CEBM004702

Shop Manual

WA250PT-3MC

PARALLEL TOOL CARRIER

SERIAL NUMBERS **WA250PT-3MC - A78001** and UP

It is our policy to improve our products whenever it is possible and practical to do so. We reserve the right to make changes or add improvements at any time without incurring any obligation to install such changes on products sold previously.

Due to this continuous program of research and development, periodic revisions may be made to this publication. It is recommended that customers contact their distributor for information on the latest revision.

August 2001

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TIGHTENING TORQUE OF HOSE NUTS

Use these torques for hose nuts.

Nominal No.	Thread diameter	Width across flat	Tightening torque	
	mm	mm	Nm	kgm
02	14	19	24.5 ± 4.9	2.5 ± 0.5
03	18	24	49 ± 19.6	5 ± 2
04	22	27	78.5 ± 19.6	8 ± 2
05	24	32	137.3 ± 29.4	14 ± 3
06	30	36	176.5 ± 29.4	18 ± 3
10	33	41	196.1 ± 49	20 ± 5
12	36	46	245.2 ± 49	25 ± 5
14	42	55	294.2 ± 49	30 ± 5

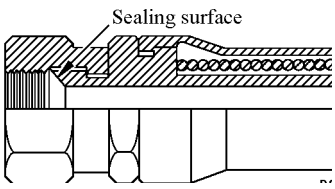
TIGHTENING TORQUE OF SPLIT FLANGE BOLTS

Use these torques for split flange bolts.

Thread diameter	Width across flat	Tightening torque	
mm	mm	Nm	kgm
10	14	65.7 ± 6.8	6.7 ± 0.7
12	17	112 ± 9.8	11.5 ± 1
16	22	279 ± 29	28.5 ± 3

TIGHTENING TORQUE FOR FLARED NUTS

Use these torques for flared part of nut.



Thread diameter	Width across flat	Tightening torque	
mm	mm	Nm	kgm
14	19	24.5 ±4.9	2.5 ±0.5
18	24	49 ±19.6	5 ±2
22	27	78.5 ±19.6	8 ±2
24	32	137.3 ±29.4	14 ±3
30	36	176.5 ±29.4	18 ±3
33	41	196.1 ±49	20 ±5
36	46	245.2 ±49	25 ±5
42	55	294.2 ±49	30 ±5

WA250PT-3 (WITH BUCKET ATTACHMENT)

PERFORMANCE			
Bucket capacity (heaped) (with bolt-on cutting edge)			1.9 m³ (2.5 cu yd)
Normal load			3040 kg (6702 lb)
Travel speed	FORWARD	1st	8.5 km/h (5.3 mph)
		2nd	12.5 km/h (7.8 mph)
		3rd	23.5 km/h (14.6 mph)
		4th	38 km/h (23.6 mph)
	REVERSE	1st	8.5 km/h (5.3 mph)
		2nd	13 km/h (8.1 mph)
		3rd	24 km/h (14.9 mph)
		4th	39 km/h (24.2 mph)
Max. rimpull			9500 N (93160 lbf)
Min. turning radius	Outside of chassis		5840 mm (19 ft 2 in)
	Center of outside tire		4950 mm (16 ft 3 in)

WEIGHT	
Operating weight (includes 1 operator: 80 kg (176 lb) (Bucket with bolt-on cutting edge)	12492 kg (27540 lb)

DIMENSIONS	
Overall length	7214 mm (284 in)
Height of bucket	455 mm (17.9 in)
Dumping clearance (tip of cutting edge)	2845 mm (112 in)
Dumping reach (tip of cutting edge)	1092 mm (42.9 in)
Bucket dump angle	45°
Bucket roll back (SAE carry position)	52°
Digging depth (10° dump angle)	310 mm (12.2 in)
Digging depth (0° dump angle)	100 mm (3.9 in)
Bucket height (with bolt-on cutting edge)	2687 mm (106 in)
Overall height (bucket raised)	5004 mm (197 in)

DRIVE TRAIN, BRAKE AND HYDRAULIC SYSTEM OIL SPECIFICATIONS

Komatsu Engine Oil or engine oil meeting American Petroleum Institute (API) performance classification CF-4, CG-4, CF-4/SG or CG-4/SH or MIL-L-2104D or E is recommended.

NOTICE:

Classification CD, CE, CD/SF or CE/SF oils may be used in areas where CF-4, CG-4, CF-4/SG or CG-4/SH oil is not yet available.

FINAL DRIVE OIL SPECIFICATIONS

Komatsu Gear Lubricant or an equivalent multi-purpose gear lubricant meeting API GL-5 or MIL-L-2105C is recommended.

DRIVE AXLE OIL SPECIFICATIONS

For drive axle oil, use only the recommended oil as follows:

SHELL:	DONAX TT or TD
CALTEX:	RPM TRACTOR HYDRAULIC FLUID
CHEVRON:	TRACTOR HYDRAULIC FLUID
TEXACO:	TDH OIL
MOBIL:	MOBIL 424
Engine oil:	SAE 30 API classification CD (May increase brake noise, but will not affect durability.)

DIESEL FUEL SPECIFICATIONS

WARNING

Never mix gasoline, gasohol and/or alcohol with diesel fuel. This practice creates an extreme fire hazard and, under certain conditions, an explosion which could result in personal injury or death.

WARNING

Never remove the fuel tank filler cap or refill the fuel tank while the engine is running or when hot or when the machine is indoors. Fumes are dangerous, a spark or flame could result in a fire or explosion.

NOTICE:

The precise tolerances of diesel fuel injection systems demand that the fuel be kept clean and free of contaminates or water. Contaminates or water in the system can cause severe damage to both the injection pump and nozzles.

REMARK:

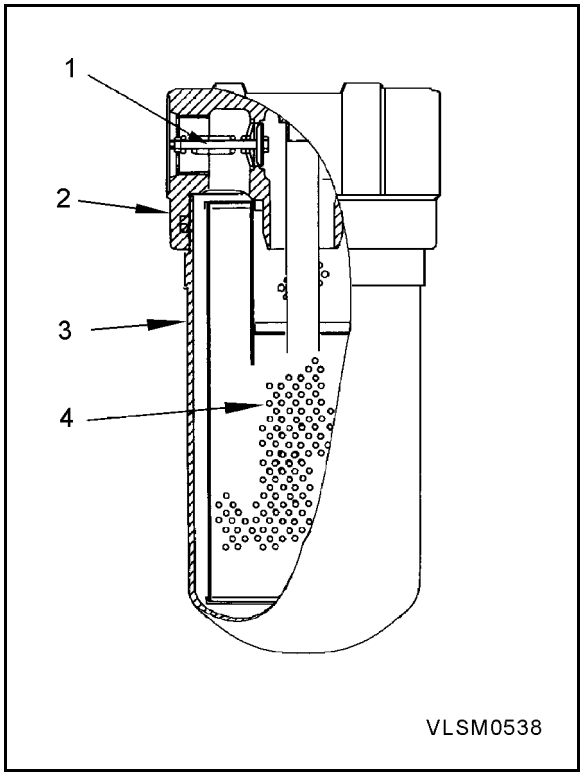
Below -12°C (+10°F) the paraffin in ASTM Grade No. 2-D diesel fuel will change to wax particles and clog the fuel filters. For best results use Grade No. 1-D diesel fuel in cold weather.

For normal service above -10°C (+14°F), the use of ASTM Grade No. 2-D diesel fuel with a minimum Cetane number of 40 is recommended. The use of No. 2-D diesel fuel will result in optimum engine performance under most operating conditions. Fuels with Cetane numbers higher than 40 may be needed in high altitudes or extremely low ambient temperatures to prevent misfires and excessive smoke.

At operating temperatures below -10°C (+14°F) or extended engine idling, use ASTM Grade No. 1-D diesel fuel. The use of lighter fuels can reduce fuel economy.

Where a winterized blend of Grade No. 2-D and No. 1-D fuels is available, it may be substituted for Grade No. 1-D fuel. However, it is the supplier's responsibility to provide the fuel for the anticipated ambient temperature.

TORQUE CONVERTER OIL FILTER



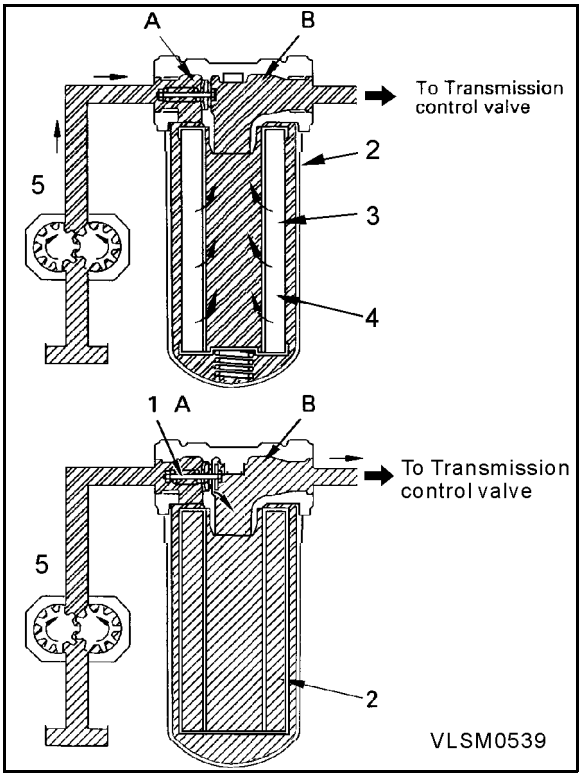
1. Relief valve
2. Head assembly
3. Cartridge
4. Filter element

Specifications
Filter mesh size: 10 microns
Filtering area:8900 cm²
Relief pressure:0.34 MPa (3.5 kg/cm²)

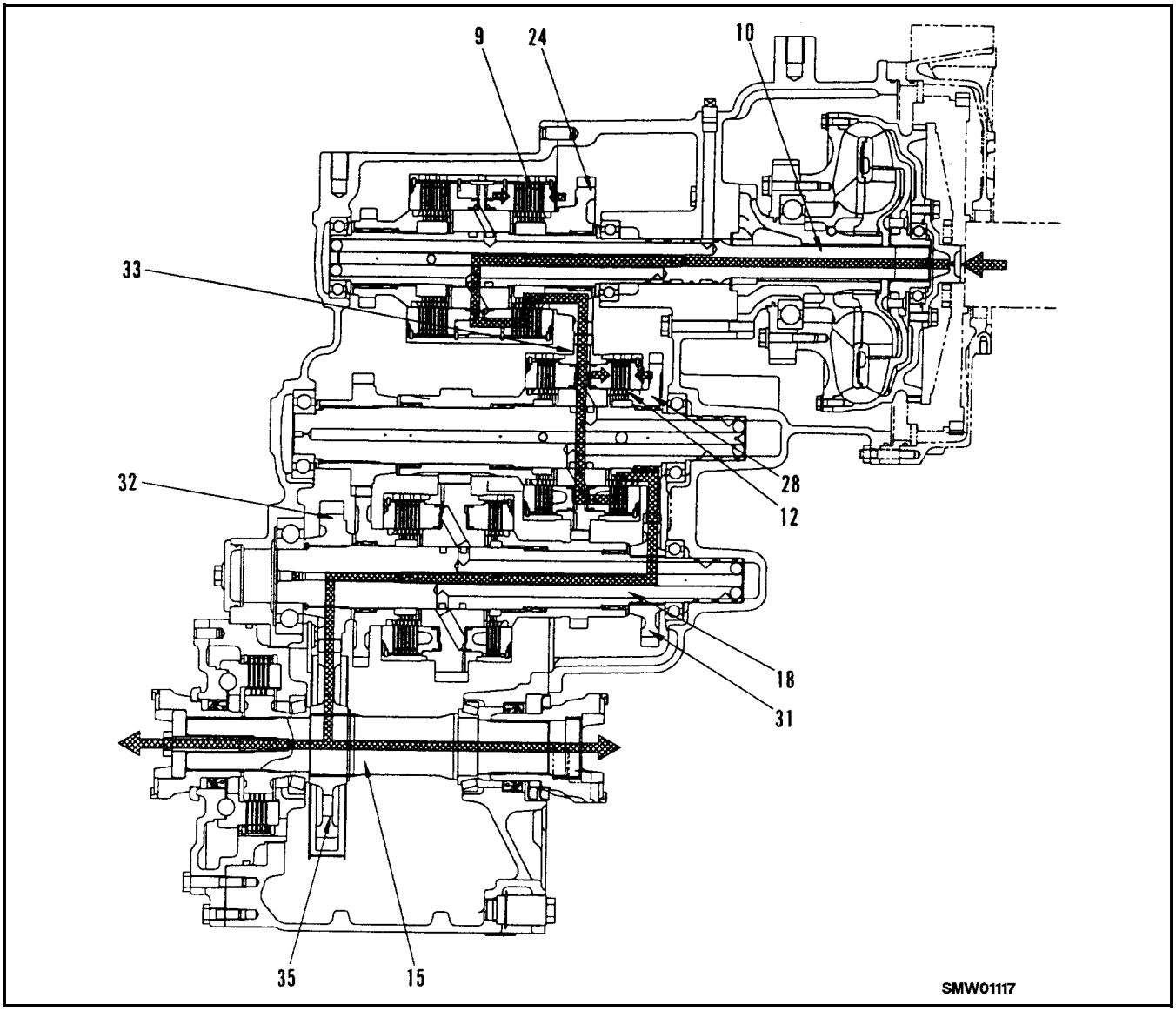
Operation

- The oil from the torque converter charging pump (5) enters filter inlet port **A.** It is filtered from the outside of the element to the inside, and flows to outlet port **B**.

- If the filter becomes clogged with dirt, or the oil temperature is low and the pressure rises at inlet port **A,** the oil from inlet port **A** opens the relief valve (1) and flows directly to outlet port **B** in order to prevent damage to the pump or filter.



FORWARD 3RD



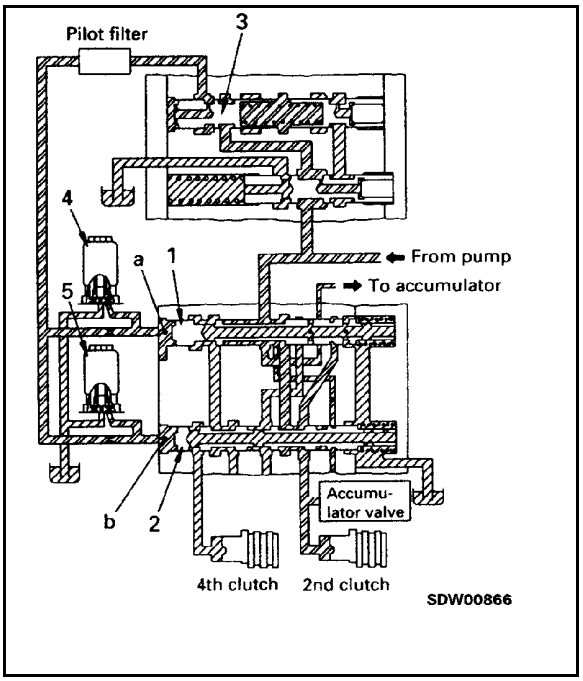
Operation

- In forward 3rd, forward clutch (**9**) and 3rd clutch (**12**) are engaged. The motive force from the torque converter transmitted to input shaft (**10**) is transmitted to output shaft (**15**).
- The clutch discs of forward clutch (**9**) and 3rd clutch (**12**) are held by the hydraulic pressure applied to the clutch piston.
- The motive force from the torque converter is transmitted from input shaft (**10**) via forward clutch (**9**) to forward gear (**24**), then to 1st and 3rd gear (**33**).
- Since 3rd clutch (**12**) is engaged, the motive force transmitted to 1st and 3rd cylinder gear (**33**) is transmitted from 3rd gear (**28**) via the 3rd clutch, then to output shaft (**15**) via 2nd and 4th shaft (**18**), idler gear (**32**) and output gear (**35**).

TRANSMISSION SOLENOID VALVE

Function

- There are four solenoid valves installed to the transmission control valve. When the gear shift lever in the operator's compartment is operated, the solenoid valves are switched ON/OFF, and the oil is drained to actuate the gear shift spool.



Operation

1. Solenoid valve OFF

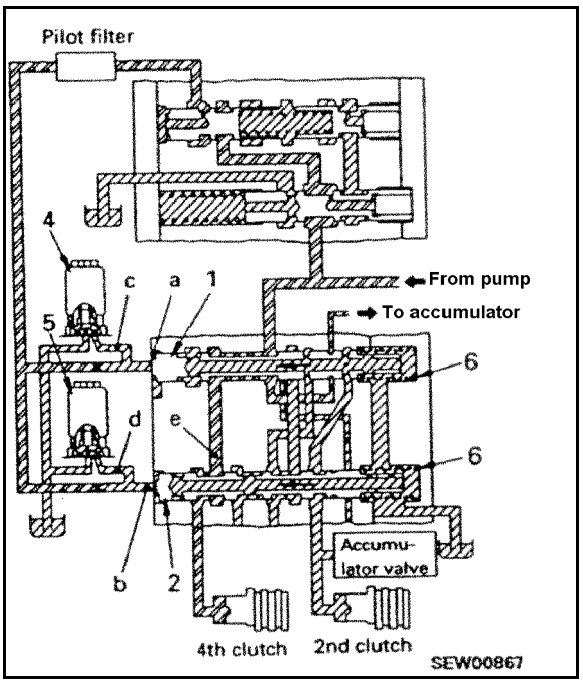
The oil from pilot reducing valve (**3**) flows to ports **a** and **b** of gear shift spools (**1**) and (**2**). The oil at ports **a** and **b** is stopped by solenoids (**4**) and (**5**), and gear shift spools (**1**) and (**2**) move to the right in the direction of the arrow. As a result, the oil from the pump flows to the 2nd clutch.

