CEBM000704

Shop Manual

WA250-6

WHEEL LOADER

SERIAL NUMBERS **WA250-6 A76001 and up**

ENGINE **6D107E-1**

March 2016

CONTENTS

The affected pages are indicated by using the following marks. It is requested that necessary actions be taken to these pages according to the table below.

Mark	Indication	Action
❍	New page to be added	Add
●	Page to be replaced	Replace
( )	Page to be deleted	Discard

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SAFETY

Safety Notice

Important Safety Notice

Proper service and repair is extremely important for the safe operation of your machine. The service and repair techniques recommended and described in this manual are both effective and safe methods of operation. Some of these operations require the use of tools specially designed for the purpose.

To prevent injury to workers, the symbols ⚠ and ⚠ are used to mark safety precautions in this manual. The cautions accompanying these symbols should always be followed carefully. If any dangerous situation arises or may possibly arise, first consider safety, and take the necessary actions to deal with the situation.

General Precautions

Mistakes in operation are extremely dangerous. Read the *Operation & Maintenance Manual* carefully BEFORE operating the machine. In addition, read this manual and understand its contents before starting the work.

1. Before carrying out any greasing or repairs, read all the precautions given on the labels which are fixed to the machine. For the locations of the safety labels and a detailed explanation of precautions, see the *Operation & Maintenance Manual*.

2. When carrying out any operation, always wear safety shoes and helmet. Do not wear loose work clothes, or clothes with buttons missing.
   - Always wear safety glasses when hitting parts with a hammer.
   - Always wear safety glasses when grinding parts with a grinder, etc.

3. If welding repairs are needed, always have a trained, experienced welder carry out the work. When carrying out welding work, always wear welding gloves, apron, shielding goggles, cap, and other clothes suited for welding work.

   ⚠ **WARNING!** Never modify, weld, cut, or drill on any part of a ROPS structure. Doing so may weaken the structure which could lead to possible failure in a rollover situation

4. When carrying out any operation with two or more workers, always agree on the operating procedure before starting. Always inform your fellow workers before starting any step of the operation. Before starting work, hang UNDER REPAIR signs on the controls in the operator's compartment.

5. Keep all tools in good condition; learn the correct way to use them; and use the proper ones. Before starting work, thoroughly check the tools, machine, forklift, service car, etc.

6. Only qualified workers must carry out work and operations which require license or qualification.

7. Decide a place in the repair workshop to keep tools and removed parts. Always keep the tools and parts in their correct places. Always keep the work area clean and make sure that there is no dirt or oil on the floor. Smoke only in the areas provided for smoking. Never smoke while working.

8. Avoid continuing work for long hours and take rests at proper intervals to keep your body in good condition. Take rests in specified safe places.

Safety Points

1	Good arrangement
2	Correct work clothes
3	Following work standard
4	Making and checking signs
5	Prohibition of operation and handling by unlicensed workers
6	Safety check before starting work
7	Wearing protective goggles (for cleaning or grinding work)
8	Wearing shielding goggles and protectors (for welding work)
9	Good physical condition and preparation
10	Precautions against work which you are not used to or work with which you are too familiar

Preparations for Work

1. Before adding oil or making repairs, park the machine on hard, level ground, and block the wheels or tracks to prevent the machine from moving.

2. Before starting work, lower blade, ripper, bucket, or any other work equipment to the ground. If this is not possible, insert the safety pin or use blocks to prevent the work equipment from falling. In addition, be sure to lock all the control levers and hang warning signs on them.

3. When disassembling or assembling, support the machine with blocks, jacks, or stands before starting work.

4. Remove all mud and oil from the steps or other places used to get on and off the machine. Always use the handrails, ladders, or steps when getting on or off the machine. Never jump on or off the machine. If it is impossible to use the handrails, ladders, or steps, use a stand to provide safe footing.

Precautions During Work

1. When removing the oil filler cap, drain plug, or hydraulic pressure measuring plugs, loosen them slowly to prevent the oil from spurting out. Before disconnecting or removing components of the oil, water, or air circuits, first release the pressure completely from the circuit.

2. The coolant and oil in the circuits are hot when the engine is stopped; be careful not to get burned. Wait for the oil and coolant to cool before carrying out any work on the oil or water circuits.

3. Before starting work, remove the leads from the battery. ALWAYS remove the lead from the negative (-) terminal first.

4. When raising heavy components (in excess of 25 kg (55 lb)), use a hoist or crane. Check that the wire rope, chains, and hooks are free from damage. Always use lifting equipment which has ample capacity. Install the lifting equipment at the correct places. Use a hoist or crane and operate slowly to prevent the component from hitting any other part. Do not work with any part still raised by the hoist or crane.

5. When removing a cover which is under internal pressure or under pressure from a spring, always leave two bolts in position on opposite sides. Loosen the bolts gradually and alternately to release the pressure, and then remove the cover.

6. When removing components, be careful not to break or damage the wiring, Damaged wiring may cause electrical fires.

7. When removing piping, stop the fuel or oil from spilling out. If any fuel or oil drips on the floor, wipe it up immediately. Fuel or oil on the floor can cause you to slip, or can even start fires.

8. Gasoline or other fuels should never be used to clean parts. Clean parts with appropriate solvents.

9. Be sure to assemble all parts again in their original places. Replace any damaged parts or parts that must not be reused with new parts.
   - When installing hoses and wires, be sure that they will not be damaged by contact with other parts when the machine is being operated.

10. When installing high pressure hoses, make sure that they are not twisted. Damaged tubes are dangerous, so be extremely careful when installing tubes for high pressure circuits. Also check that connecting parts are correctly installed.

11. When assembling or installing parts, always use the specified tightening torques. When installing protective parts such as guards, or parts which vibrate violently or rotate at high speed, be particularly careful to check that they are installed correctly.

12. When aligning two holes, never insert your fingers or hand. Be careful not to get your fingers caught in a hole.

13. When measuring hydraulic pressure, check that the measuring tool is correctly assembled before taking any measurements.

14. Take care when removing or installing the tracks of track-type machines. When removing the track, the track separates suddenly; never let anyone stand at either end of the track.

15. When jump-starting the machine, only use a machine of similar size and voltage. Never use an arc welder or other electrical generating equipment to jump-start the machine. Carefully review the safety procedures for jump starting the machine.

16. Before starting work, stop the engine. When working on or around a rotating part, stop the engine. When checking the machine without stopping the engine (measuring oil pressure, revolving speed, temperature, etc.), be extremely careful not to get rolled or caught in rotating or moving parts.

17. If the engine is operated for a long time in a place which is not ventilated well, you may suffer from gas poisoning. Before starting the engine, open the windows and doors so that the area is well ventilated.

GENERAL

This shop manual has been prepared as an aid to improve the quality of repairs by giving the serviceman an accurate understanding of the product and by showing him the correct way to perform repairs and make judgments. Make sure you understand the contents of this manual and use it to full effect at every opportunity.

This shop manual mainly contains the necessary technical information for operations performed in a service workshop. For ease of understanding, the manual is divided into the following sections. These sections are further divided into each main group of components.

General

This section lists the general machine dimensions, performance specifications, component weights, and fuel, coolant, and lubricant specification charts.

Structure, Function, and Maintenance Standard

This section explains the structure and function of each component. It serves not only to give an understanding of the structure, but also serves as reference material for troubleshooting. In addition, this section gives the judgment standards when inspecting disassembled parts.

Standard Value Table

This section explains the standard values for a new machine and the judgment criteria for testing, adjusting, and troubleshooting. This standard value table is used to check the standard values in testing and adjusting and to judge parts in troubleshooting.

Testing and Adjusting

This section explains checks to be made before and after performing repairs, as well as adjustments to be made at completion of the checks and repairs.

Troubleshooting

Troubleshooting charts correlating *Problems* to *Causes* are also included in this section.

Disassembly and Assembly

This section explains the order to be followed when removing, installing, disassembling, or assembling each component, as well as precautions to be taken for these operations.

Other

This section has the foldout drawings for the machine.

NOTICE

The specifications contained in this shop manual are subject to change at any time and without any advance notice.
Contact your distributor for the latest information.

HOW TO READ THE SHOP MANUAL

Volumes

Shop manuals are issued as a guide to carrying out repairs. They are divided as follows:

Chassis volume: Issued for every machine model

Engine volume: Issued for each engine series

Electrical volume: One issued to cover all models

Attachment volume: One issued to cover all models

These various volumes are designed to avoid duplication of information. Therefore to deal with all repairs for any model, it is necessary that chassis, engine, electrical, and attachment manuals be available.

Distribution and Updating

Any additions, amendments, or other changes will be sent to your distributors. Get the most up-to-date information before you start any work.

Filing Method

1. See the page number on the bottom of the page. File the pages in correct order.
2. Following examples show how to read the page number:

   Example:

   10 - 3

   Item number (10. Structure and Function)

   Consecutive page number for each item

3. Additional pages: Additional pages are indicated by a hyphen (-) and numbered after the page number. File as in the example.

   Example:

   10-4
   10-4-1
   10-4-2 — Added pages
   10-5

Revised Edition Mark

When a manual is revised, an edition mark (①②③…) is recorded on the bottom, outside corner of the pages.

Revisions

Revised pages are shown at the List of Revised Pages between the title page and SAFETY page.

Symbols

So that the shop manual can be of ample practical use, important places for safety and quality are marked with the following symbols.

Symbol	Item	Remarks
	Safety	Special safety precautions are necessary when performing the work.
★	Caution	Special technical precautions or other precautions for preserving standards are necessary when performing the work.
	Weight	Weight of parts or systems. Caution necessary when selecting hoisting wire or when working posture is important, etc.
	Tightening torque	Places that require special attention for tightening torque during assembly.
	Coat	Places to be coated with adhesives and lubricants, etc.
	Oil, water	Places where oil, water, or fuel must be added, and the capacity.
	Drain	Places where oil or water must be drained, and quantity to be drained.

HOISTING INSTRUCTIONS

Hoisting

★ If a part cannot be smoothly removed from the machine by hoisting, the following checks should be made.

1. Check for removal of all bolts fastening the part to the relative parts.
2. Check for existence of another part causing interface with the part to be removed.

Making Signs

1. Only one appointed worker must make signs and coworkers must communicate with each other frequently.
2. The appointed sign maker must make specified signs clearly at a place where he is well seen from the operator's seat and where he can see the working condition easily.
3. The sign maker must always stand in front of the load and guide the operator safely.
   - Do not stand under the load.
   - Do not step on the load.

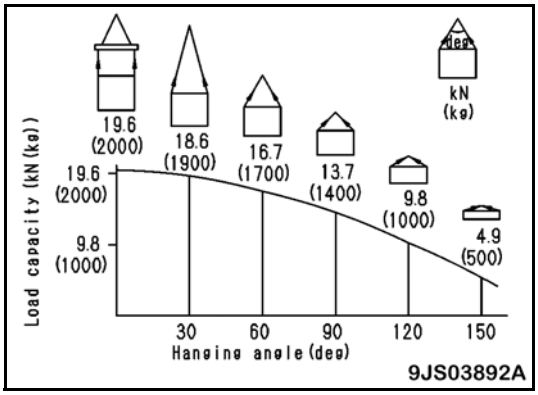
Precautions

Precautions for Sling Work

1. Check the slings before starting sling work.
2. Wear gloves during sling work. Use leather gloves, if available.
3. Measure the weight of the load visually and check its center of gravity.
4. Use a proper sling according to the weight of the load and method of slinging. If the wire ropes you use are too thick when slinging a light load, the load may slip and fall.
5. Do not sling a heavy load with one rope alone, but sling with two or more ropes symmetrically wound on to the load.

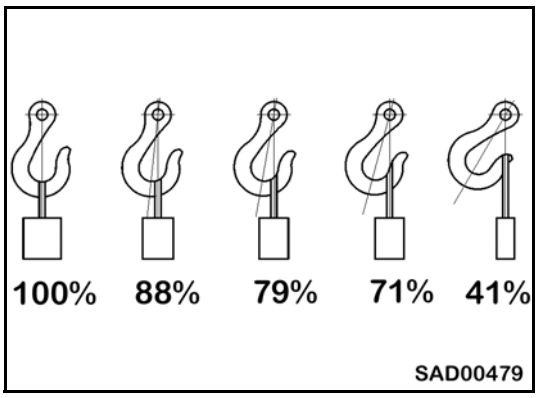
WARNING! Slinging with one rope may cause the load to turn during hoisting, the rope to untwist, or the rope to slip from its original winding position on the load, which can result in a dangerous accident.

