SEN06611-02

Shop Manual

BULLDOZER

D375A-8

SERIAL NUMBERS 80001 and up

KOMATSU

00 INDEX AND FOREWORD

INDEX

ABBREVIATION LIST

- This list of abbreviations includes the abbreviations used in the text of the shop manual for parts, components, and functions whose meaning is not immediately clear. The spelling is given in full with an outline of the meaning.
- Abbreviations that are used in general society may not be included.
- Special abbreviations which appear infrequently are noted in the text.
- This list of abbreviations consists of two parts. The first part is a list of the abbreviations used in the text of the manual, and the second part is a list of the abbreviations used in the circuit diagrams.

List of abbreviations used in the text

Abbreviation	Actual word spelled out	Purpose of use (major applicable machine (*1), or component/system)	Explanation
ABS	Antilock Brake System	Travel and brake (HD, HM)	This is a function that releases the brake when the tires skid (tires are not rotated). This function applies the brake again when the tires rotate.
AISS	Automatic Idling Setting System	Engine	This is a function that automatically sets the idle speed.
AJSS	Advanced Joystick Steering System	Steering (WA)	This is a function that performs the steering operations with a lever instead of using a steering wheel. This function performs gear shifting and changing forward and reverse direction.
ARAC	Automatic Retarder Accelerator Control	Travel and brake (HD, HM)	This is a function that automatically operates the retarder with a constant braking force when letting go of the accelerator pedal on the downhill.
ARSC	Automatic Retarder Speed Control	Travel and brake (HD, HM)	This is a function that automatically operates the retarder to ensure that the machine speed does not accelerate above the speed set by the operator when letting go of the accelerator pedal on the downhill.
ASR	Automatic Spin Regulator	Travel and brake (HD, HM)	This is a function that drives both wheels automatically using the optimum braking force when the tire on one side spins on the soft ground surfaces.
ATT	Attachment	Work equipment	A function or component that can be added to the standard specification.
BCV	Brake cooling oil control valve	BRAKE (HD)	This is a valve that bypasses a part of the brake cooling oil to reduce the load applied to the hydraulic pump when the retarder is not being used.
CAN	Controller Area Network	Communication and electronic control	This is one of communication standards that are used in the network on the machine.
CDR	Crankcase Depression Regulator	Engine	This is a regulator valve that is installed to KCCV ventilator. It is written as CDR valve and is not used independently.
CLSS	Closed-center Load Sensing System	Hydraulic system	This is a system that can actuate multiple actuators simultaneously regardless of the load (provides better combined operation than OLSS).

Abbreviation	Actual word spelled out	Purpose of use (major applicable machine (*1), or component/system)	Explanation
CRI	Common Rail Injection	Engine	This is a function that maintains optimum fuel injection amount and fuel injection timing. This is performed the engine controller which electronically controls supply pump, common rail, and injector.
ECM	Electronic Control Module	Electronic control system	This is an electronic control device that send the command to actuators using the signals from the sensors on the machine so that the optimum actuation is performed. (Same as ECU)
ECMV	Electronic Control Modulation Valve	Transmission (D, HD, WA, etc)	This is a proportional electromagnetic valve that decreases the transmission shock by gradually increasing oil pressure for engaging clutch.
ECSS	Electronically Controlled Suspension System	Travel (WA)	This is a device that ensures smooth high-speed travel by absorbing vibration of machine during travel with hydraulic spring effect of accumulator.
ECU	Electronic Control Unit	Electronic control system	This is an electronic control device that send the command to actuators using the signals from the sensors on the machine so that the optimum actuation is performed. (Same as ECM)
EGR	Exhaust Gas Recirculation	Engine	This is a function that recirculates a part of exhaust gas to combustion chamber, so that it reduces combustion temperature, and reduces emission of NOx.
EMMS	Equipment Management Monitoring System	Machine monitor	This is a function with which operator can check information from each sensor on the machine (filter, oil replacement interval, malfunctions on machine, failure code, and failure history).
EPC	Electromagnetic Proportional Control	Hydraulic system	Electromagnetic proportional control This is a mechanism with which actuators operate in proportion to the current.
FOPS	Falling Object Protective Structure	Cab and canopy	This structure protects the operator's head from falling objects. (Falling object protective structure) This performance is standardized as ISO 3449.
F-N-R	Forward-Neutral-Reverse	Operation	Forward - Neutral - Reverse
GPS	Global Positioning System	Communication (KOMTRAX, KOMTRAX Plus)	This system uses satellites to determine the current location on the earth.
GNSS	Global Navigation Satellite System	Communication (KOMTRAX, KOMTRAX Plus)	This is a general term for system uses satellites such as GPS, GALILEO, etc.
HSS	Hydrostatic Steering System	Steering (D Series)	This is a function that enables the machine to turn without steering clutch by controlling a difference in travel speed of right and left tracks with a combination of hydraulic motor and bevel shaft.
HST	Hydro Static Transmission	Transmission (D, WA)	Hydraulic transmission system that uses a combination of hydraulic pump and hydraulic motor without using gears for stepless gear shifting.

Abbreviation	Actual word spelled out	Purpose of use (major applicable machine (*1), or component/system)	Explanation
ICT	Information and Communication Technology	Communication and electronic control	A general term for the engineering and its socially applied technology of information processing and communication.
IMA	Inlet Metering Actuator	Engine	This is a valve that adjusts the fuel intake amount at the pump inlet in order to control the supply pump fuel discharged volume. (Same as IMV)
IMU	Inertial Measurement Unit	Engine	This is a device to detect the angle (or angular velocity) and acceleration of the 3 axes that control motions.
IMV	Inlet Metering Valve	Engine	This is a valve that adjusts the fuel intake amount at the pump inlet in order to control the supply pump combustion discharged volume. (Same as IMA)
KCCV	Komatsu Closed Crankcase Ventilation	Engine	This is a mechanism that burns the blowby gas again by separating oil from blowby gas and returning it to the intake side. It primarily consists of filters.
KCSF	Komatsu Catalyzed Soot Filter	Engine	This is a filter that captures soot in exhaust gas. It is built in to KDPF.
KDOC	Komatsu Diesel Oxidation Catalyst	Engine	This is a catalyst that is used for purifying exhaust gas. It is built in to KDPF or assembled with the muffler.
KDPF	Komatsu Diesel Particulate Filter	Engine	This is a component that is used to purify the exhaust gas. KDOC (catalyst) and KCSF (filter to capture soot) are built-in it. It is installed instead of the conventional muffler.
KTCS	Komatsu Traction Control System	Travel and brake (HM)	This is a function that performs braking with the optimum force and recovers the driving force of the wheels by actuating the inter-axle differential lock when the wheels runs idle while the machine travels on the soft ground.
LCD	Liquid Crystal Display	Machine monitor	This is an image display equipment such as a monitor in which the liquid crystal elements are assembled.
LED	Light Emitting Diode	Electronic parts	This is a semiconductor element that emits light when the voltage is applied in forward direction.
LIN	Local Interconnect Network	Communication and electronic control	This is one of communication standards that are used in the network on the machine.
LS	Load Sensing	Hydraulic system	This is a function that detects differential pressure of pump, and controls discharged volume corresponding to load.
LVDS	Low Voltage Differential Signaling	Communication and electronic control	This is one of communication standards that are used in the network on the machine.
MAF	Mass Air Flow	Engine	This indicates engine intake air flow. This is not used independently but is used as combined with sensor. Mass air flow sensor can be called as MAF sensor.

Abbreviation	Actual word spelled out	Purpose of use (major applicable machine (*1), or component/system)	Explanation
MMS	Multimedia Messaging Service	Communication	This is a service that allows transmission and reception of short messages consisting of characters or voice or images between cell phones.
NC	Normally Closed	Electrical system, hydraulic system	This is a characteristic of electrical or hydraulic circuits. Circuit is normally closed if it is not actuated, and it opens when it is actuated.
NO	Normally Open	Electrical system, hydraulic system	This is a characteristic of electrical or hydraulic circuits. Circuit is normally open if it is not actuated, and it closes when it is actuated.
OLSS	Open-center Load Sensing System	Hydraulic system	This is a hydraulic system that can operate multiple actuators at the same time regardless of the load.
PC	Pressure Compensation	Hydraulic system	This is a function that corrects the oil pressure.
PCCS	Palm command control system	Steering (D Series)	This is a function that electrically controls the engine and transmission in an optimal way with the controller instantly analyzing data from levers, pedals, and dials.
PCV	Pre-stroke Control Valve	Engine	This is a valve that adjusts the fuel intake amount at the pump inlet in order to control fuel discharged volume of supply pump.
PPC	Proportional Pressure Control	Hydraulic system	This is a system that operates actuators in proportion to the oil pressure.
PPM	Piston Pump and Motor	Hydraulic system (D, PC, etc)	Piston type hydraulic pump and motor.
PTO	Power Take Off	Power train system	Power take-off mechanism
PTP	Power Tilt and power Pitch dozer	Work equipment (D Series)	This is a function that performs hydraulic control of the tilt and pitch of the dozer blade of the bulldozer.
ROPS	Roll-Over Protective Structure	Cab and canopy	ROPS is a protective structure that intended to protect the operator wearing seat belt from suffering injury which may be caused if the cab is crushed when the machine rolls over. (Roll-over protective structure) This performance is standardized as ISO 3471 or ISO 12117-2.
SCR	Selective Catalytic Reduction	Urea SCR system	This is an exhaust gas purifier using urea water that converts nitrogen oxides (NOx) into harmless nitrogen and water by oxidation-reduction reaction. It may also be mentioned as exhaust gas purification catalyst or part of the name of related devices.
SI	Le Systeme International d' Unites (International unit system)	Unit	Abbreviation for "International System of Units" It is the universal unit system and "a single unit for a single quantity" is the basic principle applied.
SOL	Solenoid	Electrical system	This is an actuator that consists of a solenoid and an iron core that is operated by the magnetic force when the solenoid is energized.

Abbreviation	Actual word spelled out	Purpose of use (major applicable machine (*1), or component/system)	Explanation
TOPS	Tip-Over Protective Structure	Cab and canopy	This is a protective structure that intended to protect the operator wearing seat belt from suffering injury which may be caused if the cab is crushed when the machine tips over. (Roll-over protective structure of hydraulic excavator) This performance is standardized as ISO 12117.
TWV	2-Way Valve	Hydraulic system	This is a solenoid valve that switches over direction of flow.
VGT	Variable Geometry Turbocharger	Engine	This is a turbocharger on which the cross-section area of the exhaust passage is variable.
VHPC	Variable Horse Power Control	Engine control	This is a function that finely controls the maximum output of the machine so that high work efficiency and low fuel consumption rate are both achieved.

*1: Code for applicable machine model

D: Bulldozer

HD: Dump truck

HM: Articulate dump truck

PC: Hydraulic excavator

WA: Wheel loader

List of abbreviations used in the circuit diagrams

Abbreviation	Actual word spelled out
A/C	Air Conditioner
A/D	Analogue-to-Digital
A/M	Air Mix Damper
ACC	Accessory
ADD	Additional
AUX	Auxiliary
BR	Battery Relay
CW	Clockwise
CCW	Counter Clockwise
ECU	Electronic Control Unit
ECM	Electronic Control Module
ENG	Engine
EXGND	External Ground
F.G.	Frame Ground
GND	Ground
IMA	Inlet Metering Actuator
NC	No Connection

Abbreviation	Actual word spelled out
S/T	Steering
STRG	
SIG	Signal
SOL	Solenoid
STD	Standard
OPT	Option
OP	
PRESS	Pressure
SPEC	Specification
SW	Switch
TEMP	Temperature
T/C	Torque Converter
T/M	Transmission

FOREWORD, SAFETY, BASIC INFORMATION

HOW TO READ THE SHOP MANUAL

REMARK

- Some of the attachments and options described in this shop manual may not be available in some areas. If they are required, consult your Komatsu distributor.
- The materials and specifications are subject to change without notice.
- Shop Manuals are available for "machine part" and "engine part". For the engine unit, see the shop manual for the machine which has the same engine model.
- Actual machine may differ from the images which are contained in this manual. A typical model is shown in the illustrations of this shop manual.

Composition of the shop manual

This shop manual contains technical information necessary to perform services in workshops. It is divided into the following chapters for the ease of use.

00 INDEX AND FOREWORD

This section describes the index, foreword, safety, and basic information.

01 SPECIFICATIONS

This section describes the specifications of the machine.

10 STRUCTURE AND FUNCTION

This section describes the structure and operation of each component with respect to each system. "STRUCTURE AND FUNCTION" is helpful in not only understanding the structure of each component but performing troubleshooting.

20 STANDARD VALUE TABLE

This section describes the standard values for new machine and failure criteria for testing and adjusting, and troubleshooting. Use the standard values table to check the standard values for testing and adjusting, and judge troubles in troubleshooting.

30 TESTING AND ADJUSTING

This section describes the measuring tools and measuring methods for testing and adjusting as well as the adjusting method of each part. The standard values and repair limit for TESTING AND ADJUSTING are described in "STANDARD VALUE TABLE".

40 TROUBLESHOOTING

This section describes troubleshooting of failure part and its remedy method on the occurrence of the failure. Descriptions of troubleshooting are sorted by failure mode.

50 DISASSEMBLY AND ASSEMBLY

This section describes the special tools, work procedures, and safety precautions necessary for removal, installation, disassembly, and assembly of the components and parts. In addition, tightening torques, quantity, and weight of the coating materials, lubricants, and coolant necessary to these works are shown.

60 MAINTENANCE STANDARD

This section describes the maintenance standard value of each component. The maintenance standard shows the criteria and remedies for disassembly and assembly.

80 THE OTHER INFORMATION

This section describes the structure and function, testing and adjusting, and troubleshooting for all of the other components or equipment which cannot be separately classified in the appendix.

90 Circuit diagrams

This section describes hydraulic circuit diagrams and electrical circuit diagrams.

Symbols

Important safety and quality portions are marked with the following symbols so that shop manual is used effectively.

Symbol	Item	Remark
	Danger	This signal indicates an extremely hazardous situation which will result in death or serious injury if it is not avoided.
	Warning	This signal indicates a potentially hazardous situation which will result in death or serious injury if it is not avoided.
	Caution	This signal indicates a potentially hazardous situation which will result in injury or property damage around the machine if it is not avoided.
	Weight	This signal indicates the weight of parts and components, and items which requires great attention to a selection of wires and working posture for slinging work.
	Tightening torque	This signal indicates the tightening torque for portions which requires special care in assembling work.
	Coat	This signal indicates a place to be coated with adhesive, grease, etc. in assembling work.
	Oil and coolant	This signal indicates a place to supply oil, coolant, etc. and the quantity.
	Draining	This signal indicates a place to drain oil, coolant, etc. and the quantity.

Signal word

Signal word for notice and remark describes the following.

Symbol	Item	Remark
NOTICE	Notice	If the precaution of this signal word is not observed, the machine damage or shortening of service life may occur.
REMARK	Remark	This signal word contains useful information to know.

Unit

International System of Units (SI) is used in this manual. For reference, units that have been used in the past are given in { }.

SAFETY NOTICE FOR OPERATION

- Appropriate servicing and repair are extremely important to ensure safe operation of the machine. The shop manuals describe the effective and safe servicing and repair methods recommended by Komatsu. Some of the servicing and repair methods require the use of special tools designed by Komatsu for special purposes.
- The symbol mark ⚠ is indicated for such matters that require special precautions. The work indicated with this warning mark ⚠ should be performed according to the instructions with special attention. Should a hazardous situation occurs or be anticipated during such work, be sure to keep safe first and take every necessary measures.

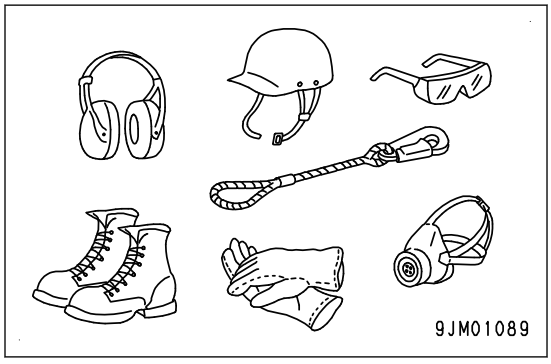
Safety matters

- Well organized work place
- Correct work clothes
- Observance of work standard
- Enforcement of hand signals
- Prohibition against unlicensed persons operating and handling the machine
- Safety check before starting work
- Wear of dust glasses (for cleaning or grinding work)
- Wear of welding goggles and protectors (for welding work)
- Being in good physical condition, and good preparation
- Always be alert and careful.

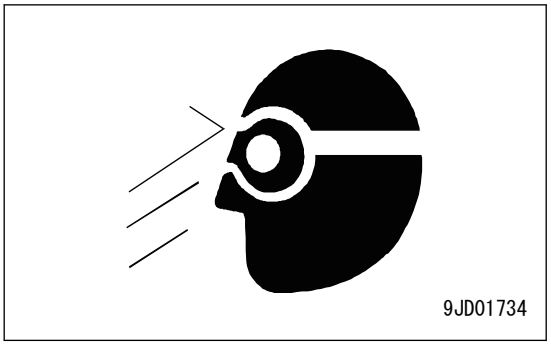
General precautions

⚠ **If the machine is handled incorrectly, it is dangerous. Read and understand what is described in the operation and maintenance manual before operation. Read and understand what is described in this manual before operation.**

- Read and understand the meaning of all the safety labels stuck to the machine before performing any greasing or repairs. For the locations of the safety labels and detailed explanation of precautions, see Operation and Maintenance Manual.
- Tools and removed parts in the workshop should be well organized. Always keep the tools and parts in their correct places. Always keep the work area clean and make sure that there is no dust, dirt, oil, or water on the floor. Smoke only in the designated areas. Never smoke while working.
- Keep all tools in good condition, learn the correct way to use them, and use the proper ones. Check the tools, machine, forklift truck, service car, etc. thoroughly before starting the work.
- Always wear safety shoes and helmet when performing any operation. Do not wear loose clothes, or clothes with buttons missing.