2. Solenoid valve ON

When the gear shift lever is operated, the drain port of solenoid valves (**4**) and (**5**) opens.

The oil at ports **a** and **b** of gear shift spools (**1**) and (**2**) flows from ports **c** and **d** to the drain circuit. Therefore, ports **a** and **b** become the low pressure circuit, and the gear shift spool is moved to the left in the direction of the arrow by the tension of spring (**6**).

As a result, the oil at port **e** flows to the 4th clutch and the clutch is switched.



EMERGENCY MANUAL SPOOL

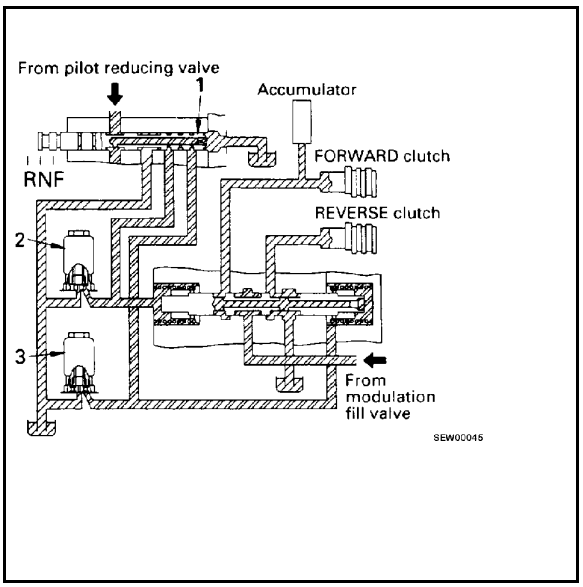
Function

- If there should be any failure in the electrical circuit and the directional solenoid valve does not work, this spool can be operated manually to engage the FORWARD or REVERSE clutch.

Operation

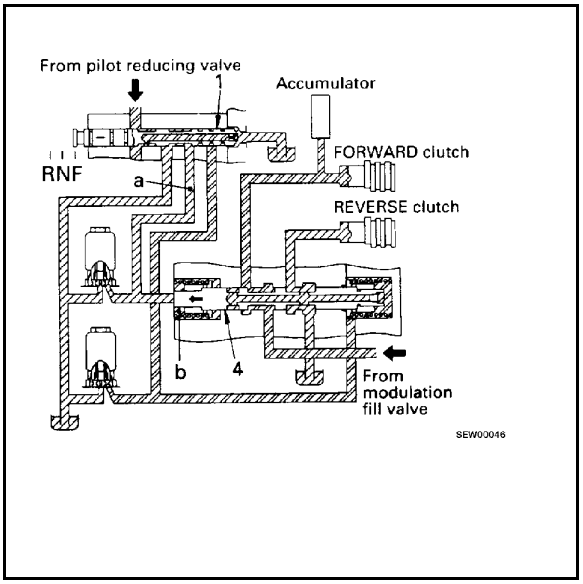
1. Emergency manual spool at neutral

- The oil from the upper valve (pilot reducing valve) passes around emergency manual spool (**1**), and is blocked by solenoid valves (**2**) and (**3**).
- When the operating condition is normal, the emergency manual spool is at the neutral position.



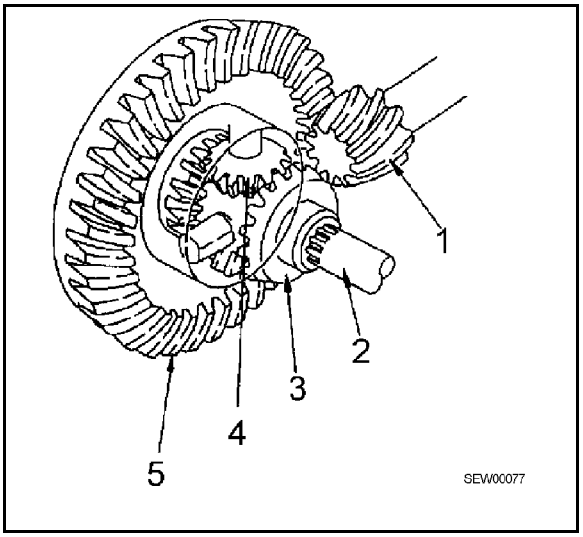
2. Emergency manual spool actuated (FORWARD)

When emergency manual spool (**1**) is pushed in, port **a** and the drain port are connected, so the oil in chamber **b** is drained. As a result, directional spool (**4**) moves to the left in the direction of the arrow, and the oil flows to the FORWARD clutch to engage the clutch.



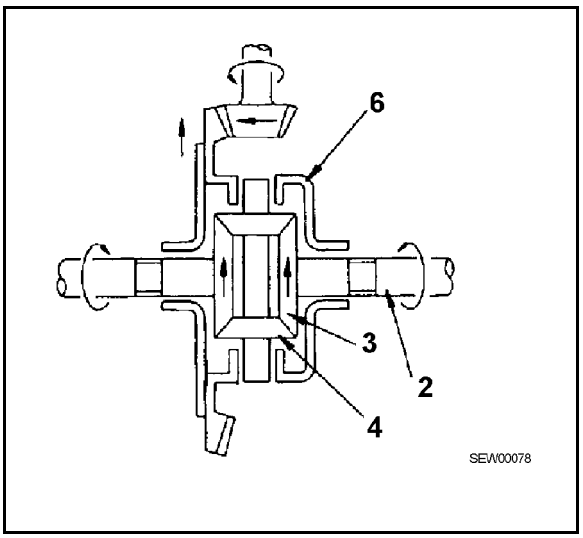
Outline

- The motive force from the engine is transmitted to the front and rear axles via the torque converter, the transmission and the propeller shaft.
- In the axle, the motive force is transmitted from pinion gear (**1**) to bevel gear (**5**), shifted 90° and reduced, and transmitted to sun gear shaft (**2**) via differential (**4**).
- The motive force of the sun gear is further reduced by planetary gear-type final drive, and transmitted to the axle shaft and wheel.



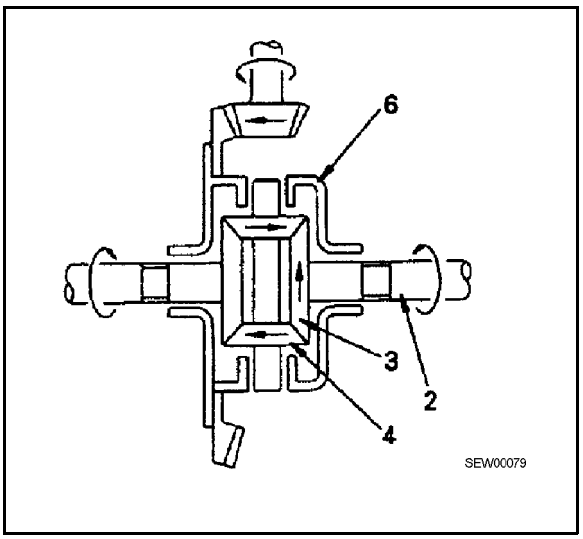
When moving straight forward

- When moving straight forward, the speed of rotation of the left and right wheels is equal, so pinion gear (**4**) in the differential assembly does not rotate, and the motive force of carrier (**6**) is transmitted equally to the left and right sun gear shafts (**2**) via the pinion gear (**4**) and side gear (**3**).



When slewing

- When slewing, the speed of rotation of the left and right wheels is unequal, so pinion gear (**4**) and side gear (**3**) in the differential assembly rotate according to the difference in the left and right rotation speeds, and the motive force of carrier (**6**) is transmitted to the sun gear shafts (**2**).

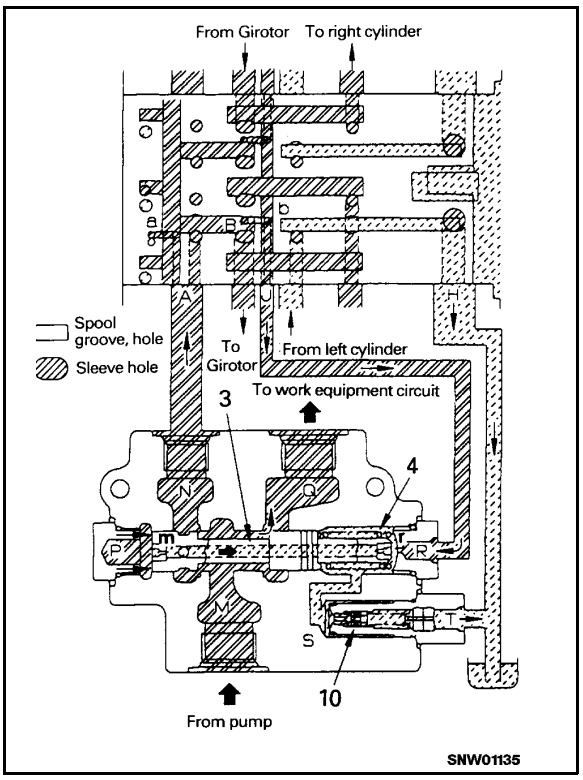


3. Steering cylinder at end of stroke

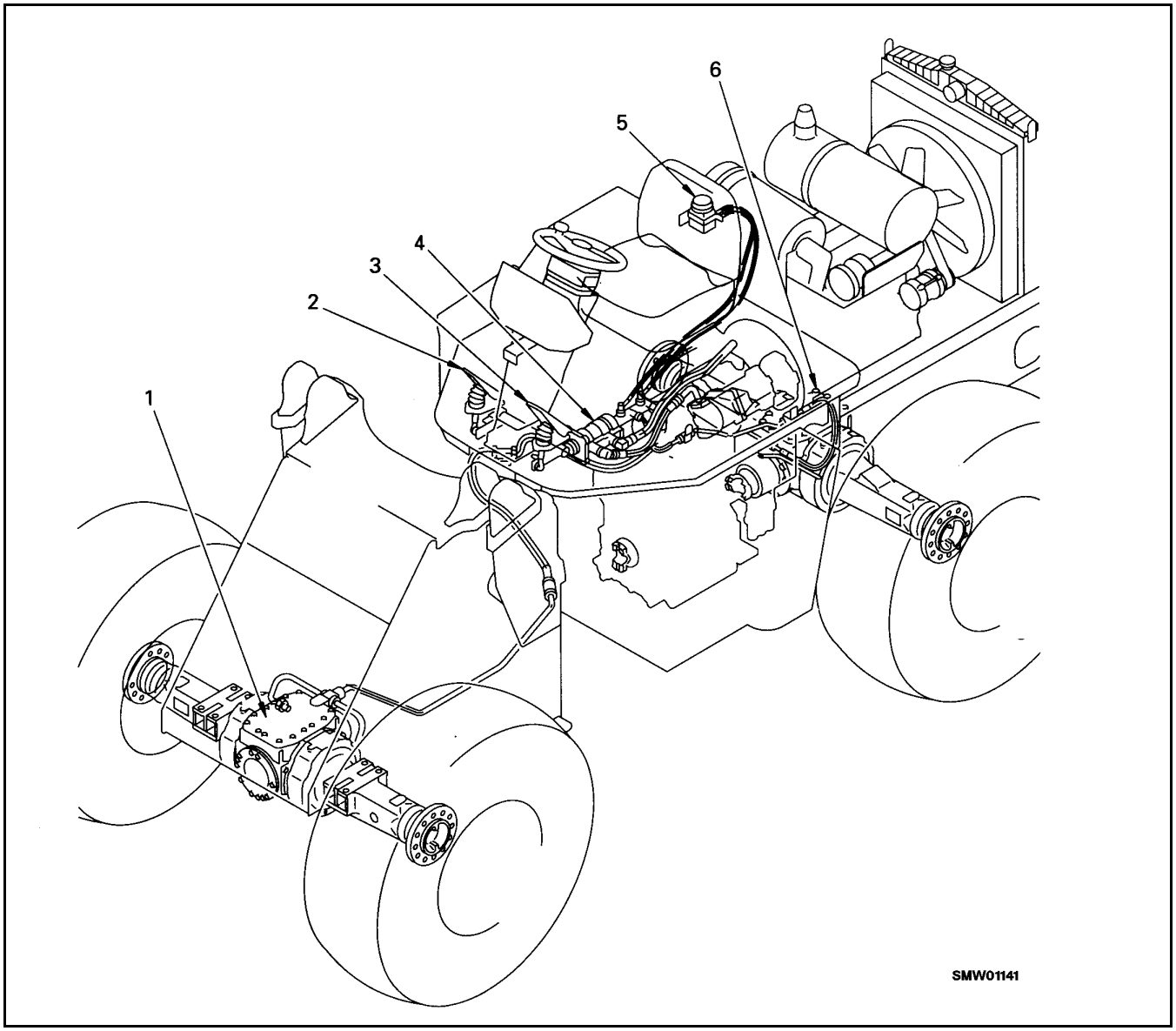
If the operator tries to turn the steering wheel further when the steering cylinder has reached the end of its stroke, the circuit from port **M** through port **N** to port **S** is kept open and the pressure rises.

When this pressure rises above 190 kg/cm², relief valve (**10**) opens and the oil is relieved to the hydraulic tank. Because of this flow of oil, a differential pressure is created on both sides of orifice **r**. Therefore, the balance is lost between the load of spring (**4**) and the pressure up to port **A** and the pressure beyond port **B.** As a result, the pressure up to port **A** becomes relatively higher.

For this reason, the pressure at port **P** moves spool (**3**) even further to the right from the condition in Item 2. It stabilizes the condition at a position where the circuit between ports **M** and **N** is almost fully closed, and the circuit between ports **M** and **Q** is almost fully open.



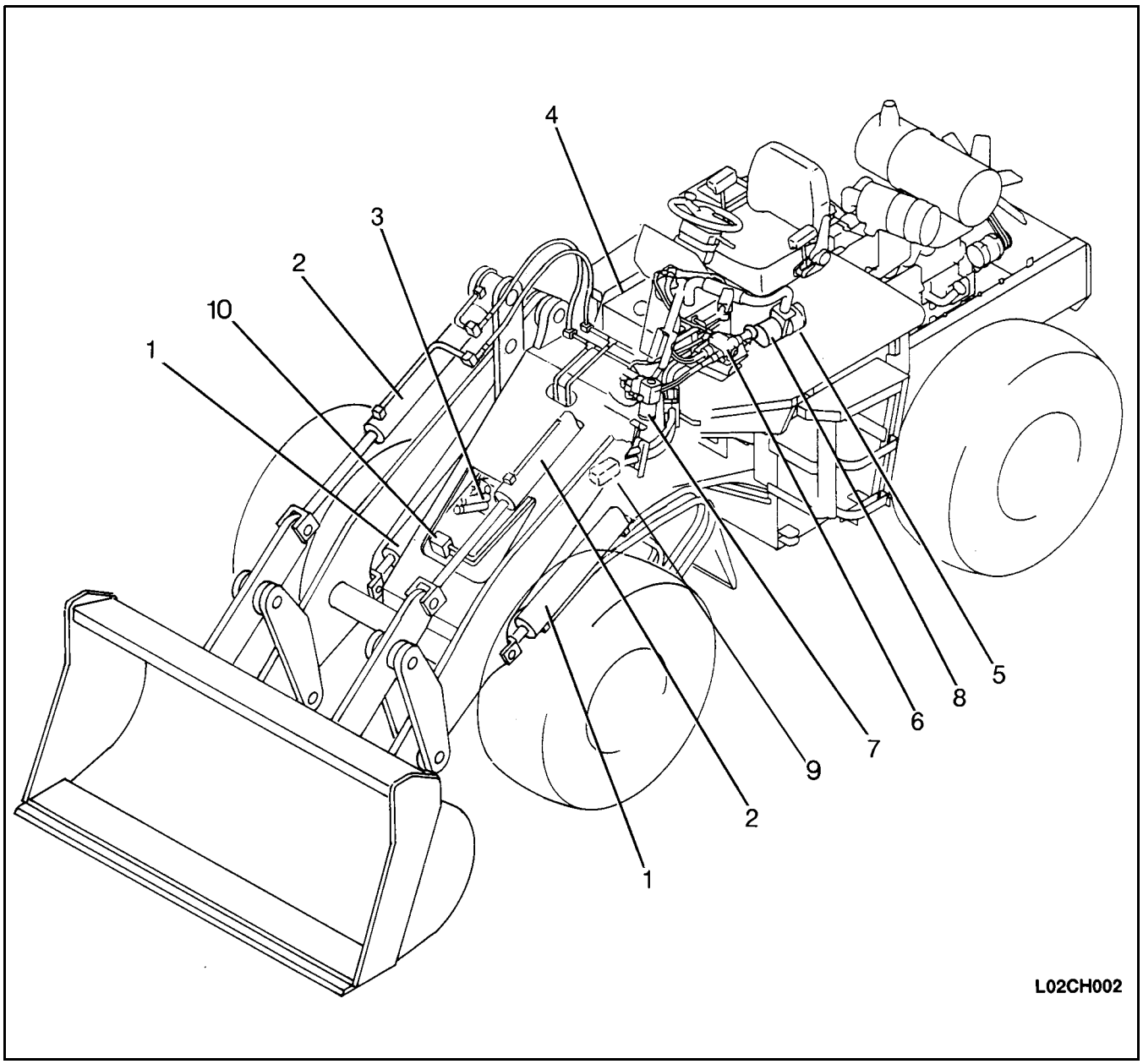
BRAKE PIPING



1. Front axle (with single disc plate)
2. Right brake
3. Left brake pedal (with transmission cut-off selector)
4. Power master cylinder
5. Brake oil tank
6. Rear axle (with single disc brake)

Outline

- The power master cylinder consist of a hydraulically actuated booster mechanism. It reduces the operating force of the pedal and also ensures a powerful braking force.
  A relief valve is installed to protect the circuit if any abnormal pressure should be generated in the power master cylinder.
- When the brake pedal is depressed, the oil sent from the pump shuts of the drain circuit inside the valve and actuates the piston to apply the front and rear brakes.



