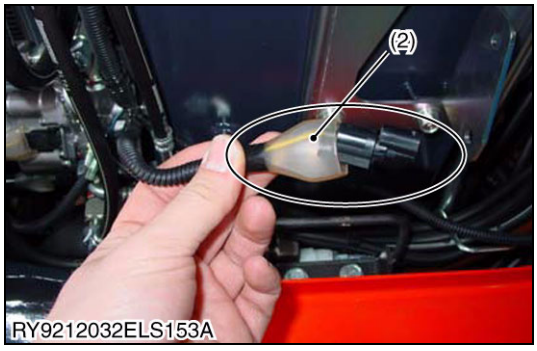
RY9212032ELS0105US0

1. How to use the multipurpose function

RY9212032ELS0106US0







Attachment parts

Depending on which mode you want to use, you have to attach the following parts to the excavator:

- an additional valve
- an electric wire harness
- hydraulic hoses

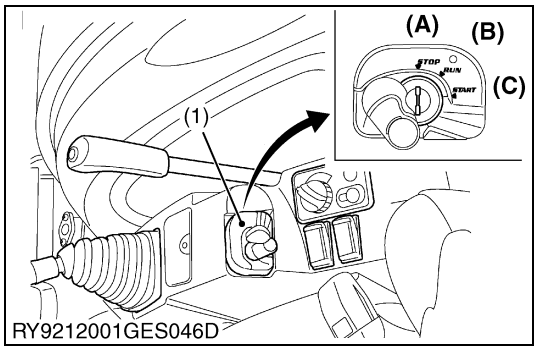
The valve can be attached in the valve base (1).
The hydraulic hoses must be connected appropriate to the intended use.

■ **NOTE**

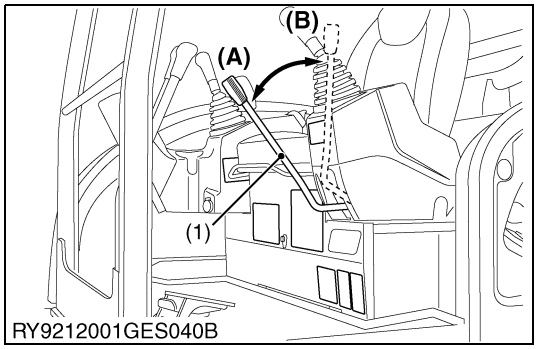
- **To check the voltage with a multimeter, the wire harness connector must be attached to the additional valve, and the valve must be fixed on the machine.**
  Otherwise the ground connection is not established, and the multimeter would not show the correct data.
- **The wire harness of the additional valve is connected to the "ECU-Main +B (5A)" circuit, which can be found on the electric wiring diagram in the excavators workshop manual. The maximum allowable electric current flow for the additional valve is 2 Ampere.**

(1) Valve base
(2) Wire harness connector (Multipurpose Sol (HS025-2pf))

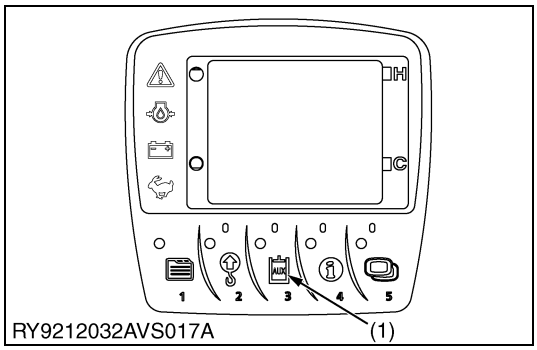
RY9212032ELS0107US0



RY9212001GES046D



RY9212001GES040B



RY9212032AVS017A

Handling Procedure

RY9212032ELS0108US0

1. Turn the starter key to the "RUN" position.
   Let the engine warm up after start-up for approx. 10 minutes under no load conditions.

(1) Starter switch
(A) "STOP"
(B) "RUN"
(C) "START"

RY9212032ELS0068US0

2. Lower the pilot control lock lever (UNLOCK).

(1) Pilot control lever
(A) "Unlock"
(B) "Locked"

RY9212032ELS0069US0

3. Push the AUX port enable switch (switch 3).

■ **NOTE**
- **If the pilot control lock lever is not at the "UNLOCK" position, the following message appears on the screen. Down this lever to the "UNLOCK" position first and then press the AUX port enable switch (switch 3).**

RY9212032ELS126A

(1) AUX port enable switch (switch 3)

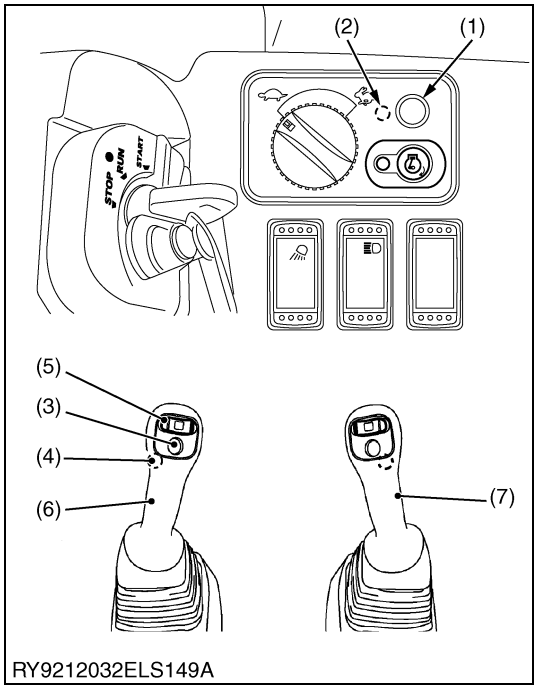
RY9212050ELS0022US0

2. Mode number for Multipurpose

Over all there are 10 different modes to use.

Depending on which mode you are selecting, and which valve you installed, you can use the multipurpose switch to control various other hydraulic functions of your excavator.

RY9212050ELS0067US0



RY9212032ELS149A

Multipurpose Switch

In the model settings menu, you have to select "Multipurpose Operating Spec" to YES. For the method refer to "Model Setting".

Depending on which multipurpose mode you selected, some of the following buttons/switches can be used.

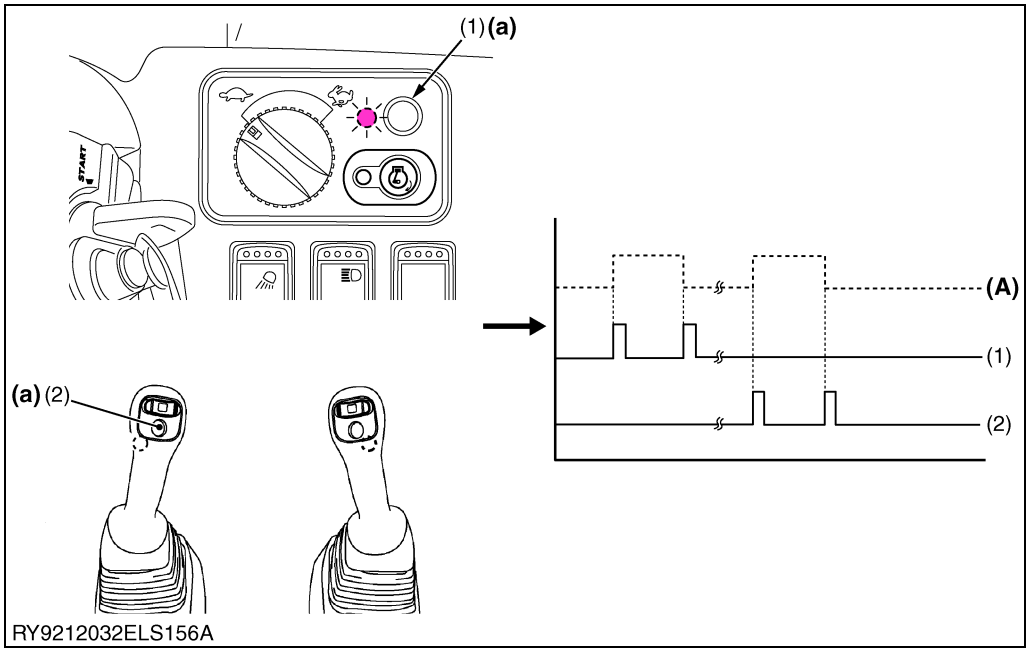
■ **NOTE**

- **When the multipurpose function is working, the Indication light (2) is glowing.**

(1) Button A
(2) Indication Light
(3) Button B
(4) Button C (AUX2 / Thumb One Way Hold Switch)
(5) AUX2 / Thumb Slide Lever
(6) Attachment Control Lever (Left)
(7) Attachment Control Lever (Right)

RY9212032ELS0113US0

Mode number 02	Intended use	Switches operations, such as between swivel and swing.
	Operation	**Multipurpose switch continuous operation** When pressing button "B", the multipurpose switch is operating continuously. If you press button "B" again, the continuous operation will be deactivated. Additionally you can activate the multipurpose switch by pressing button "A". If you press button "A" again, the continuous operation will be deactivated. And you can activate the multipurpose switch with one button, and deactivate it with the other button.

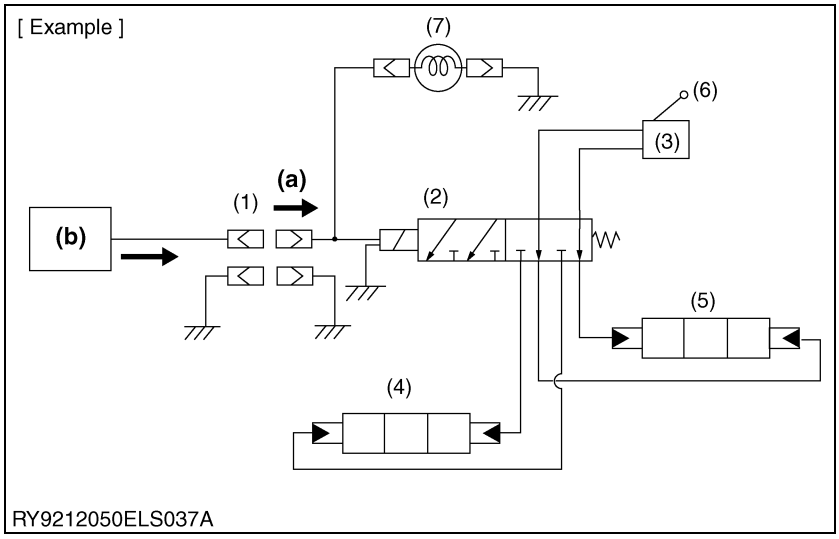


RY9212032ELS156A

(1) Button A
(2) Button B

(A) Multipurpose signal
(a) When pressing Button B (2) or pressing Button A (1)

RY9212032ELS0095US0



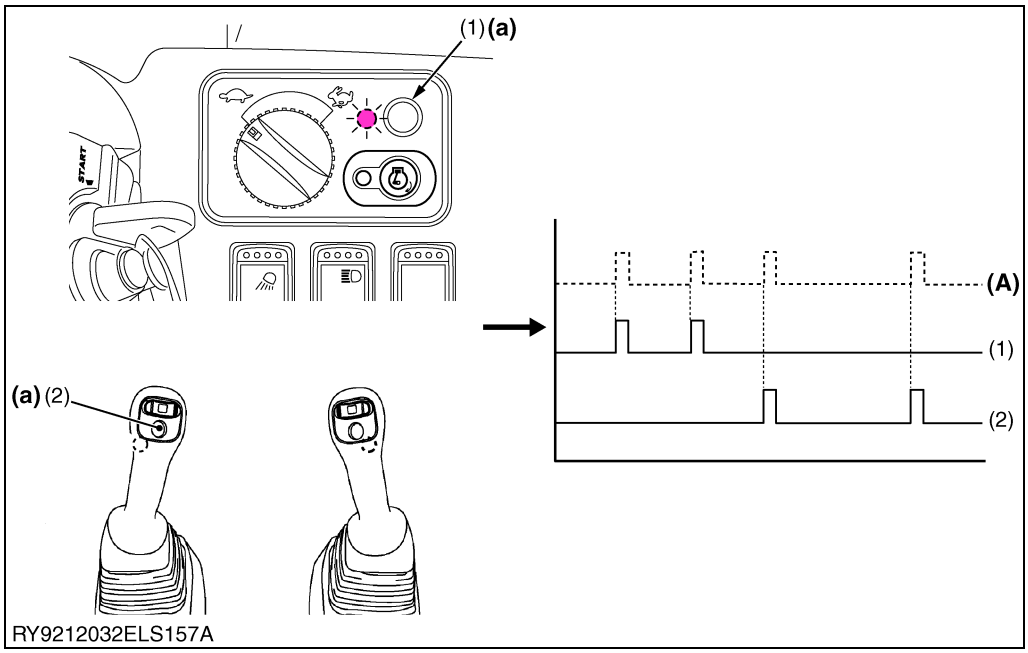
RY9212050ELS037A

(1) Multipurpose Sol (HS025-2pf)
(2) Sol valve (Less than 1.5 A)
(3) Pilot pressure
(4) Swing
(5) Swivel
(6) Lever
(7) Indicator (Less than 2.0 W)

(a) Less than 18 W
(b) ECU Outlet

RY9212050ELS0071US0

Mode number 04	Intended use	ON-OFF Output (spray attachment, road planer, etc.)
	Operation	**Multipurpose switch operation** When pressing button "B", the multipurpose switch is operating. If you release button "B", the operation will be deactivated. You can use this function also by pressing button "A" instead of button "B".

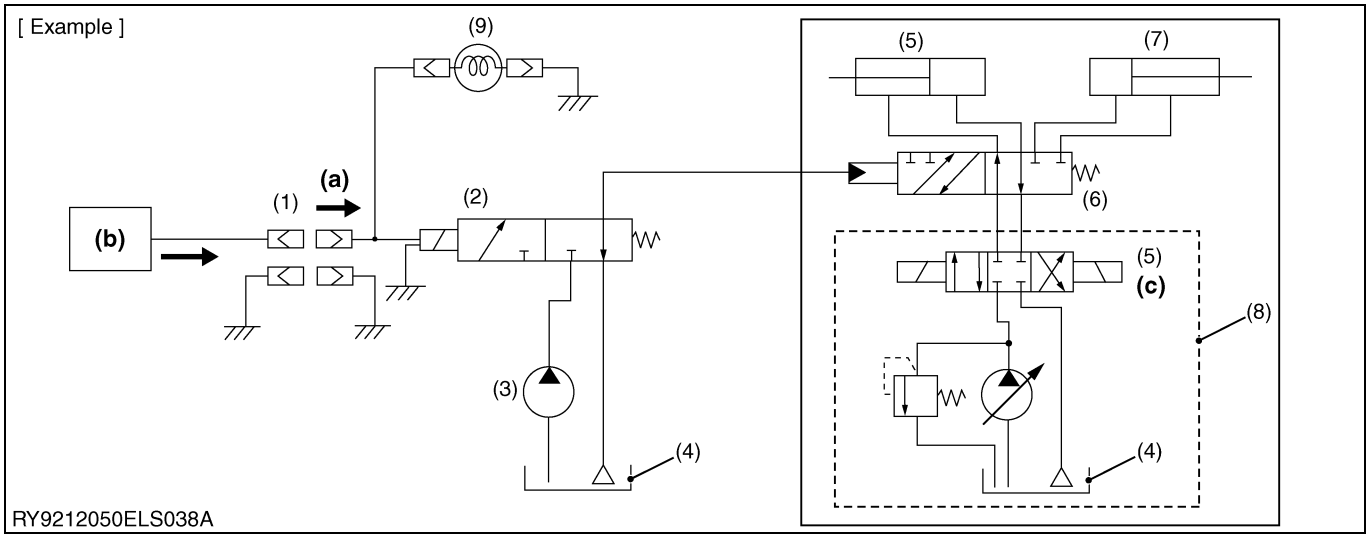


RY9212032ELS157A

(1) Button A
(2) Button B

(A) Multipurpose signal
(a) When pressing Button B (2) or pressing Button A (1)

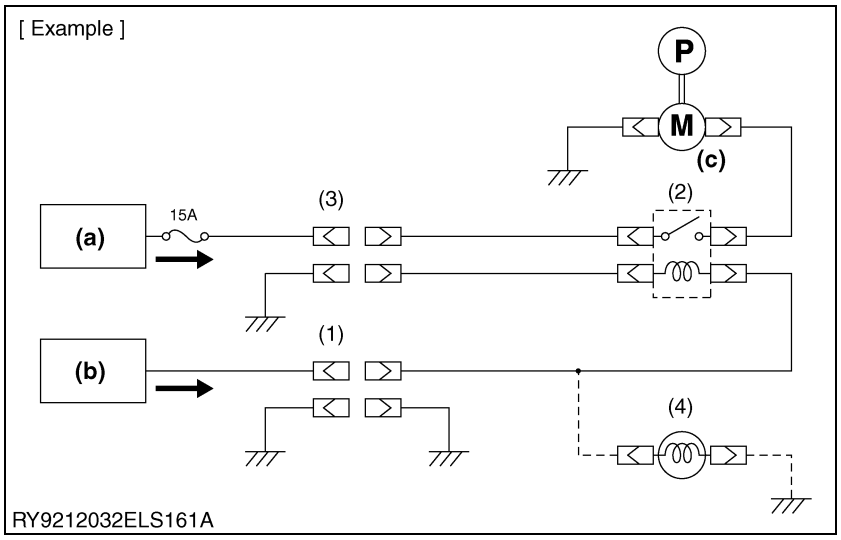
RY9212032ELS0097US0



(1) Multipurpose Sol (HS025-2pf)
(2) Sol valve (Less than 1.5 A)
(3) Pilot pressure
(4) Tank
(5) AUX1
(6) ON-OFF valve
(7) AUX2 / Thumb
(8) Excavator
(9) Indicator (Less than 3.4 W)

(a) Less than 18 W
(b) ECU Outlet
(c) Original c/v section

RY9212050ELS0072US0

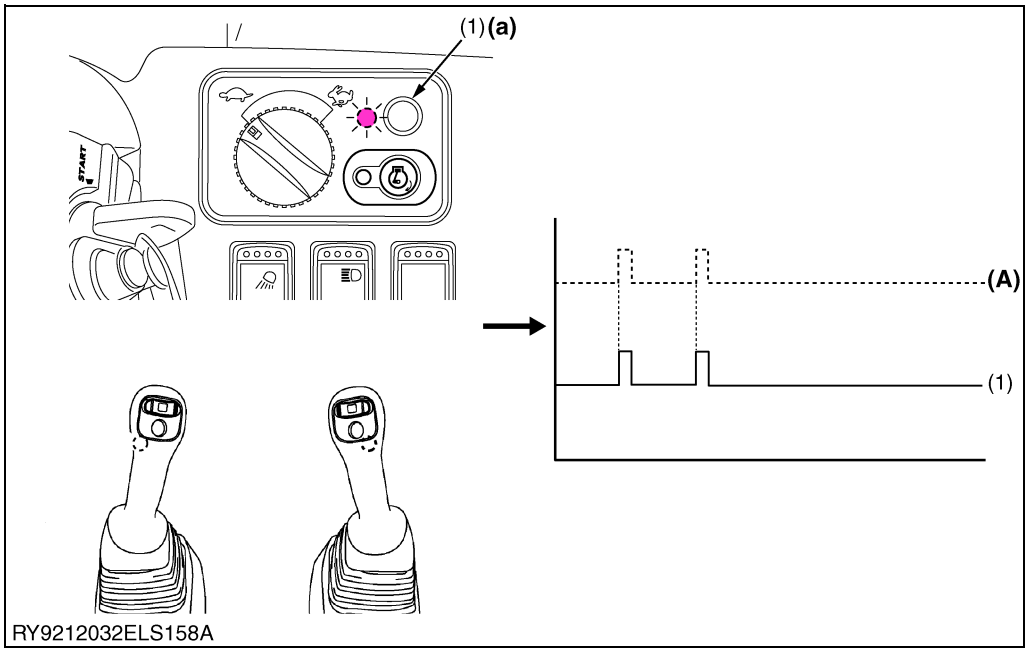


(1) Multipurpose Sol (HS025-2pf)
(2) Relay
(3) Power-Supply (P-Lock-2pf)
(4) Indicator (Less than 2.0 W)

(a) Electrical Outlet
(b) ECU Outlet
(c) Less than 120 W

RY9212050ELS0068US0

Mode number 06	Intended use	Quick Hitch (With AUX1 and AUX2 / Thumb live) The quick hitch that can be moved by pilot pressure Spring lock mechanism release: single-action, cylinder type: double-action (Operates with the blade, swing, etc.)
	Operation	**Multipurpose switch operation** When pressing button "A", the multipurpose switch is operating. If you release button "A", the operation will be deactivated.

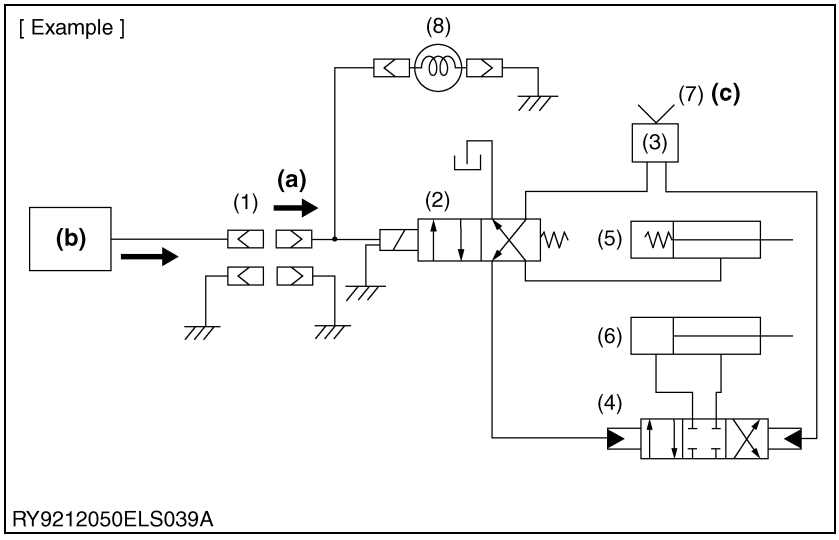


RY9212032ELS158A

(1) Button A

(A) Multipurpose signal
(a) When pressing Button A (1)

RY9212032ELS0099US0



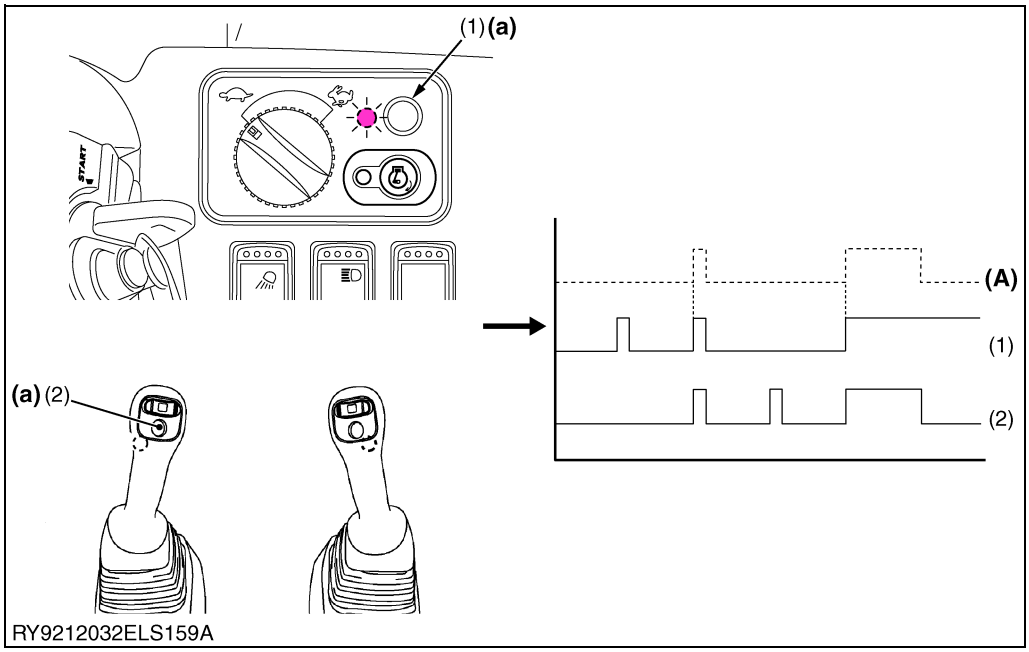
RY9212050ELS039A

(1) Multipurpose Sol (HS025-2pf)
(2) Sol Valve (Less than 1.5 A)
(3) Pilot pressure
(4) Swing Section
(5) Single-action Quick Hitch
(6) Swing Cylinder
(7) Swing Pedal
(8) Indicator (Less than 2.0 W)

(a) Less than 18 W
(b) ECU Outlet
(c) When operating swing right, (5) is operating.

RY9212050ELS0073US0

Mode number 08	Intended use	Engcon Tiltrotator mode. Quick Hitch (When using with both AUX1 and AUX2 / Thumb live). The quick hitch that can be moved by pilot pressure Spring lock mechanism release: single-action
	Operation	**Multipurpose switch operation** When pressing button "A" and button "B" together, the multipurpose switch is operating. If one of the two buttons is released, the operation will be deactivated.

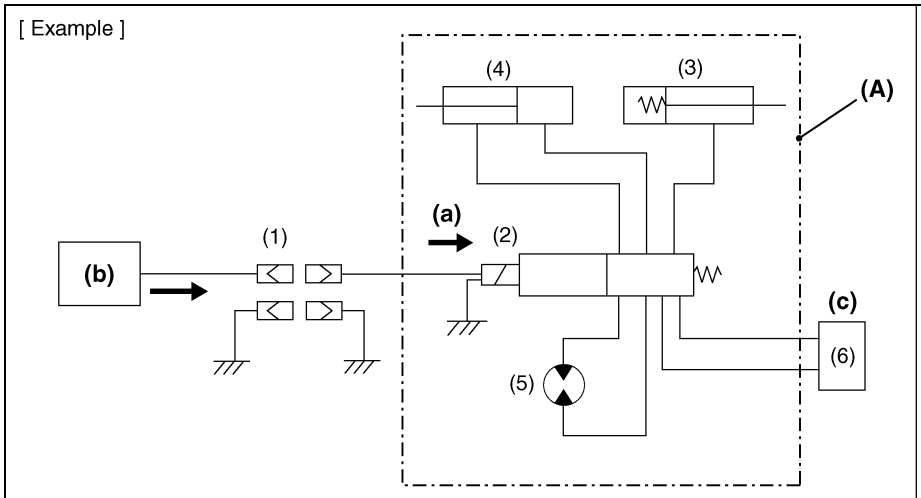


RY9212032ELS159A

(1) Button A
(2) Button B

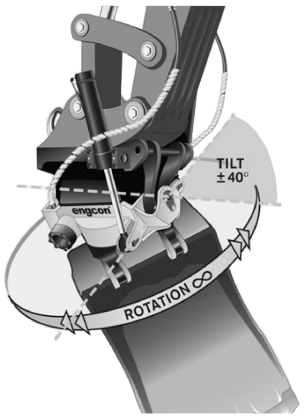
(A) Multipurpose signal
(a) When pressing Button A (1) and button B (2)

RY9212032ELS0101US0



RY9212050ELS040A

(A)



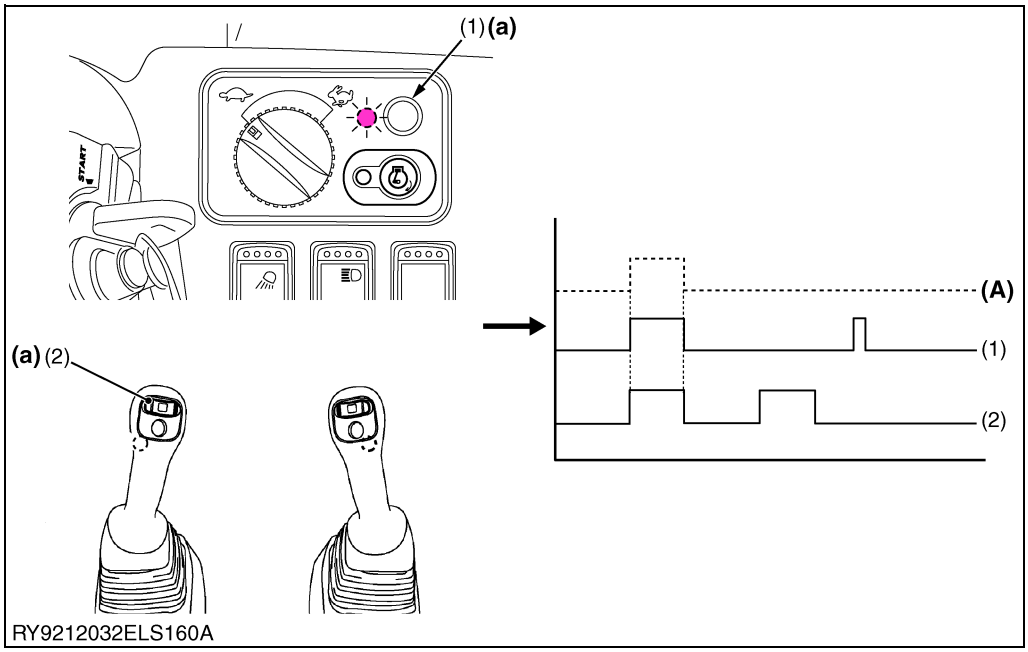
(1) Multipurpose Sol (HS025-2pf)
(2) Select valve
(3) Quick Hitch
(4) Tilt
(5) Rotation
(6) Bucket or AUX1 or AUX2 / Thumb (Original c/v section)

(A) Tiltrotator

(a) Less than 18 W
(b) ECU Outlet
(c) Allocation of Hydraulic Press. soure
Bucket (Pilot pressure): Quick Hitch
AUX1: Tilt
AUX2 / Thumb: Rotation

RY9212050ELS0074US0

Mode number 10	Intended use	Quick Hitch (When using AUX2 / Thumb on the quick designated port.) Spring lock mechanism release: single-action or double-action, cylinder type: double-action
	Operation	**AUX2 / Thumb operation** When pressing button "A", and using the AUX2 / Thumb slide lever of the left lever, AUX2 / Thumb can be operated. If button "A" is released, the operation will be deactivated.

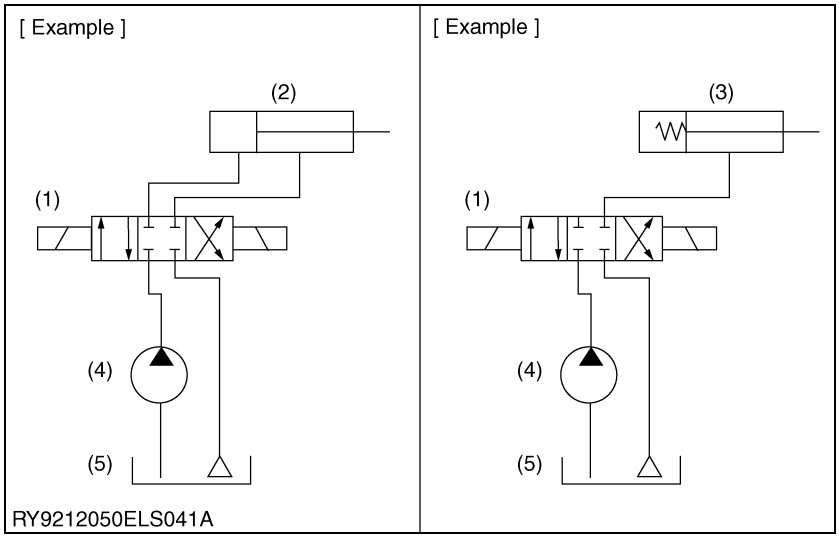


RY9212032ELS160A

(1) Button A
(2) AUX2 / Thumb Slide Lever

(A) AUX2 / Thumb
(a) When pressing Button A (1) and using the AUX2 / Thumb port knob (2)

RY9212032ELS0103US0



RY9212050ELS041A

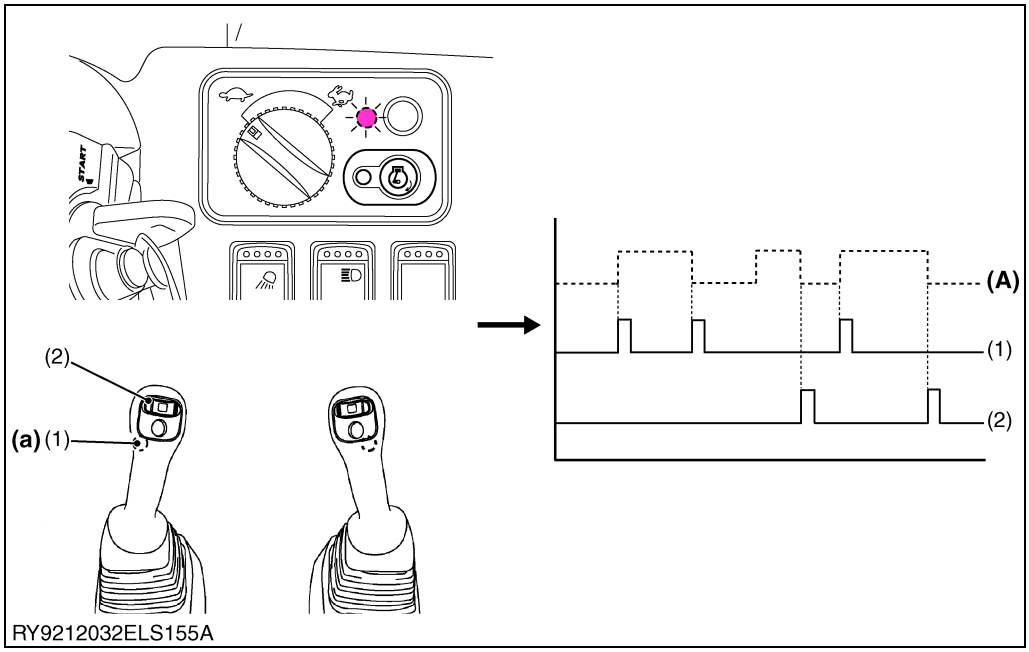
(1) AUX2 / Thumb
(2) Double-action Quick Hitch
(3) Single-action Quick Hitch
(4) Pilot pressure
(5) Tank

RY9212050ELS0075US0

AUX2 / Thumb continuous operation	Intended use	Select the number of below table then you can use AUX2 / Thumb one way hold function with each former multipurpose functions.
	Operation	When pressing button "C", AUX2 / Thumb continuous operation is activated. If you press button "C" again, or if you use the AUX2 / Thumb slide lever of the left lever, the continuous operation will be deactivated.

Mode number of AUX2 / Thumb continuous operation

		Each former multipurpose functions
Mode number 01	←	No multipurpose function
Mode number 03	←	**Mode number 02**
Mode number 05	←	**Mode number 04**
Mode number 07	←	**Mode number 06**
Mode number 09	←	**Mode number 08**



RY9212032ELS155A

(1) Button C
(2) AUX2 / Thumb Slide Lever

(A) AUX2 / Thumb
(a) When pressing Button C (1)

RY9212050ELS0070US0

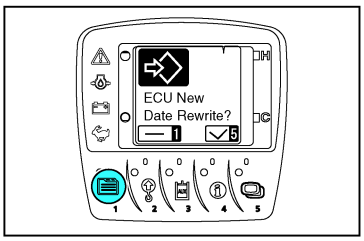
[O] At the time of Replacing the Meters and ECU's

When the meters and ECU's are replaced, the following images will be displayed.

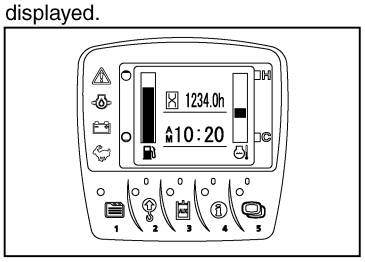
1. In the case of confirming whether or not the temporary replacement by the meters and ECU's of the other machine will make the machine operable.

[Operation 1]

Press SW1 "No".



The normal image will be displayed.

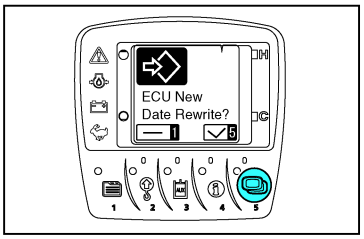


RY9212032ELS089A

2. At the time of replacing the meters and ECU's to new ones.

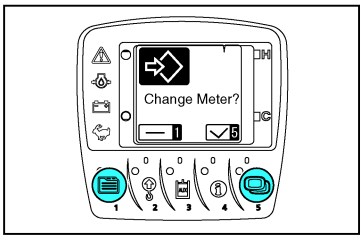
[Operation 1]

Press SW5 "Yes".



[Operation 2]

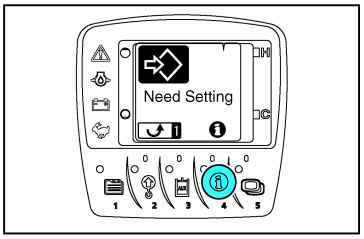
In the case of replacing the meters, press SW5 "Yes".
In the case of replacing the ECU's, press SW1 "No".



The stored set values will be initialized.

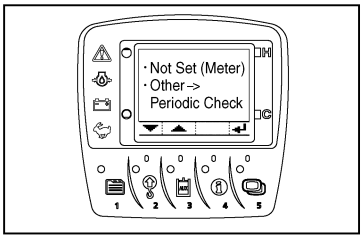
[Operation 3]

Press SW4 and items to be set can be confirmed.



[Operation 4]

After confirming the necessary items, turn the key to [STOP] to make necessary setting.



RY9212032ELS090A

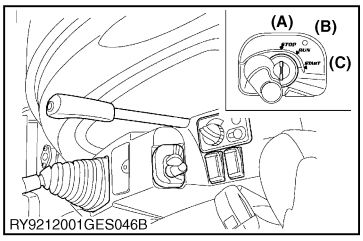
RY9212007ELS0047US0

[P] Resetting of the Clock after Removing the Battery

1. "Set clock? " guidance when the battery has been removed;

[Operation 1]

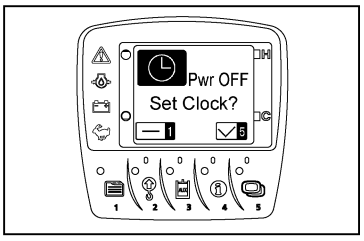
Remove the battery, mount the battery again, and turn the key to [RUN] position.

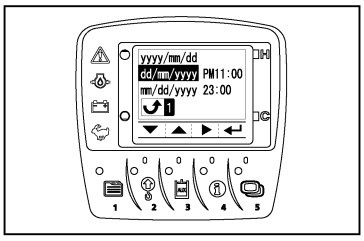


(A)STOP (B)RUN (C)START

[Operation 2]

Press SW1, "No".



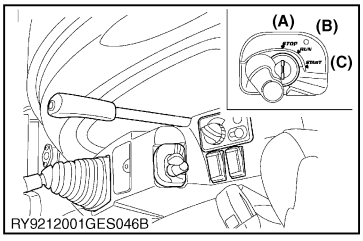


RY9212032ELS023A

2. In the case of resetting the clock.

[Operation 1]

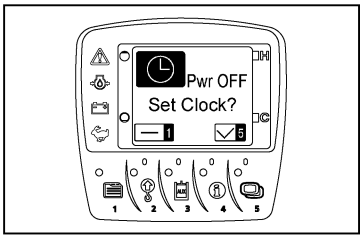
Remove the battery, mount the battery again, and turn the key to [RUN] position.



(A)STOP (B)RUN (C)START

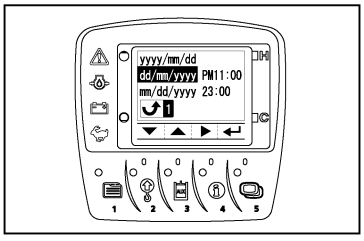
[Operation 2]

The following image will be displayed.
Press SW5, "Yes".

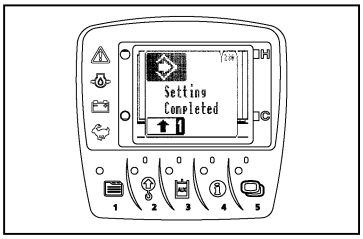


[Operation 3]

Set the clock and press SW5.



[Setting completed]



[Procedures for clock setting]

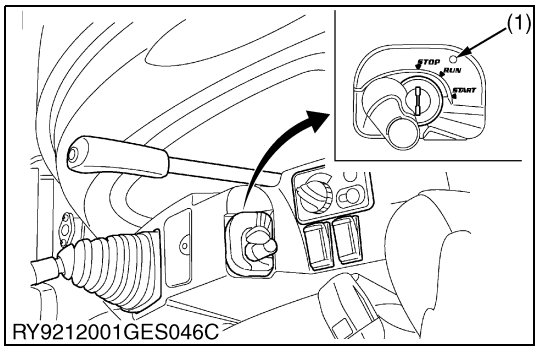
Pressing SW4 (▶) will change the item in such a way as year→ month→day→ hour→ minutes→ year.
Pressing SW2 (▲) will reduce the number.
Pressing SW3 (▼) will increase the number.
Pressing SW1 on the clock setting screen will return the screen to the original image without changing the set time.

Clock precision : 2 seconds/day
It is possible to set in such a way not to display the alarm for clock setting according to the customers f request.
(Factory preset mode: To be displayed.)

RY9212032ELS024A

RY9212007ELS0048US0

[Q] Anti-Theft Device



Anti-Theft Device

This machine is equipped with the anti-theft device, Which allows you to start the engine with the registered key alone.

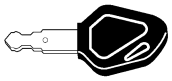
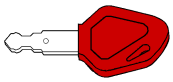
If a registered key is stolen, the stolen key can be unregistered. It prevents this key from starting the engine to protect the machine against theft.

With the key at "STOP", the "anti-theft indicator" stays on to tell that the ant-theft function is enabled. Be sure that this indicator is on before leaving the machine.

(1) Anti-theft indicator

RY9212007ELS0049US0

The machine comes with two different types of keys.

 RY9212032ELS093A	Back key (individual key)	This key is used to start the engine. It is possible to start the engine as before by inserting the key and turning it to the **[START]** position. Registering a black key with the machine by using the red key will allow the black key to start the engine. A key not registered with the machine cannot be used to start the engine. * Initially two keys including a spare key are supplied. The two accompanying keys have been already registered. Up to four keys can be registered.
 RY9212032ELS092A	Red key (registration key)	If a black key for starting the engine should be lost, the red key is used to register another black key with the machine. The engine cannot be started with this key. For the method of using the red key, refer to "How to register a black key with the machine".

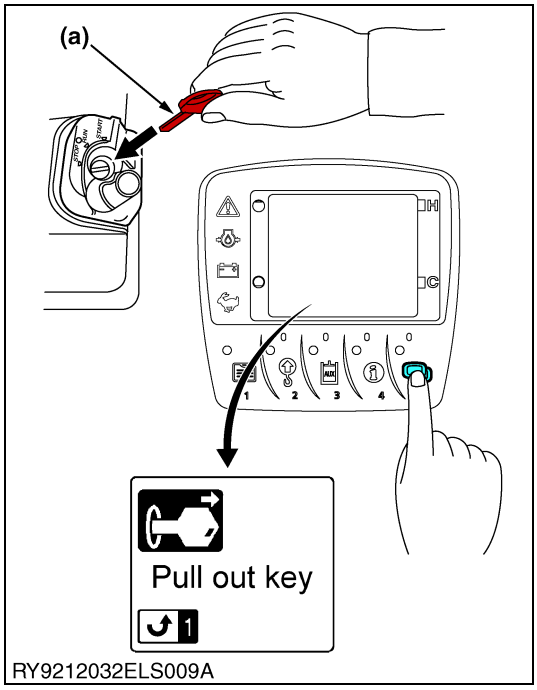
RY9212007ELS0050US0

How to register a black key (individual key) with the machine (When a black key is lost)

WARNING

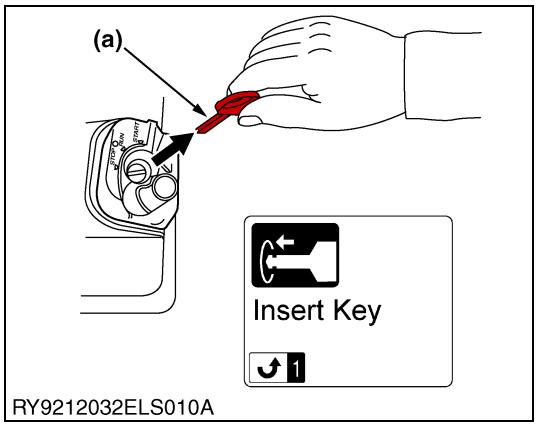
- **To avoid personal injury or death:**
  - **Before programming an anti-theft key, be sure to sit on the operator's seat and make sure all the control levers are in the "Neutral" position. If this is neglected, the machine may get moving as soon as the engine gets started, leading to a dangerous situation.**
  - **The exhaust gas from the engine includes harmful substances such as carbon monoxide. Be careful not to make this setting in a room where the exhaust gases easily build up or in an ill-ventilated place.**

RY9212007ELS0051US0



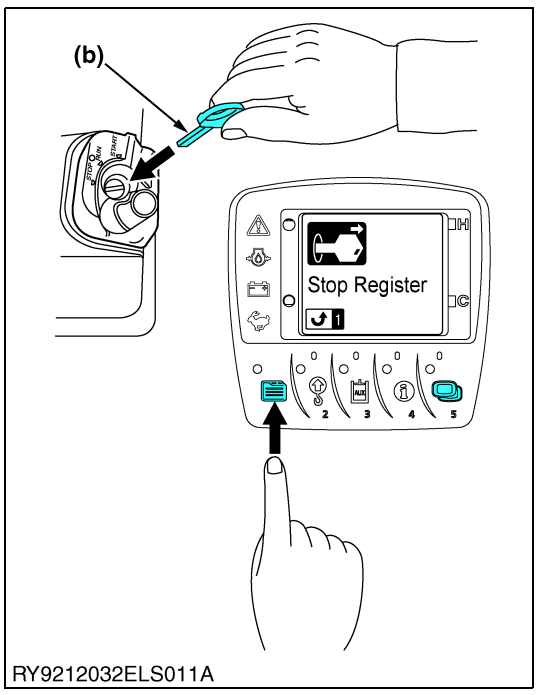
RY9212032ELS009A

1. Insert the red key into the key switch.
   (*Do not turn the inserted key. If the key is turned to the **[RUN]** position, be sure to return it to the **[STOP]** position.)
2. Press the display change switch (SW5) once.
3. The display of Certification completed.
   "Pull out the red key" will be displayed on the meter panel.



RY9212032ELS010A

4. Pull out the red key from the key switch.
5. The display of "Insert keys to be registered in series" will be displayed on the meter panel.



RY9212032ELS011A

6. Insert the black key into the key-switch.
   (*Do not turn the inserted key.If the key is turned to the **[RUN]** position, be sure to return it to the **[STOP]** position and repeat the procedures from 1.)
7. "Pull out the black key" appears to the meter panel after a while moment. With this message displayed, the black Key has been registered with the machine.
8. When all the registration work has completed, press the user setting switch (SW1).
9. Up to four black keys will be able to register yourself when you insert.
   Warning appears if you try to register the fifth black key.

(a) Red key **(b) Black key**

RY9212007ELS0009US0

■ **NOTE**

- **If a registered black key is stolen or lost, re-register the remaining black key. When re-registering is performed, the stolen or lost black key is unregistered and it becomes impossible to start the engine with that key.**
- **If the red key is stolen or lost, it becomes impossible to register or re-register a black key (for starting the engine) and the peripheral devices should be replaced. Therefore keep the red key with great care. If by any chance it gets lost, promptly contact your dealer or a KUBOTA-designated service factory.**
- **Use the KUBOTA-specified key ring to hold the black key or the red key. Any unspecified key rings may interfere with the signal transfer between the key and the key switch, possibly failing to start the engine or to register a key properly.**
- **Do not bundle two or more keys when using them. Doing so may cause electric wave interference, possibly failing to start the engine.**
- **Cut and remove the ring that is used to bundle the keys at the time of delivery. (If the keys are used still bundled, the engine may get started with the red key or re-registering could not be performed properly.)**
- **If an unregistered key is inserted and turned more than six times, the alarm sounds for 30 seconds. (The alarm keeps sounding even if the key is drawn out.)**
- *** Insert and turn on the registered key, and the alarm stops itself.**

RY9212007ELS0053US0

For U.S.A. and Canada (FCC/IC)

FCC WARNING

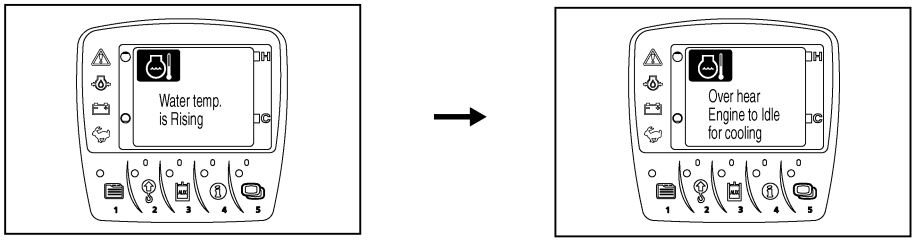
- Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.
- This device complies with Part 15 of the FCC Rules and RSS-Gen of the IC rules.
  Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

RY9212007ELS0054US0

[R] Overheat Caution

Leave the engine at idling speed until the warning disappears. Do not stop the engine, other wise coolant temperature becomes shareply high and may boil and gush out. Be sure to cool down the engine without stopping it.

Furthermore, engine high rpm turns to idle speed automatically when water temperature rises. (Engine speed does not change even if accel dial is turned.)
A buzzer sounds Pi , Pi , Pi , Pi



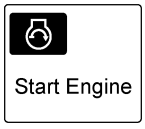
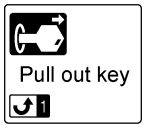
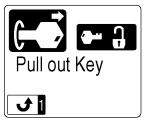
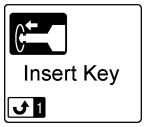
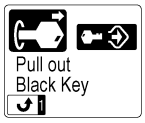
RY9212032ELS087A

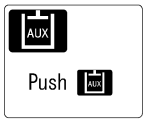
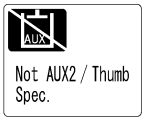
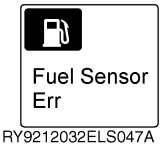
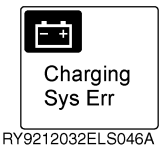
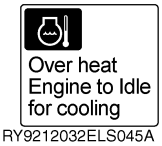
Setting values of the water temperatures.

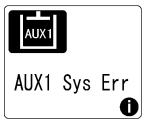
Give a message	
"Water temp. rising" is appears.	113 to 118 °C, 236 to 244 °F
Overheat Engine to Idle for cooling.	118 °C (244 °F) and above
This warning disappears.	110 °C (230 °F) and below

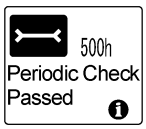
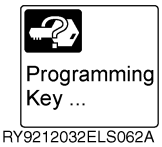
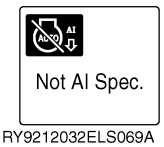
RY9212007ELS0055US0

[6] LIST OF WARNING ALARM DISPLAYS

No.	Message	Problem or failure (What happened)	Machine behavior (Provisional measure)	Correction
1	RY9212032ELS065A	The battery is disconnected, thereby requiring to Set the Clock.	Press Switch 5 to set the Clock.	–
2	RY9212032ELS067A	This message indicates a procedural step.	Tilt up the pilot control lock lever. This message disappears by tilting up the pilot control lock lever.	–
3	RY9212032ELS074A	This message indicates a procedural step.	Tilt down the pilot control lock lever. This message disappears by tilting down the pilot control lock lever.	–
4	 RY9212032ELS075A	This message indicates a procedural step.	Start the engine. Now this message disappears.	–
5	 RY9212032ELS068A	This message appears if the key switch is set at "STOP" and left at this position for a while.	Draw out the key.	–
6	 RY9212032ELS076A	This message appears when the anti-theft setting key is authenticated.	Draw out the key. Now this message disappears.	–
7	 RY9212032ELS077A	This message appears when the anti-theft setting keys are ready to register.	Insert the register keys sequentially. To interrupt the registering procedure, press Switch 1.	–
8	 RY9212032ELS078A	This message appears when the black key has been successfully registered.	Draw out the black key.	–
9	RY9212032ELS079A	This message appears if a registered key is tried to get registered again.	Draw out the key and insert an unregistered key.	–
10	RY9212032ELS080A	This message appears if the number of registered keys has exceeded their limit.	No more keys can be registered.	–

No.	Message	Problem or failure (What happened)	Machine behavior (Provisional measure)	Correction
11	 RY9212032ELS081A	This message appears if the AUX function is tried without pressing the AUX port enable switch.	Press the AUX port enable switch.	–
12	 RY9212032ELS082A	The AUX2 port is tried on machines not quipped with AUX2 function.	–	–
13	RY9212032ELS083A	This message appears if the overload warning switch is pressed on machines not quipped with over load warning system.	–	–
14	RY9212032ELS058A	Fuel is running out.	–	Add fuel.
15	 RY9212032ELS047A	The fuel sensor system is in trouble.	The fuel level indicator does not appear on the meter. Press the display selector switch, and the normal display is switched back.The machine is other functions are still operative.	–
16	 RY9212032ELS046A	Charging system is in trouble. Charging is failure.	The machine works until the battery gets dead.	–
17	RY9212032ELS044A	The engine lubricating system Oil pressure is too low.Stop the engine.	The engine may get burnt out. Immediately stop the engine.	–
18	RY9212032ELS052A	This message appears if a jumper cable is connected to a 24V battery or improper device to get the engine started or if the alternator is in trouble.	Immediately interrupt the engine if with a 24V battery. When the engine gets restarted and is running With no message appearing, it means there is no problem.	–
19	RY9212032ELS061A	Water temperature is rising somewhat higher than specified.	Operate with the load a little lessened. Check the radiator and other components for clog. Immediately clean them up.	–
20	 RY9212032ELS045A	The engine is forced to run idling to a void an overheat.	Leave the engine idling until this warning disappears. Do not stop the engine because other wise coolant become shot sharply and may boil and gushout.Be sure to cool down the engine without stopping it.	Refill the radiator with coolant by its boiled-over amount.Unclog the radiator and other components before use again. Check also the hydraulic system for oil leak and other troubles.

No.	Message	Problem or failure (What happened)	Machine behavior (Provisional measure)	Correction
21	RY9212032ELS048A	Water temperature sensor error system is in trouble.	The meter does not show water temperature. Press the display selector switch, and the normal display is switched back. The machine's other functions are operative, but an overheat and other problems cannot be detected.	–
22	RY9212032ELS050A	The lock lever system is in trouble.	The engine can run, but the machine fails to move.	–
23	RY9212032ELS051A	The 2-speed switching system is in trouble.	The machines till runs at low speed with out switching to high speed. The machine's other functions are still operative.	–
24	RY9212032ELS053A	The Auto Idle system is in trouble. The accelerator fails too.	The accelerator fails, but the machine's other functions are still operative. Move the machine to a place suited for repair.	–
25	RY9212032ELS055A	The sensor's or switch is 5V power short-circuited.	The majority of systems fail. *The engine may get started and the machine may move. But do not try any jobs. (Just move the machine to a safe place.)	–
26	RY9212032ELS056A	The sensor's or switch is 12V line is short-circuited.	The majority of systems fail. *The engine may get started and the machine may move. But do not try any jobs. (Just move the machine to a safe place.)	–
27	RY9212032ELS049A	The communication (CAN) system is in trouble. Some meter readings may be erroneous or some switches may malfunction.	The engine may get started and the machine may move. But do not try any jobs. (Just move the machine to a safe place.)	–
28	RY9212032ELS084A	The multipurpose switching system is in trouble. (This message appears only When the multipurpose switching function is preset effective.)	The engine can get restarted and the machine can move, but the multipurpose switching system fails. When the other systems than the multipurpose switching system function, the job can be continued.	–
29	 RY9212032ELS085A	The AUX1 port system is in trouble.	The engine can get restarted and the machine can move, but the AUX1 port system fails. When the other systems than the AUX1 port system function, the job can be continued.	–
30	RY9212032ELS142A	The AUX2 port system is in trouble.	The engine can get restarted and the machine can move, but the AUX2 port system fails. When the other systems than the AUX2 port system function, the job can be continued.	–

No.	Message	Problem or failure (What happened)	Machine behavior (Provisional measure)	Correction
31	RY9212032ELS086A	The Thumb system is in trouble.	The engine can get restarted and the machine can move, but the Thumb 2 system fails. When the other systems than the Thumb and AUX port system function, the job can be continued.	–
32	RY9212032ELS059A	This message appears 10 hours before the periodic check interval. Press the information switch, and the list of related components can be reviewed.	Get the engine started as usual.	–
33	 RY9212032ELS060A	The periodic check interval has passed. Press the information switch, and the list of related components can be reviewed.	The engine can still get started, but immediately replacement.	–
34	RY9212032ELS054A	The anti-theft system is in trouble. The engine cannot get started.	–	–
35	 RY9212032ELS062A	The key's ID code is being authenticated.	The engine fails to start. *Wait for a while to do a retry. *If the key is attached with anything else metallic or inserted on a key ring, detach them. *If two or more keys are bundled, have the correct only at hand. *If this message never disappears, the key it self may be damaged. Try with a spare key.	Detach any thing metallic from the key and have this key only at hand.
36	RY9212032ELS063A	The engine has been started with the incorrect black key of other model.	The engine fails to start.	Start the engine with the correct key.
37	RY9212032ELS064A	The engine has been started with the red key (registration key)	The engine fails to start.	Start the engine with the correct key.
38	 RY9212032ELS069A	The AI switch has been pressed for the machine with Not AI Specification.	When you have selected "AI Set" as "NO"?	–
39	RY9212032ELS141A	The load being lifted is too heavy.	–	For jobs (excavating, for example) other than lifting, press the overload warning switch and release the warning. The load being lifted is too heavy. Place it on the ground to lessen the lifting load.

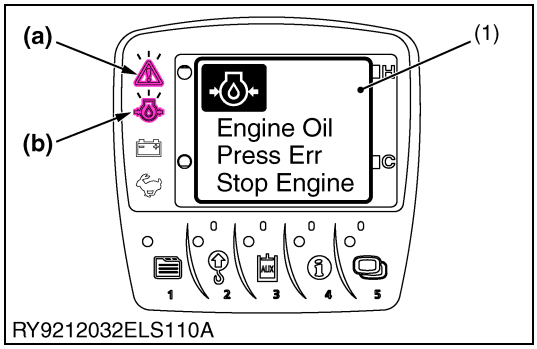
RY9212007ELS0056US0

6. TROUBLESHOOTING (METER PANEL EDITION)

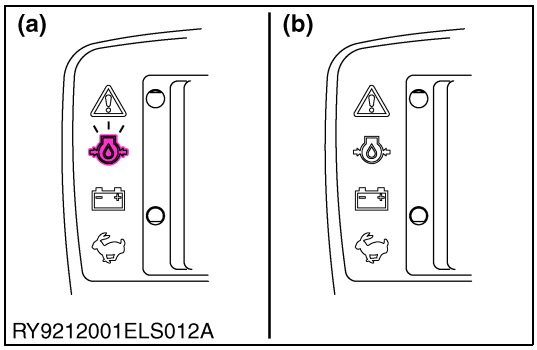
[1] ENGINE RELATED SYSTEMS

(1) Engine Oil Pressure Errors

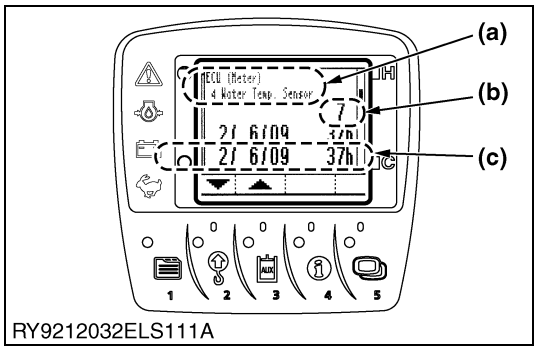
[A] Checking via the LCD Panel Display



RY9212032ELS110A



RY9212001ELS012A



RY9212032ELS111A

1. LCD Panel Display

1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Check whether the oil lamp **(b)** is lit in red or off.

(1) Engine Oil Press Err Stop Engine

(a) Warning lamp
(b) Oil lamp

RY9212032ELS0008US0

[Test Conditions]

1. Key switch : ON

(a) If the oil lamp is lit : caused by a short
(b) If the oil lamp is off : caused by break in wiring

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

RY9212001ELS0053US0

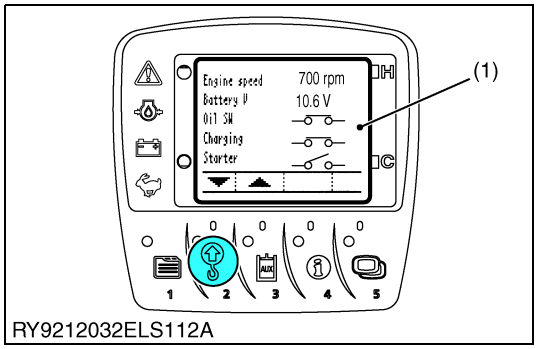
2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0



RY9212032ELS112A

3. Tester mode

1. Select the tester mode.
2. Check the operation of the oil switch according to the table below.

	Regu-lar	Oil Lamp	When cut off	Oil Lamp	When shorted	Oil Lamp
Key Off		Off		Off		Off
Key On		Lit		Off		Lit
Key Start		Off		Off		Lit

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) Engine Speed
Battery V
Oil SW
Charging
Starter

RY9212032ELS0002US0

[B] Inspecting each device visually and physically

1. Checking fuses

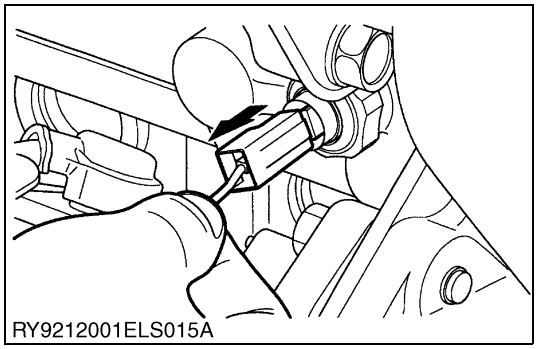
1. Checking fuses is not necessary.

RY9212001ELS0008US0

2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0


RY9212001ELS015A

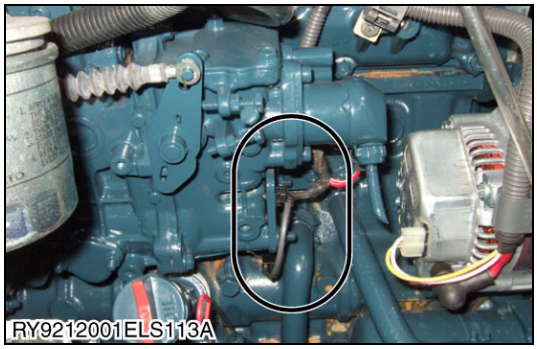
3. Causes when a break in wiring

[Test Conditions]
1. Key switch : OFF
2. The oil switch connector CN28 is disconnected.
3. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force) If it comes off, plug the connector back in securely and check the operation of the oil switch again in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

RY9212001ELS0056US0


RY9212001ELS113A

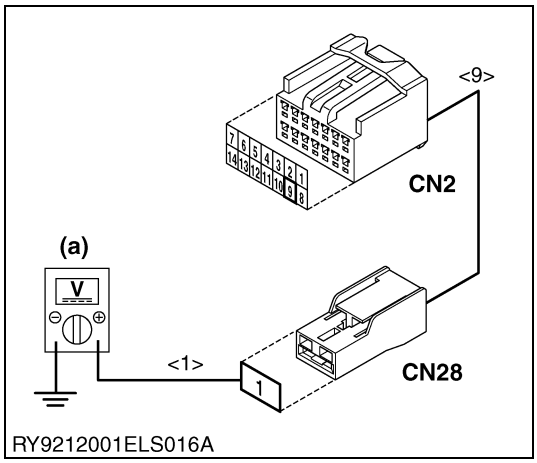
4. Causes when a short

[Test Conditions]
1. Key switch : OFF
2. The oil switch wire is pinched against or touching the body.
   If the insulation is damaged, repair it properly and check the operation of the oil switch again in the tester mode.