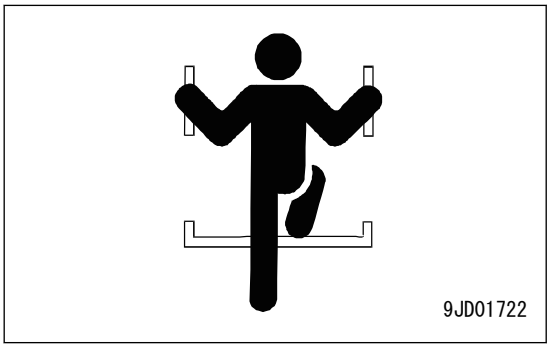
- Always wear the protective eyeglasses when hitting parts with a hammer.
- Always wear the protective eyeglasses when grinding parts with a grinder, etc.
- When performing any operation with multiple workers, always agree on the operating procedure before starting. Be clear in verbal communication, and observe hand signals. Hang "UNDER REPAIR" warning tag in the operator's compartment Before starting work.
- Work and operation which require license or qualification should be performed by qualified workers.



- Welding repairs should be performed by trained and experienced welders. When performing welding work, always wear welding gloves, apron, welding goggles, cap and other clothes suited for welding work.
- Warm up before starting the work with exercise which increases alertness and the range of motion in order to prevent injury.
- Avoid prolonged work, and take a rest at times to keep up a good condition. Take a rest at designated safe area.

Precautions for preparatory work

- Place the machine on a firm and level ground, and apply the parking brake and chock the wheels or tracks to prevent the machine from moving before adding oil or making any repairs.
- Lower the work equipment (blade, ripper, bucket, etc.) to the ground before starting work. If this is not possible, insert the lock pin or use blocks to prevent the work equipment from falling. In addition, be sure to lock all the control levers and hang "UNDER REPAIR" warning tag on them.
- When performing the disassembling or assembling work, support the machine securely with blocks, jacks, or stands before starting the work.
- Remove all mud and oil from the steps or other places for going up and down on the machine. Always use the handrails, ladders or steps when for going up and down on the machine. Never jump on or off the machine. When the scaffold is not provided, use steps or stepladder to secure your footing. Do not use handrails, ladders, or steps if they are damaged or deformed. Repair it or replace it immediately.



Precautions during work

- For the machine with the battery disconnect switch, check before starting the work that the system operating lamp is not lit. Then, turn the battery disconnect switch to OFF (○) position.

  REMARK

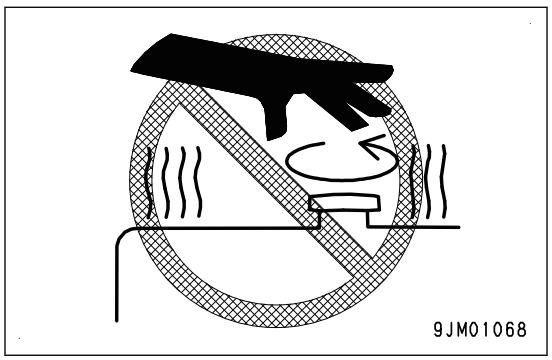
  Remove the key after it is turned to OFF (○) position if the battery disconnect switch is a switch key type. For the machine without the battery disconnect switch, turn the starting switch to OFF position, wait for two minutes or more before starting the work. Disconnect the battery cable by starting from the negative (-) terminal first.

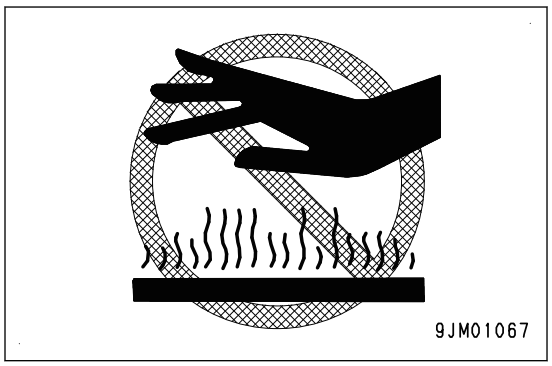
- For the machine with the quick release battery terminal (-), check before starting the work that the system operating lamp is not lit. Then, disconnect the quick release battery terminal (-).

  REMARK

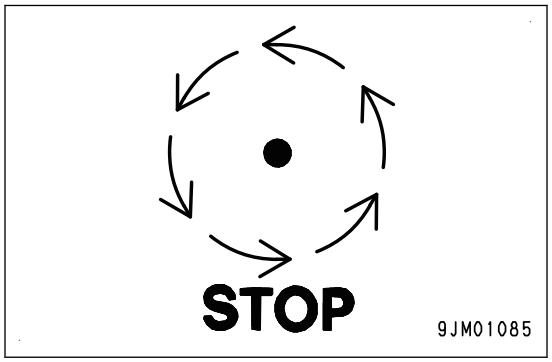
  For the machine without the system operating lamp, turn the starting switch to OFF position, wait for two minutes or more before starting the work. Disconnect the quick release battery terminal (-).

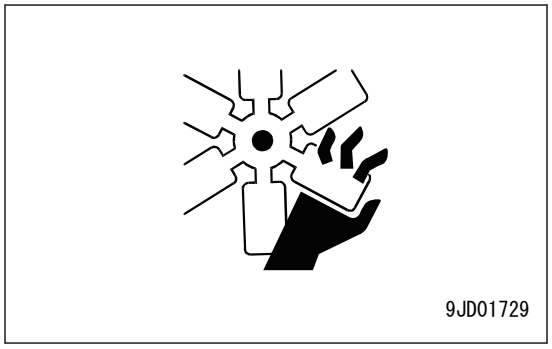
- Release the remaining pressure from the circuit before starting the work of disconnecting and removing of oil, fuel, water, or air from the circuit. When removing the cap of oil filter, drain plug, or oil pressure plug, it should be done slowly otherwise the oil spills.
- When removing or installing the checking plug or the piping in the fuel circuit, wait 30 seconds or longer after the engine is shut down and start the work after the remaining pressure is released from the fuel circuit.
- The coolant and oil in the circuits are hot when the engine is shut down. Be careful not to get scalded. Wait for the oil and coolant to cool before performing any work on the oil or coolant circuits.





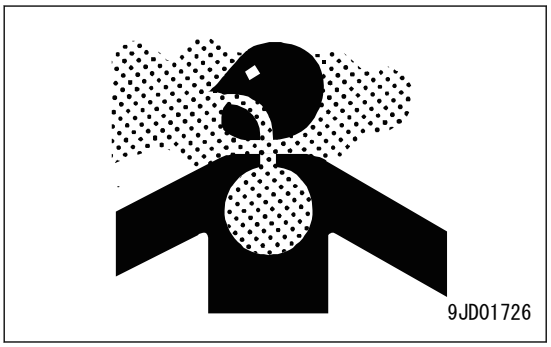
- Before starting work, shut down the engine. When working on or around a rotating part, in particular, shut down the engine. When checking the machine without shutting down the engine (measuring oil pressure, revolving speed, temperature, etc.), take extreme care not to get caught in rotating parts or moving parts.
- When raising a heavy component (heavier than 25 kg), use a hoist or crane. Before starting work, check that the slings (wire ropes, webbing slings, chains, and hooks) are free from damage. Always use slings which have ample capacity and install them to proper places. Operate the hoist or crane slowly to prevent the component from hitting any other part. Do not work with any part still raised by the hoist or crane.
- When removing a part which is under internal pressure or under reaction force of a spring, always leave 2 bolts in diagonal positions. Loosen those 2 bolts gradually and alternately to release the pressure, and then remove the part.
- When removing components, do not break or damage the electrical wiring. Damaged wiring may cause a fire.
- When removing piping, do not spill the fuel or oil. If any fuel or oil drips onto the floor, wipe it off immediately. Fuel or oil on the floor can cause you to slip and can even cause fires.





- Do not use gasoline to wash parts as a general rule. Do not use gasoline to clean electrical parts, in particular.

- Be sure to assemble all parts again in their original places. Replace any damaged parts and parts which must not be reused with new parts. When installing hoses and wiring harnesses, be sure that they will not be damaged by contact with other parts when the machine is operated.
- When installing high pressure hoses and tubes, make sure that they are not twisted. Damaged hoses and tubes are dangerous, so be extremely careful when installing hoses and tubes for high pressure circuits. In addition, check that high pressure hoses and tubes are correctly installed.
- When assembling or installing parts, always tighten them to the specified torques. When installing protective parts such as guards, or parts which vibrate violently or rotate at high speed, check again that they are installed correctly.
- Never insert your fingers or hand when aligning 2 holes. Be careful not to get your fingers caught in a hole.
- Check that the measuring tools are correctly installed when measuring hydraulic pressure.
- Take care when removing or installing the tracks of track-type machines. Since the track shoe may separate suddenly when you remove it, never let anyone stand at either end of the track shoe.
- If the engine is operated for a long time in a closed place with poor ventilation, it may cause gas poisoning. Open the windows and doors to ventilate the place well.



Precautions for slinging work and making signals

- Only one appointed worker must make signals and co-workers must communicate with each other frequently. The appointed signaler must make specified signals clearly at a place where he is well seen from the operator's seat and where he can see the working condition easily. The signaler must always stand in front of the load and guide the operator safely.

  ⚠ Never stand under the load.

  ⚠ Do not move a load over a person.

  ⚠ Never step on the load.

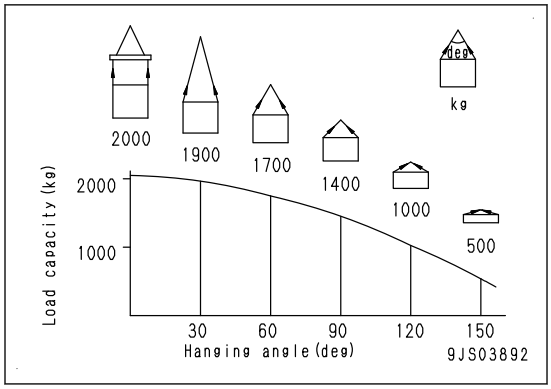
  ⚠ Do not prevent the load from swinging or falling down by holding it simply with the hands.

  ⚠ The sling workers and assistant workers other than the guide must move to a place where they are not caught between the load and materials or equipment on the ground or hit by the load even if the crane starts abruptly.
- Check the slings before starting sling work.
- Keep putting on gloves during sling work. (Put on leather gloves, if available.)
- Measure the weight of the load by the eye and check its center of gravity.
- Use proper sling corresponding to the weight of the load and method of slinging. If too thick wire ropes are used to sling a light load, the load may slip and fall.
- Do not sling a load with 1 wire rope alone. If it is slung so, it may rotate and may slip out of the rope. Install 2 or more wire ropes symmetrically.

  ⚠ Slinging with one rope may cause turning of the load during hoisting, untwisting of the rope, or slipping of the rope from its original slinging position on the load, which can result in a dangerous accident.
- Hanging angle must be 60 ° or smaller as a rule.
- When slinging a heavy load (25 kg or heavier), the hanging angle of the rope must be narrower than that of the hook.

REMARK

When slinging a load with 2 or more ropes, the force subjected to each rope increases with the hanging angle. The figure below shows the variation of allowable load in kN {kg} when slinging is made with 2 ropes, each of which is allowed to sling up to 9.8 kN {1000 kg} vertically, at various hanging angles. When the 2 ropes sling a load vertically, they can sling up to 2000 kg of total weight. This weight is reduced to 1000 kg when the 2 ropes make a hanging angle of 120 °. If the 2 ropes sling a 2000 kg load at a hanging angle of 150 °, each rope is subjected to a force as large as 39.2 kN {4000 kg} .



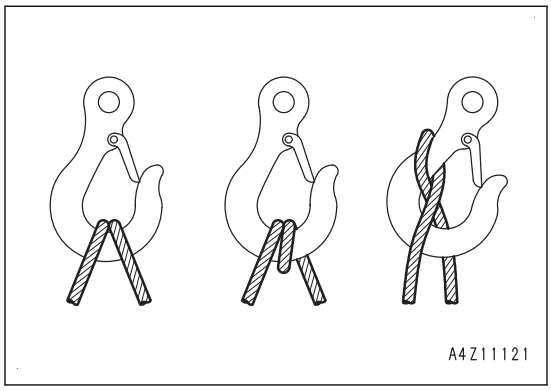
- When installing wire ropes to an angular load, apply pads to protect the wire ropes. If the load is slippery, apply proper material to prevent the wire rope from slipping.
- Use the specified eye bolts and fix wire ropes, chains, etc. to them with shackles, etc.
- Apply wire ropes to the middle part of the hook.

  ⚠ Do not use hooks if it does not have a latch system.

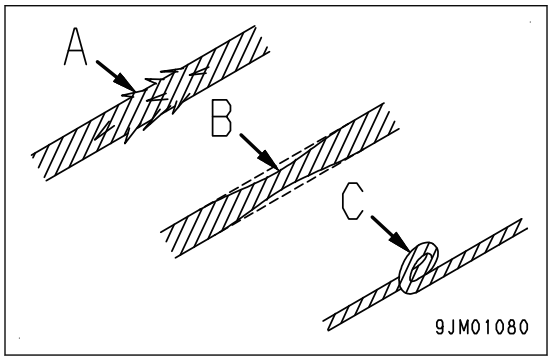
  ⚠ Slinging near the tip of the hook may cause the rope to slip off the hook during hoisting.

  REMARK

  The strength of the hook is maximum at its central part.



- Never use a wire rope which has breaks in strands (A), reduced diameter (B), or kinks (C). There is a danger that the rope may break during the towing operation.



Precautions for slinging up

- Wind in the crane slowly until wire ropes are stretched. When settling the wire ropes with the hand, do not grasp them but press them from above. If you grasp them, your fingers may be caught.
- After the wire ropes are stretched, stop the crane and check the condition of the slung load, wire ropes, and pads.
- If the load is unstable or the wire rope or chains are twisted, lower the load and lift it up again.
- Do not lift up the load at an angle.

Precautions for slinging down

- When slinging down a load, stop it temporarily at 30 cm above the floor, and then lower it slowly.
- Check that the load is stable, and then remove the sling.
- Remove kinks and dirt from the wire ropes and chains used for the sling work, and put them in the specified place.

Precautions for using mobile crane

REMARK

Read Operation and Maintenance Manual of the crane carefully in advance and operate the crane safely.

Precautions for using overhead traveling crane

⚠ When raising a heavy component (heavier than 25 kg), use a hoist or crane.

REMARK

Weight of component whose weight is heavier than 25 kg is shown with symbol  in "DISASSEMBLY AND ASSEMBLY".

- Before starting work, check the wire ropes, brake, clutch, controller, rails, over winding prevention device, ground fault circuit interrupter for electric shock prevention, crane collision prevention device, and energizing caution lamp, and check the following safety items.
  - Observe the signals for sling work.
  - Operate the hoist at a safe place.
  - Be sure to check the directions of the direction indication plate (north, south, east and west) and the operating button.
  - Do not sling a load at an angle. Do not move the crane while the slung load is swinging.
  - Do not raise or lower a load while the crane is moving longitudinally or laterally.
  - Do not drag a sling.
  - When lifting up a load, stop it just after it becomes off the ground, check the safety, and then lift it up.
  - Consider the travel route in advance and lift up a load to a safe height.
  - Place the control switch in a position where it is not an obstacle to work and passage.
  - After operating the hoist, do not swing the control switch.
  - Remember the position of the main switch so that you can turn off the power immediately in an emergency.
  - If the hoist stops because of a power failure, turn off the main switch. When turning on a switch after it is turned off by the ground fault circuit interrupter, check that the devices related to that switch are not in operating condition.
  - If you find an obstacle around the hoist, stop the operation.
  - After finishing the work, stop the hoist at the specified position and raise the hook to at least 2 m above the floor. Do not leave the sling installed to the hook.

Selecting wire ropes

Select adequate ropes depending on the weight of the parts to be hoisted referring to the table below.

REMARK

The allowable load is calculated with one sixth (safety factor 6) of the breaking load of the rope.

Wire rope (JIS G3525 6x37-A type) (Standard Z twist wire ropes without galvanizing)

Nominal diameter of rope (mm)	Allowable load (kN { t})
10	8.8 {0.9}
12	12.7 {1.3}
14	17.3 {1.7}
16	22.6 {2.3}
18	28.6 {2.9}
20	35.3 {3.6}
25	55.3 {5.6}
30	79.6 {8.1}
40	141.6 {14.4}
50	221.6 {22.6}
60	318.3 {32.4}

Precautions for disconnecting air conditioner piping

NOTICE

When replacing the air conditioner unit, air conditioner compressor, condenser or receiver drier, etc., collect the refrigerant (air conditioner gas: R134a) from the air conditioner circuit before disconnecting the air conditioner hoses.