1. Boom cylinders
2. Tilt cylinders
3. Main control valve
4. Hydraulic tank
5. Steering pump
6. Priority valve
7. Steering valve
8. Hydraulic pump
9. Pilot solenoid valve
10. Pin puller valve

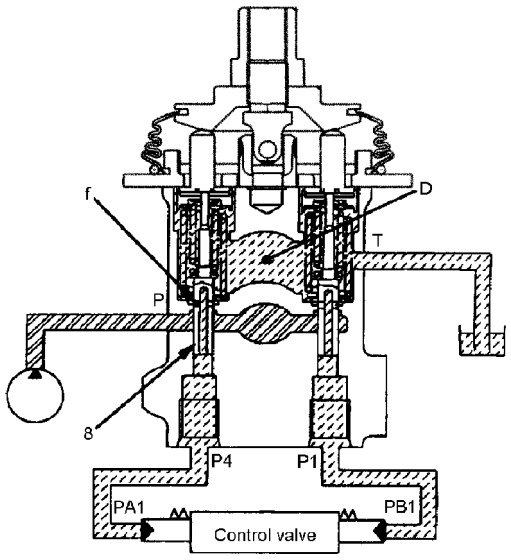
FUNCTION OF PPC VALVE

The PPC valve supplies pressure oil from the charging pump to the side face of the spool of each control valve according to the amount of travel of the control lever. This pressure oil actuates the spool.

OPERATION

Control lever at "hold" (Fig. 1)

Ports **PA1, P4**, **PB1** and **P1** are connected to drain chamber **D** through fine control hole **(f)** in valve (8).



(Fig. 1) LNC00867

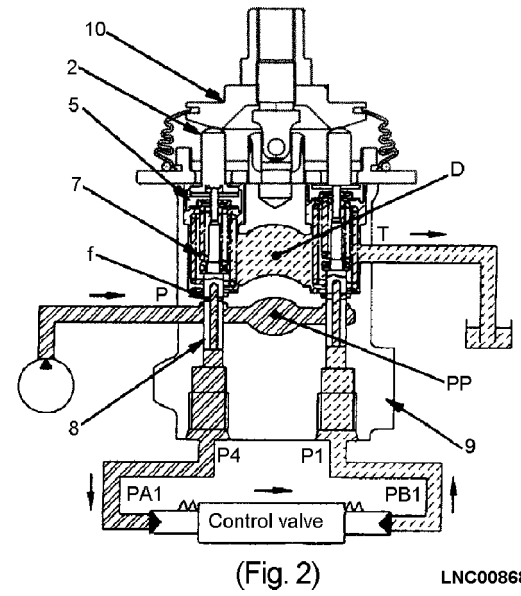
Control lever operated slightly (fine control) (Fig. 2):

As the control lever is operated, it moves the plate (10) which pushes down on the piston (2), which then pushes down the retainer (5). The retainer pushes down the spring (7) which pushes the valve (8). When this occurs, the fine control hole (**f**) is shut off from the drain chamber **D**. At almost the same time, the fine control hole (**f**) is connected to the pump pressure chamber **PP**; the pilot pressure of the control valve is sent through fine control hole (**f**) to port **P4**.

When the pressure at port **P4** rises, the valve (8) is pushed up. Fine control hole (**f**) is shut off from the pump pressure chamber **PP** and at almost the same time is connected to the drain chamber **D**, allowing the pressure at port **D4** to escape to the drain chamber **D**.

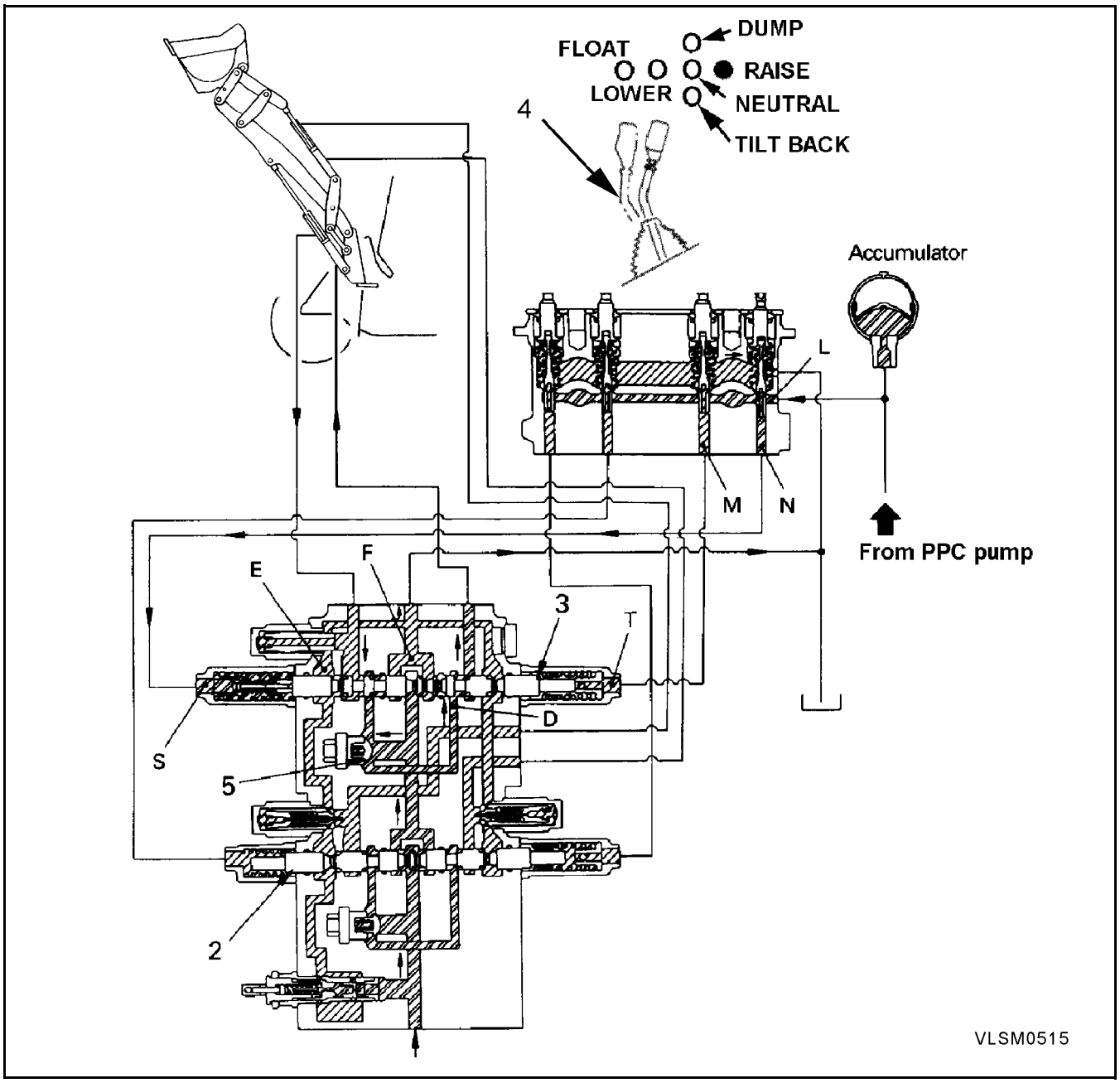
The valve (8) moves up and down until the force of the spring (7) is balanced with the pressure of port **P4**. When the fine control hold (**f**) is midway between the drain chamber **D** and the pump pressure chamber **PP**, the position of the valve (8) and body (9) does not change until the head of the valve (8) contacts the bottom of the piston (2).

Therefore, the spring (7) is compressed in proportion to the travel of the control lever, thus the pressure at port **P4** also rises in proportion to the travel of the control lever. The control valve spool moves to a position where the pressure of port **PA1** (same pressure as at port **P4**) and the force of the control valve return spring are balanced.



(Fig. 2) LNC00868

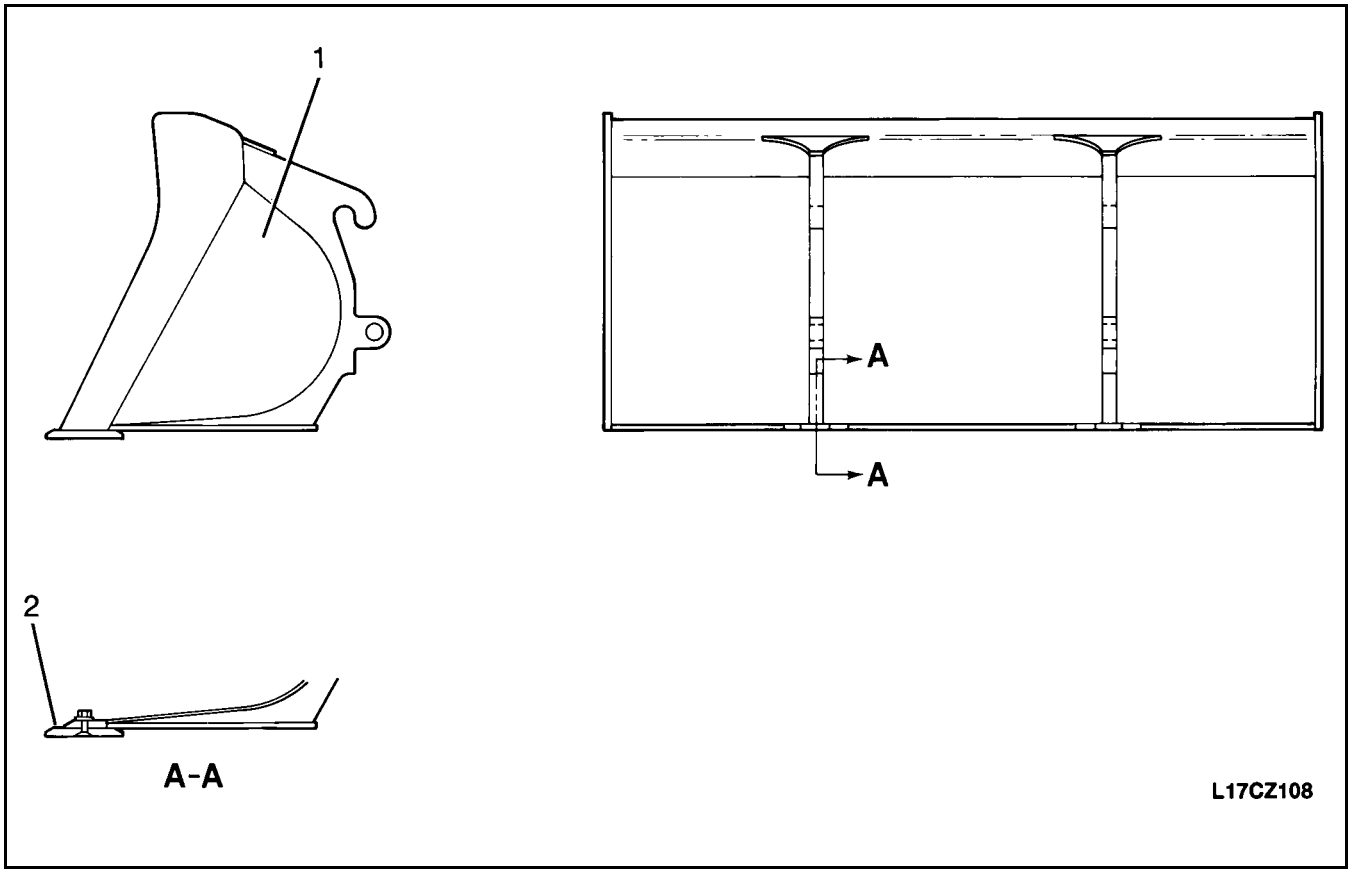
BOOM SPOOL AT "RAISE" POSITION



Operation

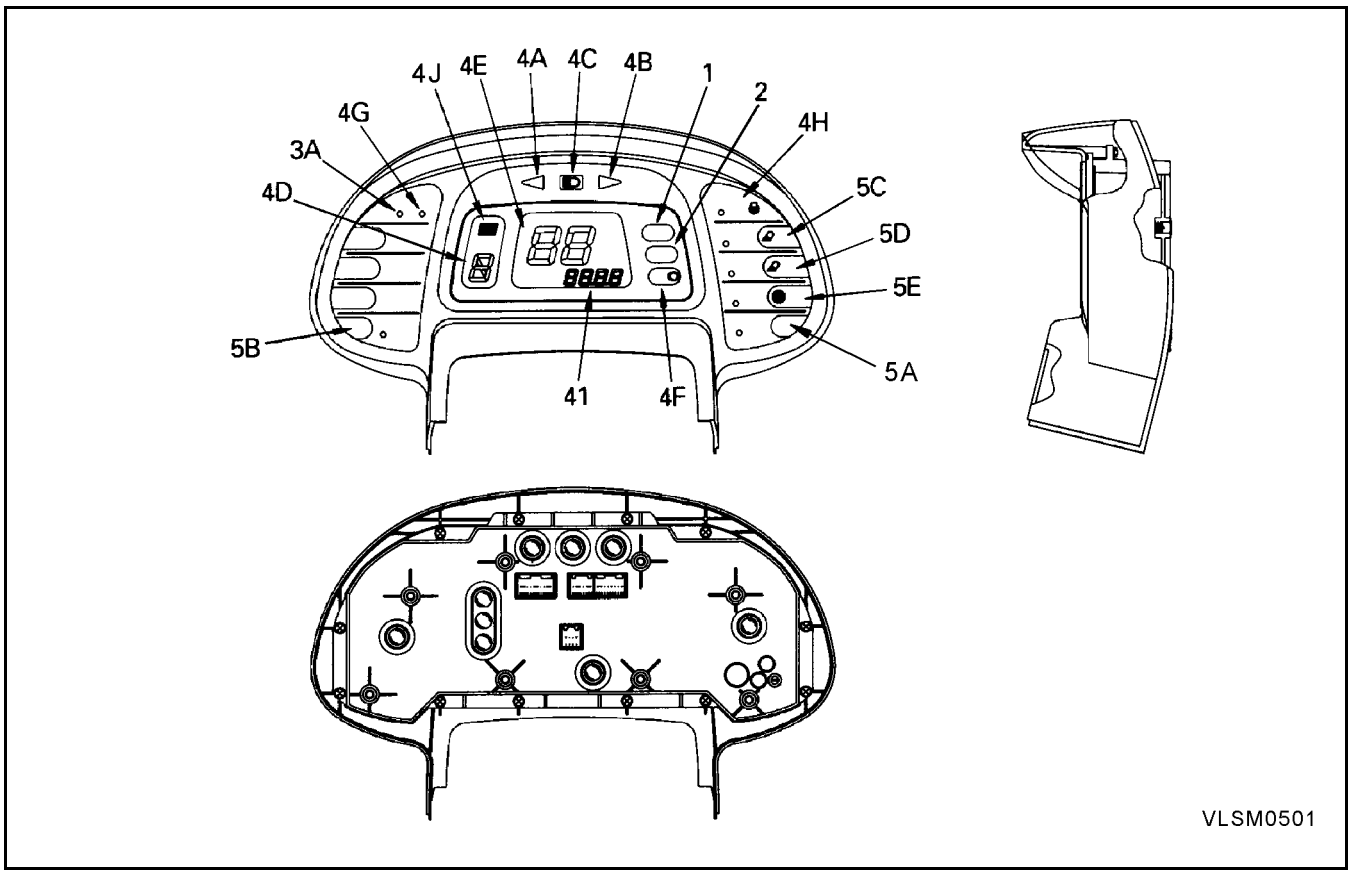
- When operator lever (4) is pulled, oil flows from the PPC valve port **L** to port **N** and port **S**. The oil at port **T** passes through port **M** and flows to the drain circuit. The oil pressure at port **S** presses the boom spool (3) and sets it to the RAISE position.
- Oil from the pump passes through the bucket spool (2) bypass circuit and flows to the boom spool (3) bypass circuit. The bypass circuit is closed by boom spool (3), so the oil pushes open check valve (5). The oil from check valve (5) flows to port **D** and to the cylinder bottom side.
- The oil on the cylinder rod side enters drain port **F** from port **E** and returns to the tank, thereby raising the boom.