6. Limit the hanging angle to 60°, as a rule.
   - Do not sling a heavy load with ropes forming a wide hanging angle from the hook. When hoisting a load with two or more ropes, the force subjected to each rope will increase with the hanging angles.
   - The following table shows the variation of allowable load in kN (kg) when hoisting is made with two ropes, each of which is allowed to sling up to 9.8 kN (1,000 kg) vertically, at various hanging angles.
   - When two ropes sling a load vertically, up to 19.6 kN (2,000 kg) of total weight can be suspended. This weight is reduced to 9.8 kN (1,000 kg) when two ropes make a 120° hanging angle. On the other hand, two ropes are subject to an excessive force as large as 39.2 kN (4,000 kg) if they sling a 19.6 kN (2,000 kg) load at a lifting angle of 150°.



7. 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.
8. Use the specified eyebolts and fix wire ropes, chains, etc. to them with shackles, etc.

9. Apply wire ropes from the middle portion of the hook.
    - Slinging near the edge of the hook may cause the rope to slip off the hook during hoisting, and a serious accident can result. Hooks have maximum strength at the middle portion.



10. Do not use twisted or kinked wire ropes.

11. When lifting up a load, observe the following.
    - Wind in the crane slowly until wire ropes are stretched. When settling the wire ropes by 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 the load at a slanted angle.

12. When lowering a load, observe the following.
    - When lowering a load, stop it temporarily at 30 cm (12 in) 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

★ Read the *Operation & Maintenance Manual* provided with the crane in advance and operate the crane safely.

Precautions for Using Overhead Hoist Crane

WARNING! Heavy parts (25 kg (55 lb) or more) must be lifted with a hoist, etc. In the *Disassembly and Assembly* section, every part weighing 25 kg or more is indicated clearly with the symbol.

1. Before starting work, inspect the wire ropes, brake, clutch, controller, rails, overwind stop device, ground fault protection breaker, crane collision prevention device, and power application warning lamp, and check safety.

2. Observe the signs for sling work.

3. Operate the hoist at a safe place.

4. Check the direction indicator plates (east, west, south, and north) and the directions of the control buttons without fail.

5. Do not sling a load at a slant. Do not move the crane while the slung load is swinging.

6. Do not raise or lower a load while the crane is moving longitudinally or laterally.

7. Do not drag a sling.

8. When lifting up a load, stop it just after it leaves the ground and check safety, and then lift it up.

9. Consider the travel route in advance and lift up a load to a safe height.

10. Place the control switch at a position where it will not be an obstacle to work and passage.

11. After operating the hoist, do not swing the control switch.

12. Remember the position of the main switch so that you can turn off the power immediately in an emergency.

13. If the hoist stops because of a power failure, turn the power switch OFF. When turning on a switch which was turned OFF by the ground fault protection breaker, check that the devices related to that switch are not in operational state.
    - If you find an obstacle around the hoist, stop the operation.
14. After finishing the work, stop the hoist at the specified position and raise the hook to at least 2 m (6.6 ft) above the floor. Do not leave the sling installed to the hook.

Selecting Wire Ropes

1. Use adequate ropes depending on the weight of parts to be hoisted. Refer to the following table.

Wire ropes
(Standard “Z” twist ropes without galvanizing)
(JIS G3525, No. 6, Type 6X37-A)

Nominal Rope Diameter	Allowable load	
mm	kN	ton
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

★ The allowable load value is 1/6 of the breaking strength of the rope used. Safety coefficient: 6

AIR CONDITIONER CIRCUITS

Precautions for Handling Hoses and Tubes

Observe these precautions when connecting and disconnecting hoses and tubes in the air conditioner circuit.

WARNING! The air conditioner of this machine uses a refrigerant (air conditioner gas: R134a) which has fewer factors to cause the depletion of the ozone layer. However, it does not mean that you may discharge the refrigerant into the atmosphere. Be sure to recover the refrigerant when disconnecting the refrigerant gas circuit and then reuse it.

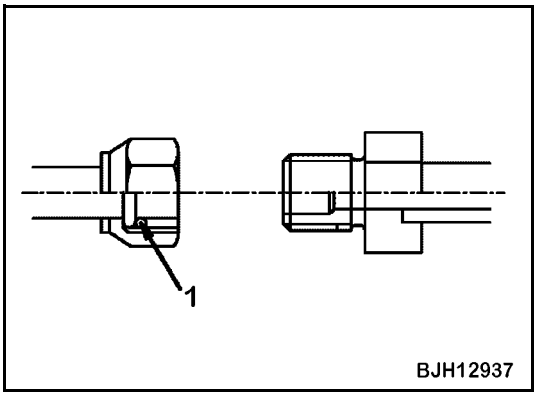
Disconnecting Hoses and Tubes

★ Ask professional tradesmen to perform the collecting and filling operation of the refrigerant (R134a).
★ Never release the refrigerant (R134a) to the atmosphere.

WARNING! If the refrigerant gas gets in your eyes or contacts your skin, you may lose your sight and your skin may be frozen. Wear safety glasses, safety gloves, and safety clothes when recovering or adding the refrigerant. Refrigerant gas must be recovered and added by a qualified person.

Connecting Hoses and Tubes

1. When installing the air conditioner circuit hoses and tubes, be careful that dirt, dust, water, etc. does not get into them.
2. When connecting the air conditioner hoses and tubes, check that O-rings (1) are fitted to their joints.
3. Check that each O-ring is not damaged or deteriorated.
4. When connecting the refrigerant piping, apply compressor oil for refrigerant (R134a) (DENSO: ND-OIL8, VALEO THERMAL SYSTEMS: ZXL100PG (equivalent to PAG46)) to its O-rings.
   ★ See example of O-ring in the graphic. O-rings are fitted to every joint of the hoses and tubes.



★ For tightening torque, see the precautions for installation in the appropriate *Disassembly and Assembly* sections.

MAINTENANCE STANDARD TERMS

The *Structure, Function, and Maintenance* section explains the criteria for replacing or reusing products and parts in the machine maintenance work. The following terms are used to explain the criteria.

Standard Size and Tolerance

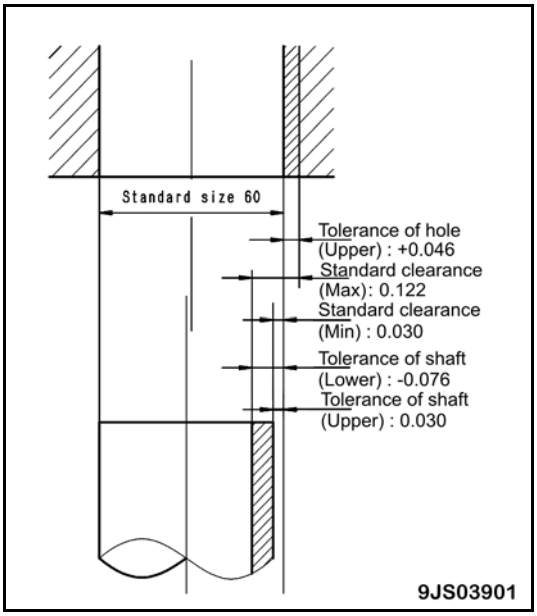
- To be accurate, the finishing size of parts is a little different from one to another.
- To specify a finishing size of a part, a temporary standard size is set and an allowable difference from that size is indicated.
- The temporary size set is called the *standard size* and the range of difference from the standard size is called the *tolerance*.
  - Tolerance with the symbols (+) or (-) is indicated on the right side of the standard size as shown in this table.

Standard Size	Tolerance
120	-0.022 -0.126

  ★ Tolerance may be indicated in the text and a table as [standard size (upper limit of tolerance/lower limit of tolerance)].

  Example: 120 (-0.022/-0.126)

  - Usually, the size of a hole and the size of the shaft to be fitted to that hole are indicated by the same standard size and different tolerances of the hole and shaft. The tightness of fit is decided by the tolerance.
  - Indication of size of rotating shaft and hole and relationship drawing of them is shown in the graphic and this table.



Standard Size	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.
- A value of performance and function of new products or equivalent is called the *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 size and tolerance table is smaller than that of the mating shaft, the difference between those diameters is called the *interference*.
- The range (A – B) from the difference (A) between the minimum size of the shaft and the maximum size of the hole to the difference (B) between the maximum size of the shaft and the minimum size of the hole is the *standard interference*.
- After repairing or replacing some parts, measure the size of their hole and shaft and check that the interference is in the standard range.

Repair Limit and Allowable Value or Allowable Dimension

- The size of a part changes because of wear and deformation while it is used. The limit of changed size is called the *repair limit*.
- If a part is worn to the repair limit, it must be replaced or repaired.
- The performance and function of a product lowers while it is used. A value at which the product can be used without causing a problem is called the *allowable value* or *allowable dimension*.
- If a product is worn to the allowable value, it must be checked or repaired. Since the permissible value is estimated from various tests or experiences in most cases, it must be judged after considering the operating condition and customer's requirement.

Clearance Limit

- 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 the *clearance limit*.
- If the clearance between the parts exceeds the clearance limit, they must be replaced or repaired.

Interference Limit

- The allowable maximum interference between the hole of a part and the shaft of another part to be assembled is called the *interference limit*.
- The interference limit shows the repair limit of the part of smaller tolerance.
- If the interference between the parts exceeds the interference limit, they must be replaced or repaired.

HANDLING ELECTRIC AND HYDRAULIC EQUIPMENT

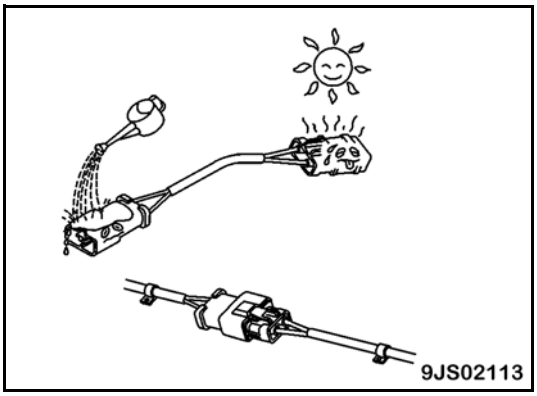
To maintain the performance of the machine over a long period and to prevent failures or other problems before they occur, correct operation, maintenance and inspection, troubleshooting, and repairs must be carried out. This section deals particularly with correct repair procedures for mechatronics and is aimed at improving the quality of repairs. For this purpose, it includes sections on handling electric equipment and handling hydraulic equipment (particularly gear oil and hydraulic oil).

Handling Electric Equipment

Handling Wiring Harnesses and Connectors

Wiring harnesses consist of wiring 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 wiring.

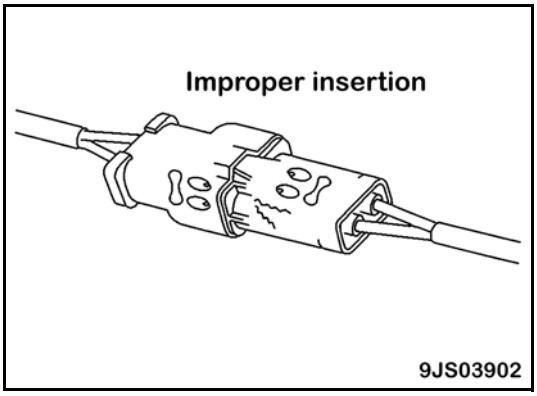
Compared with other electrical components fitted in boxes or cases, wiring harnesses are more likely to be affected by the direct effects of rain, water, heat, or vibration. Furthermore, during inspection and repair operations, they are frequently removed and installed again, so they are likely to suffer deformation or damage. For this reason, it is necessary to be extremely careful when handling wiring harnesses.