REMARK

- Ask a qualified person for collecting, adding and filling operations of the refrigerant (air conditioner gas: R134a).
- Never release the refrigerant (air conditioner gas: R134a) to the atmosphere.

⚠ **Put on the protective eyeglasses, gloves and working clothes with long sleeves while you are collecting or filling the refrigerant. Otherwise, when refrigerant gas (R134a) gets in your eyes, you may lose your sight, and when it touches your skin, you may suffer from frostbite.**

- When loosening the nuts fixing air conditioner hoses and tubes, be sure to use 2 wrenches; use one wrench to fix and use the other one to loosen the nut.

Precautions for air conditioner piping

- When installing the air conditioner piping, be careful so that dirt, dusts and water do not enter the hose.
- Check that the O-rings are fitted to the joints when connecting the air conditioner piping.
- Do not reuse an O-ring because it is deformed and deteriorated if it is used once.
- When removing the O-rings, use a soft tool so that the piping is not damaged.
- Check that the O-ring is not damaged or deteriorated.
- Apply compressor oil for refrigerant (R134a) to O-ring.

  REMARK

  Do not apply oil to the threaded portion of a bolt, nut or union.

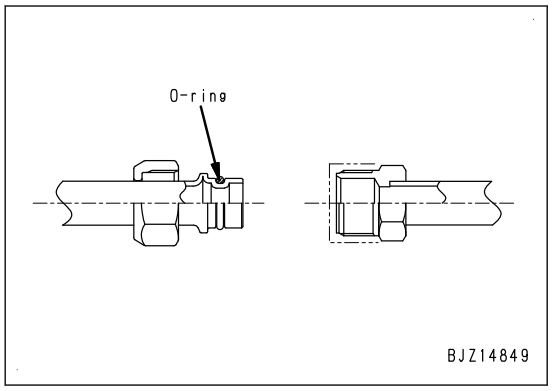
Manufacturer	Part name
DENSO	ND-OIL8
VALEO THERMAL SYSTEMS	ZXL100PG (PAG46 or equivalent)
SANDEN	SP-10

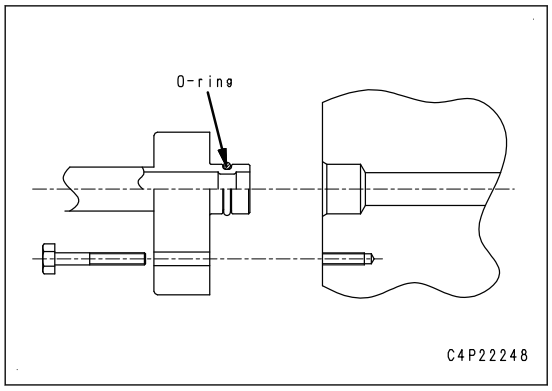
When tightening nuts of the air conditioner hoses and tubes, be sure to use 2 wrenches. Use one wrench to fix and tighten the nut with the other wrench to the specified torque (Use a torque wrench for tightening).

REMARK

- The figure shows an example of fitting of O-ring.
- An O-ring is fitted to every joint of the air conditioner piping.

For tightening torques, see THE OTHER INFORMATION, "Precautions for disconnection and connection of air conditioner piping".

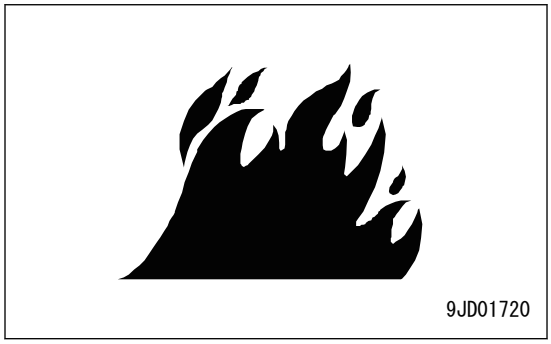




PRECAUTIONS TO PREVENT FIRE

Fire caused by fuel, oil, coolant or window washer fluid

Do not bring any open flame close to fuel, oil, coolant or window washer fluid. Always observe the following.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- Do not smoke or use any open flame near fuel or other flammable substances.
- Shut down the engine before adding fuel.
- Do not leave the machine when adding fuel or oil.
- Tighten all the fuel and oil caps securely.
- Be careful not to spill fuel on overheated surfaces or on parts of the electrical system.
- After adding fuel or oil, wipe up any spilled fuel or oil.
- Put greasy rags and other flammable materials into a safe container to maintain safety at the workplace.
- When washing parts with oil, use a non-flammable oil. Do not use diesel oil or gasoline.There is danger that they may catch fire.
- Do not weld or use a cutting torch to cut any pipes or tubes that contain flammable liquids.
- Determine well-ventilated areas for storing oil and fuel. Keep the oil and fuel in the specified place and do not allow unauthorized persons to enter.
- When performing grinding or welding work on the machine, move any flammable materials to a safe place before starting.

Fire caused by accumulation or attachment of flammable material

- Remove any dry leaves, chips, pieces of paper, coal dust, or any other flammable materials accumulated or attached to or around the engine exhaust manifold, muffler, or battery, or on the undercovers.
- To prevent fires from being caught, remove any flammable materials such as dry leaves, chips, pieces of paper, coal dust, or any other flammable materials accumulated around the cooling system (radiator, oil cooler) or on the undercover.

Fire coming from electric wiring

Short circuits in the electrical system can cause fire. Always observe the following.

- Keep all the electric wiring connections clean and securely tightened.
- Check the wiring every day for looseness or damage. Reconnect any loose connectors or refasten wiring clamps. Repair or replace any damaged wiring.

Fire caused by piping

Check that all the clamps for the hoses and tubes, guards, and cushions are securely fixed in position.

If they are loose, they may vibrate during operation and rub against other parts.There is danger that this may lead to damage to the hoses and cause high-pressure oil to spurt out, leading to fire and serious personal injury or death.

Fire around the machine due to highly heated exhaust gas

Some models and specifications may be equipped with KDPF (Komatsu Diesel Particulate Filter).

KDPF is a system for purifying exhaust gas by removing soot in exhaust gas. In the process of purification (regeneration), the temperature of discharged exhaust gas may be higher than that of conventional models. Do not bring any flammable materials close to exhaust pipe outlet.

- When there are thatched houses, dry leaves or pieces of paper near the work site, set the system to disable the regeneration before starting work to prevent fire hazards due to highly heated exhaust gas caused by KDPF regeneration.
  See the Operation and Maintenance Manual for the setting procedure.

Explosion caused by lighting equipment

- When checking fuel, oil, battery electrolyte, or coolant, always use lighting equipment with anti-explosion specifications.
- When taking the electrical power for the lighting equipment from the machine, follow the instructions in the Operation and Maintenance Manual.

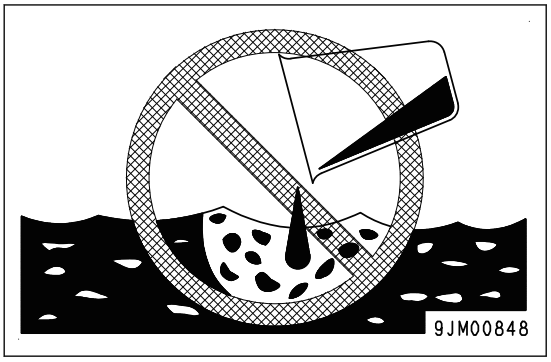
ACTIONS IF FIRE OCCURS

- Turn the starting switch to OFF position to stop the engine.
- Use the handrails and steps to get off the machine.
- Do not jump off the machine. You may fall and suffer serious injury.
- The fumes generated by a fire contain harmful materials which have a bad influence on your body when they are inhaled.
  Do not breathe the fumes.
- After a fire, there may be harmful compounds left. If they touch your skin they may have a bad influence on your body.
  Be sure to wear rubber gloves when handling the materials left after the fire.
  The material of the gloves, which is recommended is polychloroprene (Neoprene) or polyvinyl chloride (in the lower temperature environment).
  When wearing cotton work gloves, wear rubber gloves under them.

PRECAUTIONS FOR DISPOSING OF WASTE MATERIALS

To prevent pollution, pay full attention to the way to dispose of waste materials.

- Always drain the oil from your machine in containers. Never drain the oil and coolant directly onto the ground or dump into the sewage system, rivers, seas, or lakes.
- Obey appropriate laws and regulations when disposing of harmful objects such as oil, fuel, coolant, solvent, filters, and batteries.



Avoid exposure to burning rubber or plastics which produce a toxic gas that is harmful to people.

- When disposing of parts made of rubber or plastics (hoses, cables, and harnesses), always comply with the local regulations for disposing industrial waste products.

PRECAUTIONS FOR HANDLING HYDRAULIC EQUIPMENT

Because of the higher pressure and more precise hydraulic components, the most common cause of a failure is dust (foreign material) in the hydraulic circuit. The special care must be taken when adding hydraulic oil, or when disassembling, or assembling the hydraulic components.

Select an appropriate workplace

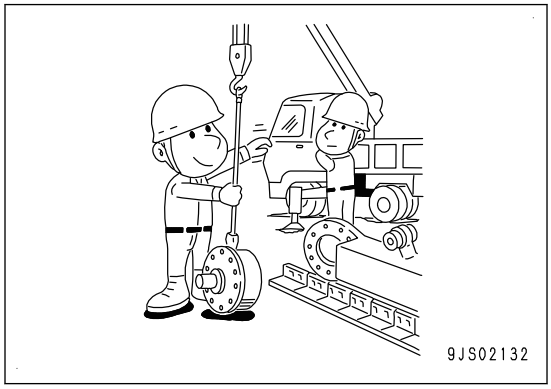
- In rain or high winds, or in dusty environment, avoid adding hydraulic oil, replacing filters, or repairing the machine.

Disassembly and maintenance work in the field

⚠ Any component may jump out or oil may spurt out by the remaining pressure in the hydraulic circuit and it may result in serious personal injury or death when removing and disassembling of the hydraulic equipment is performed.

⚠ Release the remaining pressure from the hydraulic circuit always before performing the work.

- In the field, there is a risk of dust entering the component during disassembling or maintenance work, and performance check is hardly performed. Replacement of the assembly is recommended.
- Perform disassembling and maintenance work in the dust proof area.



Sealing of openings (prevention of flowing out of oil)

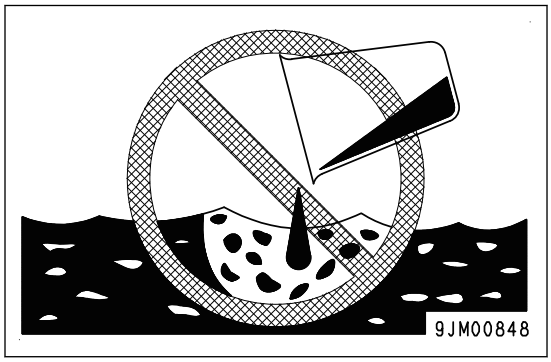
Plug the openings of the piping and the device which have been removed to prevent foreign material from entering and oil from flowing out.

NOTICE

Do not expose the openings or stuff it, otherwise foreign material may enter or leaked oil may pollute the environment.
Do not discard the oil inconsiderately. Ask the customer for disposal or bring it back to dispose it appropriately.

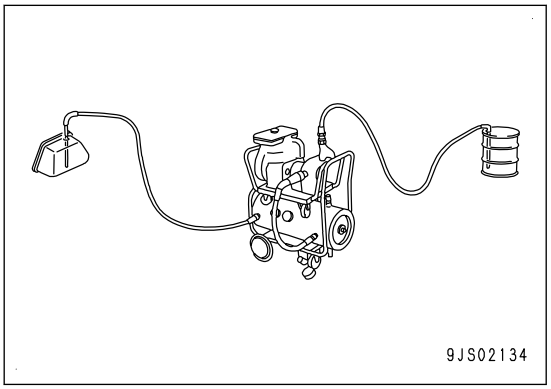
REMARK

Cover the places tightly with caps, tapes, or plastic bags if it is hard to provide the plugs.



Preventing intrusion of foreign materials during refilling

- During refilling with the hydraulic oil, do not let water enter the electrical components.
- Clean the oil filler port and its around, refilling pump, oil jug, or etc.
- Refilling by using an oil cleaning device is better method since it can filtrate the contaminants accumulated in the oil during storage.



Replacing hydraulic oil while its temperature is high

- The higher the oil temperature is, the softer the oil is, and the smoother the oil runs. Also, the sludges are easily discharged from the circuit. Perform the replacement while oil temperature is high.
- Old hydraulic oil needs to be drained as much as possible when replacing.

NOTICE

Old hydraulic oil contaminates the new one if it is mixed since it contains contaminants and sludges, and the service life of the hydraulic oil is shortened.

REMARK

Drain the old hydraulic oil not only from the hydraulic tank but also from the filter and drain plug in the circuit.

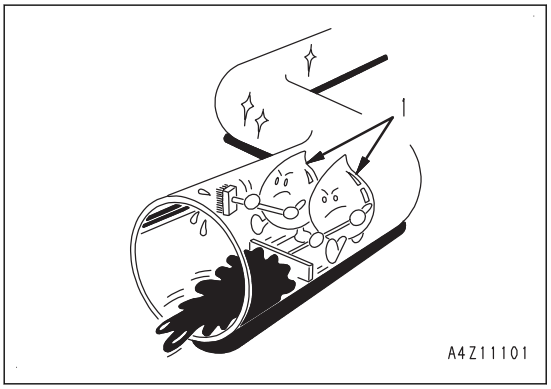
Avoid reusing the hydraulic oil and lubricating oil

Avoid reusing the hydraulic oil and lubricating oil which has been drained from the machine.

If reused, any foreign material may enter the hydraulic equipment, and it may cause a failure.

Flushing operation

- Flushing is required to completely dislodge the contaminants and sludges, and existing oil containing those inside the hydraulic circuit after disassembling and assembling, and when replacing the oil with the new one.
- Normally, flushing is performed twice. Primary flushing is performed by using the flushing oil (1) and the secondary flushing is performed by using the specified hydraulic oil.

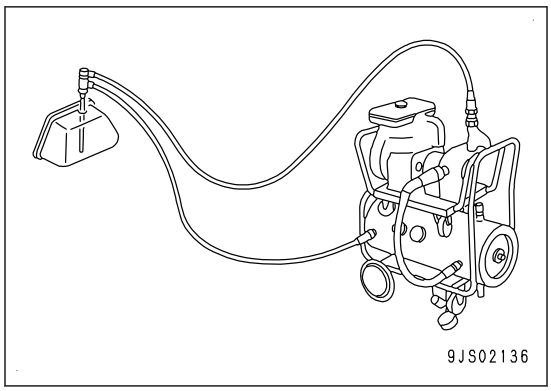


Cleaning operation

Perform oil cleaning to remove the contaminants and sludges in the hydraulic circuit after repair of the hydraulic device (pump, or control valve) or during operation of the machine.

REMARK

The oil cleaning equipment can remove the ultra fine (approximately 3 μm) particles that the filter built in the hydraulic equipment cannot remove. So, it is very effective device.



PRECAUTIONS FOR DISCONNECTION AND CONNECTION OF PIPINGS

When performing "testing and adjusting" of the machine, "removal and installation" and "disassembly and assembly" of the components, observe the following precautions.

Precautions for removal and disassembling work

- If the cooling water contains coolant, dispose of it correctly as chemicals. Do not drain it to the sewage rashly.
- After disconnecting the hoses or tubes, plug them to prevent dust from entering.
- When draining oil, prepare a container with sufficient capacity.
- Check the matchmarks which indicate the installing position, and put matchmarks on the places where they seem necessary before removal of the components to prevent any mistake when assembling.
- To prevent any excessive force from being applied to the wiring, always hold the connectors when disconnecting the connectors. Do not pull the wires.
- Attach the tags to wires and hoses so that installation is done to the correct installing positions.
- Check the thickness and number of shims when storing shims.
- When hoisting the components, prepare the slings with sufficient strength.
- When using forcing screws to remove any component, tighten the forcing screws uniformly and alternately.
- Before removing any component, clean the surrounding area and cover the component to prevent any foreign material from entering after removal.
- After disconnecting the piping or removing a pipe joint, install the following plugs.

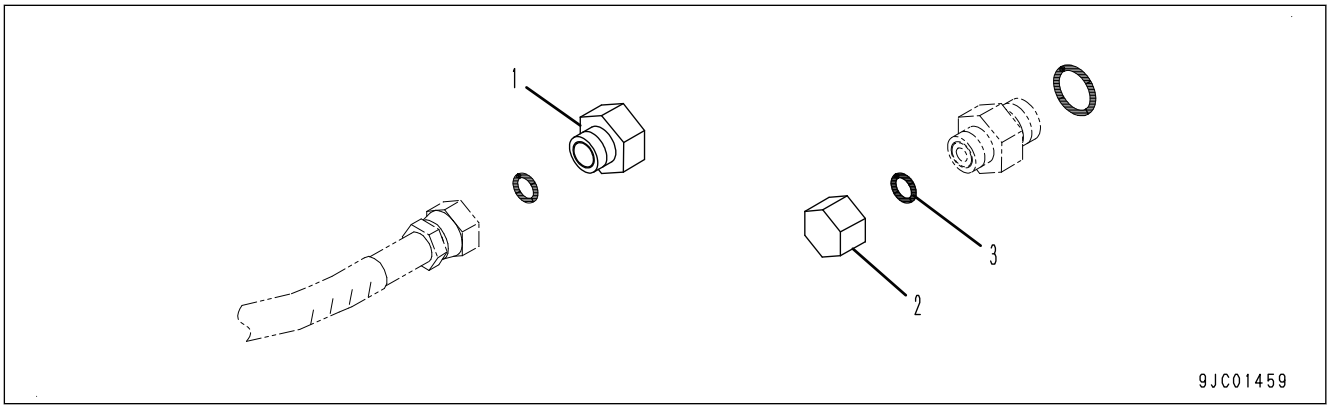
NOTICE

When disassembling the machine, check the part number by referring to the Parts Book and use the appropriate parts according to the usage conditions.