BUCKET



1. Bucket
2. Bolt-on cutting edge

MAIN MONITOR



1. CHECK lamp
2. CAUTION lamp
3. Caution item
   3A. Emergency steering actuated
4. Pilot item
   4A. Turn signal (left)
   4B. Turn signal (right)
   4C. Hi beam
   4D. Shift indicator
   4E. Speedometer
   4F. Parking brake
   4G. Emergency steering normal
   4H. Preheating
   4I. Failure action code
   4J. Shift hold
5. Switches
   5A. Auto-shift manual switch
   5B. E.C.S.S. switch
   5C. Working lamp (front) switch
   5D. Working lamp (rear) switch
   5E. Transmission cut off switch

Outline

- The main monitor has a display function for the speedometer and other gauges and a switching function to control the electric components and controllers.
- There is one CPU (Central Processing Unit) installed internally, and this processes the signals from the sensors and outputs the display.
- A liquid crystal display and LEDs are used for the display. The switches are embossed sheet switches.

2. Hold function (maintaining present speed range)
When the hold switch is turned ON, the existing speed range is held, and even if the travel speed goes down, the transmission does not downshift. However, if the direction of travel is shifted between forward and reverse, the transmission downshifts, and then it shifts back up to the speed range according to the change in the conditions. (This prevents any unnecessary downshift on level ground or unnecessary upshift when traveling downhill.) (See Table 2, Item 5.)

3. Kick-down function
If the operator wishes, he can override the automatic conditions and downshift forcibly to lst (when traveling below 12.0 km/h in 4th or 3rd, or when traveling at any speed in 2nd). (See Table 2, Item 7.) When the travel speed increases, the transmission is shifted up in accordance with the auto shift up conditions, or it is shifted to 2nd when the direction is shifted between forward and reverse. This function is also available when holding the speed range (hold, engine at low speed).

SHIFT CHARACTERISTICS

1. Auto shift (see Table 2, Items 1 and 2)

When the engine speed is above 1450 rpm, the transmission is shifted as follows according to the travel speed.

a) FORWARD (see Table 2, Item 1.) Directional lever is at F, speed lever is at 4.

Shift up
(1) When starting, the transmission is set to the F2 torque converter range.
(2) When the accelerator pedal is depressed, the engine speed rises and the machine travels faster. If the engine speed continues to rise and the travel speed reaches 10.0 km/h (10.5 km/h), the transmission is up shifted to F3. If there is insufficient acceleration, the transmission upshifts when the travel speed reaches the figure shown in parentheses.
(3) Immediately after the transmission upshifts, the engine speed will drop momentarily, but if the machine continues to travel faster and the travel speed reaches 17.5 km/h, the transmission is upshifted to F4.

Shift down
(1) If the machine is traveling in F4 and the load increases, the transmission will downshift to F3 if the travel speed drops below 15.5 km/h.
(2) If the travel speed drops further to 10.5 km/h (10.0 km/h), the transmission is downshifted to F2. If there is insufficient deceleration, the transmission downshifts when the travel speed reaches the figure shown in the parentheses.
With auto-shift, the transmission does not downshift to lst even if the travel speed drops. Normally, the transmission shifts to lst only if the speed lever is placed at 1 or if the kick-down switch is pressed.

b) REVERSE (see Table 2, Item 2.)
Directional lever at R, speed lever at 4. The transmission range is shifted according to the travel speed in the same way as for a) FORWARD.

2. Changing direction (switching between forward and reverse)

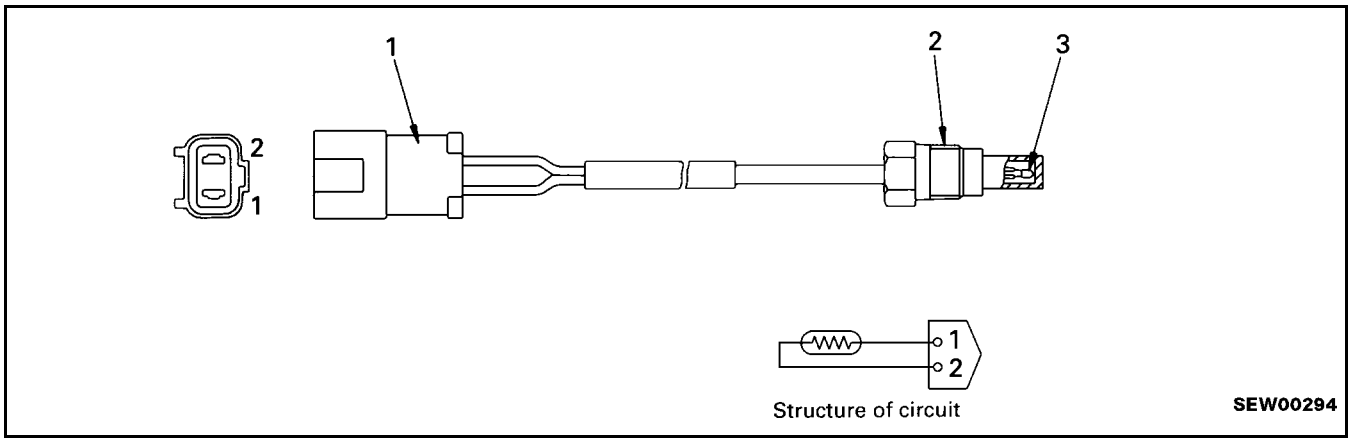
(When the directional lever is shifted to the opposite direction from the direction of travel.)

The forward-reverse direction change depends on the speed of the machine and the speed of the engine. Travel speed and engine speed are shown graphically in Fig. 2. At speeds in area I in Fig. 2, the transmission output shifts to 2nd speed in the same direction as the directional lever regardless of the speed range. Following this, the transmission shifts up to match the travel speed. (See Table 2, Item 8)

Example: Directional lever: F → N → R
Transmission output:
F4 → N → R2 → R3 → R4

ENGINE COOLANT TEMPERATURE SENSOR

TORQUE CONVERTER OIL TEMPERATURE SENSOR



1. Connector
2. Plug
3. Thermistor

Function

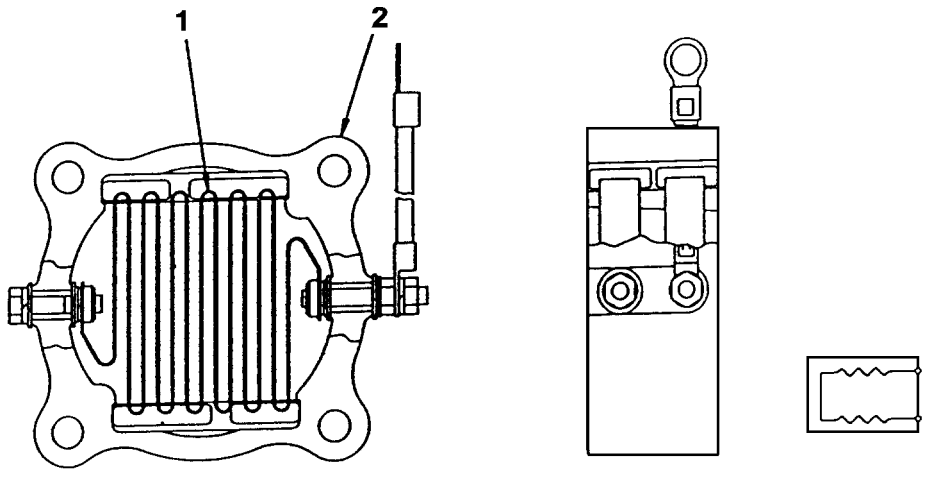
These sensors are installed to the engine cylinder block and transmission case. The change in the temperature changes the resistance of the thermistor, and a signal is sent to the maintenance monitor to display the temperature. If the display on the maintenance monitor reaches the specified position, the lamp flashes and the buzzer sounds to warn of the abnormality.

ELECTRICAL WIRING DIAGRAM (5/7)

SEE FOLD-OUT 10-153

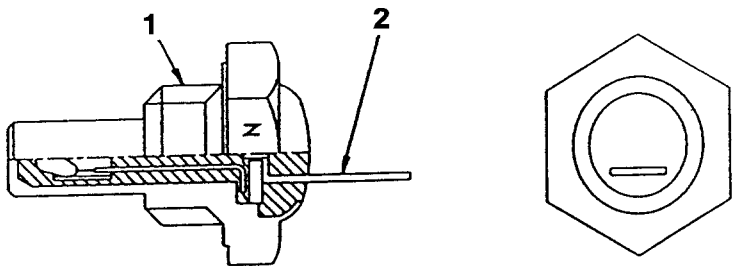
RIBBON HEATER

1. Heater coil
2. Housing

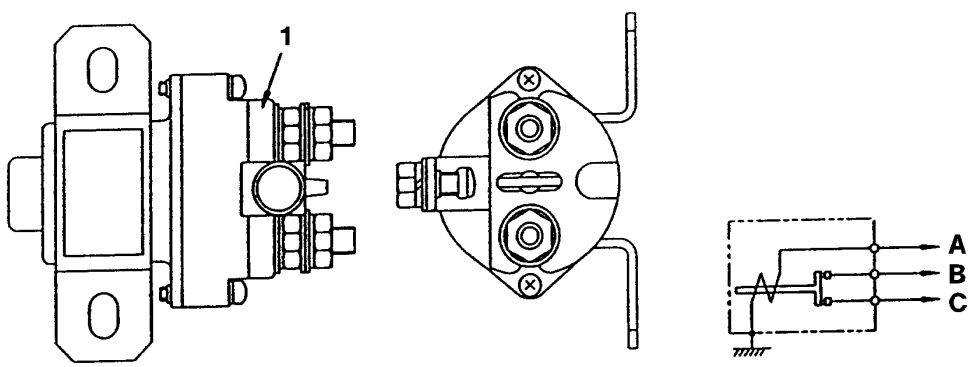


Q.H.S. WATER TEMPERATURE SENSOR

1. Water temperature sensor body
2. Terminal

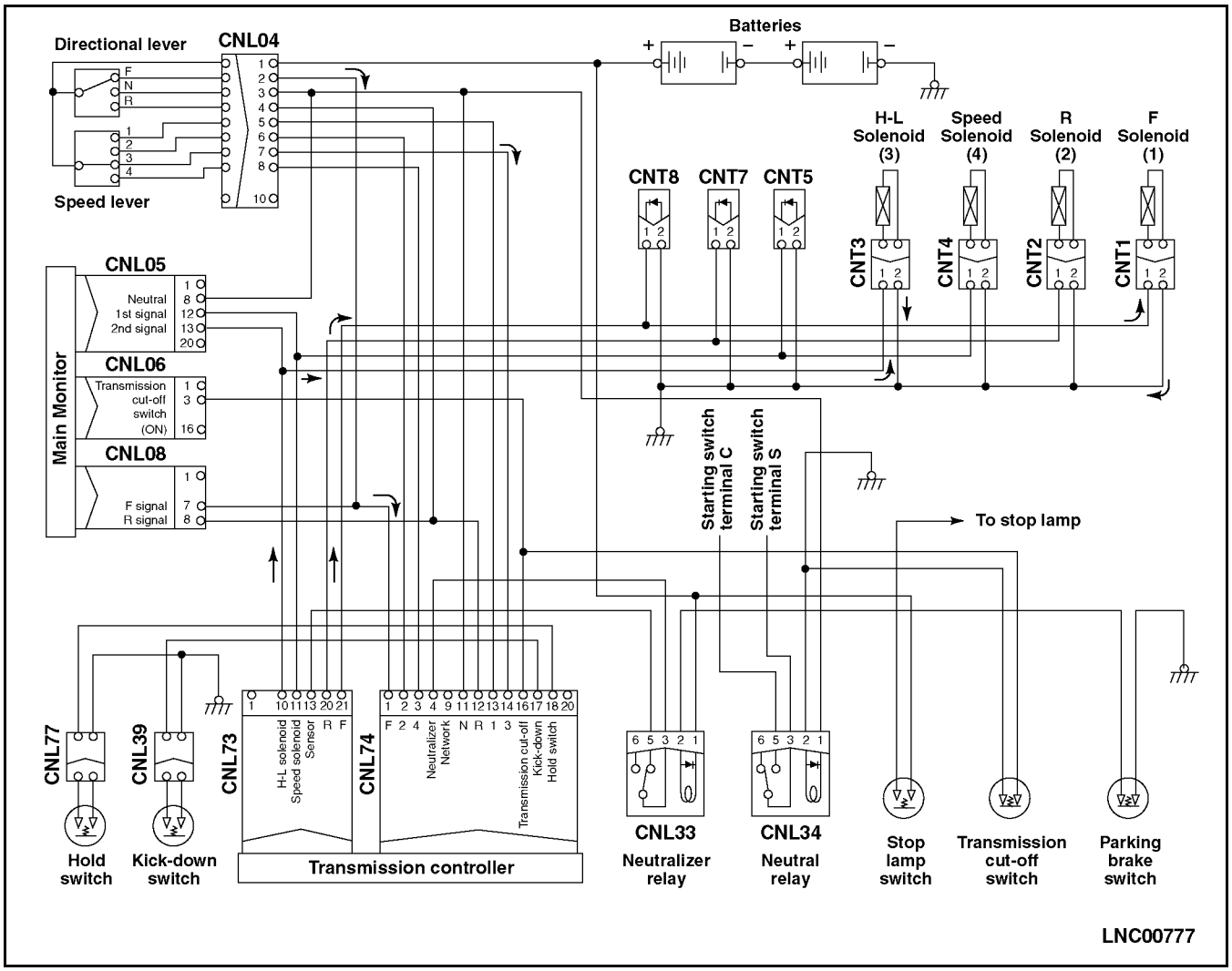


HEATER RELAY



Canceling actuation of kick-down switch (Case II)

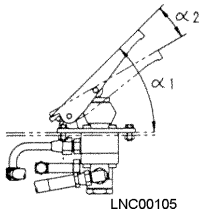
(Speed lever moved to position other than **2**)



- When the speed lever is moved to any position other than **2**, the terminal connection at the lever is turned OFF and current no longer flows from the battery positive terminal to speed lever switch connections 1 and 6 and to the transmission controller.
- Therefore, the kick-down circuit which is connected with the speed **2** circuit, is shut off within transmission controller and solenoid (4) no longer is actuated.
- When the speed lever is moved to **3**, solenoid (3) is actuated. In addition, with the directional lever at the **F** position, solenoid (1) is actuated. Therefore, solenoids (1) and (3) are actuated and the transmission is set to **F3**.

Solenoid actuation table

Solenoid		F1	F2	F3	F4	N	R1	R2	R3	R4
FORWARD	(**1**)	O	O	●	O					
REVERSE	(**2**)						O	O	O	O
H-L select	(**3**)			●	O				O	O
Speed select	(**4**)	O			O		O			O

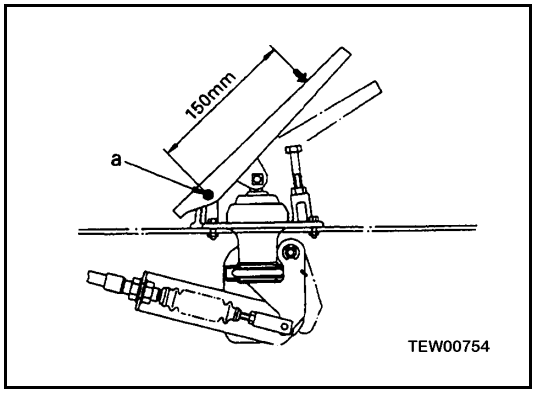
Category	Item	Measurement Condition	Unit	Standard value for new machine	Service limit value
Transmission valve	Priority valve pressure	• Torque converter oil temperature: 60-80° C (140-176° F) • Engine speed: Low idling	kgf/cm^2 (lbf/in^2)	23 ± 2 (327 ± 28.4)	23 ± 2 (327 ± 28.4)
	Pilot reducing valve pressure			10 ± 1 (142 ± 14.2)	10+1,-2 (142 +14, -28)
	Clutch pressure			23 ± 2 (327 ± 28.4)	23 +3, -4 (327 +42, -56)
	Torque converter outlet port pressure			3.9 ± 0.5 (55.4 ± 7.1)	3.9 ± 1.0 (55.4 ± 14.2)
Steering wheel	Play	• Engine speed: Low idling • Machine facing straight to front • Flat, horizontal, straight, dry paved road surface • Hydraulic oil temperature: 45-55°C (113-131°F)	mm	20 ± 20	Max. 60
	Operating Force		N (lbf)	9.8 - 12.8 (2.2 - 2.8)	Max. 14.2 (Max. 3.1)
	Operating time Low idle		Sec.	Max. 5.4	Max. 6.0
	Operating time High idle			2.9 ± 0.3	2.9 ± 1.0
Steering valve	Relief pressure	• Engine speed: High idle • Hydraulic oil temperature: 45 - 55° C (113 - 131° F)	kgf/cm^2 (lbf/in^2)	190 ± 7 (2702 ± 99.5)	190 ± 20 (2702 ± 284)
Brakes	Operating angle ∠1	• Brake pedal operating force: 206 N (46.3 lbf)  LNC00105	deg.	53	53
	Operating angle ∠2			16 ± 4	16 ± 6
	Performance	• Flat, horizontal, straight, dry paved road surface • Speed when applying brake: • 20 km/h, braking delay: 0.1 sec. • Brake pedal operating force: 490 N (40 kg) • Tire inflation pressure: Specified pressure	m	Max. 5.0	Max. 5.0
	Drop in hydraulic pressure	42 kg/cm^2 (lbf/in^2) in 5 min.	kgf/cm^2 (lbf/in^2)	Max. 3.5 (Max. 49.7)	Max. 3.5 (Max. 49.7)
	Wear of disc	Thickness of disc	mm	1.0 ± 0.1	Min. 0.6

ACCELERATOR PEDAL

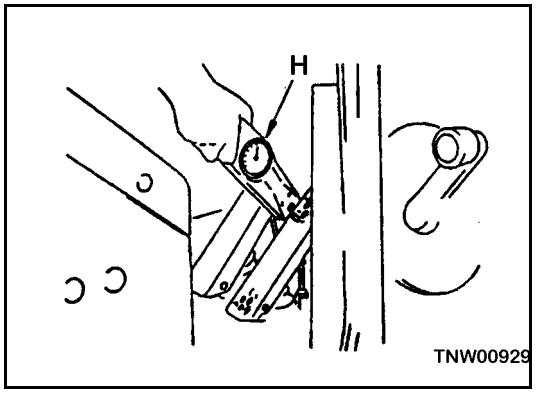
OPERATING FORCE

1. Measuring

   A. Set tool **H** at a position 150 mm from pedal fulcrum **a**.
      ★ Put the center of tool **H** in contact with a point 150 mm from the pedal fulcrum.