9JS02113

Main Failures Occurring in Wiring Harness

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

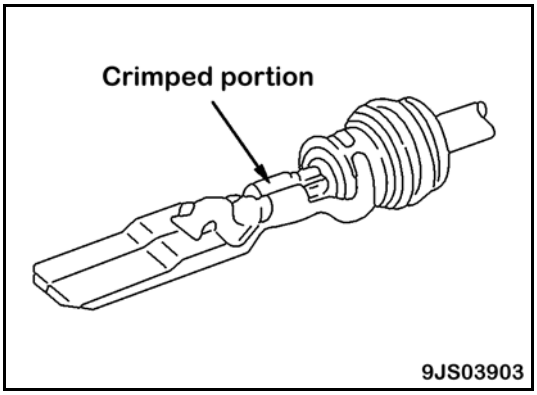
   Problems with defective contact are likely to occur because the male connector is not properly inserted into the female connector, because one or both of the connectors is deformed or the position is not correctly aligned, or because there is corrosion or oxidization of the contact surfaces. The corroded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



9JS03902

2. Defective crimping or soldering of connectors

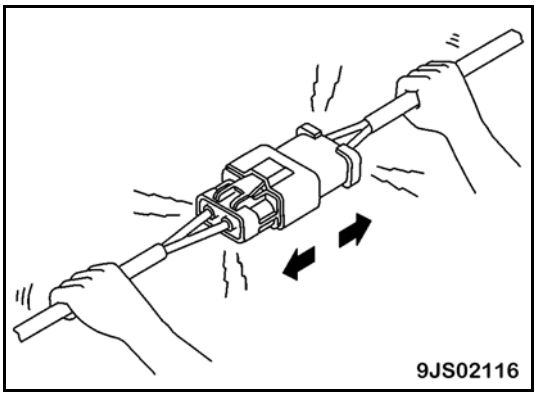
   The pins of the male and female connectors are in contact at the crimped terminal or soldered portion. If there is excessive force brought to bear on the wiring, the plating at the joint will peel and cause improper connection or breakage.



9JS03903

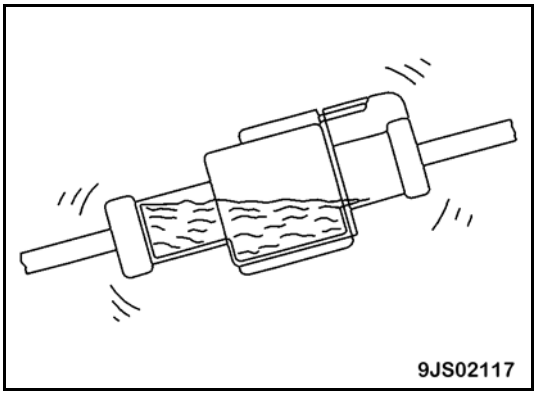
3. Disconnections in wiring

   If the wiring is held and the connectors are pulled apart, components are lifted with a crane with the wiring still connected, or a heavy object hits the wiring, the crimping of the connector may separate, the soldering may be damaged, or the wiring may be broken.



4. High-pressure water entering connector

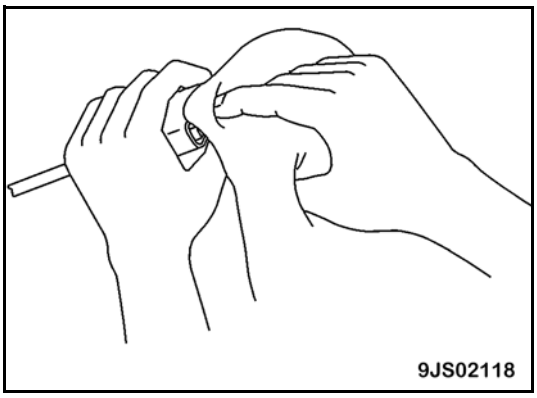
   The connector is designed to make it difficult for water to enter (drip-proof structure). If high-pressure water is sprayed directly on the connector, water may enter the connector, depending on the direction of the water jet. Be careful not to splash water over the connector. The connector is designed to prevent water from entering but, at the same time, if water does enter, it is difficult for it to be drained. If water gets into the connector, the pins will be short-circuited by the water. If any water gets in, immediately dry the connector or take other appropriate action before passing electricity through it.



5. Oil or dirt stuck to connector

   If oil or grease are stuck to the connector and an oil film is formed on the mating surface between the male and female pins, the oil will not let the electricity pass; there will be a defective contact. If there is oil or grease stuck to the connector, wipe it off with a dry cloth or blow it dry with compressed air and spray it with a contact restorer.

   ★ When wiping the mating portion of the connector, be careful not to use excessive force or deform the pins.
   ★ If there is oil or water in the compressed air, the contacts will become even dirtier. Remove the oil and water from the compressed air completely before cleaning with compressed air.



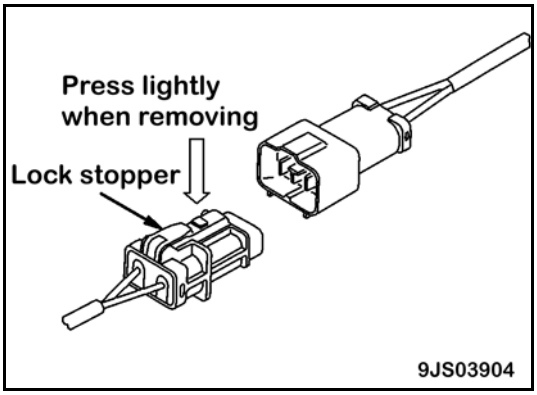
Removing, Installing, and Drying Connectors and Wiring Harnesses

1. Disconnecting connectors

   A. Hold the connectors when disconnecting.

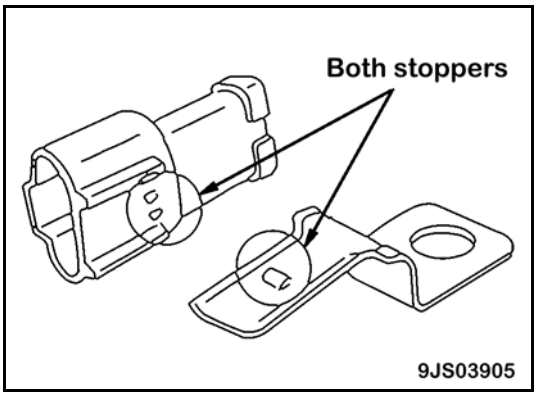
      • For connectors held by a screw, loosen the screw fully, then hold the male and female connectors in each hand and pull apart.
      • For connectors which have a lock stopper, press down the stopper with your thumb and pull the connectors apart.

      ★ Never pull with one hand.

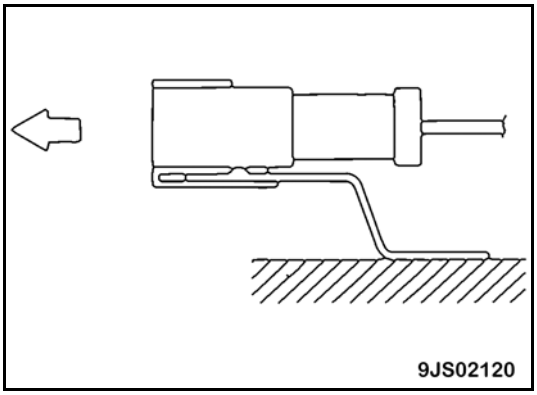


B. When removing from clips

- Both the connector and clip have stoppers, which are engaged with each other when the connector is installed.



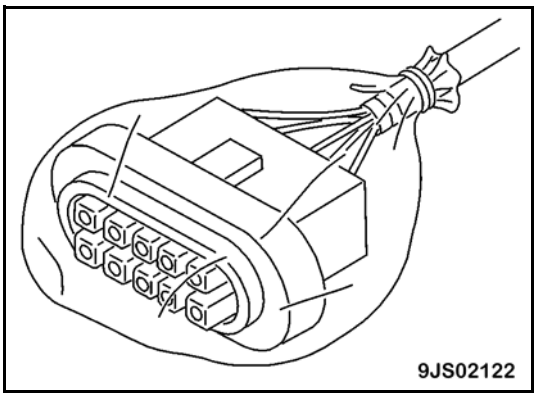
- When removing a connector from a clip, pull the connector in a parallel direction to the clip for removing the stoppers.
  - ★ If the connector is twisted up and down or to the left or right, the housing may break.



C. Action to take after removing connectors

After removing any connector, cover it with a vinyl bag to prevent any dust, dirt, oil, or water from getting in the connector portion.

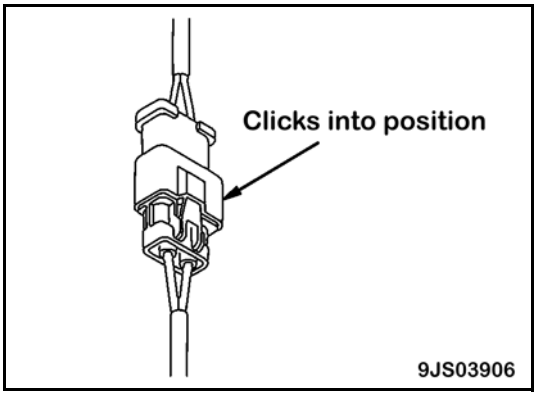
- ★ If the machine is left disassembled for a long time, it is particularly easy for improper contact to occur. Always cover the connector.



2. Connecting connectors

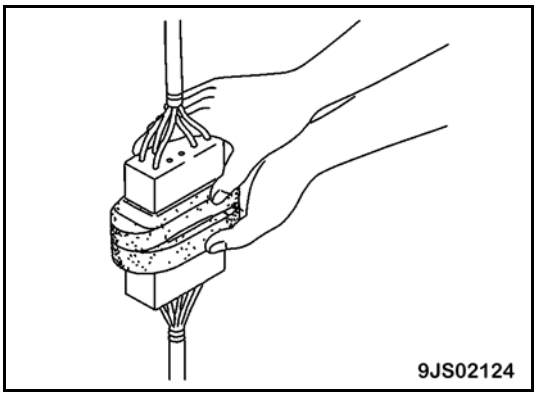
A. Check the connector visually.

- Check that there is no oil, dirt, or water stuck to the connector pins (mating portion).
- Check that there is no deformation, defective contact, corrosion, or damage to the connector pins.
- Check that there is no damage or breakage to the outside of the connector.
  - ★ If there is any oil, water, or dirt stuck to the connector, wipe it off with a dry cloth. If any water has got inside the connector, warm the inside of the wiring with a dryer, but be careful not to make it too hot as this will cause short circuits.
  - ★ If there is any damage or breakage, replace the connector.



B. Fix the connector securely.

Align the position of the connector correctly, and then insert it securely. For connectors with the lock stopper, push in the connector until the stopper clicks into position.

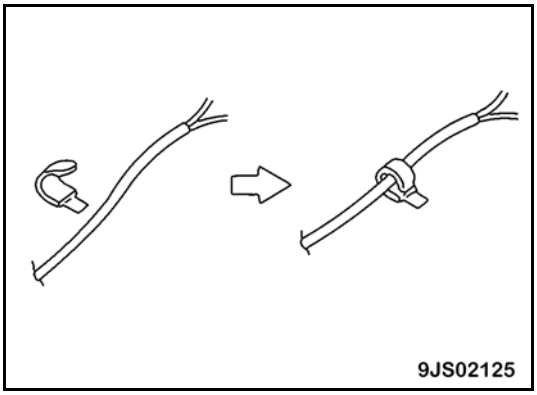


C. Correct any protrusion of the boot and any misalignment of the wiring harness.

For connectors fitted with boots, correct any protrusion of the boot. If the wiring harness is misaligned or the clamp is out of position, adjust it to its correct position.

★ If the connector cannot be corrected easily, remove the clamp and adjust the position.

★ If the connector clamp has been removed, be sure to return it to its original position. Check also that there are no loose clamps.

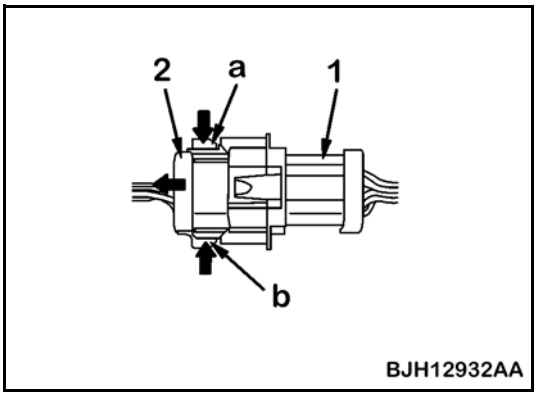


D. Heavy duty wire connector (DT 8-pole, 12-pole)

- Disconnection

  While pressing both sides of locks (a) and (b), pull out female connector (2).