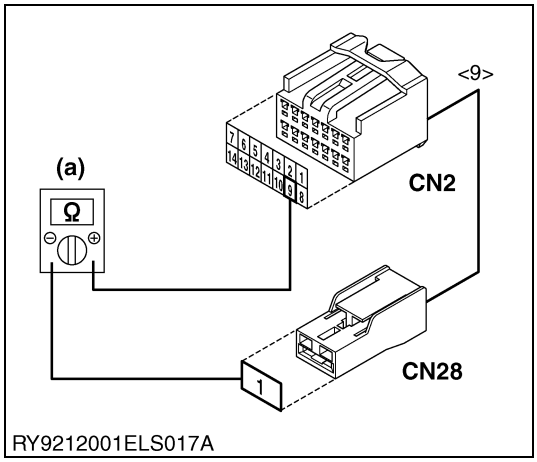
Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

RY9212001ELS0010US0

[C] Testing with a Circuit Tester



RY9212001ELS016A



RY9212001ELS017A

1. Voltage check

[Measurement Conditions]

1. Disconnect the oil switch connector CN28.
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Oil switch connector CN28	<1>	Body GND	–	

Regular : 5V (OK)
Irregular : Large discrepancy from 5V (NG)

RY9212001ELS0057US0

2. Continuity check

[Measurement Conditions]

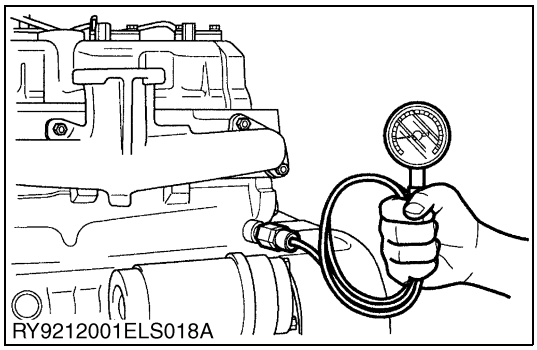
1. Key switch : OFF
2. Disconnect meter connector CN2.
3. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Oil switch connector CN28	<1>	Meter connector CN2	<9>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0058US0

[D] Testing the Equipment Itself


RY9212001ELS018A

1. Measuring engine pressure

[Measurement Conditions]

1. Remove the oil switch, attach a pressure gauge and measure the pressure.

Engine Oil Pressure	When Idling	Usable Limit	0.05 MPa 0.5 kgf/cm^2 7 psi
	At Rated RPM	Factory Spec	0.2 to 0.4 MPa 2.00 to 4.00 kgf/cm^2 28 to 57 psi
		Usable Limit	0.15 MPa 1.50 kgf/cm^2 21 psi

Torque	Oil switch tapering screw R1/8	15 to 19 N-m 1.5 to 2.0 kgf·m 11 to 14 lbf·ft

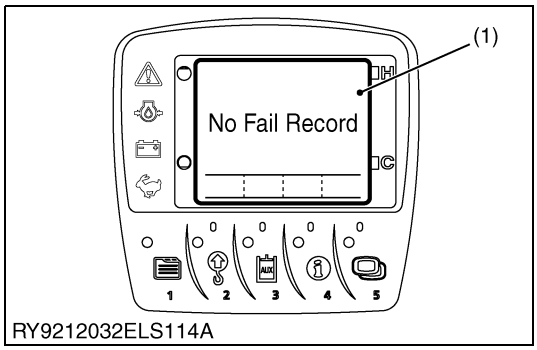
Criteria	Assessment Results
Regular : Within factory spec (OK)	
Irregular : Outside factory spec (NG)	

RY9212001ELS0059US0

2. Settings after replacing device

1. No settings required.

RY9212001ELS0013US0



RY9212032ELS114A

3. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

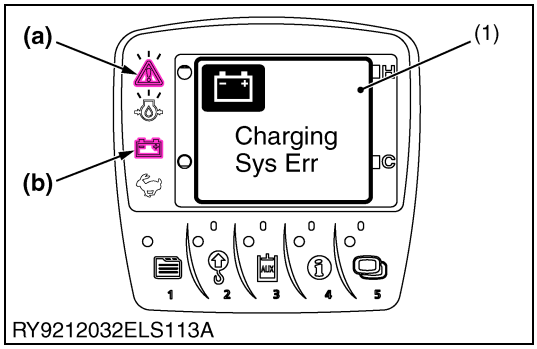
Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

(1) No Fail Record

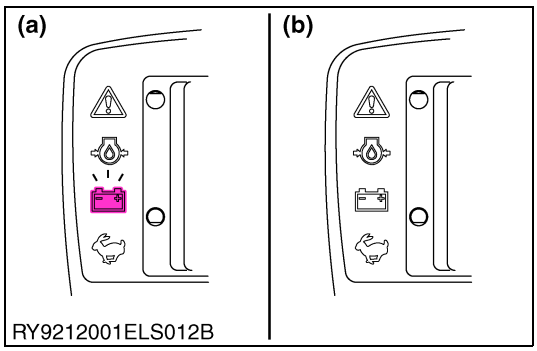
RY9212032ELS0003US0

(2) Charging System Errors

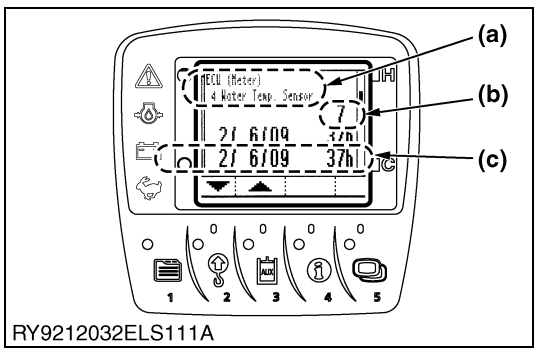
[A] Checking via the LCD Panel Display



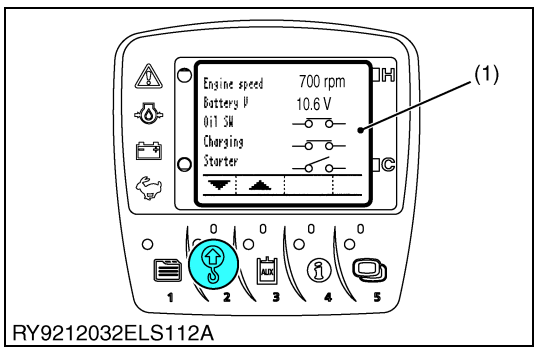
RY9212032ELS113A



RY9212001ELS012B



RY9212032ELS111A



RY9212032ELS112A

1. LCD Panel Display

1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Check whether the charging lamp **(b)** is lit in red or off.

(1) Charging Sys Err

(a) Warning lamp
(b) Charging lamp

RY9212032ELS0009US0

[Test Conditions]

1. Key switch : ON

(a) If the charging lamp is lit : caused by a short
(b) If the charging lamp is off : caused by break in wiring

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

RY9212001ELS0061US0

2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

   Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0

3. Tester mode

1. Select the tester mode.
2. Check the operation of the oil switch according to the table below.

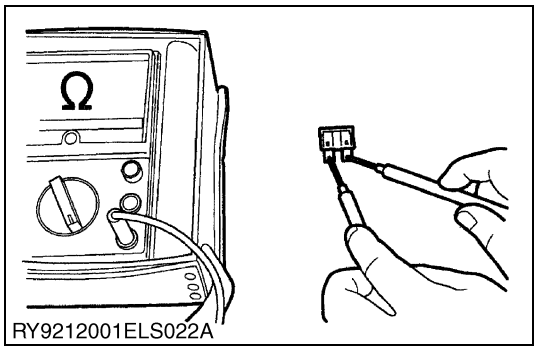
	Regular	Oil Lamp	When cut off	Oil Lamp	When shorted	Oil Lamp
Key Off		Off		Off		Off
Key On		Lit		Off		Lit
Key Start		Off		Off		Lit

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) Engine Speed
Battery V
Oil SW
Charging
Starter

RY9212032ELS0002US0

[B] Inspecting each device visually and physically



1. Checking fuses

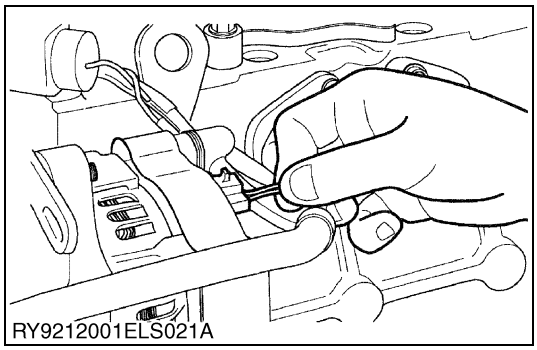
Check whether the alternator fuse (10A) is blown.

RY9212001ELS0064US0

2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0



3. Causes when a break in wiring

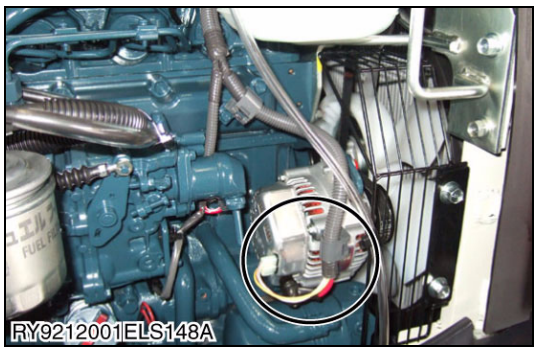
[Test Conditions]

1. Key switch : OFF
2. The alternator connector CN25 is disconnected.
3. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force) If it comes off, plug the connector back in securely and check the operation of the charging switch again in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

RY9212001ELS0065US0



4. Causes when a short

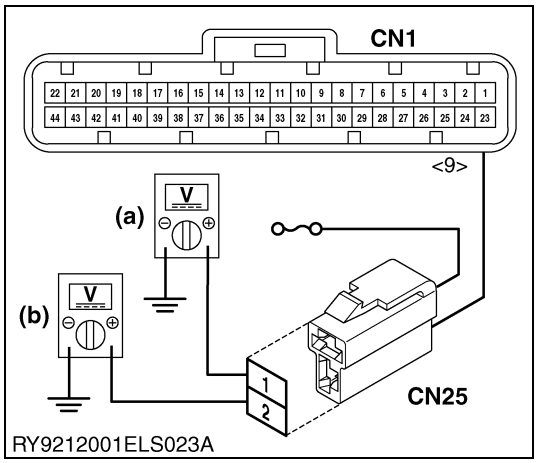
[Test Conditions]

1. Key switch : OFF
2. The alternator connector CN25 wire is pinched against or touching the body.
   If the insulation is damaged, repair it properly and check the operation of the charging switch again in the tester mode.

Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

RY9212001ELS0012US0

[C] Testing with a Circuit Tester



1. Voltage check

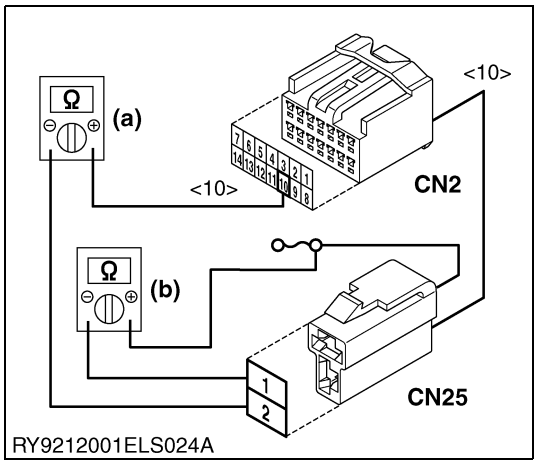
[Measurement Conditions]

1. Disconnect alternator connector CN25.
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Alternator connector CN25	<1>	Body GND	–	
(b)	Alternator connector CN25	<2>	Body GND	–	

Regular : 12 V (OK)
Irregular : Large discrepancy from 12 V (NG)

RY9212001ELS0066US0



2. Continuity check

[Measurement Conditions]

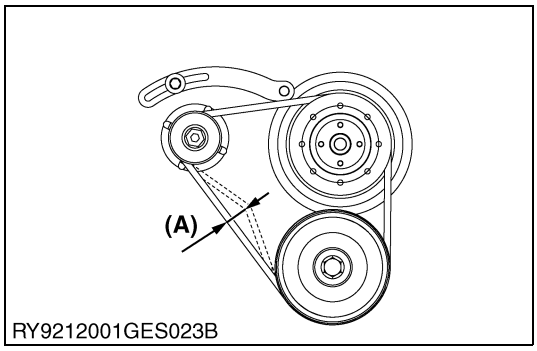
1. Key switch : OFF
2. Disconnect meter connector CN2.
3. Remove the 10A fuse.
4. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Alternator connector CN25	<2>	Meter connector CN2	<10>	
(b)	Meter connector CN2	<1>	10A fuse	–	

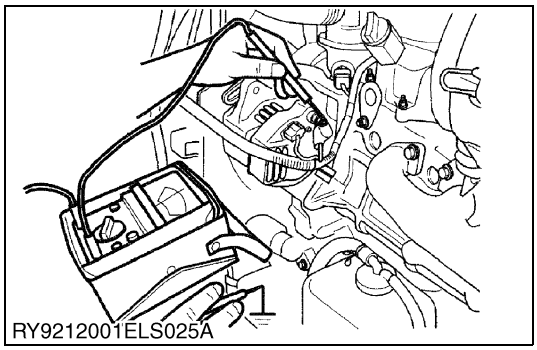
Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0067US0

[D] Testing the Equipment Itself



RY9212001GES023B


RY9212001ELS025A

1. Inspecting the alternator

1. Check for a cut, loose or slipping fan belt.
2. Measure the voltage between terminal B of the alternator and body GND. If the measured voltage is about 12V, it is normal. If the measured voltage is low, it may indicate insufficient battery capacity or looseness in connections somewhere before the alternator.
3. Next, start the engine and measure the voltage generated when the alternator is operating. Take the measurement between terminal B on the alternator side and the body GND. If the measured voltage is about 14V, it is normal. If the measured voltage does not vary from the battery voltage (about 12V), then the alternator itself or the regulator is faulty.

Criteria	Assessment Results
Regular : Within factory spec (OK)	
Irregular : Outside factory spec (NG)	

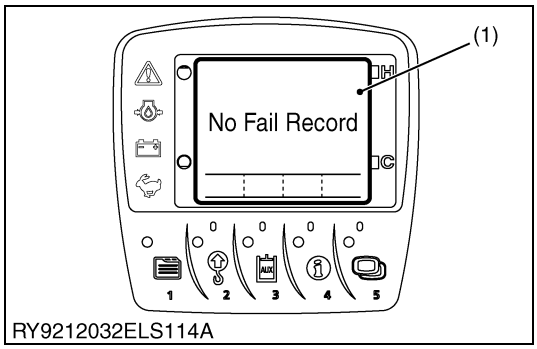
(A) Displacement 7 to 9 mm (0.3 to 0.4 in.)

RY9212001ELS0068US0

2. Settings after replacing device

1. No settings required.

RY9212001ELS0013US0



RY9212032ELS114A

3. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

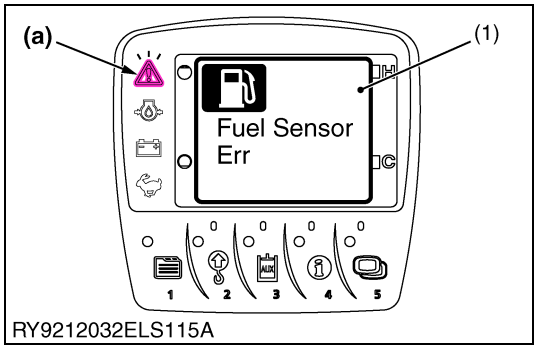
Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

(1) No Fail Record

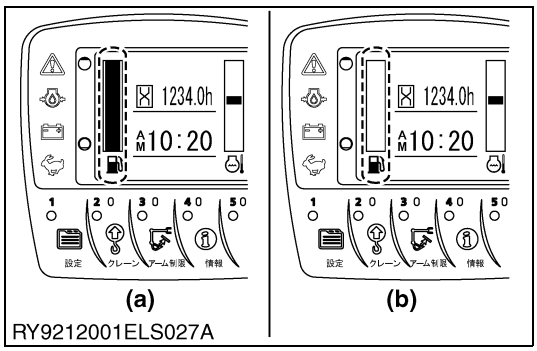
RY9212032ELS0003US0

(3) Fuel Sensor Errors

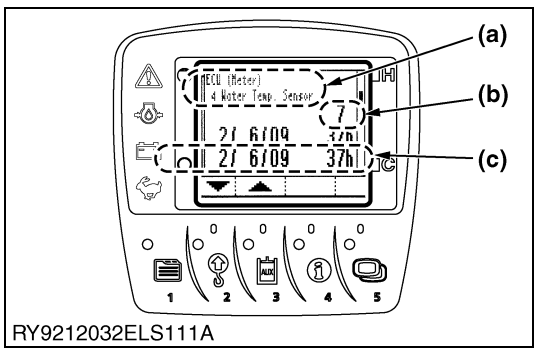
[A] Checking via the LCD Panel Display



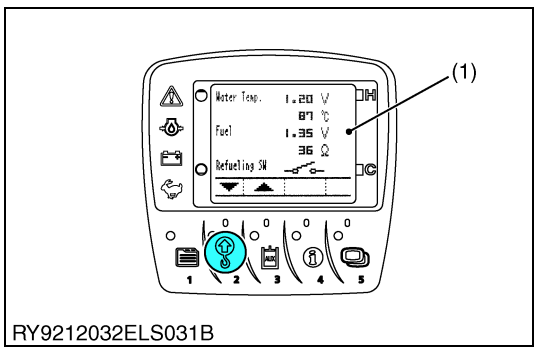
RY9212032ELS115A



RY9212001ELS027A



RY9212032ELS111A



RY9212032ELS031B

1. LCD Panel Display

Check whether or not the warning lamp **(a)** on the panel is blinking red or not.

(1) Fuel Sensor Err
(a) Warning lamp

RY9212032ELS0010US0

[Test Conditions]

1. Key switch : ON

(a) If the fuel level is at the top : caused by a short
(b) If the fuel level is blank : caused by a break

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

RY9212001ELS0070US0

2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0

3. Tester mode

1. Select the tester mode.
2. Start the engine.
3. Check the display for the voltage and resistance of the fuel based on the following table.

	Fuel voltage	Resistance
Regular	2.3 V	92Ω
When cut off	5.00 V	260Ω
When shorted	0.00 V	0Ω

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) Water temp.
Fuel
Refueling SW

RY9212032ELS0011US0

[B] Inspecting each Device Visually and Physically

1. Checking fuses

1. Checking fuses is not necessary.

RY9212001ELS0008US0

2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0

3. Causes when a break in wiring

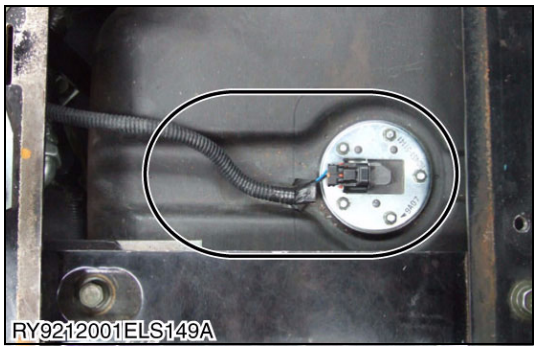
[Test Conditions]

1. Key switch : OFF
2. Fuel sensor connector CN23 disconnected.
3. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force) If it comes off, plug the connector back in securely and check the voltage and resistance for the fuel again in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

RY9212001ELS0073US0



4. Causes when a short

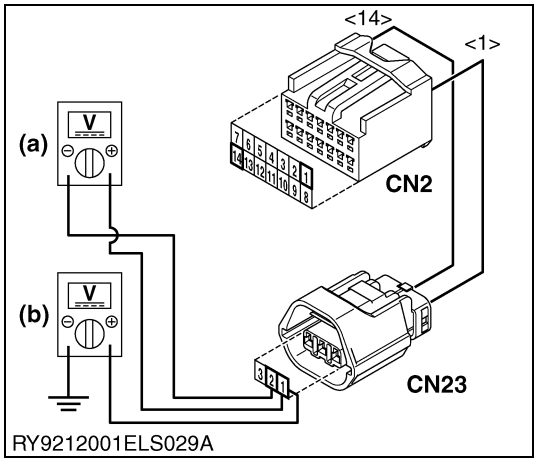
[Test Conditions]

1. Key switch : OFF
2. The fuel sensor wire is pinched against or touching the body. If the insulation is damaged, repair it properly and check the voltage and resistance for the fuel again in the tester mode.

Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

RY9212001ELS0001US0

[C] Testing with a Circuit Tester



1. Voltage check

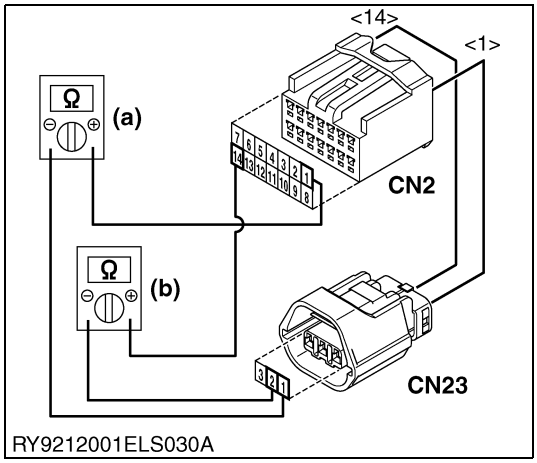
[Measurement Conditions]

1. Disconnect the fuel sensor connector CN23.
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Fuel sensor connector CN23	<1>	Fuel sensor connector CN23	<2>	
(b)	Fuel sensor connector CN23	<1>	Body GND	–	

Regular : 12 V (OK)
Irregular : Large discrepancy from 12 V (NG)

RY9212001ELS0074US0



RY9212001ELS030A

2. Continuity check

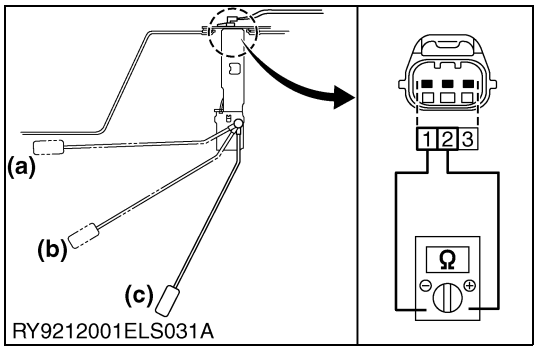
[Measurement Conditions]
1. Key switch : OFF
2. Disconnect meter connector CN2.
3. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Fuel sensor connector CN23	<1>	Meter connector CN2	<1>	
(b)	Fuel sensor connector CN23	<2>	Meter connector CN2	<14>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0075US0

[D] Testing the Equipment Itself



RY9212001ELS031A

1. Inspecting the fuel sensor

[Measurement Conditions]
1. Key switch : OFF
2. Disconnect the connector CN23 from the fuel sensor and take measurements.
3. Refer to the following table for the resistance at different float positions.

Factory Spec

Float position	F (a)	1/2 (b)	E (c)
Resistance value (Ω)	3 ±1	32.5	110 ±2.5

Criteria	Assessment Results
Regular : Within factory spec (OK)	
Irregular : Outside factory spec (NG)	

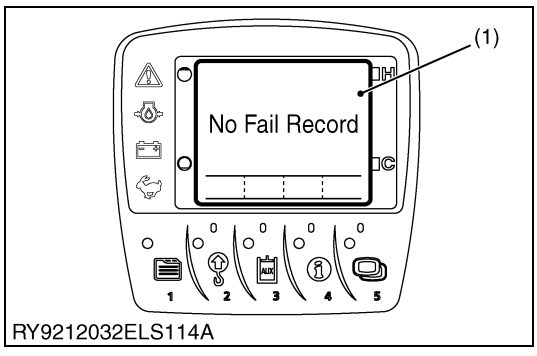
(a) Full
(b) Half
(c) Empty

RY9212001ELS0076US0

2. Settings after replacing device

1. No settings required.

RY9212001ELS0013US0



RY9212032ELS114A

3. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

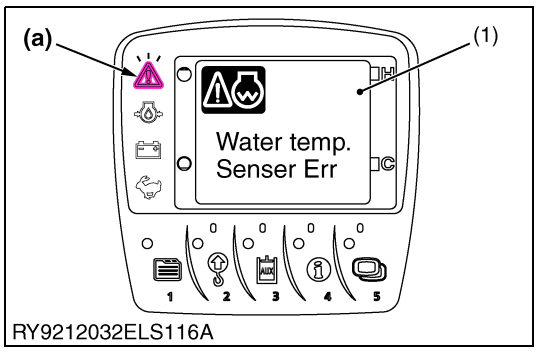
Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

(1) No Fail Record

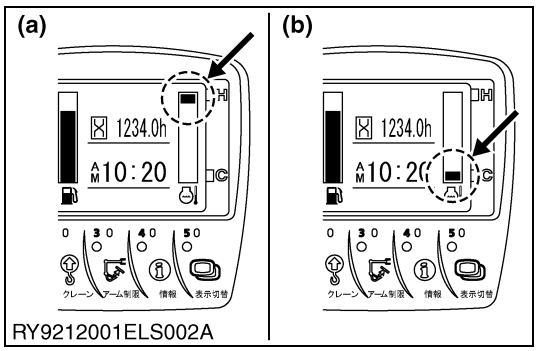
RY9212032ELS0003US0

(4) Water Temperature Sensor Errors

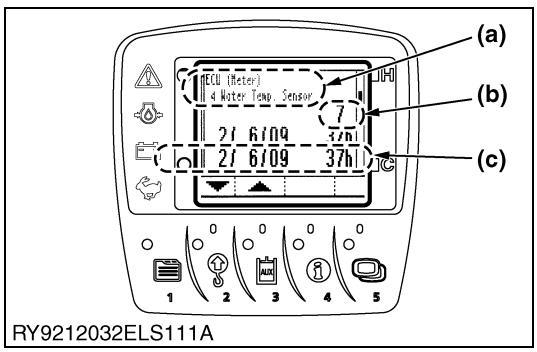
[A] Checking via the LCD Panel Display



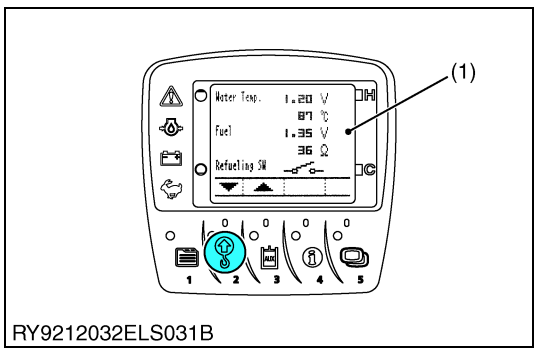
RY9212032ELS116A



RY9212001ELS002A



RY9212032ELS111A



RY9212032ELS031B

1. LCD Panel Display

Check whether or not the warning lamp **(a)** on the panel is blinking red or not.

(1) Water temp. Sensor Err
(a) Warning lamp

RY9212032ELS0012US0

[Test Conditions]

1. Key switch : ON

(a) If the water temperature level is at the top : caused by a short
(b) If the water temperature level is at the bottom : caused by a break

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

RY9212001ELS0078US0

2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0

3. Tester mode

1. Select the tester mode.
2. Start the engine.
3. Check the display for the voltage and temperature of the water based on the following table.

	Water temperature voltage	Water temperature
Regular	1.0 V	86 °C, 187 °F
When cut off	5.00 V	–50 °C, –58 °F
When shorted	0.00 V	150 °C, 302 °F

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) Water Temperature
Fuel
Refueling SW

RY9212032ELS0013US0

[B] Inspecting each Device Visually and Physically

1. Checking fuses

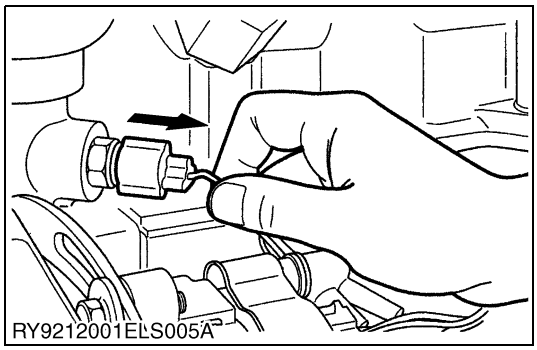
1. Checking fuses is not necessary.

RY9212001ELS0008US0

2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0


RY9212001ELS005A

3. Causes when a break in wiring

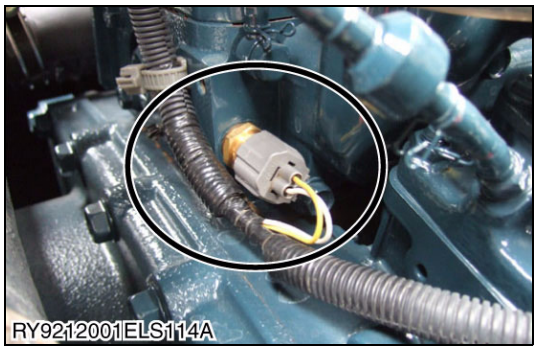
[Test Conditions]

1. Key switch : OFF
2. Water temperature sensor connector CN32 disconnected.
3. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force) If it comes off, plug the connector back in securely and check the voltage and temperature of the water temperature again in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

RY9212001ELS0081US0


RY9212001ELS114A

4. Causes when a short

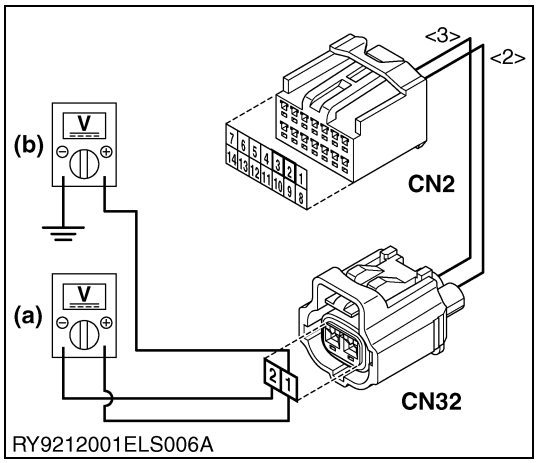
[Test Conditions]

1. Key switch : OFF
2. The water temperature sensor wire is pinched against or touching the body.
   If the insulation is damaged, repair it properly and check the voltage and temperature for the water temperature again in the tester mode.

Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

RY9212001ELS0011US0

[C] Testing with a Circuit Tester



1. Voltage check

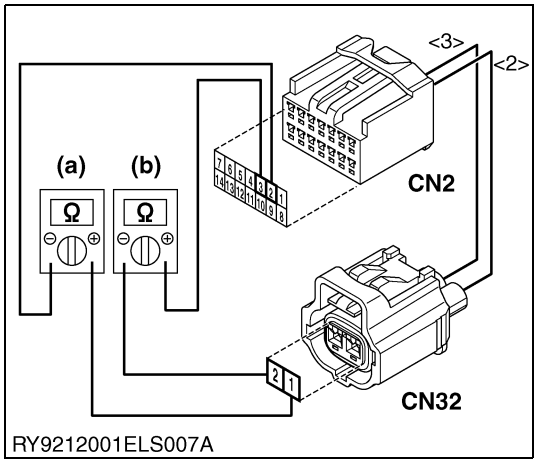
[Measurement Conditions]

1. Disconnect the water temperature sensor connector CN32.
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Water temperature connector CN32	<1>	Water temperature connector CN32	<2>	
(b)	Water temperature connector CN32	<1>	Body GND	–	

Regular : 5V (OK)
Irregular : Large discrepancy from 5V (NG)

RY9212001ELS0082US0



2. Continuity check

[Measurement Conditions]

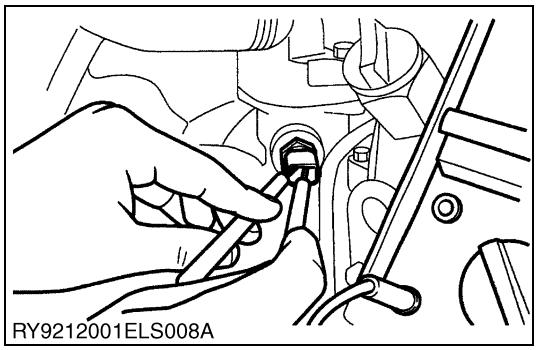
1. Key switch : OFF
2. Disconnect meter connector CN2.
3. Test the continuity based on the table below.

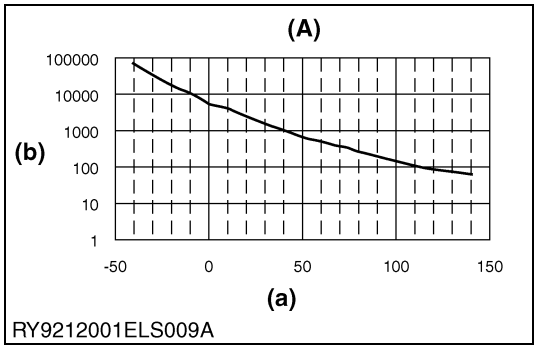
Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Fuel sensor connector CN23	<1>	Meter connector CN2	<2>	
(b)	Fuel sensor connector CN23	<2>	Meter connector CN2	<3>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0083US0

[D] Testing the Equipment Itself


RY9212001ELS008A



RY9212001ELS009A

1. Inspecting the water temperature sensor

[Measurement Conditions]

1. Key switch : OFF
2. Disconnect the connector CN32 from the water temperature sensor and take measurements.
3. Refer to the following table for the resistance at different temperatures.
4. Refer to the graph at left on the relationship between water temperature and resistance.

Water Temperature (°C)	Resistance
– 20	15.04 kΩ
20	2.45 kΩ
30	1.66 kΩ
40	1.15 kΩ
50	811Ω
60	584Ω
70	428Ω
80	318Ω
90	240Ω
100	183.6Ω
110	141.7 Ω

Criteria	Assessment Results
Regular : Within factory spec (OK)	
Irregular : Outside factory spec (NG)	

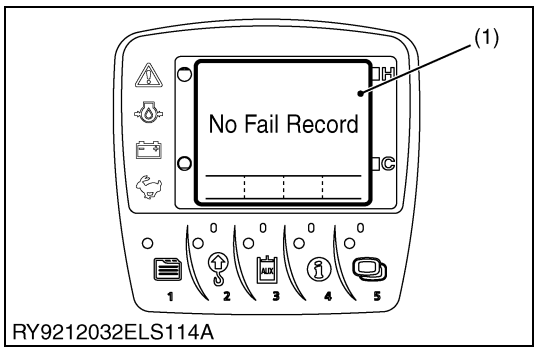
(A) Water temperature and resistance
(a) Water Temperature (°C)
(b) Resistance (Ω)

RY9212001ELS0084US0

2. Settings after replacing device

1. No settings required.

RY9212001ELS0013US0



RY9212032ELS114A

3. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

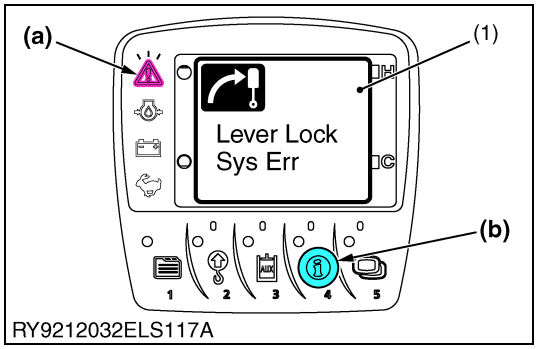
(1) No Fail Record

RY9212032ELS0003US0

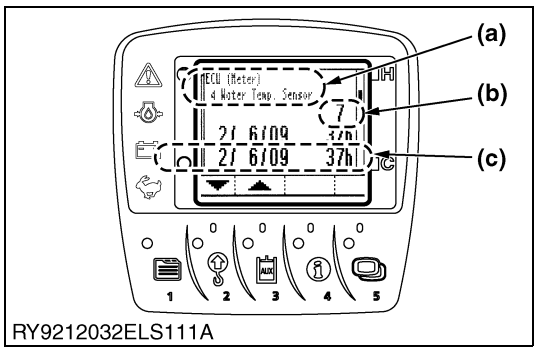
[2] MACHINE RELATED SYSTEM

(1) Lever Lock System Errors

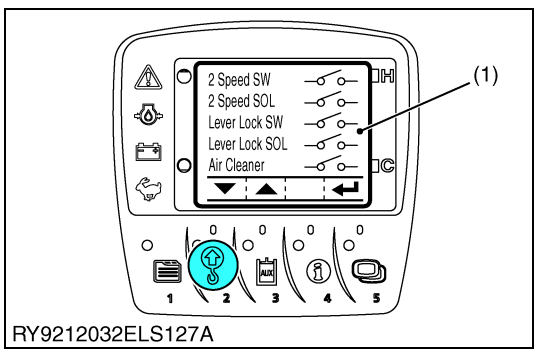
[A] Checking via the LCD Panel Display



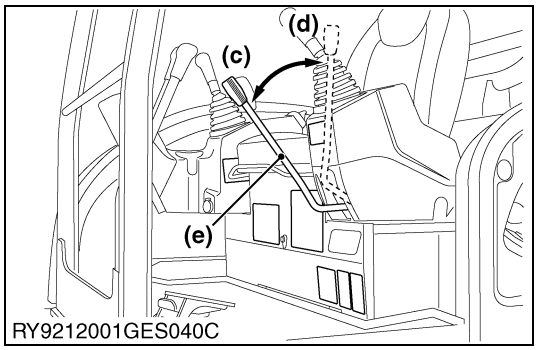
RY9212032ELS117A



RY9212032ELS111A



RY9212032ELS127A



RY9212001GES040C

1. Content of LCD Panel Display

1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Press the info button **(b)** and check the additional content.

   Ex.) Lever lock SOL

(1) Lever Lock Sys Err

(a) Warning lamp
(b) Info button

RY9212032ELS0014US0

2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

   Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0

3. Tester mode

1. Select the tester mode.
2. Start the engine.
3. Put the machinery operation lever lock in the [Unlock] position.
4. Operate the lever lock switch and lever lock solenoid and check the switch according to the following table.

	Regular	Warning lamp	When cut off	Warning lamp	When shorted	Warning lamp
Lever lock switch ON		Off		Off		Off
Lever lock switch OFF		Off		Off		Off
Lever lock solenoid ON		Off		Off		Off
Lever lock solenoid OFF		Off		Off		Off

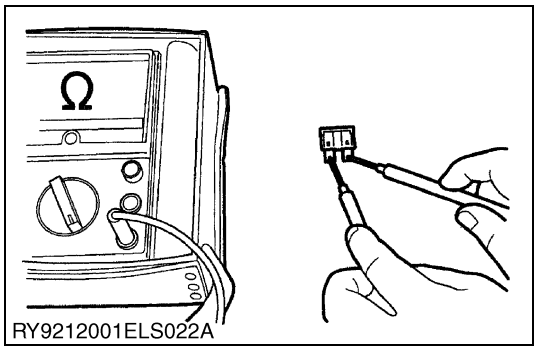
Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) 2 Speed SW
2 Speed SOL
Lever Lock SW
Lever Lock SOL
Air Cleaner

(c) Unlock
(d) Lock
(e) Machinery operation lever lock

RY9212032ELS0015US0

[B] Inspecting each Device Visually and Physically



1. Checking fuses

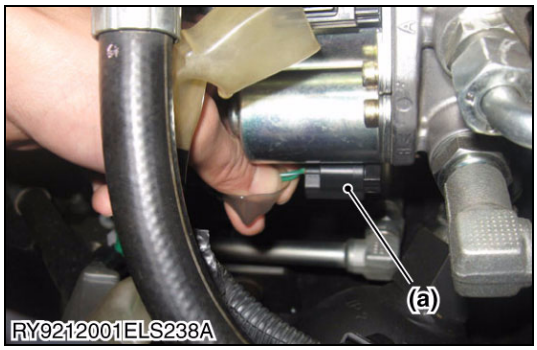
1. Check whether the 5A lever lock fuse is blown.

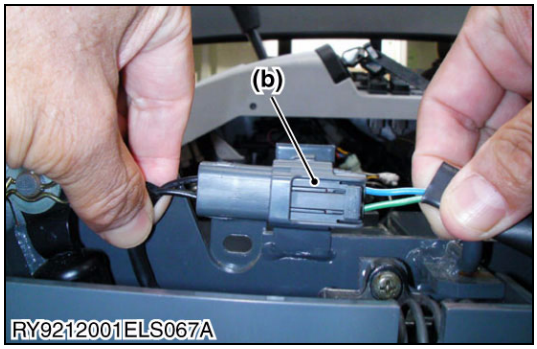
RY9212001ELS0088US0

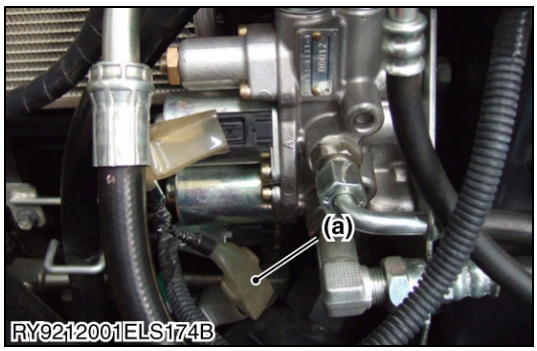
2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0







3. Causes when a break in wiring

[Test Conditions]

1. Key switch : OFF
2. The lever lock switch connector CN11 is disconnected.
3. The lever lock solenoid connector CN12 is disconnected.
4. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force) If it comes off, plug the connector back in securely and check the lever lock switch and lever lock solenoid in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

(a) Lever lock solenoid connector CN12 **(b) Lever lock switch connector CN11**

RY9212001ELS0089US0

4. Causes when a short

[Test Conditions]

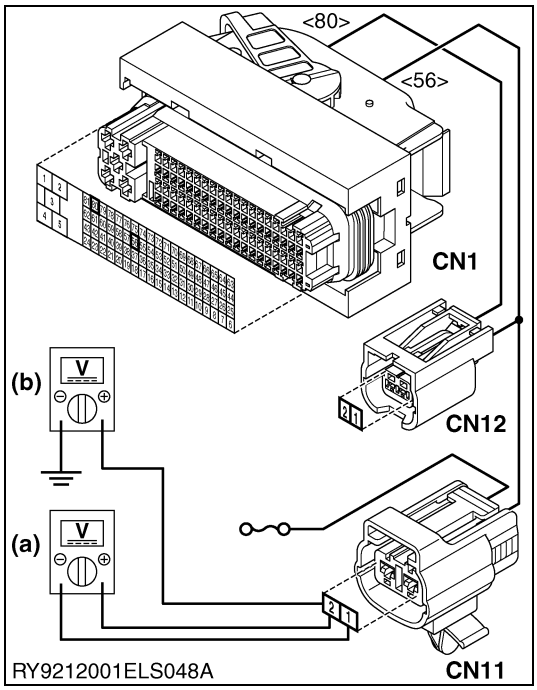
1. Key switch : OFF
2. The lever lock switch connector CN11 wire and/or lever lock solenoid connector CN12 are pinched against or touching the body.
   If the insulation is damaged, repair it properly and check the lever lock switch and the lever lock solenoid again in the tester mode.

Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

(a) Lever lock switch connector CN11

RY9212001ELS0090US0

[C] Testing with a Circuit Tester



RY9212001ELS048A

1. Voltage check (lever lock switch)

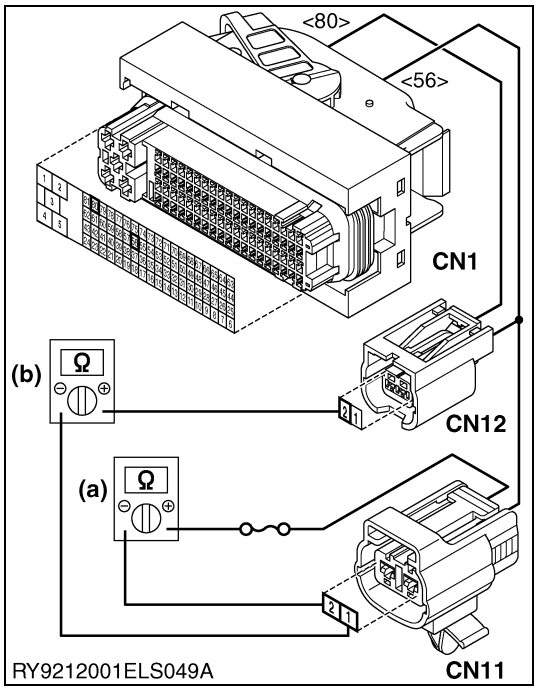
[Measurement Conditions]

1. Disconnect the lever lock switch connector CN11.
2. Key switch : ON
3. Put the machinery operation lever lock in the [Unlock] position.
4. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Lever lock switch connector CN11	<2>	Lever lock switch connector CN11	<1>	
(b)	Lever lock switch connector CN11	<2>	Body GND	–	

Regular : 12 V (OK)
Irregular : Large discrepancy from 12 V (NG)

RY9212001ELS0091US0



RY9212001ELS049A

2. Continuity check (lever lock switch)

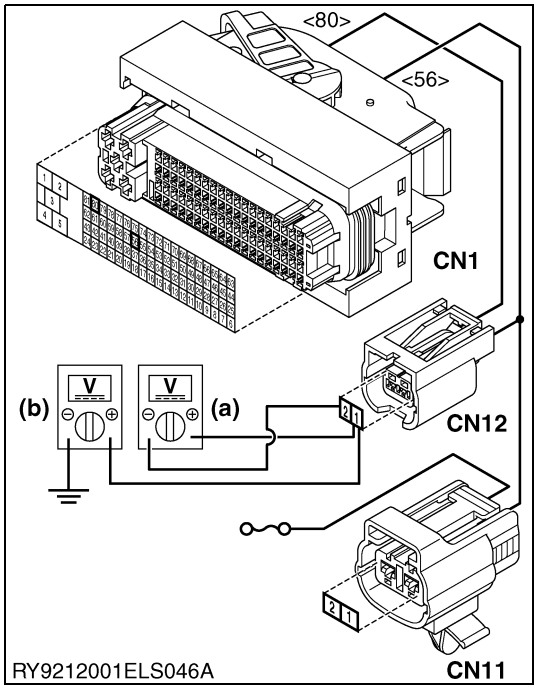
[Measurement Conditions]

1. Key switch : OFF
2. Disconnect lever lock switch connector CN11 and lever lock solenoid connector CN12.
3. Put the machinery operation lever lock in the [Unlock] position.
4. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Lever lock fuse	–	Lever lock switch connector CN11	<2>	
(b)	Lever lock switch connector CN12	<2>	Lever lock solenoid connector CN11	<1>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0092US0



RY9212001ELS046A

3. Voltage check (lever lock solenoid)

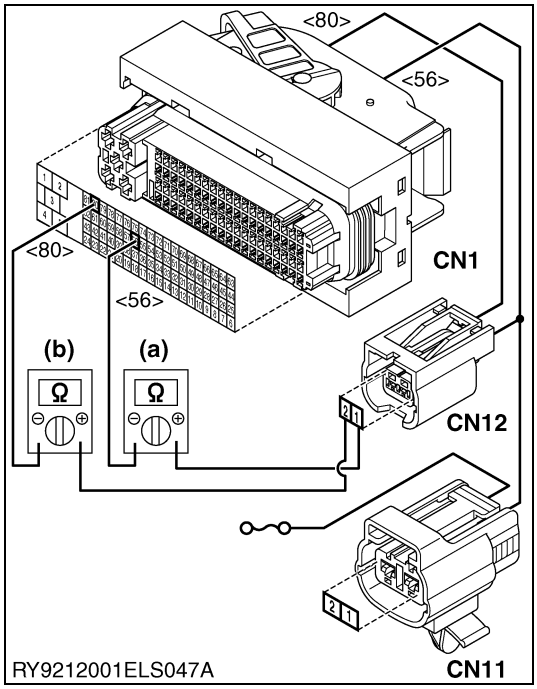
[Measurement Conditions]

1. Disconnect lever lock solenoid connector CN12.
2. Key switch : ON
3. Put the machinery operation lever lock in the [Unlock] position.
4. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Lever lock solenoid connector CN12	<1>	Lever lock solenoid connector CN12	<2>	
(b)	Lever lock solenoid connector CN12	<1>	Body GND	–	

Regular : 12 V (OK)
Irregular : Large discrepancy from 12 V (NG)

RY9212001ELS0093US0



RY9212001ELS047A

4. Continuity check (lever lock solenoid)

[Measurement Conditions]

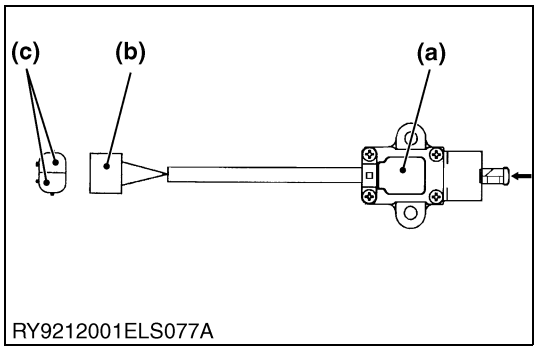
1. Key switch : OFF
2. Disconnect the ECU connector CN1.
3. Disconnect lever lock solenoid connector CN12.
4. Put the machinery operation lever lock in the [Unlock] position.
5. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Lever lock solenoid connector CN12	<1>	ECU connector CN1	<56>	
(b)	Lever lock solenoid connector CN12	<2>	ECU connector CN1	<80>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0094US0

[D] Testing the Equipment Itself



RY9212001ELS077A

1. Inspecting the lever lock switch

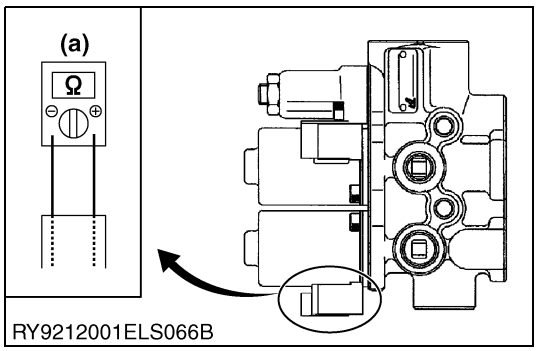
[Test Conditions]

1. Key switch : OFF
2. Disconnect the lever lock switch connector CN11 from the machine, press the switch and measure it separately.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

(a) Lever lock switch
(b) Lever lock switch connector
(c) Lever lock switch connector terminals

RY9212001ELS0095US0



RY9212001ELS066B

2. Testing the lever lock solenoid

[Test Conditions]

1. Key switch : OFF
2. Disconnect lever lock solenoid connector CN12 from the machine and test the solenoid separately.

Lever lock solenoid	Factory Spec	12 Ω ±10 %

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

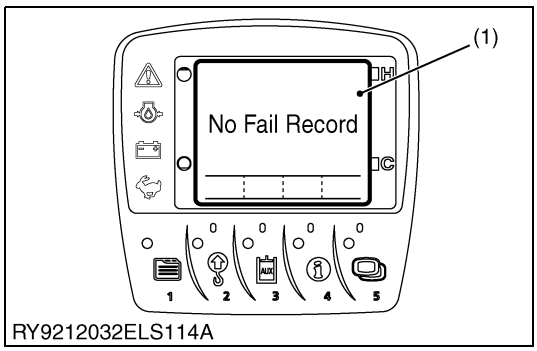
(a) Lever lock solenoid terminals

RY9212001ELS0096US0

3. Settings after replacing device

1. No settings required.

RY9212001ELS0020US0



RY9212032ELS114A

4. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

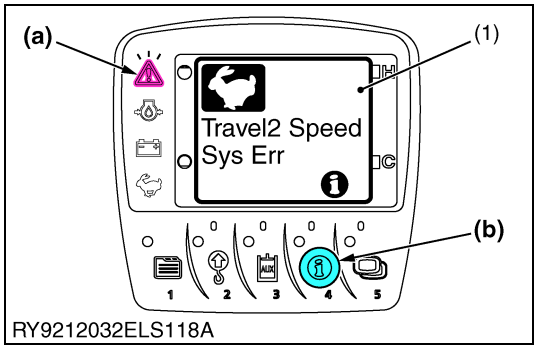
Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

(1) No Fail Record

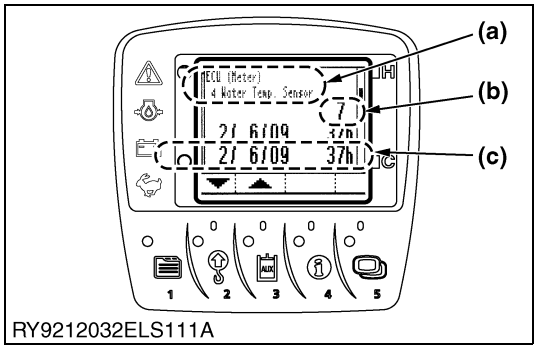
RY9212032ELS0004US0

(2) Travel 2-speed System Error

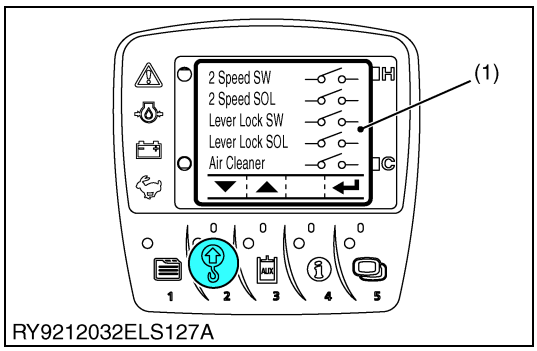
[A] Checking via the LCD Panel Display



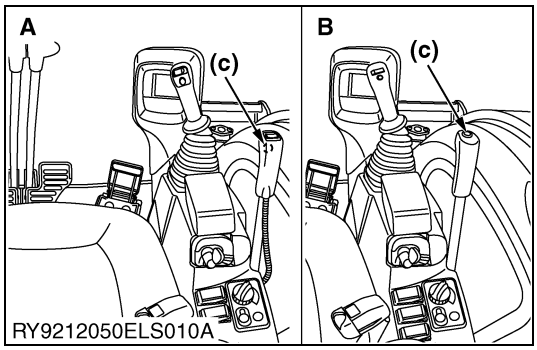
RY9212032ELS118A



RY9212032ELS111A



RY9212032ELS127A



RY9212050ELS010A

1. Content of LCD Panel Display

1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Press the info button **(b)** and check the additional content.

   Ex.) 2-speed solenoid

(1) Travel2 Speed Sys Err

(a) Warning lamp
(b) Info button

RY9212032ELS0016US0

2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

   Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0

3. Tester mode

1. Select the tester mode.
2. Start the engine.
3. Put the machinery operation lever lock in the [Unlock] position and press the 2-speed switch.
4. Operate the 2-speed switch and check the 2-speed switch and 2-speed solenoid based on the following table.

	Regu-lar	2-speed lamp	When cut off	2-speed lamp	When shorted	2-speed lamp
2-speed switch ON	—o o—	Lit	—o o—	Lit	—o o—	Off
2-speed switch OFF	—o o—	Off	—o o—	Off	—o o—	Off
2-speed solenoid ON	—o o—	Lit	—o o—	Lit	—o o—	Off
2-speed solenoid OFF	—o o—	Off	—o o—	Off	—o o—	Off

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) 2 Speed SW
2 Speed SOL
Lever Lock SW
Lever Lock SOL
Air Cleaner

(c) 2-speed switch

A : Angle blade version
B : Standard version

RY9212032ELS0017US0

[B] Inspecting each Device Visually and Physically

1. Checking fuses

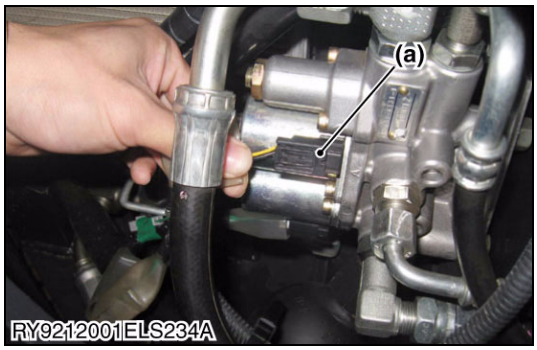
1. Checking fuses is not necessary.

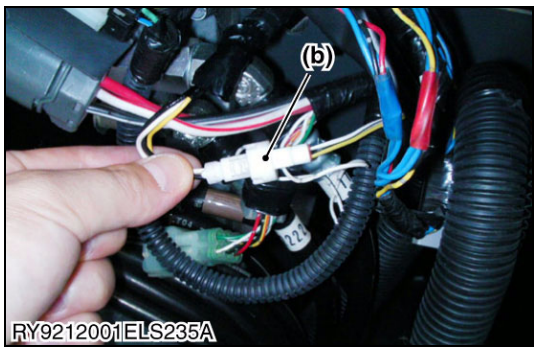
RY9212001ELS0008US0

2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0





3. Causes when a break in wiring

[Test Conditions]

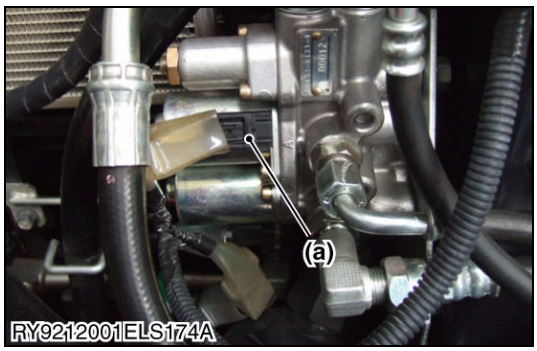
1. Key switch : OFF
2. The 2-speed solenoid connector CN13 disconnected.
3. The 2-speed switch connector CN15 disconnected.
4. There is a break somewhere in the wiring.

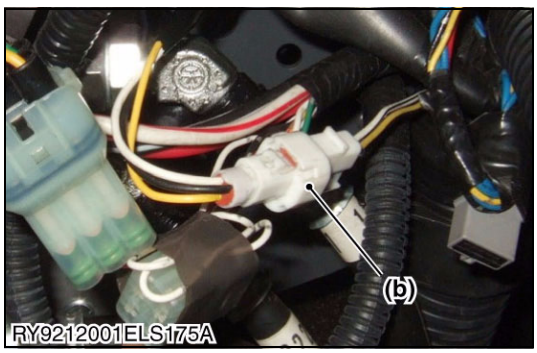
Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force) If it comes off, plug the connector back in securely and check the 2-speed solenoid and the 2-speed switch in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

(a) 2-speed solenoid connector CN13 **(b) 2-speed switch connector CN15**

RY9212001ELS0100US0





4. Causes when a short

[Test Conditions]

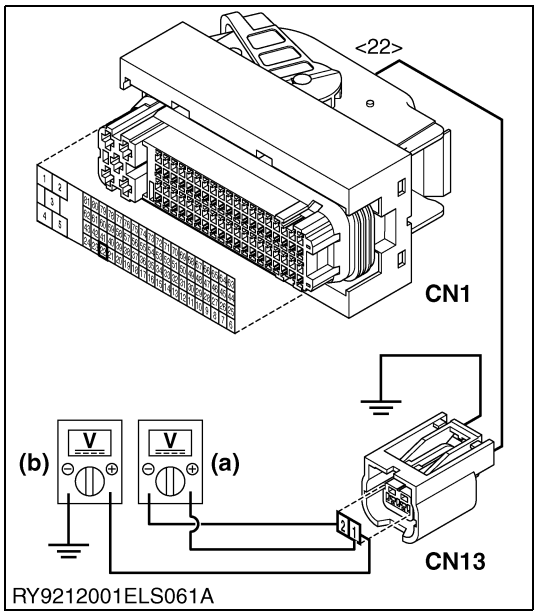
1. Key switch : OFF
2. The wiring of the 2-speed solenoid connector CN13 and/or the 2-speed switch connector CN15 are pinched against or touching the body
   If the insulation is damaged, repair it properly and check the 2-speed solenoid and the 2-speed switch again in the tester mode.

Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

(a) 2-speed solenoid connector CN13 **(b) 2-speed switch connector CN15**

RY9212001ELS0101US0

[C] Testing with a Circuit Tester



RY9212001ELS061A

1. Voltage check (2-speed solenoid)

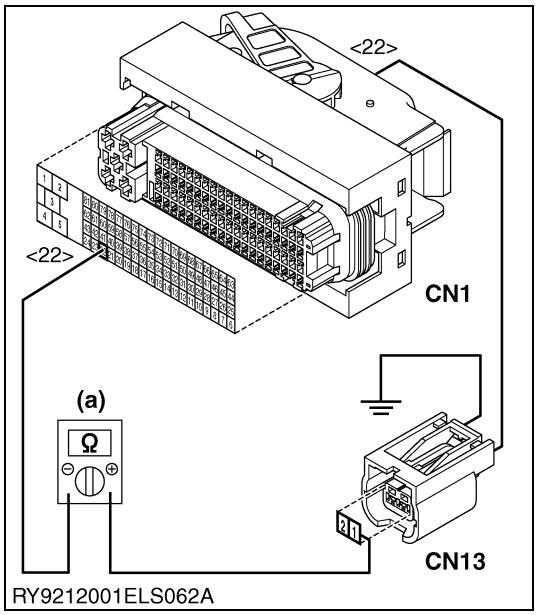
[Measurement Conditions]

1. Disconnect the travel 2-speed solenoid connector CN13.
2. Key switch : ON
3. Put the machinery operation lever lock in the [Unlock] position and press the 2-speed switch.
4. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	2-speed solenoid connector CN13	<1>	2-speed solenoid connector CN13	<2>	
(b)	2-speed solenoid connector CN13	<1>	Body GND	–	

Regular : 12 V (OK)
Irregular : Large discrepancy from 12 V (NG)

RY9212001ELS0102US0



RY9212001ELS062A

2. Continuity check (2-speed solenoid)

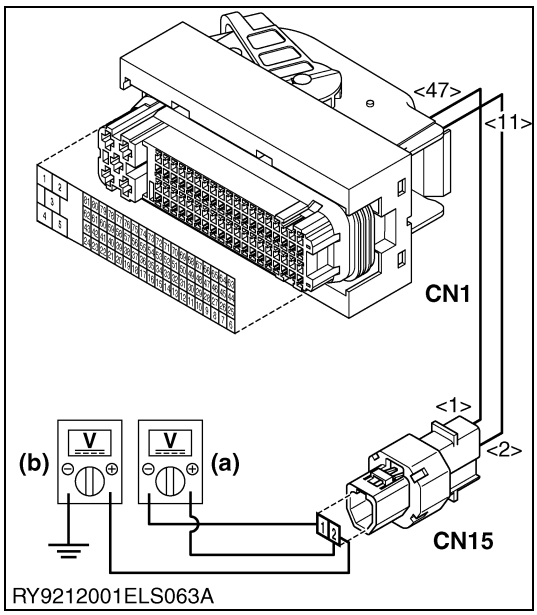
[Measurement Conditions]

1. Key switch : OFF
2. Disconnect the travel 2-speed solenoid connector CN13.
3. Disconnect the ECU connector CN1.
4. Put the machinery operation lever lock in the [Unlock] position and press the 2-speed switch.
5. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	2-speed solenoid connector CN13	<1>	ECU connector CN1	<22>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0103US0



RY9212001ELS063A

3. Voltage check (2-speed switch)

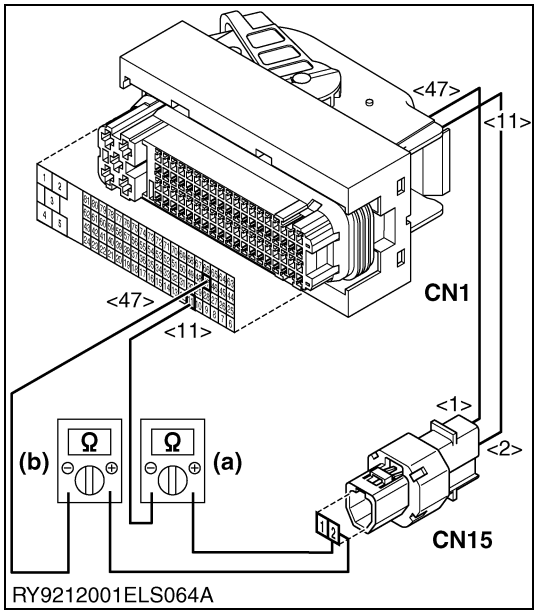
[Measurement Conditions]

1. Disconnect the 2-speed switch connector CN15.
2. Key switch : ON
3. Put the machinery operation lever lock in the [Unlock] position and press the 2-speed switch.
4. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	2-speed solenoid connector CN15	<2>	2-speed solenoid connector CN15	<1>	
(b)	2-speed solenoid connector CN15	<2>	Body GND	–	

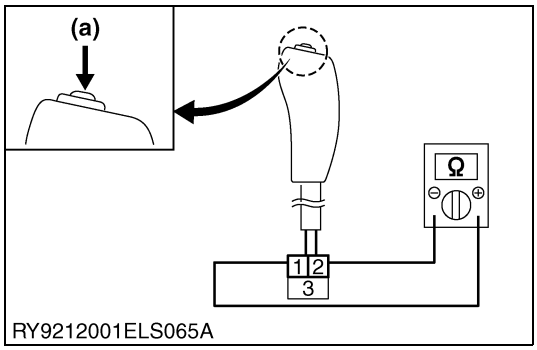
Regular : 12 V (OK)
Irregular : Large discrepancy from 12 V (NG)

RY9212001ELS0104US0

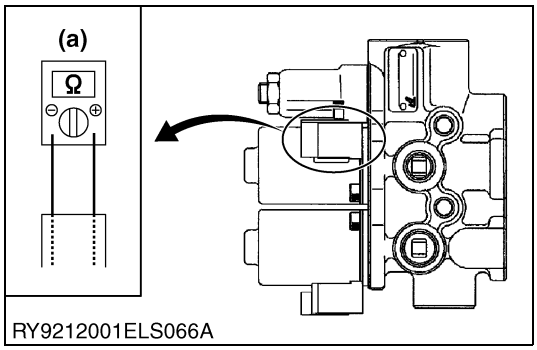


RY9212001ELS064A

[D] Testing the Equipment Itself



RY9212001ELS065A



RY9212001ELS066A

4. Continuity check (2-speed switch)

[Measurement Conditions]

1. Key switch : OFF
2. Disconnect the ECU connector CN1.
3. Put the machinery operation lever lock in the [Unlock] position and press the 2-speed switch.
4. Test the continuity based on the table below.

Mea-sure-ment	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assess-ment Results
(a)	2-speed switch connector CN15	<2>	ECU connector CN1	<11>	
(b)	2-speed switch connector CN15	<2>	ECU connector CN1	<47>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0105US0

1. Testing the 2-speed switch

[Test Conditions]

1. Key switch : OFF
2. Disconnect the 2-speed switch connector CN15 from the machine, press the switch and measure it separately.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

(a) 2-speed switch

RY9212001ELS0106US0

2. Testing the 2-speed solenoid

[Test Conditions]

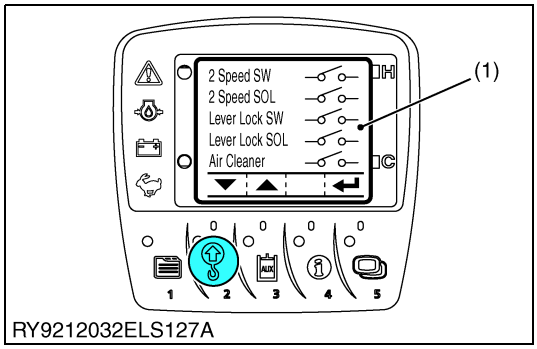
1. Key switch : OFF
2. Disconnect 2-speed solenoid connector CN13 from the machine and test the solenoid separately.

2-speed solenoid	Factory Spec	12 Ω ±10 %

Criteria	Assessment Results
Regular : Within factory spec (OK)	
Irregular : Outside factory spec (NG)	

(a) 2-speed solenoid terminals

RY9212001ELS0107US0



RY9212032ELS127A

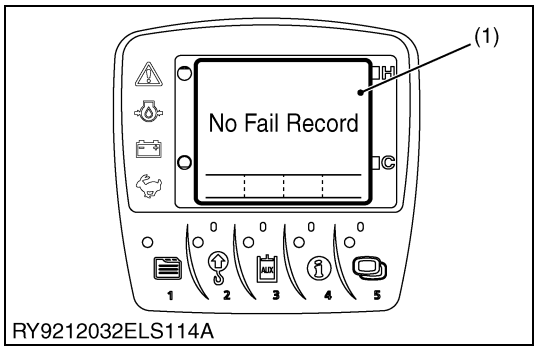
3. Settings after replacing device

1. Select the AI setting.

Criteria	Assessment Results
Regular : setting complete (OK)	
Irregular : setting failed (NG)	

(1) 2 Speed SW
2 Speed SOL
Lever Lock SW
Lever Lock SOL
Air Cleaner

RY9212032ELS0018US0



RY9212032ELS114A

4. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

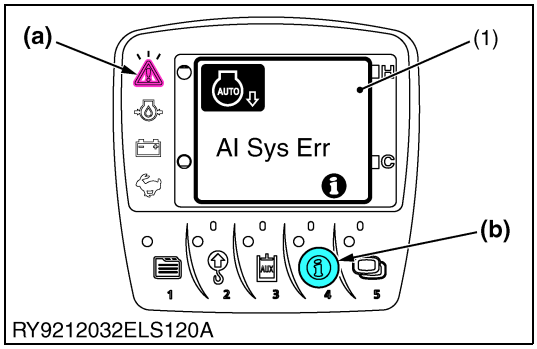
(1) No Fail Record

RY9212032ELS0004US0

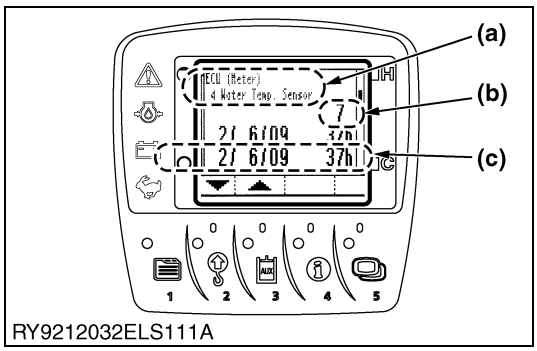
[3] AUTO IDLING (AI) SYSTEM

(1) Governor Sensor Errors

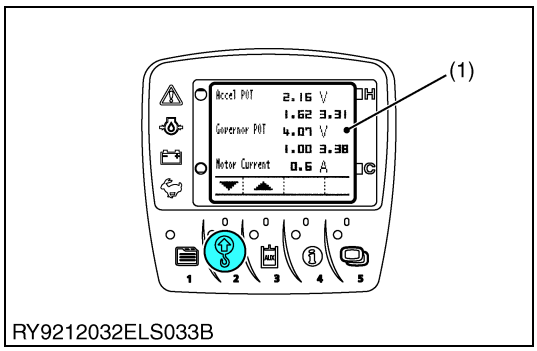
[A] Checking via the LCD Panel Display



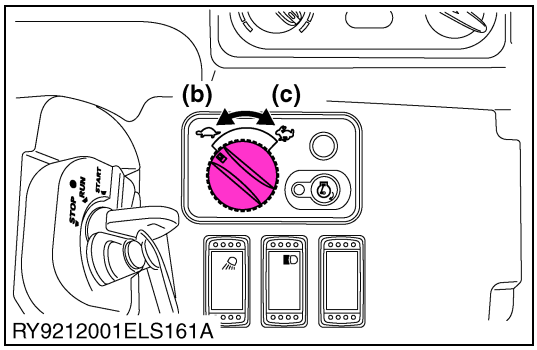
RY9212032ELS120A



RY9212032ELS111A



RY9212032ELS033B



RY9212001ELS161A

1. Content of LCD Panel Display

1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Press the info button **(b)** and check the additional content.