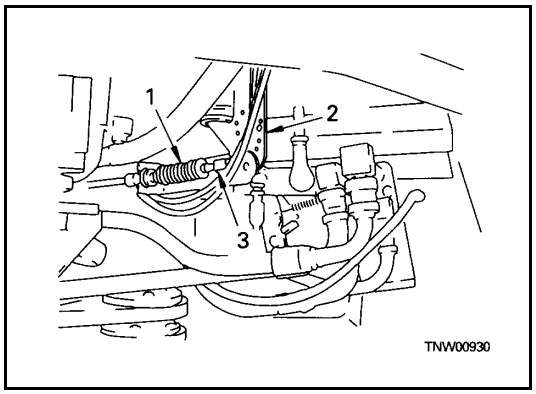
   B. Start the engine, then measure the maximum value when the pedal is moved from the pushed position (low idling) to the end of its travel (high idling).



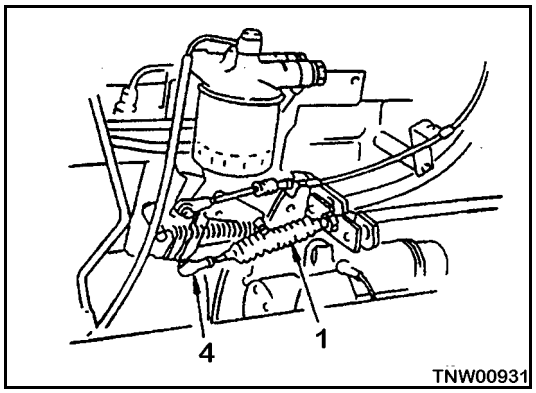
2. Testing

   A. Stop the engine.

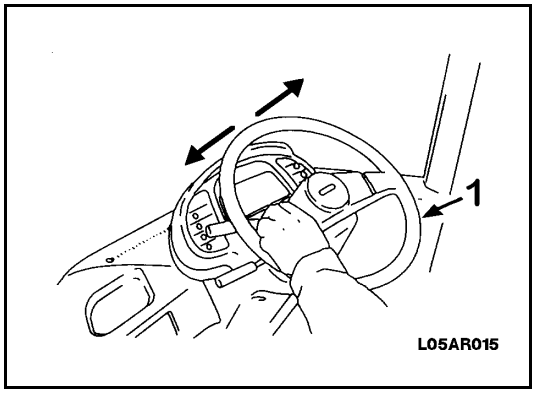
   B. Disconnect the cable (1) at the bottom of the accelerator pedal, and check that the plate (2), yoke (3) or ball joint (4) at the engine end moves smoothly.



   ★ Carry out the above inspection, and adjust or replace parts if necessary. Then carry out the measurement of the operating force again to check that it is within the standard value



OPERATING TIME



Measurement conditions

- Road surface: Flat, horizontal, dry paved surface
- Engine water temperature: Within green range on engine water temperature gauge
- Hydraulic oil temperature: 45 - 55° C (113 - 131° F)
- Tire inflation pressure: Specified pressure
- Engine speed: Low and high idle

Measurement method

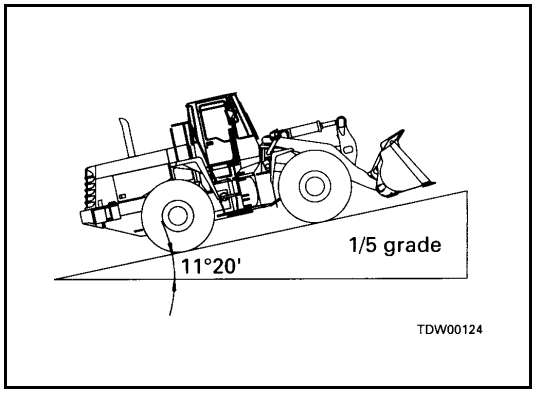
1. Start the engine.
   ★ After starting the engine, raise the bucket approximately 400 mm and remove the safety bar.

2. Operate the steering wheel (1) to the end of its stroke to turn the machine to the left or right.

3. Measure the time taken to operate the steering wheel to the end of the stroke to the right (left).
   ★ Operate the steering wheel as quickly as possible without using force.
   ★ Carry out the measurements both at low idling and high idling, and to both the left and right.

PARKING BRAKE

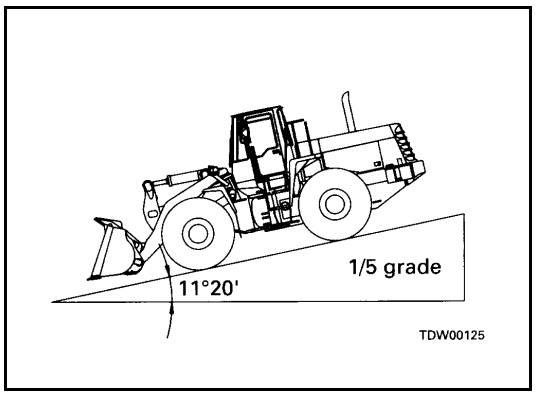
PARKING BRAKE PERFORMANCE



Measurement conditions

- Tire inflation pressure: Specified pressure
- Road surface: Flat, dry paved road surface with slope of 1/5 grade (11°20').
- Machine: Operating condition
- Operating effort: 392.3 N (88.19 lbf)

Measurement method



1. Start the engine, set the machine facing in a straight line, then drive the machine up a 1/5 grade slope with the bucket empty.

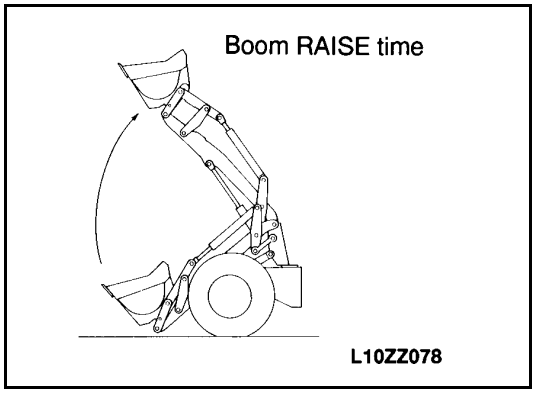
2. Depress the brake, stop the machine, set the directional lever to the neutral position, then stop the engine.

3. Depress the parking brake pedal, then gradually release the brake pedal and check that the machine is held in position.
   ★ Carry out the measurement in two ways: Once with the machine facing uphill, and once more with the machine facing downhill.

MEASUREMENT

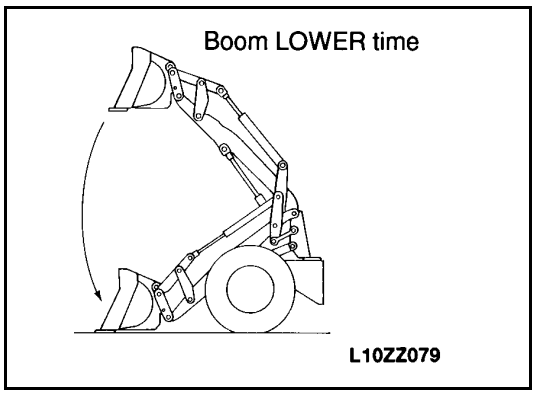
Measurement conditions

- Engine water temperature: Within green range on engine water temperature gauge
- Hydraulic oil temperature: 45 - 55° C (113 - 131° F)
- Engine speed: High idling
- Steering position: Neutral
- No load

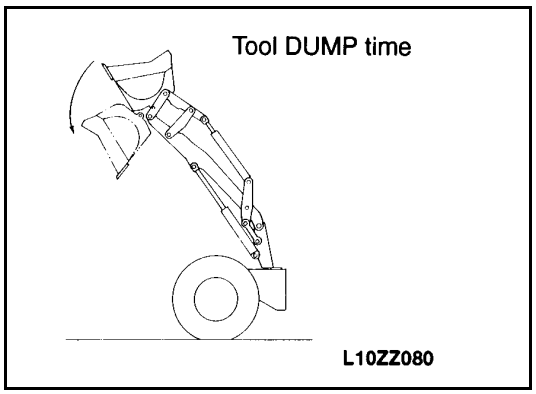


Measurement method

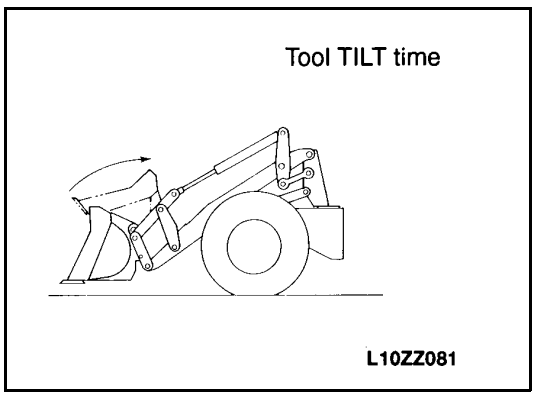
1. Boom RAISE time
   Set the bucket at the lowest position from the ground with the bucket tilted back fully, then raise it and measure the time taken for the bucket to reach the maximum boom height.



2. Boom LOWER time
   Set the bucket horizontal, then lower the boom from the maximum height and measure the time taken for the bucket to reach the lowest position from the ground.



3. Bucket DUMP time
   Raise the boom to the maximum height, and measure the time taken to move the bucket from the tilt position (bucket fully tilted back) to the dump position (bucket fully tipped forward).



4. Bucket TILT time

   A. Raise the boom to the maximum height, and measure the time taken to move the bucket to the tilt position (bucket fully tilted back).

   B. Set the bucket horizontal to the ground and measure the time taken to move the bucket from the horizontal position to the tilt position (bucket fully tilted back).

POINTS TO REMEMBER WHEN TROUBLESHOOTING

WARNING! Stop the machine in a level place, and check that the safety pin, blocks, and parking brake are securely fitted.

WARNING! When carrying out the operation with two or more workers, keep strictly to the agreed signals, and do not allow any unauthorized person to come near.

WARNING! If the radiator cap is removed when the engine is hot, hot coolant may spurt out and cause burns, so wait for the engine to cool down before starting troubleshooting.

WARNING! Be extremely careful not to touch any hot parts or to get caught in any rotating parts.

WARNING! When disconnecting wiring, always disconnect the negative (-) terminal of the battery first.

WARNING! When removing the plug or cap from a location which is under pressure from oil, water or air, always release the internal pressure first. When installing measuring equipment, be sure to connect it properly.

The aim of troubleshooting is to pinpoint the basic cause of the failure, to carry out repairs swiftly, and to prevent reoccurrence of the failure.

When carrying out troubleshooting, an important point is to understand the structure and function of the machine. However, a short cut to effective troubleshooting is to ask the operator various questions to form some idea of possible causes of the failure that would produce the reported symptoms.

1. When carrying out troubleshooting, do not hurry to disassemble the components. If components are disassembled immediately after a failure occurs:
   - Parts that have no connection with the failure or other unnecessary parts will be disassembled.
   - It will become impossible to find the cause of the failure.

   It will also cause a waste of man hours, parts, or oil and grease. At the same time, it will also lose the confidence of the user or operator. For this reason, when carrying out troubleshooting, it is necessary to carry out thorough prior investigation and to carry out troubleshooting in accordance with the fixed procedure.

2. Points to ask the user or operator.

   A. Have any other problems occurred apart from the problem that has been reported?

   B. Was there anything strange about the machine before the failure occurred?

   C. Did the failure occur suddenly, or were there problems with the machine condition before this?

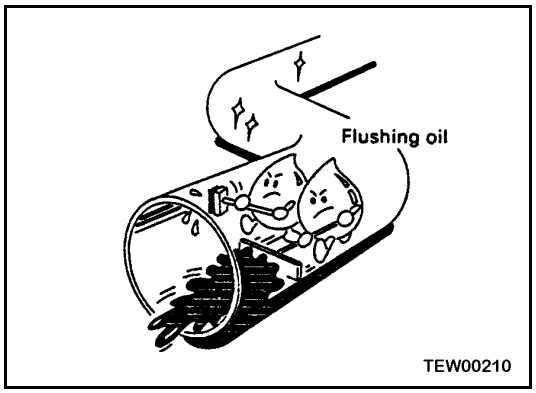
   D. Under what conditions did the failure occur?

   E. Had any repairs been carried out before the failure? When were these repairs carried out?

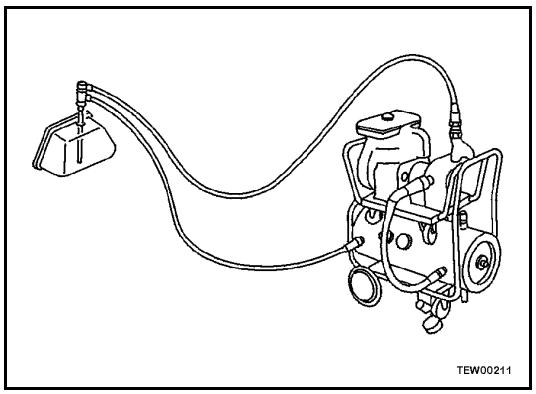
   F. Has the same kind of failure occurred before?

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, so it is best 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. (Do not drain the oil from the hydraulic tank; but 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 3μ) particles that the filter built into the hydraulic equipment cannot remove, so it is an extremely effective device.



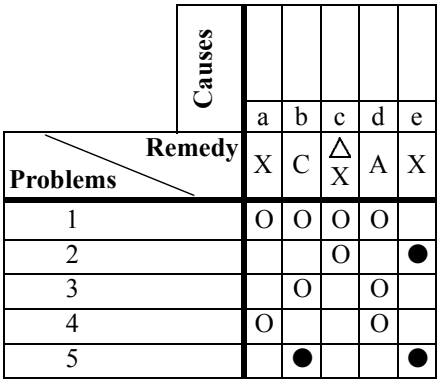
3) Operate the machine and check the troubleshooting items other than those in 1).
Operate the machine and check the items in the same way as in 1) and if the symptom appears, mark that item. (In the chart on the right, the symptom appears again for item 5).

4) Find the appropriate cause from the cause column. In the same way as in Step 2), if the symptom appears, the O marks on that line indicate the possible causes. (For item No.5 in the table on the right, the possible causes are **b** or **e**.)

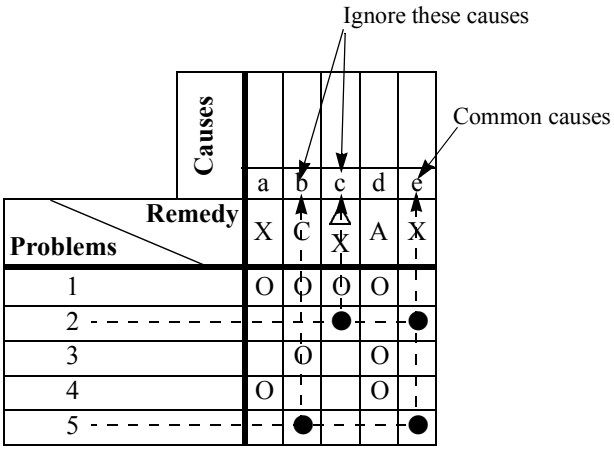
5) Narrow down the possible causes.
There is one common cause among the causes located in Steps 2) and 4). (One cause marked O, appears on the line for both items.) This cause is common to both the symptoms in troubleshooting Steps 1) and 3).
★ The causes which are not common to both troubleshooting items (items which are not marked O for both symptoms) are unlikely causes, so ignore them. (In the example given on the right, the causes for Troubleshooting Item 2 are **c** or **e,** and the causes for Troubleshooting Item 5 are **b** or **e,** so cause **e** is common to both.)

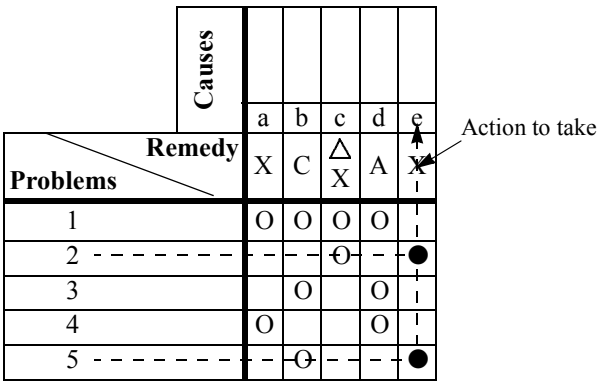
6) Repeat the operations in Steps 3), 4) and 5) until one cause (one common cause) remains.
★ If the causes cannot be narrowed down to one cause, narrow the causes down as far as possible.