  - (1): Male connector
  - (2): Female connector
  - (a), (b): Locks



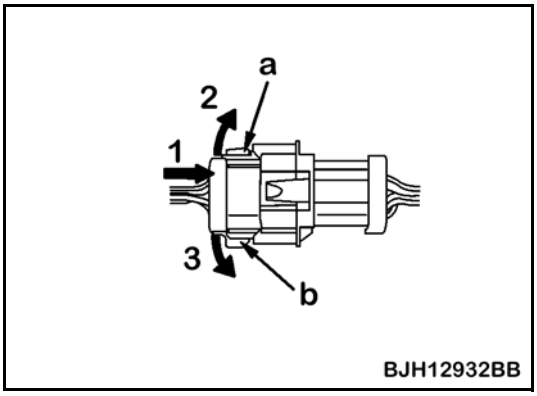
- Connection

  i. Push in female connector (2) horizontally until the lock clicks. (Arrow 1)

  ii. Since locks (a) and (b) may not be set completely, push in female connector (2) while moving it up and down until the locks are set normally. (Arrows 1, 2, 3)

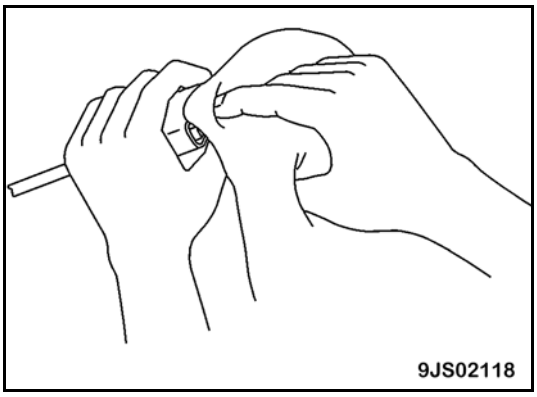
  ★ Lock (a) is pulled down (not set completely) and lock (b) is set completely.

  - (1): Male connector
  - (2): Female connector
  - (a), (b): Locks



E. Drying wiring harness

If there is any oil or dirt on the wiring harness, wipe it off with a dry cloth. Avoid washing it in water or using steam. If the connector must be washed in water, do not use high-pressure water or steam directly on the wiring harness. If water gets directly on the connector, do the following steps.



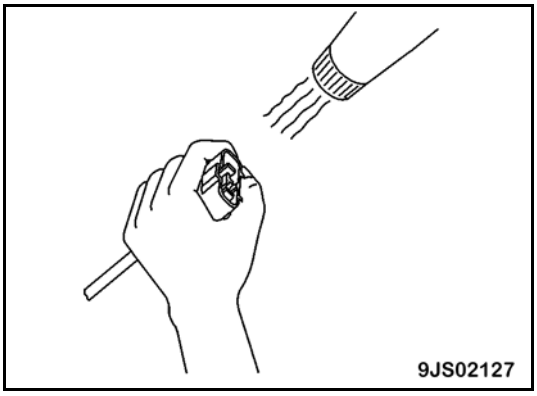
i. Disconnect the connector and wipe off the water with a dry cloth.

★ If the connector is blown dry with compressed air, there is the risk that oil in the air may cause defective contact. Remove all oil and water from the compressed air before blowing with air.

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

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

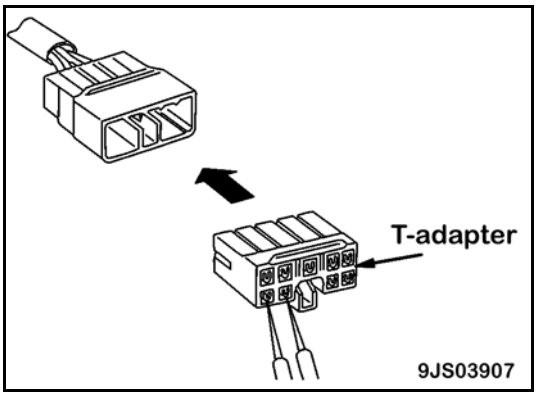
★ Hot air from the dryer can be used, but regulate the time that the hot air is used in order that the connector or related parts do not get too hot; extreme heat will deform or damage the connector.



iii. Carry out a continuity test on the connector.

After drying, leave the wiring harness disconnected and carry out a continuity test to check for any short circuits between pins caused by water.

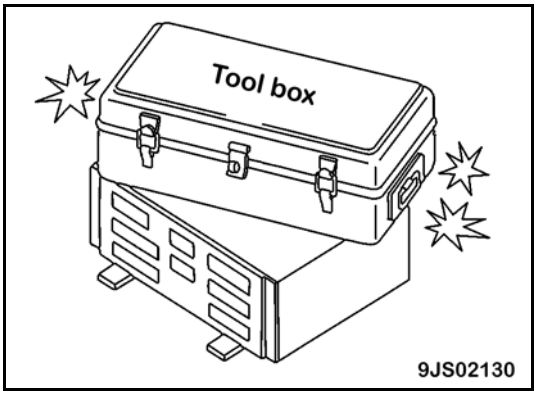
★ After completely drying the connector, blow it with contact restorer and reassemble.



Handling Controller

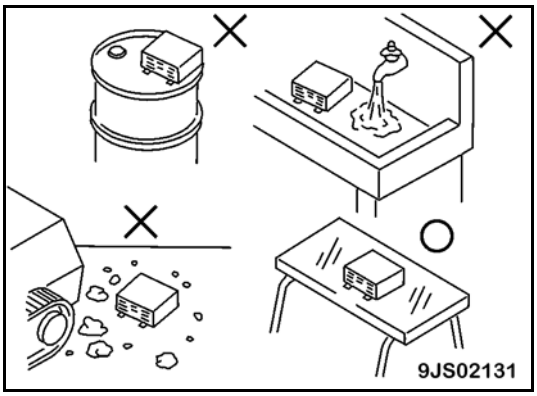
The controller contains a microcomputer and electronic control circuits. These control all of the electronic circuits on the machine; be extremely careful when handling the controller.

- Do not place objects on top of the controller.
- Cover the control connectors with tape or a vinyl bag. Never touch the connector contacts with your hand.
- During rainy weather, do not leave the controller in a place where it is exposed to rain.



- Do not place the controller on oily or damp surfaces, or on soil. Do not place the controller in a hot place, even for a short time. Place it on a suitable dry stand.
- Precautions when carrying out arc welding

  When carrying out arc welding on the body, disconnect all wiring harness connectors connected to the controller. Fit an arc welding ground close to the welding point.



Troubleshooting Electric Circuits

1. Always turn the power OFF before disconnecting or connecting connectors.
2. Before carrying out troubleshooting, check that all the related connectors are properly inserted.

   ★ Disconnect and connect the related connectors several times to check.
3. Always connect any disconnected connectors before going to the next step.

   ★ If the power is turned ON with the connectors still disconnected, unnecessary abnormal displays will be generated.
4. When carrying out troubleshooting of circuits (measuring the voltage, resistance, continuity, or current), move the related wiring and connectors several times and check that there is no change in the reading of the tester.

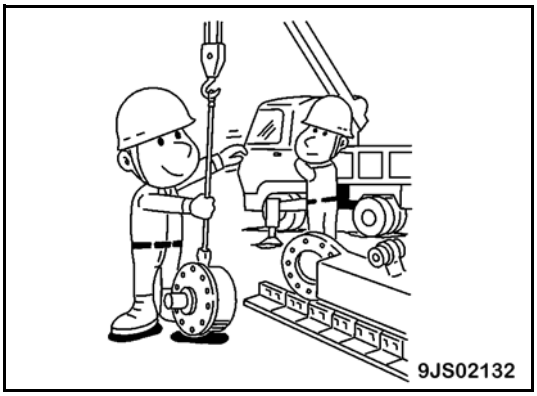
   ★ If there is any change, there is probably a defective contact in that circuit.

Handling Hydraulic Equipment

With the increase in pressure and precision of hydraulic equipment, the most common cause of failure is dirt (foreign material) in the hydraulic circuit. When adding hydraulic oil, or when disassembling or assembling hydraulic equipment, it is necessary to be particularly careful.

1. Be careful of the operating environment.

   Avoid adding hydraulic oil, replacing filters, or repairing the machine in rain or high winds, or in places where there is a lot of dust.

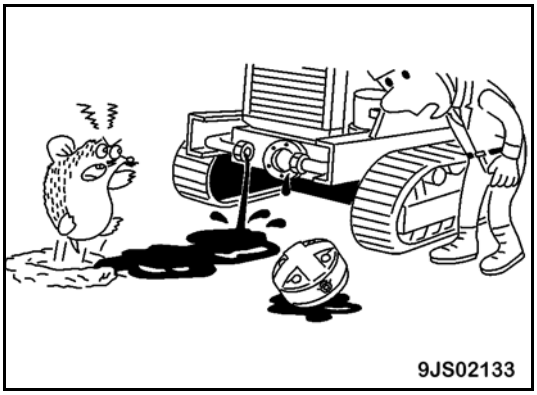


2. Disassembly and maintenance work in the field

   If disassembly or maintenance work is carried out on hydraulic equipment in the field, there is danger of dust entering the equipment. It is also difficult to check the performance after repairs. It is preferable to use unit exchange. Disassembly and maintenance of hydraulic equipment should be carried out in a specially prepared dustproof workshop, and the performance should be checked with special test equipment.

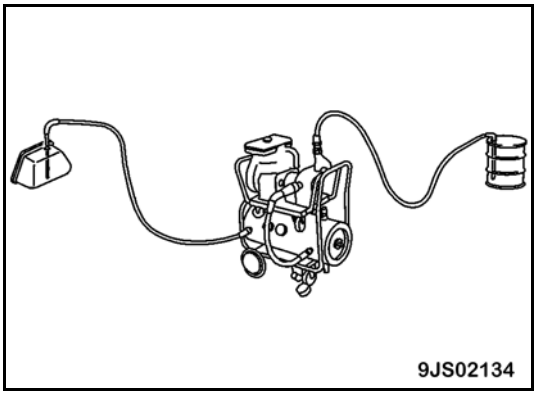
3. Sealing openings

   After any piping or equipment is removed, the openings should be sealed with caps, tapes, or vinyl bags to prevent any dirt or dust from entering. If the opening is left open or is blocked with a rag, there is danger of dirt entering or of the surrounding area being soiled by leaking oil. Do not use rags to block openings. Do not drain oil out onto the ground; collect it and ask the customer to dispose of it, or take it back with you for disposal.



4. Do not let any dirt or dust get in during refilling operations.

   Be careful not to let any dirt or dust get in when refilling with hydraulic oil. Always keep the oil filler and the area around it clean, and also use clean pumps and oil containers. If an oil cleaning device is used, it is possible to filter out the dirt that has collected during storage; this is an even more effective method.

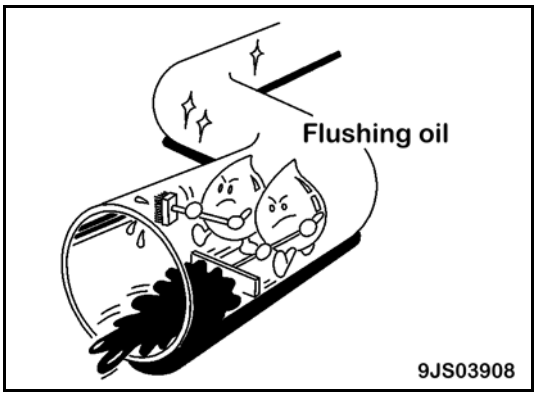


5. Change hydraulic oil when the temperature is high.

   When hydraulic oil or other oil is warm, it flows easily. In addition, the sludge can also be drained out easily from the circuit together with the oil. It is preferable to change the oil when it is still warm. When changing the oil, as much as possible of the old hydraulic oil must be drained out. Drain the oil from the hydraulic tank; also drain the oil from the filter and from the drain plug in the circuit.
   If any old oil is left, the contaminants and sludge in it will mix with the new oil and will shorten the life of the hydraulic oil.