   Ex.) Governor sensor

(1) AI Sys Err

(a) Warning lamp
(b) Info button

RY9212032ELS0007US0

2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

   Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0

3. Tester mode

1. Select the tester mode.
2. Start the engine.
3. Turn the accelerator dial to the right (hi-speed) and to the left (lo-speed) and check the governor pot voltage based on the following table.

Design Value	Governor POT	Regular	When cut off	When shorted
	Idling	1.68 ± 0.2 V	0.05 V	Voltage fails to stabilize
	MAX	3.39 ± 0.28 V	0.05 V	

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) Accel POT
Governor POT
Motor Current

(b) Slow
(c) Fast

RY9212032ELS0019US0

[B] Inspecting each Device Visually and Physically

1. Checking fuses

1. Checking fuses is not necessary.

RY9212001ELS0008US0

2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0

3. Causes when a break in wiring

[Test Conditions]

1. Key switch : OFF
2. The governor connector CN4 is disconnected.
3. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force) If it comes off, plug the connector back in securely, turn the accelerator dial to the right (hi-speed) and the left (lo-speed) and check the voltage of the governor POT again in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

RY9212001ELS0160US0

4. Causes when a short

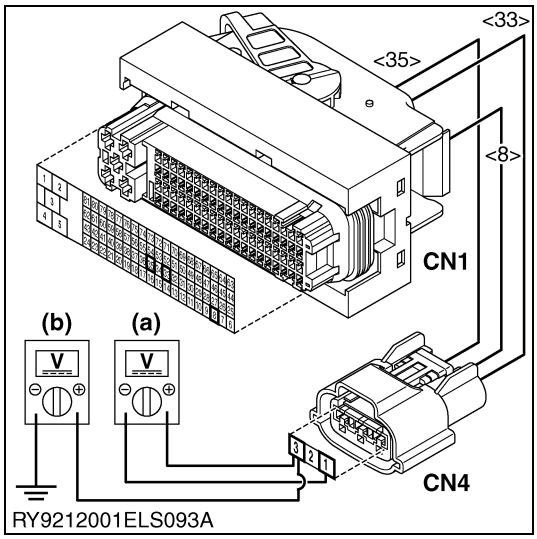
[Test Conditions]

1. Key switch : OFF
2. The wiring of the governor sensor connector CN4 is pinched against or touching the body.
   If the insulation is damaged, repair it properly, turn the accelerator dial to the right (hi-speed) and the left (lo-speed) and check the voltage of the governor POT again in the tester mode.

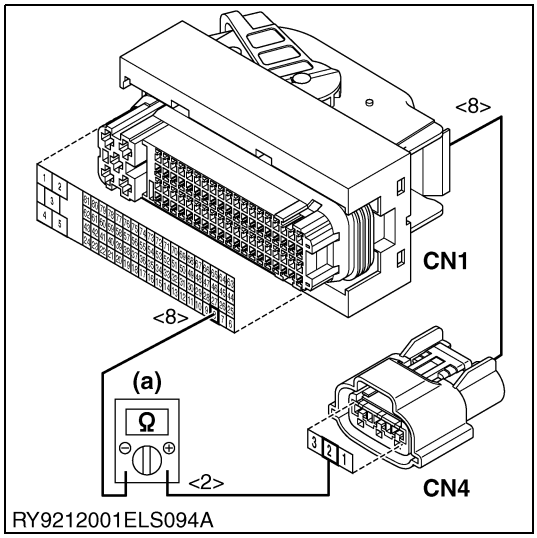
Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

RY9212001ELS0161US0

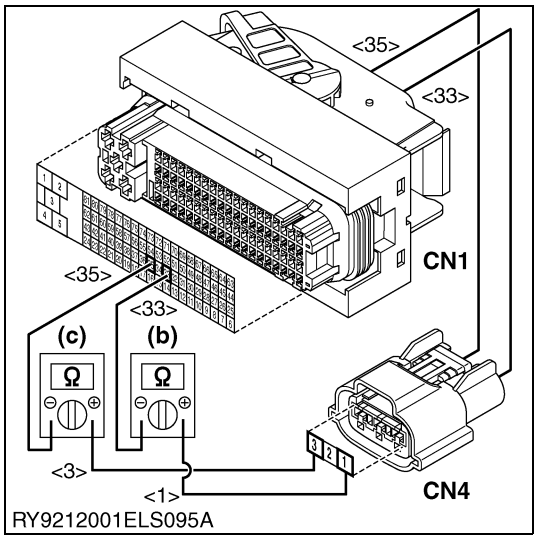
[C] Testing with a Circuit Tester



RY9212001ELS093A



RY9212001ELS094A



RY9212001ELS095A

1. Voltage check

[Measurement Conditions]

1. Disconnect the governor sensor connector CN4.
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Governor sensor connector CN4	<3>	Governor sensor connector CN4	<1>	
(b)	Governor sensor connector CN4	<3>	Body GND	–	

Regular : 5V (OK)
Irregular : Large discrepancy from 5V (NG)

RY9212001ELS0162US0

2. Continuity check

[Measurement Conditions]

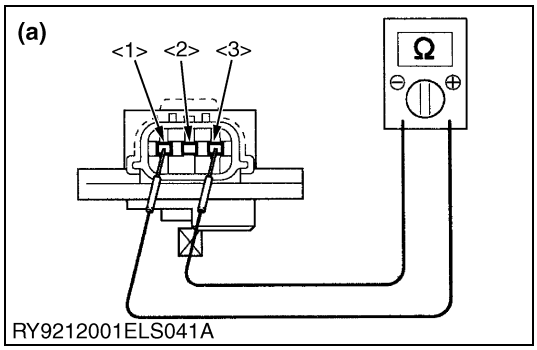
1. Key switch : OFF
2. Disconnect the governor sensor connector CN4.
3. Disconnect the ECU connector CN1.
4. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Governor sensor connector CN4	<2>	ECU connector CN1	<8>	
(b)	Governor sensor connector CN4	<1>	ECU connector CN1	<16>	
(c)	Governor sensor connector CN4	<3>	ECU connector CN1	<20>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0163US0

[D] Testing the Equipment Itself



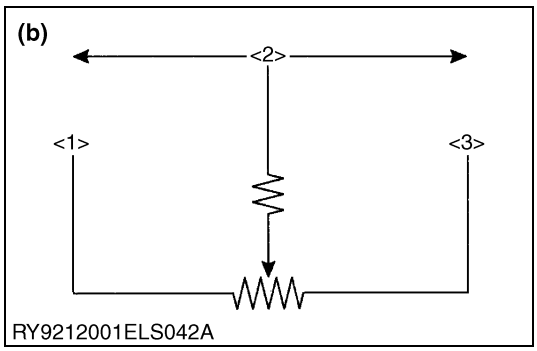
RY9212001ELS041A

1. Testing the potentiometer

[Measurement Conditions]

1. Key switch : OFF
2. Remove the potentiometer out the AI motor and measure the resistance value.

Measurements **(a)** <1> - <3>	Factory Spec	2 kΩ ±20 %



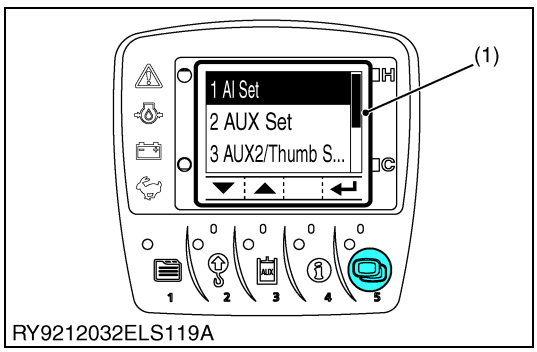
RY9212001ELS042A

Measurement**(b)**	<1> – <2>
	<2> – <3>

As shown in the diagram at left, rotate the shaft of the potentiometer and confirm that the needle of the circuit tester moves smoothly.

Criteria	Assessment Results
Regular : Within factory spec (OK)	
Irregular : Outside factory spec (NG)	

RY9212001ELS0019US0



RY9212032ELS119A

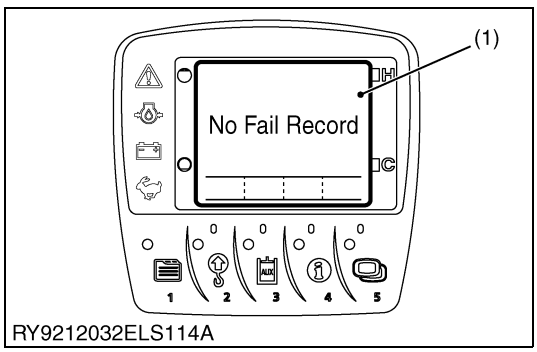
2. Settings after replacing device

1. Select the AI setting.

Criteria	Assessment Results
Regular : setting complete (OK)	
Irregular : setting failed (NG)	

(1) AI Set
AUX Set
AUX2/Thumb Set

RY9212032ELS0005US0



RY9212032ELS114A

3. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

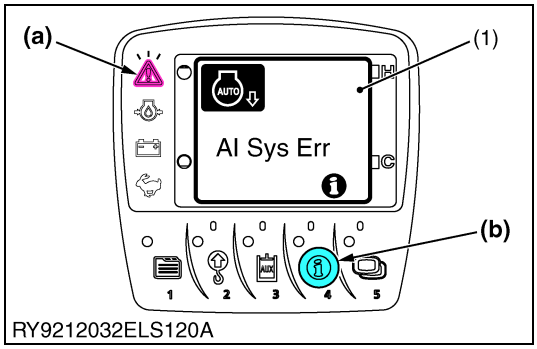
Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

(1) No Fail Record

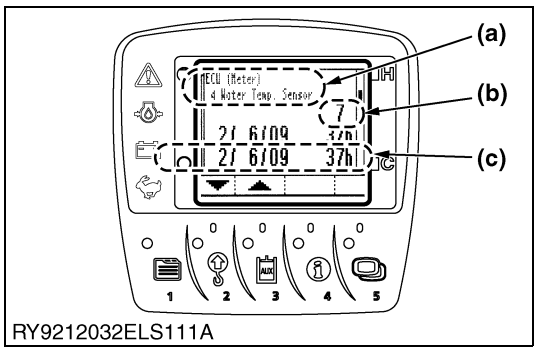
RY9212032ELS0003US0

(2) Accelerator Sensor Errors

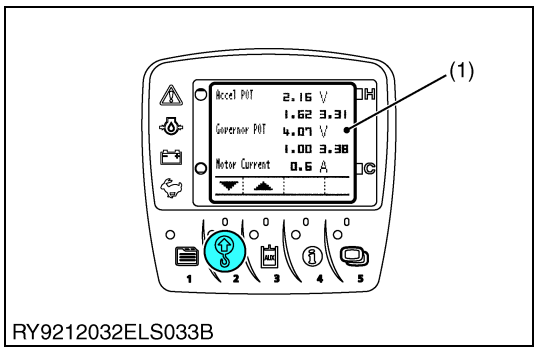
[A] Checking via the LCD Panel Display



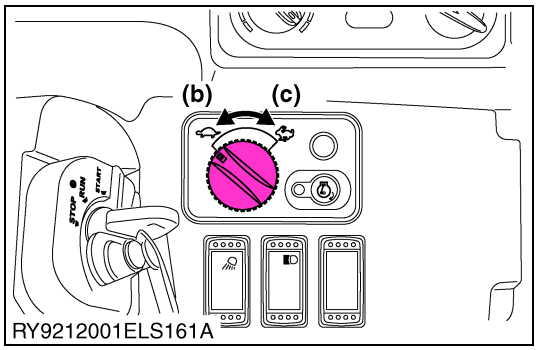
RY9212032ELS120A



RY9212032ELS111A



RY9212032ELS033B



RY9212001ELS161A

1. Content of LCD Panel Display

1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Press the info button **(b)** and check the additional content.

   Ex.) Governor sensor

(1) AI Sys Err

(a) Warning lamp
(b) Info button

RY9212032ELS0007US0

2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

   Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0

3. Tester mode

1. Select the tester mode.
2. Start the engine.
3. Turn the accelerator dial to the right (hi-speed) and to the left (lo-speed) and check the accelerator POT voltage based on the following table.

Design Value	Governor POT	Regular	When cut off	When shorted
	Idling	1.68 ± 0.2 V	0.05 V	Voltage fails to stabilize
	MAX	3.39 ± 0.28 V	0.05 V	

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) Accel POT
Governor POT
Motor Current

(b) Slow
(c) Fast

RY9212032ELS0020US0

[B] Inspecting each Device Visually and Physically

1. Checking fuses

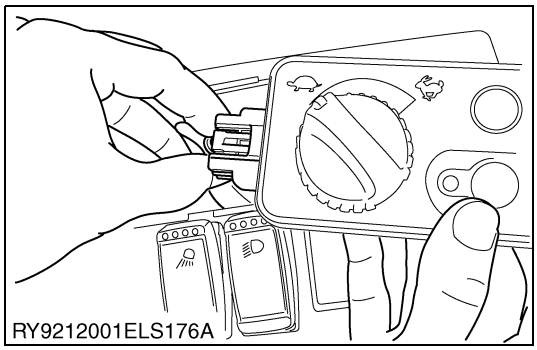
1. Checking fuses is not necessary.

RY9212001ELS0008US0

2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0


RY9212001ELS176A

3. Causes when a break in wiring

[Test Conditions]

1. Key switch : OFF
2. AI console connector CN421 disconnected.
3. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force) If it comes off, plug the connector back in securely, turn the accelerator dial to the right (hi-speed) and the left (lo-speed) and check the voltage of the accelerator sensor again in the tester mode.

Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

RY9212001ELS0165US0

RY9212001ELS154A

4. Causes when a short

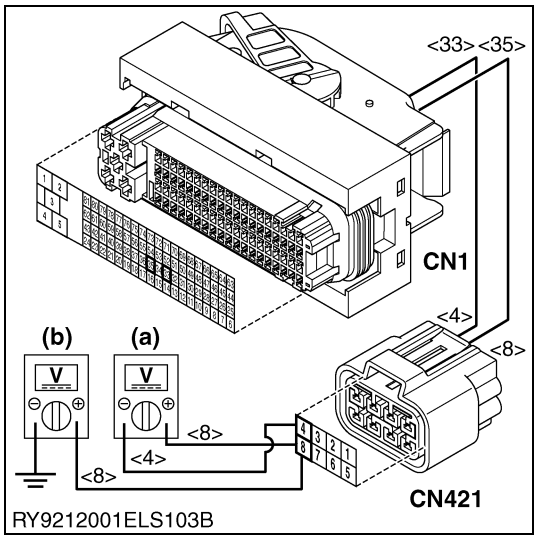
[Test Conditions]

1. Key switch : OFF
2. The wiring of the AI console connector CN421 is pinched against or touching the body.
   If the insulation is damaged, repair it properly, turn the accelerator dial to the right (hi-speed) and the left (lo-speed) and check the voltage of the accelerator sensor again in the tester mode.

Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

RY9212001ELS0166US0

[C] Testing with a Circuit Tester



RY9212001ELS103B

1. Voltage check

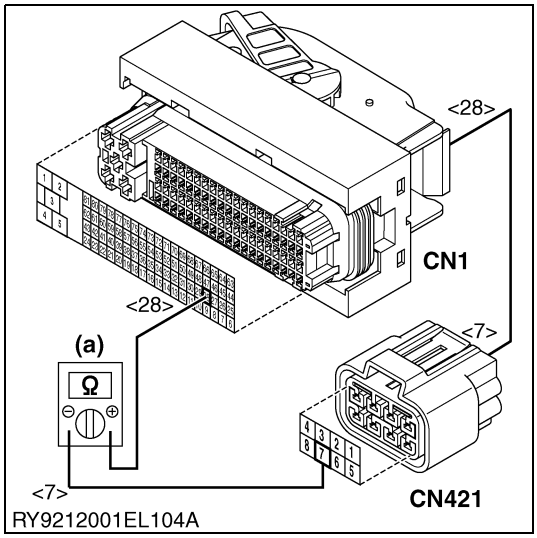
[Measurement Conditions]

1. Disconnect the AI console connector CN421.
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	AI console connector CN421	<8>	AI console connector CN421	<4>	
(b)	AI console connector CN421	<8>	Body GND	–	

Regular : 5V (OK)
Irregular : Large discrepancy from 5V (NG)

RY9212001ELS0167US0



RY9212001EL104A

2. Continuity check

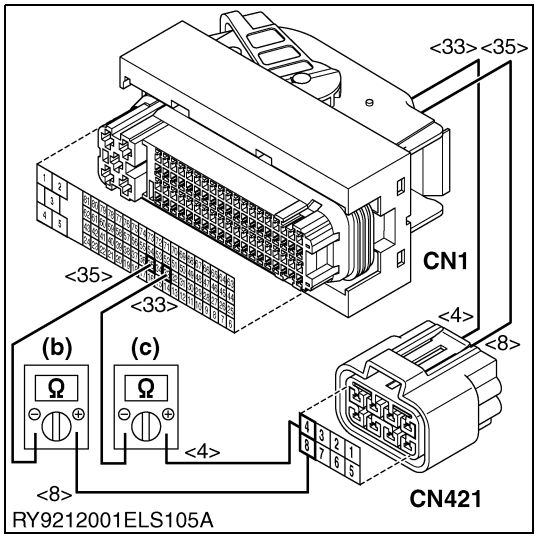
[Measurement Conditions]

1. Key switch : OFF
2. Disconnect the AI console connector CN421.
3. Disconnect the ECU connector CN1.
4. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	AI console connector CN421	<7>	ECU connector CN1	<28>	
(b)	AI console connector CN421	<8>	ECU connector CN1	<35>	
(c)	AI console connector CN421	<4>	ECU connector CN1	<33>	

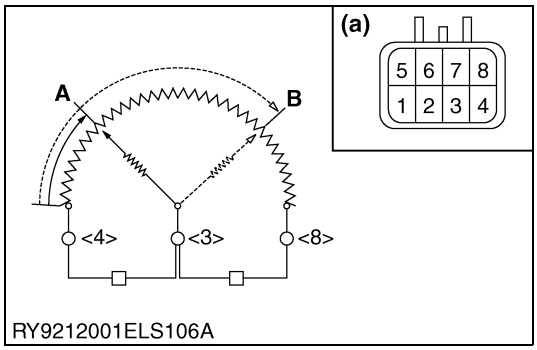
Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0168US0



RY9212001ELS105A

[D] Testing the Equipment Itself



RY9212001ELS106A

1. Testing the accelerator sensor

[Measurement Conditions]

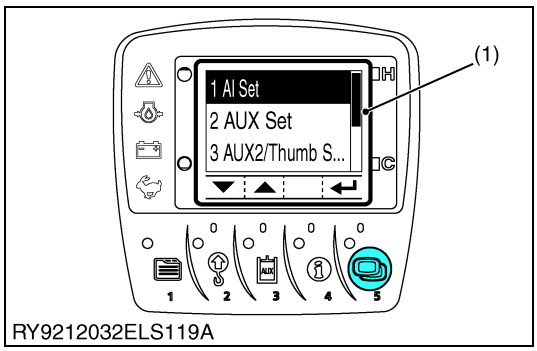
1. Key switch : OFF
2. Disconnect the accelerator sensor from the machine and test it separately.

Factory Spec	Min.	Max.
Accelerator sensor 4 to 8	1 kΩ ± 10 %	1 kΩ ± 10 %
Accelerator sensor 3 to 4	720 Ω	380 Ω
Accelerator sensor 3 to 8	380 Ω	720 Ω

Criteria	Assessment Results
Regular : Within factory spec (OK)	
Irregular : Outside factory spec (NG)	

(a) Accelerator dial terminal numbers

RY9212001ELS0169US0



RY9212032ELS119A

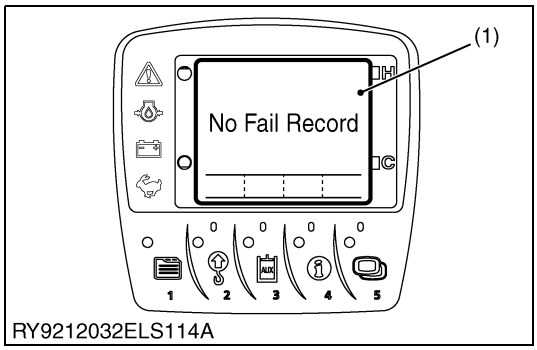
2. Settings after replacing device

1. Select the AI setting.

Criteria	Assessment Results
Regular : setting complete (OK)	
Irregular : setting failed (NG)	

(1) AI Set
AUX Set
AUX2/Thumb Set

RY9212032ELS0005US0



RY9212032ELS114A

3. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

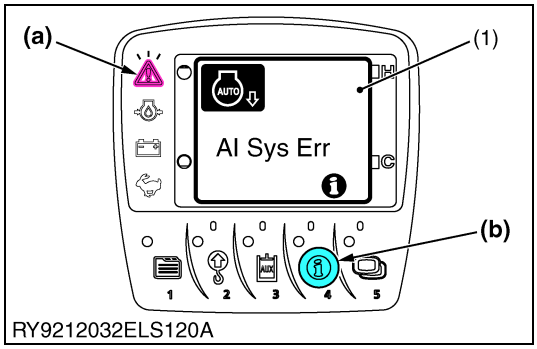
Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

(1) No Fail Record

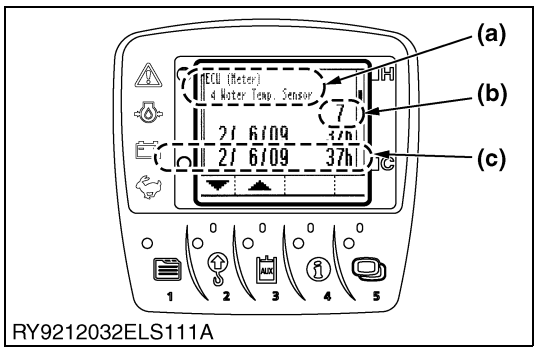
RY9212032ELS0003US0

(3) AI Motor Errors

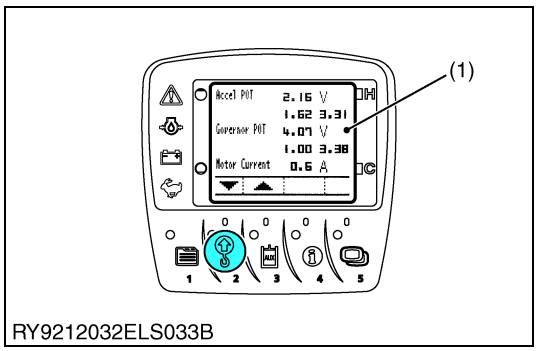
[A] Checking via the LCD Panel Display



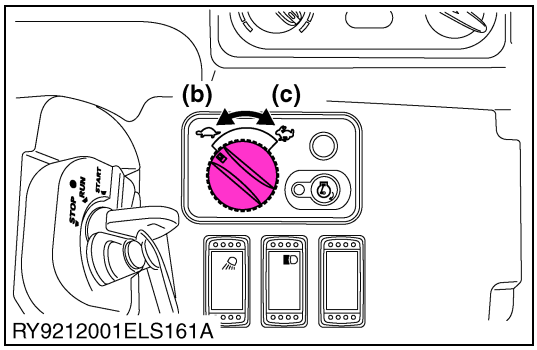
RY9212032ELS120A



RY9212032ELS111A



RY9212032ELS033B



RY9212001ELS161A

1. Content of LCD Panel Display

1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Press the info button **(b)** and check the additional content.

   Ex.) Governor sensor

(1) AI Sys Err

(a) Warning lamp
(b) Info button

RY9212032ELS0007US0

2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

   Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0

3. Tester mode

1. Select the tester mode.
2. Start the engine.
3. Turn the accelerator dial to the right (hi-speed) and to the left (lo-speed) and check the AI motor amperage based on the following table.

Motor Amperage	AI Motor Operating	0.0 to 15.0 A
	AI Motor Stopped	0.0 to 2.0 A

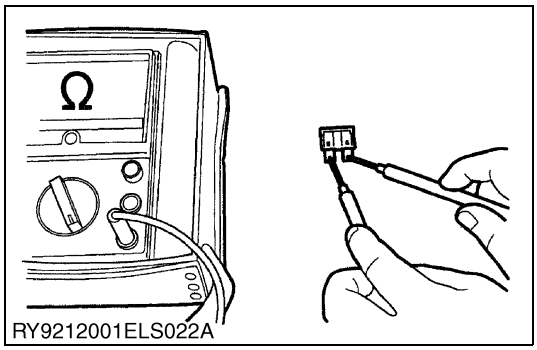
Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) Accel POT
Governor POT
Motor Current

(b) Slow
(c) Fast

RY9212032ELS0021US0

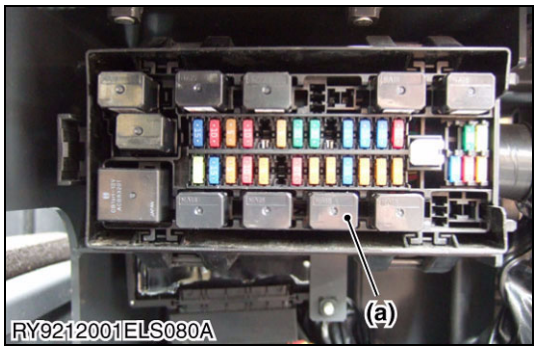
[B] Inspecting each Device Visually and Physically



1. Checking fuses

1. Check whether the AI motor fuse (15A) is blown.

RY9212001ELS0171US0



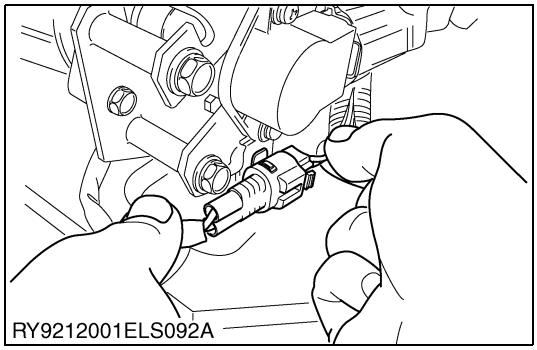
2. Checking relays

1. Replace either the left or the right AI motor relay.
   After replacing it, check for normal operation.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

(a) AI motor relay

RY9212001ELS0172US0



3. Causes when a break in wiring

[Test Conditions]

1. Key switch : OFF
2. AI motor connector CN5 disconnected.
3. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force) If it comes off, plug the connector back in securely and check the AI motor's amperage again in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

RY9212001ELS0173US0

4. Causes when a short

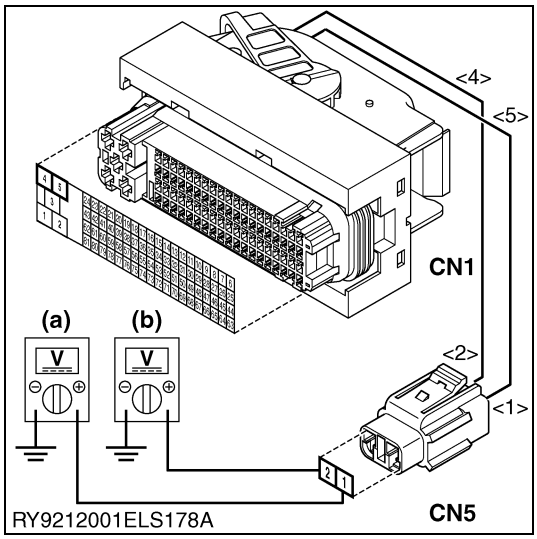
[Test Conditions]

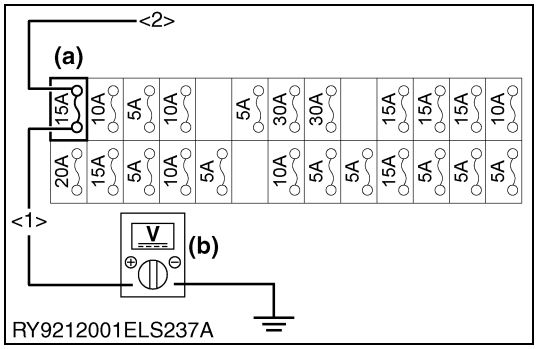
1. Key switch : OFF
2. The wiring of the AI motor connector CN5 is pinched against or touching the body.
   If the insulation is damaged, repair it properly and check the amperage of the AI motor again in the tester mode.

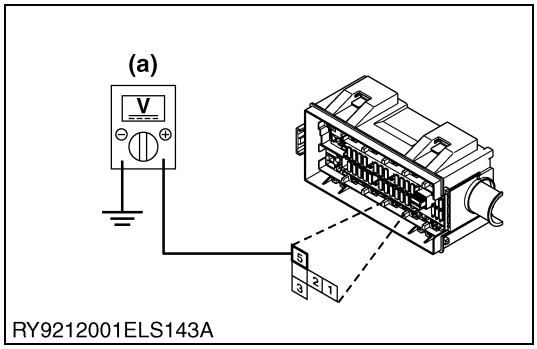
Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

RY9212001ELS0174US0

[C] Testing with a Circuit Tester







1. Voltage check-1

[Measurement Conditions]

1. Disconnect the AI motor connector CN5.
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	AI motor connector CN5	<1>	Body GND	–	
(b)	AI motor connector CN5	<2>	Body GND	–	

Regular : 12 V (OK)
Irregular : Large discrepancy from 12 V (NG)

RY9212001ELS0175US0

2. Voltage check-2

[Measurement Conditions]

1. Remove the AI motor fuse (15A).
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(b)	AI motor fuse (15A), fuse box side	<1>	Body GND	–	

Regular : 12 V (OK)
Irregular : Large discrepancy from 12 V (NG)

(a) AI motor fuse (15A)

RY9212001ELS0176US0

3. Voltage check-3

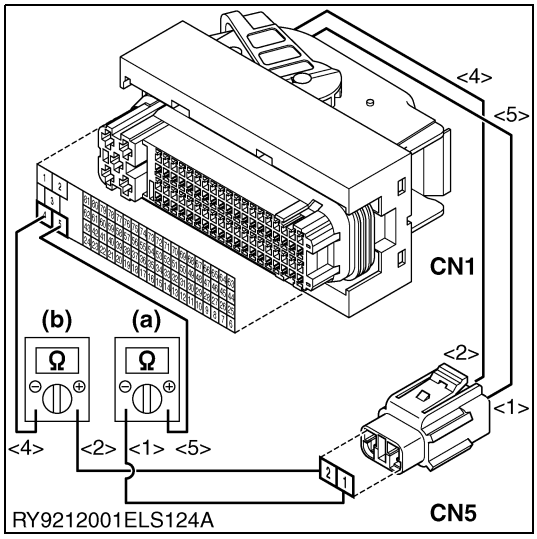
[Measurement Conditions]

1. Remove the AI motor relay.
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	AI motor relay fuse box side	<5>	Body GND	–	

Regular : 12 V (OK)
Irregular : Large discrepancy from 12 V (NG)

RY9212001ELS0177US0



4. Continuity check-1

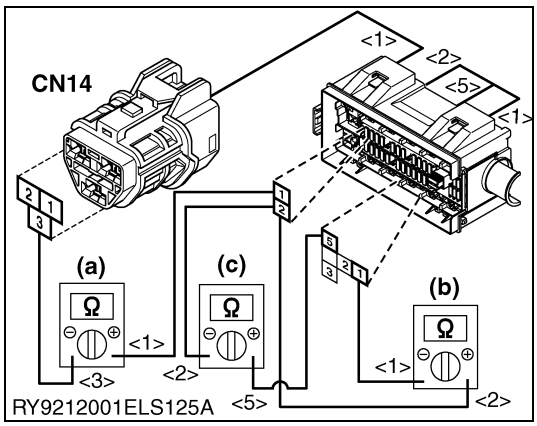
[Measurement Conditions]

1. Key switch : OFF
2. Disconnect the AI motor connector CN5.
3. Disconnect the ECU connector CN1.
4. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	AI motor connector CN5	<1>	ECU connector CN1	<5>	
(b)	AI motor connector CN5	<2>	ECU connector CN1	<4>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0178US0



5. Continuity check-2

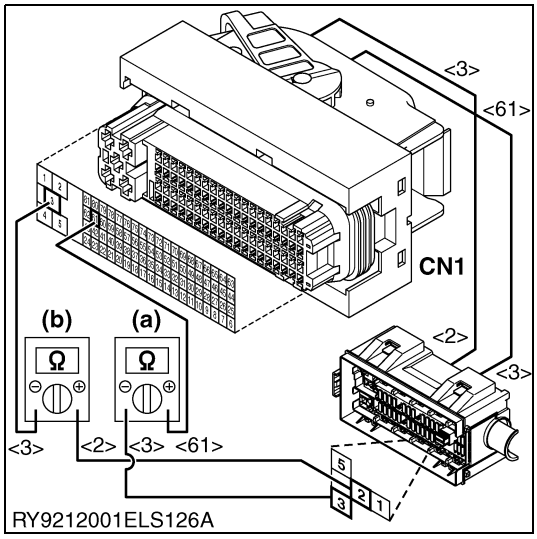
[Measurement Conditions]

1. Key switch : OFF
2. Remove the AI motor fuse (15A).
3. Remove the AI motor relay.
4. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Key switch connector CN14	<3>	AI motor fuse (15A)	<1>	
(b)	AI motor fuse (15A)	<2>	AI motor relay fuse box side	<1>	
(c)	AI motor fuse (15A)	<2>	AI motor relay fuse box side	<5>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0179US0



6. Continuity check-3

[Measurement Conditions]

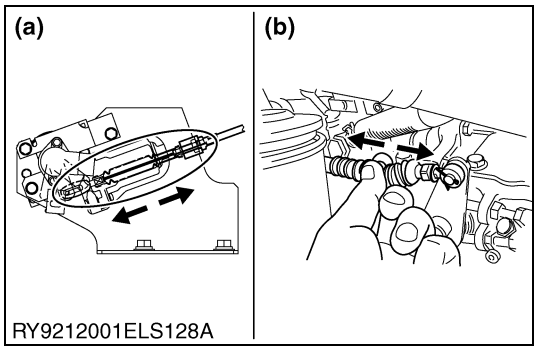
1. Key switch : OFF
2. Remove the AI motor fuse (15A).
3. Remove the AI motor relay.
4. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	AI motor relay fuse box side	<3>	ECU connector CN1	<61>	
(b)	AI motor relay fuse box side	<2>	ECU connector CN1	<3>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0180US0

[D] Testing the Equipment Itself



RY9212001ELS128A

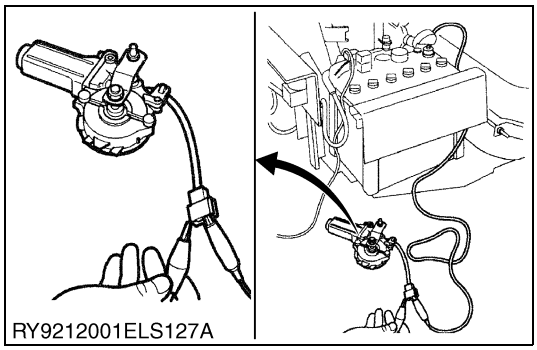
1. Inspecting the accelerator wire

[Test Conditions]

1. Key switch : OFF
2. Pull the accelerator wire on the engine side **(b)** and check whether the accelerator wire on the AI motor side **(a)** is stuck.

(a) AI motor side **(b) Engine side**

RY9212001ELS0181US0

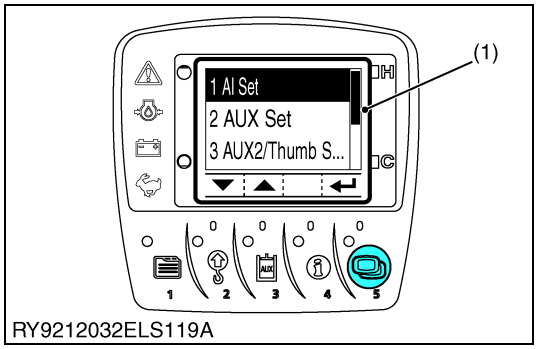

RY9212001ELS127A

2. Testing the AI motor

[Test Conditions]

1. Remove the AI motor from the machine.
2. Check to see if the AI motor will rotate when driven by an external 12V source. (No left and right. Motor reverses if polarity is reversed.)
3. The connector terminals are close together, so be careful not to short them when applying electricity. If you are concerned with the danger of shorting them, replace with a new AI motor.

RY9212001ELS0182US0



RY9212032ELS119A

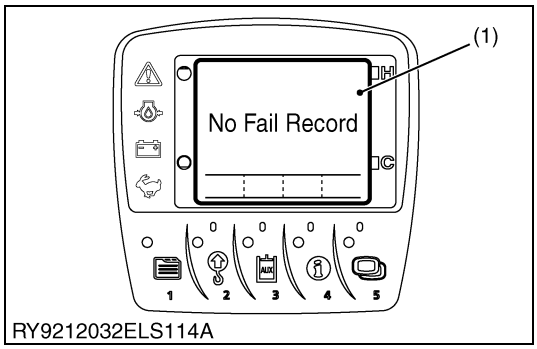
3. Settings after replacing device

1. Select the AI setting.

Criteria	Assessment Results
Regular : setting complete (OK)	
Irregular : setting failed (NG)	

(1) AI Set
AUX Set
AUX2/Thumb Set

RY9212032ELS0022US0



RY9212032ELS114A

4. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

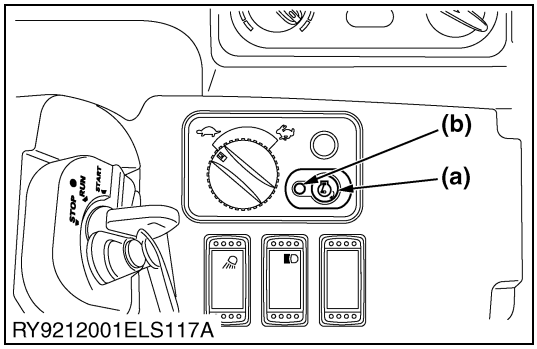
Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

(1) No Fail Record

RY9212032ELS0004US0

(4) Testing the AI Pressure Switch

[A] Checking via the LCD Panel Display



RY9212001ELS117A

1. Content of LCD Panel Display

1. When the auto-idle switch **(a)** on the panel is pressed, check whether the auto-idle lamp **(b)** lights or is off.

Criteria	Assessment Results
Regular : lamp lights (OK)	
Irregular : lamp off (NG)	

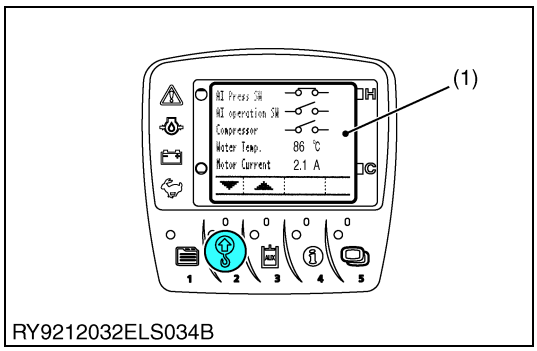
(a) Auto-idle switch **(b) Auto-idle lamp**

RY9212001ELS0049US0

2. Reading the failure history

1. Checking the failure history is not required.

RY9212001ELS0048US0



RY9212032ELS034B

3. Tester mode

1. Select the tester mode.
2. Start the engine.
3. Check the operation of the auto-idle switch according to the table below.

	Regular	When cut off	When shorted
Operating			
Not operating			

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) AI Press SW
AI operation SW
Compressor
Water Temp.
Motor Current

RY9212032ELS0023US0

[B] Inspecting each Device Visually and Physically

1. Checking fuses

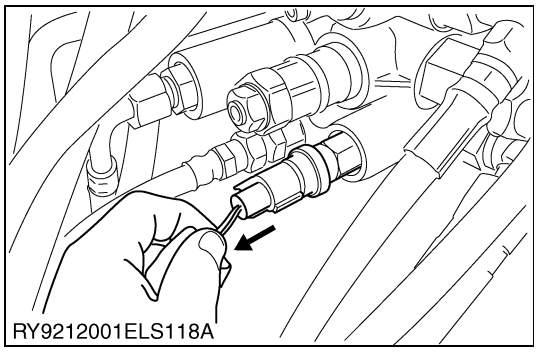
1. Checking fuses is not necessary.

RY9212001ELS0008US0

2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0


RY9212001ELS118A

3. Causes when a break in wiring

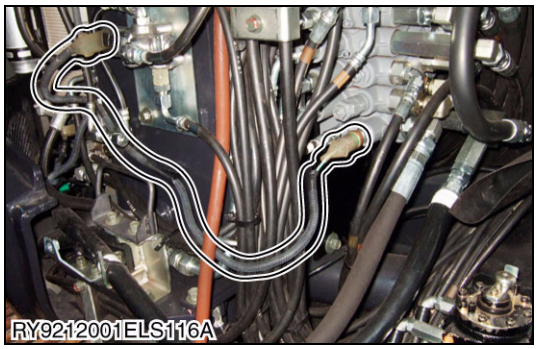
[Test Conditions]

1. Key switch : OFF
2. The auto-idle pressure switch connector CN8 is disconnected.
3. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force) If it comes off, plug the connector back in securely and check the operation of the auto-idle switch again in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

RY9212001ELS0185US0


RY9212001ELS116A

4. Causes when a short

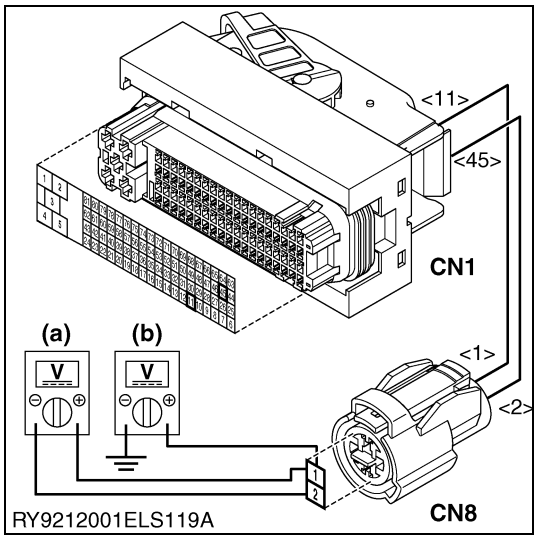
[Test Conditions]

1. Key switch : OFF
2. The wire of the auto-idle pressure switch connector CN8 is pinched against or touching the body.
   If the insulation is damaged, repair it properly and check the operation of the auto-idle switch again in the tester mode.

Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

RY9212001ELS0186US0

[C] Testing with a Circuit Tester



1. Voltage check

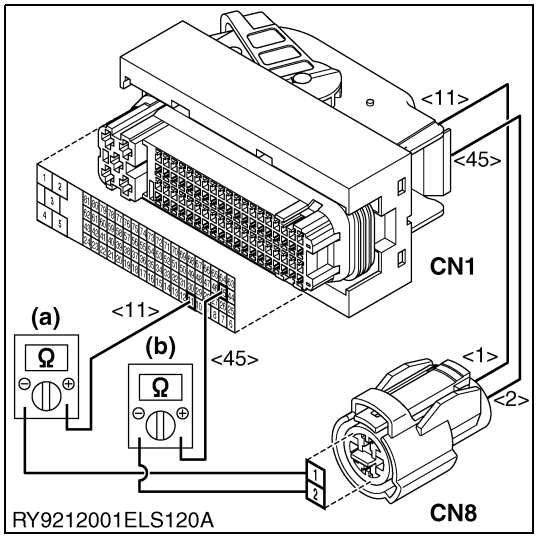
[Measurement Conditions]

1. Disconnect the auto-idle pressure switch connector CN8.
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Auto-idle pressure switch connector CN8	<1>	Auto-idle pressure switch connector CN8	<2>	
(b)	Auto-idle pressure switch connector CN8	<1>	Body GND	–	

Regular : 12 V (OK)
Irregular : Large discrepancy from 12 V (NG)

RY9212001ELS0187US0



2. Continuity check

[Measurement Conditions]

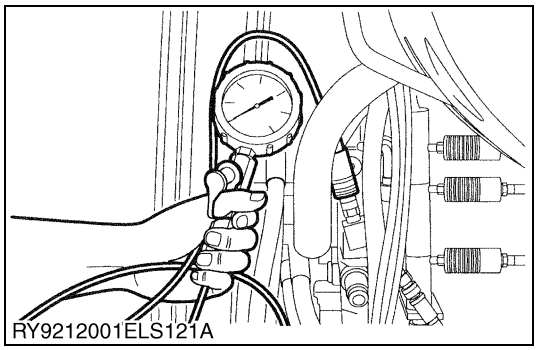
1. Key switch : OFF
2. Disconnect the auto-idle pressure switch connector CN8.
3. Disconnect the ECU connector CN1.
4. Test the continuity based on the table below.

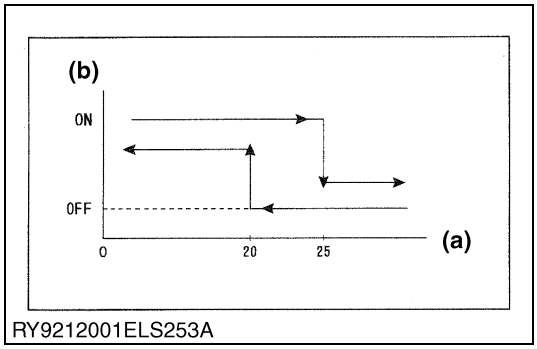
Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Auto-idle pressure switch connector CN8	<1>	ECU connector CN1	<11>	
(b)	Auto-idle pressure switch connector CN8	<2>	ECU connector CN1	<45>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

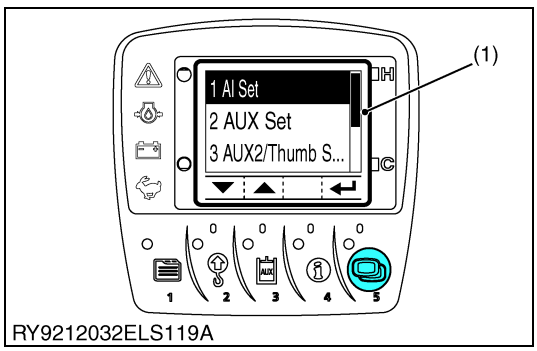
RY9212001ELS0188US0

[D] Testing the Equipment Itself

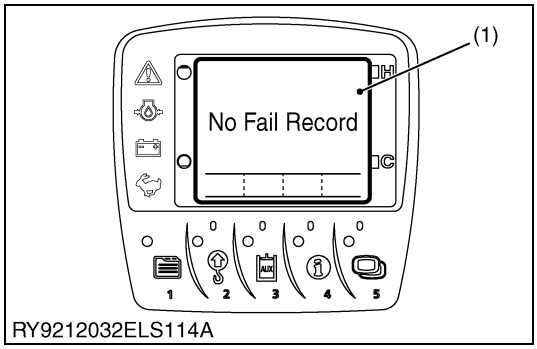

RY9212001ELS121A



RY9212001ELS253A



RY9212032ELS119A



RY9212032ELS114A

1. Measuring the auto-idle pressure

[Measurement Conditions]

1. Remove the auto-idle pressure switch from the control valve and attach a pressure gauge and test the pressure.

Operating pressure	AI pressure switch	Engine RPM
25 ± 3 kgf/cm^2 2.5 ± 0.3 MPa 360 ± 45 psi	OFF	Accelerate from idling rpm to max rpm.
20 ± 3 kgf/cm^2 2.0 ± 0.3 MPa 280 ± 45 psi	ON	Decelerate from max rpm to idling rpm.

The AI switch is normally closed (normally ON)

Criteria	Assessment Results
Regular : Within factory spec (OK)	
Irregular : Outside factory spec (NG)	

(a) Pressure **(b) State of Pressure switch**

RY9212001ELS0189US0

2. Settings after replacing device

1. Select the AI setting.

Criteria	Assessment Results
Regular : setting complete (OK)	
Irregular : setting failed (NG)	

(1) AI Set
AUX Set
AUX2/Thumb Set

RY9212032ELS0005US0

3. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

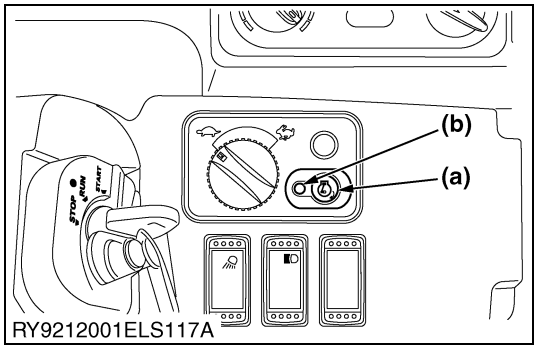
Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

(1) No Fail Record

RY9212032ELS0003US0

(5) Testing the AI Switch

[A] Checking via the LCD Panel Display



RY9212001ELS117A

1. Content of LCD Panel Display

1. When the auto-idle switch **(a)** on the panel is pressed, check whether the auto-idle lamp **(b)** lights or is off.

Criteria	Assessment Results
Regular : lamp lights (OK)	
Irregular : lamp off (NG)	

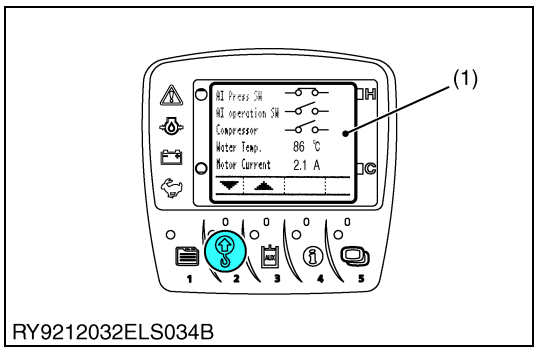
(a) Auto-idle switch **(b) Auto-idle lamp**

RY9212001ELS0049US0

2. Reading the failure history

1. Checking the failure history is not required.

RY9212001ELS0048US0



RY9212032ELS034B

3. Tester mode

1. Select the tester mode.
2. Check the operation of the oil switch according to the table below.

	Regular	When cut off	When shorted
With AI SW pressed			
With AI SW released			

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) AI Press SW
AI operation SW
Compressor
Water Temp.
Motor Current

RY9212032ELS0024US0

[B] Inspecting each Device Visually and Physically

1. Checking fuses

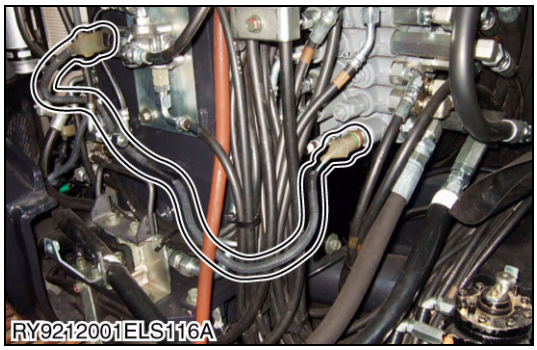
1. Checking fuses is not necessary.

RY9212001ELS0008US0

2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0



3. Causes when a break in wiring

[Test Conditions]

1. Key switch : OFF
2. Auto-idle console connector CN421 disconnected.
3. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force) If it comes off, plug the connector back in securely and check the operation of the auto-idle switch again in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

RY9212001ELS0191US0

4. Causes when a short

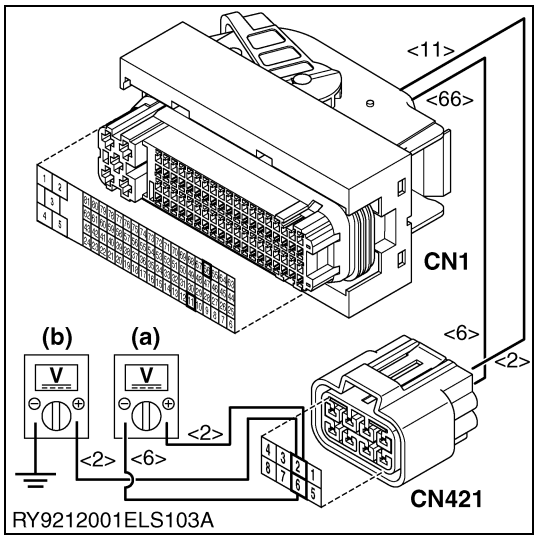
[Test Conditions]

1. Key switch : OFF
2. The wiring of the auto-idle console connector CN421 is pinched against or touching the body.
   If the insulation is damaged, repair it properly and check the operation of the auto-idle switch again in the tester mode.

Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

RY9212001ELS0192US0

[C] Testing with a Circuit Tester



RY9212001ELS103A

1. Voltage check

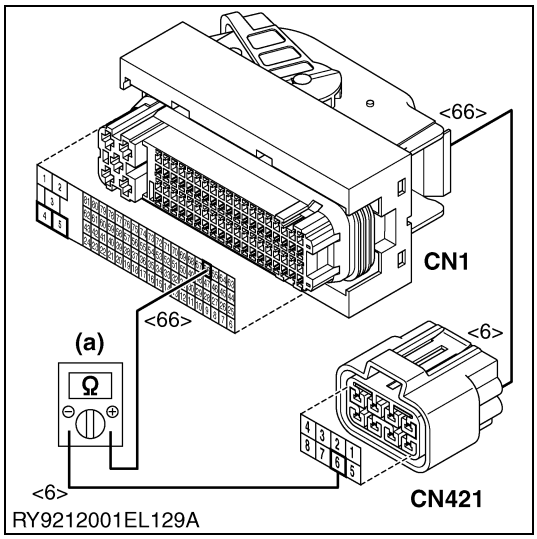
[Measurement Conditions]

1. Disconnect auto-idle console connector CN421.
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Auto-idle console connector CN421	<2>	Auto-idle console connector CN421	<6>	
(b)	Auto-idle console connector CN421	<2>	Body GND	–	

Regular : 12 V (OK)
Irregular : Large discrepancy from 12 V (NG)

RY9212001ELS0193US0



RY9212001EL129A

2. Continuity check

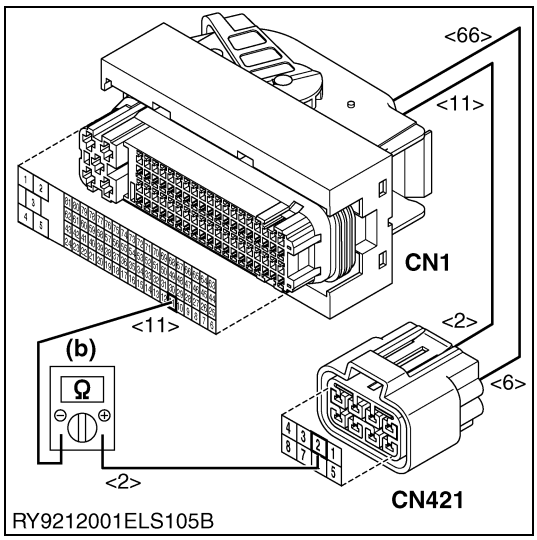
[Measurement Conditions]

1. Key switch : OFF
2. Disconnect auto-idle console connector CN421.
3. Disconnect the ECU connector CN1.
4. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Auto-idle console connector CN421	<6>	ECU connector CN1	<66>	
(b)	Auto-idle console connector CN421	<2>	ECU connector CN1	<11>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0194US0



RY9212001ELS105B

[D] Testing the Equipment Itself

RY9212001ELS154A

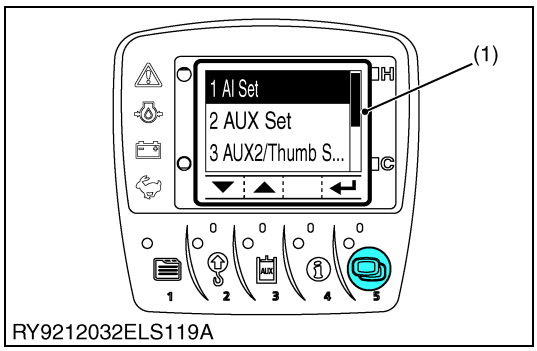
1. Testing the accelerator dial

[Measurement Conditions]

1. Key switch : OFF
2. Remove the accelerator dial from the machine and replace with a new accelerator dial.
3. Select the tester mode and check the voltage of the accelerator dial.

Criteria	Assessment Results
Regular : Within factory spec (OK)	
Irregular : Outside factory spec (NG)	

RY9212001ELS0196US0



RY9212032ELS119A

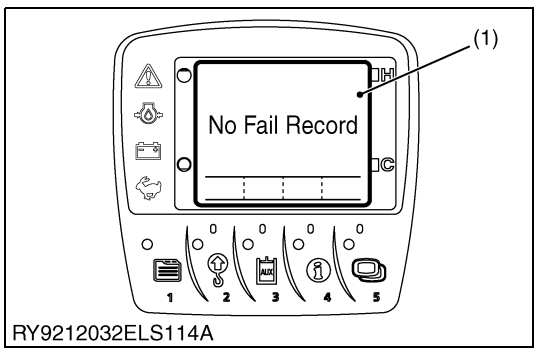
2. Settings after replacing device

1. Select the AI setting.

Criteria	Assessment Results
Regular : setting complete (OK)	
Irregular : setting failed (NG)	

(1) AI Set
AUX Set
AUX2/Thumb Set

RY9212032ELS0005US0



RY9212032ELS114A

3. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

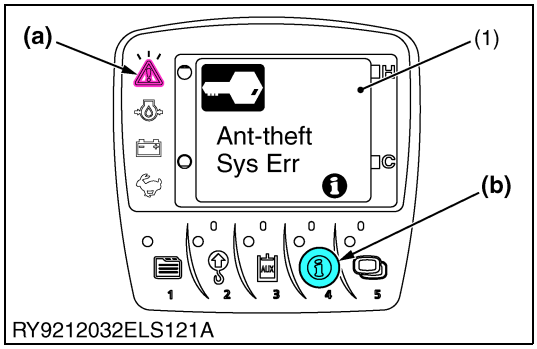
(1) No Fail Record

RY9212032ELS0003US0

[4] ANTI-THEFT (AT) SYSTEM

(1) Anti-Theft System Errors

[A] Checking via the LCD Panel Display



RY9212032ELS121A

1. Content of LCD Panel Display

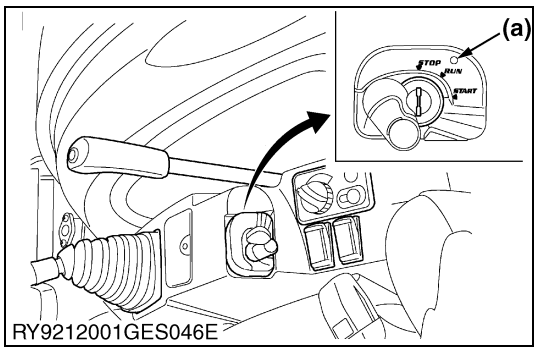
1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Press the info button **(b)** and check the additional content.

Ex.) Antenna

(1) Ant-theft Sys Err

(a) Warning lamp
(b) Info button

RY9212032ELS0025US0



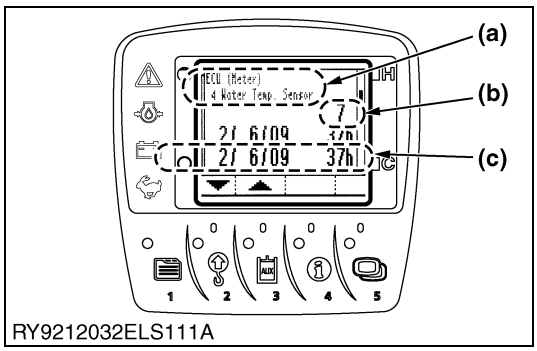
RY9212001GES046E

[Test Conditions]

1. Key switch : OFF
2. Check whether the anti-theft indicator is blinking or not.

(a) Anti-theft indicator

RY9212001ELS0198US0



RY9212032ELS111A

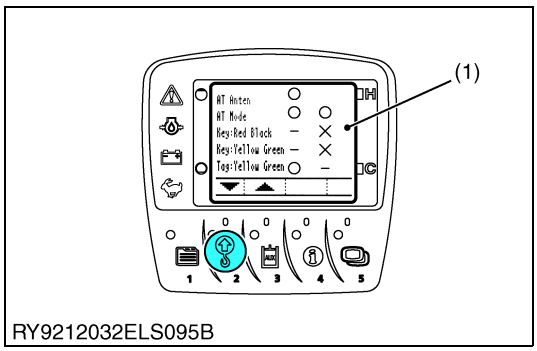
2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0



RY9212032ELS095B

3. Tester mode

1. Select the tester mode.
2. Check the anti-theft antenna.

	Regular		Irregular	
Anti-theft antenna	OK		NG	
On/off Valid cancel	OK	OK	NG	OK
Red key Black key	–	OK	–	–

(1) AT Anten
AT Mode
Key : Red Black
Key : Yellow Green
Tag : Yellow Green

RY9212032ELS0026US0

[B] Inspecting each Device Visually and Physically

1. Checking fuses

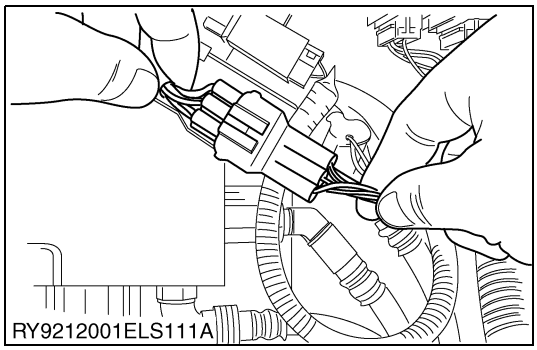
1. Checking fuses is not necessary.

RY9212001ELS0008US0

2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0


RY9212001ELS111A

3. Causes when a break in wiring

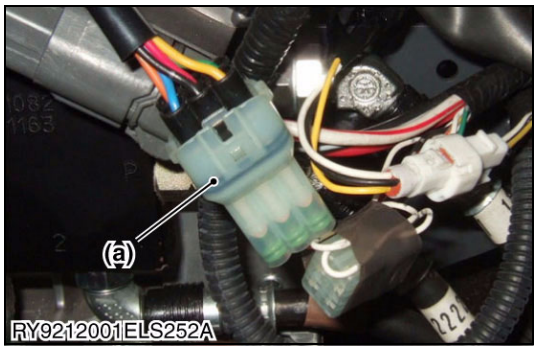
[Measurement Conditions]

1. Key switch : OFF
2. Anti-theft connector CN441 disconnected.
3. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force) If it comes off, plug the connector back in securely and check the anti-theft antenna again in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

RY9212001ELS0201US0



RY9212001ELS252A

4. Causes when a short

[Measurement Conditions]

1. Key switch : OFF
2. The anti-theft connector wire is pinched against or touching the body.
   If the insulation is damaged, repair it properly and check the operation of the anti-theft antenna again in the tester mode.

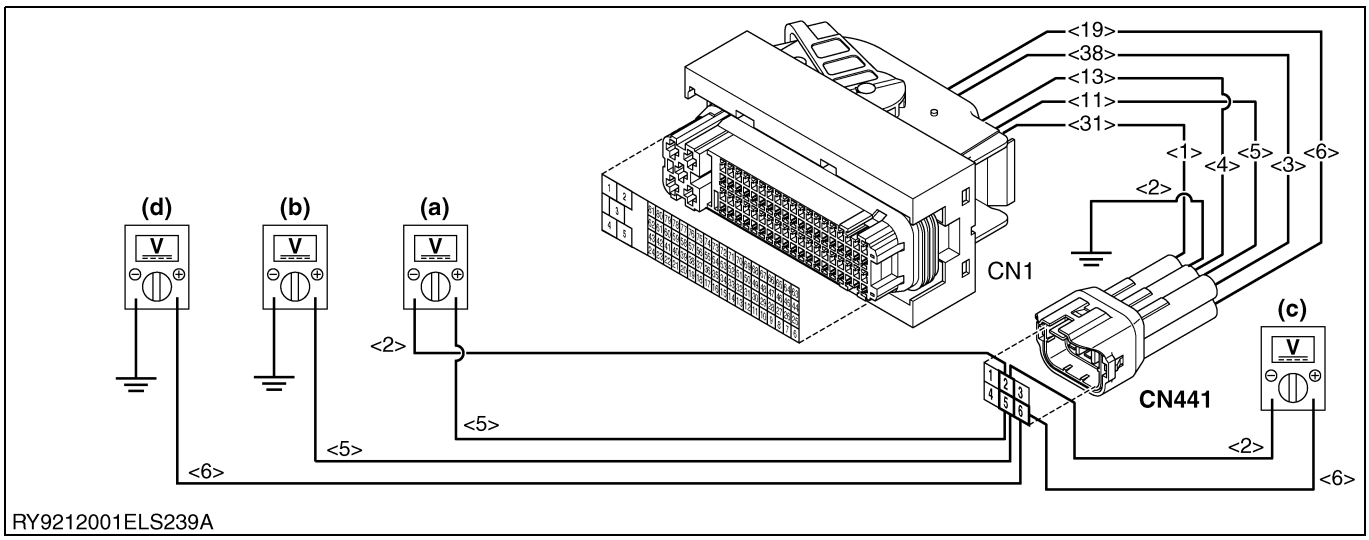
Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

(a) Anti-theft connector

RY9212001ELS0202US0

[C] Testing with a Circuit Tester

1. Voltage check



RY9212001ELS239A

[Measurement Conditions]

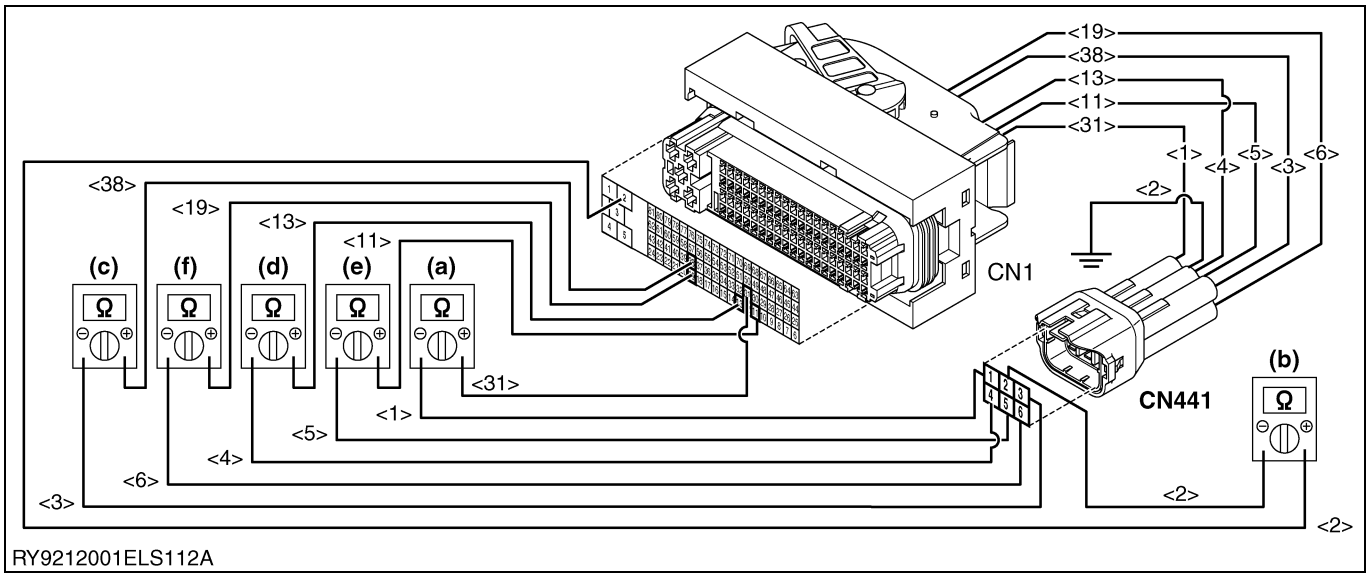
1. Disconnect the anti-theft connector CN441.
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	Anti-theft connector CN441	<5>	Anti-theft connector CN441	<2>	
(b)	Anti-theft connector CN441	<5>	Body GND	–	
(c)	Anti-theft connector CN441	<6>	Anti-theft connector CN441	<2>	
(d)	Anti-theft connector CN441	<6>	Body GND	–	

Regular : 5V (OK)
Irregular : Large discrepancy from 5V (NG)

RY9212001ELS0203US0

2. Continuity check



RY9212001ELS112A

[Measurement Conditions]

1. Key switch : OFF
2. Disconnect the anti-theft connector CN441.
3. Disconnect the ECU connector CN1.
4. Test the continuity based on the table below.