7) Remedy
If the causes are narrowed down to one common cause, take the action given in the remedy column.
The symbols given in the remedy column indicate the following:
X: Replace
△: Repair
A: Adjust
C: Clean



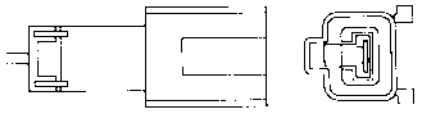
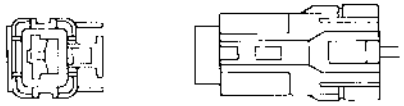
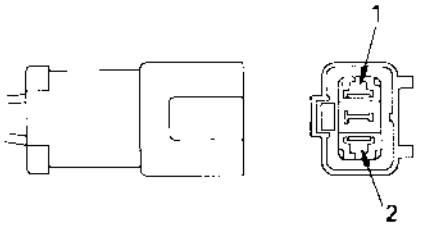
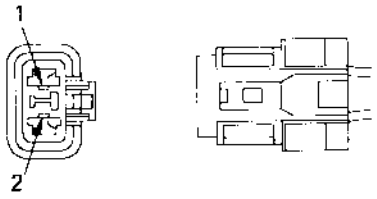
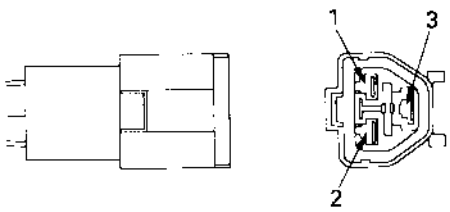
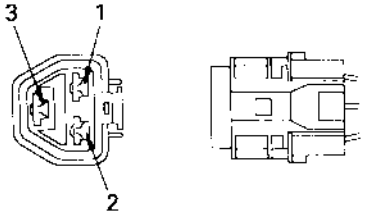
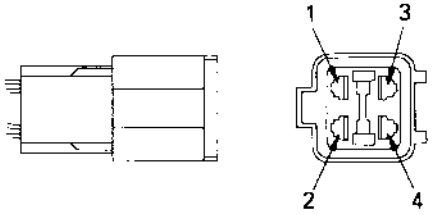
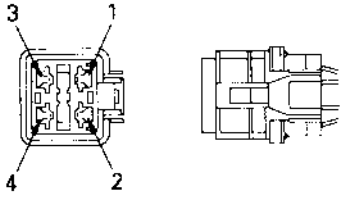
Applicable troubleshooting item located in Step 3).
Applicable troubleshooting item located in Step 1).





CONNECTION TABLE FOR CONNECTOR PIN NUMBERS

★ The terms male and female refer to the pins, while the terms male housing and female housing refer to the mating portion of the housing.

No. of pins	X type connector	
	Male (female housing)	Female (male housing)
1		
2		
3		
4		

S08CD271

TRANSMISSION CONTROL, PARKING BRAKE SYSTEM

SEE FOLDOUT 20-219

TABLE OF TROUBLESHOOTING MODES AND CAUSES

	Related equipment															
Cause of failure / Failure mode	F solenoid system	R solenoid system	H-L solenoid system	Speed solenoid system	Directional lever signal system	Speed lever signal system	Travel speed sensor signal system	Engine speed sensor signal system	Hold switch signal system	Kick-down signal system	Transmission cut-off signal	Neutralizer relay signal system	Alarm buzzer signal system	Network signal system	Controller power source voltage system	Troubleshooting code when no abnormality is display is given
Main monitor display failure code	12	13	14	16	20	21	22	23	--	--	--	--	--	--	--	--
Impossible to travel	O	O			O						O	O			O	H-1
Auto-shift does not work			O	O		O	O									--
Position of directional lever and direction of travel do not match					O											--
Machine travels forward when directional lever is not at F position	O															--
Machine travels in reverse when directional lever is not at R position		O														--
Transmission doesn't shift down with travel speed			O	O			O									--
Transmission doesn't shift up with travel speed			O	O												--
Transmission stays in same range as speed lever regardless of travel speed							O									H-2
Excessive shock when shifting gear								O								H-3
Shift hunting when traveling						O										--
Shift hunting when shifting gear								O								--
Transmission range can't be controlled with speed lever						O										--
Shift cannot be held									O							A-9
Kick-down switch doesn't shift transmission to 1st										O						A-10
No power for scooping operations when kick-down switch is ON										O						A-10
Transmission is not cut off when left brake is operated											O					A-11
Machine can travel when parking brake is applied												O				A-12
Alarm buzzer does not sound when travel direction is switched between forward and reverse while traveling at high speed													O			A-13
Alarm buzzer does not stop													O			A-13
Main monitor does not display transmission controller data (alarm buzzer, failure code, etc.)														O		A-14
Troubleshooting code when error code is displayed	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	--	--	--	--	--	--	--	--

A-8 TROUBLESHOOTING CODE [23]

ABNORMALITY IN ENGINE SPEED SIGNAL SYSTEM

★ Before troubleshooting, check that all related connectors are in good condition and properly connected.
★ Restore disconnected connectors before proceeding to the next step.
★ Turn starting switch OFF before disengaging connectors, when connecting the T-adapter or socket adapter.

Is insulation between CNL75 (female) (4), (12) and chassis normal?

1) Turn starting switch OFF.
2) Disconnect CNL75, CNAS2, and CNL07.
2) Min. 1 MΩ.

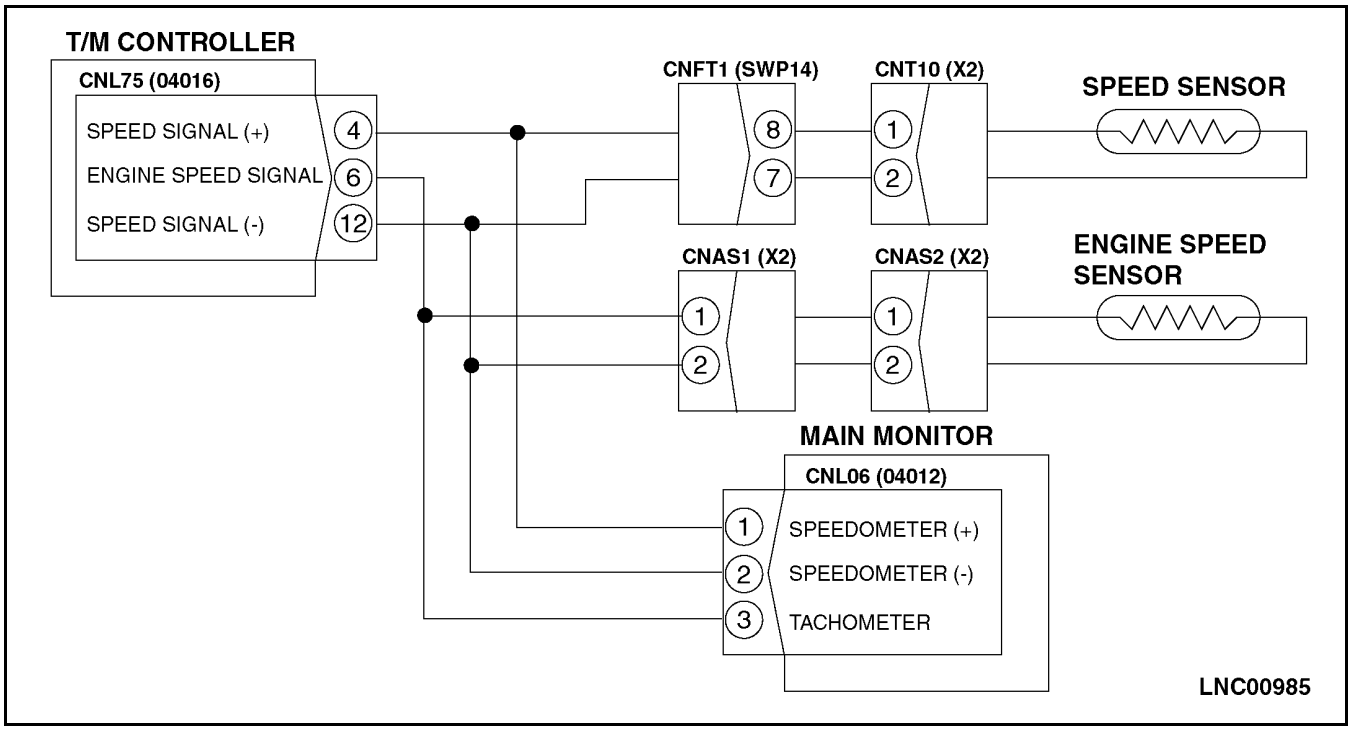
1 YES

Is continuity between CNL75 (female) (5) and (12) normal?

1) Turn starting switch OFF.
2) Disconnect CNL75, CNAS2 and CNL07.
3) Between CNAS2 (female) (1) and (2) short to ground.

2 YES

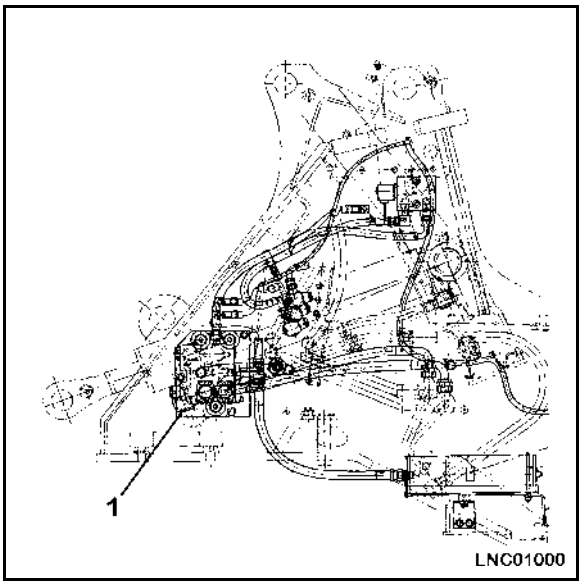
Cause	Remedy
Defective controller	Replace
Disconnected wiring between CNL75 (female) (5) - CNAS2 (female) (1) or faulty connection	Repair wiring harness or replace
Wiring harness between CNL75 (female) (5), (12) - CNL07 (female) (3), (2), between CNL75 (female) (5), (12) - CNAS2 (female) (1), (2) short circuiting with chassis ground	Repair wiring harness or replace



ECSS CIRCUIT - REMAINING PRESSURE REMOVAL

INSPECTION / ADJUSTMENT

★ When removing ECSS circuit piping and the ECSS valve, use the following the procedure to extract the accumulator pressure.

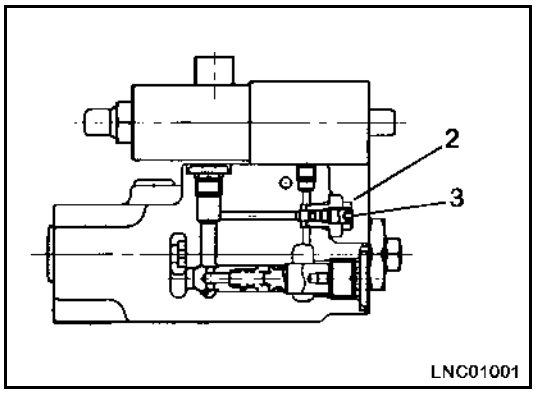


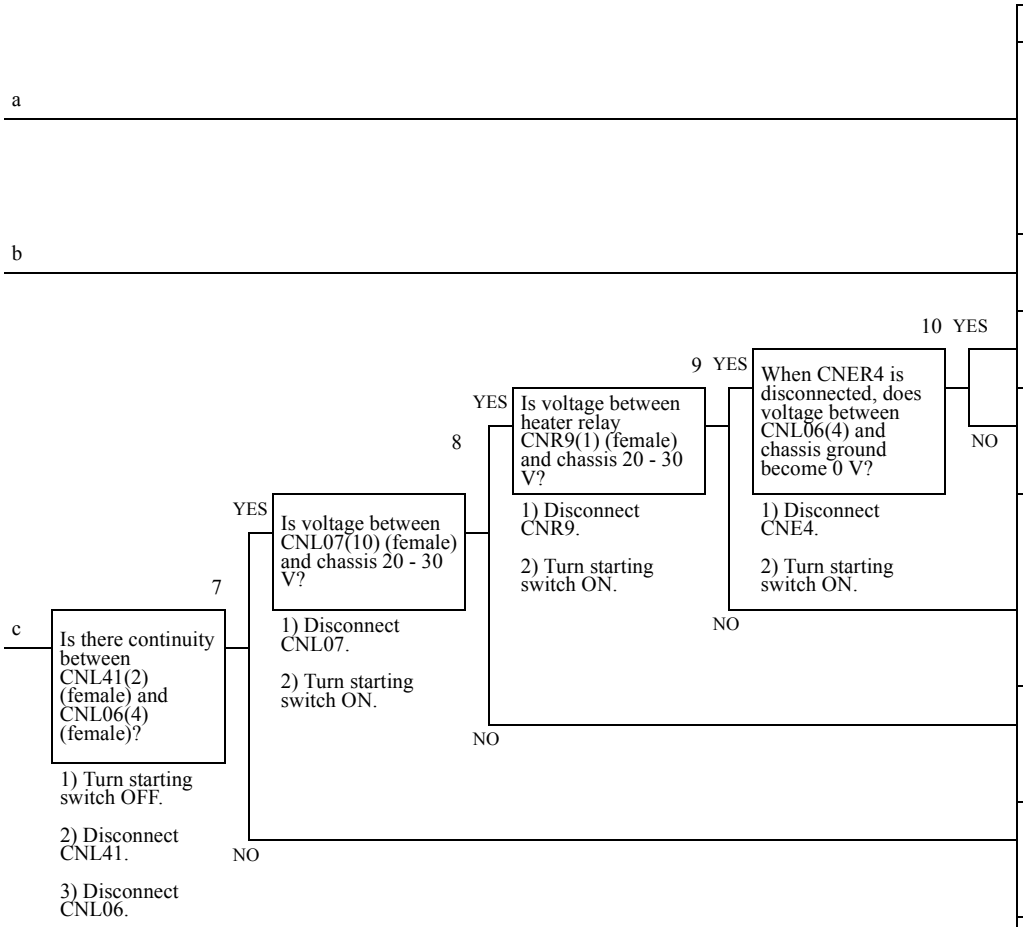
1. Loosen lock nut (2) on ECSS valve (1).

2. Loosen adjusting screw (3) by turning 1/2 to 1 turns at a time to extract the accumulator pressure.
   ★ The lock nut (2) and the adjustment screw (3) are painted red.

3. After extracting the remaining pressure, return adjustment screw (3) to its original position, then tighten with lock nut (2).

   Lock nut torque: 12.7 ± 0.6 Nm (9.36 ± 0.44 lbf ft)





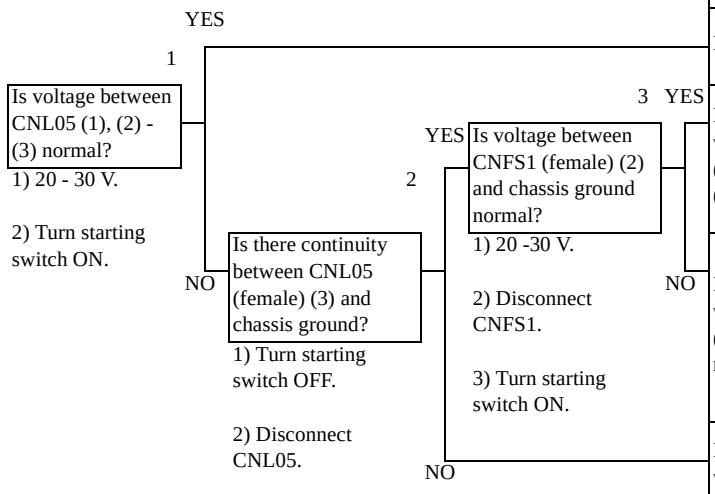
Cause	Remedy
Defective contact or disconnection in wiring harness between heater relay terminal CNR4 and electrical intake air heater terminal CNE3	After inspection, repair or replace
Defective heater relay	Replace
Defective QHS water temperature sensor	Replace
Defective QHS controller inside monitor	Replace
Defective contact or disconnection in wiring harness between CNL41(3) - CNR5(7) - CNR9	After inspection, repair or replace
Defective contact or disconnection in wiring harness between starting switch terminal BR - CNL09(2) - CNL07(10)	After inspection, repair or replace
Defective contact or disconnection in wiring harness between CNL41(2) and CNL06(4)	After inspection, repair or replace
Defective contact or disconnection in wiring harness between CNL41(1) - CNFS2(7)	After inspection, repair or replace
Defective contact or disconnection in wiring harness between CNL41(5) - CNFS2(7) - CNFS1(2) - CNLR4(1) - CNR5	After inspection, repair or replace
Defective contact or disconnection in wiring harness between battery relay terminal M and heater relay terminal CNR3	After inspection, repair or replace
Defective contact or disconnection in wiring harness between battery - battery relay - CNR7(2) - CNLR3(1) - CNFS3(6), (4) - CNL09(1) - starting switch terminal B, or defective starting switch	After inspection, repair or replace

K-1 WHEN STARTING SWITCH IS TURNED ON, ALL LAMPS ON MAINTENANCE MONITOR DO NOT LIGHT UP FOR 3 SECONDS, MAINTENANCE MONITOR DOES NOT WORK

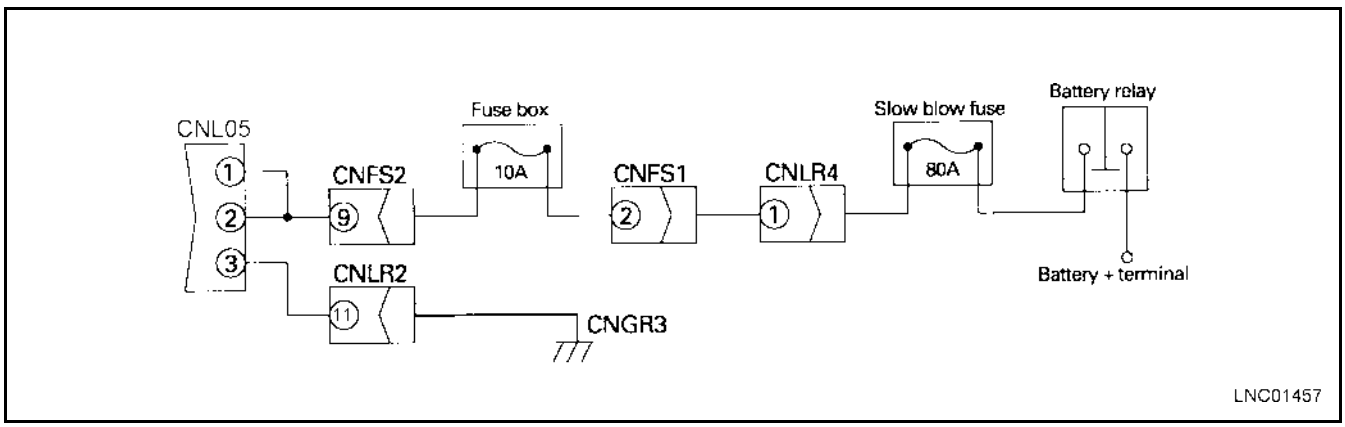
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.