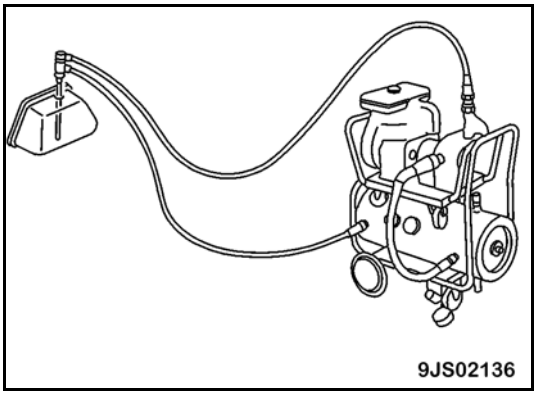
6. Flushing operations

   After disassembling and assembling the equipment, or changing the oil, use flushing oil to remove the contaminants, sludge, and old oil from the hydraulic circuit. Normally, flushing is carried out twice: primary flushing is carried out with flushing oil, and secondary flushing is carried out with the specified hydraulic oil.



7. Cleaning operations

   After repairing the hydraulic equipment (pump, control valve, etc.) or when running the machine, carry out oil cleaning to remove the sludge or contaminants in the hydraulic oil circuit. The oil cleaning equipment is used to remove the ultra fine (about 3 μ) particles that the filter, built in the hydraulic equipment, cannot remove; it is an extremely effective device.



Handling Connectors Used for Engines

The following engines use the connectors described in this section.

- 95E-5
- 107E-1
- 114E-3
- 125E-5
- 140E-5
- 170E-5
- 12V140E-3

★ Your machine has a 107-E engine.

Slide Lock Type

FRAMATOME-3, FRAMATOME-2

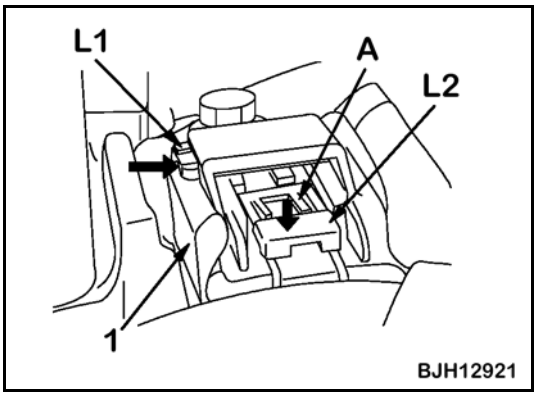
★ 95 – 170, 12V140 engines

- Pressure sensors and NE speed sensor

Engine	Sensor
125, 170, 12V140	Intake air pressure sensor in intake manifold: PIM
125, 170, 12V140	Oil pressure sensor: POIL
95, 107, 114	Oil pressure switch
95 – 170, 12V140	Ne speed sensor of flywheel housing: NE
125, 170, 12V140	Ambient pressure sensor: PAMB

Disconnect connector (1) according to the following procedure.

1. Slide lock (L1) to the right.
2. While pressing lock (L2), pull out connector (1) toward you.
3. Even if lock (L2) is pressed, connector (1) cannot be pulled toward you if part A does not float. In this case, float part A with a small screwdriver while pressing lock (L2), and then pull out connector (1) toward you.



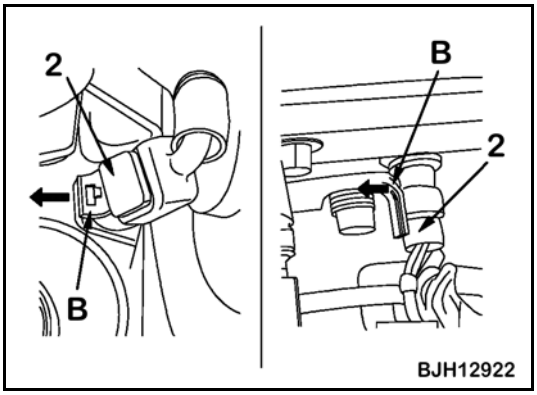
Pull Lock Type

PACKARD-2

★ 95 – 170, 12V140 engines

• Temperature sensors

Engine	Sensor
95 – 170, 12V140	Intake air temperature sensor in intake manifold: TIM
	Fuel temperature sensor: TFUEL
	Oil temperature sensor: TOIL
	Coolant temperature sensor: TWTR, etc.



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

Push Lock Type

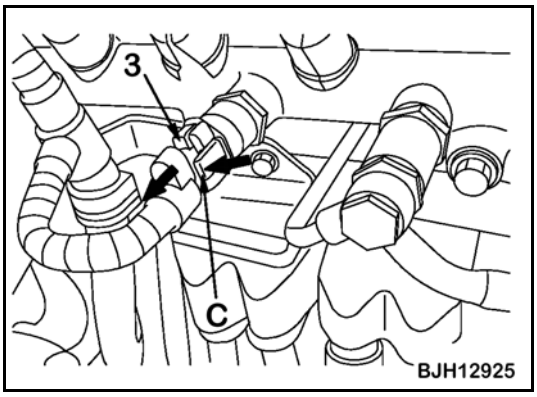
★ 95, 107, 114 engines

Connector	Sensor
BOSCH0-03	Fuel pressure sensor in common rail

Disconnect connector (3) according to the following procedure.

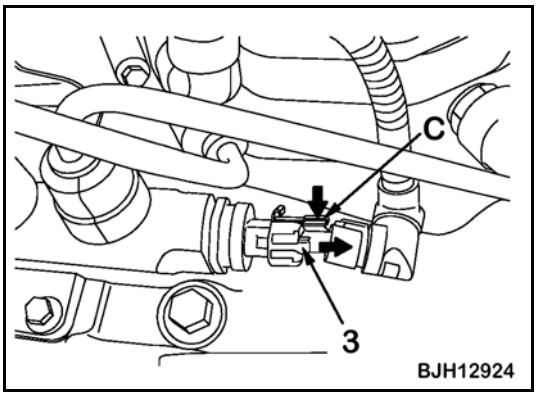
1. While pressing lock (C), pull out connector (3) in the direction of the arrow.

   ★ 114 engine (see graphic)

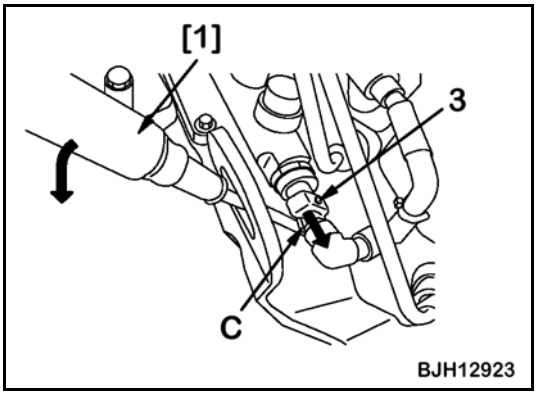


★ 107 engine (see graphic)

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



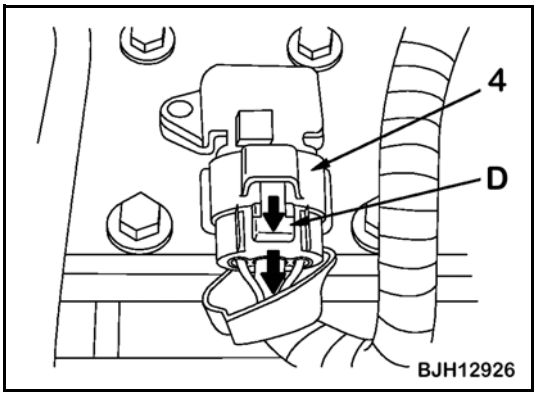
2. While pressing up lock (C) of the connector with flat-head screwdriver [1], pull out connector (3) in the direction of the arrow.



★ 107, 114 engines

Connector	Sensor
SUMITOMO-04	Intake air pressure/temperature sensor in intake manifold

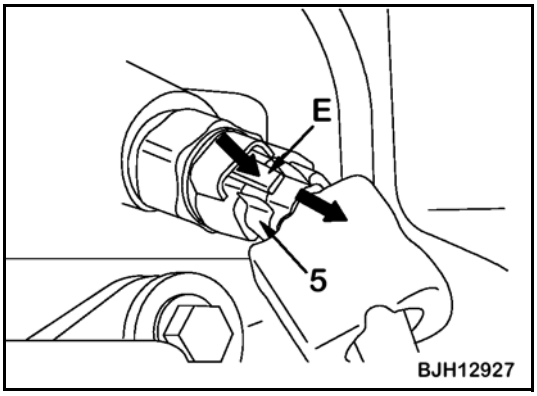
3. While pressing lock (D), pull out connector (4) in the direction of the arrow.



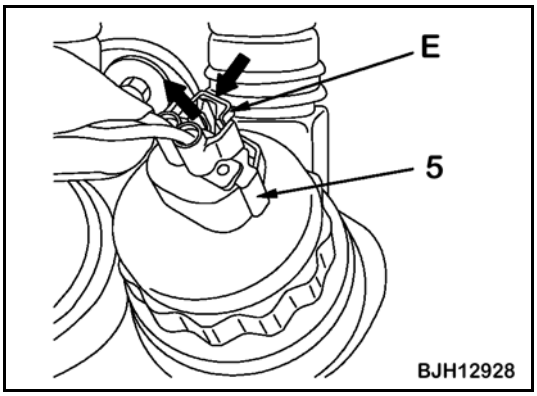
★ 95, 125 – 170, 12V140 engines

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

★ Fuel pressure sensor in common rail: PFUEL, etc. (AMP-3)

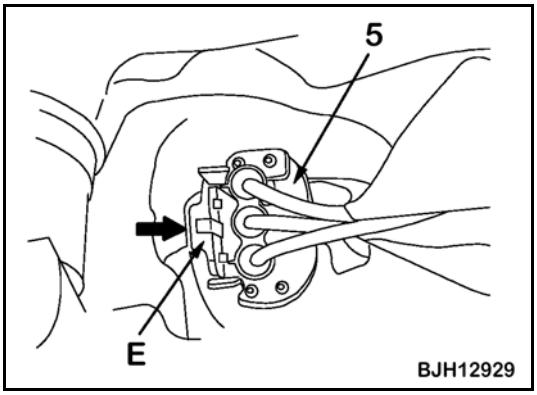


★ Injection pressure control valve of fuel supply pump: PCV (SUMITOMO-2)



★ Speed sensor of fuel supply pump: G (SUMITOMO-3)

★ Pull the connector straight up.



Turn-housing Type (Round Green Connector)

★ 140 engine

★ Intake air pressure sensor in intake manifold (CANNON-04): PIM etc.

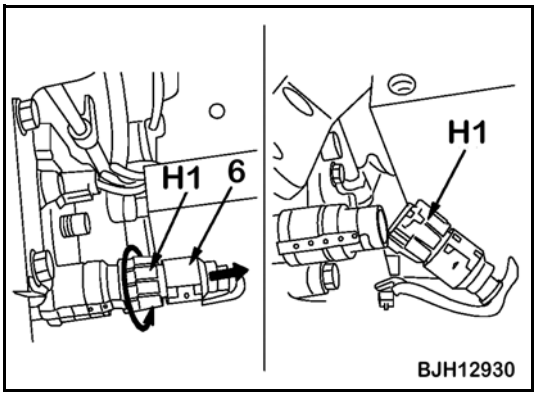
1. Disconnect connector (6) according to the following procedure.

   A. Turn housing (H1) in the direction of the arrow.

      ★ When the connector is unlocked, housing (H1) becomes heavy to turn.

   B. Pull out housing (H1) in the direction of the arrow.

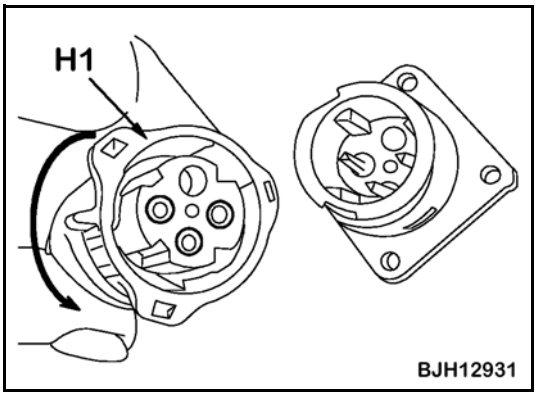
      ★ Housing (H1) is left on the wiring harness side.