REMARK

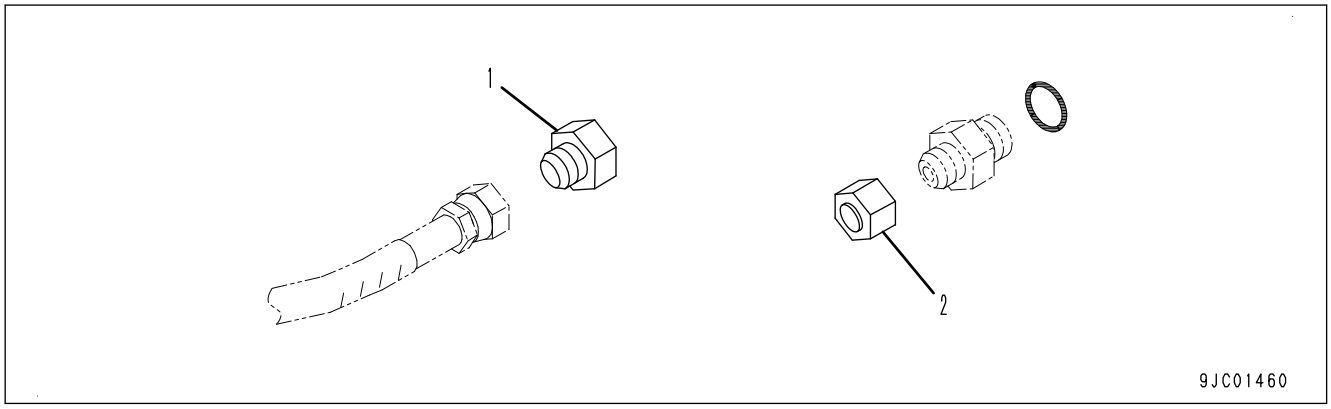
The part numbers of O-ring shown in the table indicate the temporary part number when disassembling and transporting the machine.

Introduction of parts for the disassembly of the face seal type hoses and tubes



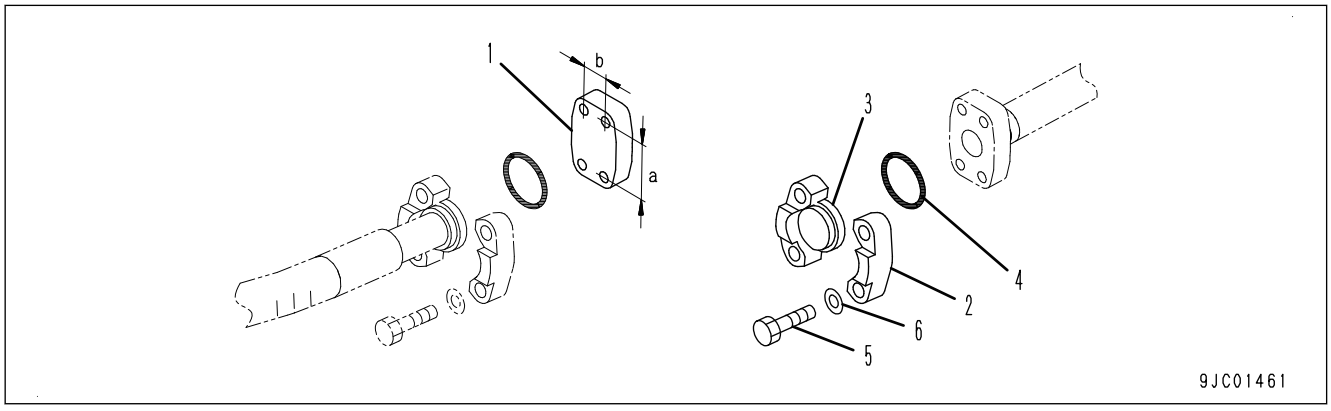
Nominal No.	Hose side	Pipe joint side	O-ring (3)
	Plug (1)	Nut (2)	
02	07376-70210	02789-00210	02896-11008
03	07376-70315	02789-00315	02896-11009
04	07376-70422	02789-00422	02896-11012
05	07376-70522	02789-00522	02896-11015
06	07376-70628	02789-00628	02896-11018

Introduction of parts for the disconnection of the taper seal type hoses and tubes



Nominal No.	Hose side	Pipe joint side
	Plug (1)	Nut (2)
02	07376-50210	07222-00210
03	07376-50315	07222-00312
04	07376-50422	07222-00414
05	07376-50522	07222-00515
06	07376-50628	07222-00616
10	07376-51034	07222-01018
12	07376-51234	07222-01219
14	07376-51443	07222-01422

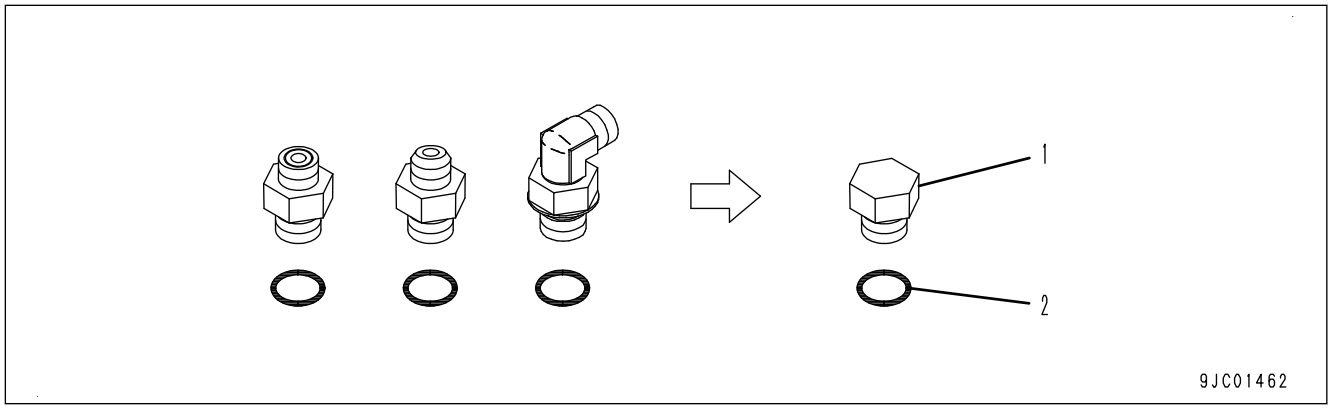
Introduction of parts for the disconnection of the split flange type hoses and tubes



Nominal No.	Bolt pitch (mm)		Hose side	Tube side		O-ring (4)	Bolt (5)	Washer (6)
	a	b	Flange (1)	Split flange (2)	Sleeve head (3)			
04	38.1	17.5	07379-00400	07371-30400	07378-10400	07000-12021	01010-80825	01643-50823
05	42.9	19.8	07379-00500	07371-30500	07378-10500	07000-13022	01010-80830	01643-50823
06	47.6	22.2	07379-00640	07371-30640	07378-10600	07000-13025	07372-51035	01643-51032
10	52.4	26.2	07379-01044	07371-31049	07378-11000	07000-13032	07372-51035	01643-51032

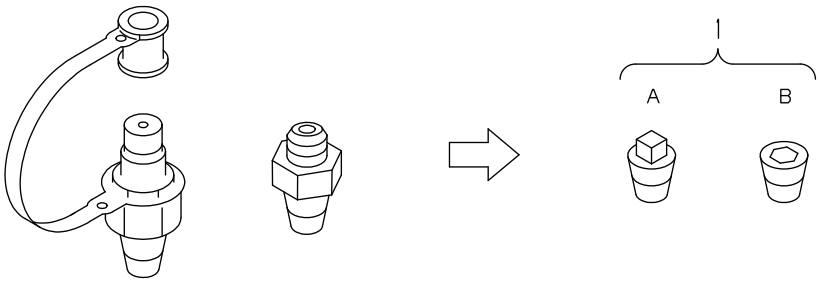
Nominal No.	Bolt pitch (mm)		Hose side	Tube side		O-ring (4)	Bolt (5)	Washer (6)
	a	b	Flange (1)	Split flange (2)	Sleeve head (3)			
12	58.7	30.2	07379-01250	07371-31255	07378-11200	07000-13038	07372-51035	01643-51032
	66.7	31.8	07379-01260	07371-51260	07378-11210	07000-13038	01010-81245	01643-51232
14	69.9	35.8	07379-01460	07371-31465	07378-11400	07000-13048	07372-51240	01643-51232
	79.4	36.5	07379-01470	07371-51470	07378-11410	07000-13048	01010-81455	01643-31445
20	77.8	42.8	07379-02071	07371-32076	07378-12000	07000-12060	07372-51240	01643-51232
	96.8	44.5	07379-02080	07371-52080	07378-12010	07000-12060	01010-81865	01643-31845
24	88.9	50.8	07379-02484	07371-12484	07378-12400	07000-12070	07372-51240	01643-51232
30	106.4	62	07379-03010	07371-13010	07378-13000	07000-12085	07372-51650	01643-51645
34	120.6	69.8	07379-03411	07371-13411	07378-13400	07000-12100	07372-51650	01643-51645
40	130.2	77.8	07379-04012	07371-14012	07378-14000	07000-12110	07372-51650	01643-51645
50	152.4	92	07379-05011	07371-15011	07378-15000	07000-12135	07372-51655	01643-51645

Introduction of parts for the removal of O-ring boss type joint



Nominal No.	Plug (1)	O-ring (2)
08	07040-10807	07002-10823
10	07040-11007	07002-11023
12	07040-11209	07002-11223
14	07040-11409	07002-11423
16	07040-11612	07002-11623
18	07040-11812	07002-11823
20	07040-12012	07002-12034
24	07040-12412	07002-12434
30	07041-13012	07002-13034
33	07040-13316	07002-13334
36	07041-13612	07002-13634
42	07040-14220	07002-14234
52	07040-15223	07002-15234

Introduction of parts for the removal of taper pipe thread type joint



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Nominal No.	Nominal thread size	Plug (1)	
		Square head type (A)	Hexagonal socket head (B)
01	$R^1/_8$	07042-00108	07043-00108
02	$R^1/_4$	07042-00211	07043-00211
03	$R^3/_8$	07042-00312	07043-00312
04	$R^1/_2$	07042-00415	07043-00415
06	$R^3/_4$	07042-00617	07043-00617
10	R1	07042-01019	07043-01019
12	$R1^1/_4$	07042-01222	07043-01222
14	$R1^1/_2$	07042-01422	07043-01422
20	R2	07042-02026	07043-02026

Precautions for installation and assembling work

- Tighten the bolts and nuts (sleeve nuts) to the specified torque (KES) unless otherwise specified.
- Install the hoses without twist and interference. If there is any in-between clamp, securely fasten it.
- Replace all of the gaskets, O-rings, cotter pins, and lock plates with new ones.
- Bend the cotter pins and lock plates securely.
- When applying adhesive, clean and degrease the surface to apply, and apply 2 to 3 drops of adhesive to the threaded portion.
- When applying liquid gasket, clean and degrease the surface, and apply it uniformly after making sure that the surface is free from dust or damage.
- Clean all of the parts. If there is any damage, dents, burrs, or rust found on them, repair it.
- Apply engine oil to the rotating parts and sliding surface.
- Apply molybdenum disulfide lubricant (LM-P) to the surfaces of the press-fitting parts.
- After installing the snap ring, check that the snap ring is settled in the ring groove completely.
- When connecting wiring harness connectors, clean the connectors to remove oil, dust, or water, then connect them securely.
- Use the eye bolts without fatigue and deformation and screw them in securely. Match the directions of the eyes and the hook.
- When installing split flanges, tighten the bolts uniformly and alternately to prevent uneven tightening.
- As a rule, apply liquid gasket (LG-5) or liquid sealant (LS-2) to the threaded portion of each taper male screws which receive pressure.

REMARK

If the threaded portion is difficult to degrease, you may use a seal tape.

When winding a seal tape onto a right-handed taper male screw, start winding the screw clockwise from the third thread in the advancing direction of the threads seeing from the screw end.

NOTICE

If the seal tape is wound counterclockwise, it may become loose when screwed in, and it may come off. If the sealed tip is pushed outside, it may cause oil leakage.

NOTICE

When assembling the hydraulic equipment such as cylinders, pumps and pipings which are removed, be sure to bleed air from the hydraulic circuit before operating it for the first time according to the following procedure.

1. Start the engine, and run it at low idle.
2. Perform the operation to extend and retract each cylinder of the work equipment and stop it at approximately 100 mm before the stroke end for 4 or 5 times.
3. Perform the operation to extend and retract each cylinder of the work equipment and stop it at the stroke end for 3 or 4times.

NOTICE

After repair is finished, when operating the machine which has been stored for a long period, bleed air from the hydraulic circuit according to the same procedure.

Precautions at the time of completion of work

Refilling of coolant or water or oil, greasing, and adding

- Supply the specified amount of grease to the work equipment parts.
- When the coolant is drained, be sure that the drain valve is securely tightened, then refill the coolant reservoir with the coolant Komatsu recommends to the specified level. Start the engine to circulate the coolant in the piping, and add the coolant to the specified level again.
- When the hydraulic components are removed and installed, refill the tank with the oil Komatsu recommends to the specified level. Start the engine to circulate the oil in the piping, and add the oil to the specified level again.
- If the hydraulic piping or hydraulic equipment is removed, be sure to bleed air from the system after rebuilding the parts, by referring to TESTING AND ADJUSTING.

Testing installed condition of cylinder heads and manifolds

- Check the cylinder head and intake and exhaust manifold mountings for looseness.
- If there is any looseness, retighten the part.

  REMARK

  For the tightening torques, see "DISASSEMBLY AND ASSEMBLY".

Test engine piping for damage and looseness

Intake and exhaust system

Check that there is no damage on the pipings, or no looseness on mounting bolts, nuts and clamps, or no leak of air or exhaust gas from connecting portion.

If there is any looseness, damage, or gas leak, retighten or repair the part.

Cooling system

Check that there is no damage on the pipings, no looseness on mounting bolts, nuts and clamps, and no water leak from connecting portion.

If there is any looseness, damage, or water leak, retighten or repair the part.

Fuel system

Check that there is no damage on the pipings, no looseness on mounting bolts, nuts and clamps, and no fuel leak from connecting portion.

If there is any looseness, damage, or fuel leak, retighten or repair the part.

Check the exhaust equipment and its installation portion for looseness and damage.

REMARK

When an equipment is described as an exhaust equipment, it is one of the followings. (The applications or components of equipment are different depending on its models or specifications.)

- KDPF
- KDOC muffler
- Muffler
- Exhaust pipe
- Parts which connects the above, or etc.

Visually check that there is no crack or no damage on the exhaust equipment and its installation portion. If there is any damage, replace the part.

Check that there is no looseness on the exhaust equipment and mounting bolts, nuts, and clamps on the installation portion.

If there is any looseness, retighten the part.

Check of function of muffler in exhaust system

REMARK

When an equipment is described as an muffler in exhaust system, it is one of the followings. (The applications or components of equipment are different depending on its models or specifications.)

- KDPF
- KDOC muffler
- Muffler
- Exhaust pipe
- Parts which connects the above, or etc.

Check that there is no unusual noise by comparing to it of the time when the machine was new.

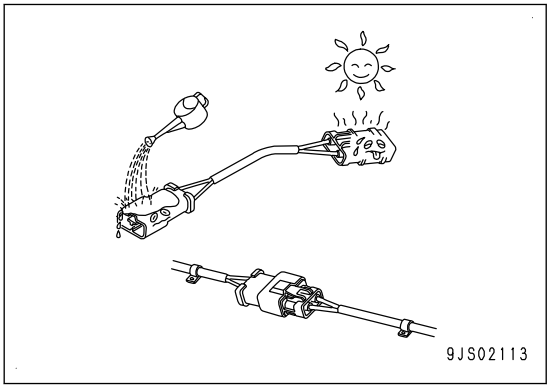
If there is any unusual noise, repair KDPF or muffler, referring to "TROUBLESHOOTING" and "DISASSEMBLY AND ASSEMBLY".

PRECAUTIONS FOR HANDLING ELECTRICAL EQUIPMENT

To maintain the performance of the machine over a long period, and to prevent failures or troubles before they occur, correct "operation", "maintenance and inspection" "troubleshooting", and "repairs" must be performed. This section deals particularly with correct repair procedures for mechatronics components and is aimed at improving the quality of repairs. For this purpose, it describes the working procedures in "Handling of electrical equipment".