★ Always connect any disconnected connectors before going on to the next step.

A. ALL LAMPS ON MAINTENANCE MONITOR DO NOT LIGHT UP FOR 3 SECONDS



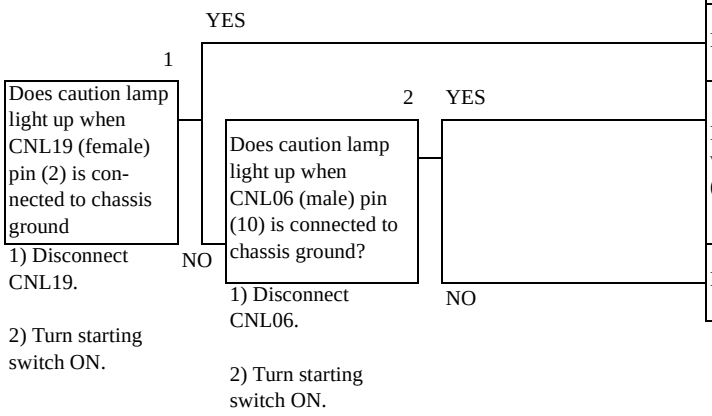
Cause	Remedy
Defective maintenance monitor module	Replace
Defective contact or disconnection in writing harness between CNL05 (female) (1), (2) - CNFS2(9) - fuse box - CNFS1 (male) (2) or blown fuse	Repair wiring harness, replace or replace fuse
Defective contact or disconnection in wiring harness between CNFS1 (female) (2) - CNLR4(1) - slow blow fuse - battery relay or blown fuse	Repair wiring harness, replace or replace fuse
Defective contact or disconnection in wiring harness between CNL05(3) - CNLR2(11) - CNGR3 ground	Repair wiring harness or replace



K-8 CAUTION ITEMS ARE FLASHING BUT WARNING LAMP (CHECK LAMP, CAUTION LAMP) DO NOT LIGHT UP

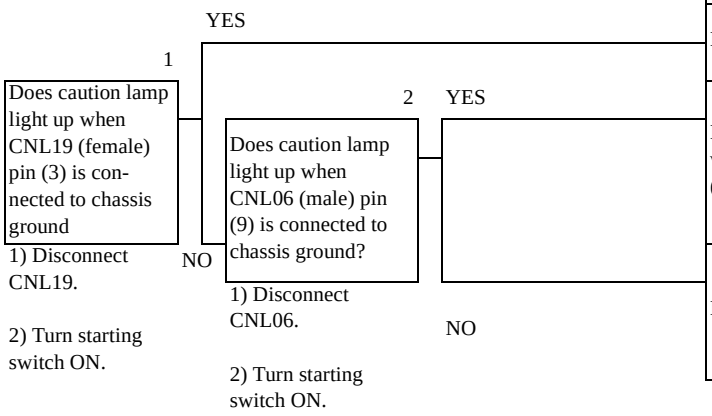
★ Before carrying out troubleshooting, check that there are no blown lamp bulbs.
★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on to the next step.

A. CHECK LAMP

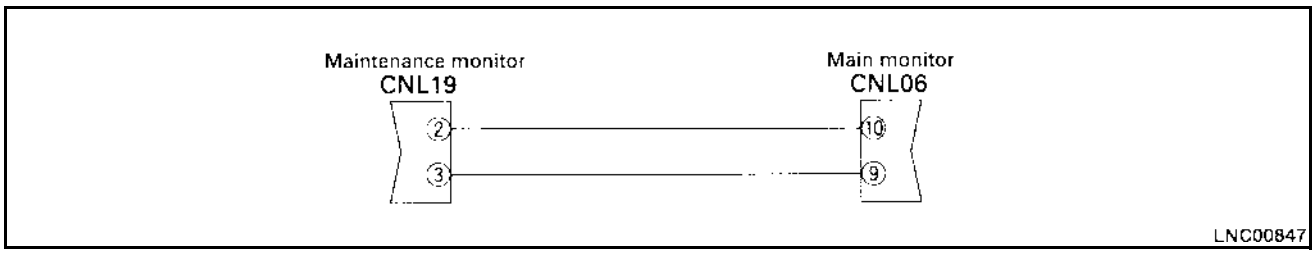


Cause	Remedy
Defective maintenance monitor module	Replace
Defective contact or disconnection in wiring harness between CNL19 (female) (2) and CNL06 (female) (10)	Repair wiring harness or replace
Defective main monitor	Replace

B. CAUTION LAMP



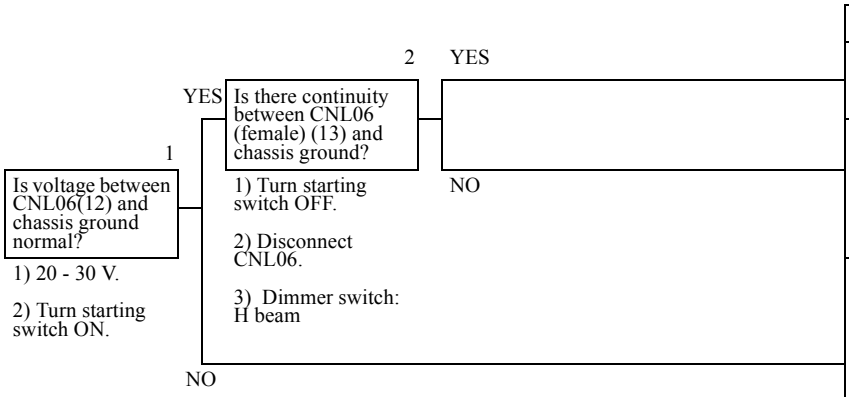
Cause	Remedy
Defective maintenance monitor module	Replace
Defective contact or disconnection in wiring harness between CNL19 (female) (3) and CNL06 (female) (9)	Repair wiring harness or replace
Defective main monitor	Replace



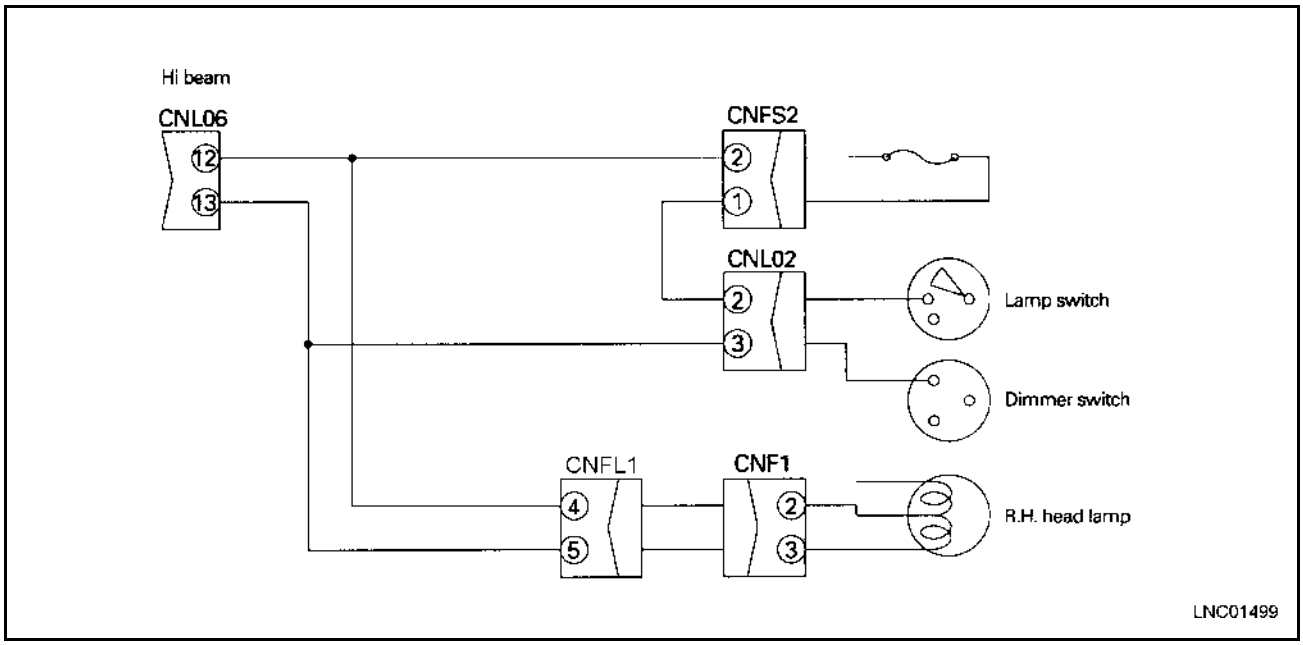
TROUBLESHOOTING OF MAIN MONITOR SYSTEM (M-MODE)

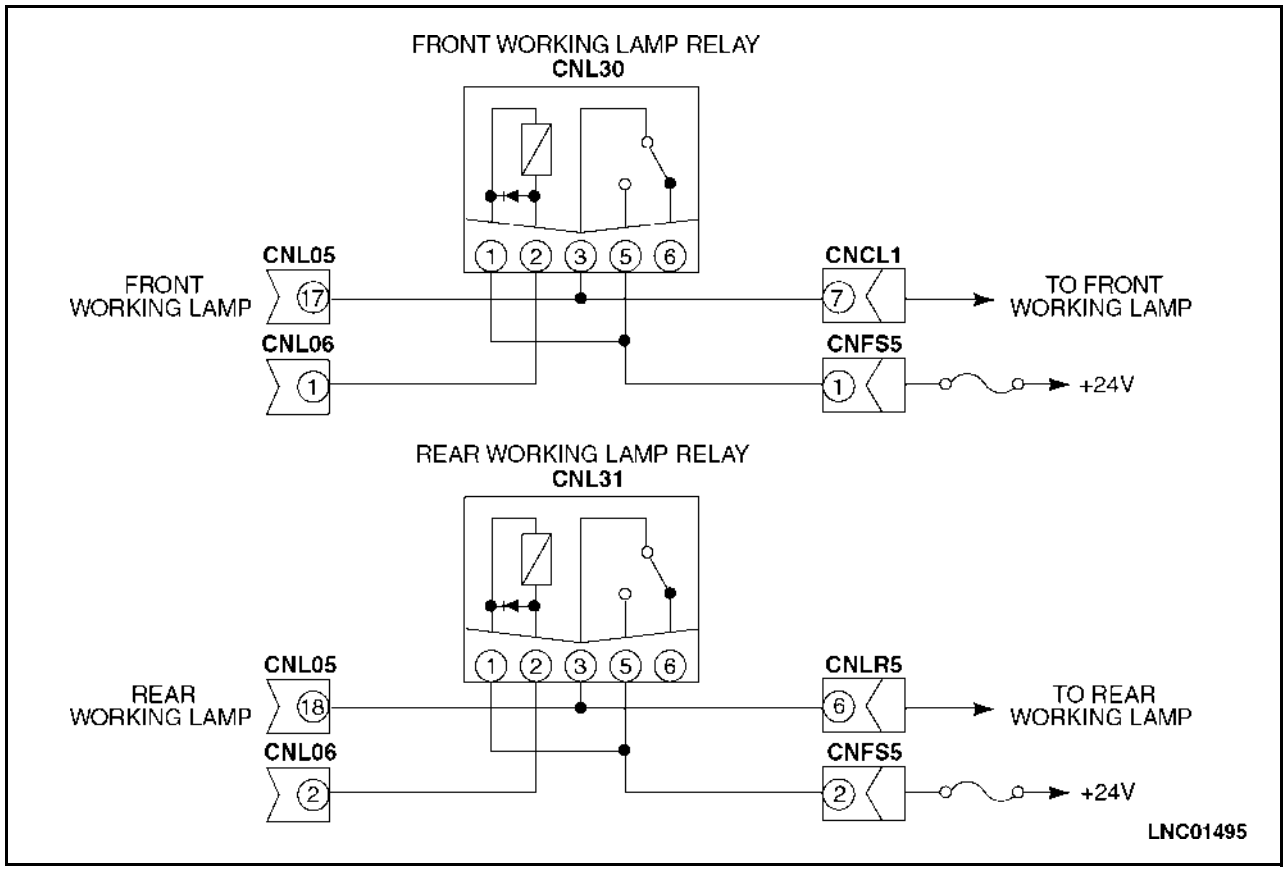
M-5 HIGH BEAM DOES NOT LIGHT UP

★ Before carrying out troubleshooting, check that all the related connectors are properly inserted.
★ Always connect any disconnected connectors before going on to the next step.
★ Before starting troubleshooting, check that the lamp bulb is not blown.



Cause	Remedy
Defective main monitor	Replace
Defective contact or disconnection in wiring harness between CNL06 (female) (13) and CNL02(3)	After inspection, repair or replace
Defective contact or disconnection in wiring harness between CNL06 (female) (12) and CNFS2(2)	After inspection, repair or replace




FRONT WORKING LAMP RELAY
CNL30
1 2 3 5 6
CNL05
FRONT
WORKING LAMP
17
CNL06
1
CNCL1
7
TO FRONT
WORKING LAMP
CNFS5
1
+24V
REAR WORKING LAMP RELAY
CNL31
1 2 3 5 6
CNL05
REAR
WORKING LAMP
18
CNL06
2
CNLR5
6
TO REAR
WORKING LAMP
CNFS5
2
+24V
LNC01495

S1 STARTING PERFORMANCE IS POOR

(Starting always takes time)

General causes why starting performance is poor

Defective electrical system - Insufficient supply of fuel - Insufficient intake of air - Improper selection of fuel

(At ambient temperature of -10° C (-14° F) or below, use ASTM D975 No. 1, and -10° C (-14° F) or above, use ASTM D975 No. 2 diesel fuel.)