2. Connect the connector according to the following procedure.

   A. Insert the connector to the end, while setting its groove.

   B. Turn housing (H1) in the direction of the arrow until it clicks.



PRECAUTIONS FOR OPERATIONS

★ When carrying out removal or installation (disassembly or assembly) of units, be sure to follow the general precautions given in this section when carrying out the operation.

Precautions when Carrying Out Removal Work

- If the coolant contains antifreeze, dispose of it correctly.
- After disconnecting hoses or tubes, cover them or fit plugs to prevent dirt or dust from entering.
- When draining oil, prepare a container of adequate size to catch the oil.
- Confirm the match marks showing the installation position, and make match marks in the necessary places before removal 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.
- Fit wires and hoses with tags to show their installation position to prevent any mistake when installing.
- Check the number and thickness of the shims, and keep in a safe place.
- When raising components, be sure to use lifting equipment of ample strength.
- When using forcing screws to remove any components, tighten the forcing screws uniformly in turn.
- Before removing any unit, clean the surrounding area and fit a cover to prevent any dust or dirt from entering after removal.

★ Precautions when handling piping during disassembly

Fit the following plugs into the piping after disconnecting it during disassembly operations.

- Face seal type hoses and tubes

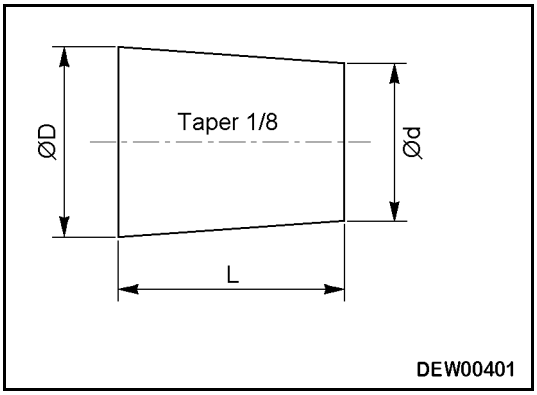
Nominal Number	Plug (nut end)	Sleeve Nut (elbow end)
02	07376-70210	02789-20210
03	07376-70315	02789-20315
04	07376-70422	02789-20422
05	07376-70522	02789-20522
06	07376-70628	02789-20628
10	07376-71034	07221-21034
12	07376-71234	07221-21234

- Split flange type hoses and tubes

Nominal Number	Flange (hose end)	Sleeve Head (tube end)	Split Flange
04	07379-00400	07378-10400	07371-30400
05	07379-00500	07378-10500	07371-30500

- If the part is not under hydraulic pressure, the following corks can be used.

Nominal Number	Part Number	Dimensions		
		D	d	L
06	07049-00608	6	5	8
08	07049-00811	8	6.5	11
10	07049-01012	10	8.5	12
12	07049-01215	12	10	15
14	07049-01418	14	11.5	18
16	07049-01620	16	13.5	20
18	07049-01822	18	15	22
20	07049-02025	20	17	25
22	07049-02228	22	18.5	28
24	07049-02430	24	20	30
27	07049-02734	27	22.5	34



Precautions when Carrying Out Installation Work

- Tighten all bolts and nuts (sleeve nuts) to the specified (KES) torque.
- Install the hoses without twisting or interference and fix them with intermediate clamps, if there are any.
- Replace all gaskets, O-rings, cotter pins, and lock plates with new parts.
- Bend the cotter pins and lock plates securely.
- When coating with adhesive, clean the part and remove all oil and grease, then coat the threaded portion with two to three drops of adhesive.
- When coating with gasket sealant, clean the surface and remove all oil and grease; check that there is no dirt or damage; then coat uniformly with gasket sealant.
- Clean all parts, and correct any damage, dents, burrs, or rust.
- Coat rotating parts and sliding parts with engine oil.
- When press-fitting parts, coat the surface with anti-friction compound (LM-P).
- After fitting snap rings, check that the snap ring is fitted securely in the ring groove.
- When connecting wiring connectors, clean the connector to remove all oil, dirt, or water; then connect securely.
- When using eyebolts, check that there is no deformation or deterioration; screw them in fully; and align the direction of the hook.
- When tightening split flanges, tighten uniformly in turn to prevent excessive tightening on one side.

★ When operating the hydraulic cylinders for the first time after reassembling cylinders, pumps, and other hydraulic equipment removed for repair, always bleed the air in the following manner:

1. Start the engine and run at low idle.
2. Operate the work equipment control lever to operate the hydraulic cylinder four to five times, stopping the cylinder 100 mm from the end of its stroke.
3. Next, operate the hydraulic cylinder three to four times to the end of its stroke.
4. After doing this, run the engine at normal speed.

★ When using the machine for the first time after repair or long storage, do the same procedure.

Precautions when Completing the Operation

1. Refilling with coolant, oil, and grease

   - If the coolant has been drained:
     - Tighten the drain valve and add coolant to the specified level.
     - Run the engine to circulate the coolant through the system.
     - Check the coolant level again.
   - If the hydraulic equipment has been removed and installed again:
     - Add oil to the specified level.
     - Run the engine to circulate the oil through the system.
     - Check the oil level again.
   - If the piping or hydraulic equipment has been removed, always bleed the air from the system after reassembling the parts.
     ★ For details, see *WORK EQUIPMENT: Bleeding Air from Hydraulic Circuit* in the *Testing and Adjusting* section.
   - Add the specified amount of grease (molybdenum disulphide grease) to the work equipment parts.

2. Checking cylinder head and manifolds for looseness

   - Check the cylinder head and intake and exhaust manifold for looseness.
   - If any part is loosened, retighten it.
     ★ For the tightening torque, see *ENGINE AND COOLING SYSTEM: Cylinder Head Assembly* in the *Disassembly and Assembly* section.

3. Checking engine piping for damage and looseness

   - Intake and exhaust system
     - Check the piping for damage; the mounting bolts and nuts for looseness; and the joints for air suction and exhaust gas leakage.
     - If any part is loosened or damaged, retighten or repair it.
   - Cooling system
     - Check the piping for damage; the mounting bolts and nuts for looseness; and the joints for coolant leakage.
     - If any part is loosened or damaged, retighten or repair it.
   - Fuel system
     - Check the piping for damage; the mounting bolts and nuts for looseness; and the joints for fuel leakage.
     - If any part is loosened or damaged, retighten or repair it.

4. Checking muffler and exhaust pipe for damage and looseness

   - Visually check the muffler, exhaust pipe, and their mounting parts for cracks or damage.
     - If any part is damaged, replace it.
   - Check the mounting bolts and nuts of the muffler, exhaust pipe, and their mounting parts for looseness.
     - If any bolt or nut is loosened, retighten it.

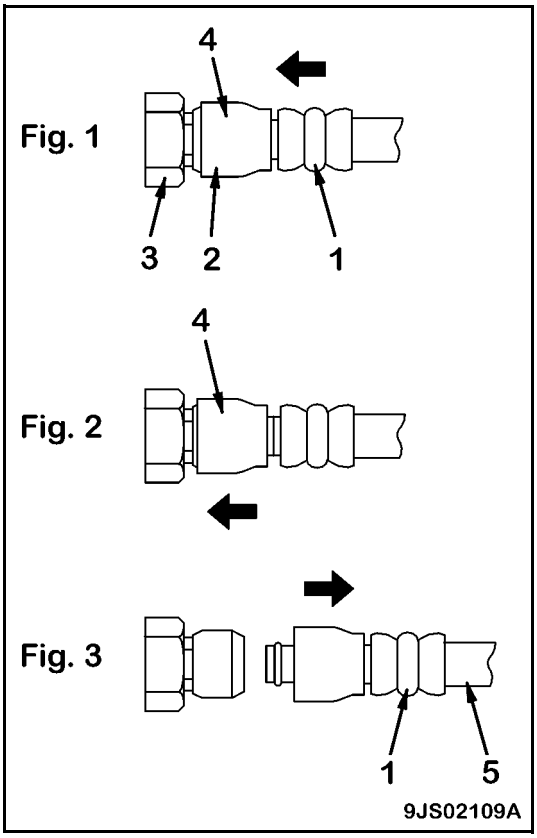
5. Checking muffler function

   - Check the muffler for abnormal sound and sound different from that of a new muffler.
   - If any abnormal sound is heard, repair the muffler.

PUSH-PULL COUPLER

WARNING! Before carrying out the following work, release the residual pressure from the hydraulic tank. Loosen the oil filler cap of the hydraulic tank gradually to release the residual pressure from the hydraulic tank.

WARNING! Even if the residual pressure is released from the hydraulic tank, some hydraulic oil flows out when the hose is disconnected. Prepare a container to receive the oil.



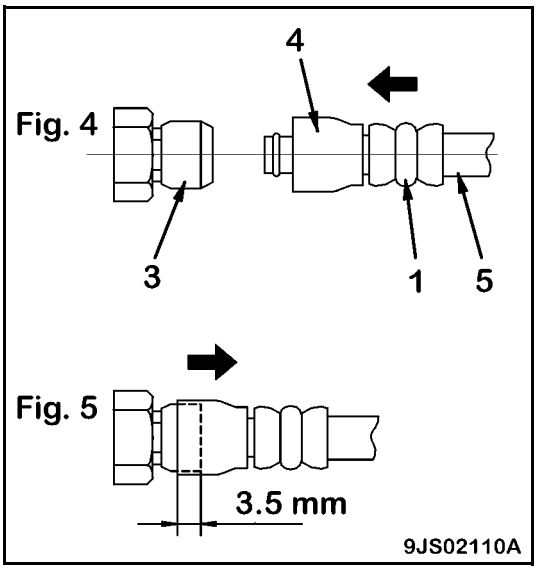
Type 1

Disconnection

1. Release the residual pressure from the hydraulic tank. For details, see *WORK EQUIPMENT: Releasing Remaining Pressure in Hydraulic Circuit* in the *Testing and Adjusting section.*
2. Hold adapter (1) and push hose joint (2) into mating adapter (3). (Fig. 1)
   - The adapter can be pushed in about 3.5 mm (0.14 in).
   - ★ Do not hold the rubber cap portion (4).
3. After hose joint (2) is pushed into adapter (3), press rubber cap portion (4) against the adapter until it clicks. (Fig. 2)
4. Hold hose adapter (1) or hose (5) and pull it out. (Fig. 3)
   - Since some hydraulic oil flows out, prepare a container to receive the oil.

Connection

1. Hold hose adapter (1) or hose (5) and insert it in mating adapter (3), aligning them with each other. (Fig. 4)
   - ★ Do not hold the rubber cap portion (4).
2. After inserting the hose in the mating adapter, pull it back to check its connecting condition. (Fig. 5)
   - ★ When the hose is pulled back, the rubber cap portion moves toward the hose about 3.5 mm (0.14 in). This does not indicate an abnormality.