Mea-sure-ment	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assess-ment Results
(a)	Anti-theft connector CN441	<1>	ECU connector CN1	<31>	
(b)	Anti-theft connector CN441	<2>	ECU connector CN1	<2>	
(c)	Anti-theft connector CN441	<3>	ECU connector CN1	<38>	
(d)	Anti-theft connector CN441	<4>	ECU connector CN1	<13>	
(e)	Anti-theft connector CN441	<5>	ECU connector CN1	<11>	
(f)	Anti-theft connector CN441	<6>	ECU connector CN1	<19>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212001ELS0204US0

[D] Testing the Equipment Itself

RY9212001ELS240A

1. Inspecting the anti-theft antenna

[Measurement Conditions]

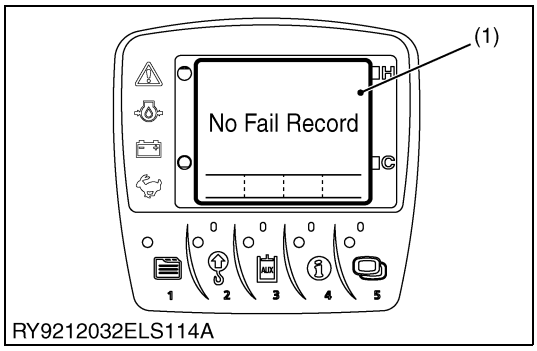
1. Key switch : OFF
2. Replace with a new antenna.
3. Select the tester mode and check the anti-theft antenna.

RY9212001ELS0205US0

2. Settings after replacing device

1. No settings required.

RY9212001ELS0013US0



RY9212032ELS114A

3. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

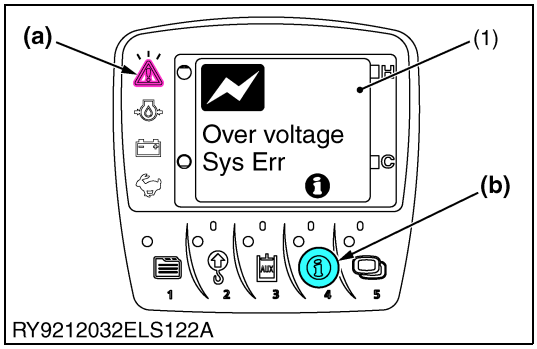
(1) No Fail Record

RY9212032ELS0003US0

[5] POWER SUPPLY SYSTEM

(1) Over voltage

[A] Checking via the LCD Panel Display



RY9212032ELS122A

1. Content of LCD Panel Display

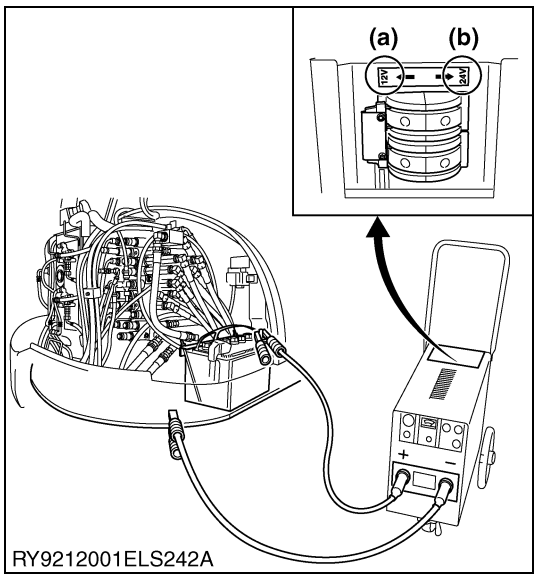
1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Press the info button **(b)** and check the additional content.

Ex.) Over voltage

(1) Over voltage Sys Err

(a) Warning lamp
(b) Info button

RY9212032ELS0027US0



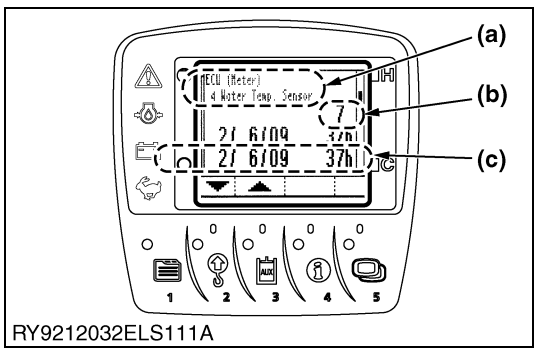
RY9212001ELS242A

Check whether the machine has been jump started with a 24 V battery.

Ex.) Whether switched to 24V

(a) 12 V **(b) 24 V**

RY9212001ELS0207US0



RY9212032ELS111A

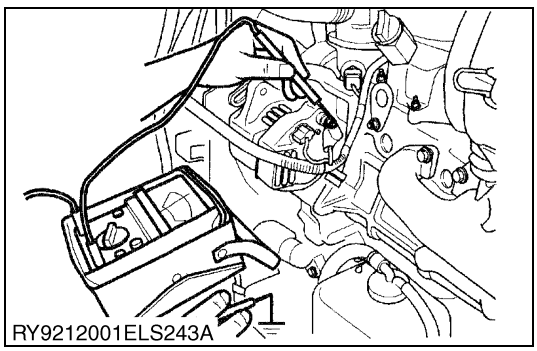
2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0

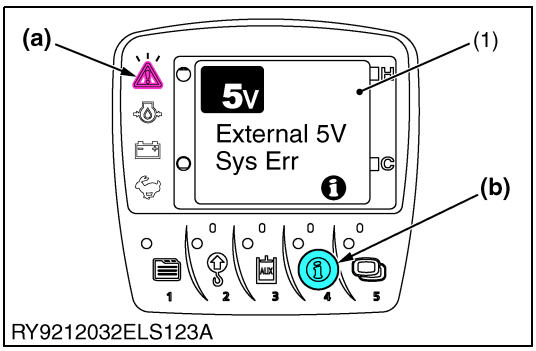

RY9212001ELS243A

An alternator recharging error is also possible.
Refer to the pages on the recharging system errors.

RY9212001ELS0209US0

(2) 5V Short System Error

[A] Checking via the LCD Panel Display



RY9212032ELS123A

1. Content of LCD Panel Display

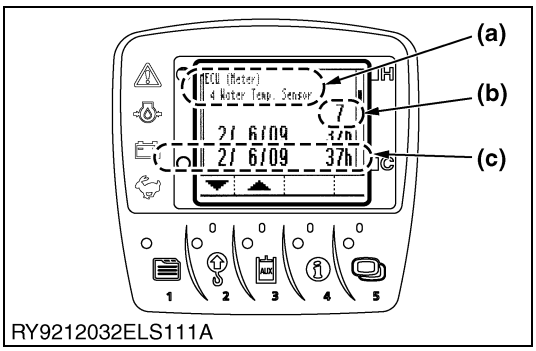
1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Press the info button **(b)** and check the additional content.

   Ex.) External 5 V

(1) External 5V Sys Err

(a) Warning lamp
(b) Info button

RY9212032ELS0028US0



RY9212032ELS111A

2. Reading the failure history

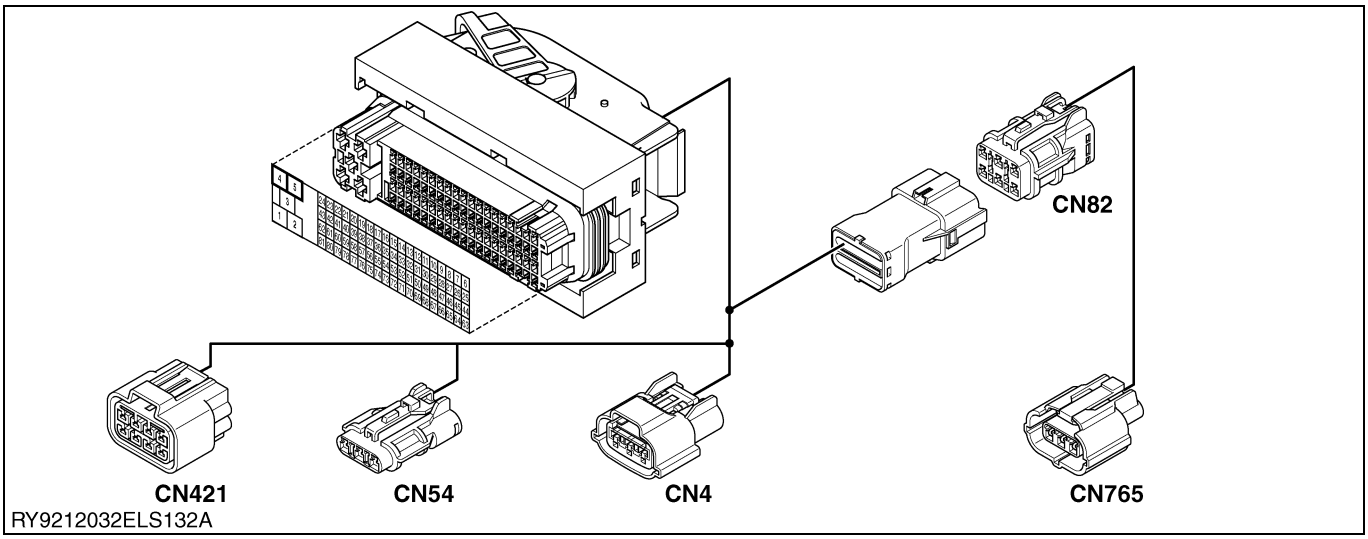
1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

   Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0

Testing the 3.5V line



RY9212032ELS132A

[Test Conditions]

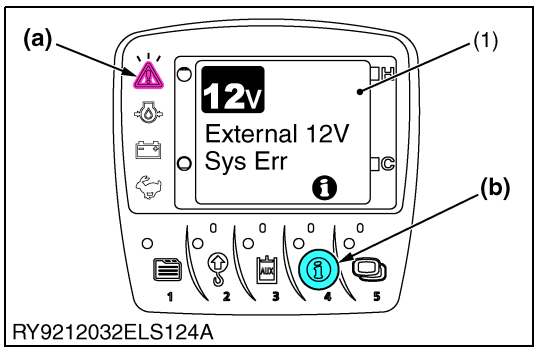
1. Check whether each line is pinched against or touching the body If the insulation is damaged, repair it properly and check the meter display again.

- CN4 : Governor sensor connector
- CN54 : Arm main connector
- CN421 : AI console connector
- CN765 : Boom bottom pressure sensor connector

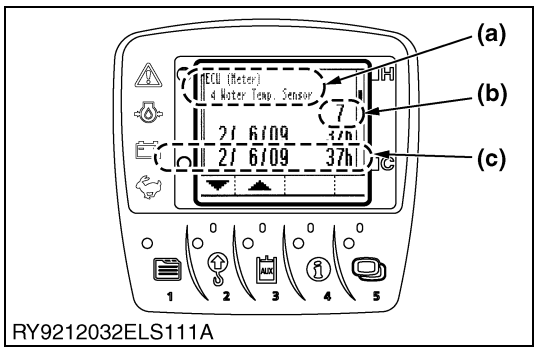
RY9212001ELS0212US0

(3) 12V Short System Error

[A] Checking via the LCD Panel Display



RY9212032ELS124A



RY9212032ELS111A

1. Content of LCD Panel Display

1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Press the info button **(b)** and check the additional content.

   Ex.) External 12V

(1) External 12V Sys Err

(a) Warning lamp
(b) Info button

RY9212032ELS0029US0

2. Reading the failure history

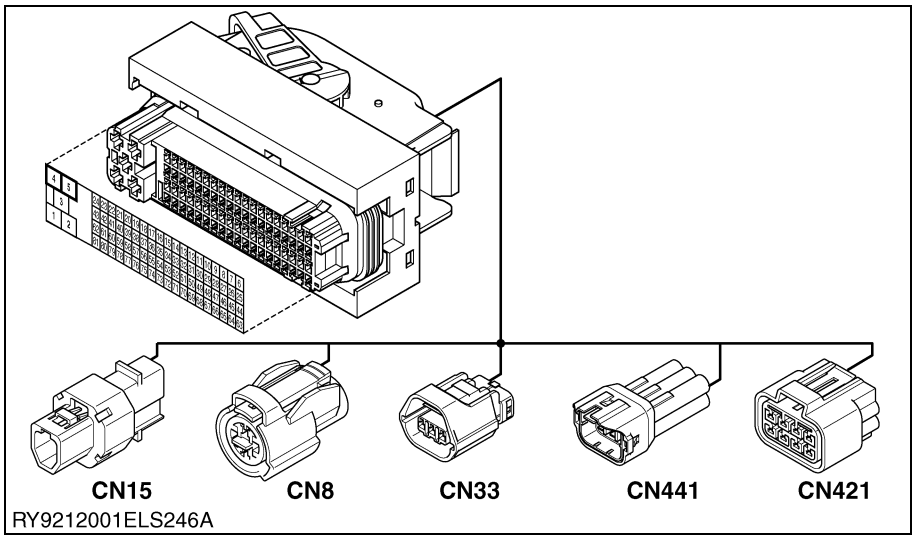
1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

   Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0

3. Testing the 12V line



RY9212001ELS246A

[Test Conditions]

1. Check whether each line is pinched against or touching the body If the insulation is damaged, repair it properly and check the meter display again.

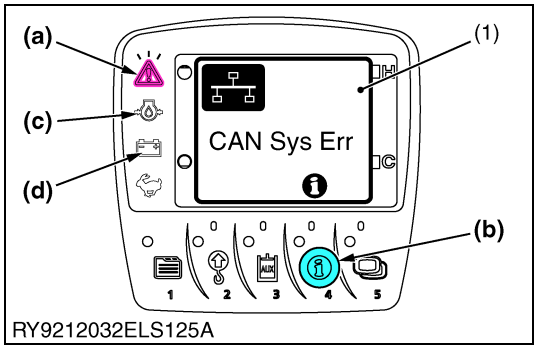
- CN33 : Engine rpm sensor connector
- CN441 : Anti-theft
- CN5 : AI motor connector
- CN15 : 2-speed switch connector
- CN421 : AI console connector
- CN8 : AI pressure sensor connector

RY9212032ELS0093US0

[6] COMMUNICATION SYSTEM

(1) CAN Communication Errors

[A] Checking via the LCD Panel Display



RY9212032ELS125A

1. Content of LCD Panel Display

1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Press the info button **(b)** and check the additional content.

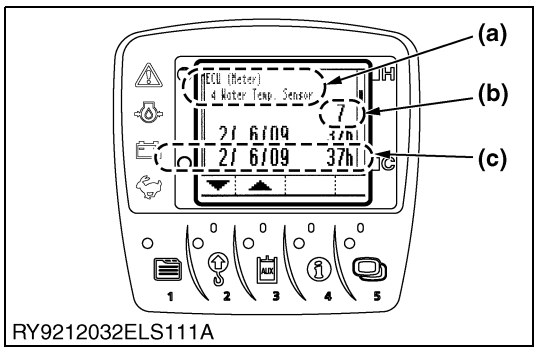
   EX.) CAN system (main)

- When a CAN communication error is displayed, the oil lamp **(c)** and charging lamp **(d)** light up and the engine will not start.

(1) CAN Sys Err

(a) Warning lamp
(b) Info button
(c) Oil lamp
(d) Charging lamp

RY9212032ELS0030US0



RY9212032ELS111A

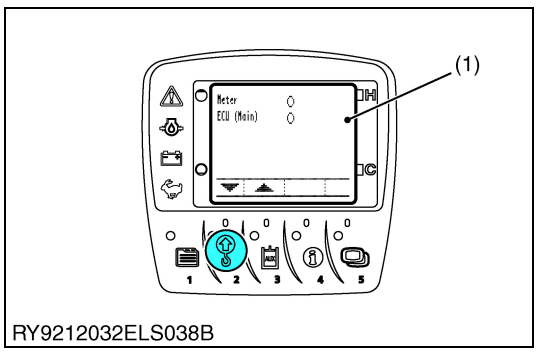
2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

   Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0



RY9212032ELS038B

3. Tester mode

1. Select the tester mode.
2. Confirm the ECU is O.

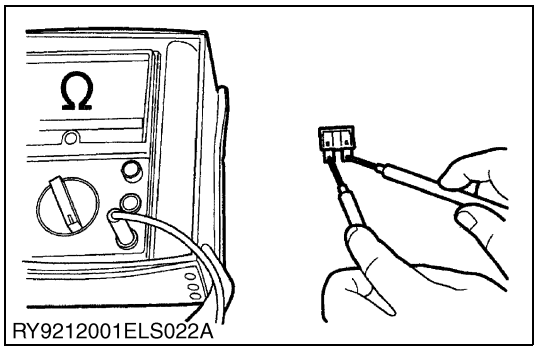
	Regular	Irregular
ECU (main)	OK	NG

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) Meter
ECU (Main)

RY9212032ELS0031US0

[B] Inspecting each Device Visually and Physically



1. Checking fuses

1. Check whether the 5 A ECU (main) fuse is blown.

RY9212001ELS0219US0

2. Checking relays

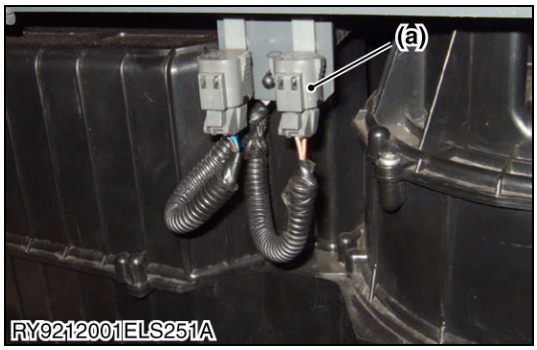
1. Checking relays is not necessary.

RY9212001ELS0009US0

3. Causes when a break in wiring

1. Checking for breaks in wiring is not necessary.

RY9212001ELS0220US0



4. Causes when a short

[Test Conditions]

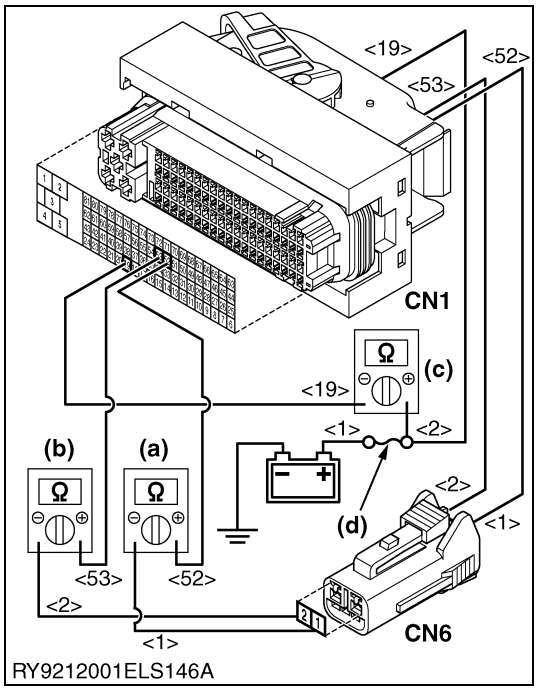
1. Key switch : OFF
2. The CAN connector CN6 wire is pinched against or touching the body. If the insulation is damaged, repair it properly and check the ECU (main) again in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
When shorted : has a break (NG)	

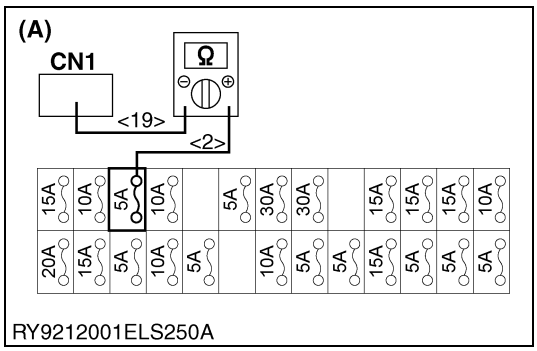
(A) CAN communication (2 wires)

RY9212001ELS0221US0

[C] Testing with a Circuit Tester



RY9212001ELS146A



RY9212001ELS250A

1. Continuity check

[Measurement Conditions]

1. Key switch : OFF
2. Disconnect the ECU connector CN1.
3. Disconnect the CAN connector CN6.
4. Check for continuity in the combinations in the table below.

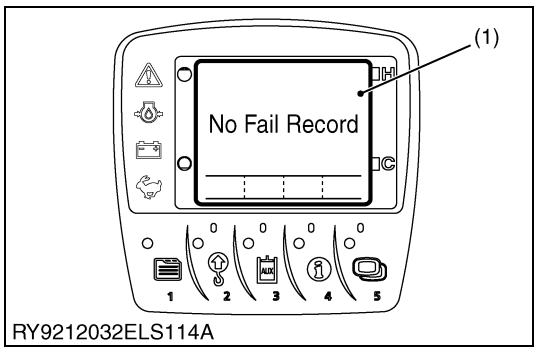
Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	CAN connector CN6	<1>	ECU connector CN1	<52>	
(b)	CAN connector CN6	<2>	ECU connector CN1	<53>	
(c)	ECU main 5A fuse	<2>	ECU connector CN1	<19>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

(A) Details on C measurements **(d) ECU (+B) 5A fuse**

RY9212001ELS0222US0

[D] Testing the Equipment Itself



RY9212032ELS114A

1. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

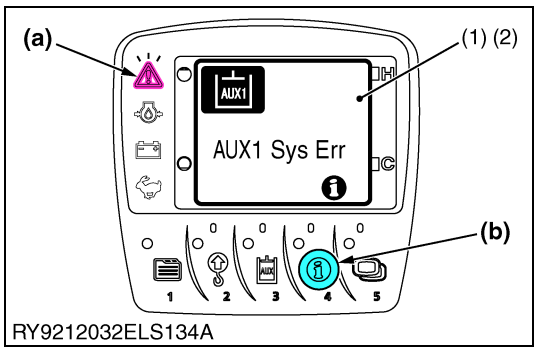
(1) No Fail Record

RY9212032ELS0032US0

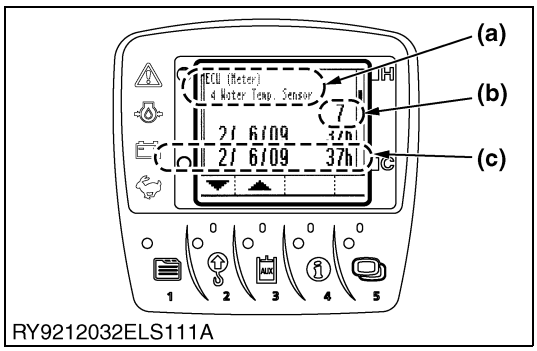
[7] AUX SYSTEM

(1) AUX1 / AUX2/Thumb System Errors

[A] Checking via the LCD Panel Display



RY9212032ELS134A



RY9212032ELS111A

1. Content of LCD Panel Display

1. Check whether or not the warning lamp **(a)** on the panel is blinking red or not.
2. Press the info button **(b)** and check the additional content.

   Ex.) AUX1 Sys Err

(1) AUX1 Sys Err
(2) AUX2 Sys Err

(a) Warning lamp
(b) Info button

RY9212032ELS0048US0

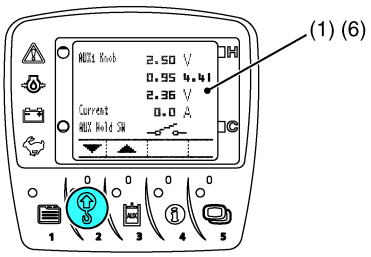
2. Reading the failure history

1. Select the failure history read mode.
2. Read the failure history and check the date (y/m/d) and hour meter of the last occurrence.

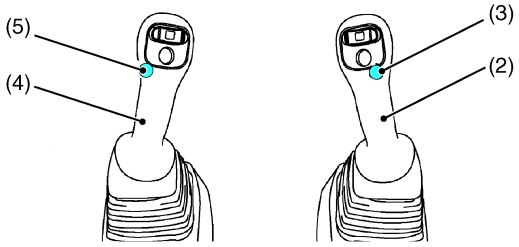
   Ex.) The last failure record was February 6, 2009 at 37 hours.

(a) Breakdowns
(b) Number of breakdowns
(c) The last breakdown date (y/m/d) and hour meter.

RY9212032ELS0001US0



RY9212032ELS070C



RY9212032ELS133A

3. Tester mode

1. Select the tester mode.
2. Start the engine.
3. Measure the voltage of AUX switch based on the table below.

	Indicated value	Set value (ex.)			At stop
		Left (small)	Right (large)	Center (medium)	
AUX1 knob switch	0.25 to 4.75 V	0.95 V	4.41 V	2.36 V	0 V
AUX2 / Thumb knob switch	0.25 to 4.75 V	0.77 V	4.21 V	2.59 V	0 V
Output current	0.5 to 2.0 A				0 to 0.2 A

	Regular	When cut off	When shorted
AUX one way hold SW ON			
AUX one way hold SW OFF			

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	
Irregular : shorted (NG)	

(1) AUX1 Knob
Current
AUX Hold SW
(2) Control Lever (Light)
(3) AUX One Way Hold SW
(4) Control Lever (Left)
(5) AUX One Way Hold SW
(6) AUX2 / Thumb knob
Current
AUX Hold SW

RY9212050ELS0052US0

[B] Inspecting each Device Visually and Physically

1. Checking fuses

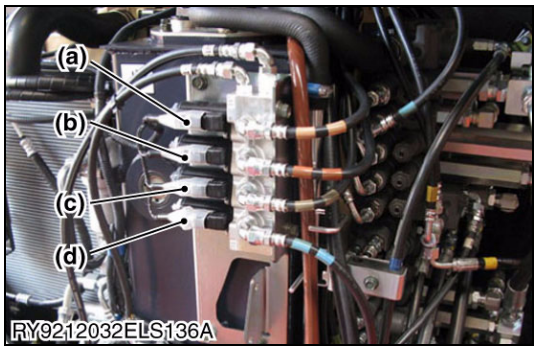
1. Checking fuses is not necessary.

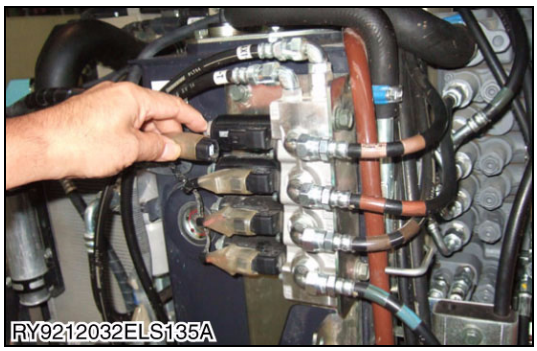
RY9212001ELS0008US0

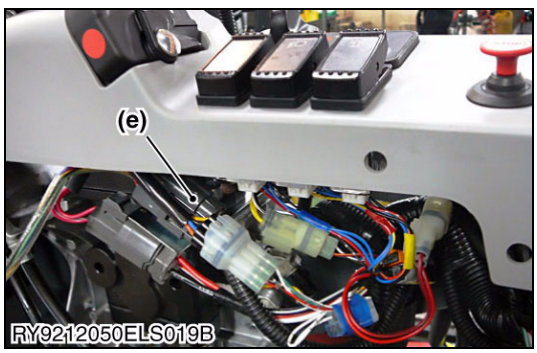
2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0







3. Causes when a break in wiring

[Test Conditions]

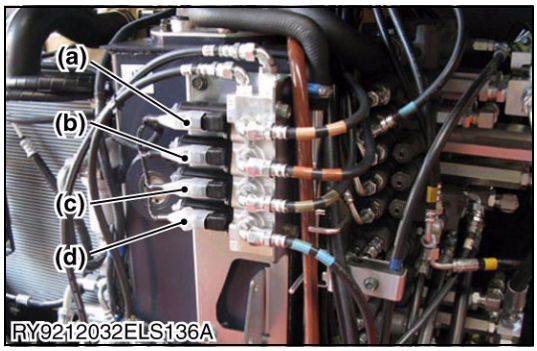
1. Key switch : OFF
2. The AUX1 / AUX2 SOL connector CN427 is disconnected.
3. The AUX switch connector CN422 is disconnected.
4. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force)
If it comes off, plug the connector back in securely and check the AUX switch and AUX1 / AUX2 SOL again in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

(a) AUX1 SOL (High)
(b) AUX1 SOL (Low)
(c) AUX2 SOL (High)
(d) AUX2 SOL (Low)
(e) AUX switch connector

RY9212032ELS0050US0



4. Causes when a short

[Test Conditions]

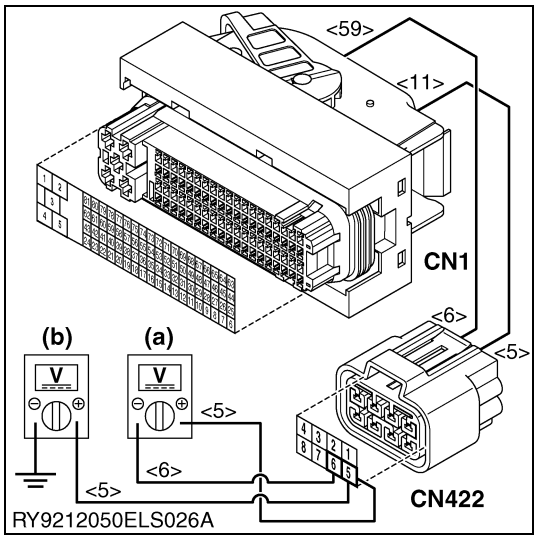
1. Key switch : OFF
2. The AUX switch connector wire and/or AUX1 / AUX2 SOL wire is pinched against or touching the body.
   If the insulation is damaged, repair it properly and check the AUX switch and AUX1 / AUX2 SOL again in the tester mode.

Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

(a) AUX1 SOL (High)
(b) AUX1 SOL (Low)
(c) AUX2 SOL (High)
(d) AUX2 SOL (Low)

RY9212032ELS0051US0

[C] Testing with a Circuit Tester



1. Voltage check (AUX one way hold Switch)

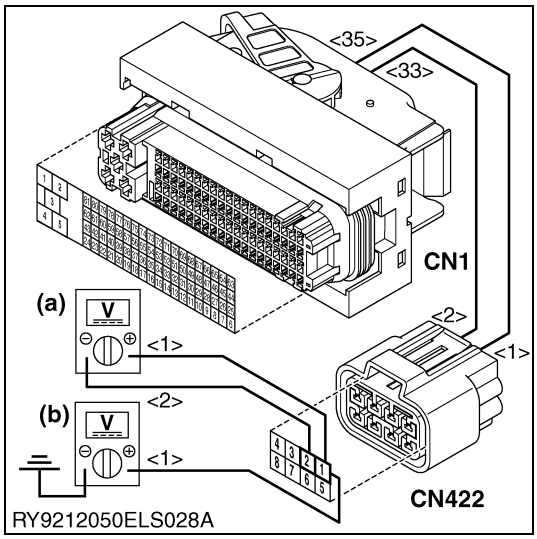
[Measurement Conditions]

1. Disconnect the AUX1 / AUX2 switch connector CN422.
2. Key switch : ON
3. AUX one way hold Switch : ON
4. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	AUX1 / AUX2 switch connector CN422	<5>	AUX1 / AUX2 switch connector CN422	<6>	
(b)	AUX1 / AUX2 switch connector CN422	<5>	Body GND	–	

Regular : 12 V (OK)
Irregular : Large discrepancy from 12 V (NG)

RY9212050ELS0043US0



2. Voltage check (AUX1 / AUX2 Switch)

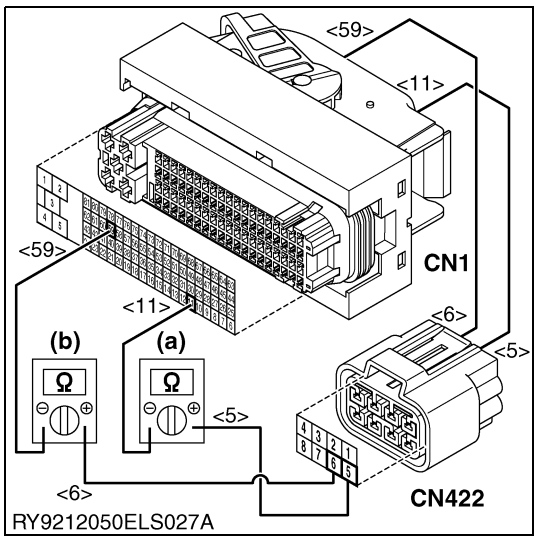
[Measurement Conditions]

1. Disconnect the AUX1 / AUX2 switch connector CN422.
2. Key switch : ON
3. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	AUX1 / AUX2 switch connector CN422	<1>	AUX1 / AUX2 switch connector CN422	<2>	
(b)	AUX1 / AUX2 switch connector CN422	<1>	Body GND	–	

Regular : 5 V (OK)
Irregular : Large discrepancy from 5 V (NG)

RY9212050ELS0045US0



3. Continuity check (AUX one way hold Switch)

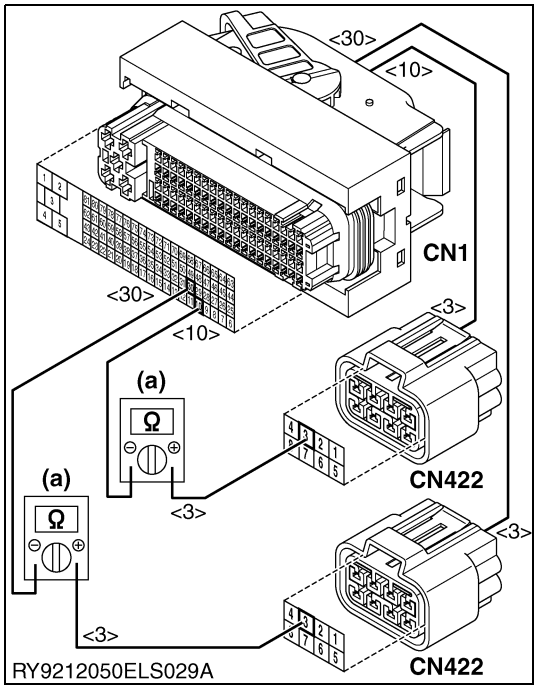
[Measurement Conditions]

1. Key switch : OFF
2. Disconnect the AUX1 / AUX2 switch connector CN422.
3. Disconnect the ECU connector CN1.
4. Test the continuity based on the table below.

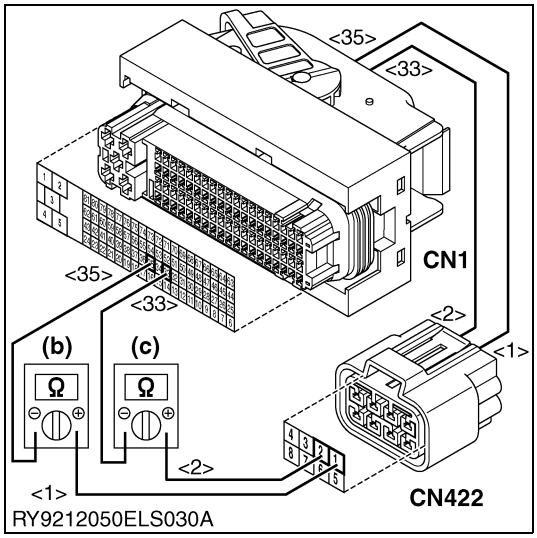
Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	AUX1 / AUX2 switch connector CN422	<5>	ECU connector CN1	<11>	
(b)	AUX1 / AUX2 switch connector CN422	<6>	ECU connector CN1	<59>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

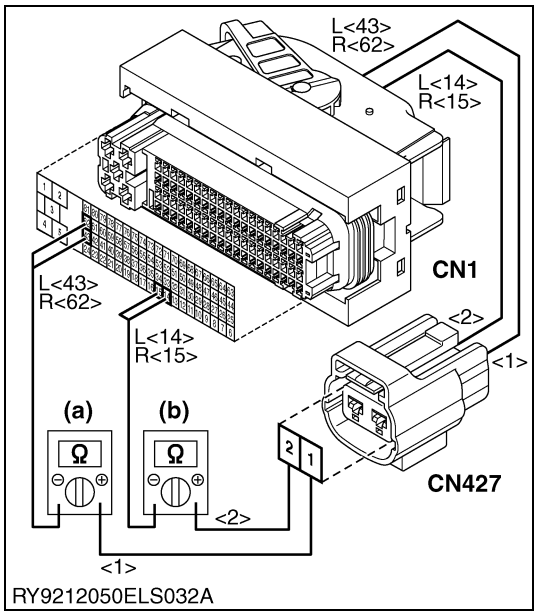
RY9212050ELS0044US0



RY9212050ELS029A



RY9212050ELS030A



RY9212050ELS032A

4. Continuity check (AUX1 / AUX2 Switch)

[Measurement Conditions]

1. Key switch : OFF
2. Disconnect the AUX1 / AUX2 switch connector CN422.
3. Disconnect the ECU connector CN1.
4. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin No.	Connector Name (- terminal side)	Pin No.	Assessment Results
(a)	AUX1 / AUX2 switch connector CN422	L Lever <3>	ECU connector CN1	L Lever <30>	
		R Lever <3>		R Lever <10>	
(b)	AUX1 / AUX2 switch connector CN422	<1>	ECU connector CN1	<35>	
(c)	AUX1 / AUX2 switch connector CN422	<2>	ECU connector CN1	<33>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212050ELS0046US0

5. Continuity check (AUX1 SOL)

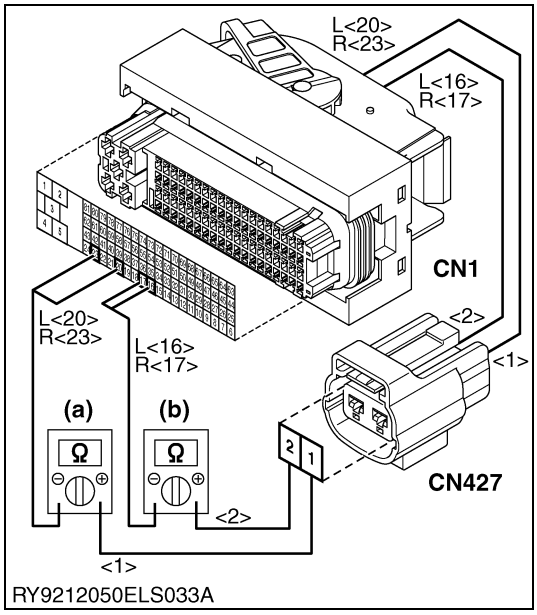
[Measurement Conditions]

1. Key switch : OFF
2. Disconnect the ECU connector CN1.
3. Disconnect the AUX1 SOL connector CN427.
4. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal side)	Pin NO.	Connector Name (– terminal side)	Pin NO.	Assessment Results
(a)	AUX1 SOL Connector CN427	High <1>	ECU Connector CN1	<43>	
		Low <1>		<62>	
(b)	AUX1 SOL Connector CN427	High <2>	ECU Connector CN1	<14>	
		Low <2>		<15>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212050ELS0048US0



RY9212050ELS033A

6. Continuity check (AUX2 SOL)

[Measurement Conditions]

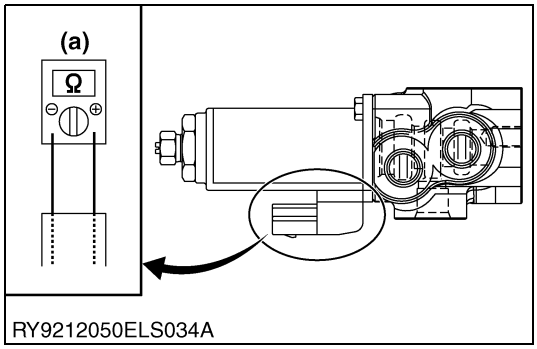
1. Key switch : OFF
2. Disconnect the ECU connector CN1.
3. Disconnect the AUX2 SOL connector CN427.
4. Test the continuity based on the table below.

Mea-sure-ment	Connector Name (+ terminal side)	Pin NO.	Connector Name (– terminal side)	Pin NO.	Assess-ment Results
(a)	AUX2 SOL Connector CN427	High <1>	ECU Connector CN1	<20>	
		Low <1>		<23>	
(b)	AUX2 SOL Connector CN427	High <2>	ECU Connector CN1	<16>	
		Low <2>		<17>	

Regular : Continuity (OK)
Irregular : No continuity (NG)

RY9212050ELS0050US0

[D] Testing the Equipment Itself



RY9212050ELS034A

1. Testing the AUX1 / AUX2 solenoid

[Test Conditions]

1. Key switch : OFF
2. Disconnect AUX1 / AUX2 solenoid connector CN427 from the machine and test the solenoid separately.

AUX1 / AUX2 solenoid	Factory Spec	3.2 ± 0.5 Ω (at 20 °C, 68 °F)

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

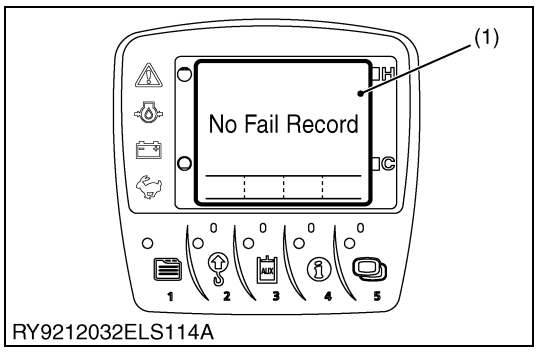
(a) AUX1 / AUX2 solenoid terminals

RY9212050ELS0051US0

2. Settings after replacing device

1. No settings required.

RY9212001ELS0013US0



RY9212032ELS114A

3. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

(1) No Fail Record

RY9212032ELS0003US0

[8] HOLDING VALVE

1. Checking fuses

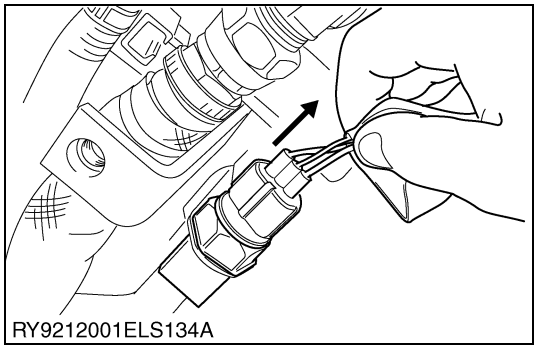
1. Checking fuses is not necessary.

RY9212001ELS0008US0

2. Checking relays

1. Checking relays is not necessary.

RY9212001ELS0009US0


RY9212001ELS134A

3. Causes when a break in wiring

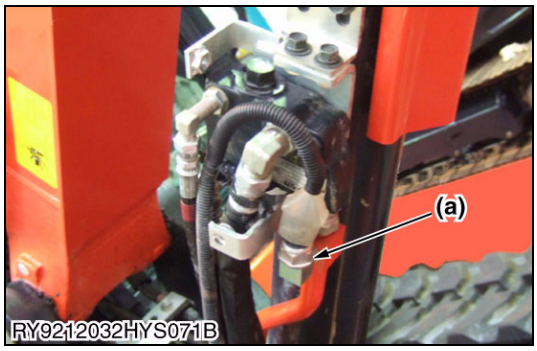
[Test Conditions]

1. Key switch : OFF
2. The boom pressure sensor connector CN765 is disconnected.
3. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (pull with a max of 3 kgf (30 N, 7 lbf) of force)
If it comes off, plug the connector back in securely and check the boom pressure again in the tester mode.

Criteria	Assessment Results
Regular : no break (OK)	
Irregular : has a break (NG)	

RY9212032ELS0054US0



RY9212032HYS071B

4. Causes when a short

[Test Conditions]

1. Key switch : OFF
2. The oil switch wire is pinched against or touching the body.
   If the insulation is damaged, repair it properly and check the voltage of boom raise end point again in the tester mode.

Criteria	Assessment Results
Regular : no short (OK)	
Irregular : shorted (NG)	

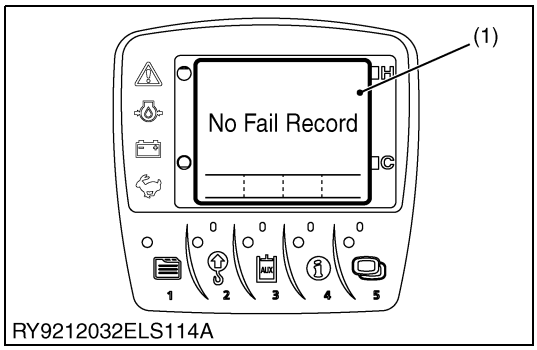
(a) Boom pressure sensor

RY9212032ELS0055US0

5. Settings after replacing device

1. No settings required.

RY9212032ELS0056US0



RY9212032ELS114A

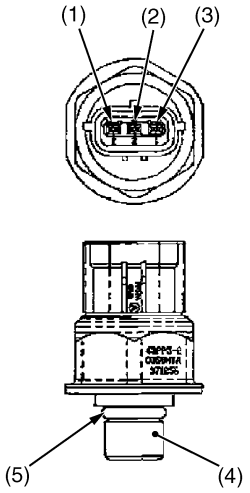
6. Erasing failure history

1. After completing repairs, select Erase Failure History and erase the records.
2. After erasing the records, read the failure history again and make sure there are no failures.

Criteria	Assessment Results
Regular : Failure history erased (OK)	
Irregular : failure history not erased (NG)	

(1) No Fail Record

RY9212032ELS0057US0



RY9212001CVS045A

7. Pressure switch

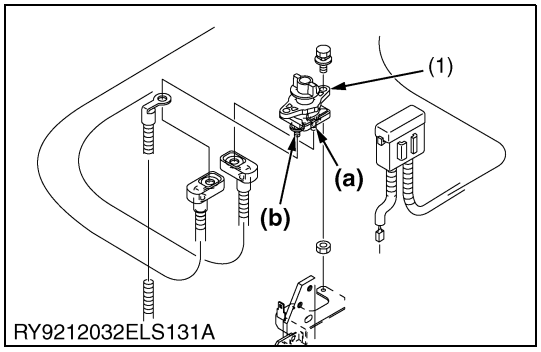
No.	Contents	Specifications
1	Rated voltage	5 ± 0.25 VDC
2	Pressure range	0 to 34.5 MPaG
3	Load resistance	22 kΩ

Tightening torque	Sensor (pressure 35MPA)	18.6 to 28.4 N·m 1.9 to 2.9 kgf·m 13.7 to 21.0 lbf·ft

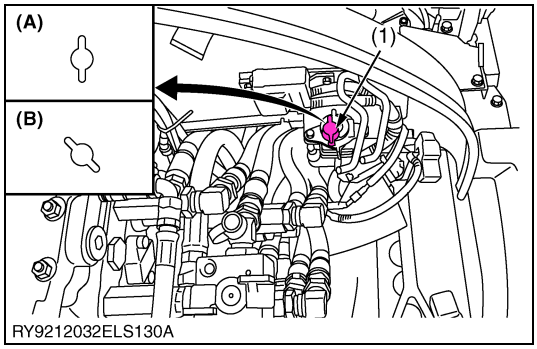
(1) GND
(2) Output signal
(3) power supply
(4) G1/4 nut
(5) O-ring (Equiv. NBR90IRHD)

RY9212032ELS0087US0

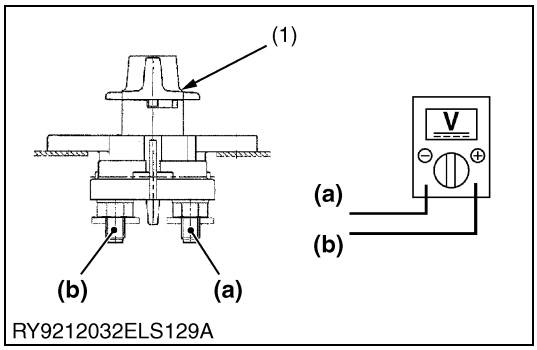
[9] BATTERY ISOLATOR



RY9212032ELS131A



RY9212032ELS130A



RY9212032ELS129A

Check for the Switch Actuation

1. Remove the battery (–) code.
2. Remove the battery (+) code.
3. Check the battery isolator terminal **(a)** and **(b)** for their continuity.

(1) Battery isolator
(a) Terminal
(b) Terminal

RY9212032ELS0033US0

4. Turn the battery isolator ON **(A)** and check for continuity.

Criteria	Assessment Results
Regular : Continuity (OK)	
Irregular : No continuity (NG)	

5. Turn the battery isolator OFF **(B)** and check for non-continuity.

Criteria	Assessment Results
Regular : No continuity (OK)	
Irregular : Continuity (NG)	

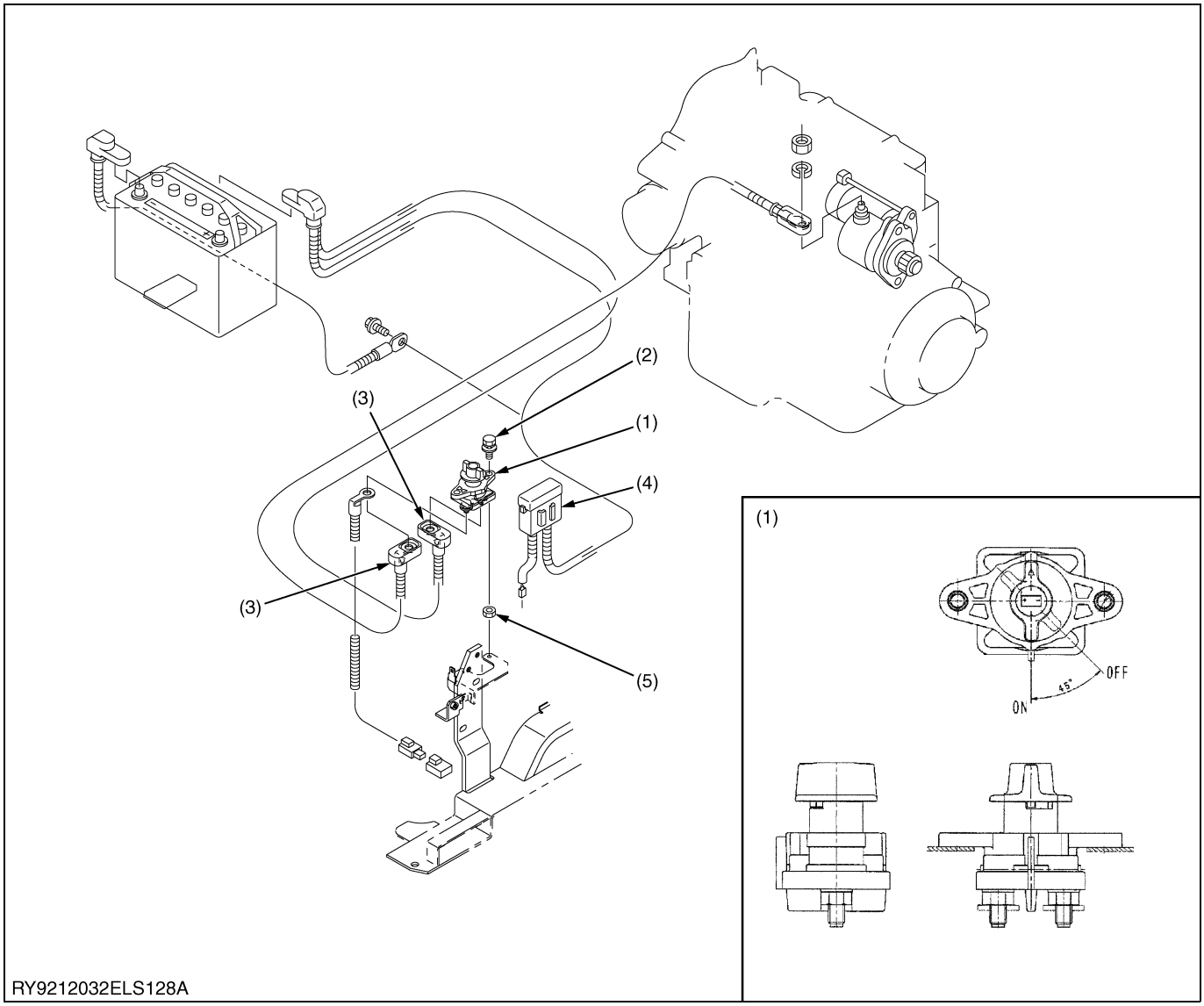
(1) Battery isolator
(A) ON
(B) OFF

RY9212032ELS0034US0

CAUTION

- **Remove the battery code before starting the maintenance and inspection.**
- **Re-setting is required for the digital meter clock because it stops when the battery code is removed.**

RY9212032ELS0035US0



(1) Battery isolator (Battery connection switch)
(2) Bolt
(3) Battery cable
(4) Slow-blow fuse box
(5) Nut

Battery isolator (battery cut-off switch)

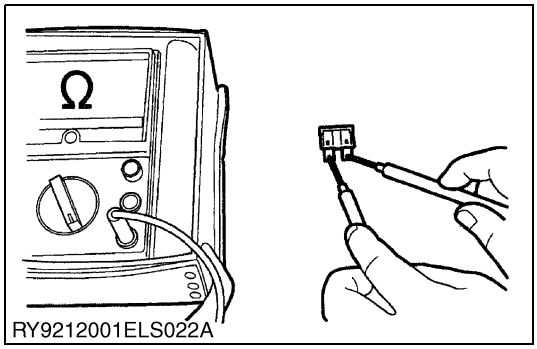
Install a boot securely on the connections of each battery cable switch.

Torque	Battery isolator	7.8 to 9.3 N·m 0.8 to 0.95 kgf·m

RY9212032ELS0036US0

[10] FUEL SUPPLY PUMP

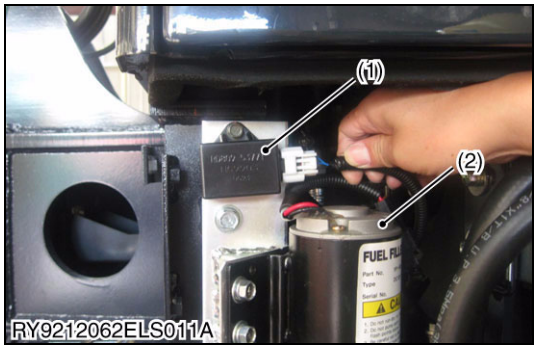
(1) Inspecting each Device Visually and Physically

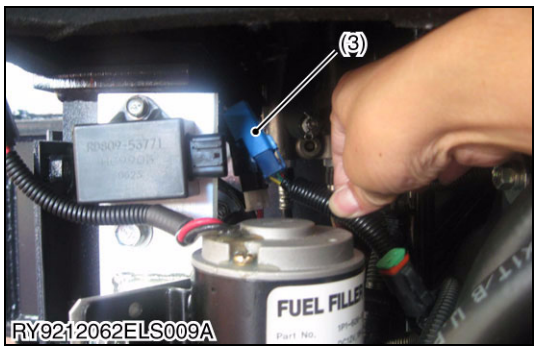


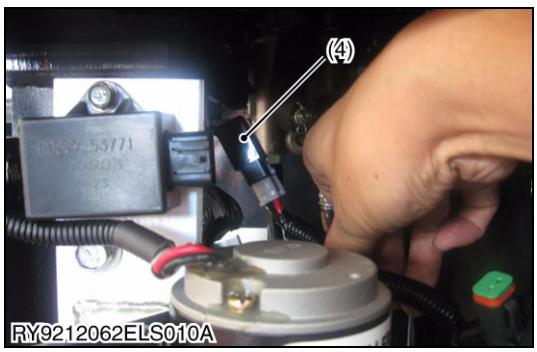
Checking Fuses

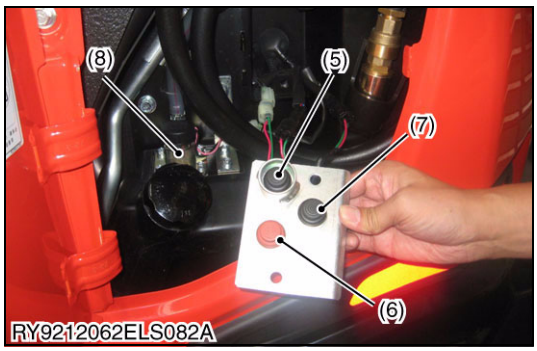
1. Check whether the following fuses have been blown or not.
   - Fuel supply control fuse (5A)
   - Fuel supply pump fuse (30A)
   - Cabin light fuse (5A)

RY9212062ELS0004US0









Cause when Blown

[Test Conditions]

1. Key switch: OFF
2. Remove the (–) battery cord.
3. Remove the (+) battery cord.
4. Disconnect the 6P connector of the timer (1).
5. Disconnect the 2P connector of the fuel supply pump (2).
6. Disconnect the 6P connector of the fuel supply stop relay (3).
7. Disconnect the 4P connector of the fuel supply start relay (4).
8. Disconnect the 2P connector of the fuel supply start switch (5).
9. Disconnect the 2P connector of the fuel supply stop switch (6).
10. Disconnect the 2P connector of the fuel level sensor (8).
11. There is a break somewhere in the wiring.

Pull on the harness and make sure the connector/harness does not come off. (Pull with a maximum of 3 kgf of force.) If they disconnect, reconnect securely and check again.

Criteria	Assessment Results
Regular: no break (OK)	
Irregular: has a break (NG)	

(1) Timer
(2) Fuel supply pump
(3) Fuel supply stop relay
(4) Fuel supply start relay
(5) Fuel supply start switch
(6) Fuel supply stop switch
(7) Full tank signal switch
(8) Fuel level sensor

RY9212062ELS0005US0

Causes when a short

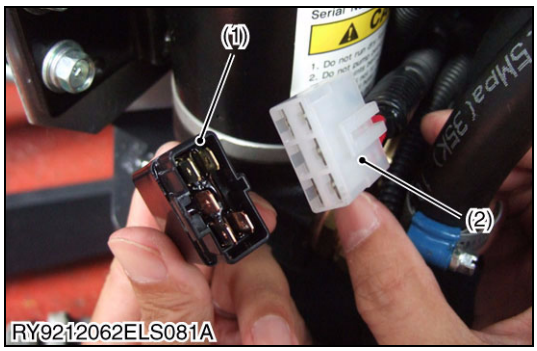
[Test Conditions]

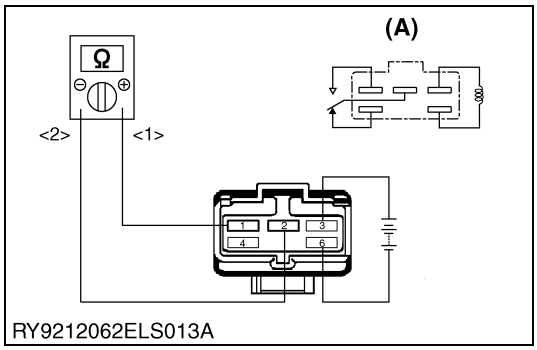
1. Key switch: OFF
2. Remove the (–) battery cord.
3. Remove the (+) battery cord.
4. Check whether the wiring of each connector (motor, timer, relays, sensor, switches) is pinched against or touching the body. If the insulation is damaged, repair it properly.

Criteria	Assessment Results
Regular: no short (OK)	
Irregular: shorted (NG)	

RY9212062ELS0006US0

(2) Testing with a Circuit Tester





Testing Relays

[Fuel supply start relay]

Isolation Tests

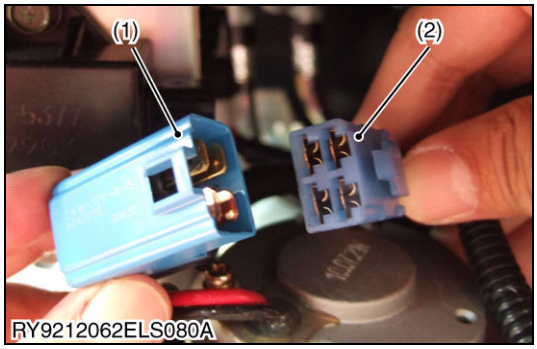
1. Apply battery voltage between terminals 3 and 6 of the relay.
2. Check for continuity between terminals 2 and 4 of the relay.
3. Check for continuity between terminals 1 and 2 of the relay.

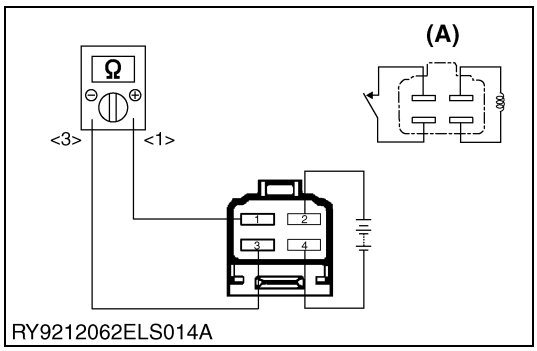
Regular	Relay terminals 2-4	Switches from continuity to no continuity (OK)
	Relay terminals 1-2	Switches from no continuity to continuity (OK)
Irregular	Relay terminals 2-4	Continues to have continuity (NG)
	Relay terminals 1-2	Continues to have no continuity (NG)

(1) Fuel supply start relay
(2) Fuel supply start connector

(A) Wiring diagram

RY9212062ELS0007US0





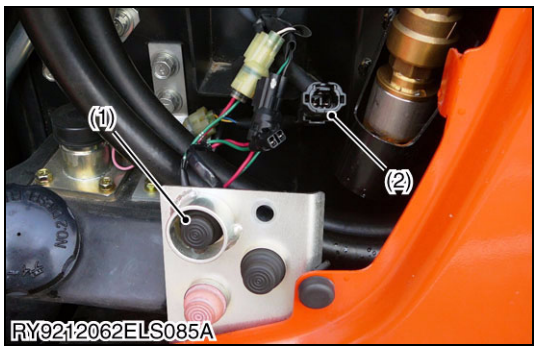
[Fuel supply stop relay]
Isolation Tests

1. Apply battery voltage between terminals 2 and 4 of the relay.
2. Check for continuity between terminals 1 and 3 of the relay.

Regular	Relay terminals 1-3	Switches from continuity to no continuity (OK)
Irregular	Relay terminals 1-3	Continues to have continuity (NG)

(1) Fuel supply stop relay
(2) Fuel supply stop relay connector
(A) Wiring diagram

RY9212062ELS0008US0



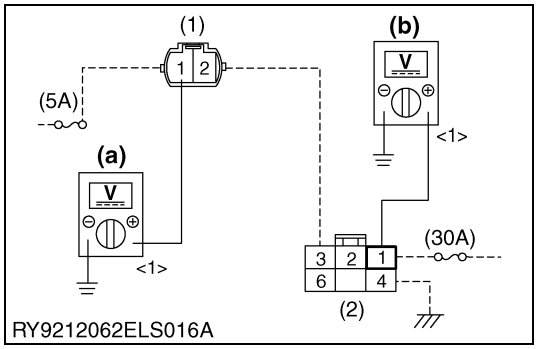
Voltage Check

[Fuel supply start switch and start relay]
[Measurement Conditions]

1. Disconnect the fuel supply start switch connector.
2. Disconnect the fuel supply start relay connector.
3. Measure the voltage based on the table below.

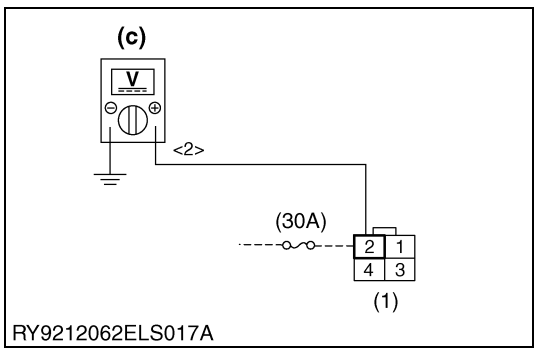
Measurement	Connector Name (+ terminal)	Pin No.	Connector Name (– terminal)	Pin No.	Assessment Results
(a)	Fuel supply start switch	<1>	Body GND	–	
(b)	Fuel supply start relay	<1>	Body GND	–	

Regular: 12 V (OK)
Irregular: Large discrepancy from 12 V (NG)



(1) Fuel supply start switch
(2) Fuel supply start switch connector

RY9212062ELS0009US0



[Fuel supply stop relay]
[Measurement Conditions]

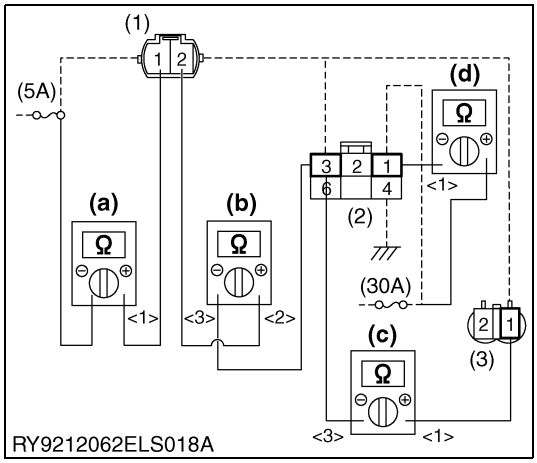
1. Disconnect the fuel supply stop relay connector.
2. Measure the voltage based on the table below.