Handling wiring harnesses and connectors

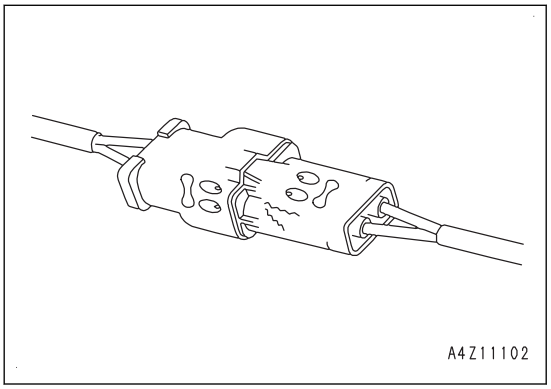
- Wiring harnesses consist of wires connecting one component to another component, connectors used for connecting and disconnecting one wire from another wire, and protectors or tubes used for protecting the wires.
- Compared with other electrical components fitted in boxes or cases, wiring harnesses are likely to be directly affected by rain water, heat, or vibration. Furthermore, during inspection and repair operations, they are frequently removed and installed again, so they are likely to suffer deformation or damage. For this reason, it is necessary to be extremely careful when handling and maintenance of the wiring harnesses.



Main causes of failure in wiring harness

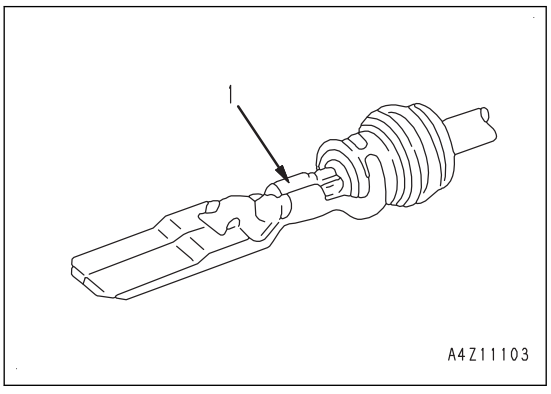
Defective contact of connectors (defective contact between male and female connectors)

Problems with defective contact are likely to occur because the male connector is not properly inserted into the female connector,or because one or both of connectors are deformed or the position is not correctly aligned, or because there is corrosion or oxidization of the contact surfaces. The corroded or oxidized contact surfaces may become shiny again (and contact may become normal) by connecting and disconnecting the connectors approximately 10 times.



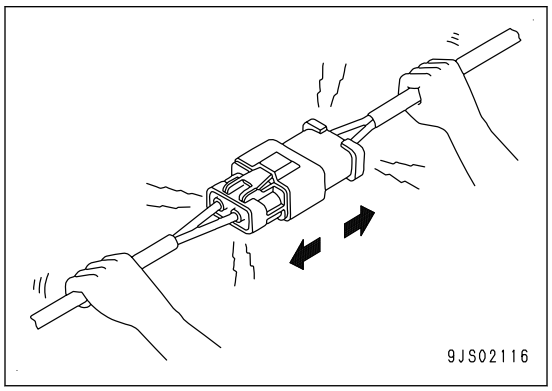
Defective crimping or soldering of connectors

The pins of the male and female connectors are attached to wires by crimping or soldering. If excessive force is applied to the wire, the jointed portion (1) may become loose, and it may result in a defective connection or breakage.



Disconnection in wiring

If the wiring harness is pulled to disconnect the connector, or the components are lifted with a crane while the wiring harness is still connected, or a heavy object hits the wiring harness, it may separate the crimping of the connector, or damage the soldering, or break the wiring harness.

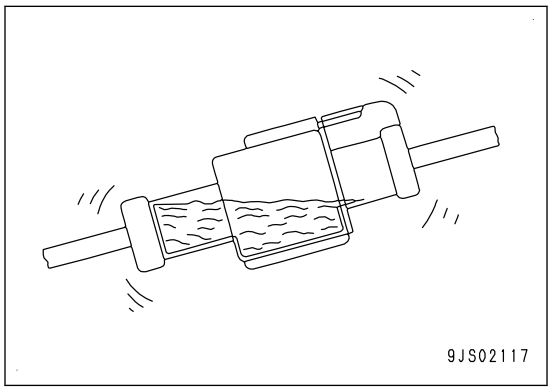


Water entering the connector by high-pressure jetting

The connector is designed to make it difficult for water to enter (drip-proof structure), but if high-pressure water is sprayed directly on the connector, water may enter the connector, depending on the direction of the water jet.

Do not spray water directly on the connector.

If the connector is waterproof, intruded water is hardly drained. Once water enters into the connector, water goes through pins to cause short-circuit. Drying the drenched connector or take appropriate actions before providing electricity.



Entry of water, dirt, or dust when disconnecting a connector

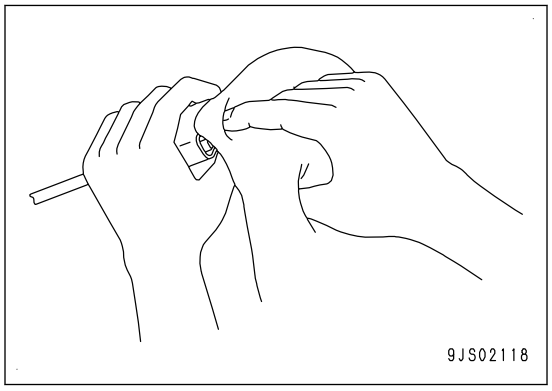
If any water, mud or dust is stuck to the outside surface of a connector, it can enter inside the connector when the connector is disconnected. Before disconnecting the connector, wipe off any stuck water or dirt by using a dry cloth or blow it with compressed air.

Oil, mud, or dust stuck to connector

If any oil or grease is stuck to the connector and an oil film is formed on the mating surface of the male and female pins, the oil prevents electricity from passing through resulting in defective contact. If any oil, grease, dirt or dust is stuck to the connector, wipe it off with a dry cloth or blow it with compressed air, and wash it with electrical contact restorer.

NOTICE

- **When wiping the jointed portion of the connector, do not apply excessive force or deform the pins.**
- **If there is oil or water in the compressed air, it causes the contacts to become dirtier. Use clean air which any oil and water has been removed from.**



PRECAUTIONS FOR HANDLING FUEL SYSTEM EQUIPMENT

The machines equipped with common rail fuel injection system (CRI) consists of more precise parts than the parts used in the conventional fuel injection pump and nozzle. If foreign material enters this system, it may cause a failure. Use special care to prevent entry of the foreign material when servicing the fuel system.

Select an appropriate workplace

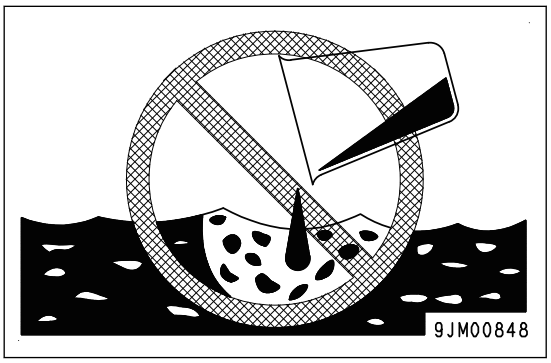
Avoid the work of adding hydraulic oil, replacing filters, or repairing the machine in rainy or windy weather, or in dusty environment.

Sealing the opening

Plug the removed pipes and the openings of the removed components with the caps, tapes, plastic bags, etc. to prevent foreign material from entering.

NOTICE

Do not expose the openings or stuff it, otherwise foreign material may enter or leaked oil may pollute the environment.
Do not discard the oil inconsiderately. Ask the customer for disposal or bring it back to dispose it appropriately.



How to clean parts when dirt is stuck

If any dirt or dust sticks the parts of the fuel system, clean it off thoroughly with clean fuel.

Precautions for replacing fuel filter cartridge

Be sure to use the Komatsu genuine fuel filter cartridge.

NOTICE

The machine equipped with common rail fuel injection system (CRI) consists of more precise parts than the parts used in the conventional fuel injection pump and nozzle. In order to prevent foreign material from entering this system, the filter employs a specially high performance of filter element. If a filter other than a Komatsu genuine filter is used, fuel system contamination and damage may occur. Therefore Komatsu recommends using only Komatsu fuel filters and install them following the procedures in the shop manual.

PRECAUTIONS FOR HANDLING INTAKE SYSTEM EQUIPMENT

The machines equipped with Variable Geometry Turbocharger (VGT) consists of more precise parts (variable system)than the parts used in the conventional turbocharger. If foreign material enters this system, it may cause a failure. Use special care to prevent entry of the foreign material when servicing the intake system.

Select an appropriate workplace

Avoid the work of adding hydraulic oil, replacing filters, or repairing the machine in rainy or windy weather, or in dusty environment.

Sealing the opening

Plug the removed pipes and the openings of the removed components with the caps, tapes, plastic bags, etc. to prevent foreign material from entering.

NOTICE

Do not expose the openings or stuff it, otherwise foreign material may enter it.

PRACTICAL USE OF KOMTRAX

Various information which KOMTRAX system transmits by using the radio communication is useful for KOMTRAX operator to provide various services for the customers.

When KOMTRAX system is installed to the machine and it is enabled, machine information can be checked by KOMTRAX system, and it is used for testing and troubleshooting to be performed efficiently.

Large-sized models are equipped with KOMTRAX Plus which can use more detailed information.

REMARK

(KOMTRAX may not be installed to the machine in some countries or areas.)

Merit of using KOMTRAX

- The location where the machine is working at can be checked on the map in a personal computer.
- Operation information such as service meter, operating hours, fuel consumption, and occurred caution as well as failure code can be checked.
- The operator can check the hours used and replacement interval of consumable parts of the machine such as fuel filter, hydraulic oil filter, hydraulic oil and engine oil.
- Information of how machine is operated (idling time, traveling time, digging time, relieving time, etc.) can be checked, and it is used to presume the machine operating condition.
- Various reports such as “Fuel saving operation support”, “Operation summary”, etc. is generated, and it is utilized as an advice tool for the user and operator.
- KOMTRAX Plus can record the data of abnormality record, trend data, snap shot data, etc. to grasp the soundness of machine, in addition to KOMTRAX function described above. These data can be used on personal computer screens.

How to make a full use of KOMTRAX

Making use of KOMTRAX enables the following activities.

- Quick response to a request for immediate repair
  1. To check the displayed caution and failure code, etc. through KOMTRAX upon receiving a repair request from a user.
  2. To immediately arrange necessary tools, replacement parts, etc, immediately in accordance with the displayed failure code.
  3. To find the location of the failed machine by using the map of KOMTRAX, to visit the customer there.
- Proactive maintenance
  1. To check the service summary screen of KOMTRAX, to find the machine which has high priority failure code indicated by a red or yellow flag.
  2. To check the condition of the machine with the customer and to make a plan to visit.
  3. To immediately arrange necessary tools, replacement parts, etc, immediately in accordance with the displayed failure code.
- Practice of periodic maintenance and periodic inspection service
  1. To check the service summary screen of KOMTRAX, and to find the machine of which the usage limits for the consumable parts indicated by red flags are over.
  2. To submit an estimate sheet for the consumable parts to be replaced and the labor cost for the replacement work to the customer.
  3. To propose the periodic inspection (Pm clinic, etc.) according to the service meter reading.

How to operate KOMTRAX

For the operating method of each screen of KOMTRAX, ask KOMTRAX key person in your Komatsu distributor.

DISCONNECT AND CONNECT PUSH-PULL TYPE COUPLER

REMARK

- Loosen the oil filler cap of the hydraulic tank slowly to release the remaining pressure in the hydraulic tank.
- Provide an oil container to receive oil since some hydraulic oil flows out when the hose is disconnected even after the remaining pressure is released from the hydraulic tank.

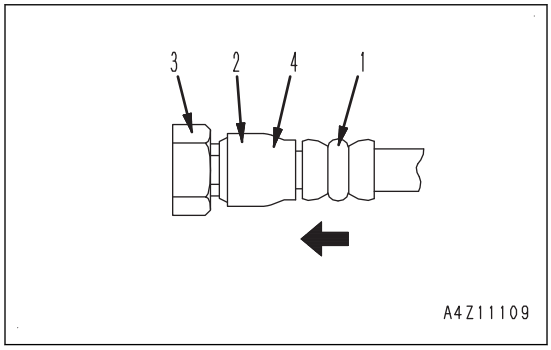
METHOD FOR DISCONNECTING AND CONNECTING TYPE 1 PUSH-PULL TYPE COUPLER

Disconnection

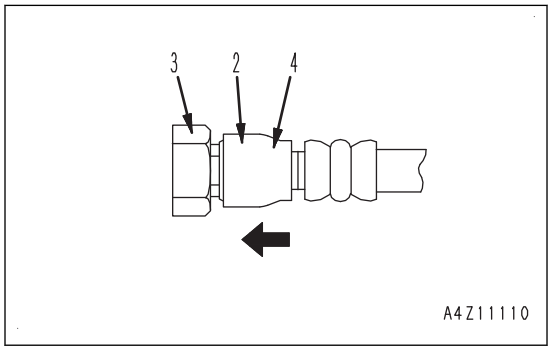
1. Hold adapter (1), and push hose joint (2) into mating adapter (3).

   REMARK

   - Push it in approximately 3.5 mm.
   - Do not hold rubber cap portion (4).



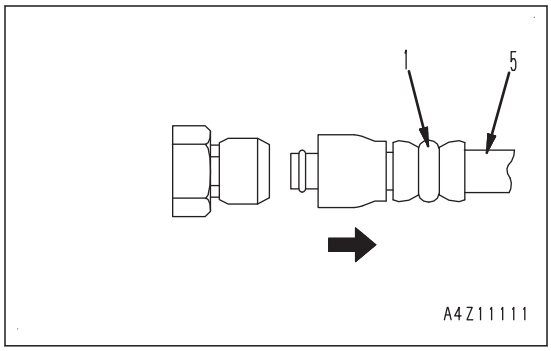
2. While having adapter (3) inserted into hose side joint (2), insert rubber cap (4) to adapter (3) side until it clicks.



3. Hold hose adapter (1) or hose (5), and pull it out.

   REMARK

   Provide an oil container to receive a quantity of hydraulic oil which may flow out.

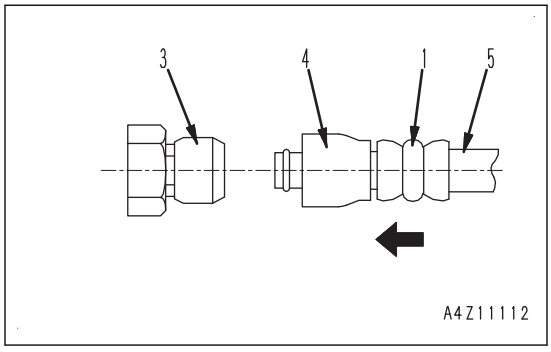


Connection

1. Hold hose adapter (1) or hose (5), and insert it in mating adapter (3), aligning the axis.

   REMARK

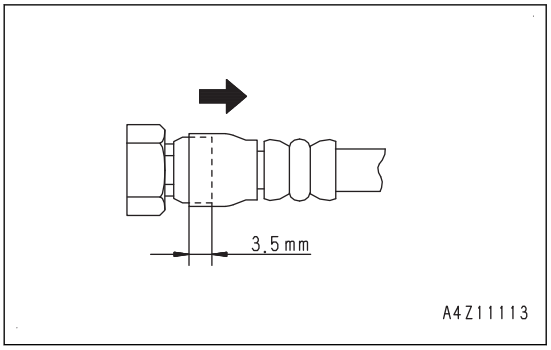
   Do not hold rubber cap portion (4).



2. After inserting the hose in the mating adapter perfectly, pull it back to check the connecting condition.

   REMARK

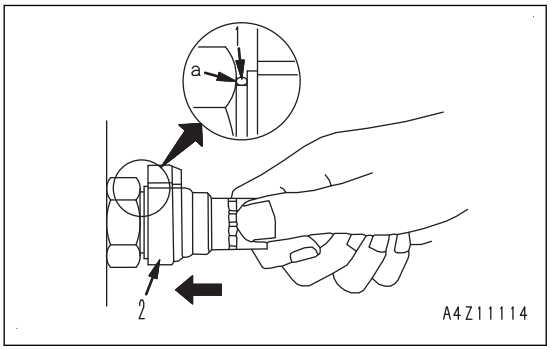
   When the hose fitting is pulled back, the rubber cap moves approximately 3.5 mm toward the hose, but it is not a problem.



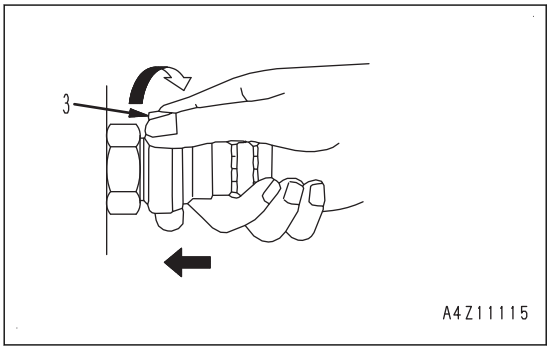
METHOD FOR DISCONNECTING AND CONNECTING TYPE 2 PUSH-PULL TYPE COUPLER

Disconnection

1. Hold the tightening adapter part and push body (2) straight until sliding prevention ring (1) contacts contact surface (a) of the hexagonal part at the male end.



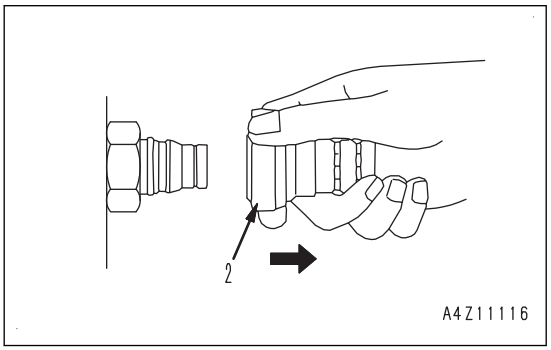
2. While keeping the condition of step 1, turn lever (3) to the right (clockwise).