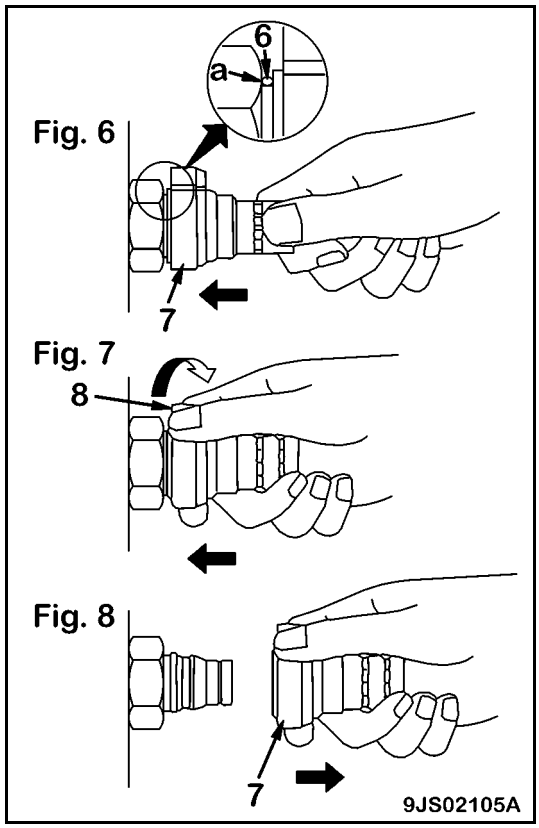
Type 2

Disconnection

1. Hold the tightening portion and push body (7) in straight until sliding prevention ring (6) contacts contact surface (**a**) of the hexagonal portion at the male end. (Fig. 6)

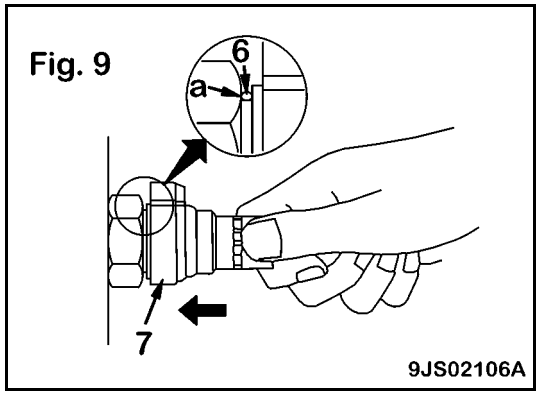
2. Hold in the condition in Step 1 and turn lever (8) to the right (clockwise). (Fig. 7)

3. Hold in the condition in Steps 1 and 2, and pull out whole body (8) to disconnect it. (Fig. 8)



Connection

1. Hold the tightening portion and push body (7) in straight until sliding prevention ring (6) contacts contact surface (**a**) of the hexagonal portion at the male end. (Fig. 9)



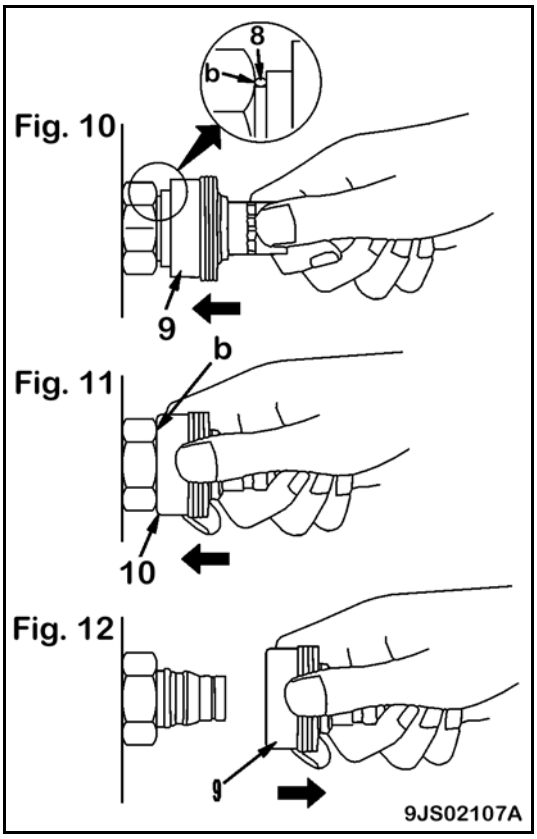
Type 3

Disconnection

1. Hold the tightening portion and push body (9) in straight until sliding prevention ring (8) contacts contact surface (**b**) of the hexagonal portion at the male end. (Fig. 10)

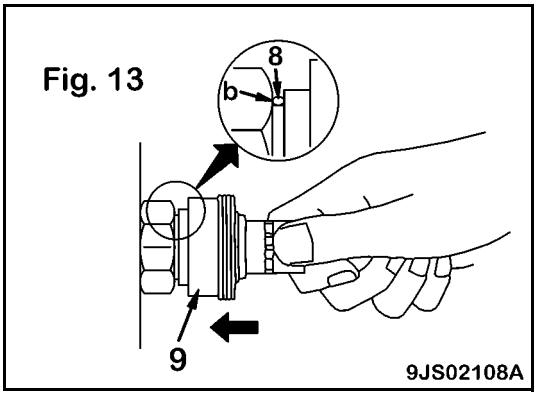
2. Hold in the condition in Step 1 and push cover (10) straight until it contacts contact surface (**b**) of the hexagonal portion at the male end. (Fig. 11)

3. Hold in the condition in Steps 1 and 2, and pull out whole body (9) to disconnect it. (Fig. 12)



Connection

1. Hold the tightening portion and push body (9) in straight until the sliding prevention ring contacts contact surface (**b**) of the hexagonal portion at the male end. (Fig. 13)



COATING MATERIALS

★ The recommended coating materials prescribed in the shop manuals are listed below.

Category	Code	Part No.	Quantity	Container	Main Applications, Features
Adhesives	LT-1A	790-129-9030	150 g	Tube	• Used to prevent rubber gaskets, rubber cushions, and cork plugs from coming out
	LT-1B	790-129-9050	20 g (2 pes.)	Polyethylene container	• Used in places requiring an immediately effective, strong adhesive. • Used for plastics (except polyethylene, polypropylene, tetrafluoroethylene, and vinyl chloride), rubber, metal, and non-metal.
	LT-2	09940-00030	50 g	Polyethylene container	• Features: Resistance to heat, chemicals • Used for anti-loosening and sealant purposes for bolts and plugs.
	LT-3	790-129-9060 (Set of adhesive and hardening agent)	Adhesive: 1 kg Hardening agent: 500 g	Can	• Used as adhesive or sealant for metal, glass, or plastic.
	LT-4	790-129-9040	250 g	Polyethylene container	• Used as sealant for machined holes.
	Holtz MH 705	790-126-9120	75 g	Tube	• Used as heat-resisting sealant for repairing engine.
	Three bond 1735	179-129-9140	2 g	Polyethylene container	• Quick hardening-type adhesive. • Cure time: within 5 sec. to 3 min. • Used mainly for adhesion of metals, rubbers, plastics, and woods.
	Aron-alpha 201	790-129-9130	50 g	Polyethylene container	• Quick hardening-type adhesive. • Quick cure-type (maximum strength after 30 minutes). • Used mainly for adhesion of rubbers, plastics, and metals.
	Loctite 648-50	79A-129-9110	50 cc	Polyethylene container	• Features: Resistance to heat, chemicals • Used at joint portions subject to high temperature.
Gasket sealant	LG-1	790-129-9010	200 g	Tube	• Used as adhesive or sealant for gaskets and packing of power train case, etc.
	LG-3	790-129-9070	1 kg	Can	• Features: Resistance to heat • Used as sealant for flange surfaces and bolts at high temperature locations; used to prevent seizure. • Used as sealant for heat-resistant gasket for high-temperature locations such as engine precombustion chamber, exhaust pipe.

Category	Code	Part No.	Quantity	Container	Main Applications, Features
Gasket sealant	LG-4	790-129-9020	200 g	Tube	• Features: Resistance to water, oil • Used as sealant for flange surface, thread. • Also possible to use as sealant for flanges with large clearance. • Used as sealant for mating surfaces of final drive case, transmission case.
	LG-5	790-129-9080	1 kg	Polyethylene container	• Used as sealant for various threads, pipe joints, flanges. • Used as sealant for tapered plugs, elbows, nipples of hydraulic piping.
	LG-6	09940-00011	250 g	Tube	• Features: Silicon-based, resistant to heat, cold. • Used as sealant for flange surface, thread. • Used as sealant for oil pan, final drive case, etc.
	LG-7	09920-00150	150 g	Tube	• Features: Silicon-based, quick-hardening type. • Used as sealant for flywheel housing, intake manifold, oil pan, thermostat housing, etc.
	Three bond 1211	790-129-9090	100 g	Tube	• Used as heat-resisting sealant for repairing engines.
Molybdenum disulphide lubricant	LM-G	09940-00051	60 g	Can	• Used as lubricant for sliding parts (to prevent squeaking).
	LM-P	09940-00040	200 g	Tube	• Used to prevent seizure or scuffing of the thread when press fitting or shrink fitting. • Used as lubricant for linkage, bearings, etc.
Grease	G2-LI	SYG2-400LI SYG2-350LI SYG2-400LI-A SYG2-160LI SYGA160CNLI	Various	Various	• General purpose type.
	G2-CA	SYG2-400CA SYG2-350CA SYG2-400CA-A SYG2-160CA SYG2-160CNCA	Various	Various	• Used for normal temperature, light load bearing at places in contact with water or steam.
	Molybdenum disulphide lubricant	SYG2-400M	400 g (10 per case)	Belows type	• Used for places with heavy load.

STANDARD TIGHTENING TORQUE

Standard Tightening Tables

For Bolts and Nuts

★ Unless there are special instructions, tighten metric nuts and bolts to the torque shown in this table.

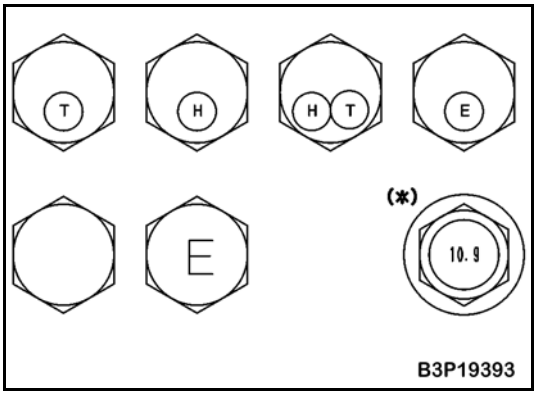
★ The following table applies to the bolts in Figure A.

Thread Diameter of Bolt	Width across Flats	Tightening Torque		
mm	mm	N•m	kgm	lbf ft
6	10	11.8 – 14.7	1.2 – 1.5	9 – 11
8	13	27 – 34	2.8 – 3.5	20 – 25
10	17	59 – 74	6.0 – 7.5	44 – 55
12	19	98 – 123	10.0 – 12.5	72 – 91
14	22	157 – 196	16 – 20	116 – 145
16	24	245 – 309	25 – 31.5	181 – 228
18	27	343 – 427	35 – 43.5	253 – 315
20	30	490 – 608	50 – 62	361 – 448
22	32	662 – 829	67.5 – 84.5	488 – 611
24	36	824 – 1,030	84 – 105	608 – 760
27	41	1,180 – 1,470	120 – 150	870 – 1,044
30	46	1,520 – 1,910	155 – 195	1,121 – 1,409
33	50	1,960 – 2,450	200 – 250	1,446 – 1,807
36	55	2,450 – 3,040	250 – 310	1,807 – 2,242
39	60	2,890 – 3,630	295 – 370	2,132 – 2,677

★ Figure A

The widths across flats against the thread diameters of flanged bolts (marks with “*”) in Figure A are the ones indicated in the table for bolts shown in Figure B.

Values of tightening torques shown in the table for Figure A are applied.



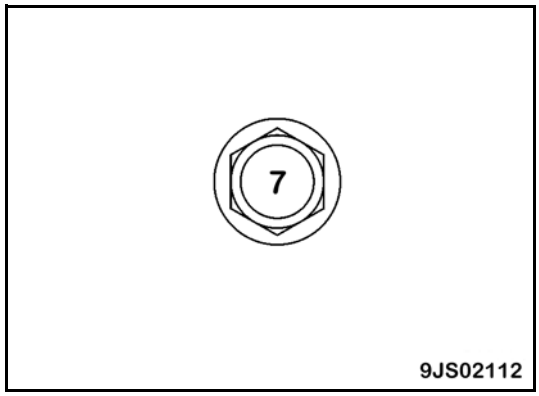
★ This table corresponds to the bolts in Figure B.

Thread Diameter of Bolt	Width across Flats	Tightening Torque		
mm	mm	N•m	kgm	lbf in
6	10	5.9 – 9.8	0.6 – 1.0	52 – 88
mm	mm	N•m	kgm	lbf ft
8	13	13.7 – 23.5	1.4 – 2.4	10 – 17
10	14	34.3 – 46.1	3.5 – 4.7	25 – 34
12	27	74.5 – 90.2	7.6 – 9.2	55 – 66

★ Figure B

The widths across flats against the thread diameters of flanged bolts (marks with "*") in Figure A are the ones indicated in the table for bolts shown in Figure B.