Measurement	Connector Name (+ terminal)	Pin No.	Connector Name (– terminal)	Pin No.	Assessment Results
(c)	Fuel supply stop relay	<2>	Body GND	–	

Regular: 12 V (OK)
Irregular: Large discrepancy from 12 V (NG)

(1) Fuel supply stop relay connector

RY9212062ELS0010US0



Continuity Test

[Measurement Conditions]

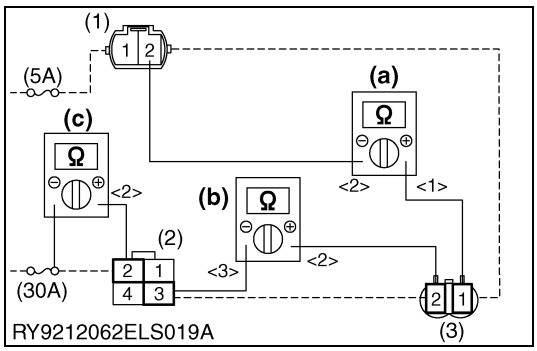
1. Remove the cabin light fuse (5A).
2. Remove the fuel supply pump fuse (30A).
3. Disconnect the fuel supply start switch connector (1).
4. Disconnect the fuel supply start relay connector (2).
5. Test the continuity based on the table below.

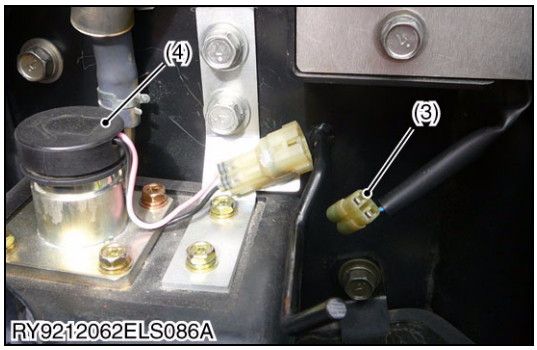
Measurement	Connector Name (+ terminal)	Pin No.	Connector Name (– terminal)	Pin No.	Assessment Results
(a)	Fuel supply start switch	<1>	Cabin light fuse (5A)	–	
(b)	Fuel supply start switch	<2>	Fuel supply start relay	<3>	
(c)	Fuel level sensor	<1>	Fuel supply start relay	<3>	
(d)	Fuel supply pump fuse (30A)	–	Fuel supply start relay	<1>	

Regular: Continuity (OK)
Irregular: No continuity (NG)

(1) Fuel supply start switch connector
(2) Fuel supply start connector
(3) Fuel level sensor connector

RY9212062ELS0011US0





Continuity Test

[Measurement Conditions]

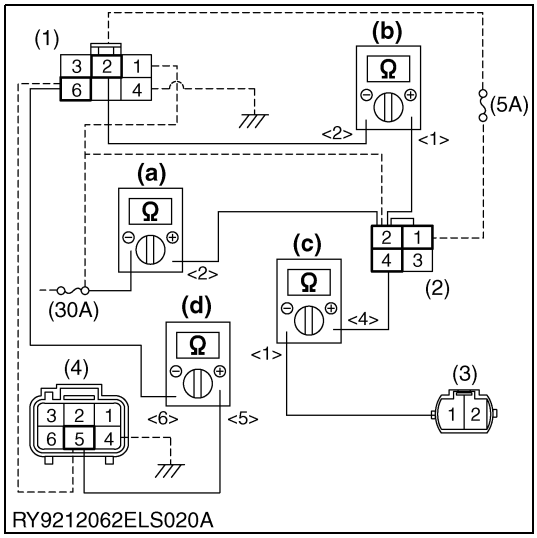
1. Remove the cabin light fuse (5A).
2. Remove the fuel supply pump fuse (30A).
3. Disconnect the fuel supply start switch connector (1).
4. Disconnect the fuel supply stop relay connector (2).
5. Disconnect the fuel level sensor connector (3).
6. Test the continuity based on the table below.

Measurement	Connector Name (+ terminal)	Pin No.	Connector Name (– terminal)	Pin No.	Assessment Results
(a)	Fuel level sensor	<1>	Fuel supply start switch	<2>	
(b)	Fuel level sensor	<2>	Fuel supply stop relay	<3>	
(c)	Fuel supply stop relay	<2>	Fuel supply pump fuse (30A)	–	

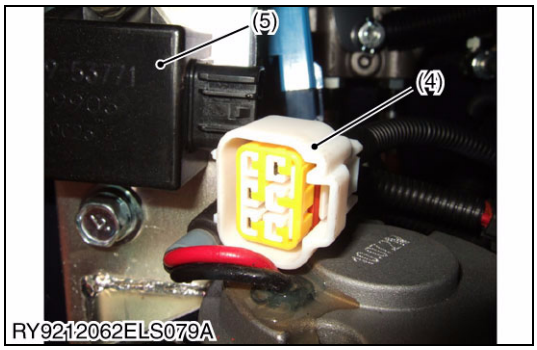
Regular: Continuity (OK)
Irregular: No continuity (NG)

(1) Fuel supply start switch connector
(2) Fuel supply stop relay connector
(3) Fuel level sensor connector
(4) Fuel level sensor

RY9212062ELS0012US0



RY9212062ELS020A



RY9212062ELS079A

Continuity Test

[Measurement Conditions]

1. Remove the cabin light fuse (5A).
2. Remove the fuel supply pump fuse (30A).
3. Disconnect the fuel supply start relay connector (1).
4. Disconnect the fuel supply stop relay connector (2).
5. Disconnect the fuel supply stop switch connector (3).
6. Test the continuity based on the table below.

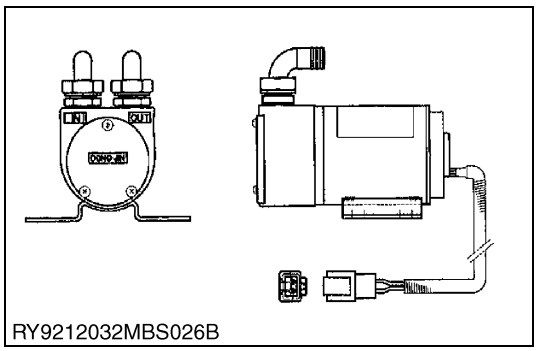
Measurement	Connector Name (+ terminal)	Pin No.	Connector Name (– terminal)	Pin No.	Assessment Results
(a)	Fuel supply stop relay	<2>	Fuel supply pump fuse (30A)	–	
(b)	Fuel supply stop relay	<1>	Fuel supply start relay	<2>	
(c)	Fuel supply stop relay	<4>	Fuel supply stop switch	<1>	
(d)	Timer	<5>	Fuel supply start switch	<6>	

Regular: Continuity (OK)
Irregular: No continuity (NG)

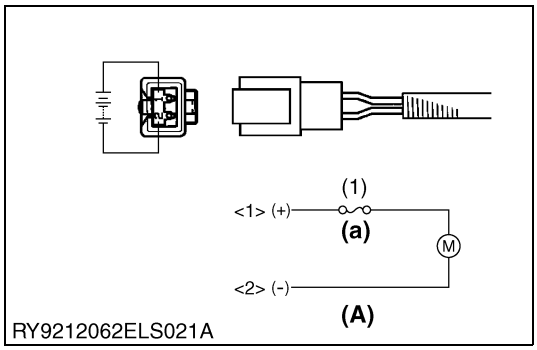
(1) Fuel supply start connector
(2) Fuel supply stop relay connector
(3) Fuel supply stop switch connector
(4) Timer connector
(5) Timer

RY9212062ELS0013US0

(3) Testing the Equipment Itself



RY9212032MBS026B



RY9212062ELS021A

Fuel Supply Pump Test

Isolation Tests

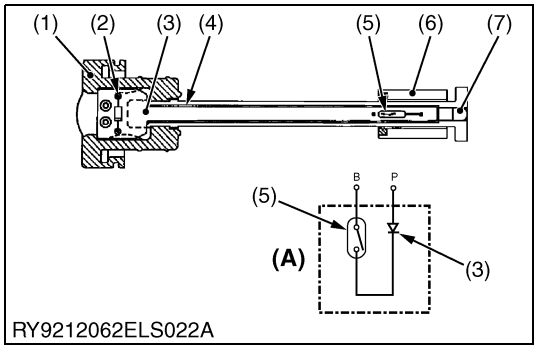
1. Disconnect the 2P connector from the pump.
2. Connect a jumper lead from the positive (+) terminal of the battery to terminal <1> of the connector.
3. Connect a jumper lead from the negative (–) terminal of the battery to terminal <2> of the connector.
4. Check the flow rate.

Normal: Flow rate of 31.5 to 38.5 L/min (OK)
Irregular: Large deviation from the flow rate (NG)

(1) Circuit breaker

(a) Actuation temp: 150 °C
(A) Wiring diagram

RY9212062ELS0014US0



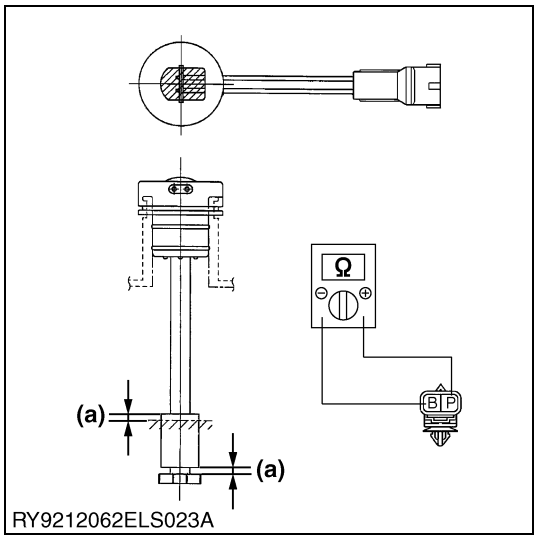
RY9212062ELS022A

Fuel Level Sensor Test

No.	Part Name	Q'ty
(1)	Gasket	1
(2)	Circuit board	1
(3)	Diode	1
(4)	Rod	1
(5)	Reed SW	1
(6)	Float COMP	1
(7)	Gasket	1

(A) Wiring diagram

RY9212062ELS0015US0



RY9212062ELS023A

Isolation Tests

1. Check for continuity when the gap between the float COMP (6) and gasket (7) is 3 mm or less.
2. Check for continuity when the gap between the float COMP (6) and gasket (7) is more than 3 mm.

Regular	Gap 3mm or less	Continuity (OK)
	Gap more than 3mm	No continuity (OK)
Irregular	Gap 3mm or less	No continuity (NG)

(a) 3 mm

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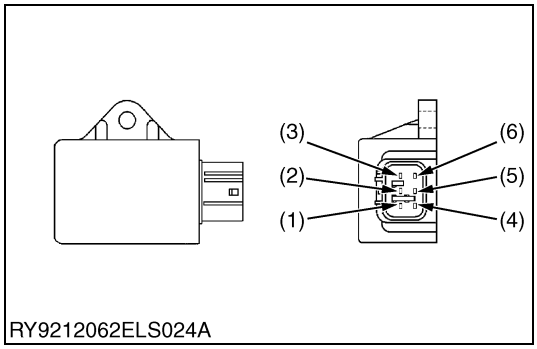


RY9212062ELS024A

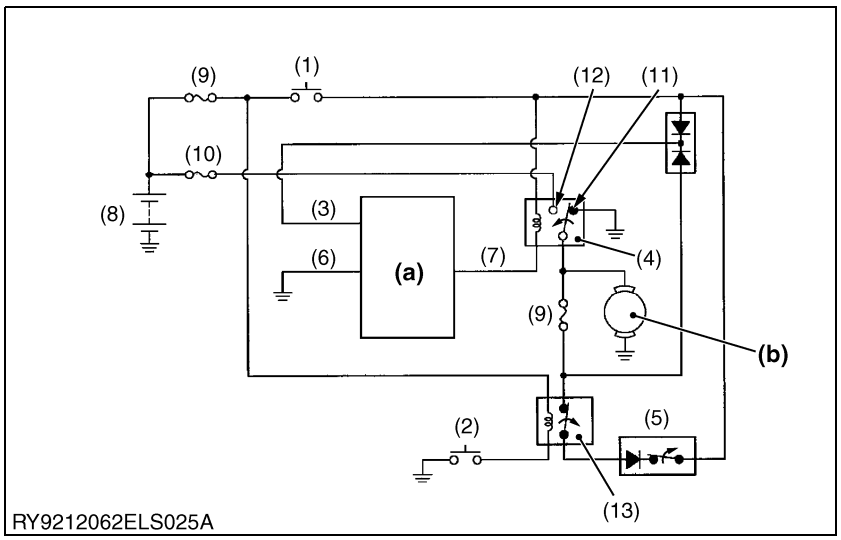
Timer Test

6P connector terminal layout

(1) Free
(2) Free
(3) +B power
(4) GND
(5) Relay OUT
(6) Free

RY9212062ELS0017US0

- Wiring diagram



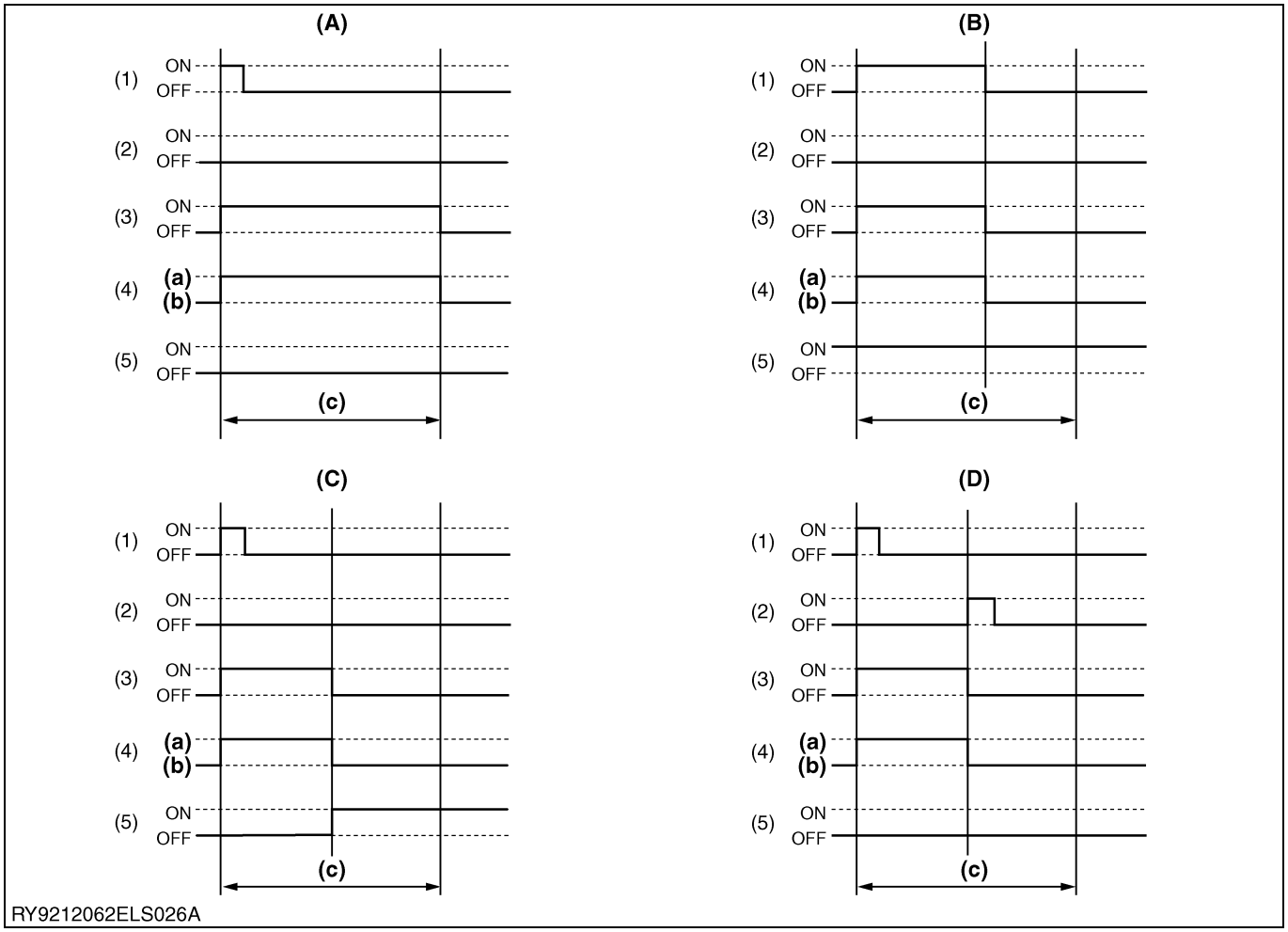
RY9212062ELS025A

(1) Fuel supply start switch
(2) Fuel supply stop switch
(3) Power supply (battery)
(4) Fuel supply start relay
(5) Fuel level
(6) Power (GND)
(7) Relay OUT
(8) Battery 12 V
(9) Fuse 5A
(10) Fuse 30A
(11) Contact 1
(12) Contact 2
(13) Fuel supply stop relay

(a) HC9903 ECU
(b) Fuel supply pump

RY9212062ELS0020US0

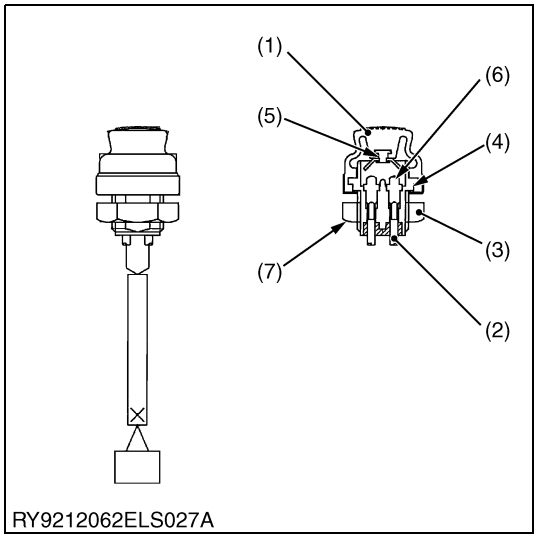
• Operating Modes



(1) Fuel supply start switch
(2) Fuel supply stop switch
(3) Unit power
(4) Fuel supply start relay
(5) Fuel level sensor

(a) Contact 2
(b) Contact 1
(c) 4 minutes ± 10%

RY9212062ELS0018US0



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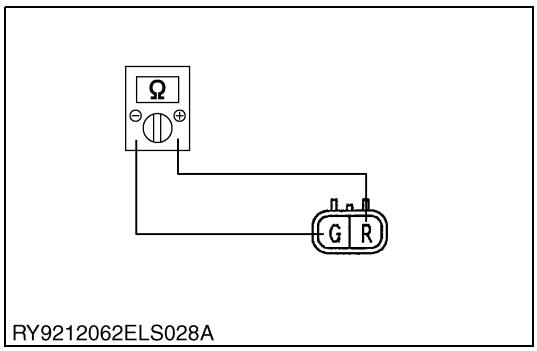


RY9212062ELS028A

Switch Tests

The structures of the fuel supply start and stop switches and the full tank signal switch are identical.

No.	Part Name	Q'ty
(1)	Rubber cover	1
(2)	Cord	1
(3)	Nut	1
(4)	Body	1
(5)	Contact plate COMP	1
(6)	Terminal	2
(7)	Ring	1

Isolation Tests

[Measurement Conditions]

1. Check for continuity when the button is pressed and held.
2. Assess as OK if continuity breaks when the button is released.

Circuit Table

	G	R
FREE		
PUSH	●	●

RY9212062ELS029A

RY9212062ELS0019US0

5 CABIN

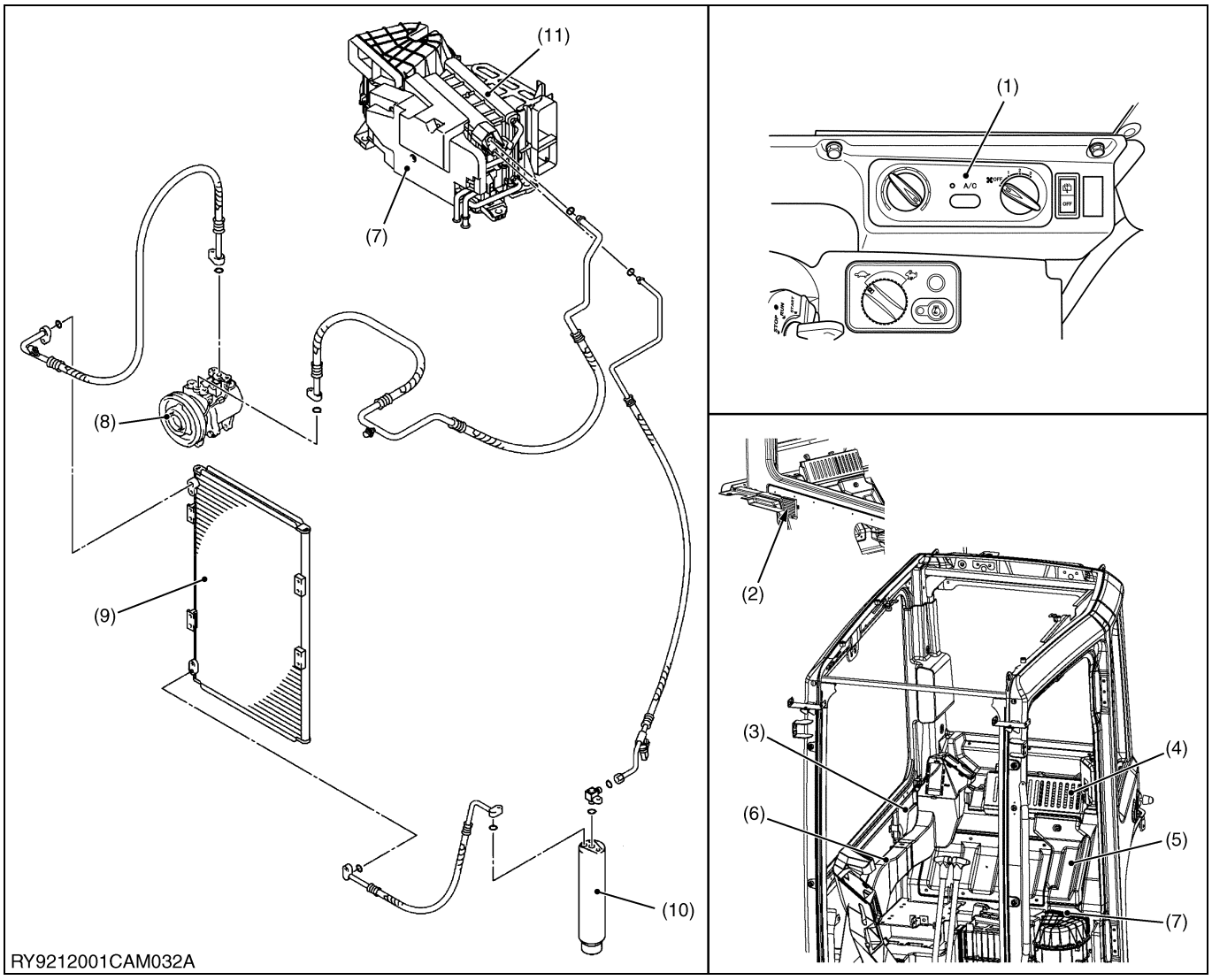
MECHANISM

CONTENTS

1. AIR CONDITIONING SYSTEM 5-M1
   [1] STRUCTURE 5-M1
   [2] HOW THE MECHANISMS OF THE SYSTEM WORK 5-M3
   [3] COMPRESSOR 5-M4
   [4] AIR CONDITIONING UNIT 5-M7
   [5] CONDENSER 5-M12
   [6] RECEIVER 5-M13
   [7] PRESSURE SWITCH 5-M14
   [8] SYSTEM CONTROLS 5-M15
   [9] ADJUSTING THE AIR FLOW AND DIRECTION 5-M16
   [10] ELECTRICAL SYSTEM 5-M17
      (1) Electrical Circuits 5-M17
      (2) Relays 5-M18
      (3) Blower switch 5-M19
2. WIPER 5-M20
   [1] WIPER SWITCH 5-M20
   [2] WIPER 5-M20
   [3] WIPER MOTOR 5-M21

1. AIR CONDITIONING SYSTEM

[1] STRUCTURE



(1) Control Panel
(2) Outside Air Inlet
(3) Outside Air Duct
(4) Cabin Air Inlet
(5) In/Outside Air Duct
(6) Air Duct ASSY
(7) Air Conditioning Unit
(8) Compressor
(9) Condenser
(10) Receiver
(11) Heater Core

The cabin is equipped with a high-capacity, low-profile air conditioner that can circulate cabin air or bring in fresh air from outside.

Cabin air is sucked into the cabin air inlet (4), which is located behind the seat; it then passes through the in/outside air duct (5) to the air conditioning unit (7) (cabin air circulation). Fresh air is taken in via the outside air inlet (2) and passes through the in/outside air duct (5) and enters the air conditioning unit (7) (fresh air intake).
The inside or outside air that is sucked into the air conditioning unit (7) is cooled and dehumidified by the cooler of the air conditioning unit (7).

When the system is used for heating, the air is heated by the heater core (11) and then expelled from the air duct ASSY (6). The vents installed inside the cabin can be opened and closed as well as adjusted to blow in different directions.

(To be continued)

(Continued)

Cooling Capacity	Factory spec.	3.4 kW ±10 %
Heating Capacity		4.1 kW ±10 %
Type of Refrigerant (charge capacity)		R134a 0.65 to 0.75 kg 1.43 to 1.65 lbs
Pressure Sensor (Low)		0.196 MPa 2.0 kgf/cm^2 28.4 psi
Pressure Sensor (High)		3.14 MPa 32.0 kgf/cm^2 455 psi

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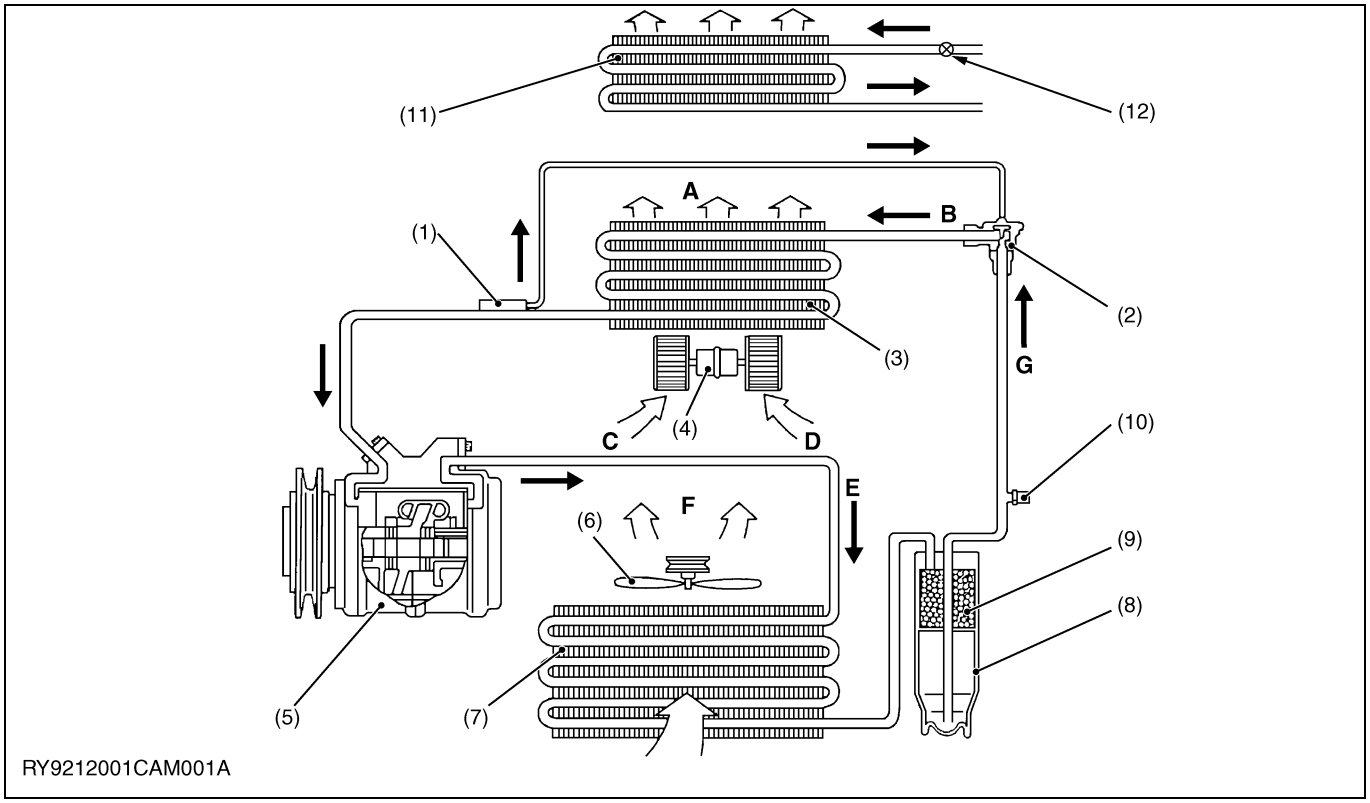
[2] HOW THE MECHANISMS OF THE SYSTEM WORK



(1) Capillary Tube (heat sensitive capillary tube)
(2) Expansion Valve
(3) Evaporator
(4) Blower Motor
(5) Compressor
(6) Engine Cooling Fan
(7) Condenser
(8) Receiver
(9) Dryer
(10) Pressure Switch
(11) Heater Core
(12) Hot Water Valve

A : Cooled Air
B : Low pressure and temperature vapor
C, D : Air passes through in / outside air filter
E : High pressure/temperature gas
F : Hot Air
G : Liquid

This air conditioning system works as follows.

1. Refrigerant passes through the evaporator (3), is vaporized and then is compressed by the compressor (5) to approximately 1.47 MPa (15 kgf/cm^2, 210 psi) and raised to a temperature of approximately 70 °C (158 °F) the refrigerant is then sent in this state to the condenser (7).
2. The vaporized refrigerant passes through the condenser (7), where it is cooled down to approximately 50 °C (122 °F) and the refrigerant changes back from a vapor to a liquid; it is then sent on to the receiver (8).
   Then the heat from inside the cabin that is captured by the condenser (7) is released outside the cabin.
3. The liquid refrigerant collects in the receiver (8) and any moisture is removed from the refrigerant by the dryer (9).
4. The liquid refrigerant then passes on to the expansion valve (2), where it is sprayed through the small holes in the valve into the evaporator (3), which produces a mist of the refrigerant; its pressure and temperature drop and the refrigerant evaporates.
5. The refrigerant simultaneously captures heat from the surface of the evaporator's (3) pipes and evaporates vigorously at 0 °C (32 °F).
6. As this happens, warm air from inside the cabin is drawn into the evaporator (3) by the blower motor (4) and the refrigerant captures the heat and evaporates. In this way the air in the cabin is cooled.
   [NOTE]
   - Because the warm air inside the cabin is cooled quickly, the moisture in the air condenses. In other words, the air in the cabin can be dehumidified.
7. The refrigerant vaporized in the evaporator (3) is returned to the compressor (5) and compressed, changing it back into a liquid. In doing so, the refrigerant is put under high pressure and temperature.
8. The air that passed through the evaporator (3) can be adjusted to the desired temperature by then passing it through the heater core (11). Engine coolant is heated by the engine and the amount of the coolant that flows into the heater core (11) is controlled by the hot water valve (12), and this adjusts the temperature of the air that flows through the heater core (11).

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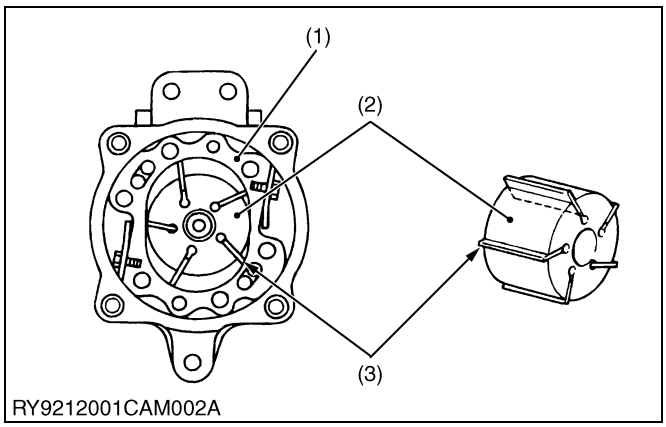
[3] COMPRESSOR



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The vane type of compressor installed in this system is composed of a cylinder (1) that is elliptical in cross-section, along with five vanes (3) attached to the rotor (2). This vane compressor has two each of intake and discharge ports.

The five vanes (3) are attached to the rotor (2) and as it rotates, the tips of the vanes come in contact with the walls of the cylinder (1) and an airtight compression space is maintained both by the centrifugal force exerted by the rotor (2) along with the back pressure on the vanes (3), which is in proportion to the rpms of the rotor (2).

As a result, the volume changes in each of the five segments of the cylinder, which are divided by the five vanes (3) in the cylinder (1).

Each time that the rotor (2) rotates, each of the five segments of the cylinder goes through two cycles of intake, compression and discharge.

(1) Cylinder
(2) Rotor
(3) Vane

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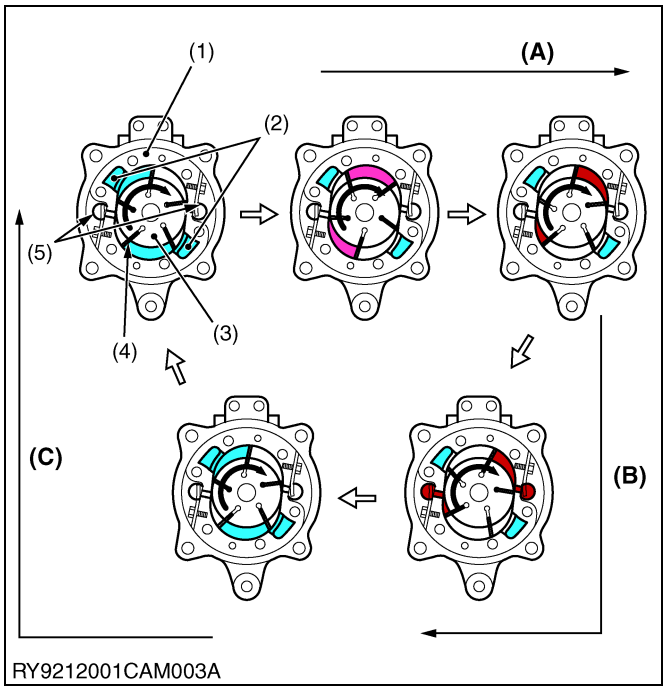

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How it Works

As the rotor (3) turns, the volume of space in a segment, as divided by the cylinder (1) and vanes (4), increases, sucking refrigerant gas from the intake port (2) into the cylinder space.

As the rotor (3) turns further, the volume of the space created between the cylinder (1) and vanes (4) decreases, compressing the refrigerant gas. As the rotor (3) continues to turn, the refrigerant gas is compressed further, putting it under a great deal of pressure, pressing on the discharge valve and opening it. The refrigerant gas is then expelled via the discharge port (5).

(1) Cylinder
(2) Intake Port
(3) Rotor
(4) Vane
(5) Discharge Port
(A) Compression Cycle
(B) Discharge Cycle
(C) Intake Cycle

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Compressor Oil

The compressor oil is dissolved in the refrigerant and circulates throughout the entire cooling system acting as the lubricating oil for the compressor. However, because the previously used R12 compressor oil does not dissolve in R134a, it does not circulate through the cooling cycle. So it drastically reduces the working life of the compressor.

As a result, it is imperative that the right compressor oil is always used. The mineral oil that is used in an R12 cooling system cannot be used in an R134a cooling system. A synthetic PAG oil has to be used in an R134a cooling system. This oil mixes extremely well with refrigerant gas and provides the entire system with the optimum lubrication.

Volume of Oil	Product Name
110 to 120 cc 0.116 to 0.127 U.S.qts 0.098 to 0.106 Imp.qts	ND–OIL8 <PAG* oil>

*PAG : Polyalkylene glycol (synthetic oil)

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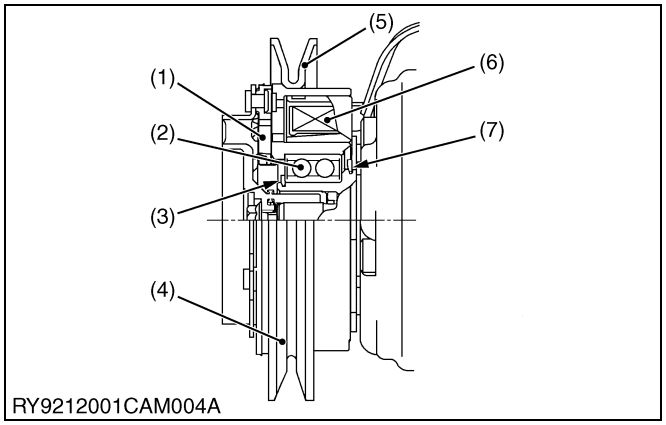

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Magnetic Clutch

A magnetic clutch is a device that governs the mechanical linkage between the engine and the compressor. When the engine is rotating and the AC switch is on, air at cabin temperature comes out and when the temperature reaches the temperature set with the temperature control switch, or when the cabin gets hot, the clutch works to stop or to drive the compressor, respectively.

The hub of the magnetic clutch is attached to the compressor shaft and when it is not driving the compressor, it is separate from the rotor and just the pulley turns. When the AC switch is turned on, current flows into the stator coil, making the stator into a magnet, which then holds onto the hub and the pulley turns along with the compressor.

(1) Pressure plate
(2) Ball bearing
(3) Snap ring
(4) Pulley
(5) Rotor w/ Pulley
(6) Stator
(7) Snap ring

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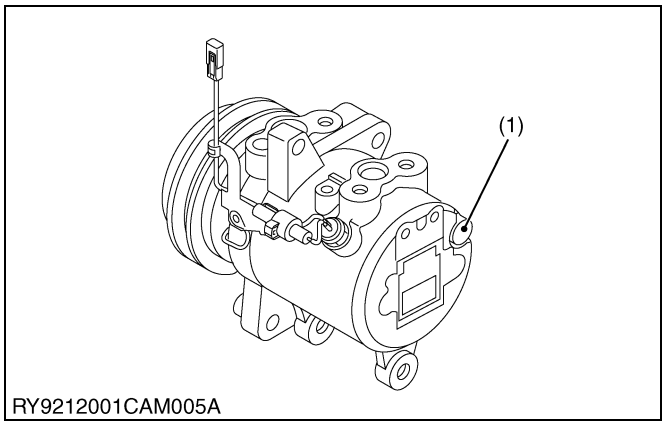

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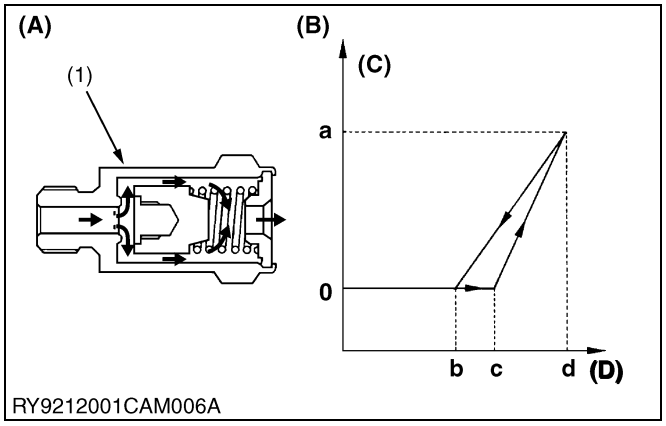
B. Safety Valve

The valve opens when the refrigerant pressure reaches the specified pressure, thus relieving the pressure. When the pressure becomes abnormally high, it overcomes the force of the spring, allowing refrigerant to leak out of the relief port; when the pressure drops the reverse happens--the spring overcomes the pressure and the safety valve closes. When an error occurs, this also keeps the discharge of refrigerant to a minimum.



RY9212001CAM006A

(1) Safety valve
(A) Refrigerant leak route
(B) Functional Characteristics
(C) Amount of Refrigerant Leaked
(D) Pressure

a : 113 L/min., 27.2 U.S.gals./min., 24.86 Imp.gals./min.
b : 2.76 MPa, 28.1 kgf/cm^2, 399.7 psi
c : 3.43 MPa, 35.0 kgf/cm^2, 497.8 psi
d : 4.14 MPa, 42.4 kgf/cm^2, 603.1 psi

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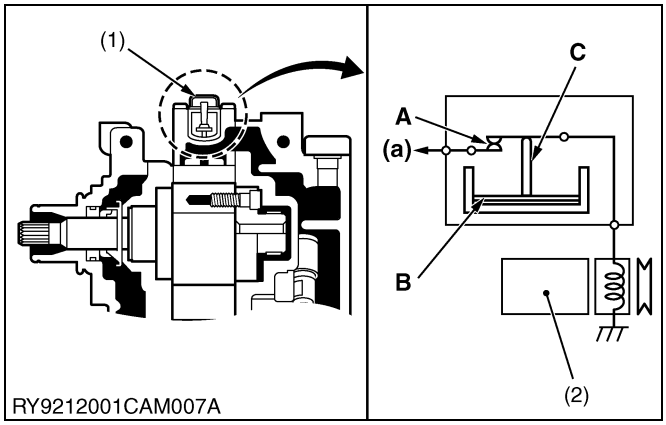

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Temperature Sensor

A temperature sensor is installed on the head of the vane type of compressor. This sensor detects the temperature of the refrigerant and when the refrigerant becomes unusually hot, it cuts off the magnetic clutch, stopping the compressor. The temperature sensor is composed of a bimetallic strip and contacts. A bimetallic strip is a sandwich of two metals with different rates of expansion and it bends when heated due to these different rates of expansion. This characteristic is exploited when there is an excessive temperature via the rod, which breaks the contact and switches the magnetic clutch off.

Operating Ranges	OFF	153 to 163 °C 307 to 325 °F
	ON	120 ± 5 °C 248 ± 41 °F

Tightening torque	Temperature Sensor	11.8 ± 1.47 N·m 1.2 ± 0.15 kg·fm 8.7 ± 1.08 lbf·ft

(1) Temperature sensor
(2) Compressor

A : Contact
B : Bimetallic strip
C : Rod

(a) To battery + terminal

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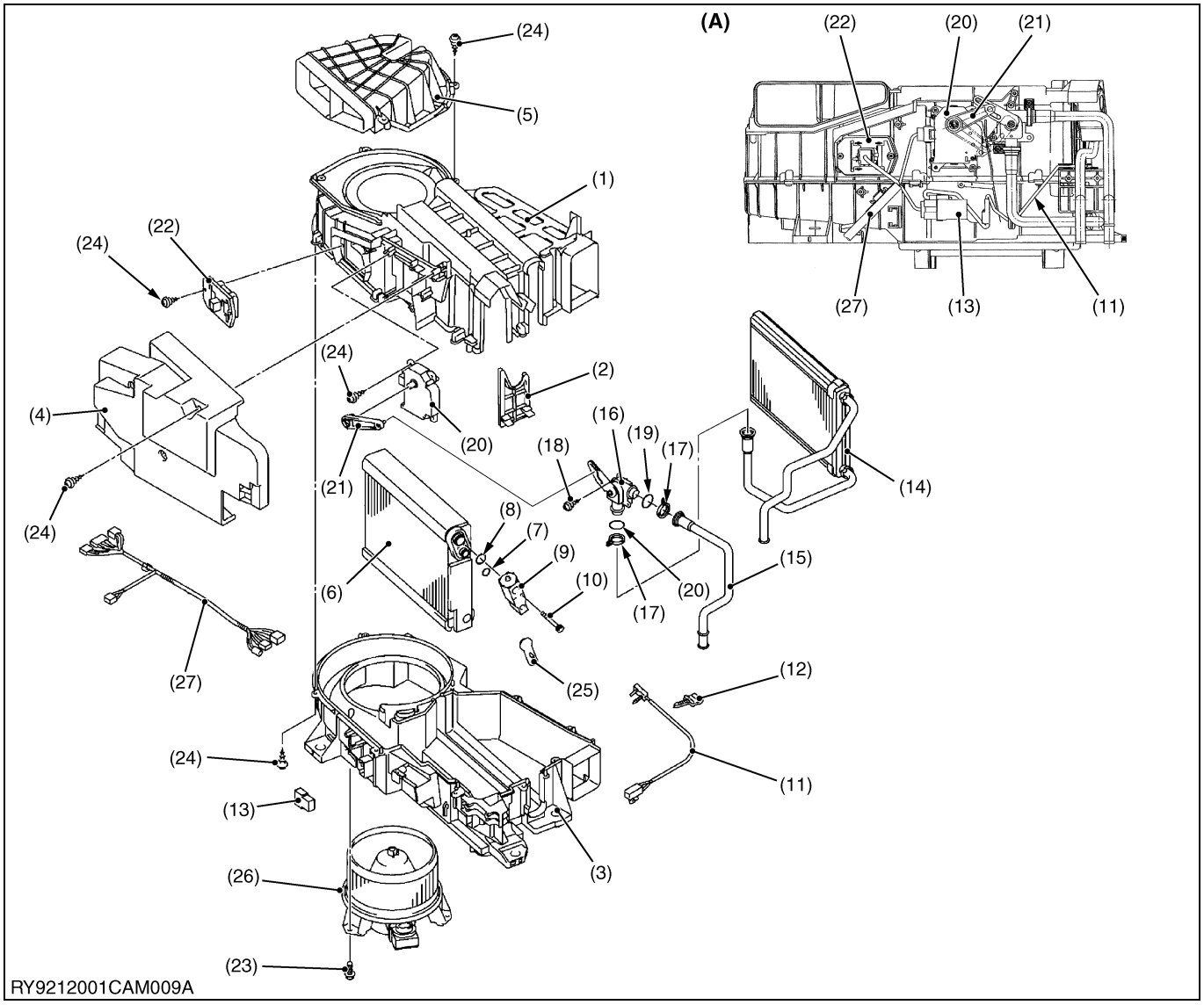
[4] AIR CONDITIONING UNIT



(A) Diagram of Linkages and Electrical Parts

The air conditioning unit is composed of an evaporator, an expansion valve, a heater core, a blower, etc.

No.	Name of part	Notes	No.	Name of part	Notes
(1)	Case, air conditioning unit	Top case	(15)	Pipe	
(2)	Case, air conditioning unit	Evaporator	(16)	Hot water valve	
(3)	Case, air conditioning unit	Bottom case	(17)	Clip	D24
(4)	Case, air conditioning unit	Linkage cover	(18)	Screw, W/washer	M4, L10
(5)	Case, air conditioning unit	Intake cover	(19)	O-Rings	ID15.8
(6)	Evaporator		(20)	Servo motor	Temperature control
(7)	O-Rings	1/2" 134A	(21)	Linkage lever	
(8)	O-Rings	5/8" 134A	(22)	Blower resistor	Plate
(9)	Expansion valve	BOX 1.0 ton	(23)	Tapping screw	D5, L16
(10)	Bolt	For expansion valve	(24)	Tapping screw	D4, L16
(11)	Fin Thermistor		(25)	Cap (plug)	For expansion valve
(12)	Clamp	For thermistor	(26)	Blower motor	
(13)	AC Amp		(27)	Wire harness	
(14)	Heater core				

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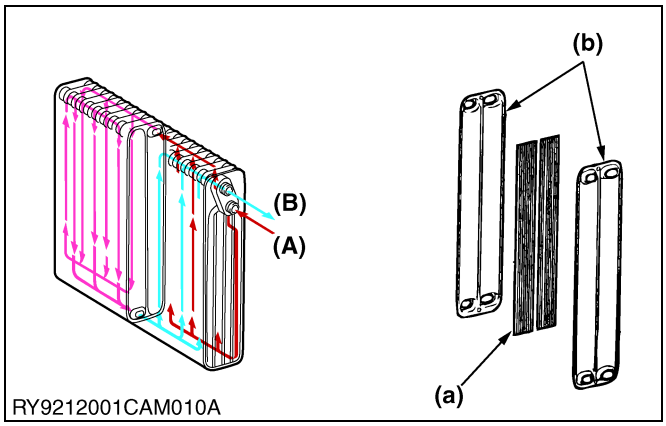

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Evaporator

The evaporator takes the refrigerant, which has been made liquid by the condenser and cooled and put under low-pressure by the expansion valve, and by evaporating it, the heat and humidity of the air passing through the evaporator is removed, thus producing cool, dehumidified air.

(a) Fins
(b) Tubes
(A) Inlet
(B) Outlet

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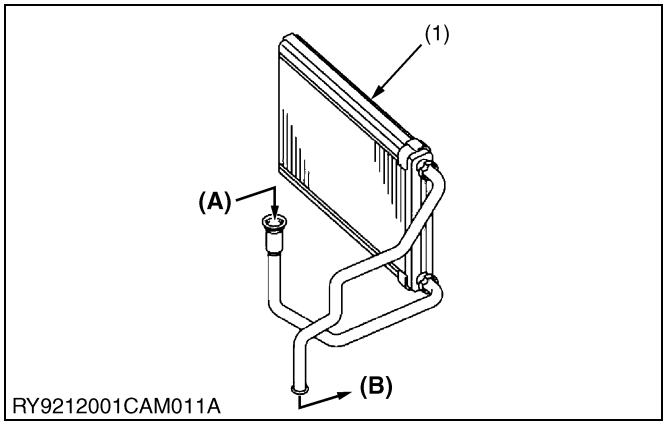

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Heater Core

The heater core dissipates the heat of the heated engine coolant. So, the air that is blown through it by the blower motor passes through the fins of the heater core and the air takes on the heat of the coolant.

(1) Heater Core
(A) Inlet
(B) Outlet

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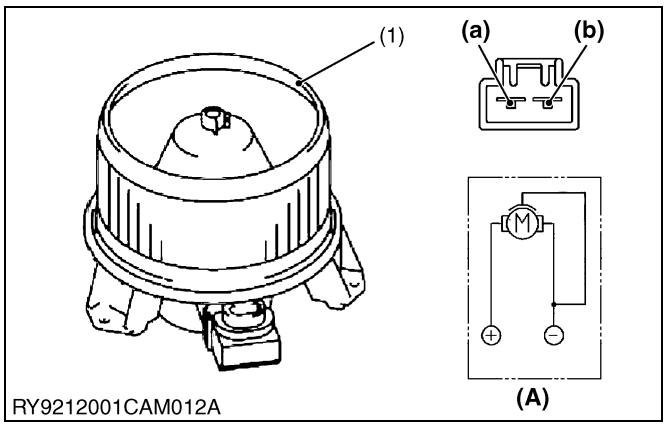

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Blower

The blower is built into the right side of the AC unit. The blower forces cool, warm or fresh outside air through the vents into the cabin.

The rpm of the blower motor can be adjusted to three levels with the blower resistor. The blower fan is the type that uses centrifugal force and it sucks in air parallel to its axis of rotation and blows it out perpendicular to the centrifugal force, or in other words, perpendicular to the axis of rotation.

Specifications (at 20 °C)	
Model	DC Ferrite
Rated Voltage	12 V
No load RPM	4300 ± 400 rpm
No load amperage	1 to 3 A
Direction of rotation (viewed from drive side)	Left
Rated load torque	461 N·m, 47.0 kgf·m, 340 lbf·ft
RPM	2800 ± 280 rpm
Amperage	18.3 ± 1.8A

(1) Blower
(A) Circuit Diagram
(a) (+) Terminal
(b) (-) Terminal

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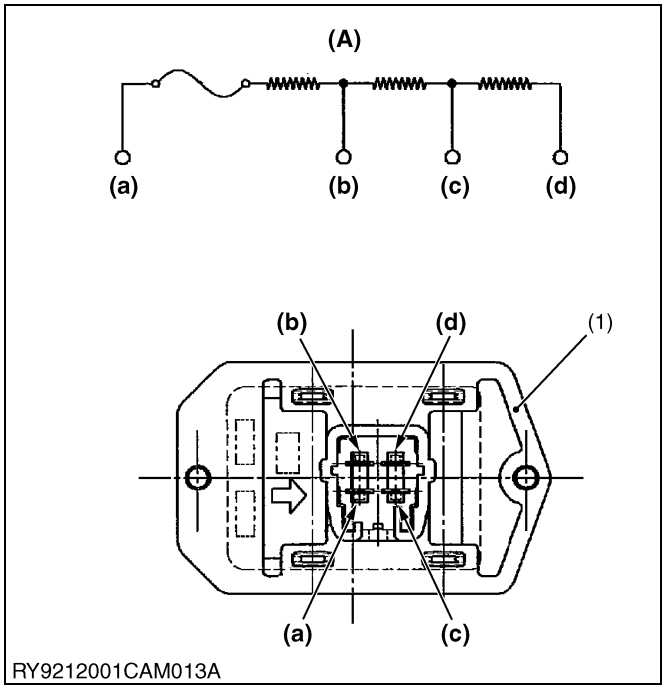

RY9212001CAM013A

Blower resistor

Acts as the blower switch and controls the rpm of the blower motor by switching the degree of resistance. The fan speed can be switched to three levels, 1, 2 and 3, with 3 being the fastest.

(1) Blower resistor
(A) Wiring diagram
(a) HI
(b) M2
(c) M1
(d) LO

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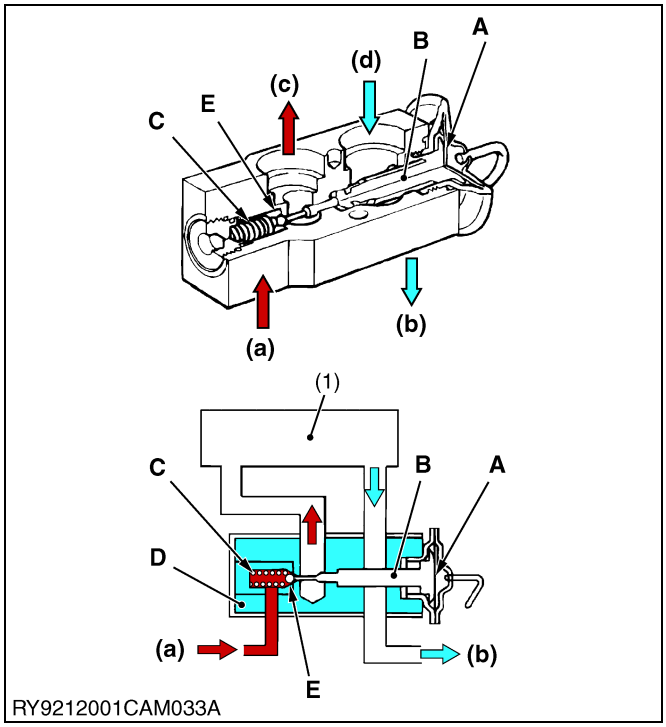

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Expansion Valve

[Functions]

The expansion valve works in the following two ways.

1. By spraying the liquid refrigerant, which is hot and under high pressure, it makes it expand rapidly, producing a low-temp, low-pressure refrigerant vapor.
2. It adjusts the amount of refrigerant according to the vaporized state of the refrigerant in the evaporator. In order to take full advantage of the capabilities of the evaporator, a state must always be maintained in which the liquid refrigerant takes on the ambient heat, then it is completely vaporized at the outlet of the evaporator. In order to do so, the expansion valve automatically adjusts the volume of refrigerant in response to changes in the cabin temperature (cooling load) and changes in the compressor RPM.

[Structure (box type)]

- The expansion valve is composed of a diaphragm, heat-sensing rod, and a needle valve (ball) and the refrigerant gas is enclosed upstream of the diaphragm. The downstream side of the diaphragm is pressurized by the evaporator outlet pressure.

[How it Works]

- The heat-sensitive rod senses the temperature of the refrigerant passing to the evaporator and the temperature at that point is communicated to the refrigerant gas on the upstream side of the diaphragm via the heat-sensitive rod. As such, the pressure of the gas varies with the temperature, thus moving the heat-sensitive rod directly connected to the diaphragm and adjusting the opening of the needle valve.

Evaporator outlet temperature	Operation
When low (when cooling load is low)	The pressure of the gas in the diaphragm chamber drops, reducing the volume and moving the heat-sensitive rod to the right, which constricts the needle valve and reduces the flow of refrigerant to the evaporator.
When high (when cooling load is high)	The pressure of the gas in the diaphragm chamber rises, increasing the volume and moving the heat-sensitive rod to the left, which opens the needle valve and supplies more refrigerant to the evaporator.

(1) Evaporator

A : Diaphragm
B : Heat-sensitive rod
C : Spring
D : Body
E : Needle valve
(a) From receiver (hi-pressure)
(b) To compressor (lo-pressure)
(c) To evaporator
(d) From evaporator

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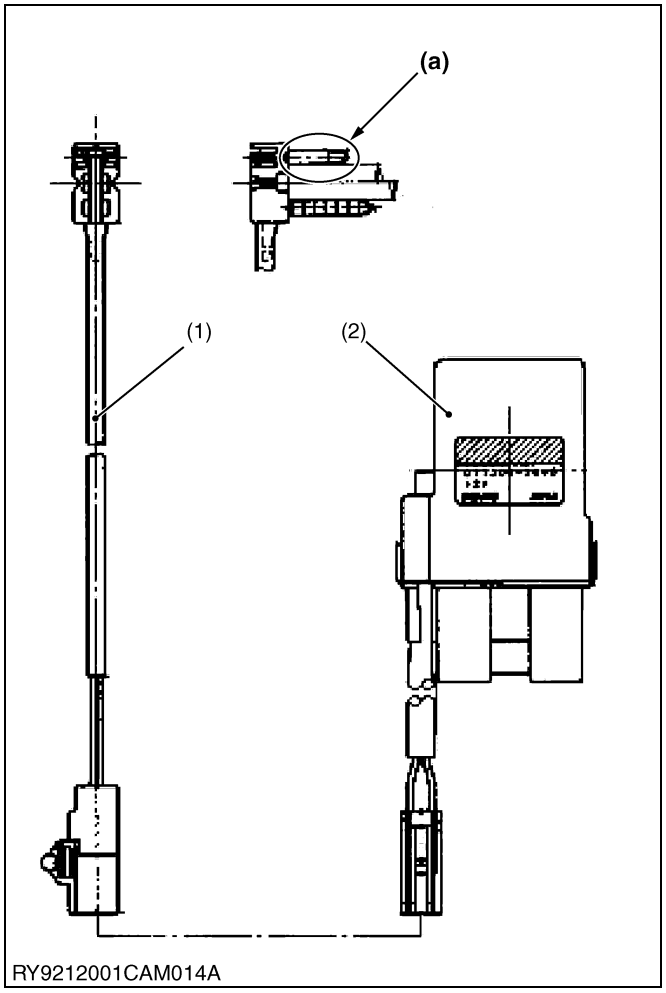

RY9212001CAM014A

Fin Thermistor (for frost control)

[Function]

Senses the temperature of the fins of the evaporator and when they are too cold, it stops the compressor and prevents frost from forming before it happens.

[How it Works]

The sensor of the fin thermistor senses the evaporator's fin temperature and if the resistance inside the sensor exceeds the thermo-amp resistance setting, its internal circuit shuts off the power to the compressor clutch.

Specifications		
Rated Voltage	DC12 V	
Measurement Conditions	DC13 ±0.2 V at 25 ± 5 °C (77 ± 9 °F)	
Temperature Detection	OFF R1	4383 ±131 Ω (2 °C, 36 °F)
	ON R2	(4095 Ω) (3.35 °C, 38 °F)
	Hysteresis	215 ±5.0 Ω (1 °C, 34 °F)

Usage Conditions	
Temperature Range	–30 to 80 °C (–22 to 176 °F)
Voltage Range	DC10 to 16 V
Operating Voltage Range	DC8 to 16 V (at 25 °C, 77 °F)

Temperature Detection	10 °C / 50 °F	15 °C / 59 °F	20 °C / 68 °F	25 °C / 77 °F	30 °C / 86 °F
Resistance Value	2.96 kΩ	2.34 kΩ	1.87 kΩ	1.50 kΩ	1.22 kΩ

(1) Fin Thermistor
(2) Thermo-amp

(a) Evaporator fin temperature detector

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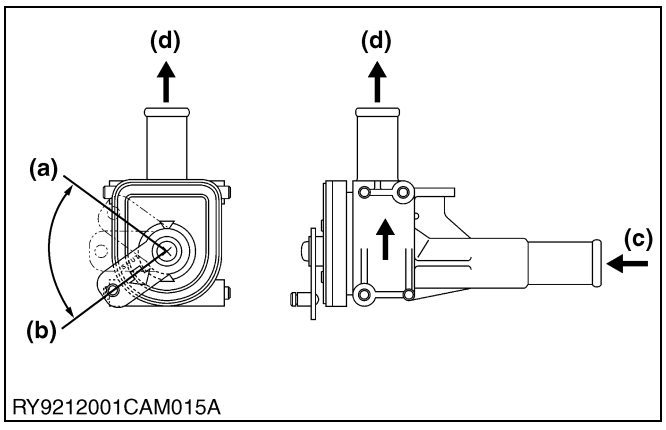

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Hot Water Valve

The hot water valve is the valve that adjusts the volume of engine coolant that flows into the heater core, and this adjustment changes the temperature of the heater core and thus controls the temperature of air flowing through it.

(a) Open (MAX Hot)
(b) Closed (MAX Cool)
(c) Inlet
(d) Outlet

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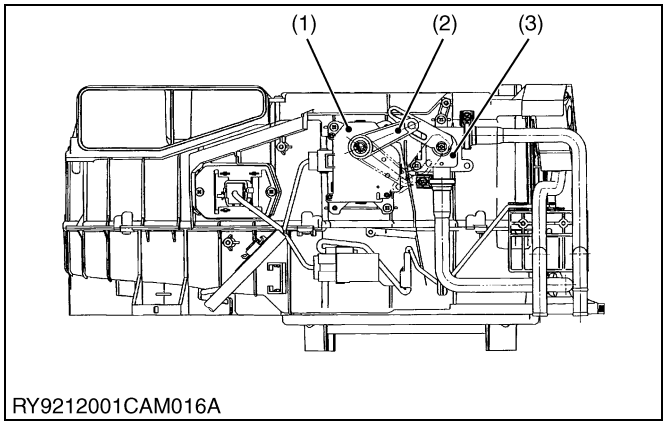

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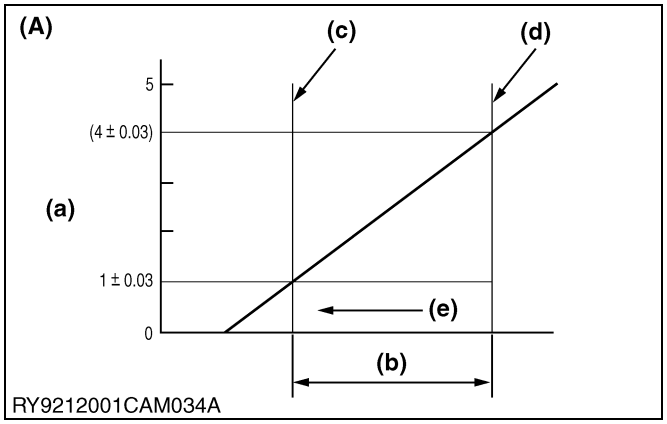

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Servo Motor (for adjusting temperature)

The servo motor is composed of a motor, a potentiometer, movable contacts, etc., and operates according to signals from the AC's CPU.

The servo motor uses a DC ferrite motor and rotates forward and reverse. Its potentiometer also uses variable resistance and changes the resistance value according to the operating angle.

The servo motor and the hot water valve are linked via a linkage lever and turning the temperature control dial on the control panel opens/closes the hot water valve and adjusts the temperature of air vented inside the cabin.

Specifications (at 20 °C, 68 °F)	
Model	DC Ferrite
Rated Voltage	12 V
Rated load torque	0.3 N·m, 0.03 kgf·m, 0.2 lbf·ft
RPM	3.5 to 5.5 rpm
Amperage	0.02 to 0.10 A
Potentiometer Linearity	± 3 %
Impressed Voltage Terminals	6 (POS.2) 7 (POS.1)

(1) Servo motor
(2) Linkage lever
(3) Hot Water Valve

(A) Potentiometer Output Schematic
(a) Voltage (V)
(b) Operating Angle 60 °
(c) MAXCOOL
(d) MAXHOT
(e) CW

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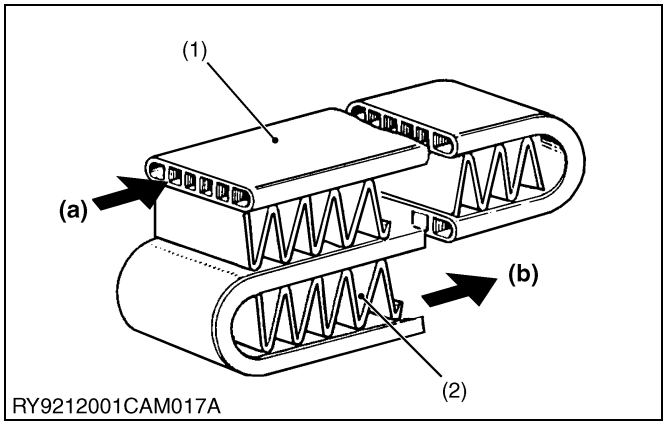
[5] CONDENSER



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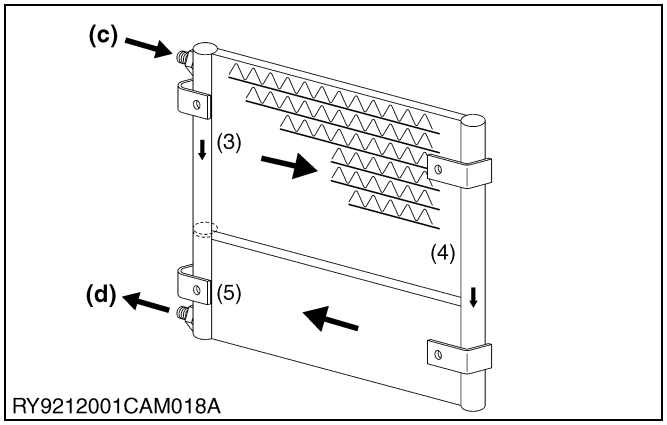

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The hot, compressed refrigerant is under high pressure and in a gaseous state; the condenser cools it and returns it to a liquid state. In the interval between entering and passing through the condenser, the refrigerant is cooled and becomes liquid refrigerant again. At this point, it is necessary to be sure the refrigerant is liquid at the outlet of the condenser. If the refrigerant is not condensed enough in the condenser some refrigerant would be in a gaseous state and that would reduce the AC's cooling efficiency.