3. While keeping the conditions of steps 1 and 2, pull out whole body (2) to disconnect it.

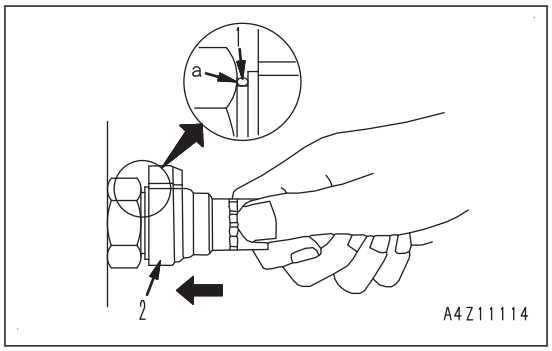
   REMARK

   Provide an container to receive a quantity of hydraulic oil which may flow out.



Connection

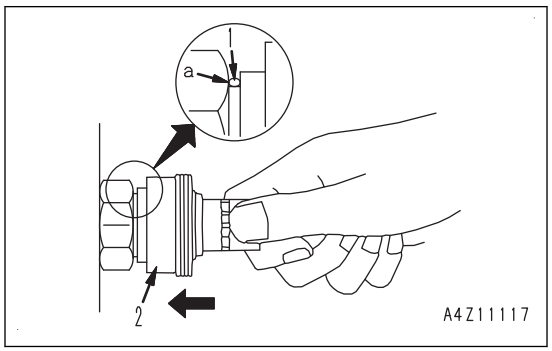
Hold the tightening adapter part, and push body (2) straight until sliding prevention ring (1) contacts contact surface (a) of the hexagonal part at the male end.



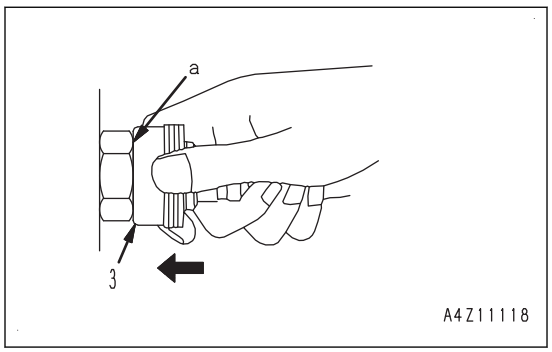
METHOD FOR DISCONNECTING AND CONNECTING TYPE 3 PUSH-PULL TYPE COUPLER

Disconnection

1. Hold the tightening adapter part and push body (2) straight until sliding prevention ring (1) contacts contact surface (a) of the hexagonal part at the male end.



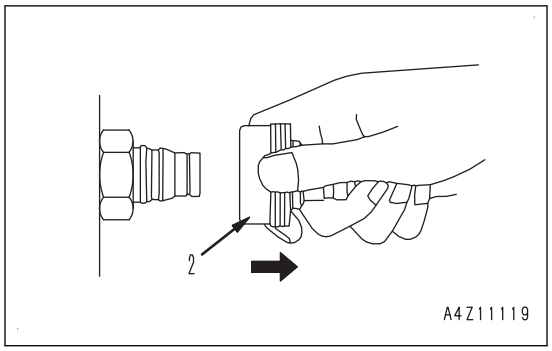
2. While keeping the condition of step 1, push cover (3) straight until it contacts contact surface (a) of the hexagonal portion on the male side.



3. While keeping the conditions of steps 1 and 2, pull out whole body (2) to disconnect it.

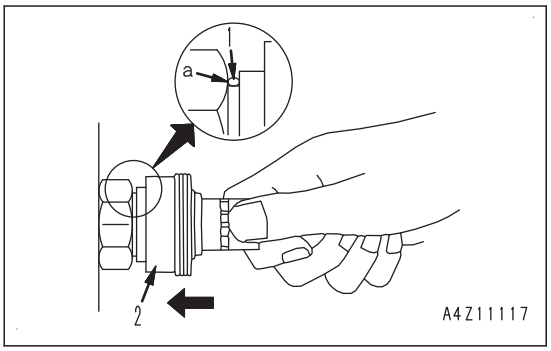
   REMARK

   Provide an container to receive a quantity of hydraulic oil which may flow out.



Connection

Hold the tightening adapter part, and push body (2) straight until sliding prevention ring (1) contacts contact surface (a) of the hexagonal part at the male end.



PRECAUTIONS FOR DISCONNECTION AND CONNECTION OF CONNECTORS

Disconnecting connectors

1. Hold the connectors when disconnecting.

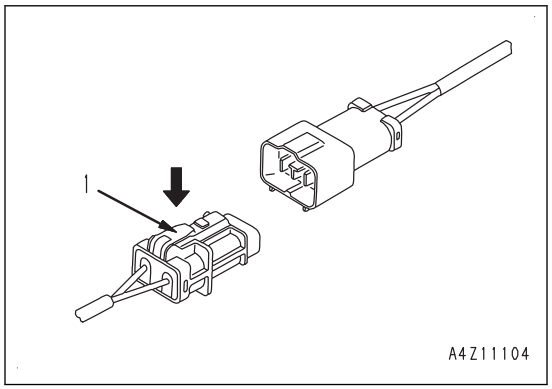
   When disconnecting the connectors, always hold the connecting portion. If the connector is fixed with screw, loosen the screw of the connector completely, hold the both of male and female connectors, and pull them out in parallel.

   NOTICE

   Do not pull the connectors with one hand.

   REMARK

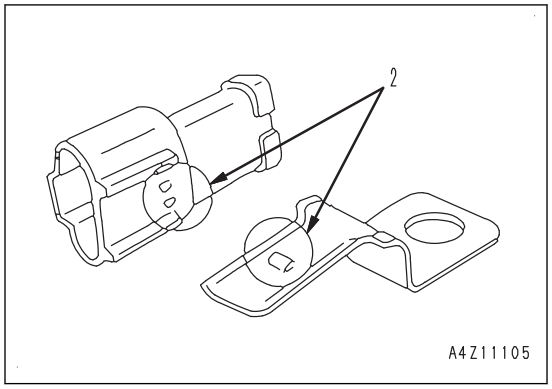
   If it is a lock stopper type connector, pull it out as pushing the stopper (1) with your thumb.

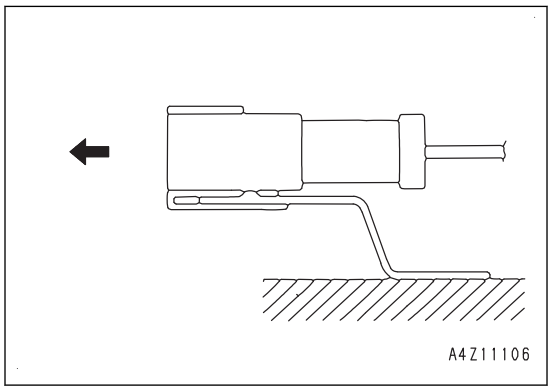


2. When removing a connector from a clip
   - Both of the connector and clip have stoppers (2), which are engaged with each other when the connector is connected.
   - When removing a connector from a clip, pull the connector in parallel with the clip as removing stoppers.

     NOTICE

     If the connector is pried up and down or to the right or left, it may break the housing.



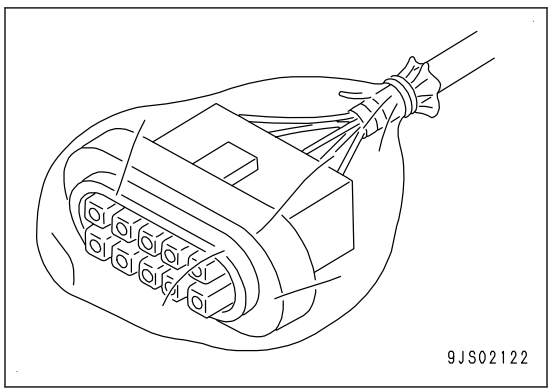


3. Action to be taken after removing connectors

   After removing the connector, cover it with plastic bags to prevent entry of dust, dirt, oil, or water in the contact portion.

   NOTICE

   Be sure to cover the connector with plastic bags when leaving the machine disassembled for a long time, otherwise defective contact may occur.



Connecting connectors

1. Check the connector visually.
   - Check that there is no dust, dirt, oil, or water stuck to the connector pins (joint portion).

- Check that there is no deformation, defective contact, corrosion, or damage on the connector pins.
- Check that there is no damage or crack on the external surfaces of the connectors.

NOTICE

- **If there is any dust, dirt, oil, or water stuck to the connector, wipe it off with a dry cloth. If there is any water intrusion into the connector, warm the inside of the connector and harness with a dryer. Do not overheat the connector, otherwise short circuit may occur.**
- **If there is any damage or breakage, replace the connector.**

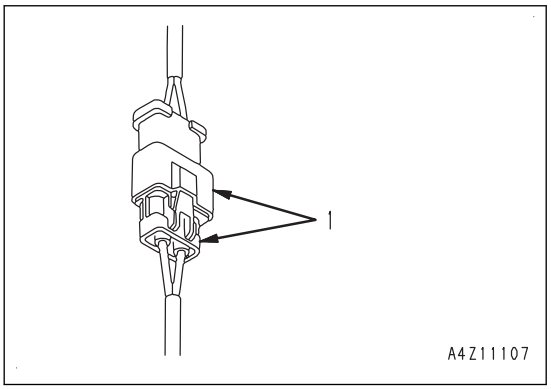
2. Connecting the connector securely

   Position connector (1) correctly, and fit it in securely.

   REMARK

   If the connector is lock stopper type, insert it until it clicks.

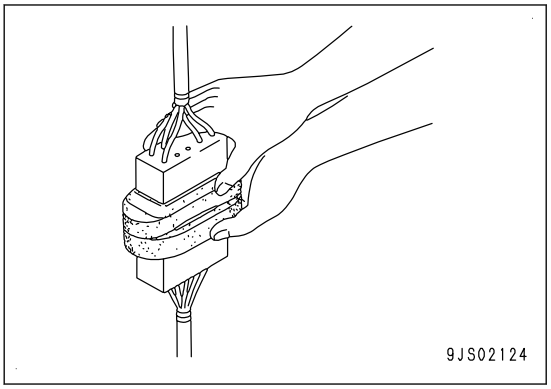
3. Correct the protrusion of the boot and misalignment of the wiring harness.



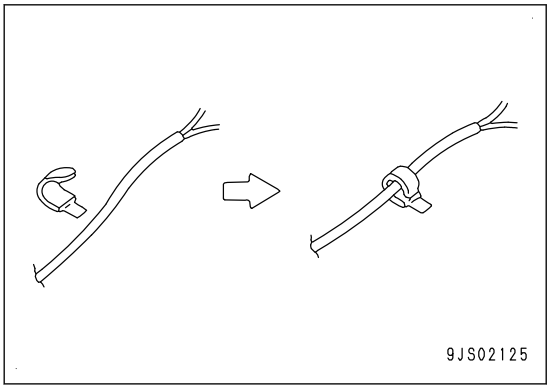
- If the connector is with the boot, correct any extrusion of the boot. In addition, if the wiring harness is misaligned or the clamp is out of position, adjust it to its correct position.

  REMARK

  If the protrusion of the boot and misalignment of the wiring harness cannot be fixed, remove the clamp to adjust them.



- If the connector clamp is removed, be sure to return it to its original position. Check that there is no looseness.



Drying wiring harness

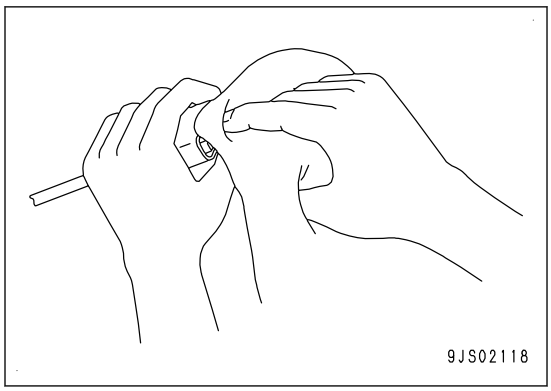
REMARK

If the wiring harness is dirty with oil and dust, wipe it off with a dry cloth. Avoid water washing or steam washing. If water washing is unavoidable, do not use high-pressure water or steam directly on the wiring harness. If water gets directly on the connector, do as follows.

1. Disconnect the connector and wipe off the water with a dry cloth.

   NOTICE

   If the connector is to be blown with dry compressed air, there is the risk that oil in the air may cause defective contact, remove oil and water in the air before starting air blow.

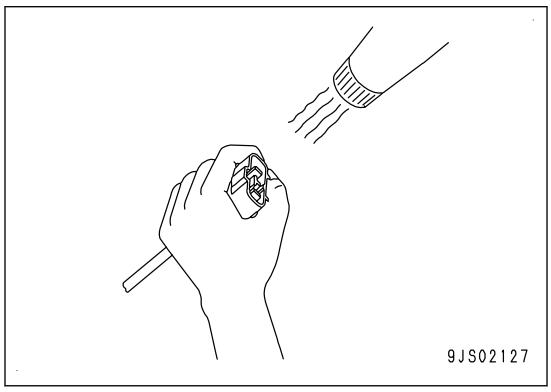


2. Dry the inside of the connector with a dryer.

   If water enters inside the connector, use a dryer to dry the connector.

   NOTICE

   Hot air from a dryer can be used, but limit the time of using a dryer to prevent the connector or related parts from becoming too hot, as this will cause deformation or damage to the connector.

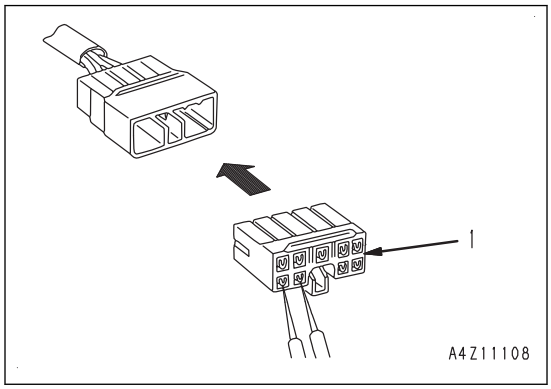


3. Perform a continuity test on the connector.

   After drying, leave the wiring harness disconnected, connect T-adapter(1), and perform a continuity test to check for any short circuits between pins caused by water or etc.

   REMARK

   After the connector is completely dried, blow the contact restorer, and reassemble them.

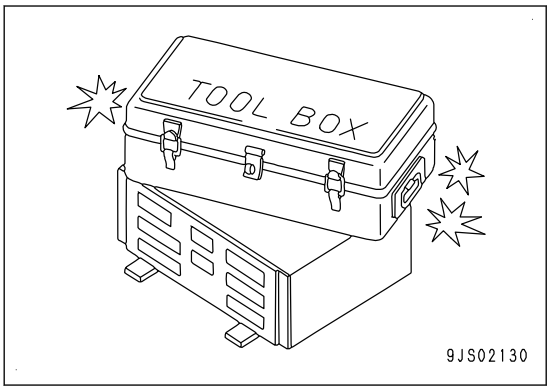


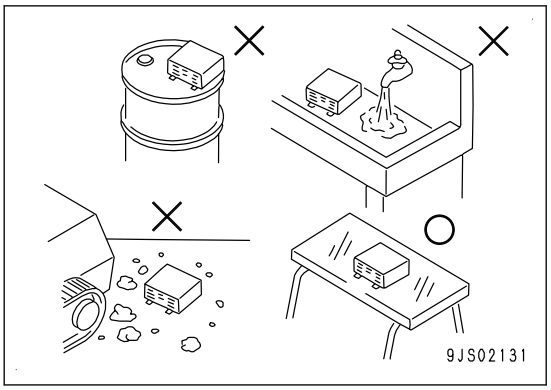
Handling controller

⚠ **When performing arc welding on the machine body, disconnect all of the wiring harness connectors connected to the controller. Fit an arc welding ground close to the welding point.**

NOTICE

- **Controller has been assembled with electronic circuits for control including microcomputers. These electronic circuits inside of the controller must be handled with care since they control the machine.**
- **Do not leave things on the controller.**
- **Cover the connector portion of the controller with a tape and a plastic bag. Do not touch the connecting portion of connector.**
- **Do not leave the controller in a place where it is exposed to rain.**
- **Do not place the controller on oil, water, soil or any places where the temperature is likely to be high even for a short period of time (Place it on a suitable dry stand).**





Precautions for troubleshooting electrical circuits

- Be sure to turn the starting switch to OFF position before disconnecting or connecting the connectors.
- Before performing troubleshooting, check all the related connectors for loose connection.

  REMARK

  Check the related connectors for their performance by disconnecting and connecting them several times.
- Be sure to connect all the disconnected connectors before proceeding to the next step.

  NOTICE

  If the starting switch is turned to ON position while the connectors are disconnected, an unrelated failure beside the actual failed part may be displayed.
- When performing the troubleshooting for the circuit (measurement of voltage, resistance,continuity, current, etc.), shake the related wiring harnesses and connectors several times and check that the multimeter reading does not change.