Values of tightening torques shown in the table for Figure A are applied.



For Split Flange Bolts

★ Unless there are special instructions, tighten split flange bolts to the torque in this table.

Thread Diameter	Width across Flats	Tightening Torque		
mm	mm	N•m	kgm	lbf ft
10	14	59 – 74	59 – 74	44 – 55
12	17	98 – 123	98 – 123	72 – 91
16	22	235 – 285	235 – 285	173 – 210

For O-Ring Boss Piping Joints

★ Unless there are special instructions, tighten the O-ring boss piping joints to the torque in this table.

Norminal No.	Thread Diameter	Width across Flats	Tightening Torque (N•m [kgm] {lbf ft})	
	mm	mm	Range	Target
02	14	Varies depending on type of connector.	35 – 63 [3.5 – 6.5] {25.81 – 46.47}	44 [4.5] {33}
03, 04	20		84 – 132 [8.5 – 13.5] {61.96 – 97.36}	103 [10.5] {76}
05, 06	24		128 – 186 [13.0 – 19.0] {94.41 – 137.19}	157 [16.0] {116}
10, 12	33		363 – 480 [37.0 – 49.0] {267.73 – 354.03}	422 [43.0] {311}
14	42		746 – 1010 [76.0 – 103.0] {550.22 – 744.94}	883 [90.0] {651}

For O-Ring Boss Plugs

★ Unless there are special instructions, tighten the O-ring boss plugs to the torque in this table.

Norminal No.	Thread Diameter	Width across Flats	Tightening Torque (N•m [kgm] {lbf lb})	
	mm	mm	Range	Target
08	08	14	5.88 – 8.82 [0.6 – 0.9] {4.33 – 6.50}	7.35 [0.75] {5}
10	10	17	9.8 – 12.74 [1.0 – 1.3] {7.22 – 9.39}	11.27 [1.15] {8}
12	12	19	14.7 – 19.6 [1.5 – 2.0] {10.84 –- 14.45}	17.64 [1.8] {13}
14	14	22	19.6 – 24.5 [2.0 – 2.5] {14.45 – 18.07}	22.54 [2.3] {17}
16	16	24	24.5 – 34.3 [2.5 – 3.5] {18.07 – 25.29}	29.4 [3.0] {22}
18	18	27	34.3 – 44.1 [3.5 – 4.5] {25.29 – 32.52}	39.2 [4.0] {29}
20	20	30	44.1 – 53.9 [4.5 – 5.5] {32.52 – 39.75}	49.0 [5.0] {36}
24	24	32	58.8 – 78.4 [6.0 – 8.0] {43.36 – 57.82}	68.6 [7.0] {51}
30	30	32	93.1 – 122.5 [9.5 – 12.5] [{68.66 – 90.35}	107.8 [11.0] {80}
33	33	_	107.8 – 147.0 [11.0 – 15.0] {79.50 – 108.42}	124.4 [13.0] {92}
36	36	36	127.4 – 176.4 [13.0 – 18.0] {93.96 – 130.10}	151.9 [15.5] {112}
42	42	_	181.3 –240.1 [18.5 – 24.5] {133.72 – 177.08}	210.7 [21.5] {155}
52	52	_	274.4 – 367.5 [28.0 – 37.5] {202.38 – 271.05}	323.4 [33.0] {239}

For Hoses (Taper-Seal Type and Face-Seal Type)

★ Unless there are special instructions, tighten the hoses (taper seal type and face seal type) to the torque in this table.

★ Apply the following torque when the threads are coated (wet) with engine oil.

Nominal Size of Hose	Width across Flat	Tightening Torque (N•m [kgm] {lbf ft})		Taper-Seal Type	Face-Seal Type	
		Range	Target	Thread Size (mm)	Nominal Thread Size Threads per Inch, Thread Series	Root Diameter (mm) (Reference)
02	19	34 – 54 [3.5 – 5.5] {25 – 40}	44 [4.5] {33}	–	9/16 - 18UN	14.3
		34 – 63 [3.5 – 6.5] {25 – 47}		14	–	–
03	22	54 – 93 [5.5 – 9.5] {40 – 69}	74 [7.5] {55}	–	11/16 -16UN	17.5
	24	59 – 98 [6.0 – 10.0] {44 – 72}	78 [8.0] {58}	18	–	–
04	27	84 – 132 [8.5 – 13.5] {62 – 97}	103 [10.5] {76}	22	13/16 - 16UN	20.6
05	32	128 – 186 [13.0 – 19.0] {94 – 137}	157 [16.0] {116}	24	1 - 14UNS	25.4
06	36	177 – 245 [18.0 – 25.0] {1315 – 181}	216 [22.0] {159}	30	1 3/16 - 12UN	30.2
(10)	41	177 – 245 [18.0 – 25.0] {131 – 181}	216 [22.0] {159}	33	–	–
(12)	46	197 – 294 [20.0 – 30.0] {145 – 217}	245 [25.0] {181}	36	–	–
(14)	55	246 – 343 [25.0 – 35.0] {181 – 253}	294 [30.0] {217}	42	–	–

For Face Seal Joints

★ Tighten the face seal joints (sleeve nut type) made of plated steel pipes for low pressure service to be used for engines, etc. to the torque shown in this table.

★ Apply the following torque to the face seal joint while their threaded parts are coated with engine oil (wetted).

Outer Diameter of Pipe (mm)	Width across Flats (mm)	Tightening Torque N•m [kgm] {lbf ft}		Face seal	
		Range	Target	Nominal No. – Number of threads, Type of Thread	Thread Diameter (mm) (Reference)
8	19	14 – 16 [1.4 – 1.6] {10 – 12}	15 [1.5] {11}	9/16-18UN	14.3
10	22	24 – 27 [2.4 – 2.7] {18 – 20}	25.5 [2.6] {19}	11/16-16UN	17.5
12	24 (27)	43 – 47 [4.4 – 4.8] {32 – 35}	45 [4.6] {33}	13/16-16UN	20.6
15 (16)	30 (32)	60 – 68 [6.1 – 6.8] {44 – 50}	64 [6.5] {47}	1-14UN	25.4
22 (20)	36	90 – 95 [9.2 – 9.7] {66 – 70}	92.5 [9.4] {68}	1-3/16-12UN	30.2

Reference: The face seal joints of the dimensions in ( ) are also used, depending on the specification.

For 102, 107, and 114 Engine Series (Bolts and Nuts)

Unless there are special instructions, tighten the metric bolts and nuts of the 102, 107 and 114 engine series to the torque in this table.

Thread Size	Tightening Torque		
	Bolts and Nuts		
mm	N•m	kgm	lbf in
6	10 ±2	1.02 ±0.20	89 ±18
mm	N•m	kgm	lbf ft
8	24 ±4	2.45 ±0.41	18 ±3
10	43 ±6	4.38 ±0.61	32 ±4
12	77 ±12	7.85 ±1.22	57 ±9
14	—	—	

For 102, 107, and 114 Engine Series (Eye Joints)

Unless there are special instructions, tighten the metric eye joints of the 102, 107, and 114 engine series to the torque in this table.

Thread size Tightening Torque			
mm	N•m	kgm	lbf in
6	8 ±2	0.81 ±0.20	71 ±18
8	10 ±2	1.02 ±0.20	89 ±18
10	12 ±2	1.22 ±0.20	106 ±18
12	24 ±4	2.45 ±0.41	212 ±35
mm	N•m	kgm	lbf ft
14	36 ±5	3.67 ±0.51	27 ±4

For 102, 107, and 114 Engine Series (Taper Screws)

★ Unless there are special instructions, tighten the taper screws (unit: inch) of the 102, 107, and 114 engine series to the torque in this table.

	Tightening Torque					
Material	**In Cast Iron or Steel**			**In Aluminum**		
Thread Size (inch)	**N•m**	**kgm**	**lbf ft**	**N•m**	**kgm**	**lbf ft**
1/16	15 ±2	1.53 ±0.20	11 ±2	5 ±1	0.51 ±0.10	4 ±1
1/8	20 ±2	2.04 ±0.20	15 ±2	15 ±2	1.53 ±0.20	11 ±2
1/4	25 ±3	2.55 ±0.31	18 ±2	20 ±2	2.04 ±0.20	15 ±2
3/8	35 ±4	3.57 ±0.41	26 ±3	25 ±3	2.55 ±0.31	18 ±2
1/2	55 ±6	5.61 ±0.61	41 ±5	35 ±4	3.57 ±0.41	26 ±3
3/4	75 ±8	7.65 ±0.82	55 ±6	45 ±5	4.59 ±0.51	33 ±4

CONVERSION TABLES

Method of Using the Conversion Table

The Converson table in this section is provided to enable simple conversion of figures. For details of the method of using the Conversion table, see the example given below.

EXAMPLE

- Method of using the Conversion Table to convert from millimeters to inches.

1. Convert 55 mm into inches.

   A. Locate the number 50 in the vertical column at the left side, take this as ①, then draw a horizontal line from ①.

   B. Locate the number 5 in the row across the top, take this as ②, then draw a perpendicular line down from ②.

   C. Take the point where the two lines cross as ③. This point ③ gives the value when converting from millimeters to inches. Therefore, 55 millimeters = 2.165 inches.

2. Convert 550 mm into inches.

   A. The number 550 does not appear in the table, so divide by 10 (move the decimal one place to the left) to convert it to 55 mm.

   B. Carry out the same procedure as above to convert 55 mm to 2.165 inches.

   C. The original value (550 mm) was divided by 10, so multiply 2.165 inches by 10 (move the decimal one place to the right) to return to the original value. This gives 550 mm = 21.65 inches.

Millimeters to Inches ②

1 mm = 0.03937 in

	0	1	2	3	4	5	6	7	8	9
0	0	0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
						③				
50	1.969	2.008	2.047	2.087	2.126	2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

①

Millimeters to Inches **1 mm = 0.03937 in**

	0	1	2	3	4	5	6	7	8	9
0	0	0.039	0.079	0.118	0.157	0.197	0.236	0.276	0.315	0.354
10	0.394	0.433	0.472	0.512	0.551	0.591	0.630	0.669	0.709	0.748
20	0.787	0.827	0.866	0.906	0.945	0.984	1.024	1.063	1.102	1.142
30	1.181	1.220	1.260	1.299	1.339	1.378	1.417	1.457	1.496	1.536
40	1.575	1.614	1.654	1.693	1.732	1.772	1.811	1.850	1.890	1.929
50	1.969	2.008	2.047	2.087	2.126	2.165	2.205	2.244	2.283	2.323
60	2.362	2.402	2.441	2.480	2.520	2.559	2.598	2.638	2.677	2.717
70	2.756	2.795	2.835	2.874	2.913	2.953	2.992	3.032	3.071	3.110
80	3.150	3.189	3.228	3.268	3.307	3.346	3.386	3.425	3.465	3.504
90	3.543	3.583	3.622	3.661	3.701	3.740	3.780	3.819	3.858	3.898

Kilogram to Pound **1 kg = 2.2046 lb**

	0	1	2	3	4	5	6	7	8	9
0	0	2.20	4.41	6.61	8.82	11.02	13.23	15.43	17.64	19.84
10	22.05	24.25	26.46	28.66	30.86	33.07	35.27	37.48	39.68	41.89
20	44.09	46.30	48.50	50.71	51.91	55.12	57.32	59.53	61.73	63.93
30	66.14	68.34	70.55	72.75	74.96	77.16	79.37	81.57	83.78	85.98
40	88.18	90.39	92.59	94.80	97.00	99.21	101.41	103.62	105.82	108.03
50	110.23	112.44	114.64	116.85	119.05	121.25	123.46	125.66	127.87	130.07
60	132.28	134.48	136.69	138.89	141.10	143.30	145.51	147.71	149.91	152.12
70	154.32	156.53	158.73	160.94	163.14	165.35	167.55	169.76	171.96	174.17
80	176.37	178.57	180.78	182.98	185.19	187.39	189.60	191.80	194.01	196.21
90	198.42	200.62	202.83	205.03	207.24	209.44	211.64	213.85	216.05	218.26