(1) Tubes
(2) Fins
(3) Vapor
(4) Vapor/liquid mix
(5) Liquid

(a) Gaseous refrigerant
(b) Liquid refrigerant
(c) Inlet (70 °C, 158 °F)
(d) Outlet (50 °C, 122 °F)

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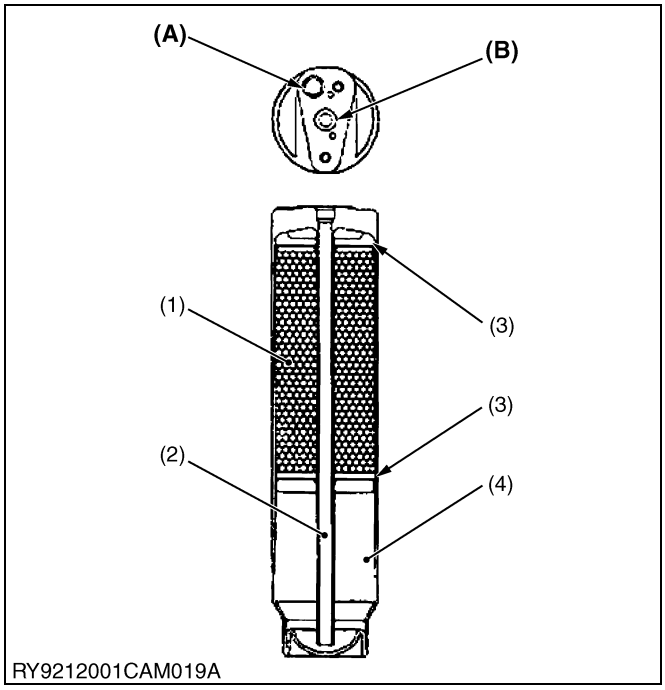
[6] RECEIVER



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The receiver is composed of a receiver tank, dryer, strainer and a receiver tube.

[Receiver Tank]

In the AC system, the rpm of the compressor changes in response to changes in the engine rpm, so the appropriate amount of refrigerant in the cooling circuit also changes. The receiver tank is the part that reacts to those changes; when a lot of refrigerant is not required in the cooling circuit, excess refrigerant is stored temporarily in the tank and when more coolant is needed, it is supplied to the circuit via the receiver tube.

It also acts to store the balance of refrigerant charges and for extra refrigerant to counteract the leak of small amounts of refrigerant, such as via permeation of rubber hoses.

[Dryer]

If any moisture exists in the cooling circuit, it damages the system by deteriorating the valves of the compressor, its oil, by corroding metal parts in the circuit, and/or freezes in the expansion valve and blocks the circuit. The AC system uses synthetic zeolite as a dryer that is compatible with the circuit, and it absorbs any moisture that gets mixed into the circuit during installation or charging of refrigerant.

If the expansion valve freezes up frequently due to moisture (icing), it means the dryer has lost its ability to absorb it, so the receiver has to be replaced.

[Strainer]

If dirt gets into the cooling circuit, it blocks the expansion valve, damages the compressor and otherwise hampers its cooling function. The strainer works to prevent any dirt flowing in the refrigerant from going any further. The strainer cannot be cleaned, so when it becomes severely clogged up, (in which case the high pressure gets high, low pressure gets low), the receiver has to be changed.

[Sight Glass]

The sight glass is mounted at the receiver joint on top of the receiver and it is the only place in the circuit where the amount of refrigerant can be visually inspected.

(1) Dryer
(2) Receiver tube
(3) Strainer
(4) Receiver tank

(A) Refrigerant inlet
(B) Refrigerant outlet

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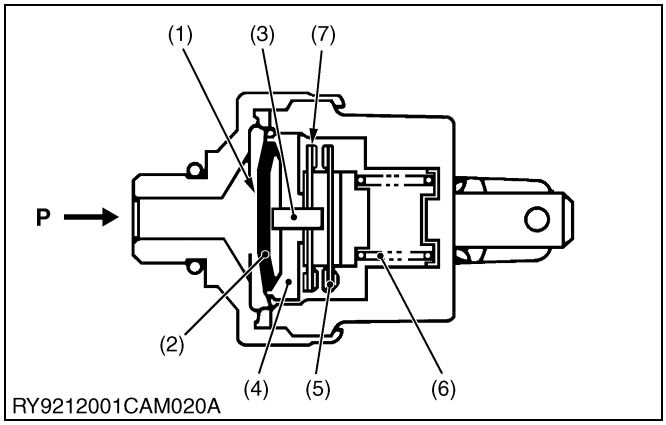
[7] PRESSURE SWITCH



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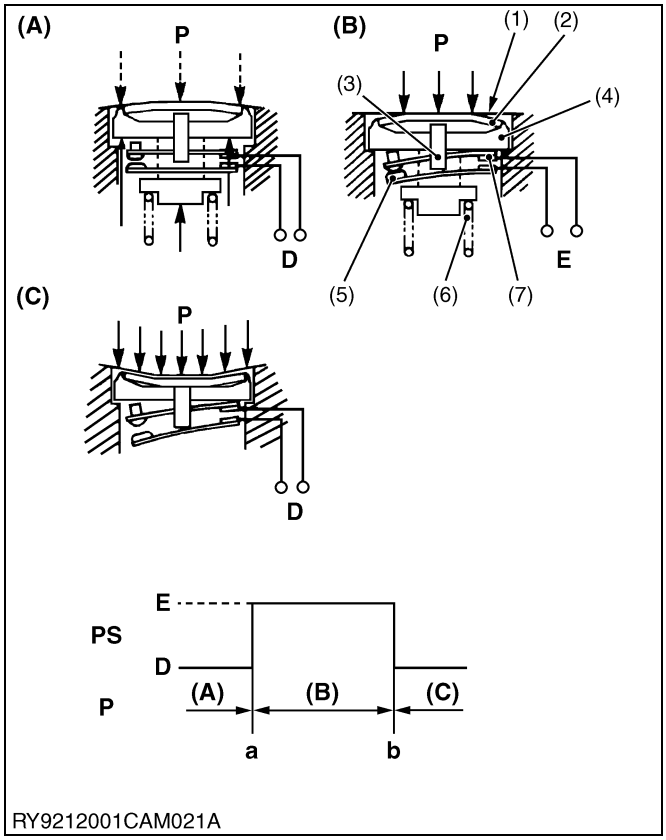

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This dual type of switch detects unusually high and low pressures in the cooling cycle. If the pressure gets abnormally high or, due to a leak, abnormally low, it may damage the equipment or deteriorate the lubricating ability of the compressor oil, leading to scorching and breakdown. To prevent these kind of problems from occurring, the switch cuts the power to the compressor clutch and stops the compressor.

	Refrigerant pressure	Operation
(A)	No increase in pressure state (when abnormally low)	The refrigerant pressure becomes less than the force of the spring, so the spring presses the plate up and the upper contact opens (OFF).
(B)	Contact ON (normal operation)	The refrigerant pressure is greater than the force of the spring, so the pressure plate is pressed down, which presses the upper contact down, closing the contact (ON).
(C)	Contact OFF (abnormally high pressure)	The refrigerant pressure becomes greater than the force of the plate spring and the plate spring pushes down on the pin, which press on the lower contact, opening it (OFF).

(1) Diaphragm
(2) Plate Spring
(3) Pin
(4) Plate
(5) Contact
(6) Spring
(7) Terminal

a : 0.19 MPa (2.0 kgf/cm^2, 28.4 psi)
b : 3.14 MPa (32 kgf/cm^2, 455 psi)
D : OFF
E : ON
P : Pressure
PS : Pressure Switch

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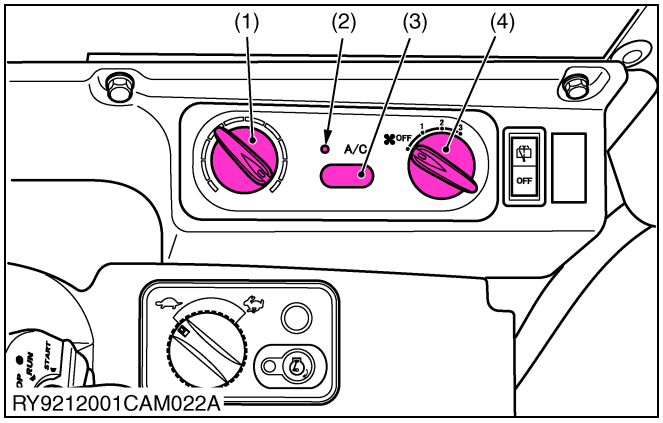
[8] SYSTEM CONTROLS



Control Panel

● **AC Switch (AC specification)**
Press this switch [ON] to use the AC. When the AC is [ON], the indicator lamp lights up. Press the switch again to turn it [OFF].

● **Temperature Control Dial**
Turning the dial to the left to cool, to the right for heat.

● **Fan Switch**
The fan can be switched to 3 different speeds. The strongest speed is [3].

[Operating the AC]

● **Heating**

1. Adjust the fan switch and the temperature control dial to the desired temperature.

■ **NOTE**

- **When not using the heater in the summer, turn the temperature control dial all the way to the left (cool air side) so hot air does not raise the cabin temperature.**

● **Dry Heat**

1. Press the AC switch to operate the AC.
2. Turn the fan switch to operate the fan.
3. Turn the temperature control dial to the right (warm air) and adjust the air temperature.

■ **NOTE**

- **Keep the door closed while operating the AC.**

● **Cooling**

1. Press the AC switch to operate the AC.
2. Turn the fan switch to operate the fan.
3. Turn the temperature control dial to the left (cool air) and adjust the air temperature.

■ **NOTE**

- **The moisture from dehumidifying the cabin collects in the AC unit and is expelled outside the machine.**
- **The idle boost function operates when the compressor is operating.**

● **Defrost**
To eliminate fog or frost from the front window,

1. open the front vents and point them toward the front window.
2. Turn the fan switch to [3] and the temperature control dial to the right (warm air).

(1) Temperature control dial
(2) Indicator lamp
(3) AC switch
(4) Fan switch

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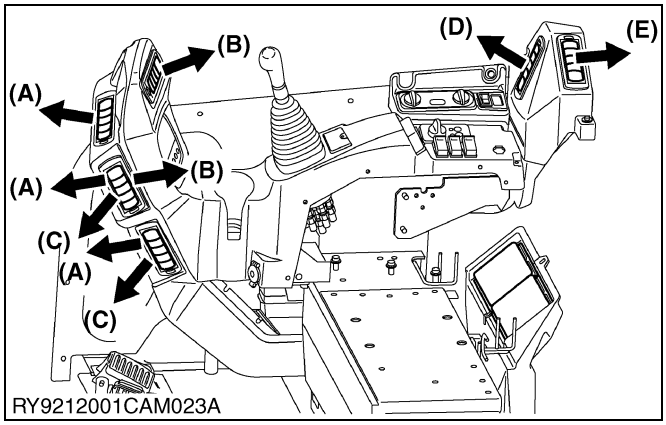
[9] ADJUSTING THE AIR FLOW AND DIRECTION



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Air Flow

The air flows inside the cab as in the diagram. The ideal condition can be achieved by adjusting the 6 vents.

(A) Front window
(B) Chest
(C) Feet
(D) Side
(E) Rear

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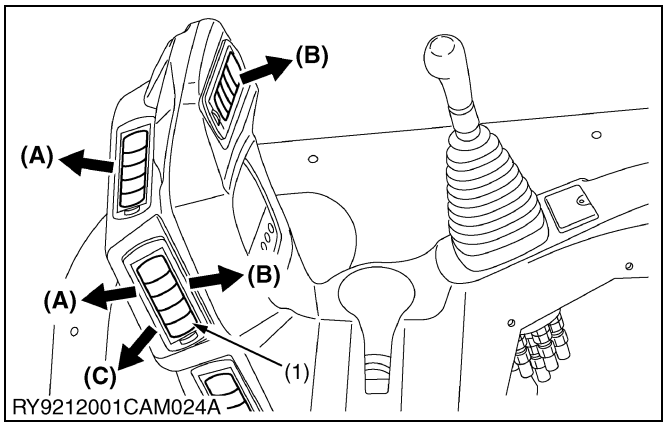

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Adjusting Air Direction

● **Front vent**

Air vents can be adjusted in whatever direction you desire. To use a vent as a defroster (stop the front window from fogging up), point the vent toward the front window.

(1) Front vent
(2) Cabin air inlet (cab air filter)

(A) Front window
(B) Chest
(C) Feet

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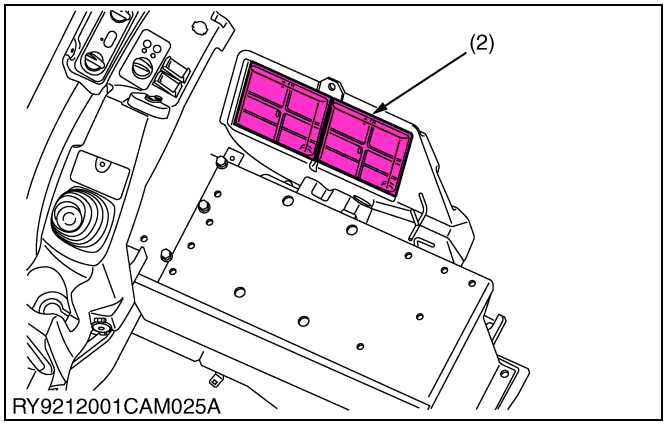

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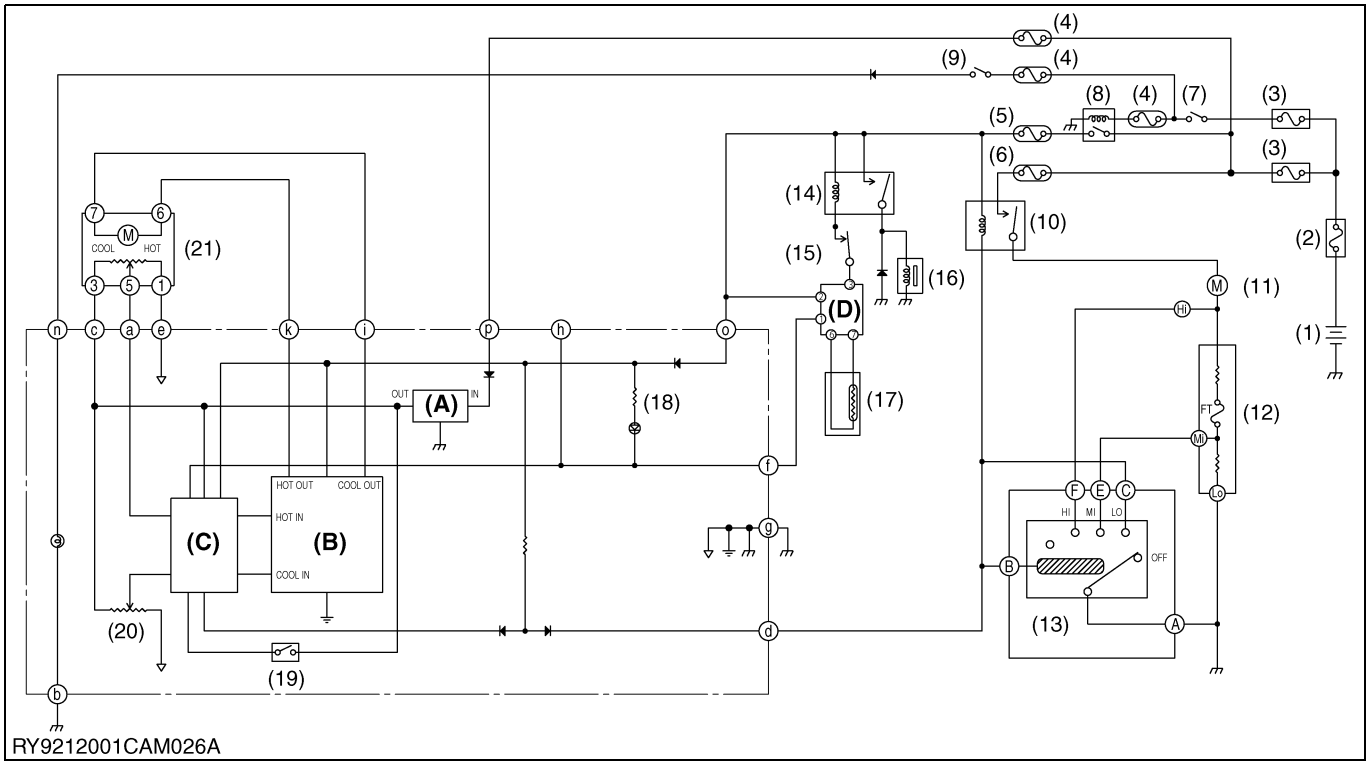
[10] ELECTRICAL SYSTEM
(1) Electrical Circuits



(1) Battery
(2) Slow-blow Fuse (80A)
(3) Slow-blow Fuse (50A)
(4) Fuse (5A)
(5) Fuse (10A)
(6) Fuse (30A)
(7) Start switch
(8) Cab relay
(9) Headlight switch
(10) Blower Motor Relay
(11) Blower Motor
(12) Blower resistor
(13) Blower switch (shorting type)
(14) Compressor clutch relay
(15) Pressure Switch
(16) Compressor magnetic clutch
(17) Fin thermistor (frost sensor)
(18) Indicator lamp
(19) AC switch
(20) Volume (temperature setting)
(21) Servo motor

(A) Fixed voltage circuit
(B) Servo motor drive circuit
(C) CPU
(D) Electronic thermo amp

(a) Potentiometer signal
(b) ILL–
(c) Potentiometer power
(d) Blower motor
(e) Potentiometer GND
(f) Electronic thermo
(g) GND
(h) (free)
(i) Servo motor output1 (COOL output)
(j) (free)
(k) Servo motor output2 (HOT output)
(l) (free)
(m) (free)
(n) Headlight switch
(o) IG
(p) +B power

The processes up to the compressor's magnetic clutch engaging are indicated below.

1. Start switch → cab relay ON → blower motor relay ON → blower switch ON (LO, MI or HI) →blower motor ON
2. AC switch ON (indicator lamp lights up) → pressure switch ON → fin thermistor ON → compressor clutch relay ON → compressor magnetic clutch ON (compressor operates)

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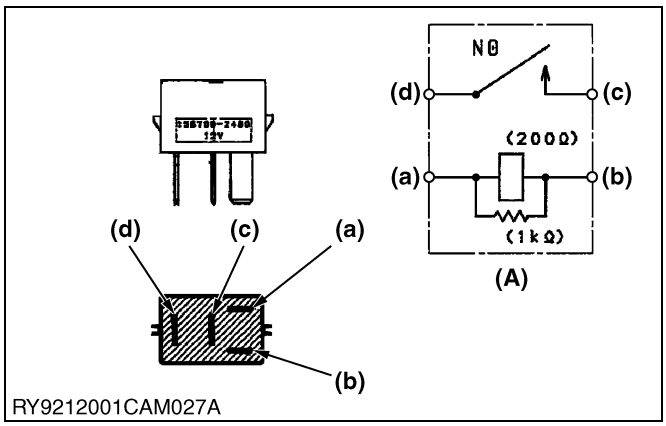
(2) Relays



RY9212001CAM027A

Current flows in the components of the AC system to the blower motor and compressor's magnetic clutch. If all of the current were supplied via the main switch, the current would be too much for the switch, so the contacts of the main switch would be in danger of burning out. Similarly, if this current flowed directly from the battery and the operator forget to turn the blower motor off, the battery would discharge.

The system is equipped with relays in order to prevent these kind of problems. When the current flows through the coils of these relays, their contacts close, allowing electricity to be supplied from the battery. By adopting these relays, only a tiny amount of current is needed to operate the relays, so very little current flows through the main switch. As a result, the concern over its contacts burning out is eliminated and when the main switch is open, the relays' contacts open at the same time. When this occurs, the flow of electricity in the AC circuit ceases and the possibility of the battery discharging is also eliminated.

(a) Relay terminal 5
(b) Relay terminal 3
(c) Relay terminal 2
(d) Relay terminal 1

(A) Connection diagram

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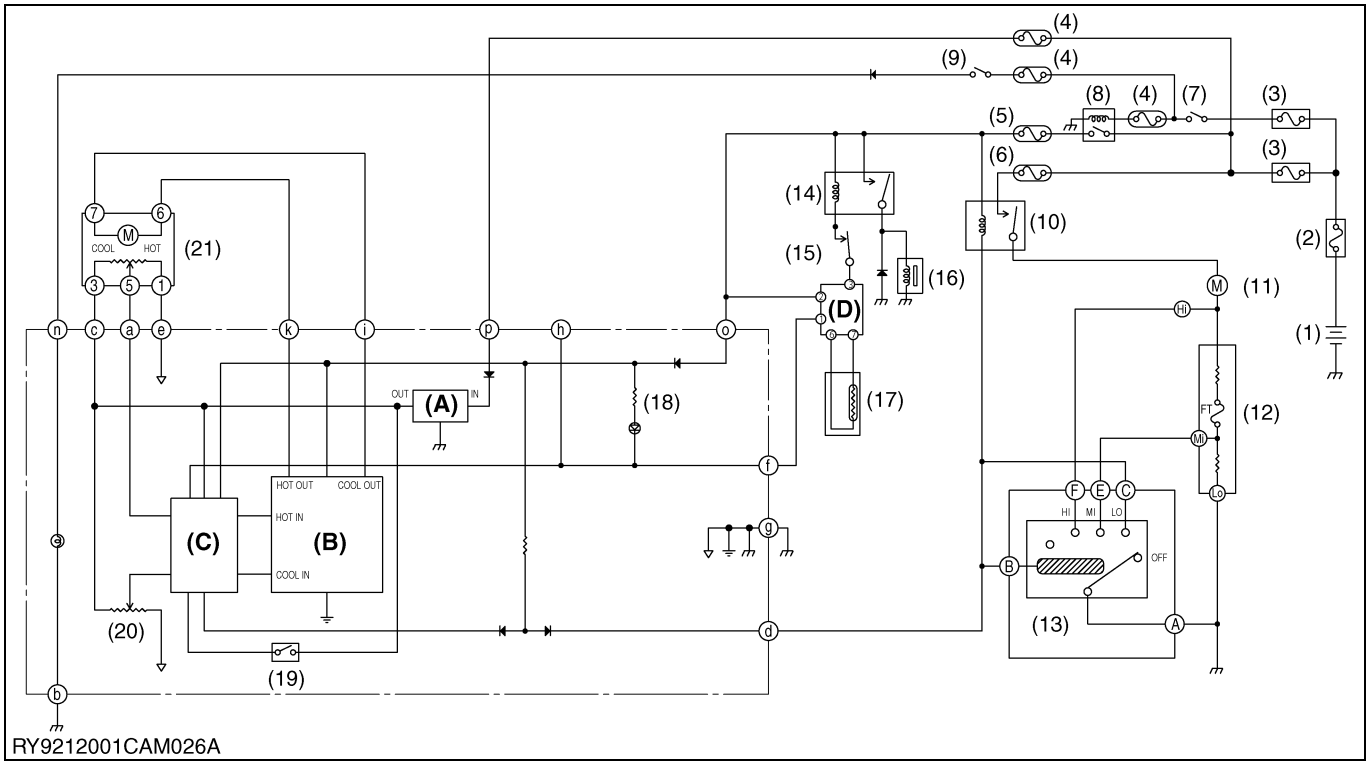
(3) Blower switch

When the blower switch is in the LO, MI, or HI position



RY9212001CAM026A

(1) Battery
(2) Slow-blow Fuse (80A)
(3) Slow-blow Fuse (50A)
(4) Fuse (5A)
(5) Fuse (10A)
(6) Fuse (30A)
(7) Start switch
(8) Cab relay
(9) Headlight switch
(10) Blower Motor Relay
(11) Blower Motor
(12) Blower resistor
(13) Blower switch (shorting type)
(14) Compressor clutch relay
(15) Pressure Switch
(16) Compressor magnetic clutch
(17) Fin thermistor (frost sensor)
(18) Indicator lamp
(19) AC switch
(20) Volume (temperature setting)
(21) Servo motor

(A) Fixed voltage circuit
(B) Servo motor drive circuit
(C) CPU
(D) Electronic thermo amp

When the starter switch and the blower switch are turned on, electricity flows from the battery to the coil of the blower motor relay, turning the blower motor relay on. With the blower motor relay on, the electricity flows to the blower motor as indicated below.

- **Lo Position**
  - Battery → slow-blow fuse (80A) → slow-blow fuse (50A) → fuse (30A) → blower motor relay → blower motor → blower resistor → ground
- **Mi Position**
  - Battery → slow-blow fuse (80A) → slow-blow fuse (50A) → fuse (30A) → blower motor relay → blower motor → blower resistor → blower switch (E→A) → ground
- **Hi Position**
  - Battery → slow-blow fuse (80A) → slow-blow fuse (50A) → fuse (30A) → blower motor relay → blower motor → blower resistor → blower switch (F→A) → ground

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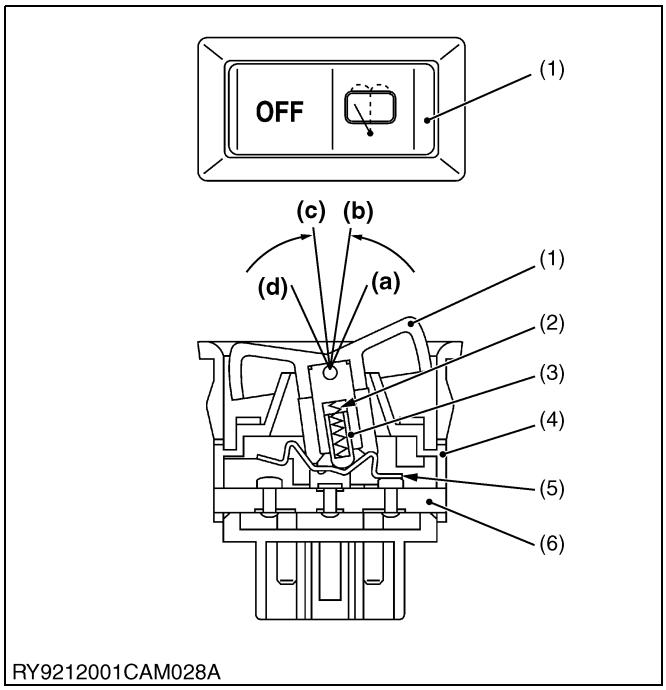
2. WIPER

[1] WIPER SWITCH



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This switch has four positions, namely **(a)**, **(b)**, **(c)** and **(d)** as indicated in the figure. When the starter key is in its [RUN] position and the switch is pressed to its **(b)** position, the wiper motor operates; pressing it in further to its **(a)** position operates the window washer. When the operator releases the switch, it automatically returns from position **(a)** to position **(b)**.

The window washer also operates if it is pressed in to position **(d)** on the [OFF] side. When it is released, it automatically returns in the same way to position **(c)**.

(1) Switch
(2) Spring
(3) Contact
(4) Switch body
(5) Movable contact
(6) Insulator

(a) Wash 1 position (both wiper motor and window washer operate)
(b) On position (only the wiper motor operates)
(c) Off position
(d) Wash 2 position (only the window washer operates)

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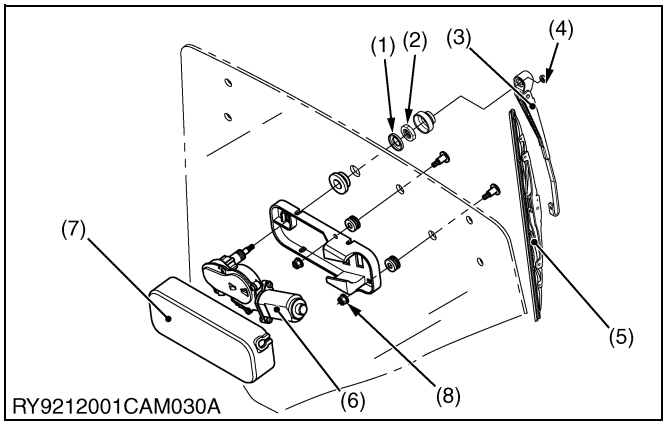
[2] WIPER



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The wiper is composed of a motor, wiper arm, wiper blade, etc.

The motor is fixed speed and automatically returns to a set position.

(1) Washer
(2) Nut
(3) Wiper arm
(4) Nut
(5) Wiper blade
(6) Wiper motor
(7) Wiper motor cover
(8) Flange nut

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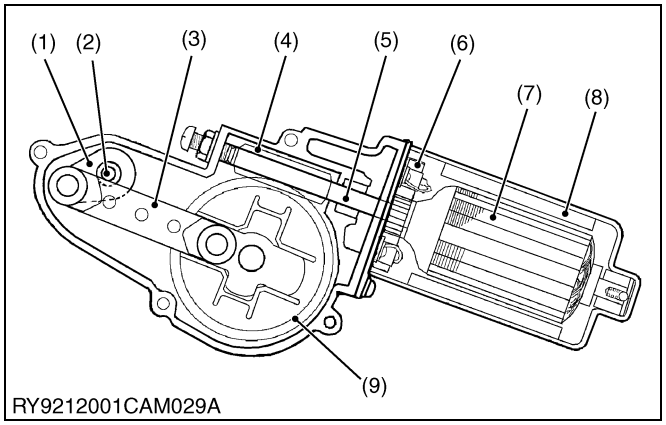
[3] WIPER MOTOR



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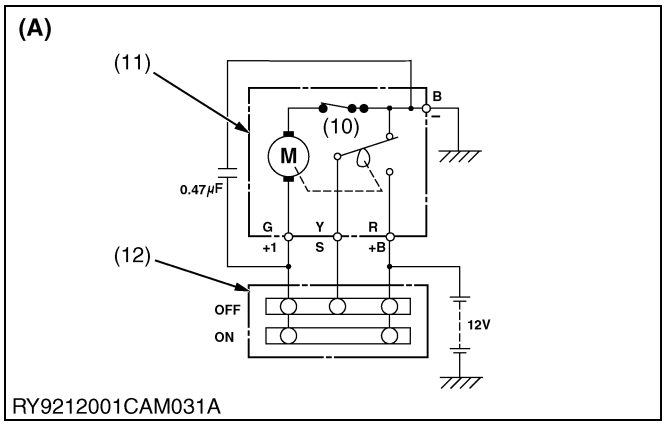

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A cylindrical ferrite magnet and an armature are assembled inside the housing of the wiper motor. A worm gear and a helical gear are attached to the end of the armature and act as reduction gears and the rod and a segmented arm provide reciprocating motion, which is communicated to the wiper arm via the arms axis.

The motor is a 2-brush specification model and its rpm cannot be altered.

(1) Segmented arm
(2) Arm's axis
(3) Rod
(4) Worm gear
(5) Armature axle
(6) Brush
(7) Armature
(8) Ferrite magnet
(9) Helical gear
(10) Breaker
(11) Motor
(12) Switch

(A) Wiring diagram (motor stop position)

RY9212001CAM0029US0

SERVICING

CONTENTS

1. TROUBLESHOOTING....5-S1
2. MAINTENANCE AND SERVICE RELATED SPECIFICATIONS....5-S4
3. TORQUE....5-S5
4. PRECAUTIONS WHEN REPAIRING THE REFRIGERANT SYSTEM....5-S6
   [1] USE OF SERVICE TOOLS....5-S6
      (1) Manifold Gauge Set....5-S6
      (2) Refrigerant charging hoses....5-S9
      (3) Vacuum Pump Adapter....5-S10
      (4) Electric Gas Leak Tester....5-S10
      (5) Canister Tap Valve....5-S10
      (6) T-Joint....5-S11
      (7) R134a Refrigerant Collection/Recycling Device....5-S11
5. INSPECTING AND CHARGING THE REFRIGERANT SYSTEM....5-S12
   [1] CHECKING THE SYSTEM WITH A MANIFOLD GAUGE....5-S12
   [2] COLLECTION, VACUUMING AND CHARGING....5-S16
      (1) Collecting Refrigerant....5-S16
      (2) Vacuuming out the System....5-S16
      (3) Charging from the High-pressure Side....5-S18
      (4) Charging from the Low-Pressure Side....5-S18
      (5) Inspections and Troubleshooting....5-S19
6. INSPECTION AND DISASSEMBLY....5-S21
   [1] CHECKS AND ADJUSTMENTS....5-S21
      (1) Compressor....5-S21
      (2) Relays....5-S21
      (3) Blower motor....5-S23
      (4) Blower resistor....5-S24
      (5) Blower switch....5-S25
      (6) Servo Motor (for temp control)....5-S26
      (7) Pressure Switch....5-S27
   [2] DISASSEMBLY AND ASSEMBLY....5-S28
      (1) Connecting / Disconnecting AC Hoses....5-S29
      (2) Mounting and Removing the Compressor....5-S30
      (3) Connecting / Disconnecting Hoses....5-S33
      (4) Removing and Mounting the Receiver....5-S34
      (5) Removing and Mounting AC Ducts....5-S35
      (6) Removal and Installation of AC Cabin Air Inlets....5-S37
7. CABIN REMOVAL AND MOUNTING....5-S39
   [1] REMOVING THE CABIN....5-S39
8. WINDOW WASHER....5-S41
   [1] WIPER SWITCH....5-S41
   [2] COMPONENT SCHEMATIC....5-S42
   [3] WIPER MOTOR....5-S43
   [4] WASHER MOTOR....5-S43
9. LIGHTING DEVICES (CAB WORK LIGHT, INTERIOR LIGHT)....5-S44
10. REMOVAL AND INSTALLATION OF GLASS....5-S47
   [1] PREPARATION....5-S47
   [2] REMOVING GLASS....5-S47
   [3] INSTALLING GLASS....5-S48
   [4] GLASS TRIM TYPE....5-S49

[5] HOW TO REPLACE THE GLASS OF THE RIGHT-SIDE WINDOW 5-S49
11. FRONT WINDOW.....5-S52
[1] ADJUSTING THE CLOSING LOCK OF THE FRONT WINDOW (TOP) 5-S52
[2] ADJUSTING THE OPEN LOCK OF THE FRONT WINDOW (TOP) 5-S53

1. TROUBLESHOOTING

Compressor

Problem and/or Situation	Possible Cause	Solution
Noise (compressor on)	Wearing of or damage to the compressor's bearings	Replace
	Compressor valve damaged	Replace
	Belt slipping	Adjust or replace
	Compressor bracket mounting bolt(s) loose	Tighten
	Lines vibrating	Tighten and/or add clamp(s)
Noise (compressor off)	Blower damaged	Repair or replace
	Magnetic clutch, idler pulley and/or crank pulley bearings damaged or wearing	Replace

Air Conditioning System

Problem and/or Situation	Possible Cause	Solution
Cooling not working (air not blowing)	Blown fuse	Replace
	Main AC relay defective	Replace
	AC's blower motor damaged	Replace
	AC's blower switch broken	Replace
	Wiring harness unplugged or poor contact	Fix
Cooling not working (compressor not turning)	Blown fuse	Replace
	Magnetic clutch broken	Repair or replace
	AC switch broken	Replace
	Pressure switch broken	Replace
	Belt slipping	Adjust or replace
Cooling not working (other)	Not enough refrigerant	Check with a manifold gauge
	Expansion valve broken	Replace
	Compressor broken	Replace
Cooling not working effectively (not enough air blowing)	Filter clogged	Clean or replace
	Frost on the evaporator	Clean or replace the temperature switch
	AC's blower motor damaged	Replace
	AC blower resistor broken	Replace
Not cooling effectively (lots of foam visible in sight glass)	Not enough refrigerant	Check with a manifold gauge
	Refrigerant gas leaking from the cooling circuit	Repair and/or recharge refrigerant
	Air got in	Check with a manifold gauge
Too much refrigerant (no foam in sight glass)	Refrigerant overcharged	Check with a manifold gauge
Not cooling effectively (compressor not rotating properly)	Belt slipping	Adjust or replace
	Magnetic clutch broken	Repair or replace
	Compressor broken	Replace

Problem and/or Situation	Possible Cause	Solution
Not cooling effectively (other)	Thermistor broken	Replace
	Hot water valve damaged	Replace
	Condenser clogged with dirt or debris	Clean
	Expansion valve broken	Replace
Not heating effectively	Hot water valve damaged	Replace
	Servo motor broken	Check and repair
Not enough air flow (blower motor not turning)	Blower fan switch broken	Check and repair
	AC main relay broken	Replace
	Brushes have poor contact	Replace
	Blown fuse	Replace
	Miswiring or poor connections	Check and repair
Not enough air flow (air flow does not change to speed 3)	Blower resistor damaged	Replace
	Relay damaged	Replace
	Blower fan switch broken	Replace
Not enough air flow (other)	Blower not tight enough	Check and repair
	Blower deformed	Replace
	Blower hitting its casing	Check and repair
	Something blocking the inlet	Check and repair
	Frost on the evaporator	Clean or replace
	Filter clogged	Clean or replace
	Vent ducts clogged or detached	Check and repair
Not cooling effectively (compressor clutch not working)	Battery voltage too low	Charge the battery
	Rotor is hitting the stator	Replace
	Miswiring or loose connectors	Check and repair
	Relay damaged	Replace
	Coil shorted	Replace
	Ground defective	Check and repair
	Coil burned out	Replace
Not cooling effectively (high-pressure level too high)	Refrigerant overcharged	Check with a manifold gauge
	Condenser clogged with dirt or debris	Clean
	Air got in	Check with a manifold gauge
Not cooling effectively (high-pressure level too low)	Not enough refrigerant	Check with a manifold gauge
	Compressor discharge valve damaged	Replace
	Compressor gasket damaged	Replace
	Error in the low-pressure line (cracked or clogged)	Replace
Not cooling effectively (low-pressure level too high)	Refrigerant overcharged	Check with a manifold gauge
	Expansion valve too far open	Replace

Problem and/or Situation	Possible Cause	Solution
Not cooling effectively (low-pressure level too low)	Not enough refrigerant	Check with a manifold gauge
	Frost on the evaporator	Clean or replace
	Error in the low-pressure line (cracked or clogged)	Replace
	Expansion valve clogged	Replace
Not cooling effectively (both low and high pressure levels too high)	Refrigerant overcharged	Check with a manifold gauge
Not cooling effectively (both low and high pressure levels too low)	Not enough refrigerant	Check with a manifold gauge
Cannot control temperature (servo motor and/or temperature control dial defective)	Servo motor broken	Replace
	Temperature control dial broken	Replace
	Controller of the wire harness is off	Repair or replace
Cannot control the temperature (hot water valve does not open normally)	Servo motor broken	Replace
	Hot water valve damaged	Replace
Cannot control the temperature (poor heater hose layout)	Heater hose is pinched	Fix
	Heater hose is bent or broken	Repair or replace
Water leak (water leak inside the cab)	Drain hose bent or broken	Check and repair
	Drain hose clogged	Clean

Wiper

Problem and/or Situation	Possible Cause	Solution
Wiper doesn't work	Fuse blown (a part inside the wiper motor or some other moving part is shorted or burned out)	Pinpoint the cause of the damage and replace
	Wiper motor faulty (damaged armature, worn motor brushes, motor shaft locked)	Replace
	Wiper switch faulty	Replace
	Faulty operation of linkage mechanism due to foreign matter	Fix
	Wiper arm locked or rusted together	Grease up or replace
Wiper moves too slowly	Wiper motor faulty (damaged armature, poor contact due to worn motor brushes, faulty operation of motor shaft)	Replace
	Battery voltage low	Recharge or replace
	Wiper arm shaft rusty, foreign matter stuck in it	Grease up or replace
	Poor contact in wiper switch	Replace
Wiper fails to stop in the correct position	Wiper motor faulty (Dirty or poor contact of the contacts at the auto-stop position due to foreign matter)	Replace

RY9212001CAS0001US0

2. MAINTENANCE AND SERVICE RELATED SPECIFICATIONS

Item		Factory spec.	Allowable Limit Value
AC Compressor Magnetic Clutch	Air Gap	0.30 to 0.65 mm 0.0118 to 0.0255 in.	–
Magnetic Clutch Stator Coil	Electrical Resistance	3.0 to 4.0 Ω	–
Cooling Cycle (cooling cycle when operating normally)	Pressure (low-pressure side)	0.15 to 0.20 MPa 1.5 to 2.0 kgf/cm^2 21 to 28 psi	–
	Pressure (high-pressure side)	1.27 to 1.66 MPa 13 to 17 kgf/cm^2 185 to 242 psi	–
Pressure switch (dual type) (when pressure switch is off)	Pressure setting (low-pressure side)	Lower than the values below About 0.196 MPa 2.0 kgf/cm^2 28.4 psi	–
	Pressure setting (high-pressure side)	Higher than the values below About 3.14 MPa 32 kgf/cm^2 455 psi	–
AC drive belt	Tension	Deflects 12 to 15 mm (0.47 to 0.59 in.) when 68.6 N (7 kgf, 15.4 lbf) of forced is applied	–
Refrigerant	Type (recharge volume)	R134a 0.65 to 0.75 kg 1.43 to 1.65 lbs	–
Compressor Oil	Type (usage volume)	ND-OIL8 <PAG*oil> 100 to 120 cc 0.106 to 0.127 U.S.qts 0.088 to 0.106 Imp.qts	–

*PAG : Polyalkylene glycol (synthetic oil)

RY9212001CAS0002US0

3. TORQUE

The following table indicates the specified tightening torque for nuts.

Items		N·m	kgf·m	lbf·ft
Condenser mounting	M8 nut	17.7 to 20.6	1.8 to 2.1	13.0 to 15.2
Compressor mounting	M8 bolt	16.7 to 19.6	1.7 to 2.0	12.3 to 14.5
Compressor bracket mounting	M12 bolt	77.5 to 90.2	7.9 to 9.2	57.1 to 66.5
	M8 bolt	16.7 to 19.6	1.7 to 2.0	12.3 to 14.5
Receiver mounting	M6 bolt	3.9 to 6.9	0.4 to 0.7	2.9 to 5.1
High pressure line 1 mounting (on condenser side)	M6 bolt	7.8 to 11.8	0.8 to 1.2	5.8 to 8.7
	M22 × 1.5 lock nut	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Between condenser and receiver	M6 bolt	3.9 to 6.9	0.4 to 0.7	2.9 to 5.1
	M16 × 1.5 lock nut	11.8 to 14.7	1.2 to 1.5	8.7 to 10.8
High pressure line 2 mounting (on receiver side)	M16 × 1.5 lock nut	11.8 to 14.7	1.2 to 1.5	8.7 to 10.8
Low-pressure line between AC and compressor	M6 bolt	7.8 to 11.8	0.8 to 1.2	5.8 to 8.7
	M24 × 1.5 lock nut	29.4 to 34.3	3.0 to 3.5	21.7 to 25.3
AC mounting	M6 bolt	3.9 to 6.9	0.4 to 0.7	2.9 to 5.1
	M8 bolt	9.8 to 15.7	1.0 to 1.6	7.2 to 11.6
Magnetic clutch mounting	M6 bolt	10.8 to 16.2	1.10 to 1.65	8.0 to 11.9

RY9212001CAS0003US0

4. PRECAUTIONS WHEN REPAIRING THE REFRIGERANT SYSTEM

[1] USE OF SERVICE TOOLS

(1) Manifold Gauge Set

Always follow the warnings and regulations below when inspecting or repairing the air conditioning system. It is also extremely important that no one other than specially trained service personnel handles refrigerants.

⚠ CAUTION

- **If the liquid refrigerant comes in contact with skin, it results in frostbite, so always be careful when handling refrigerants. Always wear goggles when working on this system in order to protect your eyes.**
- **Refrigerant service containers are made very sturdy for safety. However, they can explode if handled improperly. Always follow the instructions printed on their labels. In particular, never heat a refrigerant container above 40 °C (104 °F). Also, never drop one from any height.**
- **Do not steam clean this system. In particular, this system is under extremely high pressure, so do not steam clean the condenser as it may cause the system to explode.**
- **If an error is made in handling the service valve or in connecting a hose between the compressor's service valve and a manifold gauge, it may cause the refrigerant service container or the charging hose to explode. When connecting hoses or handling service valves, always check the pressure on the high-pressure side or on the low-pressure side.**
- **When recharging refrigerant with the compressor operating, do not open the high-pressure valve of the manifold gauge.**
- **Be careful of gas toxicity. The refrigerant gas in its natural state is harmless and is not toxic. However, when it comes in contact with very hot parts, it can break down chemically, producing hazardous materials.**
- **Do not heat service canisters unless absolutely necessary. When necessary to heat a canister, use water at or below 40 °C (104 °F). Never use boiling water to heat a canister.**

■ **IMPORTANT**

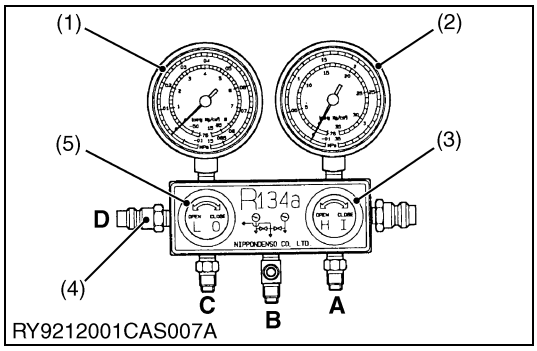
- **Using R12 refrigerant in an R134a AC system may cause problems to result, such as leaks of refrigerant at O-rings and fogging of the sight glass. Consequently, the shapes of line joints, service valves and service tools are different in order to prevent mistakes in connecting or recharging the wrong system.**
- **Always keep the work area clean, dry and free of any dirt or dust. Always wipe off any water from line fittings with a clean cloth before opening the fitting.**
- **Only use R134a refrigerant service tools.**
- **When discharging refrigerant, use an R134a refrigerant collection/recycling machine.**
- **Prior to connecting a charging hose to the tap valve of a refrigerant canister, check each seal and make sure it is not clogged up.**
- **When disconnecting charging hoses from compressor and receiver valves, do so as quickly as possible to minimize the leakage of gas.**
- **Be careful to only charge with the specified amount of refrigerant; never overcharge the system. This is important because overcharging the refrigerant can cause poor cooling performance among other things.**
- **Hand tighten when connecting the charging hose to the canister's tap valve. Do not use pliers to tighten the charging hose.**
- **Store refrigerant containers in a cool, dark place and never leave them in direct sunlight or in a hot place.**
- **R134a compressor oil readily absorbs moisture, so always seal any parts after disconnecting them.**
- **Do not use any of the old style R12 refrigerant or previous kinds of refrigerant compressor oil.**

CAUTION
- **Take care with the following points on storing and handling service canisters.**
  - **Store in a cool, dry place.**
  - **Never drop or strike a canister.**
  - **Do not use service canisters that are deformed, have unusable screws or are otherwise damaged.**
  - **Never heat a service canister unless necessary. If one must be heated for some reason, use water at or below 40 °C (In such cases, never warm the canister while heating the water.) Do not immerse the valve of the service canister in water. Do not turn the service canister upside down. Turning it upside down allows liquid refrigerant into the compressor, which damages the valve.**
  - **Do not shake hard. (If the mounting of the valve is not secure, it may come off.)**
  - **Use ND-OIL8 (made by DENSO (Co. Ltd.)) compressor oil. (ND-OIL6 is designated for use with R12, so do not mistakenly use ND-OIL6.)**

CAUTION
- **Precautions on Inspecting and Charging AC Gas**
  - **Perform all work in a well-ventilated location.**
  - **Be careful when handling high-pressure valves. When recharging refrigerant with the engine running, do not open the high-pressure valve (HI) of the manifold gauge. Overcharging refrigerant may cause problems such as poor cooling and overheating.**

IMPORTANT
- **Collection of Refrigerant (AC gas)**
  In line with the Freon Collection and Destruction Law (Oct. 1, 2007), registration (Category 1 Freon Collector) is required with the prefectural and municipal governments prior to collecting refrigerants with a gas collection device, so do not perform this work if you are not registered. For details, contact the relevant office in the prefectural and municipal governments.

RY9212001CAS0004US0

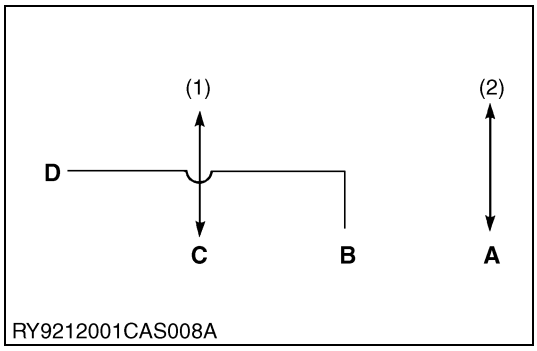


RY9212001CAS007A

The manifold gauge set has a valve handle for opening and closing valves. The valve handle marked LO is for use on the low-pressure valve (5) and the valve handle marked HI is for use on the high-pressure valve (3). The following circuits can be achieved by variously opening and closing the high and low pressure valves.

(1) Low-pressure gauge
(2) High-pressure gauge
(3) High-pressure valve
(4) Valve core
(5) Low-pressure valve

RY9212001CAS0005US0



RY9212001CAS008A

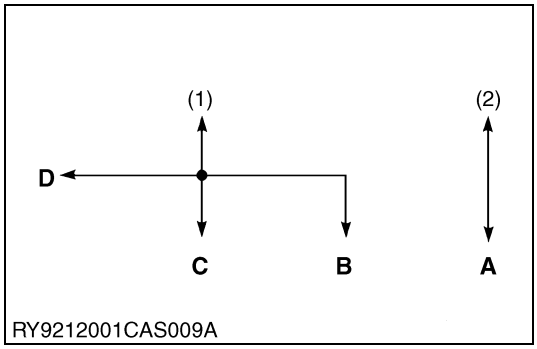
When low and high pressure valves are closed

The following 2 circuits are formed.
Port (C) → Low-pressure gauge (1)
Port (A) → High-pressure gauge (2)

CAUTION
- **Be sure to open the valve core (d).**

(1) Low-pressure gauge
(2) High-pressure gauge

RY9212001CAS0006US0



RY9212001CAS009A

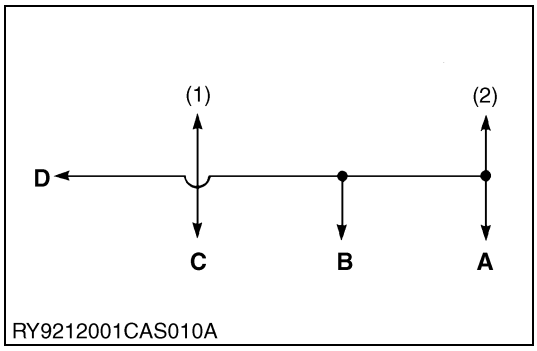
With the low-pressure valve open and the high-pressure valve closed

The following circuits are formed.
Port (C) → Low-pressure gauge (1)
Port (C) → Port (B)
Port (C) → Port (D)
Port (A) → High-pressure gauge (2)

CAUTION
- **Be sure to open the valve core (D).**

(1) Low-pressure gauge (2) High-pressure gauge

RY9212001CAS0007US0



RY9212001CAS010A

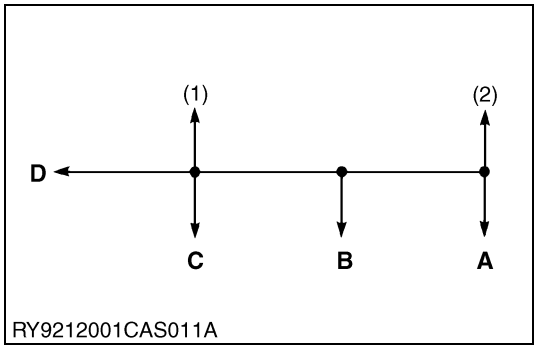
With the low-pressure valve closed and the high-pressure valve open

The following circuits are formed.
Port (C) → Low-pressure gauge (1)
Port (A) → Port (B)
Port (A) → Port (D) (Be sure to open the valve core.)
Port (A) → High-pressure gauge (2)

CAUTION
- **Be sure to open the valve core (D).**

(1) Low-pressure gauge (2) High-pressure gauge

RY9212001CAS0008US0



RY9212001CAS011A

With low and high pressure valves open

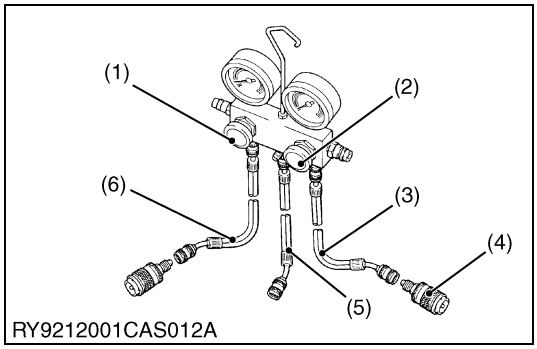
The following circuits are formed.
Port (A) → High-pressure gauge (2)
Port (A) → Low-pressure gauge (1)
Port (A) → Port (B)
Port (A) → Port (C)
Port (A) → Port (D) (Be sure to open the valve core.)

CAUTION
- **Be sure to open the valve core (D).**

(1) Low-pressure gauge (2) High-pressure gauge

RY9212001CAS0009US0

(2) Refrigerant charging hoses



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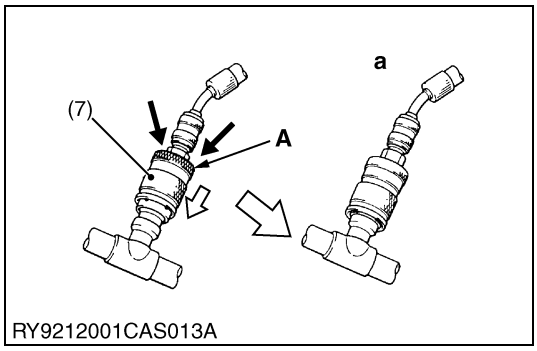

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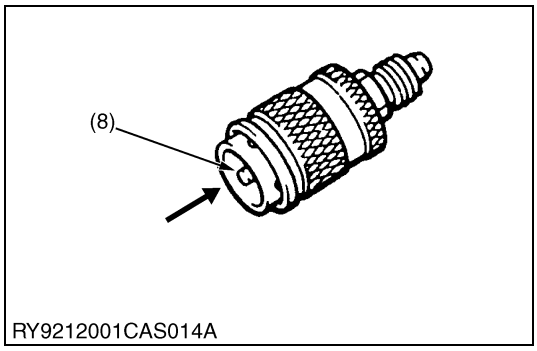

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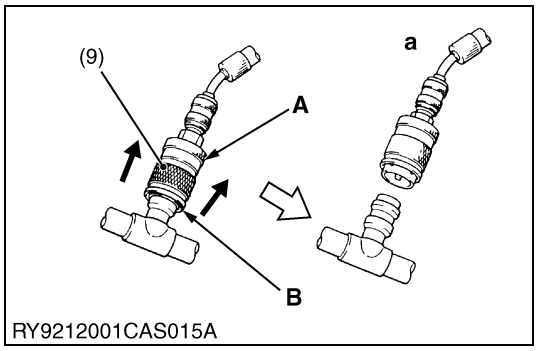


RY9212001CAS015A

The three kinds of refrigerant charging hoses are distinguishable by color. Each of the refrigerant charging hoses is to be used as follows.

- In line with the AC manufacturer's recommendation, the blue hose (6) is to be used on the low-pressure side (intake side), the green hose (5) on the cooling side (center connection port) and the red hose (3) on the high-pressure side (discharge side).

(When connecting)

- Press the quick-disconnect adapter (4) into the recharge valve and press part A in until you hear it catch.

CAUTION

- **While pressing in to make a connection, be careful not to bend any lines.**
- **When connecting a quick-disconnect adapter, if you move the sleeve (7) before the quick-link connector is connected to the charge valve, move the sleeve back to its original position and then try making the connection again.**
- **If there is any refrigerant left in the refrigerant charging hose, it can be difficult to connect the quick-link connector. In this case, make the connection after relieving the pressure remaining in the refrigerant charging hose. (Pressing on the pusher (8) eliminates any remaining pressure.)**

(When disconnecting)

- With part A of the quick-disconnect adaptor held in place, slide part B up.

CAUTION

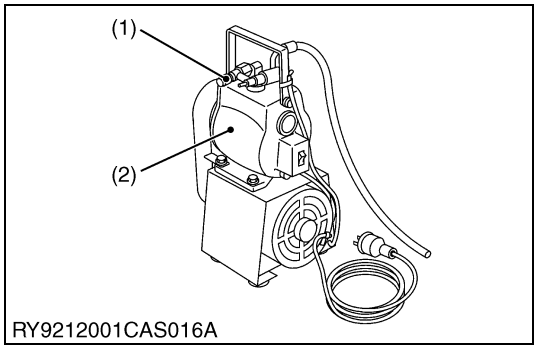
- **After removing the quick-disconnect adaptor, be sure to put a cap on the service valve of the adaptor.**

(1) Low-pressure valve
(2) High-pressure valve
(3) Red hose
(4) Quick-disconnect adapter
(5) Green hose
(6) Blue hose
(7) Sleeve
(8) Pusher
(9) Sleeve

a : Makes a catching sound

RY9212001CAS0010US0

(3) Vacuum Pump Adapter



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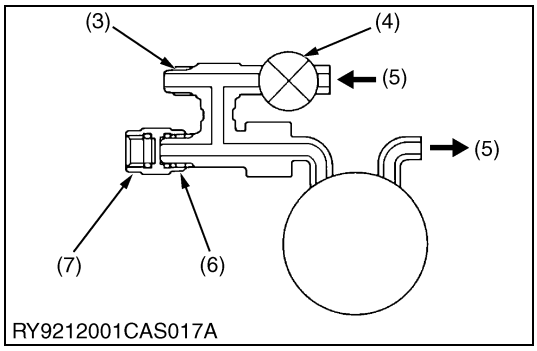


RY9212001CAS017A

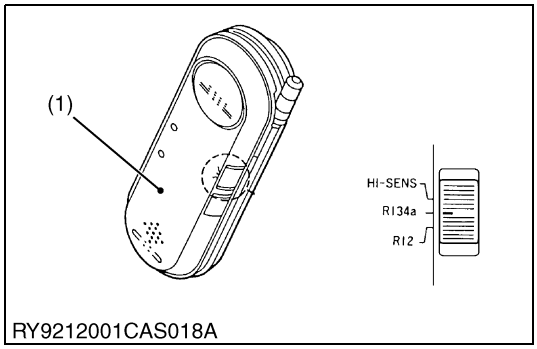
Purpose of the Vacuum Pump Adapter

1. After the AC cooling system is vacuumed, when the vacuum pump is stopped, there is a vacuum inside the hoses of the manifold gauge, so the oil of the vacuum pump flows back into the refrigerant charging hose. If the refrigerant system is charged in this state, the vacuum pump oil remaining in the refrigerant charging hose will go into the AC refrigerant system along with the refrigerant. A vacuum pump adaptor equipped with a solenoid valve is used to prevent this backflow of oil from the vacuum pump. The role of the solenoid valve is to close when electricity is flowing to the solenoid valve, cutting it off from outside air and maintaining the vacuum; when the electricity is cut off, the valve opens, bringing in outside air and relieving the vacuum.
2. If this adapter is connected to the currently used R12 vacuum pump, it enables the vacuum pump to be used for both R134a and R12.

(1) Vacuum pump adapter
(2) Vacuum pump
(3) For R134a
(4) Solenoid valve
(5) Air
(6) For R12
(7) Plug cap

RY9212001CAS0011US0

(4) Electric Gas Leak Tester



RY9212001CAS018A

The old style R12 gas leak tester are not sensitive enough for R134a and cannot be used. Consequently a new and very sensitive electrical gas leak tester has been designed that can be used with both R134a and R12.

[NOTE]

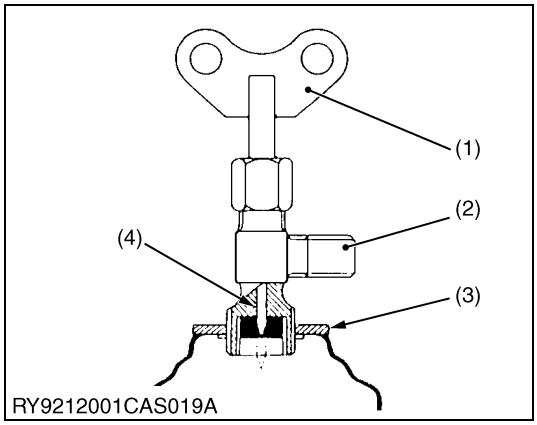
Halogenated Torch Gas Leak Testers

- Because this tester detects gas leaks based on the reaction of chlorine in the refrigerant, it cannot detect R134a because it does not contain chlorine.

(1) Electrical gas leak tester

RY9212001CAS0012US0

(5) Canister Tap Valve



RY9212001CAS019A

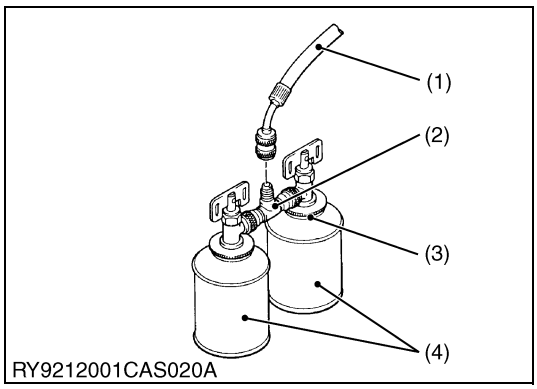
The canister tap valve used in recharging the refrigerant of the AC system has to be used as follows.

1. Before attaching the canister tap valve to the refrigerant container, rotate the handle (1) counterclockwise until the needle of the valve is completely retracted.
2. Rotate the plate nut (disk) (3) counterclockwise to its highest position and then screw the canister tap valve into the sealed tap.
3. Rotate the plate nut clockwise as far as you can and fasten the center charging hose to the canister tap valve.
4. Tighten the plate nut securely by hand.
5. Rotate the handle (1) clockwise to open a hole in the sealed tap.
6. To charge the system with refrigerant, turn the handle (1) counterclockwise. To stop charging, turn the handle clockwise.

(1) Butterfly handle
(2) Connector
(3) Disc
(4) Needle

RY9212001CAS0013US0

(6) T-Joint



RY9212001CAS020A

A T-joint (2) is used when using two refrigerant canisters (4) at the same time to make gas recharging more efficient.

1. Attach a refrigerant canister service valve on each side of the T-joint (2) and connect a refrigerant charging hose (1) to the T-joint.

(1) Refrigerant charging hose (green)
(2) T-joint
(3) Canister tap valve
(4) Refrigerant canister

RY9212001CAS0014US0

(7) R134a Refrigerant Collection/Recycling Device

When it is necessary to discharge the refrigerant in order to work on the backhoe, a collection / recycling device must be used. (Never release refrigerant into the atmosphere.)

■ **IMPORTANT**

- **Use a dedicated R134a refrigerant collection/recycling device.**
- **To prevent any damage to the compressor, use neither R12 system refrigerant nor cooling system oil in R134a equipment.**

RY9212001CAS0015US0

5. INSPECTING AND CHARGING THE REFRIGERANT SYSTEM

[1] CHECKING THE SYSTEM WITH A MANIFOLD GAUGE

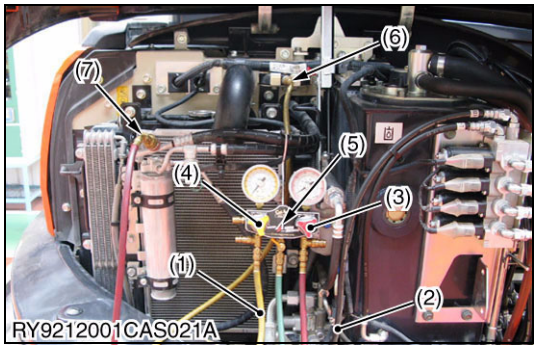
■ **IMPORTANT**

- **Be aware that the gauge pressure values noted in the following test are measured under identical conditions and they may vary somewhat from your gauge pressure values, depending on the prevailing conditions.**

Conditions

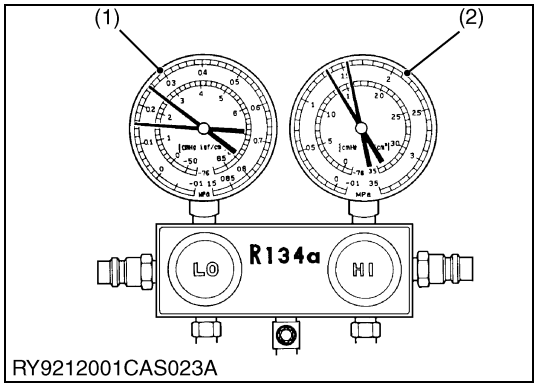
- **Ambient temperature : 30 to 35 °C (86 to 95 °F)**
- **Engine RPM : Approx. 1,500**
- **Temperature control lever : Max cooling position**
- **Blower switch : HI Position**

RY9212001CAS0016US0



RY9212001CAS021A

RY9212001CAS022A



RY9212001CAS023A

Manifold connections and test preparations

1. Close the manifold gauge's high (3) and low (4) pressure valves tightly.
2. Connect the red (2) refrigerant charging hose to the high-pressure charge valve (7) and the blue or yellow (1) refrigerant charging hose to the low-pressure charge valve (6).

CAUTION

- **Use the refrigerant pressure in the refrigerant cycle to completely flush out the air in the refrigerant charging hose from the end of the manifold gauge's connection.**

3. Start up the engine and set it at approximately 1,500 rpms.
4. Turn the AC switch on and set the temperature control dial to the max cooling position.
5. Set the blower switch to its HI position.

(1) Refrigerant charging hose (blue or yellow)
(2) Refrigerant charging hose (red)
(3) High-pressure valve
(4) Low-pressure valve
(5) Manifold gauge
(6) Low-pressure side charge valve
(7) High-pressure side charge valve

RY9212001CAS0017US0

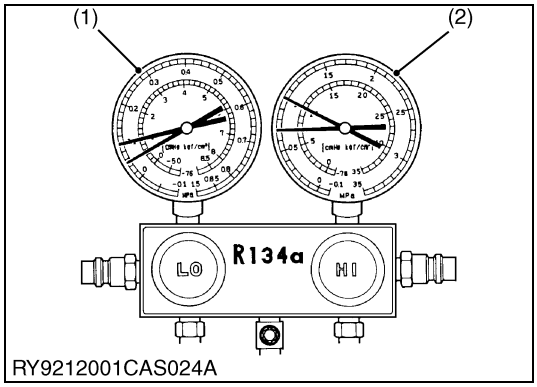
When operating normally

If the refrigerant cycle is operating normally, readings will be around the factory specifications in the table below.

Gas Pressure	Factory specification	Low pressure side	0.15 to 0.20 MPa 1.5 to 2.0 kgf/cm^2 21 to 28 psi
		High pressure side	1.27 to 1.66 MPa 13 to 17 kgf/cm^2 185 to 242 psi

(1) Low pressure side
(2) High pressure side

RY9212001CAS0018US0



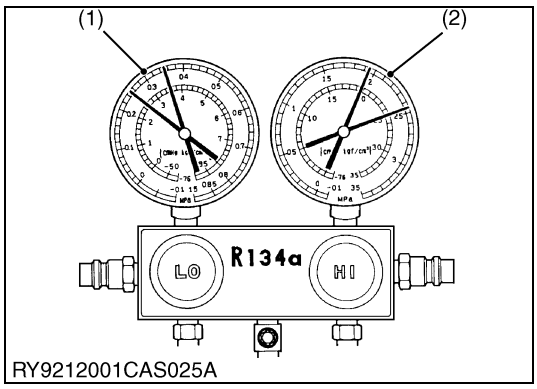
RY9212001CAS024A

Without enough refrigerant

1. Symptoms that appear in the refrigerant cycle
   - Both high (2) and low (1) side pressures are too low. Low-pressure side (1) : 0.05 to 0.10 MPa (0.5 to 1.0 kgf/cm^2, 7.1 to 14.2 psi)
     High-pressure side (2) : 0.69 to 0.98 MPa (7 to 10 kgf/cm^2, 99.6 to 142.2 psi)
   - Foam visible in the sight glass.
   - Air output by the AC appears to be cooled.
2. Possible Cause
   - Gas leaking from the circuit of the refrigerant cycle.
3. Solution Methods
   - Use an electric gas leak tester to check for leaks and repair any found.
   - Recharge the system with an appropriate amount of refrigerant.