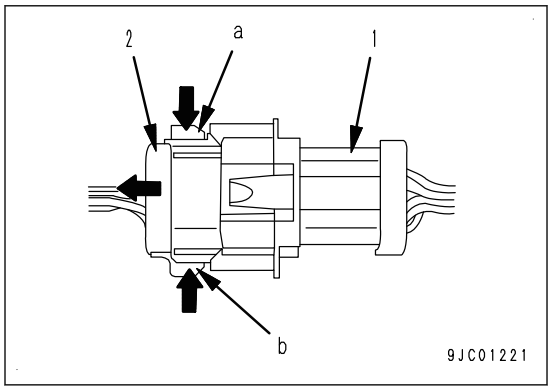
  NOTICE

  If the value changes on the multimeter, there may be a defective contact in the circuit.

METHOD FOR DISCONNECTING AND CONNECTING DEUTSCH CONNECTOR

Method for disconnecting Deutsch connector

While pressing locks (a) and (b) from each side respectively, pull out female connector (2).

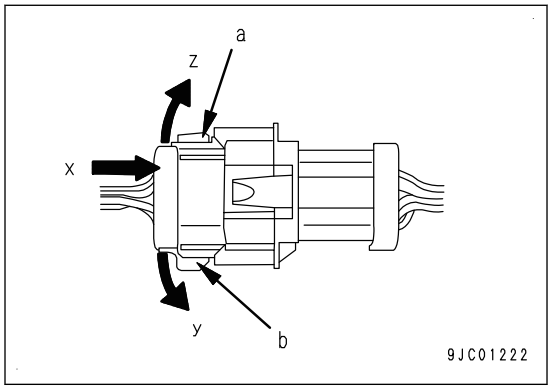


Method for connecting Deutsch connector

1. Push in female connector (2) horizontally, and insert it straight until it clicks. (Arrow: x)
2. In order to check whether locks (a) and (b) are completely inserted, insert female connector (2) by rocking it vertically (in the arrow z direction). (Arrow: x, y, z)

   REMARK

   Lock (a) in the figure is pulled down (not set completely), and lock (b) is set completely.



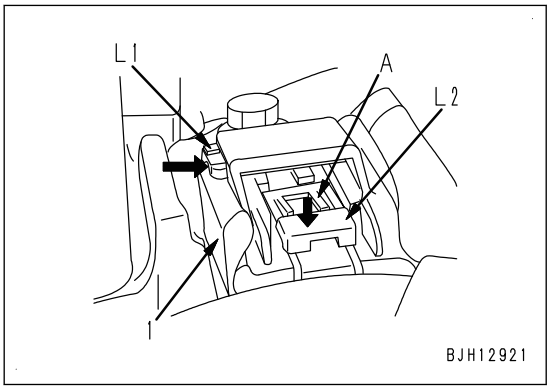
METHOD FOR DISCONNECTING AND CONNECTING SLIDE LOCK TYPE CONNECTOR

Method for disconnecting slide lock type connector (FRAMATOME-3, FRAMATOME-2)

1. Slide lock (L1) to the right.
2. While pressing lock (L2), pull out connector (1) toward you.

REMARK

If portion A does not float when lock (L2) is pressed, and if connector (1) does not come out when it is pulled toward you, push up portion A with a small flat-head screwdriver while pressing lock (L2), and then pull out connector (1) toward you.

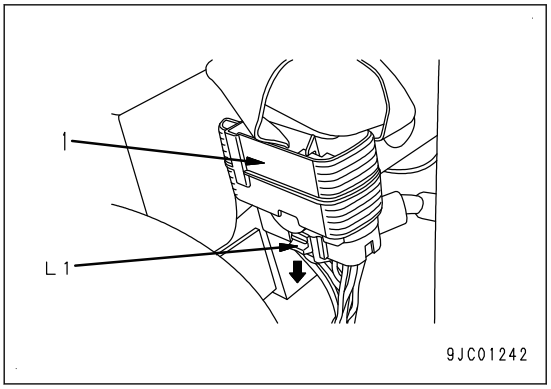


Method for connecting slide lock type connector (FRAMATOME-3, FRAMATOME-2)

Insert it straight until it clicks.

Method for disconnecting slide lock type connector (FRAMATOME-24)

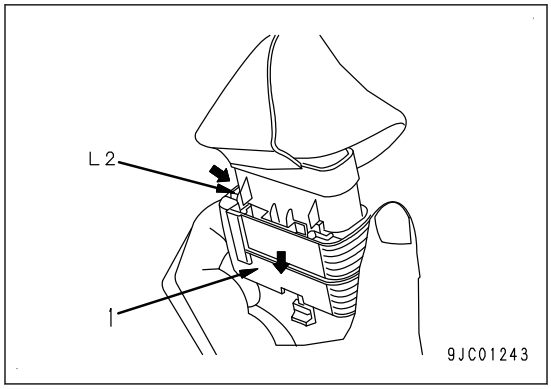
1. Slide down lock (red) (L1).

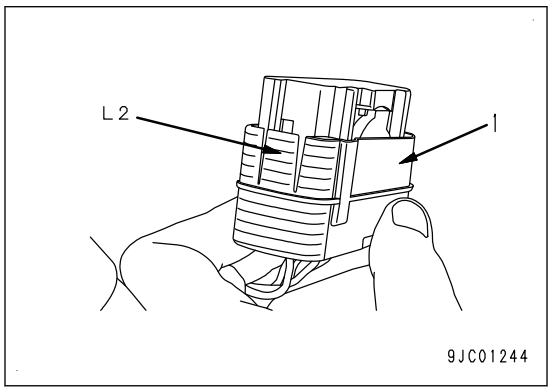


2. While pressing lock (L2), pull out connector (1).

   REMARK

   Lock (L2) is located behind connector (1) in the figure.





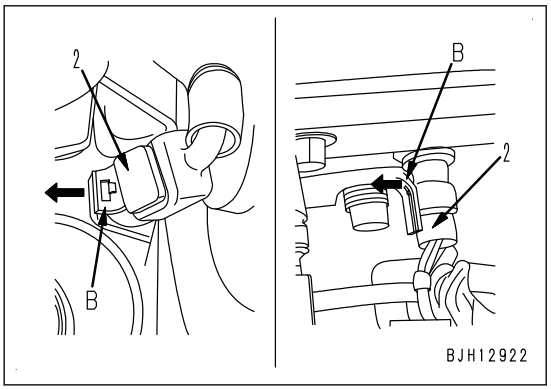
Method for connecting slide lock type connector (FRAMATOME-24)

Insert it straight until it clicks.

METHOD FOR DISCONNECTING AND CONNECTING CONNECTOR WITH LOCK TO PULL

Method for disconnecting connector with lock to pull

Disconnect the connector (2) by pulling lock (B) (on the wiring harness side) of connector (2) outward.



Method for connecting connector with lock to pull

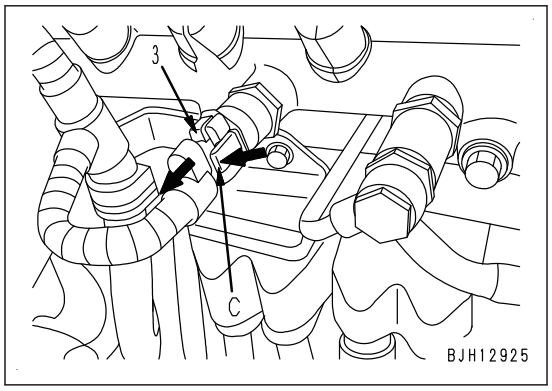
Insert the connector securely until it "clicks".

METHOD FOR DISCONNECTING AND CONNECTING CONNECTOR WITH LOCK TO PUSH

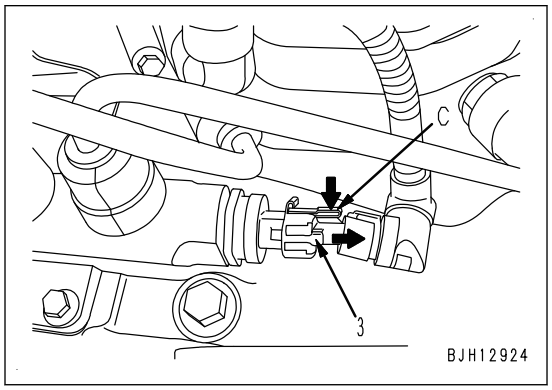
Method for disconnecting connector with lock to push (BOSCH-3)

While pressing lock (C), pull out connector (3) in the direction of the arrow.

- 114 series



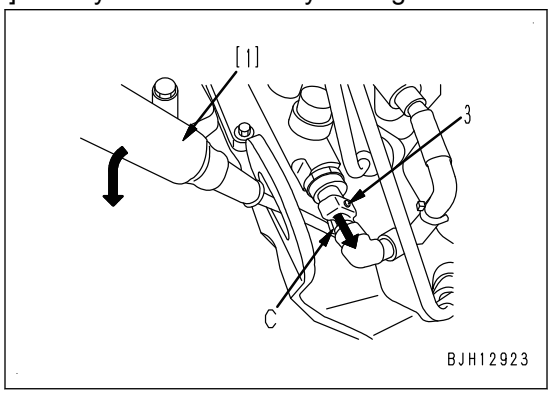
- 107 series



REMARK

If the lock is located on the underside, use flat-head screwdriver [1] since you cannot insert your fingers.

While pushing up lock (C) of the connector with flat-head screwdriver [1], pull out connector (3) in the direction of the arrow.

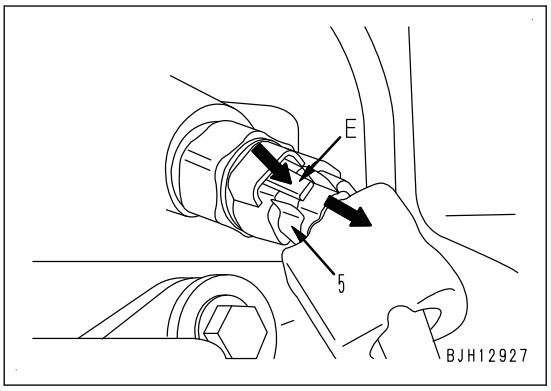


Method for connecting connector with lock to push (BOSCH-3)

Insert it straight until it clicks.

Method for disconnecting connector with lock to push (AMP-3)

While pressing lock (E), pull out connector (5) in the direction of the arrow.



Method for connecting connector with lock to push (AMP-3)

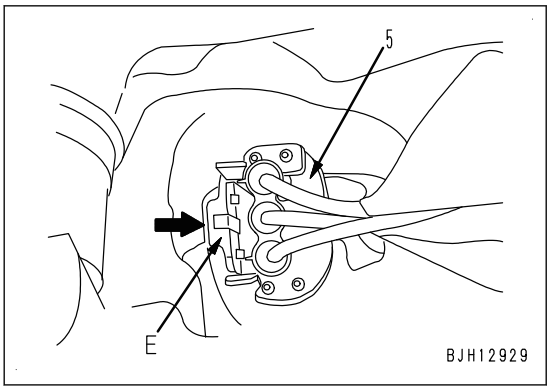
Insert it straight until it clicks.

Method for disconnecting connector with lock to push (SUMITOMO-3)

While pressing lock (E), pull out connector (5) in the direction of the arrow.

REMARK

Pull up the connector straight.

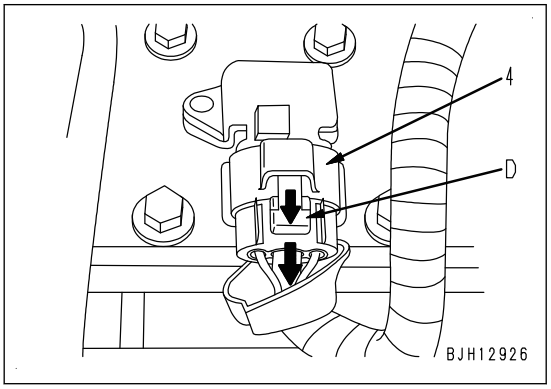


Method for connecting connector with lock to push (SUMITOMO-3)

Insert it straight until it clicks.

Method for disconnecting connector with lock to push (SUMITOMO-4)

While pressing lock (D), pull out connector (4) in the direction of the arrow.



Method for connecting connector with lock to push (SUMITOMO-4)

Insert it straight until it clicks.

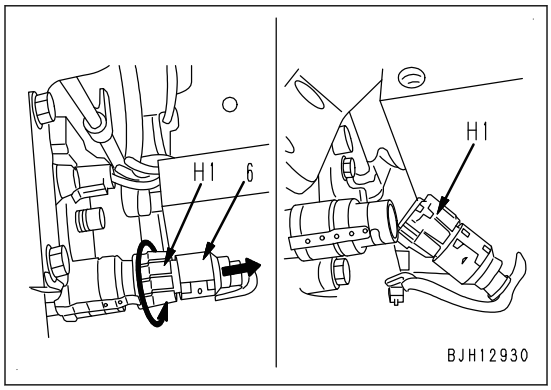
METHOD FOR DISCONNECTING AND CONNECTING CONNECTOR WITH HOUSING TO ROTATE

Method for disconnecting connector with housing to rotate

Turn housing (H1) to the left, and pull it out.

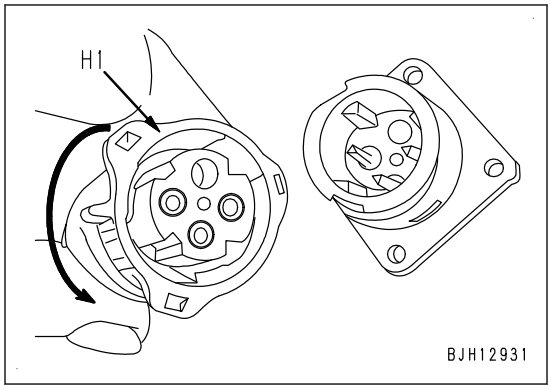
REMARK

Housing (H1) is left on the wiring harness side.



Method for connecting connector with housing to rotate

1. Insert the connector to the end while aligning its groove to the other.
2. Turn housing (H1) clockwise until it clicks.



HOW TO READ ELECTRICAL WIRE CODE

In the electrical circuit diagram, the material, thickness, and color of each electric wire are indicated by symbols. The electrical wire code is helpful in understanding the electrical circuit diagram.

Example) AEX 0.85 L: Indicates heat-resistant, low-voltage blue wire for automobile, having nominal No. of 0.85

AEX	Indicates type of wire by symbol. Type, symbol, and material of wire are shown in (Table 1). (Since the use of AV and AVS wires depends on size (nominal No.), the symbols are not indicated on the diagram.)
0.85	Indicates size of wire by nominal No. Sizes (Nominal Nos.) are shown in (Table 2).
L	Indicates color of wire by color code. Color codes are shown in (Table 3).

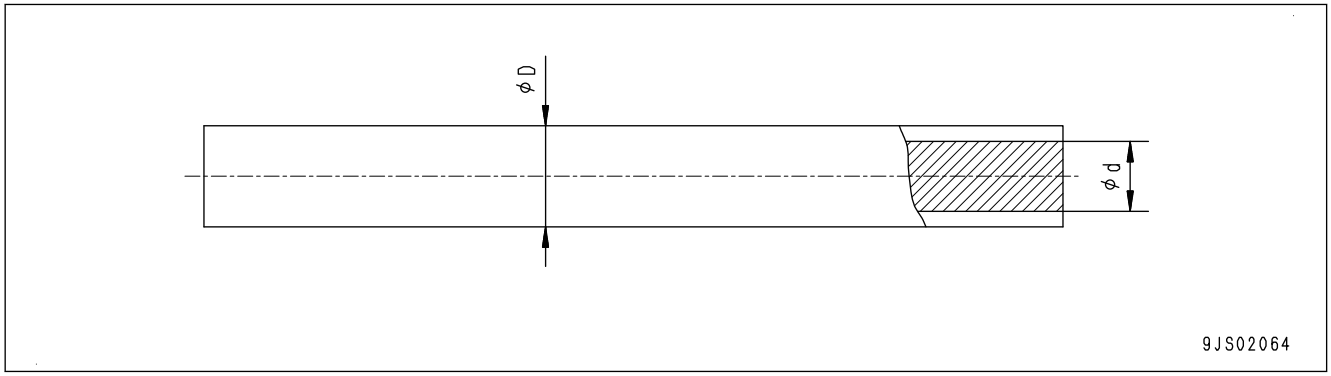
Type, symbol, and material

AV and AVS are different in only thickness and outside diameter of the coating. CAVS has a circular compressed conductor. It differs from AV and AVS in the outside diameter of conductor and thickness of the coating. AEX is similar to AV in thickness and outside diameter of the coating but different from AV and AVS in material of the coating.