(1) Low pressure side (2) High pressure side

RY9212001CAS0019US0



RY9212001CAS025A

Excess refrigerant or insufficient condenser cooling

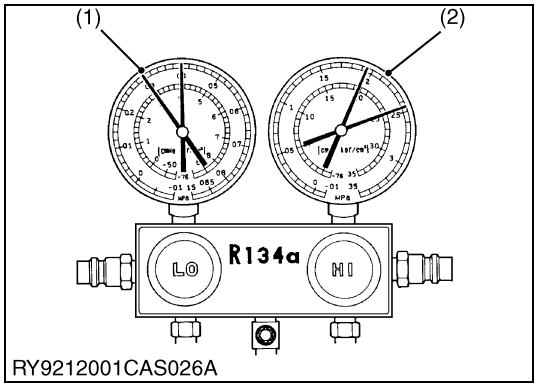
1. Symptoms that appear in the refrigerant cycle
   - Both high (2) and low (1) side pressures are too high. Low-pressure side (1) : 0.20 to 0.35 MPa (2.0 to 3.5 kgf/cm^2, 28.4 to 49.8 psi)
     High-pressure side (2) : 1.96 to 2.45 MPa (20 to 25 kgf/cm^2, 284.5 to 355.6 psi)
2. Possible Causes
   - Cycle charged with too much refrigerant.
   - Poor condenser cooling.
3. Solution Methods
   - Clean the condenser.
   - Adjust the tension of the AC drive belt to the appropriate tension.
   - If the 2nd item above is normal, check the amount of refrigerant.

CAUTION

- **To discharge excess refrigerant, loosen the manifold's gauge's low-pressure valve and slow discharge it.**

(1) Low pressure side (2) High pressure side

RY9212001CAS0020US0



RY9212001CAS026A

Air mixed into the cycle

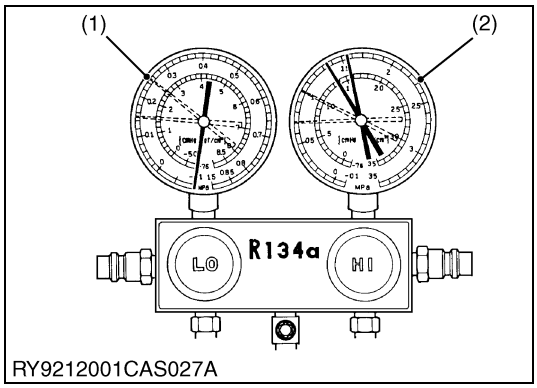
1. Symptoms that appear in the refrigerant cycle
   - Both high (2) and low (1) side pressures are too high. Low-pressure side (1) : 0.20 to 0.35 MPa (2.0 to 3.5 kgf/cm^2, 28.4 to 49.8 psi)
     High-pressure side (2) : 1.96 to 2.45 MPa (20 to 25 kgf/cm^2, 284.5 to 355.6 psi)
   - The line on the low-pressure side (1) feels cold to the touch.
2. Possible Causes
   - Air is mixed in the refrigerant cycle
3. Solution Methods
   - Replace the receiver.
   - Check the amount of compressor oil and whether it is contaminated.
   - Vacuum it out and charge the cycle again with fresh refrigerant.

CAUTION

- **If you fail to vacuum out a refrigerant cycle like that mentioned above and simply charge the cycle with refrigerant, the problem may recur.**

(1) Low pressure side (2) High pressure side

RY9212001CAS0021US0



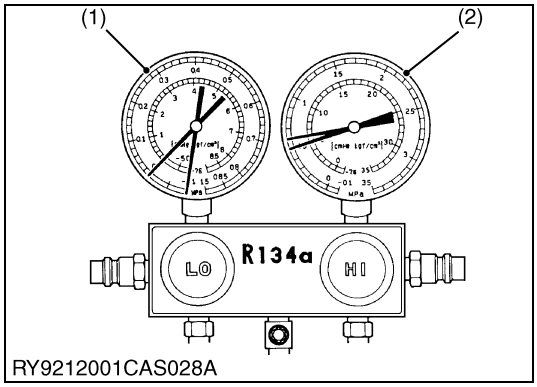
RY9212001CAS027A

Moisture mixed into the cycle

1. Symptoms that appear in the refrigerant cycle
   - At first the AC works normally, but after some time, the pressure on the low-pressure side (1) becomes a vacuum and the high-pressure side (2) is at a low pressure. Low-pressure side (1) : Vacuum;
     High-pressure side (2) : 0.69 to 0.98 MPa (7 to 10 kgf/cm^2, 99.6 to 142.2 psi)
2. Possible Causes
   - Moisture in the refrigerant cycle freezes up in the expansion valve orifice, creating a temporary blockage. As time elapses, the ice thaws and it returns to normal.
3. Solution Methods
   - Replace the receiver.
   - Eliminate the moisture in the refrigerant cycle by repeatedly vacuuming it out.
   - Recharge the system with an appropriate amount of refrigerant.

(1) Low pressure side (2) High pressure side

RY9212001CAS0022US0



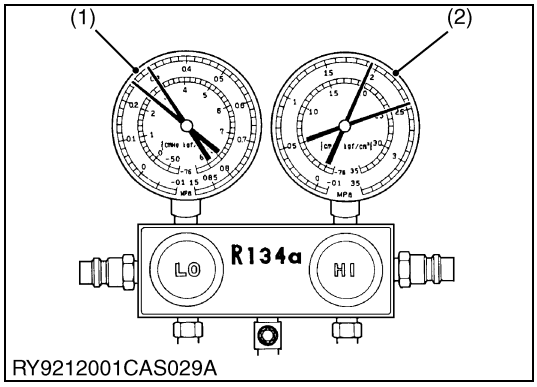
RY9212001CAS028A

Refrigerant fails to circulate

1. Symptoms that appear in the refrigerant cycle
   - Low-pressure side (1) becomes a vacuum and the high-pressure side (2) is at low pressure.
     Low-pressure side (1) : Vacuum;
     High-pressure side (2) : 0.49 to 0.59 MPa (5 to 6 kgf/cm^2, 71.2 to 85.3 psi)
2. Possible Causes
   - The line above the expansion valve orifice is frozen up and the refrigerant cannot flow due to moisture and/or dirt stuck in the refrigerant cycle.
3. Solution Methods
   Wait for some time to elapse and determine whether it is dirt or moisture blocking the line by whether AC operation recovers or not.
   - If the problem is moisture, the problem resolves itself, as indicated in the previous section.
   - If the cause is dirt, remove the expansion valve and blow out any dirt with compressed air.
   - If the dirt cannot be eliminated, replace the expansion valve and the receiver. Vacuum out the line and charge the cycle with an appropriate amount of fresh refrigerant.
   - If the problem is caused by a gas leak in the heat-sensitive tube, replace the expansion valve.

(1) Low pressure side (2) High pressure side

RY9212001CAS0023US0



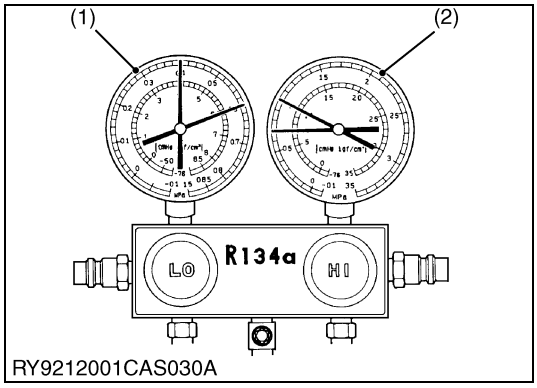
RY9212001CAS029A

Expansion valve too far open

1. Symptoms that appear in the refrigerant cycle
   - Both high (2) and low (1) side pressures are too high. Low-pressure side (1) : 0.29 to 0.39 MPa (3 to 4 kgf/cm^2, 42.7 to 56.9 psi)
     High-pressure side (2) : 1.96 to 2.45 MPa (20 to 25 kgf/cm^2, 284.5 to 355.6 psi)
   - Either frost or heavy condensation on the low-pressure side line
2. Possible Causes
   - Problem with the expansion valve.
   - The flow volume adjustment is set improperly.
3. Solution Methods
   - Replace the expansion valve.

(1) Low pressure side (2) High pressure side

RY9212001CAS0024US0



RY9212001CAS030A

Faulty compression from compressor

1. Symptoms that appear in the refrigerant cycle
   - Low-pressure side (1) : 0.39 to 0.59 MPa (4 to 6 kgf/cm^2, 56.9 to 85.3 psi)
     High-pressure side (2) : 0.69 to 0.98 MPa (7 to 10 kgf/cm^2, 99.6 to 142.2 psi)
2. Possible Causes
   - Compressor is leaking.
3. Solution Methods
   - Replace the compressor.

CAUTION

- **When the compressor is producing a faulty compression, it can be detected with a manifold gauge (figure at left).**

(1) Low pressure side (2) High pressure side

RY9212001CAS0025US0

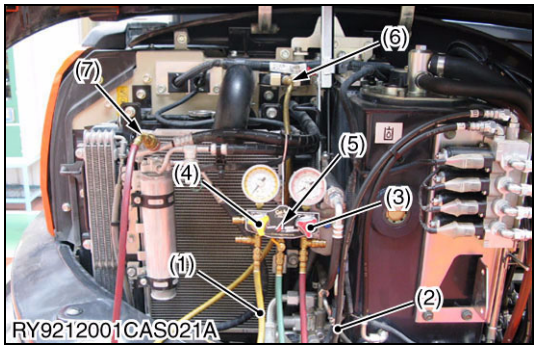
[2] COLLECTION, VACUUMING AND CHARGING

■ **IMPORTANT**

- **Follow 4. Precautions when Repairing the Refrigerant Cycle when discharging, vacuuming and charging the refrigerant system.**

RY9212001CAS0026US0

(1) Collecting Refrigerant



Get a R134a refrigerant collection/recycling device ready to use.

1. Connect the low-pressure hose (blue) (4) from the refrigerant collection/recycling machine to the low-pressure side charge valve (1). Connect the high-pressure hose (red) (5) to the high-pressure charge valve (2).
2. Follow the instructions of the manufacturer and discharge the refrigerant from the cooling system.

■ **IMPORTANT**

- **Do not use device except an R134a refrigerant collection and recycling machine. In order to prevent damage to the compressor, do not mix R134a equipment, refrigerant or compressor oil into an R12 system.**

CAUTION

- **When removing the charge valve hose, cover it with a rag to protect your fingers and eyes from frost bite from the refrigerant.**

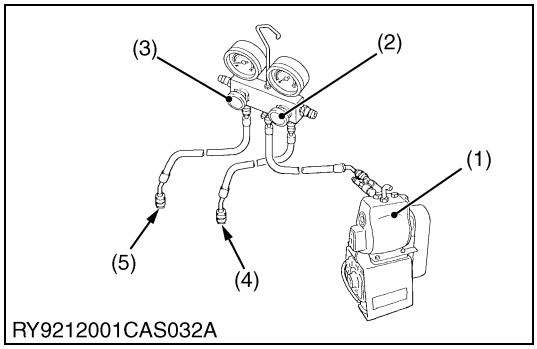
(1) Refrigerant charging hose (blue or yellow)
(2) Refrigerant charging hose (red)
(3) High-pressure valve
(4) Low-pressure valve
(5) Manifold gauge
(6) Low-pressure side charge valve
(7) High-pressure side charge valve

RY9212001CAS0027US0

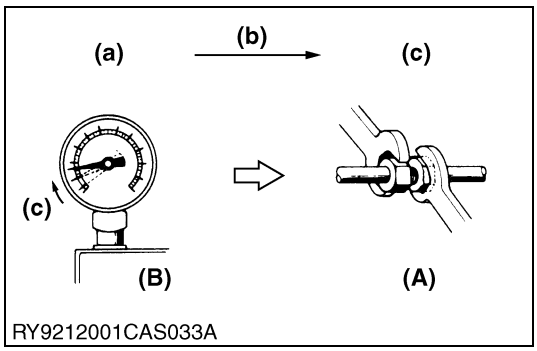
(2) Vacuuming out the System

No.	Description of Work	Remarks
(1)	Check the connected parts and correct any problems	
(2)	Start vacuuming	Approx 15 minutes, 750 mmHg (229 in.Hg) or greater
(3)	Stop vacuuming	Leave for five minutes
(4)	Check the concentration	If the gauge indicates abnormally, return to (1)
(5)	Charge with refrigerant	98 kpa, 1 kgf/cm^2, 14 psi
(6)	Check for gas leaks	
(7)	Charge with refrigerant	

RY9212001CAS0028US0



RY9212001CAS032A



RY9212001CAS033A

Manifold gauge connections and vacuuming

1. Close the high-pressure (HI) and low-pressure (LO) valves of the manifold gauge.
2. Connect the L-shaped side of 2 charging hoses to quick joints and connect them to the compressor and receiver service valves.

Blue hose	Low-pressure side (L mark)
Red hose	High-pressure side (H mark)

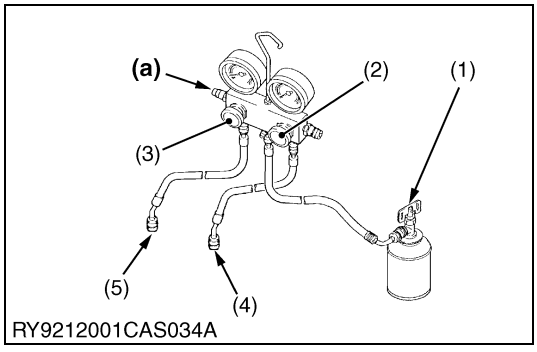
3. Connect the charging hose (green) in the middle of the manifold gauge to the vacuum pump.
4. Open the high and low pressure valves of the manifold gauge.
5. Turn the vacuum pump switch on and vacuum the line until the low-pressure gauge reaches a reading of approximately –0.1 MPa (–750 mmHg). (about 15 minutes)
6. Once about –0.1 MPa (–750 mmHg) is reached, close the high and low pressure valves of the manifold gauge and stop the vacuum pump.
7. Let it set for at least five minutes and check to make sure the indicator needle of the low-pressure gauge does not approach 0.
8. If the needle of the gauge approaches 0, the system's airtightness is compromised somewhere, so after inspecting and repairing the line connections, run the vacuum again and check to make sure there are not any places that are not airtight.

(1) Vacuum pump
(2) High-pressure valve
(3) Low-pressure valve
(4) High-pressure side (H mark)
(5) Low-pressure side (L mark)

(A) Inspection line connections
(B) Low-pressure gauge

(a) Valve settings (L: closed, H: closed)
(b) Leave for at least five minutes
(c) If the needle approaches 0, inspecting and repairing the line connections.

RY9212001CAS0029US0



RY9212001CAS034A

Connections with a refrigerant collector or service canister

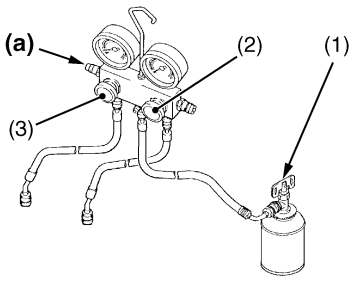
1. Close the high-pressure (HI) and low-pressure (LO) valves of the manifold gauge.
2. Connect the charging hose (green) connected to the vacuum pump to the collector or service canister. (Air is in the charging hose, so do not open the high or low pressure valves.)
3. Discharge from the collector or open the service canister's valve.
4. Press on the valve core of the manifold gauge for three to five seconds to discharge any air from the hose.

(1) Service canister valve
(2) High-pressure valve
(3) Low-pressure valve
(4) High-pressure side (H mark)
(5) Low-pressure side (L mark)

(a) Press valve core to expel air

RY9212001CAS0030US0

(3) Charging from the High-pressure Side



RY9212001CAS034B

Charging from the High-pressure Side

CAUTION
- **Important : do not start the engine. If the engine is running, the gas will flow back and burst either the service canister or a hose.**

IMPORTANT
- **Do not open the low-pressure valve of the manifold gauge.**
- **If the service canister has been changed, be sure to expel any air out of the charging hose (green).**

1. Without starting the engine, open the high-pressure valve and charge with approx 500g of gas.
2. While charging, once the low-pressure gauge indicates approx 0.10 MPa (approx 1 kgf/cm^2), close the high-pressure valve and the service canister valve for the time being.
3. Use a gas detector to check the hoses and pipe connections for gas leaks; if any exist, repair them. If there are no leaks, continue charging the refrigerant.
4. When charging on the high-pressure side stops, close the high-pressure valve on the manifold gauge and the service canister valve, and then charge from the low-pressure side.

(1) Service canister valve
(2) High-pressure valve
(3) Low-pressure valve
(a) Press valve core to expel air

RY9212001CAS0031US0

(4) Charging from the Low-Pressure Side

Charging from the Low-Pressure Side

CAUTION
- **Never open the manifold gauge's high-pressure valve when charging refrigerant while the engine is running. (If the high-pressure valve is opened, high-pressure gas will flow back up the line and rupture the service canister or a charging hose.)**
- **Always keep the service canister upright when charging.**

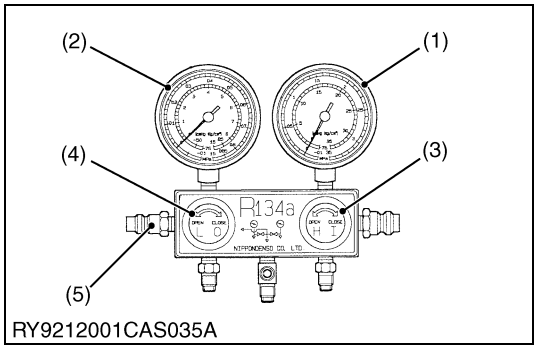
IMPORTANT
- **If the service canister has been changed, be sure to expel any air out of the charging hose (green).**

1. Check and make sure the manifold gauge's high-pressure valve is closed.
2. After starting the engine, set it to approx 1500 rpms and open all of the doors.
3. Turn the AC switch on and set the temperature control to maximum cooling.
4. Open the manifold gauge's low-pressure valve and the service canister valve and charge with the specified amount of gas.
5. After completing refrigerant charging, close the manifold gauge's low-pressure valve and the service canister valve and stop the engine.
6. Check for any gas leaks with the gas leak tester.

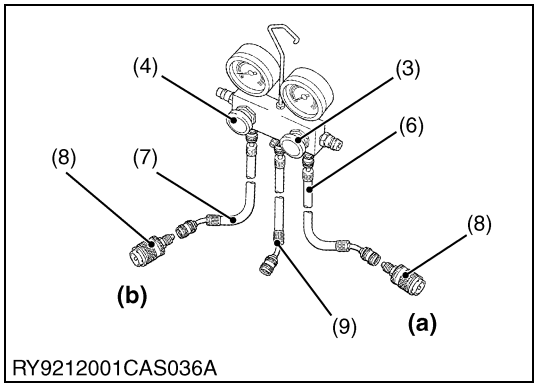
RY9212001CAS0032US0

(5) Inspections and Troubleshooting

[A] Checking the quantity of AC gas



RY9212001CAS035A



RY9212001CAS036A

Checking with a manifold gauge

All the manifold gauge values indicated below are measurements taken under the specified conditions. Please note that the measurements you take will vary depending on the prevailing conditions.

Conditions

Doors	All open
Inside/outside air switch	Inside
Ambient air temperature	30 to 35 °C (86 to 95 °F)
Engine RPM	About 1,500
Temperature control	Max cooling position
Blower switch	HI

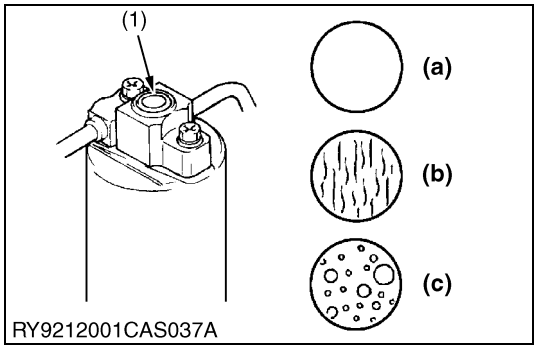
1. After closing both the high and low-pressure valves of the manifold gauge, connect charging hoses (red/blue) to the compressor and the service canister valve of the receiver tank.
2. Loosen the low-pressure valve slightly to expel any air from the charging hose. After expelling the air, close the low-pressure valve again.
3. Expel air from the charging hose on the high-pressure side in the same way.
4. Start the engine and set it at approximately 1,500 rpms.
5. Turn the AC switch ON and set the temperature control to maximum cooling and the blower switch to HI.
6. Read the values on the low-pressure and high-pressure gauges.

When Normal	Factory spec.	Low pressure side	0.15 to 0.20 MPa 1.5 to 2.0 kgf/cm^2 21 to 28 psi
	Factory spec.	High pressure side	1.27 to 1.66 MPa 13 to 17 kgf/cm^2 185 to 242 psi

(1) High-pressure gauge
(2) Low-pressure gauge
(3) High-pressure valve
(4) Low-pressure valve
(5) Valve core
(6) Red
(7) Blue
(8) Quick joint
(9) Green

(a) High-pressure side (Compressor's H-mark side)
(b) Low-pressure side (Compressor's L-mark side)

RY9212001CAS0033US0



RY9212001CAS037A

Checking with the sight glass

Conditions

Doors	All open
Inside/outside air switch	Inside
Ambient air temperature	30 to 35 °C (86 to 95 °F)
Engine RPM	About 1500 rpm
Temperature control	Max cooling position
Blower switch	HI

Criteria

(a)	Overcharged	No air bubbles at all in the flow. In this case, both high and low-pressure sides are at high pressure and the cooling is ineffective.
(b)	Normal amount	Almost no air bubbles in the flow. If the engine rpm is raised gradually from idle to 1,500 rpm, the air bubbles disappear and the flow becomes transparent.
(c)	Undercharged	Air bubbles flow past constantly.

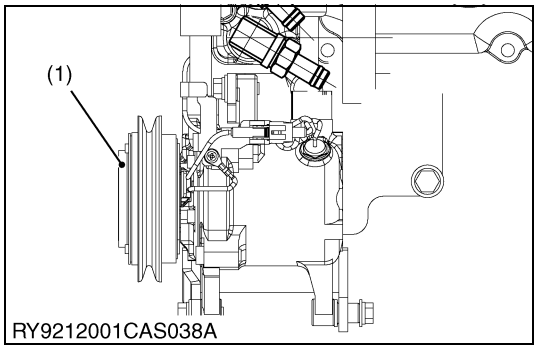
(1) Sight glass

RY9212001CAS0034US0

6. INSPECTION AND DISASSEMBLY

[1] CHECKS AND ADJUSTMENTS

(1) Compressor



Magnetic clutch

1. Start the engine.
2. With the AC switch on the AC control panel off, check and make sure that no scraping sounds or other noise comes from the pulley as it turns.
3. Turn the AC switch and the fan switch on to make the AC system operate. With the AC working, check and make sure the magnetic clutch is not slipping.
4. If there is any noise, repair or replace it.

(1) Magnetic clutch

RY9212001CAS0035US0

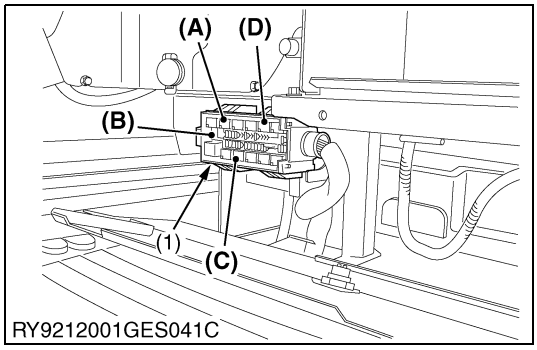
Stator coil

1. Remove the magnetic clutch's 1P connector.
2. Measure the resistance between the 1P connector on the magnetic clutch side and the body of the stator.
3. If the measurement falls outside of the factory specification, replace the stator coil.

Between stator body and harness side of stator coil	Factory spec.	3 to 4 Ω

RY9212001CAS0036US0

(2) Relays

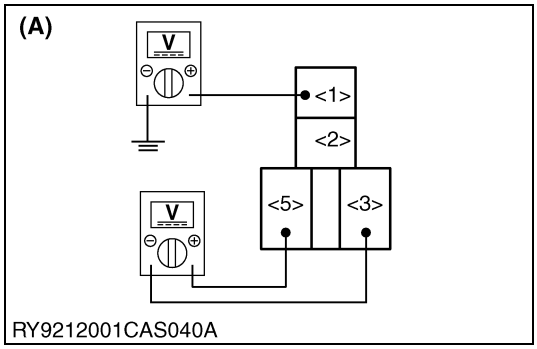


After turning the starter switch off, remove the cover under the seat, remove each relay and take the following measurements.

(1) Fuse box

(A) Blower motor relay
(B) Compressor clutch relay
(C) Cab relay
(D) Cab work light relay

RY9212001CAS0037US0



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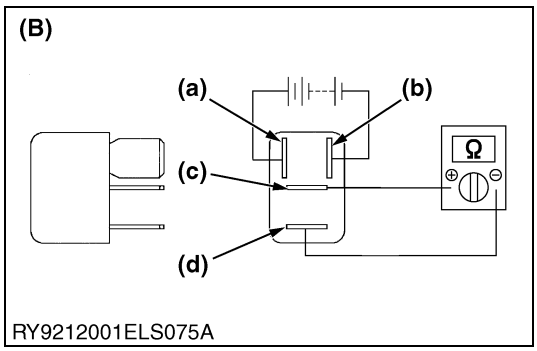


RY9212001ELS075A

Harness-side checks

Between battery and cab relay

1. Measure the voltage between terminal 1in the fuse box and ground on the body.
2. Set the starter switch to [RUN].
3. Measure the voltage between terminals 3 and 5in the fuse box.
4. If the voltages of each are the same as the battery voltage (DC 11 to 14V), they are normal.

Between battery and blower motor relay

1. Measure the voltage between terminal 1in the fuse box and ground on the body.
2. If the voltage is the same as the battery voltage (DC 11 to 14V), it is normal.

Between battery and cab work light relay

1. Measure the voltage between terminal 1in the fuse box and ground on the body.
2. If the voltage is the same as the battery voltage (DC 11 to 14V), it is normal.

Testing individual relays

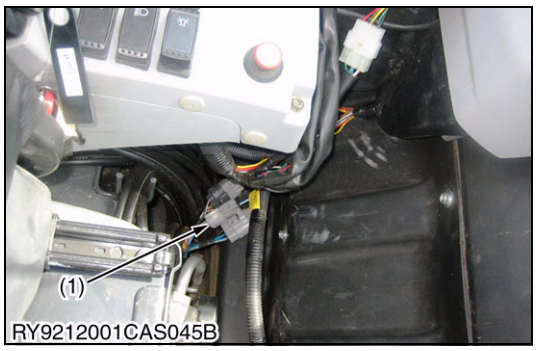
1. Impress the battery voltage between terminals 3 and 5 of the relay.
2. Check for continuity between terminals 1 and 2 of the relay.
3. If there is continuity between the terminals, it is normal.

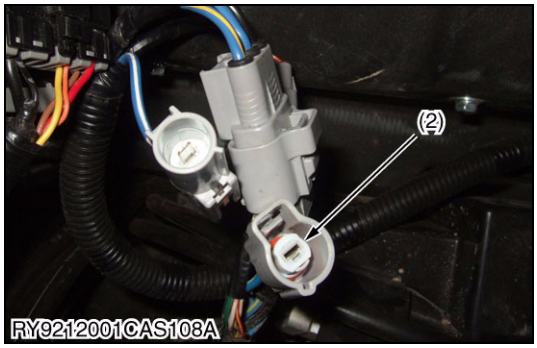
(a) Terminal 5
(b) Terminal 3
(c) Terminal 2
(d) Terminal 1

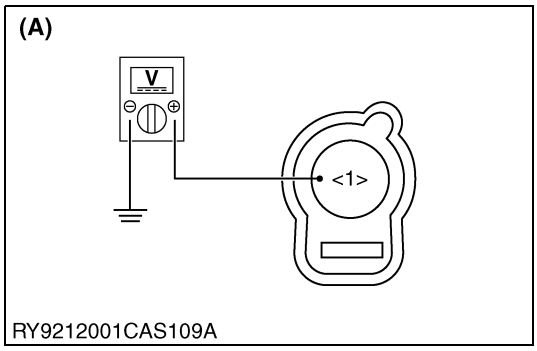
(A) Fuse box terminals
(B) Individual relay

RY9212001CAS0038US0

(3) Blower motor





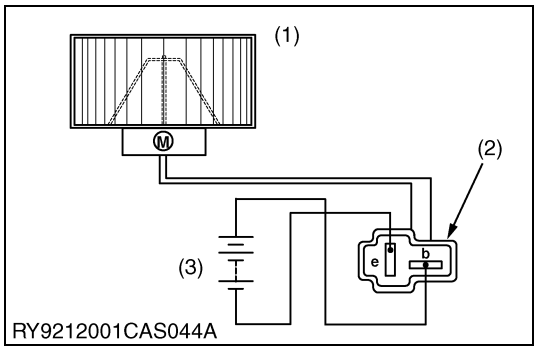


Connector voltage

1. Remove the blower motor's 1P connector.
2. Switch the starter switch to [RUN] and the blower switch to [3] (HI).
3. Measure the voltage between terminal 1of the connector on the switch side and ground on the body.
4. If the voltage is different from the battery voltage (DC 11 to 14V), then there is a fault in the wire harness, blower motor relay, the fuse and/or the starter switch.

(1) 1P connector
(2) 1P connector (Main harness side)
(A) 1P connector (Main harness side)

RY9212001CAS0039US0



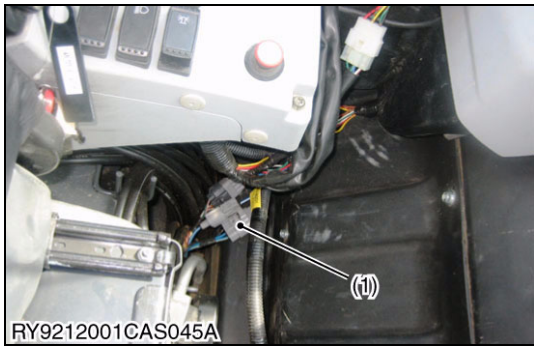
Blower motor test

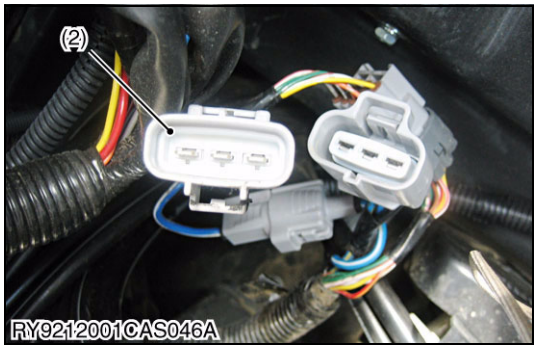
1. Turn the blower motor by hand and check whether it turns smoothly.
2. Remove the 2P connector from the blower motor.
3. Connect a jumper lead from the positive (+) terminal of the battery to terminal **b** of the connector.
4. Connect a jumper lead from the negative (-) terminal of the battery to terminal **e** of the connector for just a moment.
5. If the blower motor fails to turn, check the motor.

(1) Blower Motor
(2) 2P connector (Blower motor side)
(3) Battery (12V)
b : (+) Terminal
e : (-) Terminal

RY9212001CAS0040US0

(4) Blower resistor



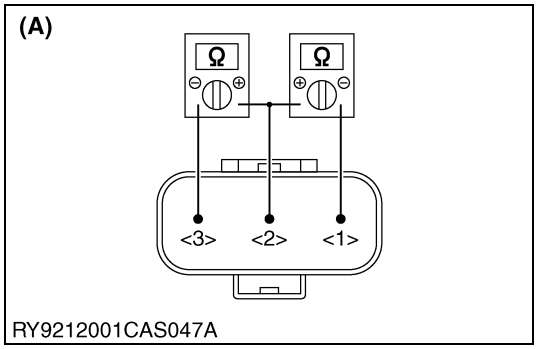


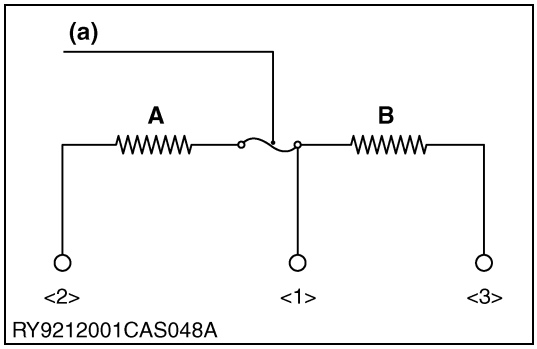
1. Remove the blower resistor's 3P connector.
2. Measure the resistance between terminals 2 and 3 and between 2 and 1 of the connector on the AC unit side.
3. If they differ from the factory specifications, the blower resistor is faulty.

Terminal 3 – terminal 2	Factory spec.	About 0.9 Ω
Terminal 1 – terminal 2		About 1.9 Ω

(1) 3P connector
(2) 3P connector (AC unit side)

RY9212001CAS0041US0





(a) Fuse (221 ± 10 °C, 430 ± 18 °F)

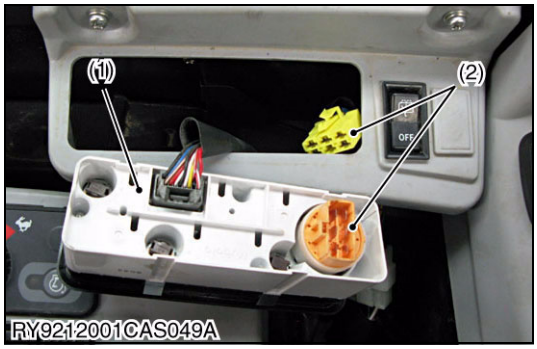
A : 0.9 Ω
B : 1.2 Ω (Reference)

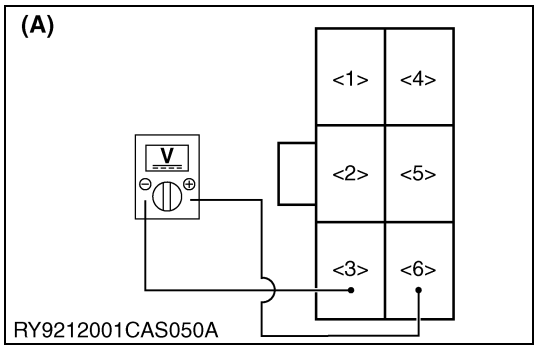
<1> R1 terminal
<2> E terminal
<3> R2 terminal

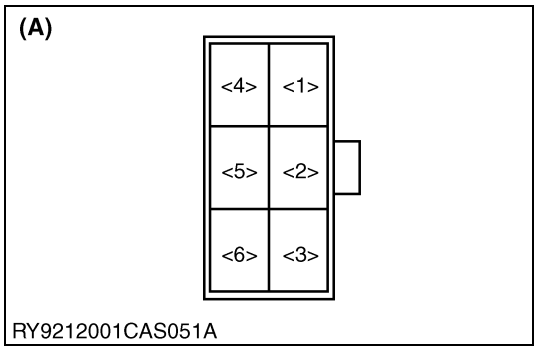
(A) 3P connector (AC unit side)

RY9212001CAS0042US0

(5) Blower switch







Connector voltage

1. Remove the 6P connector from the blower switch.
2. Turn the starter switch to [RUN].
3. Measure the voltage between terminals 3 and 6 of the connector on the harness side.
4. If the voltage is different from the battery voltage (DC 11 to 14V), then there is a fault in the wire harness, blower motor relay, the fuse and/or the starter switch.

(1) Control Panel
(2) 6P connector

(A) 6P connector (harness side)

RY9212001CAS0043US0

Blower switch test

1. Check the continuity between each of the terminals according to the table below.
2. If continuity exists, it is normal.

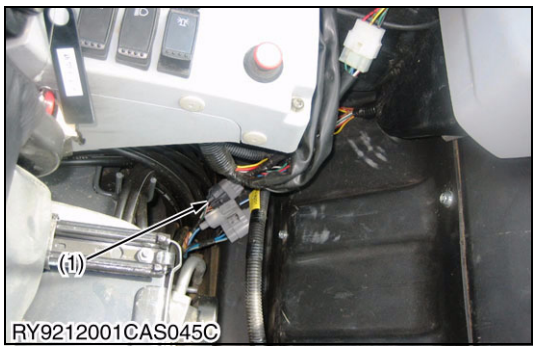
Position		<3>	<6>	<2>	<5>	<1>	<4>
Blower switch	OFF						
	● 1	●	●	●			
	● 2	●	●			●	
	● 3	●	●				●

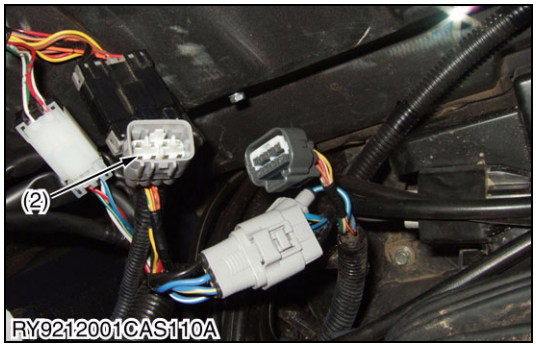
RY9212032CAS011A

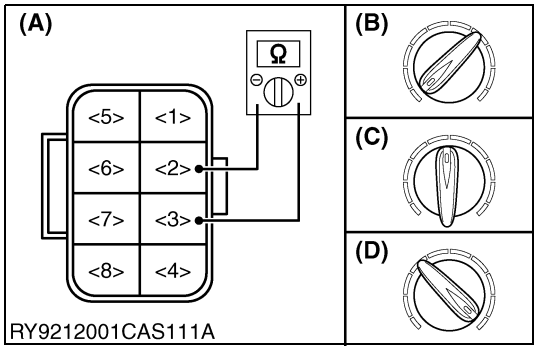
(A) 6P connector (Switch side)

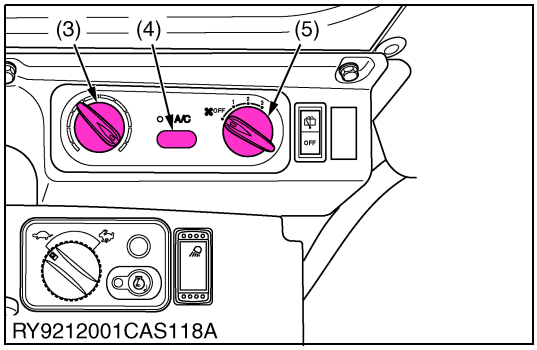
RY9212001CAS0044US0

(6) Servo Motor (for temp control)









Servo motor test

1. Switch the starter switch to [RUN] and the blower switch to ON.
2. Press the AC switch to turn the AC on.
3. Turn the Temperature control dial to the **(B)**, **(C)**, and **(D)** positions in turn as indicated in the figure at left and measure the resistance in **(A)**.
4. When making the measurements, first turn the starter switch to OFF and then disconnect the servo motor's 8P connector.
5. If the resistance measured between terminals 2 and 3 of the connector on the AC unit side differs from the factory specifications, then either the AC unit harness or the servo motor is faulty.

(B)	Factory spec.	Approx. 1.2 kΩ
(C)		Approx. 2.9 kΩ
(D)		Approx. 4.6 kΩ

(1) 8P connector
(2) 8P connector (AC unit side)
(3) Temperature control dial
(4) AC switch
(5) Fan switch

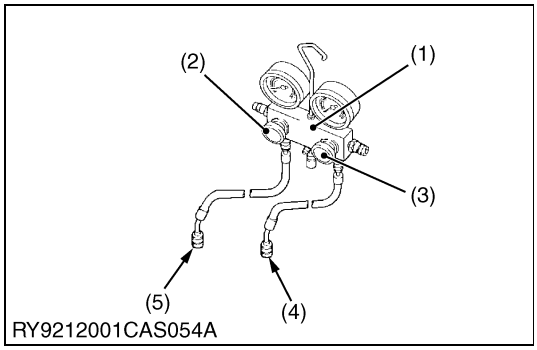
(A) 8P connector (AC unit side)
(B) Left end (blue side, max cool)
(C) Center (white center)
(D) Right end (red side, max hot)

RY9212001CAS0045US0

(7) Pressure Switch

When a pressure switch (inside the high-pressure/low-pressure switch) is operating normally, electricity is conducted (ON) and when an abnormal pressure occurs, it trips the switch, blocking the electricity (OFF).

RY9212001CAS0046US0



RY9212001CAS054A

Manifold gauge connections

1. Close the HI (high-pressure side) valve (3) and the LO (low-pressure side) valve (2) of the manifold gauge (1) securely.
2. Connect the red charging hose (4) to the HI (high-pressure side) charge valve (1) and the blue charging hose (5) to the LO (low-pressure side) charge valve (2).
3. Open the manifold gauge's HI (high-pressure side) valve (3) a little and press on the valve core to expel any air inside its charging hose (4). Then close the HI (high-pressure side) valve (3) tightly.
4. Open the manifold gauge's LO (low-pressure side) valve (2) a little and press on the valve core to expel any air inside its charging hose (5). Then close the LO (low-pressure side) valve (2) tightly.

(1) Manifold gauge
(2) Low-pressure valve
(3) High-pressure valve
(4) Red charging hose
(5) Blue charging hose

RY9212001CAS0047US0

RY9212001CAS055A

When refrigerant pressure is rising (OFF)

1. Start the engine and set it at 1,500 rpms. Turn the AC switch on the control panel on, set the fan switch to HI and set the temperature control lever to the max cool position.
2. Cover the front of the condenser with cardboard or the like and raise the pressure on the high-pressure side of the AC cycle.
3. Once the pressure on the high-pressure side rises, the high-pressure switch operates, turning the magnetic clutch of the compressor off. When it does so, read the HI (high-pressure) gauge of the manifold gauge and if it reads higher than the pressure setting, replace the pressure switch (8).

- Pressure setting on the high-pressure side of the switch:
  Switches off at approximately 3.14 MPa (32 kgf/cm^2, 460 psi) or higher

RY9212001CAS0048US0

When refrigerant pressure is dropping (OFF)

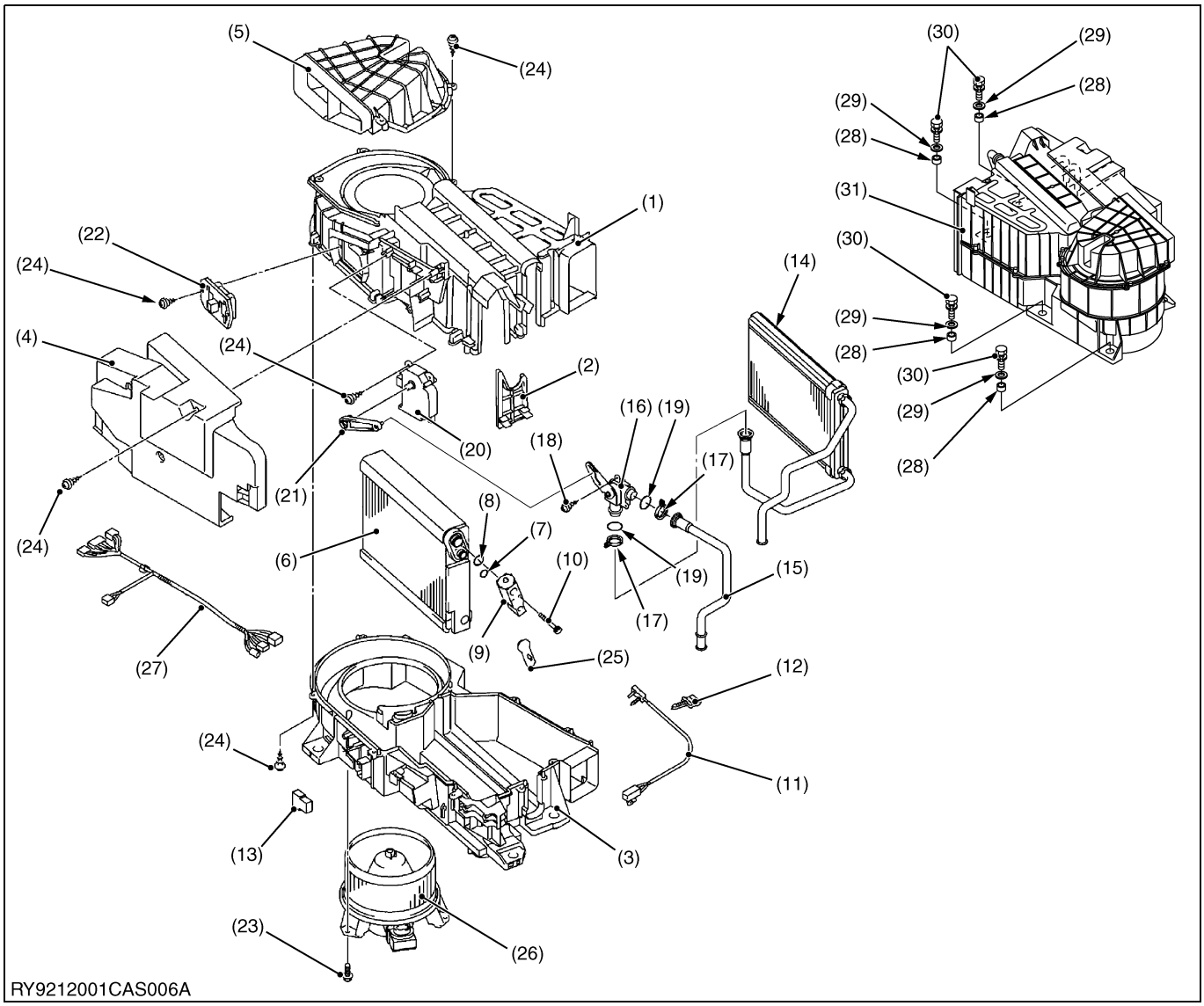
1. Remove the connector of the pressure switch (1).
2. Measure the resistance between the terminals of the pressure switch with a circuit tester. It should register 0 Ω unless there is insufficient gas due to a leak or unless the pressure switch is faulty.

- Pressure setting on the low-pressure side of the switch :
  Switches off at approximately 0.196 MPa (2.0 kgf/cm^2, 28 psi)

RY9212001CAS0049US0

[2] DISASSEMBLY AND ASSEMBLY

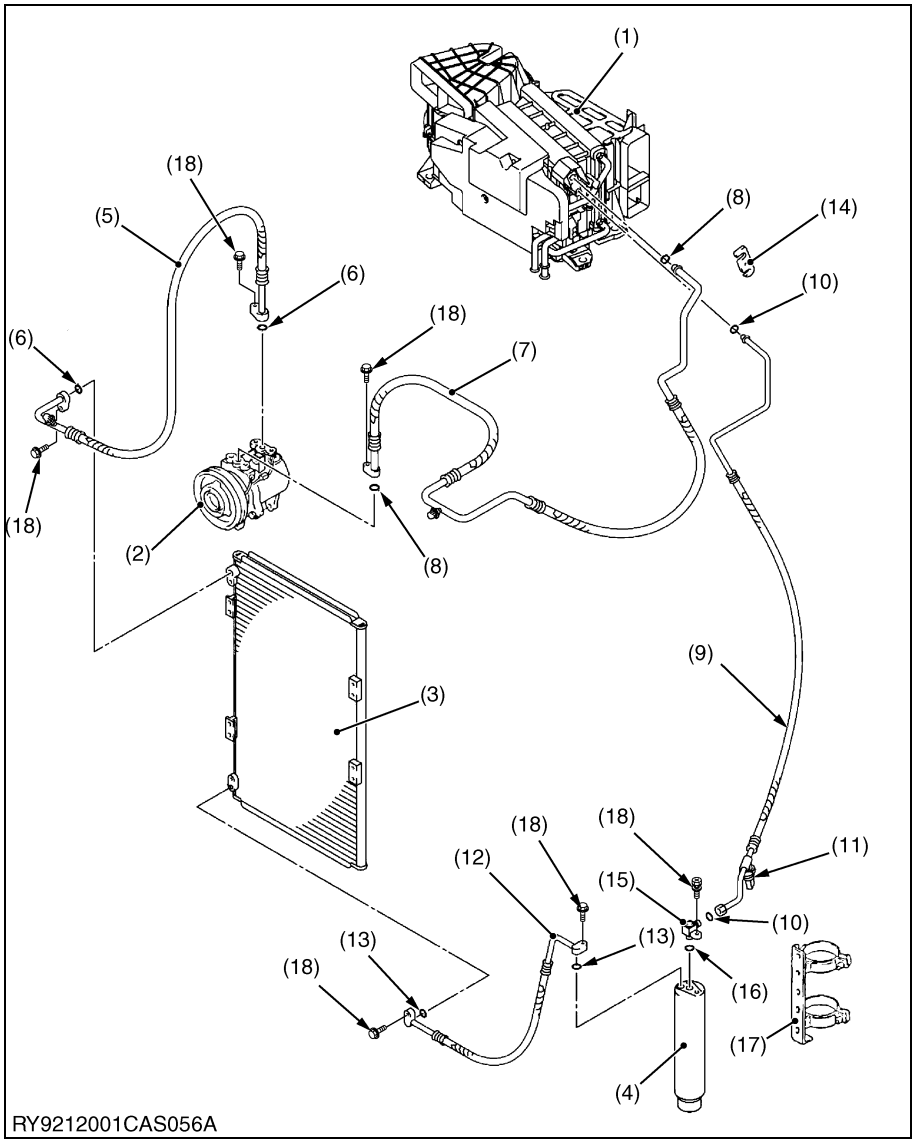
Diagram of AC Unit



(1) Top case
(2) Evaporator
(3) Bottom case
(4) Linkage cover
(5) Intake cover
(6) Evaporator
(7) O-ring
(8) O-ring
(9) Expansion valve
(10) Expansion bolt
(11) Thermistor ASSY
(12) Thermistor clamp
(13) AC amp
(14) Heater Core
(15) Pipe
(16) Water valve
(17) Clip
(18) Washer screw
(19) O-ring
(20) Servo motor
(21) Linkage lever
(22) Blower resistor
(23) Tapping screw
(24) Tapping screw
(25) Cap (plug)
(26) Blower fan
(27) Wire harness
(28) AC collar
(29) Flat washer
(30) Bolt
(31) Air Conditioning Unit

RY9212001CAS0050US0

(1) Connecting / Disconnecting AC Hoses



(1) Air Conditioning Unit
(2) Compressor and magnetic clutch
(3) Condenser
(4) Receiver
(5) Hose (discharge)
(6) O-ring
(7) Hose (suction)
(8) O-ring
(9) Hose (liquid, pressure)
(10) O-ring
(11) Pressure Switch
(12) Hose (liquid)
(13) O-ring
(14) Tube connector
(15) Joint
(16) O-ring
(17) Receiver holder
(18) Bolt (M6)

(When removing)

1. Collect the refrigerant from the AC system.
2. Disconnect the negative (–) cable from the battery and the 1P connector of the magnetic clutch.
3. Remove the AC hoses.

CAUTION

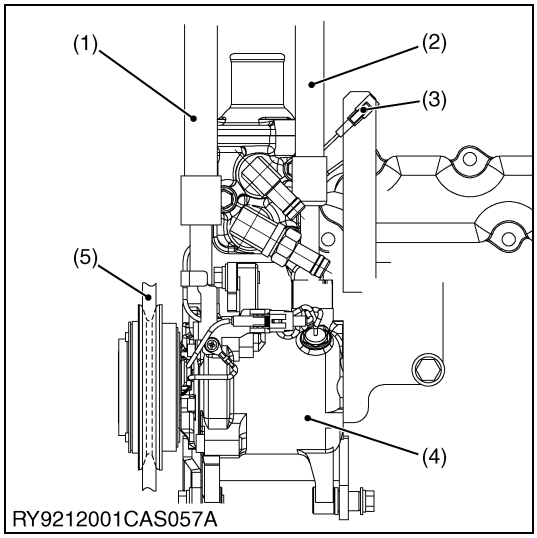
- **After removing hoses, immediately seal the AC system so no moisture or water gets into it.**

(When attaching)

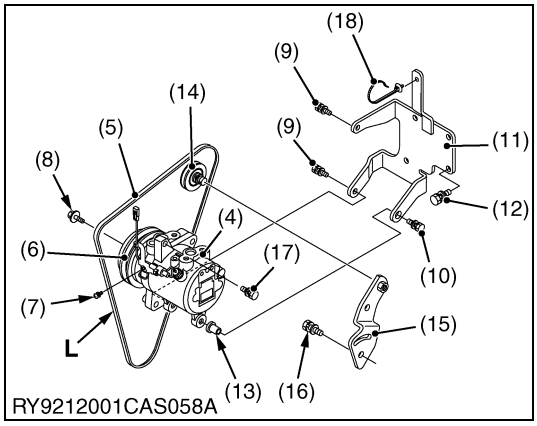
- Pay attention to whether each hose is for high or low pressure.
- Pay attention to whether each hose is an inlet or outlet hose.
- Attach each bolt and tighten to its specified torque.
- Tighten the nuts for aluminum pipe with two wrenches, holding one side from turning and tightening the nut to it. (The mating side is soft, so be careful when tightening.)
- Tighten carefully so the pipe does not turn.
- Apply some compressor oil to pipes that have O-rings and press the tip into the stepped surface.

RY9212001CAS0051US0

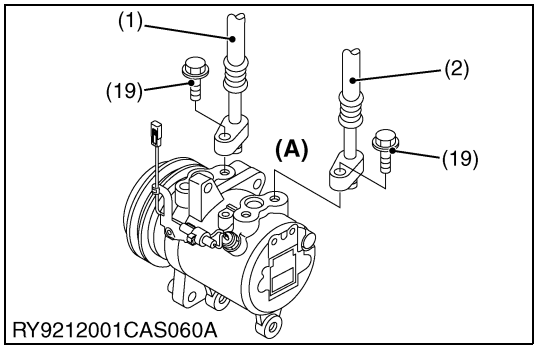
(2) Mounting and Removing the Compressor



RY9212001CAS057A



RY9212001CAS058A



RY9212001CAS060A

(When removing)

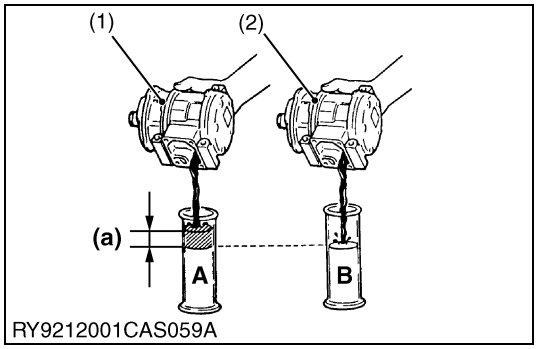
1. Collect the refrigerant from the AC system.
2. Disconnect the negative (-) cable from the battery and the 1P connector of the magnetic clutch.
3. Remove the low-pressure pipe and the high-pressure pipe from the compressor, then immediately cap them so no water or moisture gets into the AC system.
4. Remove the AC drive belt and then the compressor.

(When attaching)

- Adjust the tension of the compressor drive belt. If you press down on the L part of the belt with your fingertips [68.6 N (7 kgf, 20 lbf)] and it displaces 12 to 15 mm (0.47 to 0.59 in.), it is correct.
- Attach each bolt and tighten to its specified torque.
- Apply compressor oil to the O-rings.
- Connect the low-pressure hose to the side of the compressor marked "S" (suction). Be careful of the orientation of bolts when installing them.
- Connect the high-pressure hose to the side of the compressor marked "D" (discharge). Be careful of the orientation of bolts when installing them.
- Be careful of the orientation of bushing (compressor) when installing it.

(1) Low-Pressure Pipe
(2) High-Pressure Pipe
(3) 1P Connector (Magnetic Clutch)
(4) Compressor
(5) AC Drive Belt
(6) Clutch, ASSY (Magnet, Compressor)
(7) Small Screw w/metal Washer
(8) Bolt (Clutch)
(9) Bolt
(10) Bolt
(11) Bracket (Compressor)
(12) Bolt
(13) Bushing (Compressor)
(14) Tensioner Pulley
(15) Support (Tensioner Pulley)
(16) Bolt
(17) Bolt
(18) Clip
(19) Bolt

RY9212001CAS0052US0



RY9212001CAS059A

Filling the compressor with oil

When replacing the compressor

- The amount of oil required by the new compressor is enclosed within the AC cycle. A certain amount of compressor oil circulates along with the gas in the AC system.
- When replacing the compressor, remove the excess oil from the new compressor.
- Compressor oil (ND-OIL8) readily absorbs moisture, so seal it immediately.

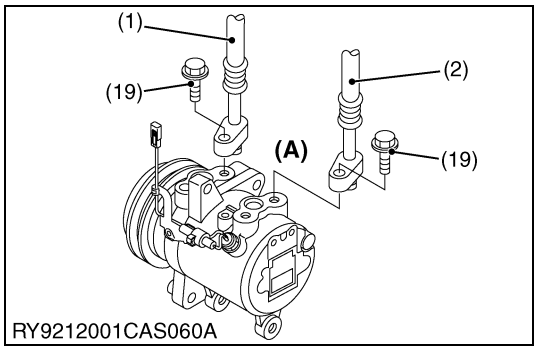
Compressor Oil	Type: ND-OIL8	Capacity (reference value): 60 cc, 0.06 U.S.qts

(1) New Compressor
(2) Old Compressor

A : Amount of oil for new compressor
B : Amount of oil from old compressor

(a) Remove Excess Oil (A-B)

RY9212001CAS0053US0

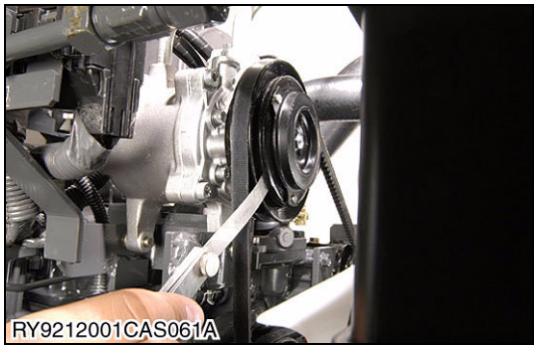


RY9212001CAS060A

(1) Low-Pressure Pipe
(2) High-Pressure Pipe
(3) Bolt

(A) Bolt Mounting Orientation

RY9212001CAS0054US0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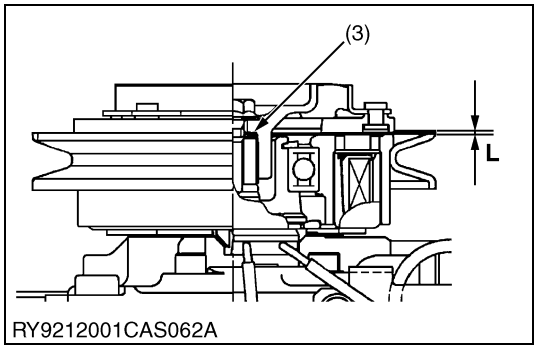

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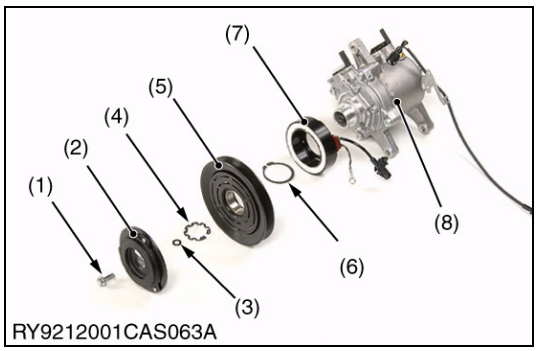


RY9212001CAS063A

Adjusting clearance

1. Use a feeler gauge to check the clearance.
2. If the measurement is outside the factory specification, adjust the clearance.

Clearance	Factory specification	0.30 to 0.65 mm 0.0118 to 0.0255 in.

[NOTE]

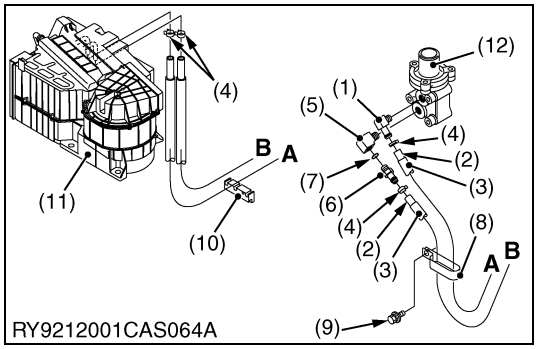
Shim Thickness	Part No.
0.10 mm (0.0039 in.)	T1065-87340
0.15 mm (0.0059 in)	T1065-87350
0.30 mm (0.012 in.)	T2055-87410
0.40 mm (0.016 in.)	T1065-87360
0.50 mm (0.020 in.)	T2055-87420
0.60 mm (0.024 in.)	T1065-87370
1.0 mm (0.0394 in.)	T1065-87380

(1) Magnetic Clutch Mounting Screw
(2) Hub Plate
(3) Shim
(4) Snap Ring
(5) Rotor
(6) Snap Ring
(7) Stator
(8) Compressor Body

L : Clearance

RY9212001CAS0055US0

(3) Connecting / Disconnecting Hoses



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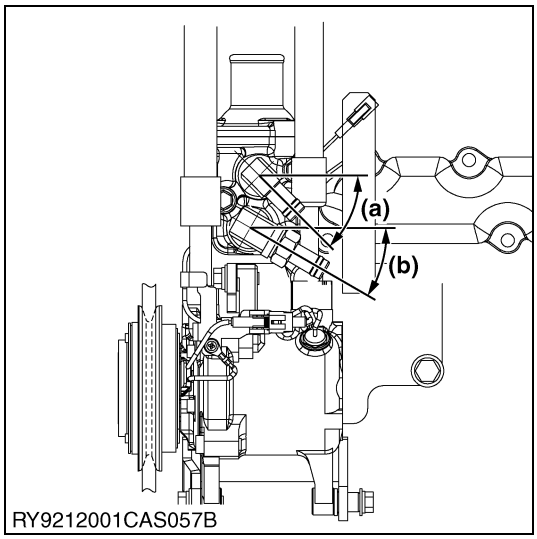
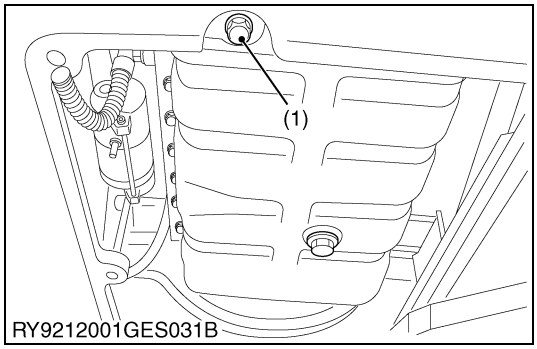
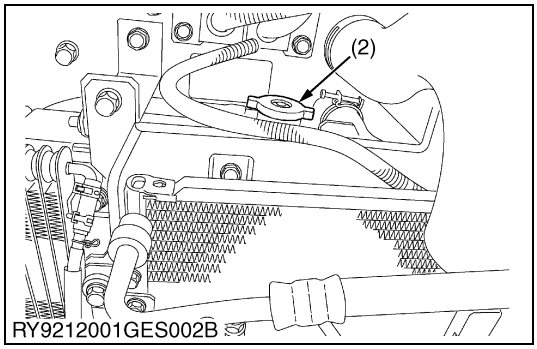


RY9212001CAS057B



RY9212001GES031B



RY9212001GES002B

(When removing)

1. Stop the engine and start working once the radiator has cooled.
2. Drain the coolant (hot water) from the engine side.
3. Simultaneously remove the heater hose from the water flange side and drain the coolant (hot water).
4. Remove the heater hose on the heater core side.

(When attaching)

- Be careful not to mistake an inlet hose for an outlet hose.
- Apply compressor oil to the O-rings.
- Adaptor mounting angles are **(a)** : 45 ° and **(b)** : 30 °
- Hose clamp (8) mounting orientation : horizontal

Torque	Adapter (R3/8)	11.8 to 13.7 N·m 1.2 to 1.5 kgf·m 85.3 to 99.1 lbf·ft

(1) Pipe joint (L, R3-13.5)
(2) Hose (1, WP)
(3) Tube (1, heater)
(4) Hose clamp (spring type)
(5) Pipe joint (L, R3-G3)
(6) Pipe joint (S, G3-13.5)
(7) O-ring
(8) Hose clamp
(9) Bolt
(10) Grommet (AC)
(11) Air Conditioning Unit
(12) Flange, compressor (water)
(a) 45 °
(b) 30 °

RY9212001CAS0056US0

Handling engine coolant

(when draining)

1. Stop the engine and start working once the radiator has cooled.
2. Remove the reserve tank hose from the radiator.
3. Remove the drain plug from the radiator, then remove the radiator cap and drain out all of the coolant.

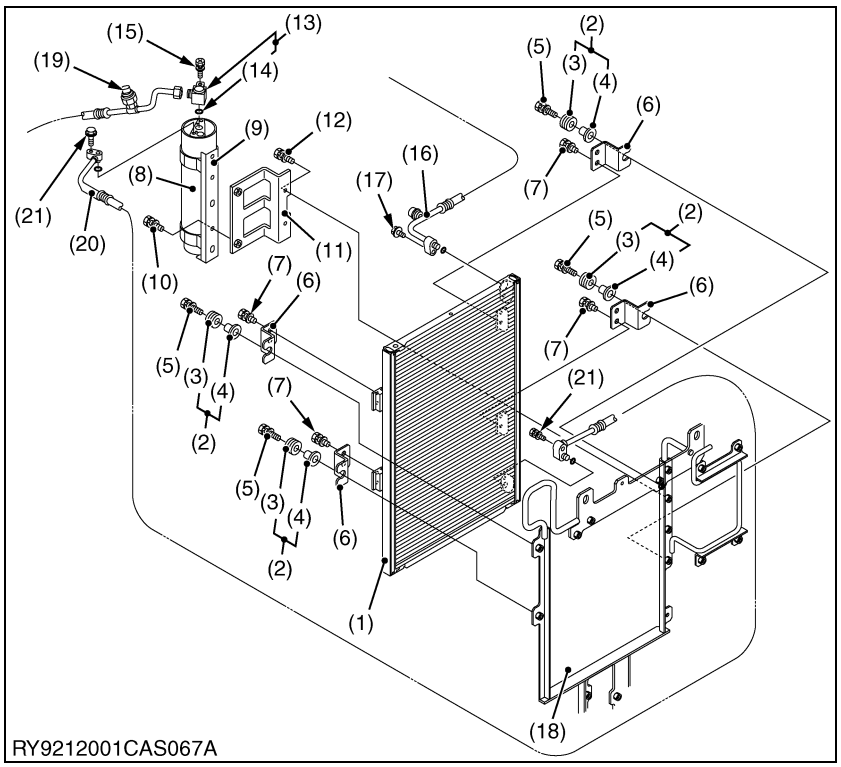
(When filling)

1. Tighten the drain plug securely and replace the reserve tank hose to the radiator.
2. Fill the radiator and the reserve tank with coolant.
3. After filling, tighten the cap, start the engine, let it idle for five minutes, stop the engine and check and make sure it has the specified amount of coolant.

(1) Coolant drain plug
(2) Radiator cap

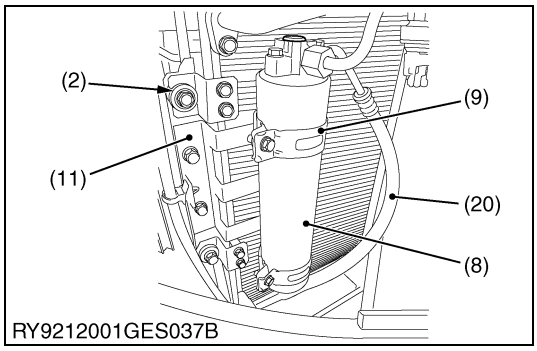
RY9212001CAS0057US0

(4) Removing and Mounting the Receiver



RY9212001CAS067A

(1) Condenser
(2) Cushion (condenser)
(3) Grommet (condenser)
(4) Thrust collar (condenser)
(5) Bolt
(6) Plate (condenser)
(7) Bolt
(8) Receiver
(9) Holder (receiver)
(10) Bolt
(11) Bracket (receiver)
(12) Bolt
(13) Joint (receiver)
(14) O-ring
(15) Bolt
(16) Hose (discharge)
(17) Flange bolt
(18) Bracket (oil cooler)
(19) Hose (liquid, pressure)
(20) Hose (liquid)
(21) Flange bolt



RY9212001GES037B

(When removing)

1. Remove the receiver and its bracket (receiver).
2. Remove the plate (condenser) from the bracket (oil cooler).
3. After removing the plate (condenser) and the cushion (condenser), remove the condenser.

CAUTION

- **The receiver has a desiccant in it, so do not remove its rubber cap until just before connecting its hoses. Be careful not to damage the fins of the condenser.**

(When attaching)

- Be careful of the orientation of the thrust collar (condenser) when installing it.
- Be careful not to mistake an inlet hose for an outlet hose.
- Attach each bolt and tighten to its specified torque.

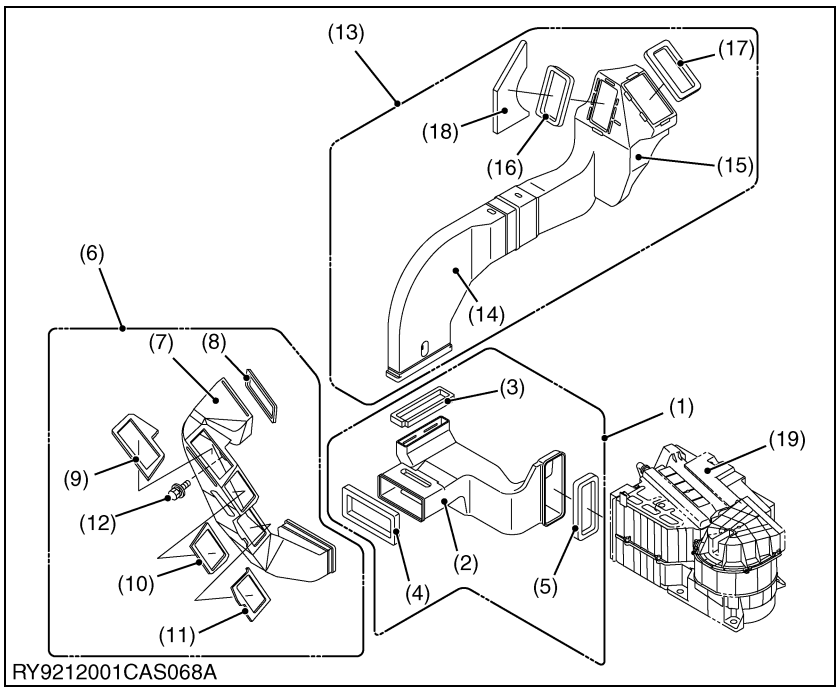
NOTE

Part Replaced	Fill Capacity	Brand Name
Condenser	40 cc 0.04 U.S.qts	ND-OIL8 <PAG* oil>
Evaporator	40 cc 0.04 U.S.qts	
Receiver	10 cc 0.01 U.S.qts	
Hose	20 cc 0.02 U.S.qts	

*PAG : Polyalkylene glycol (synthetic oil)

RY9212001CAS0058US0

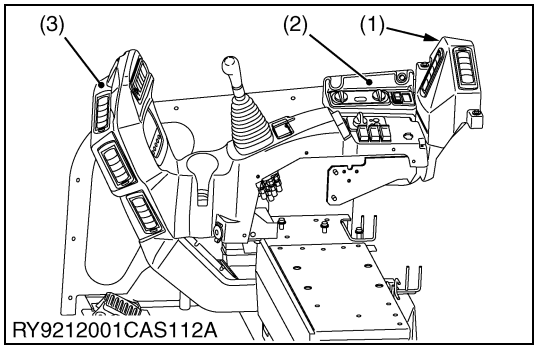
(5) Removing and Mounting AC Ducts

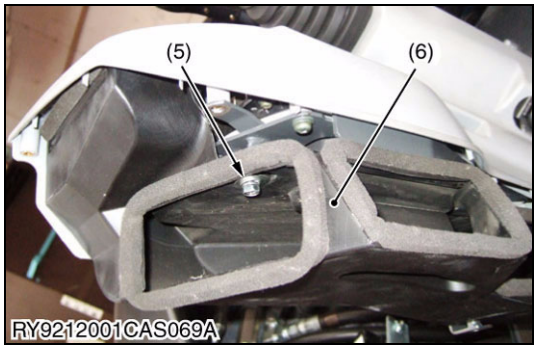


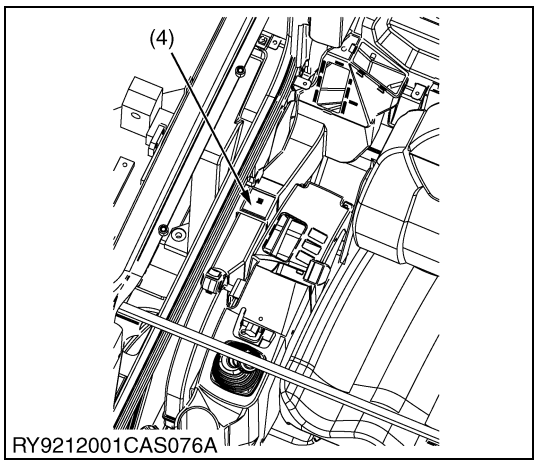
RY9212001CAS068A

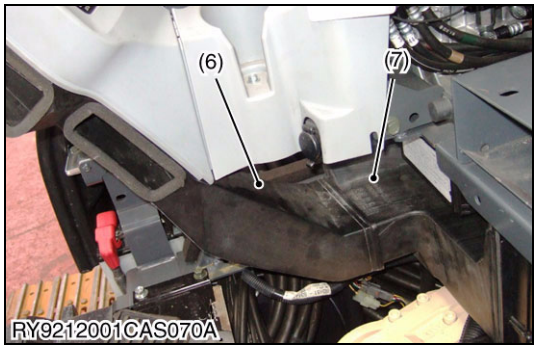
(1) Duct ASSY (1, AC)
(2) Duct (1, AC)
(3) Seal (Duct1, 1)
(4) Seal (Duct1, 2)
(5) Seal (Duct1, 3)
(6) Duct ASSY (2, AC)
(7) Duct (2, AC)
(8) Seal (1, duct, AC)
(9) Seal (2, duct, AC)
(10) Seal (3, duct, AC)
(11) Seal (4, duct, AC)
(12) Bolt
(13) Duct ASSY (3, AC)
(14) Duct (3, AC)
(15) Duct (3, AC, in)
(16) Seal (5, duct, AC)
(17) Seal (5, duct, AC)
(18) Insulation (2, AC)
(19) Air Conditioning Unit

RY9212001CAS0059US0









(When removing)

1. Remove the two bolts and then the duct cover (1).
2. Remove the two bolts and then the switch cover.
3. Remove the four bolts and then the duct cover (3).
4. Remove the duct ASSY (3, AC) from the duct ASSY (1, AC).
5. Remove just the one bolt and then remove the duct ASSY (2, AC) from the duct ASSY (1, AC).
6. Remove the duct ASSY (1, AC) from the air conditioning unit.

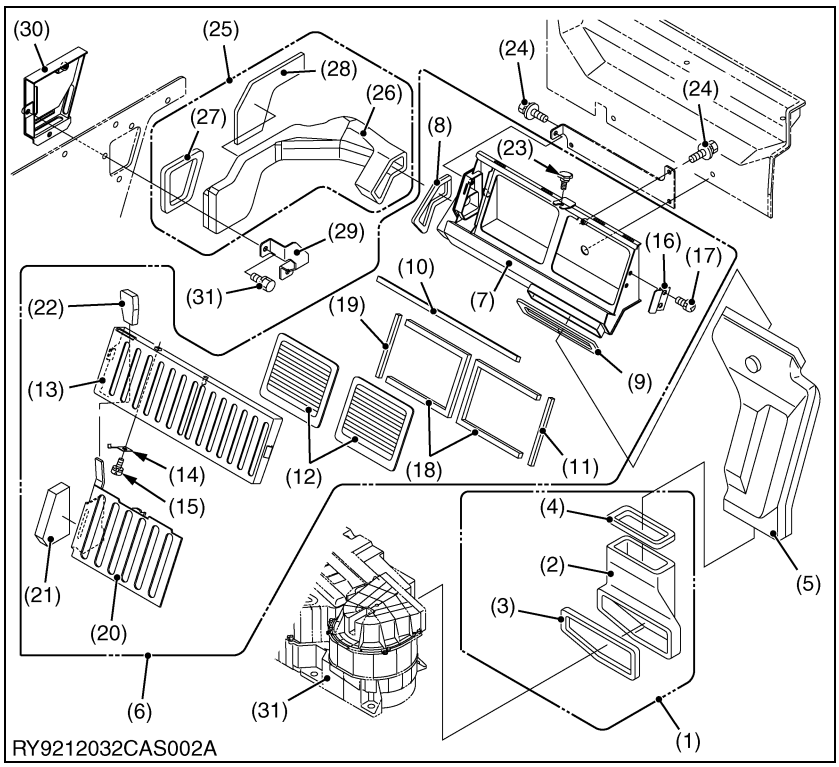
(When attaching)

- All the duct assemblies fit together.
- Press the parts that fit together in firmly until the seal is hidden.
- Attach the bolts and tighten them to the specified torque.

(1) Duct cover
(2) Switch cover
(3) Duct cover
(4) Duct ASSY (3, AC)
(5) Bolt
(6) Duct ASSY (2, AC)
(7) Duct ASSY (1, AC)

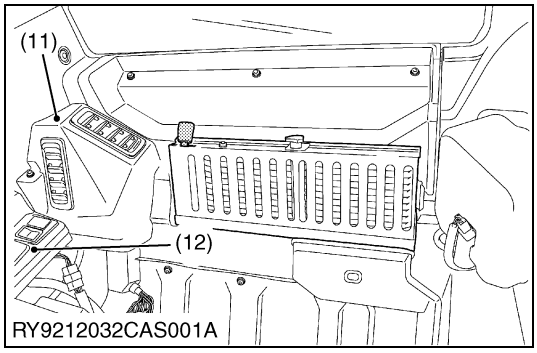
RY9212001CAS0060US0

(6) Removal and Installation of AC Cabin Air Inlets

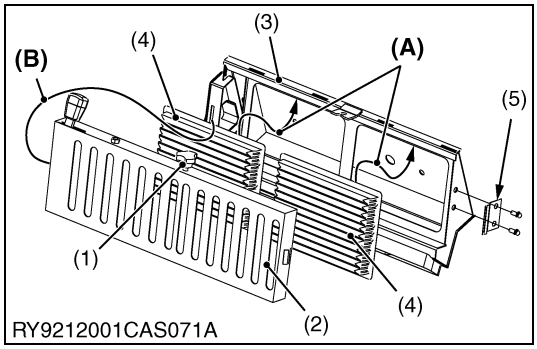


(1) Duct ASSY (1, air-intake, A/C)
(2) Duct
(3) Seal
(4) Seal
(5) Duct (2, air-intake, A/C)
(6) Duct ASSY (air-intake, base)
(7) Duct
(8) Seal
(9) Seal
(10) Seal
(11) Seal
(12) Filter
(13) Cover
(14) Spring plate
(15) Screw with washer
(16) Spring plate
(17) Screw with washer
(18) Seal
(19) Seal
(20) Plate
(21) Seal
(22) Lever
(23) Knob bolt
(24) Bolt
(25) Duct ASSY (3, air-intake, A/C)
(26) Duct
(27) Seal
(28) Insulation heat
(29) Bracket
(30) Cover
(31) Air Conditioning Unit

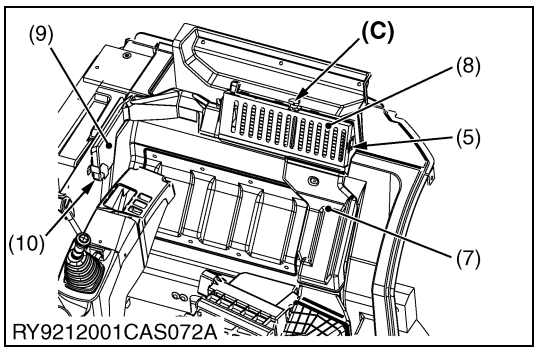
RY9212032CAS0001US0



RY9212032CAS001A



RY9212001CAS071A



RY9212001CAS072A

(When removing)

1. Remove the bolts at the two spots, and also remove the duct cover.
2. Remove the bolts at the two spots, and also remove the Switch cover.
3. Remove the bolts at the two spots, and also remove the duct assy (air-intake, base).
4. Remove the duct assy (3, air-intake, A/C) and duct (2, air-intake, A/C).
5. Remove the duct assy (1, air-intake, A/C) from the A/C unit.

Replacing the Filters

1. Loosen the knob bolt.
2. Pull the right edge of the cover front and remove the hook out of the spring plate.
3. Remove the insertion of left edge of the cover.
4. Remove the filters.

(When Attaching)

- **(A)** Insert the filters in the clearance of upper and lower of the duct. (the filter's convex surface is at the cover side.)
- **(B)** Insert the nail part of left edge of the cover into the slit part and push the right edge to the spring plate until it hooks.
- **(C)** Tighten the cover with the duct and the knob bolt.

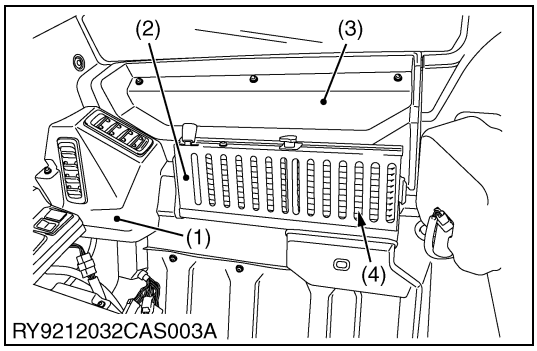
1. Insert and attach the duct assy (3, air-intake, A/C) into the duct assy (air-intake, base) and the bracket.
2. Insert and attach the duct assy (1, air-intake, A/C) into the A/C unit.
3. Insert and attach the duct (2, air-intake, A/C) into duct assy (1, air-intake, A/C) and duct assy (air-intake, base).

(1) Knob bolt
(2) Cover
(3) Duct
(4) Filter
(5) Spring plate
(6) Duct ASSY (1, air-intake, A/C)
(7) Duct ASSY (2, air-intake, A/C)
(8) Duct ASSY (air-intake, base)
(9) Duct ASSY (3, air-intake, A/C)
(10) Bracket (air-intake, duct)
(11) Duct cover
(12) Switch cover

RY9212032CAS0002US0

7. CABIN REMOVAL AND MOUNTING

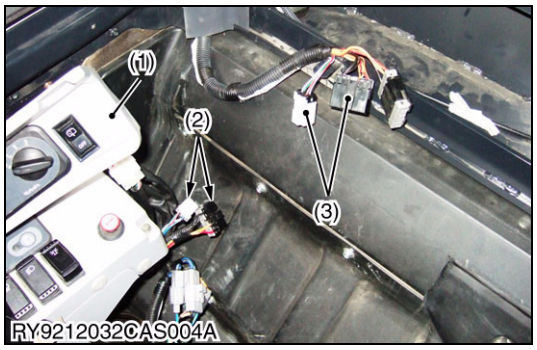
[1] REMOVING THE CABIN



1. Put the bucket on the ground, stop the engine, and slide the seat forward of the machine.
2. Remove the cover (1), (2), (3) and the filter (4).

(1) Cover
(2) Cover
(3) Cover
(4) Filter

RY9212032CAS0003US0



3. Disconnect the harness for cabin and the coupler connecting the main harness.
4. Remove the cover (1).

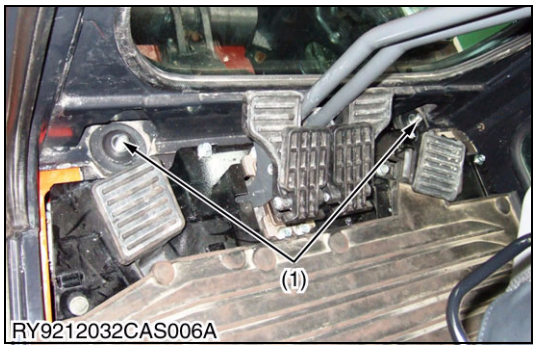
(1) Cover
(2) Main harness coupler
(3) Harness coupler for cabin

RY9212032CAS0004US0

5. Remove the air duct (1) and (2).

(1) Air duct
(2) Air duct

RY9212032CAS0005US0

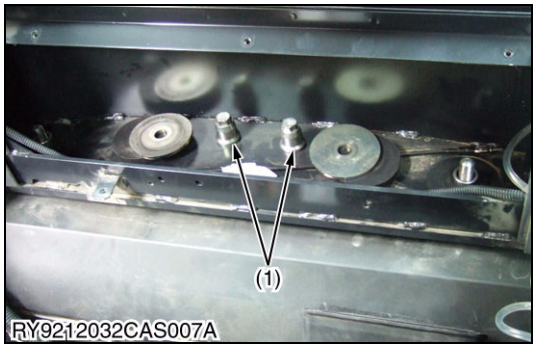


6. Remove the floor mat and the two nuts (1) at the front of the machine to attach the cabin.

Tightening torque	Nut (1)	107 to 127.4 N·m 11.0 to 13.0 kgf·m 79.69 to 92.6 lbf·ft

(1) Nut

RY9212032CAS0006US0

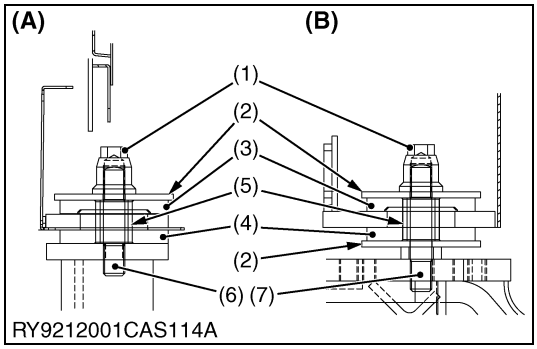


7. Remove the two nuts (1) at the rear of the machine to attach the cabin.

Tightening torque	Nut (1)	107 to 127.4 N·m 11.0 to 13.0 kgf·m 79.69 to 92.6 lbf·ft

(1) Nut

RY9212032CAS0007US0



Tightening torque	Stud (front) (6) Stud (rear) (7)	78 to 127 N·m 8.0 to 13.0 kgf·m 58 to 94 lbf·ft

Spread the screw fixation medicine (Loctite 271).

(1) Nut
(2) Washer
(3) Shock absorber rubber (cabin, upper)
(4) Shock absorber rubber (cabin, lower)
(5) collar
(6) Stud (front)
(7) Stud (rear)

(A) Two points at the front of the machine
(B) Two points at the rear of the machine

RY9212032CAS0008US0

8. Hook the nylon sling at the top of the cabin and hold it.

RY9212032CAS0009US0

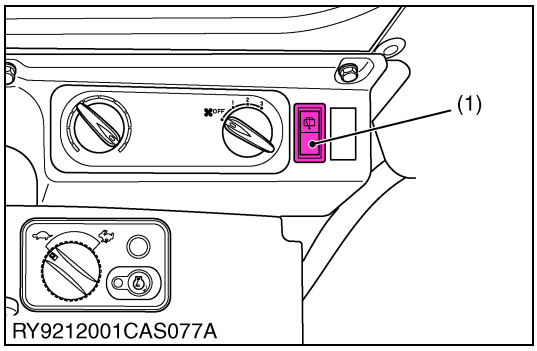
9. Lift the cabin gently and remove it.

Cabin mass	approx. 230 kg / 507 lbs.

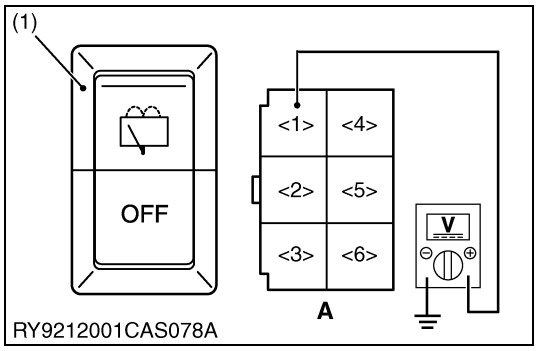
RY9212032CAS0010US0

8. WINDOW WASHER

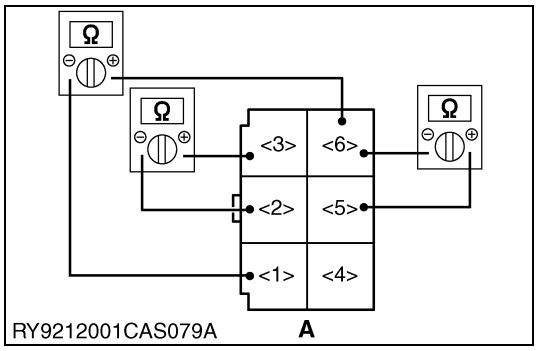
[1] WIPER SWITCH



RY9212001CAS077A



RY9212001CAS078A



RY9212001CAS079A

Connector voltage

1. Remove the 6P connector from the wiper switch.
2. Switch the starter switch to [RUN] and the wiper switch to ON.
3. Measure the voltage between terminal 1of the connector on the harness side and ground on the body.
4. If is the same as the battery voltage (DC 11 to 14 V), it is normal.

(1) Wiper switch **A : 6P connector (harness side)**

RY9212001CAS0071US0

Checking the wiper switch

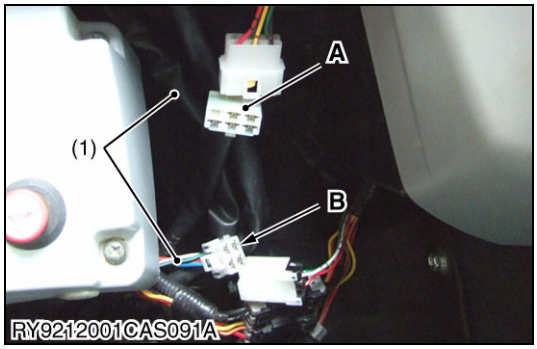
1. Check the continuity between each of the terminals according to the table below.
2. If continuity exists, it is normal.

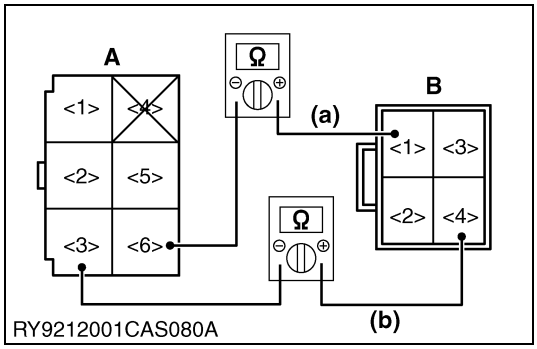
Position	<3>	<2>	<1>	<6>	<5>
WASH1	●	●		●	●
ON			●	●	
OFF				●	●
WASH2	●	●	●	●	

RY9212032CAS012A

A : 6P connector (switch side)

RY9212001CAS0072US0





Checking the cab wiper power harness

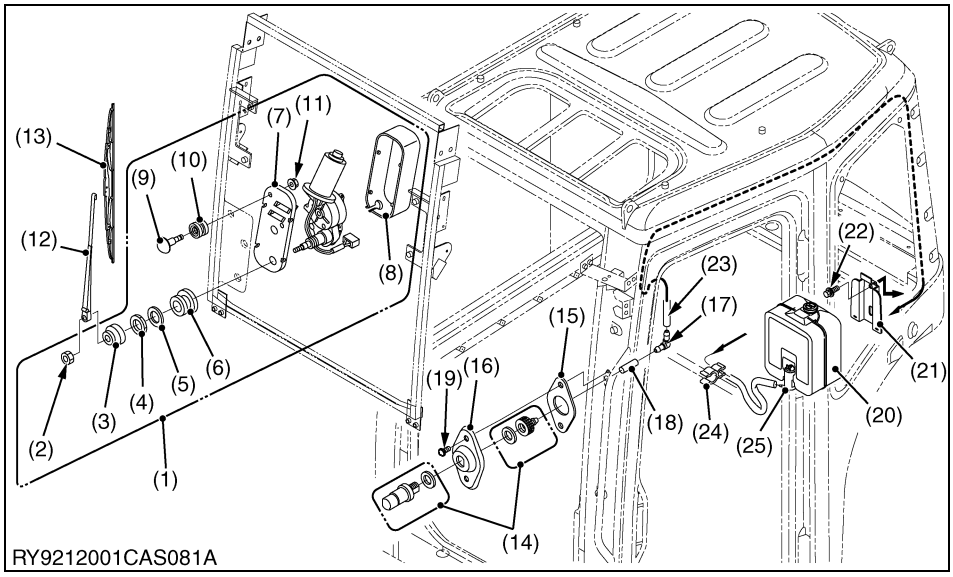
1. Disconnect the 6P connector from the wiper switch and the 4P connector from the cab wiper power harness.
2. Check the continuity between the terminals on both sides of the harness.
3. If continuity exists, it is normal.

(1) Cab wiper power harness

A : 6P connector
B : 4P connector
(a) Wiper motor line
(b) Washer motor line

RY9212001CAS0073US0

[2] COMPONENT SCHEMATIC

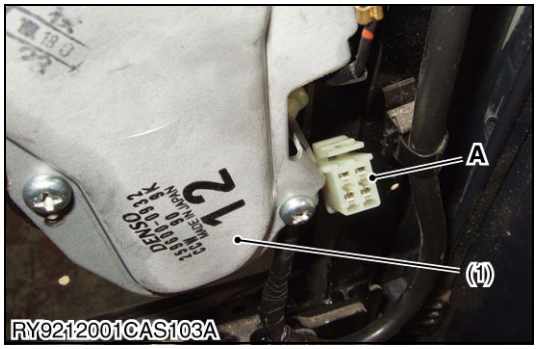


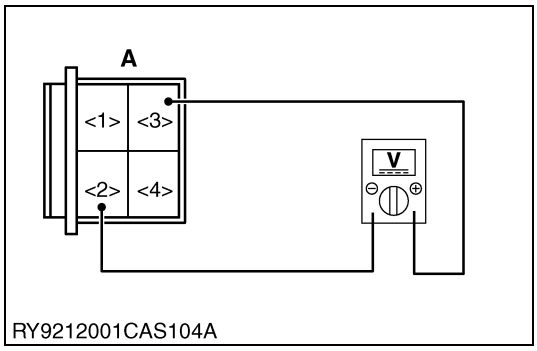
(1) Wiper motor ASSY
(2) Nut
(3) Wiper cap
(4) Nut
(5) Washer
(6) Wiper seal
(7) Wiper plate
(8) Wiper cover
(9) Bolt
(10) Cushion
(11) Flange nut
(12) Wiper arm ASSY
(13) Wiper blade
(14) Nozzle ASSY
(15) Gasket
(16) Gasket
(17) Elbow joint
(18) Tube joint
(19) Screw
(20) Washer tank
(21) Bracket
(22) Bolt
(23) Tube
(24) Clamp
(25) Washer motor

The wiper is installed on the front and is composed of a wiper motor, wiper arm, wiper blade, etc.

RY9212001CAS0074US0

[3] WIPER MOTOR





Connector voltage

1. Remove the wiper cover.
2. Remove the 4P connector from the wiper motor.
3. Switch the starter switch to [RUN] and the window washer to ON.
4. Measure the voltage between terminals 2 and 3 of the connector on the harness side.
5. If is the same as the battery voltage (DC 11 to 14 V), it is normal.

(1) Wiper motor **A : 4P connector (harness side)**

RY9212001CAS0075US0

Testing the motor separately

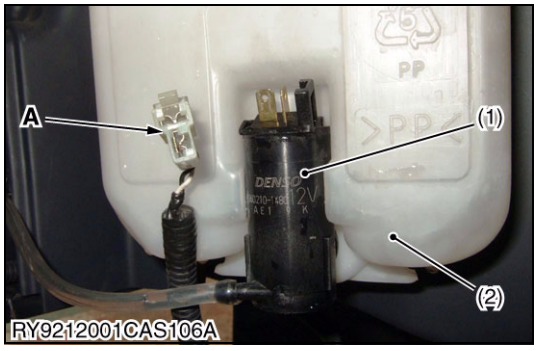
1. Raise the wiper blade so there is no load on it.
2. Switch the starter switch to [RUN] and the wiper switch to ON.
3. If the rpm and wiping angle are as indicated in the table, it is normal.

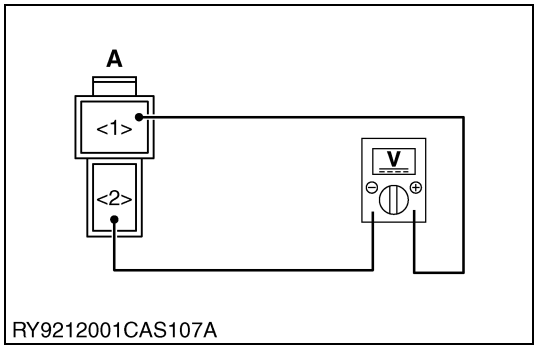
No load wiper rpm	Factory spec.	25 to 43 rpm
No load wiping angle		87 to 93 °

Torque	Flange nut (11)	3.43 to 4.41 N·m 0.35 to 0.45 kgf·m 2.5 to 3.3 lbf·ft
	Nut (4)	2.94 to 3.92 N·m 0.30 to 0.40 kgf·m 2.0 to 3.0 lbf·ft
	Nut (2)	6.37 to 9.32 N·m 0.65 to 0.95 kgf·m 4.7 to 6.9 lbf·ft

RY9212001CAS0076US0

[4] WASHER MOTOR





The window washer operates via a small, electric hi-speed motor and consists of a tank, pump and nozzle.

The washer pump is linked to the shaft of the motor and is installed below the tank.

Tank Capacity	1.6 L, 0.45 U.S.gal

(1) Washer motor **A : 2P connector (harness side)**
(2) Tank

RY9212001CAS0077US0

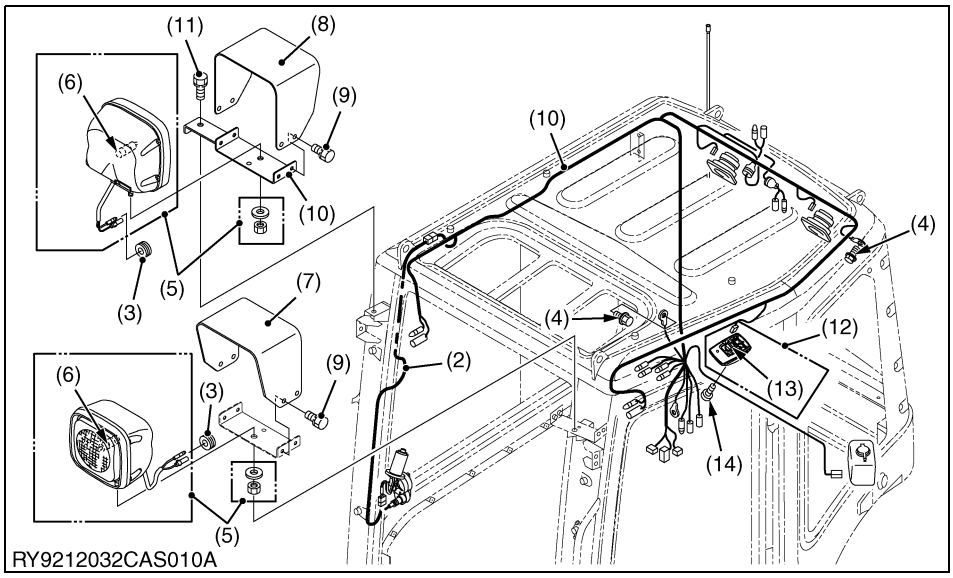
Connector voltage

1. Remove the 2P connector from the washer motor.
2. Press in on the [OFF] side of the wiper switch. (so only the window washer operates.)
3. Measure the voltage between terminals 1 and 2 of the connector on the harness side.
4. If is the same as the battery voltage (DC 11 to 14V), the connector voltage is normal.

A : 2P connector (harness side)

RY9212001CAS0078US0

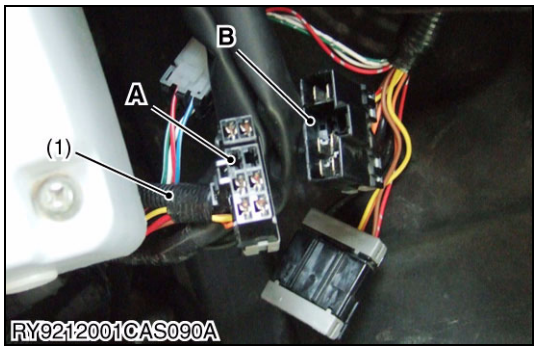
9. LIGHTING DEVICES (CAB WORK LIGHT, INTERIOR LIGHT)



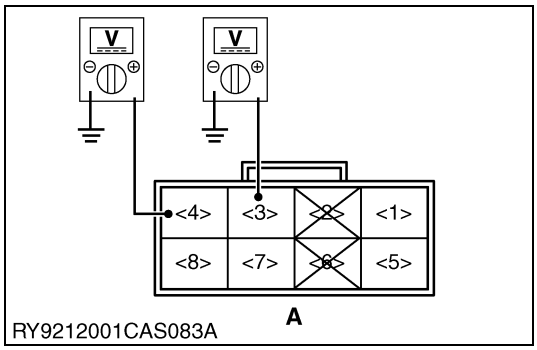
RY9212032CAS010A

(1) Wire harness (cabin)
(2) Wire harness
(3) Grommet
(4) Bolt (earth)
(5) Cabin working light
(6) Light bulb
(7) Lamp cover
(8) Wiper cover
(9) Bolt
(10) Lamp bracket assy
(11) Bolt
(12) Room light assy
(13) Light bulb
(14) Screw

RY9212032CAS0011US0



RY9212001CAS090A



RY9212001CAS083A

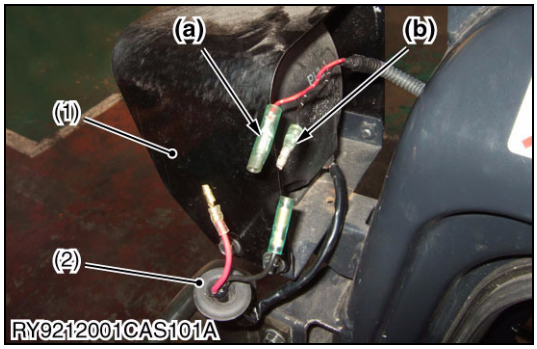
Connector voltage

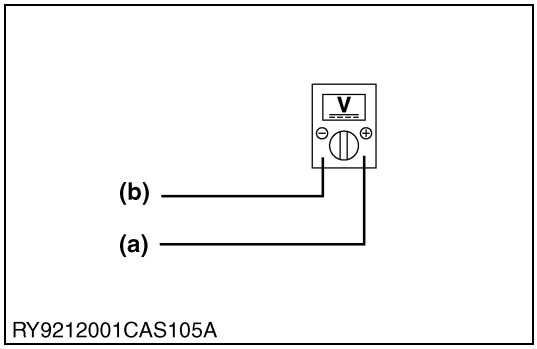
1. Disconnect the cab power 8P connector from the wire harness (cabin).
2. Measure the voltage between terminal 3 of the connector on the cabin power harness side and ground on the body. (interior light)
3. Turn the starter switch to [RUN].
4. Measure the voltage between terminal 4 of the connector on the cabin power harness side and ground on the body. (cab work light)
5. If is the same as the battery voltage (DC 11 to 14 V), the connector voltage is normal.

(1) Cab power harness

A : 8P connector (cab power harness side)
B : 8P connector (cab harness side)

RY9212001CAS0080US0



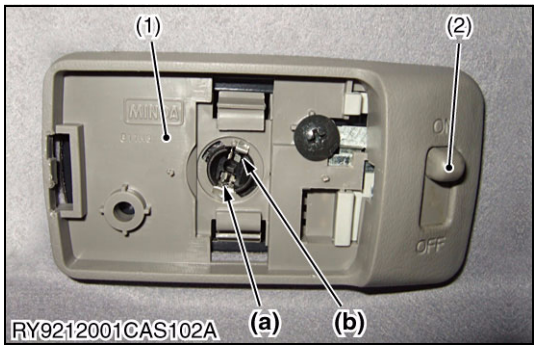


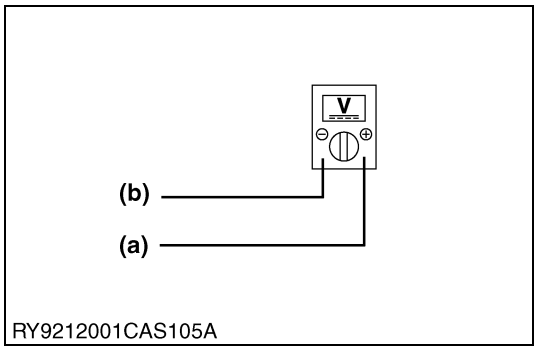
Terminal voltage (cab work light)

1. Remove the grommet and pull the work light terminal out of the frame of the cabin.
2. Remove the two work light terminals.
3. Switch the starter switch to [RUN] and the cab work light switch to ON.
4. Measure the voltage between GND and the work light terminal (+) on the harness side.
5. If is the same as the battery voltage (DC 11 to 14 V), the terminal voltage is normal.

(1) Work light
(2) Grommet
(a) (+) Terminal
(b) GND terminal

RY9212001CAS0081US0



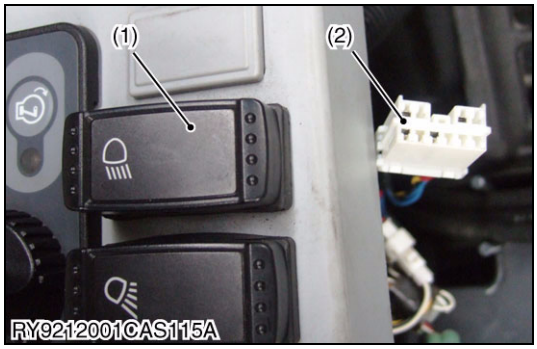


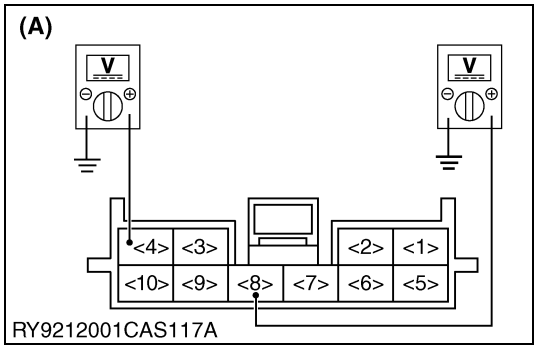
Terminal voltage (interior light)

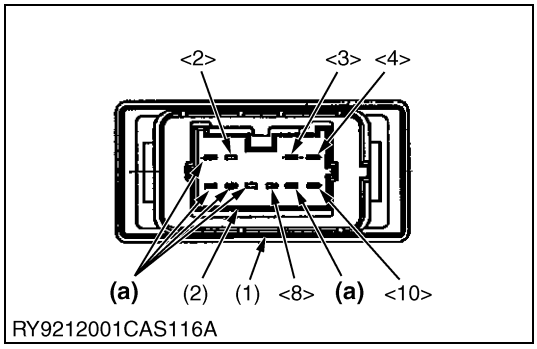
1. Remove the cover of the interior light.
2. Remove the bulb. (pull it out)
3. Switch the interior light switch to [ON].
4. Measure the voltage between GND and the interior light terminal (+).
5. If is the same as the battery voltage (DC 11 to 14 V), the terminal voltage is normal.

(1) Interior light ASSY
(2) Interior light switch
(a) (+) Terminal
(b) GND terminal

RY9212001CAS0082US0







Cab work light switch

Connector voltage

1. Turn the starter switch to [OFF] and disconnect the 10P connector from the cab work light switch.
2. Turn the starter switch to [RUN].
3. Measure the voltage between terminal 8 of the connector on the harness side and ground on the body. (switch voltage)
4. Measure the voltage between terminal 4 of the connector on the harness side and ground on the body. (LED voltage)
5. If is the same as the battery voltage (DC 11 to 14 V), it is normal.

(1) Cab work light switch
(2) 10P connector (harness side)
(A) 10P connector (harness side)

RY9212001CAS0083US0

Checking the cab work light switch

1. Check the continuity between each of the terminals according to the table below.
2. If continuity exists, it is normal.

	<8>	<2>	<3>	<10>	<4>
ON	○—○			○—◁—∿—○	
OFF	○		○		

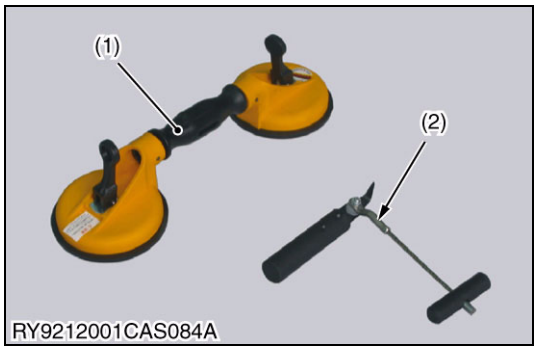
RY9212001CAS119A

(1) Cab work light switch
(2) 10P connector (switch side)
(a) (free)

RY9212001CAS0084US0

10. REMOVAL AND INSTALLATION OF GLASS

[1] PREPARATION



Items required

- Cleaner : Equivalent of Seeker Cleaner 205
- Adhesive : Equivalent of Seeker Flex 250PC-JM
- Primer : Equivalent of Seeker Primer 206
- Scraper
- Awl
- Adhesive cutter
- Glass suction cups (use if needed)

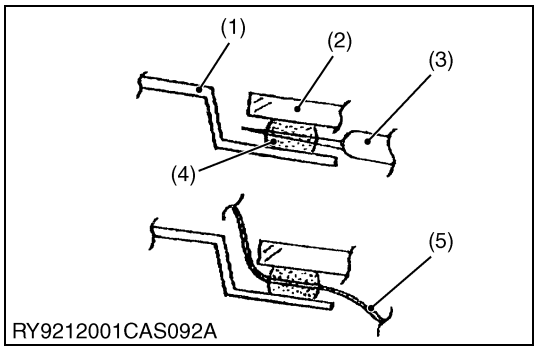
■ **NOTE**

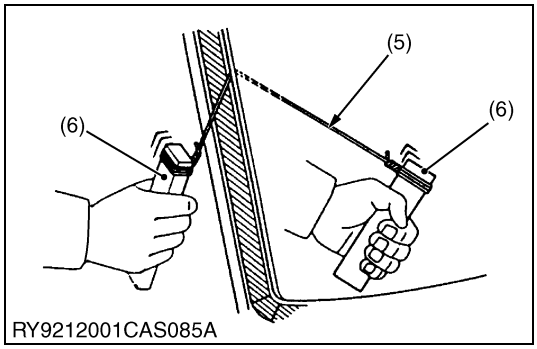
- **The cleaner and adhesive have a short shelf-life (9 to 12 months), so obtain them immediately before use from a nearby manufacturer or a shop that handles auto glass products.**

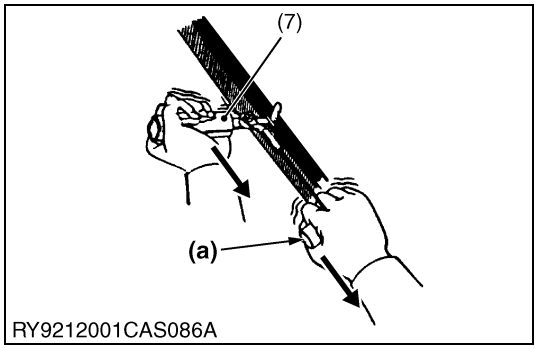
(1) Glass suction cups
(2) Adhesive cutter

RY9212001CAS0085US0

[2] REMOVING GLASS







1. Mask off painted surface around the glass to protect them from scratching while removing/installing glass.
2. Remove the glass.

[When using piano wire (damages parts of the glass)]

- Pierce and make a hole in the adhesive with an awl (or knife of glass cutter, etc.).
- Pass the piano wire (or steel wire) through the hole.
- Wrap both ends of the piano wire around a wood block or the like.
- Pull the piano wire along the edge of the window, sawing through the adhesive between the cab and the glass; then remove the glass from the cab.

[When using an adhesive cutter (completely ruins the glass)]

- Insert the adhesive cutter into the adhesive.
- Pull on part **(a)** of the cutter and cut the glass out.

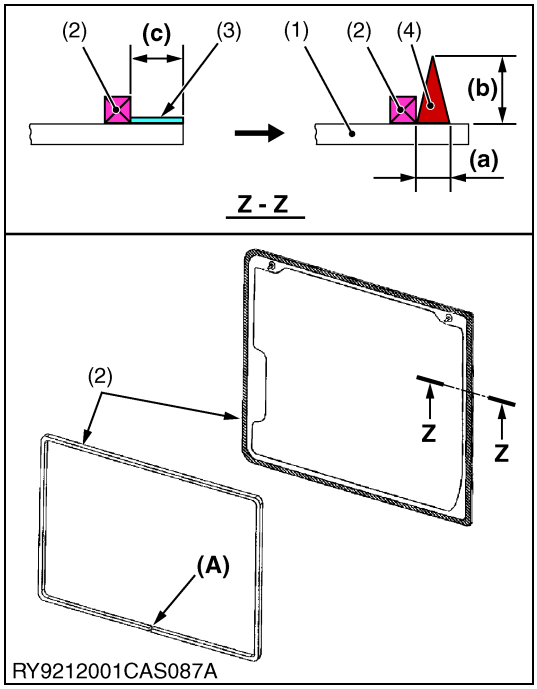
CAUTION

- **If the piano wire gets very hot in one place, it may break. Avoid rubbing it with much force against the edge of the glass.**
- **Be careful not to cut yourself on fragments of glass or the blade of the cutter.**

(1) Cab frame
(2) Glass
(3) Awl
(4) Adhesive
(5) Piano wire
(6) Wood
(7) Adhesive cutter

RY9212001CAS0086US0

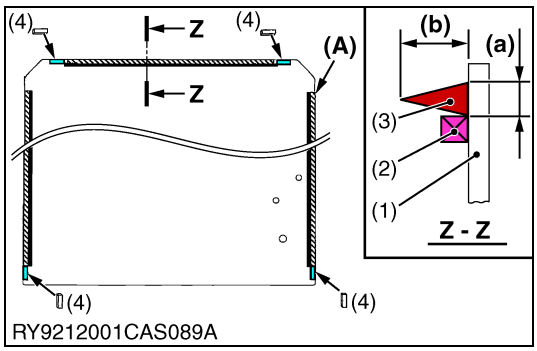
[3] INSTALLING GLASS



1. Completely eliminate all old adhesive on the frame of the cab.
2. Use the cleaner to clean the cab frame and the surface of the new glass where adhesive will be applied to get rid of any dirt or oil.
3. Affix the windshield dam to the surface of the new glass where the adhesive will be applied.
4. Apply primer uniformly around the circumference of the windshield dam.
5. Apply adhesive uniformly along the outer circumference of the windshield dam.
6. Apply primer uniformly around the entire circumference of the flange of the cab frame. (Application width: 18 mm (0.71 in.) or more)
7. Make and install a spacer for in between the edge of the glass and the cab's frame so that the glass does not slide down during installation. (holds position and prevents slipping)
8. Press lightly all the way around the edge of the glass from the outside, so the glass touches the shield dam and they stick together.
9. Hold the glass in place with packing tape until the adhesive hardens so the glass does not shift or come off.

(1) Glass
(2) Windshield dam (w/adhesive)
(3) Primer (apply)
(4) Adhesive (apply)
(a) At least 7 mm (0.28 in.)
(b) At least 12 mm (0.47 in.)
(c) 12 mm (0.47 in.)
(A) Start affixing dam here

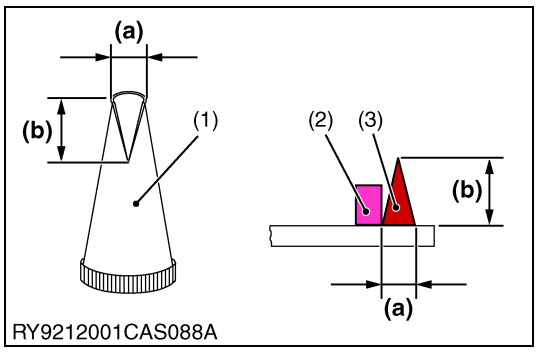
RY9212001CAS0087US0



- For the front window

(1) Glass
(2) Windshield dam (w/adhesive)
(3) Adhesive (apply)
(4) Fastener (affix as male/female set)
(a) At least 7 mm (0.28 in.)
(b) At least 12 mm (0.47 in.)
(A) Line up with the edge of the frame

RY9212001CAS0088US0



- Recommended shape of triangular bead

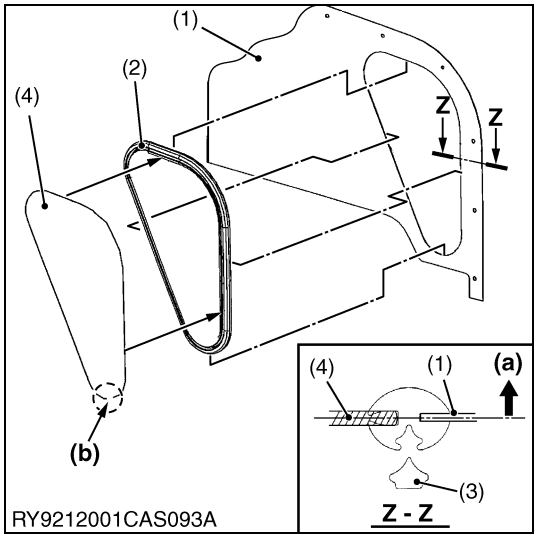
■ **NOTE**

- **Cut the tip of the nozzle of the adhesive cartridge in the shape of a V.**
- **Apply the adhesive to the glass so it forms a uniform triangular bead.**

(1) Nozzle tip
(2) Windshield dam (w/adhesive)
(3) Adhesive (apply)
(a) At least 8 mm (0.31 in.)
(b) At least 12 mm (0.47 in.)

RY9212001CAS0089US0

[4] GLASS TRIM TYPE



(When removing)
1. Lift the rubber core by its seam and remove it.
2. Remove the glass to the outside.

(When attaching)
1. From the outside, insert the glass into the glass trim.
2. Insert the rubber core into the groove all the way around the trim.
3. Start inserting the rubber core at the bottom center. (to prevent rain from getting in)

(1) Panel
(2) Glass trim
(3) Rubber core
(4) Glass

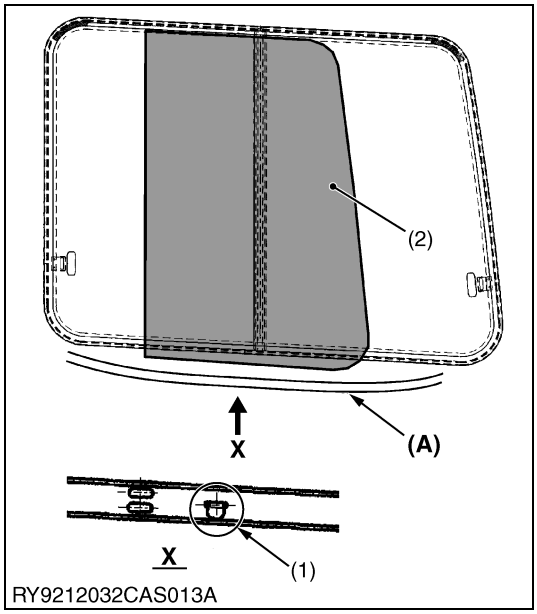
(a) Inside
(b) Start here

RY9212001CAS0090US0

[5] HOW TO REPLACE THE GLASS OF THE RIGHT-SIDE WINDOW

Put something like a piano wire into the outer window frame, pull it along the frame, remove the adhesive agent and cut it off from the cab frame. Replace the window glass followed by the next procedure.

RY9212032CAS0012US0



How to replace the glass

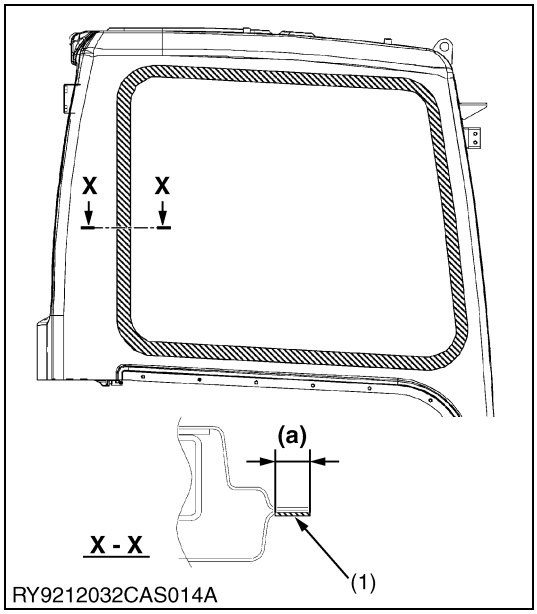
1. Lift the pin up with a flat-head driver.
   For RD451-46041, remove the sealant first and lift the pin.
2. Open the window to the point as shown in the figure.
3. Push down to widen up the window frame within elastic deflection not enough to deform itself permanently and replace the glass.
   And the same way when you install the glass.
4. Put the pin back.
   Apply sealant on this part of RD451-46041.

■ **NOTE**
- **Use same brand of an adhesive agent and a primer**
  E.g.)
  - **Cleaner: TK cleaner made in Daishin Chemistry**
  - **Adhesive agent: Sikaflex-260AP (SikaTack-Go!) or MSI made Sunrise U90**
  - **Primer: Sika Coating Activator or MSI made Sunrise Primer 24**

(1) Pin
(2) Window

(A) Push down to widen up the window frame

RY9212032CAS0013US0



RY9212032CAS014A

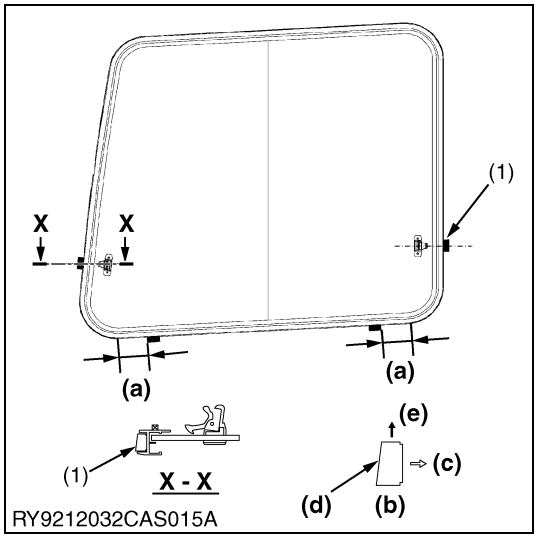
How to apply primer on the cab side

1. Remove dirt and grease on the opening surface of the glass sash's flange with a cleaner such as white gasoline. Avoid using an alcoholic cleaner.
2. Apply body primer evenly all around of flange from the end.

■ **NOTE**
- **You have to finish the glass installation within 3 min. to 6 hours after coating the primer.**

(1) Primer (apply)
(a) 18 mm (0.71 in.) or more

RY9212032CAS0014US0



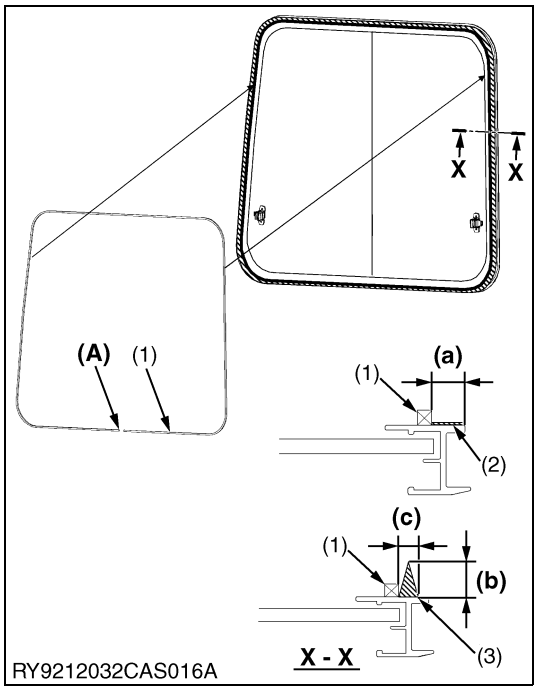
RY9212032CAS015A

How to install the glass spacer

1. Remove dirt and grease on the surface of glass spacer with a cleaner such as white gasoline.
2. Apply the primer to the glass spacer.
3. Install the glass spacer in the glass sash. (4 spots)

(1) Glass Spacer
(a) 100 mm (3.9 in.)
(b) Cross section of the spacer
(c) Install in the sash
(d) Inclined surface
(e) Cab side

RY9212032CAS0015US0



RY9212032CAS016A

How to install the sealant dam and apply the primer

1. Remove dirt and grease on the surface of the circumference at the back of the sash glass to apply an adhesive agent and on the surface of applying a sealant dam with a cleaner such as white gasoline. Avoid using an alcoholic cleaner.
2. Put a sealant dam on the position as shown in the figure and evenly apply the primer peripherally.

[How to apply adhesive]

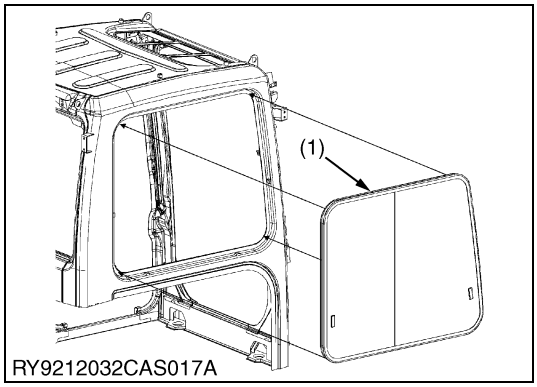
1. Apply the adhesive along the circumference of the sealant dam.

■ **NOTE**
- **You have to finish the glass installation within 3 min. to 6 hours after coating the primer.**
- **In order to keep water-tightness, the adhesive must be applied unbrokenly.**
- **Installation of glass needs to be done within 3 min. after the adhesive is applied.**

(1) Sealant Dam (w/adhesive)
(2) Primer (apply)
(3) Adhesive (apply)
(a) 12 mm (0.47 in.)
(b) 12 mm (0.47 in.) or more
(c) 7 mm (0.27 in.) or more

(A) Starting point of installation

RY9212032CAS0016US0



How to install the glass sash

1. Set the glass in the sash on which the adhesive has been already applied and install to attach on the cabin frame.

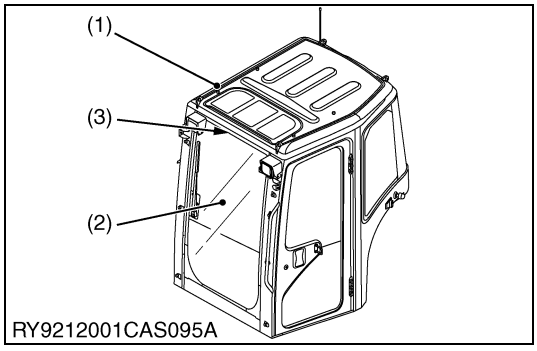
■ **NOTE**
- **Adhesive should not be run off the edge of the sash after the glass sash is set.**
- **Need to maintain that state for about 24 hours after the glass sash is set.**

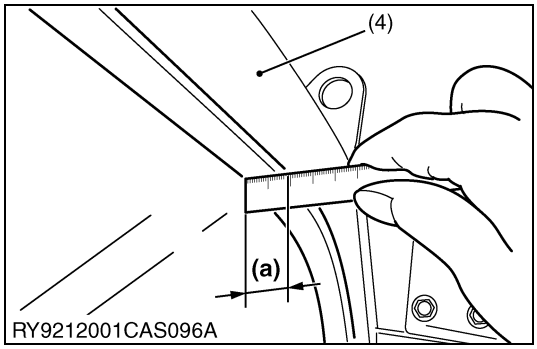
(1) Glass Sash

RY9212032CAS0017US0

11. FRONT WINDOW

[1] ADJUSTING THE CLOSING LOCK OF THE FRONT WINDOW (TOP)





When water leaks in the cabin or it rattles

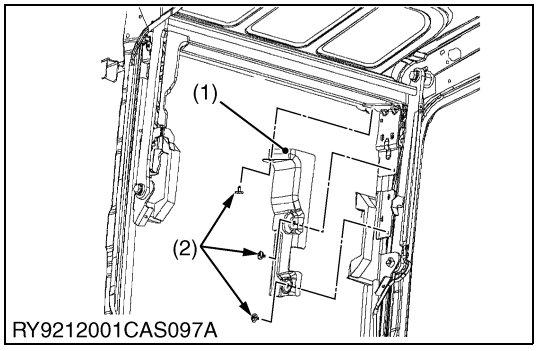
1. Close the front window (top) and lock it securely.
2. Remove the trim on the top edge of the front window (top) about half way along the frame and measure the clearance between the glass and the cab frame.

■ **NOTE**

- **If you remove the trim too far, the glass may shift out of position, preventing a reliable measurement of the clearance.**

(1) Cab ASSY
(2) Front window (top)
(3) Trim
(4) Cab frame
(a) Clearance

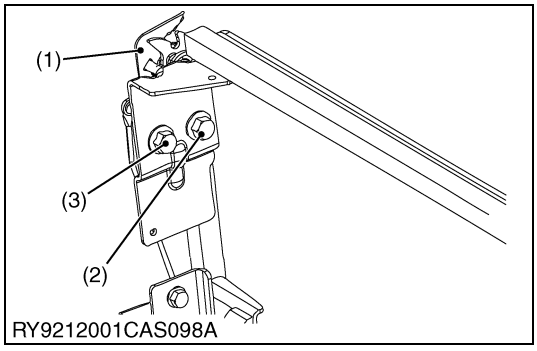
RY9212001CAS0091US0



3. Remove the clip and then the lock cover.

(1) Lock cover
(2) Clip

RY9212001CAS0092US0



4. Remove the lock of the front window (top) and loosen the lock's mounting bolts.
5. Leave the rear bolt as is and lift up the front bolt 1.0 to 1.5 mm (0.04 to 0.06 in.).

■ **NOTE**

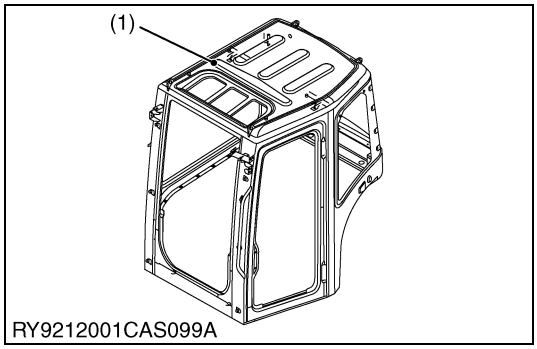
- **Lifting the bolt more than 1.5 mm (0.06 in.) may prevent the lock from working.**

6. Re-tighten the bolts to the specified torque.
7. Close the front window (top) and lock it securely.
8. Recheck the clearance between the glass and the cab frame and make sure the clearance is smaller.
9. Operate the mini-excavator and make sure the rattling has stopped while driving.
10. Spray some water on the window and make sure it does not leak.

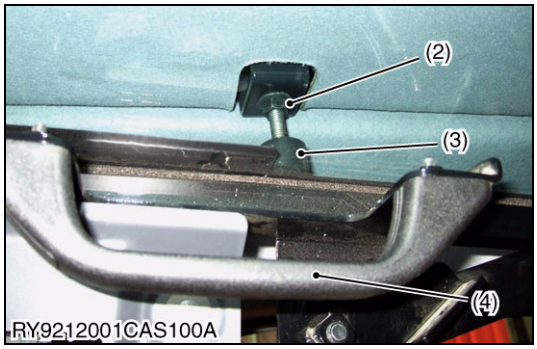
(1) Lock
(2) Bolt (front)
(3) Bolt (rear)

RY9212001CAS0093US0

[2] ADJUSTING THE OPEN LOCK OF THE FRONT WINDOW (TOP)



RY9212001CAS099A



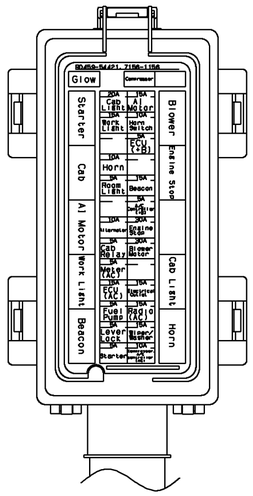
RY9212001CAS100A

When it rattles on the cabin

1. Lift the front window (top) and lock it securely to the ceiling.
2. While pulling down on the handle, check whether there is a gap between the glass and the cushion.
3. If the glass is up against the cushion without a gap, it is OK.
4. If there is a gap between the glass and the cushion, it causes the rattling. Loosen the nut and stretch the cushion until it is against the surface of the glass.
5. After adjusting the cushion, re-tighten the nut.
6. Lift the front window (top) and lock it securely to the ceiling.
7. Operate the mini-excavator and make sure the rattling has stopped while driving.

(1) Cabin
(2) Nut
(3) Cushion
(4) Handle

RY9212001CAS0094US0



Electrical Wiring Diagram

RD451-4690△ Harness (CAB)

RD451-4691△ Harness (Wiper)

WIRE HARNESS, MAIN

RD459-5341△ *	EXCEPT FP(EXCEPT K)
RD459-5342△ *	EXCEPT FP(K)
RD359-5341△ *	FP(EXCEPT K)
RD359-5342△ *	FP(K)

RD459-53360 Harness (Front.DA)

Electrical Circuit Diagram

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