(Table 1)

Type	Symbol	Conductor material	Insulator material	Temperature range (°C) in use	Example of use
Low-voltage wire for automobile	AV	Annealed copper for electric appliance	Soft polyvinyl chloride	-30 to +60	For large current wiring (nominal No. 5 and above)
Thin-cover low-voltage wire for automobile (Type 1)	AVS				General wiring (nominal No. 3 and lower)
Thin-cover low-voltage wire for automobile (Type 2)	CAVS				For mid- to small-size excavators (nominal No. 1.25 and lower)
Heat-resistant low-voltage wire for automobile	AEX		Heat-resistant cross-linked polyethylene	-50 to +110	General wiring for extremely cold weather specification Wiring at high-temperature place

Dimensions



(Table 2)

Nominal No.			0.5f	(0.5)	0.75f	(0.85)	1.25f	(1.25)	2f	2	3f	3	5
Conductor		Number of strands	20	7	30	11	50	16	37	26	58	41	65
		Diameter of strand	0.18	0.32	0.18	0.32	0.18	0.32	0.26	0.32	0.26	0.32	0.32
		Cross-sectional area (mm^2)	0.51	0.56	0.76	0.88	1.27	1.29	1.96	2.09	3.08	3.30	5.23
		d (approx.)	1.0		1.2		1.5		1.9	1.9	2.3	2.4	3.0
Coating D	AVS	Standard	2.0		2.2		2.5		2.9	2.9	3.5	3.6	-
	AV	Standard	-		-		-		-	-	-	-	4.6
	AEX	Standard	2.0		2.2		2.7		3.0	3.1	-	3.8	4.6

Nominal No.			8	15	20	30	40	50	60	85	100
Conductor		Number of strands	50	84	41	70	85	108	127	169	217
		Diameter of strand	0.45	0.45	0.80	0.80	0.80	0.80	0.80	0.80	0.80
		Cross-sectional area (mm^2)	7.95	13.36	20.61	35.19	42.73	54.29	63.84	84.96	109.1
		d (approx.)	3.7	4.8	6.0	8.0	8.6	9.8	10.4	12.0	13.6
Coating D	AVS	Standard	-	-	-	-	-	-	-	-	-
	AV	Standard	5.5	7.0	8.2	10.8	11.4	13.0	13.6	16.0	17.6
	AEX	Standard	5.3	7.0	8.2	10.8	11.4	13.0	13.6	16.0	17.6

Nominal No.		0.5f	0.5	0.75f	0.85	1.25f	1.25
Conductor	Number of strands	-	7	-	11	-	16
	Diameter of strand	-	round compression	-	round compression		round compression
	Cross-sectional area (mm^2)	-	0.56	-	0.88	-	1.29
	d (approx.)	-	0.9	-	1.1	-	1.4

Nominal No.			0.5f	0.5	0.75f	0.85	1.25f	1.25
Coating D	CAVS	Standard	-	1.6	-	1.8	-	2.1

REMARK

“f” of nominal No. denotes "flexible".

Color codes table

(Table 3)

Color Code	Color of wire	Color Code	Color of wire
B	Black	LgW	Light green and White
Br	Brown	LgY	Light green and Yellow
BrB	Brown and Black	LR	Blue and Red
BrR	Brown and Red	LW	Blue and White
BrW	Brown and White	LY	Blue and Yellow
BrY	Brown and Yellow	O	Orange
Ch	Charcoal	P	Pink
Dg	Dark green	R	Red
G	Green	RB	Red and Black
GB	Green and Black	RG	Red and Green
GL	Green and Blue	RL	Red and Blue
Gr	Gray	RW	Red and White
GR	Green and Red	RY	Red and Yellow
GW	Green and White	Sb	Sky Blue
GY	Green and Yellow	Y	Yellow
L	Blue	YB	Yellow and Black
LB	Blue and Black	YG	Yellow and Green
Lg	Light green	YL	Yellow and Blue
LgB	Light green and Black	YR	Yellow and Red
LgR	Light green and Red	YW	Yellow and White

REMARK

In a color code consisting of 2 colors, the first color is the color of the background and the second color is the color of the marking.
Example) GW indicates that the background is "Green" and marking is "White".

Types of circuits and color codes

Type of wire		AVS, AV, CAVS						AEX	
Type of circuit	Charge	R	WG	-	-	-	-	R	-
	Ground	B	-	-	-	-	-	B	-
	Start	R	-	-	-	-	-	R	-
	Light	RW	RB	RY	RG	RL	-	O	-
	Instrument	Y	YR	YB	YG	YL	YW	Y	Gr
	Signal	G	GW	GR	GY	GB	GL	G	Br
	Others	L	LW	LR	LY	LB	-	L	-
		Br	BrW	BrR	BrY	BrB	-	-	-
		Lg	LgR	LgY	LgB	LgW	-	-	-
		O	-	-	-	-	-	-	-
		Gr	-	-	-	-	-	-	-
		P	-	-	-	-	-	-	-
		Sb	-	-	-	-	-	-	-
		Dg	-	-	-	-	-	-	-
		Ch	-	-	-	-	-	-	-

EXPLANATION OF TERMS FOR MAINTENANCE STANDARD

The maintenance standard section shows the judgment criteria whether the equipment or parts should be replaced or can be reused when the machine is disassembled for the maintenance. The following terms are the descriptions of the judgment criteria.

Standard dimension and tolerance

- The finished dimension of a part is slightly different from one to another actually.
- A standard dimension of a finished part is set, and an allowable difference from that dimension is set for the part.
- The dimension set as the standard is called the standard dimension and the allowable range of difference from this standard dimension is called "tolerance".
- An indication example of a standard dimension and tolerance is shown in the following table.
  (The standard dimension is entered on the left side and the tolerance is entered with a positive or negative symbol on the right side)

Example:

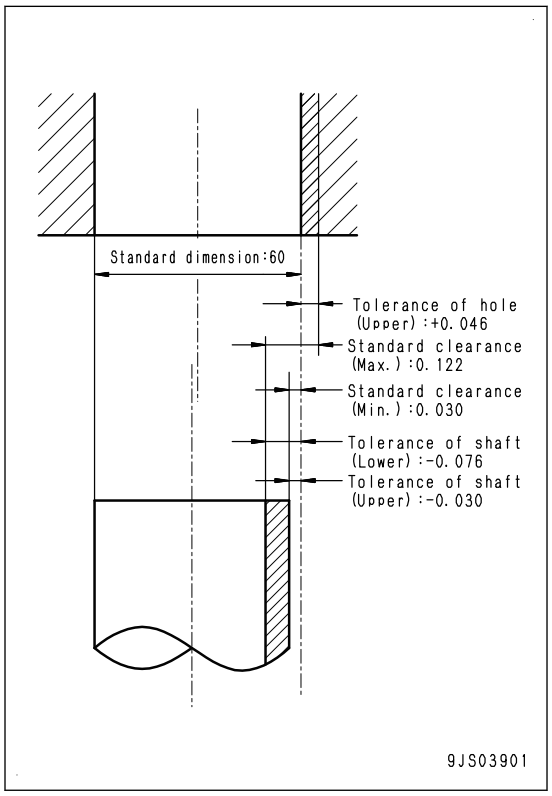
Standard dimension	Tolerance
120	-0.022 -0.126

- The tolerance may be indicated in the text and a table as "standard dimension (upper limit of tolerance/ lower limit of tolerance)."
  Example) 120 (-0.022/ -0.126)
- Usually, the dimension of a hole and the dimension of the shaft to be inserted into that hole are indicated by the same standard dimension and different tolerances of the hole and shaft. The tightness of fit is determined by the tolerance.
- A dimension indication example of a shaft and hole is shown in the following table.
  (The standard dimension is entered on the left side and the tolerance of the shaft is entered with a positive or negative symbol at the center and that of the hole on the right side)

Standard dimension	Tolerance	
	Shaft	Hole
60	-0.030 -0.076	+0.046 0

Standard clearance and standard value

- The clearance made when new parts are assembled is called the standard clearance, which is indicated by the range from the minimum clearance to the maximum clearance.
- When some parts are repaired, the clearance is generally adjusted to the standard clearance.
- The values indicating performance and function of new products or equivalent are called "standard value", which is indicated by a range or a target value.
- When some parts are repaired, the value of performance/ function is set to the standard value.



Standard interference

- When the diameter of a hole of a part shown in the given standard dimension and tolerance table is smaller than that of the shaft to be inserted, the difference between those diameters is called "interference".
- Subtract the maximum dimension of the hole from the minimum dimension of the shaft and call it (A). Subtract the minimum dimension of the hole from the maximum dimension of the shaft and call it (B). The range between (A) and (B) is "standard interference".
- After repairing or replacing some parts, measure the dimension of their hole and shaft and check that the interference is in the standard range.

Repair limit and allowable value or allowable dimension

- The dimension of parts changes due to the wear or deformation while they are used. When the dimension changes exceeding certain value, parts cannot be used any longer. This value is called "repair limit".
- If a part is worn to the repair limit, it must be replaced or repaired.
- The performance and function of products lower while they are used. A value with which the product can be used without causing a problem is called "allowable value" or "allowable dimension".
- A product whose dimension is out of the allowable value, must be repaired. However, since the allowable values are generally estimated through various tests or experiences in most cases, the judgment must be made in consideration of the operating condition and customer's requirement.

Allowable clearance

- Parts can be used until the clearance between them is increased to a certain limit. The limit at which those parts cannot be used is called "allowable clearance".
- If the clearance between the parts exceeds the allowable clearance, they must be replaced or repaired.

Allowable interference

- The allowable maximum interference between the hole of a part and the shaft of another part to be assembled is called "allowable interference".
- The allowable interference shows the repair limit of the part of smaller tolerance.

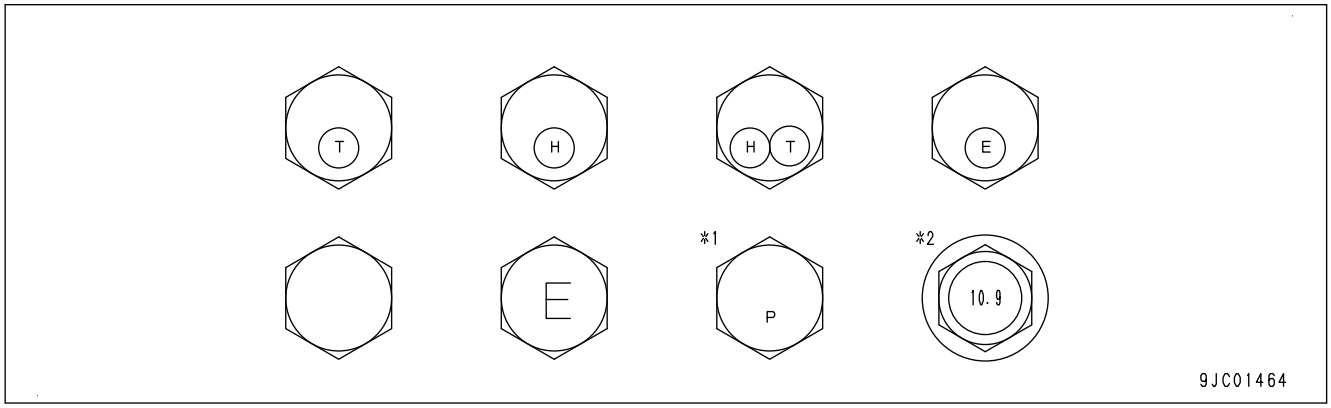
- The parts whose interferences are out of the allowable interference must be replaced or repaired.

STANDARD TIGHTENING TORQUE TABLE

Table of tightening torque for bolts and nuts

REMARK

Tighten the metric nuts and bolts to the torque shown in the table below unless otherwise specified.



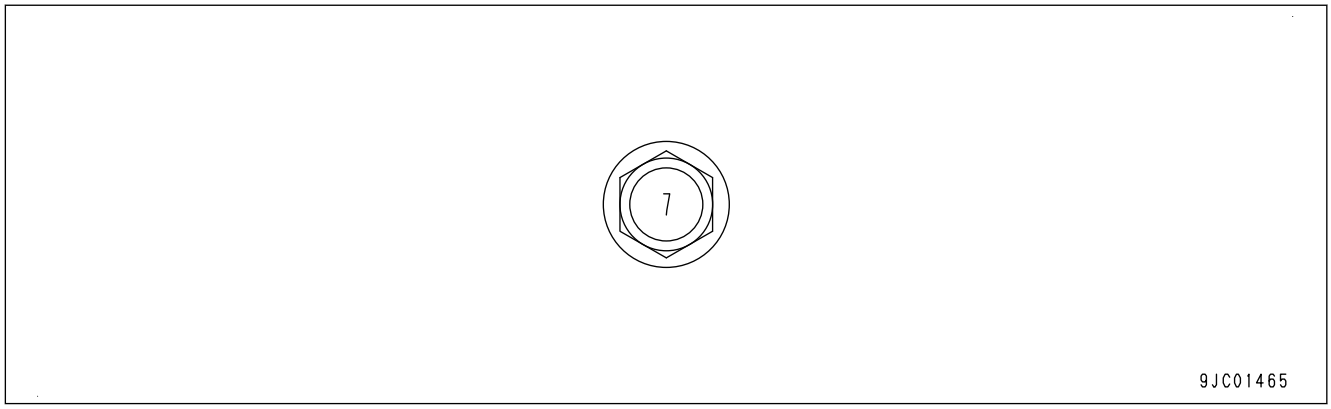
Thread diameter (mm)	Width across flats (mm)	Tightening torque (Nm { kgm})
6	10 (*2) 10	11.8 to 14.7 {1.2 to 1.5}
8	13 (*2) 12	27 to 34 {2.8 to 3.5}
10	17 (*1, *2) 14	59 to 74 {6 to 7.5}
12	19 (*1, *2) 17	98 to 123 {10 to 12.5}
14	22	153 to 190 {15.5 to 19.5}
16	24 (*1) 22	235 to 285 {23.5 to 29.5}
18	27	320 to 400 {33 to 41}
20	30	455 to 565 {46.5 to 58}
22	32	610 to 765 {62.5 to 78}
24	36	785 to 980 {80 to 100}
27	41	1150 to 1440 {118 to 147}
30	46	1520 to 1910 {155 to 195}
33	50	1960 to 2450 {200 to 250}
36	55	2450 to 3040 {250 to 310}
39	60	2890 to 3630 {295 to 370}

*1: Split flange bolt

*2: Flanged bolt

REMARK

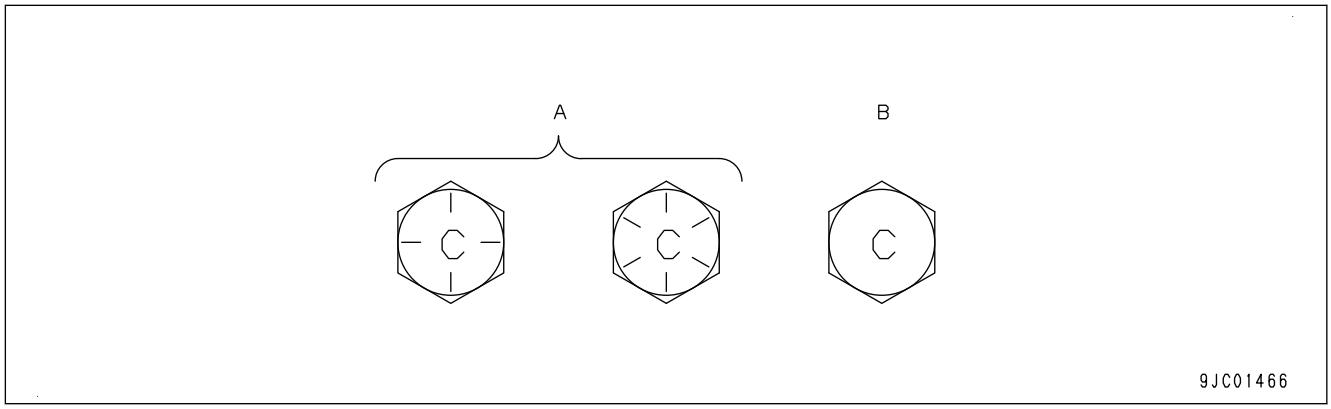
Tighten the flanged bolt marked with “7” on the head as shown in the following to the tightening torque shown in the table below.



Thread diameter (mm)	Width across flats (mm)	Tightening torque (Nm { kgm})
6	10	5.9 to 9.8 {0.6 to 1.0}
8	12	13.7 to 23.5 {1.4 to 2.4}
10	14	34.3 to 46.1 {3.5 to 4.7}
12	17	74.5 to 90.2 {7.6 to 9.2}

REMARK

Tighten the unified coarse threaded bolts and nuts to the torque shown in the table below unless otherwise specified.



Type of bolt	A		B	
Nominal size - threads per inch	Tightening torque (Nm { kgm})		Tightening torque (Nm { kgm})	
	Range	Target	Range	Target
$^{1}/_{4}$-20UNC	9.8 to 14.7 {1 to 1.5}	12.7 {1.3}	2.9 to 3.9 {0.3 to 0.4}	3.43 {0.35}
$^{5}/_{16}$-18UNC	24.5 to 34.3 {2.5 to 3.5}	29.4 {3}	6.9 to 8.8 {0.7 to 0.9}	7.8 {0.8}
$^{3}/_{8}$-16UNC	44.1 to 58.8 {4.5 to 6}	52.0 {5.3}	9.8 to 14.7 {1 to 1.5}	11.8 {1.2}
$^{7}/_{16}$-14UNC	73.5 to 98.1 {7.5 to 10}	86.3 {8.8}	19.6 to 24.5 {2 to 2.5}	21.6 {2.2}
$^{1}/_{2}$-13UNC	108 to 147 {11 to 15}	127 {13}	29.4 to 39.2 {3 to 4}	34.3 {3.5}
$^{9}/_{16}$-12UNC	157 to 216 {16 to 22}	186 {19}	44.1 to 58.8 {4.5 to 6}	51.0 {5.2}
$^{5}/_{8}$-11UNC	226 to 294 {23 to 30}	265 {27}	63.7 to 83.4 {6.5 to 8.5}	68.6 {7}
$^{3}/_{4}$-10UNC	392 to 530 {40 to 54}	461 {47}	108 to 147 {11 to 15}	127 {13}
$^{7}/_{8}$-9UNC	637 to 853 {65 to 87}	745 {76}	177 to 235 {18 to 24}	206 {21}