★ Battery charge table

Ambient temperature	Percent of full charge				
	100%	90%	80%	75%	70%
20° C (68° F)	1.28	1.26	1.24	1.23	1.22
0° C (32° F)	1.29	1.27	1.25	1.24	1.23
-10° C (-14° F)	1.30	1.28	1.26	1.25	1.24

- The specific gravity should exceed the values for 70% in the above table.
- In cold weather the specific gravity must exceed the values for 75% in the table above

Legend
O: Possible causes (judging from questions and check items)
◎: Most probable causes (judging from questions and check items)
△: Possible causes do to length of use (used for a long period)
●: Items to confirm the cause

			Causes															
			Worn piston ring, cylinder	Defective contact of valve, valve seat	Clogged air cleaner element	Clogged fuel filter, strainer	Clogged feed pump strainer	Defective air intake heater	Defective regulator	Defective alternator	Defective or deteriorated battery	Defective injection nozzle	Defective injection timing	Defective injection pump, (rack, plunger stuck)	Leakage, clogging, air in fuel system	Clogged fuel tank air breather hole	Defective feed pump
Questions	Confirm recent repair history																	
	Degree of use	Operated for long period			△	△	△				△							
	Ease of starting	Gradually became worse	◎	◎	O	O	O											
		Starts when warm						◎			◎							
	Preheating indicator lamp does not light up							◎										
	Engine oil must be added more frequently		◎															
	Replacement of filters has been carried out according to operation manual				◎	◎	◎					O		O				
	Dust indicator is red				◎													
	Non-specified fuel has been used					O	O					O		O				
Check items	Battery charge lamp is ON								◎	◎								
	Starter motor cranks engine slowly										◎							
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinders is low											◎						
	Engine does not pick up smoothly, and combustion is irregular		O	O								◎						
	Blow by gas is excessive		◎															
	Match marks on fuel injection pump are out of alignment												◎					
	Mud is stuck to fuel tank cap															O		
	When cranking engine with starter motor, little fuel comes out, even if injection pump sleeve nut is loosened													◎				
	When cranking engine with starter motor, little fuel comes out, even when fuel filter air bleed plug is loosened				◎	◎								◎				◎
	Leakage from fuel piping													O	◎			
	There is hunting from engine (rotation is irregular)				O	O									◎	O		
Troubleshooting	When compression pressure is measured, it is found too be low		●	●														
	When air element is inspected, it is found to be clogged				●													
	When fuel filter, strainer are inspected, they are found to be clogged					●									●			
	When feed pump, strainer is inspected, it is found to be clogged						●											
	Heater mount does not become warm							●										
	Voltage is 26 - 30V between alternator terminal B and terminal E with engine at low idle	Yes							●									
		No								●								
	Either specific gravity of electrolyte or voltage of battery is low										●							
	Stop fuel injection to one cylinder at a time. If there is no change in engine speed, that cylinder is not working											●						
	When check fuel injection timing, injection timing is found to be incorrect -------※												●					
	When control rack is pushed, it is found to be heavy or does not return (when blind plug at rear of pump is removed, it can be seen that plunger control sleeve does not move)													●				
	When fuel cap is inspected directly, it is found to be clogged															●		
		Remedy	Replace	Repair	Clean	Clean		Replace	Replace	Replace	Replace	Replace	Adjust	Replace	Repair	Clean	Replace	

※ Refer to TESTING AND ADJUSTING

S-9 OIL BECOMES CONTAMINATED QUICKLY

General causes why oil becomes contaminated quickly

- Intake of exhaust gas due to internal wear
- Clogging of lubrication passage
- Improper combustion
- Improper oil used
- Operation under excessive load

Legend
O: Possible causes (judging from questions and check items)
◎: Most probable causes (judging from questions and check items)
△: Possible causes do to length of use (used for a long period)
●: Items to confirm the cause

			Causes									
			Worn piston ring, cylinder	Clogged breather, breather tube	Clogged oil filter	Worn valve, valve guide	Clogged oil cooler	Clogged turbocharger drain pipe	Defective seat at turbocharger turbine end	Defective safety valve	Exhaust gas is black
Questions	Confirm recent repair history										
	Degree of use	Operated for long period	△			△			△		
	Engine oil must be added more frequently		◎								
	Non-specified fuel has been used				O						
Check items	Color of exhaust gas	Blue under light load	◎								
		Black									◎
	Amount of blow-by gas	Abnormally excessive	◎			O		O	O		Carry out troubleshooting for "Exhaust black"
		None		◎							
	Oil filter caution lamp stays ON even when oil pressure rises				◎					O	
	When oil filter is inspected, metal particles are found		O		◎	O					
	When exhaust pipe is removed, inside is found to be dirty with oil					◎					
	Engine oil temperature rises quickly						◎				
Troubleshooting	When compression pressure is measured, it is found to be low		●			●					
	When breather element is inspected, it is found to clogged with dirty oil or hose is broken			●							
	When oil filter is inspected, it is found to be clogged				●						
	When oil cooler is inspected, it found to be clogged						●				
	Turbocharger drain tube is clogged							●			
	Excessive play of turbocharger shaft								●		
	When safety valve is inspected, it is found to be catching or broken									●	
		Remedy	Replace	Clean	Replace	Replace	Clean	Clean	Replace	Replace	-

T-2 TRAVEL SPEED IS SLOW, THRUSTING POWER IS WEAK, LACKS POWER ON SLOPES

Checking for abnormalities

- Measure digging operations and speed when traveling on level ground and on slopes, and check if there is actually an abnormality or whether it is just the feeling of the operator

WORK EQUIPMENT

T-12 BOOM DOES NOT RISE

Ask the operator the following questions.

- Did the problem suddenly start?
  Yes = Equipment seized, damaged Was there any abnormal noise when this happened? (from where?)
- Was there previously any symptom, such as the speed becoming slow?
  Yes = Wear of internal parts, deterioration in spring

Checks before troubleshooting

- Is the hydraulic oil level correct?
- Is the travel of the boom control lever and spool properly adjusted?

		Causes					
		Clogged suction port of pump or excessive air in oil	No PTO drive for pump	Defective hydraulic pump and steering pump	Defective operation of main relief valve	Breakage inside valve body (boom spool)	Damaged boom cylinder piston seal
		Tank - pump			Main control valve		Cylinder
	Remedy	C X	△ X	△ X	△ X	X	X
No.	Problems	a	b	c	d	e	f
1	Bucket cannot be operated and boom cannot be raised	●	●	●	●		
2	Chassis can be raised with boom, but boom cannot be raised or bucket can be operated, but boom cannot be raised					●	●
3	Boom can be raised when there is no load, but cannot be raised when there is a load	●		●	●		
4	Abnormal noise comes from hydraulic pump	●		●			
5	Excessive hydraulic drift of boom cylinder					●	●

Legend: X: Replace △: Correct A: Adjust C: Clean

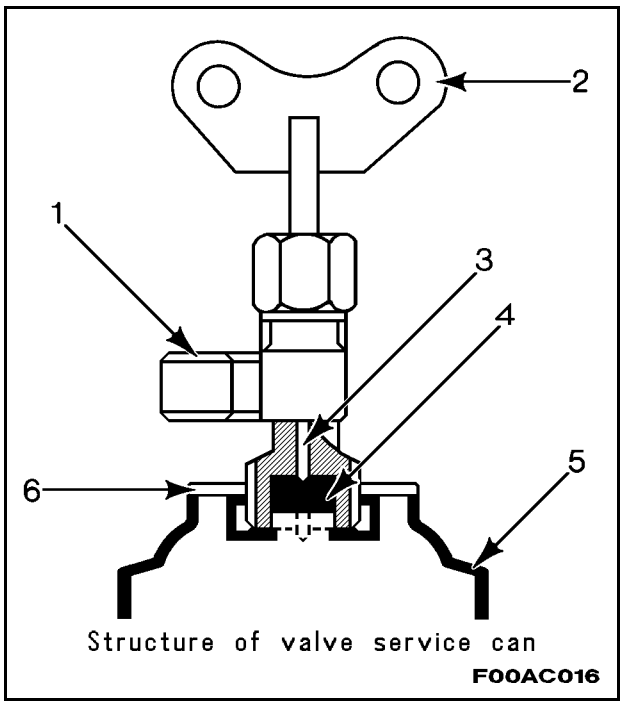
TESTING, ADJUSTING AND TROUBLESHOOTING AIR CONDITIONER

VALVE FOR SERVICE CANS

The valve for the service cans is used when charging refrigerating system. Handle it as follows:

1. Before using the service can, confirm that a packing can be used on it. Then, turn the handle fully counterclockwise to lift the needle. Lift the disc (circular nut) at this time.
2. Screw the valve into the service can, and tighten the disc. Take care not to tighten it so much that the service can is damaged.
3. Connect the green charging hose of the gauge manifold to the valve.
4. Turn the handle of the valve clockwise to lower the needle and make a hole on the blind cap of the service can.
5. Turn the handle counterclockwise to lift the needle. Then, the refrigerant will flow into the refrigerating system through the valve. To stop the gas, turn the handle fully clockwise to lower the needle.

WARNING! Never reuse an empty can.



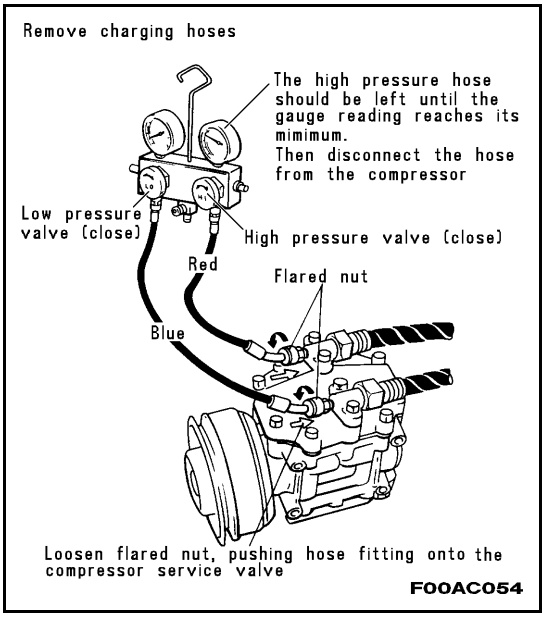
1. Adapter for charging hose
2. Handle
3. Needle
4. Packing
5. Service can
6. Disc

5. After the refrigeration circuit is stabilized, turn off the blower switch, so that only the compressor is running. The pressure on the low pressure side will gradually decrease. If the pressure on the high pressure side is kept between 13 to 15 kg/cm^2, the amount of refrigerant charged can be measured in the following manner:

   A. Too little refrigerant charged
   At a pressure of 1.01 kg/cm^2 or above on the low pressure side, bubbles pass continuously through the sight glass.

   B. Proper amount of refrigerant charged.
   At a pressure of 1.0 to 0.6 kg/cm^2 on the low pressure side, bubbles pass continuously through the sight glass.

   C. Too much refrigerant charged.
   At a pressure of 0.6 kg/cm^2 or less on the low pressure side, bubbles may or may not be observed in the sight glass at all.



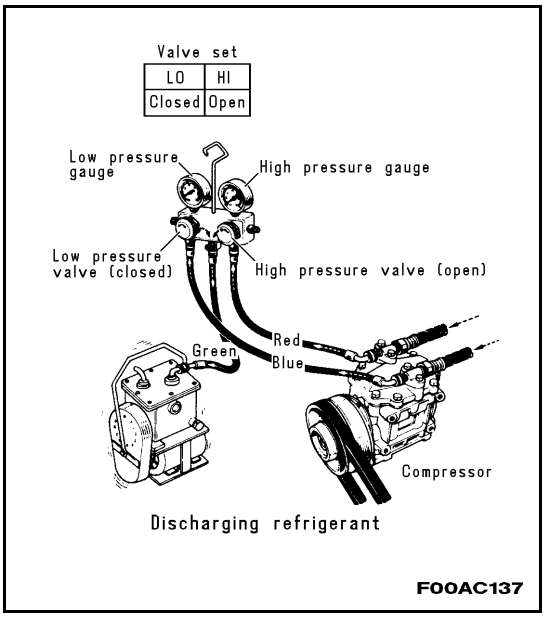
6. If there is too little refrigerant, add some from the low pressure side as described on page 20-1018 (see CHARGING FROM THE LOW PRESSURE SIDE.)

7. If there too much refrigerant, discharge some gradually from the low pressure side until the amount is decreased to the proper level.

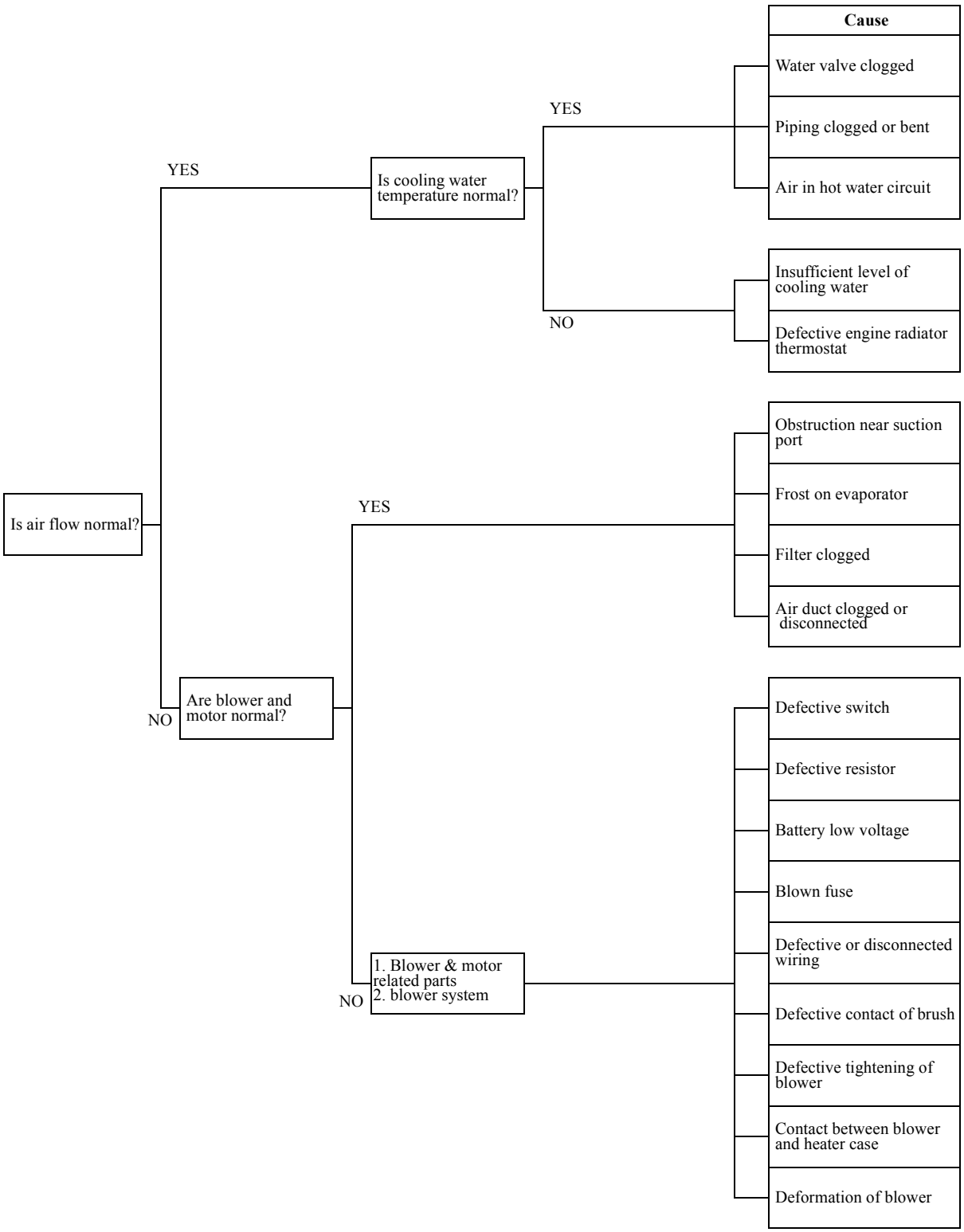
8. After making sure the refrigeration circuit contains the proper amount of refrigerant, turn on the blower switch and confirm that, at a pressure of 1.01 kg/cm^2 or more on the low pressure side, no air bubbles appear in the sight glass. Turn off the blower switch and confirm that, at a pressure of 1.0 to 0.6 kg/cm^2, air bubbles pass through the sight glass. Repeat these checks two or three more times.

9. Stop the engine, and reconnect the magnetic clutch lead wire as it was before.

10. Disconnect the charging hoses and remove the gauge manifold (SEE REMOVAL OF GAUGE MANIFOLD - page 20-1022).



DEFECTIVE HEATING



COVERS, LADDER AND ENGINE HOOD

WARNING! Stop the machine on level ground and install the safety bar on the frame. Lower the bucket to the ground and stop the engine. Then apply the parking brake and put blocks under the wheels to prevent the machine from moving.

WARNING! Disconnect the cable from the negative (-) terminal of the battery.

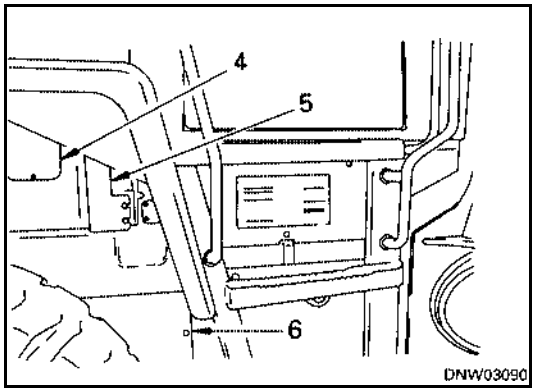
REMOVAL

1. Covers, ladder

   A. Remove hood panel.

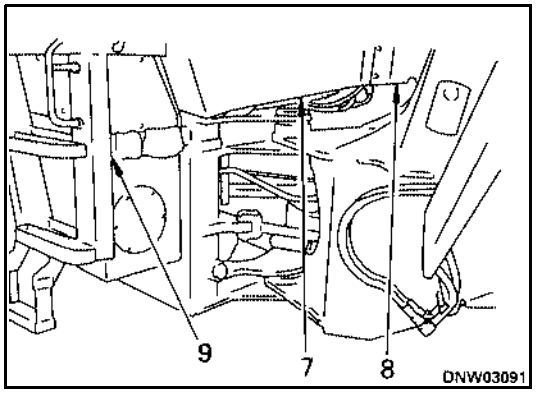
   B. Remove hood covers (4) and (5).

   C. Remove rear frame inspection cover (6).



   D. Remove covers (7) and (8) under cab.

   E. Remove ladder fender assembly (9).

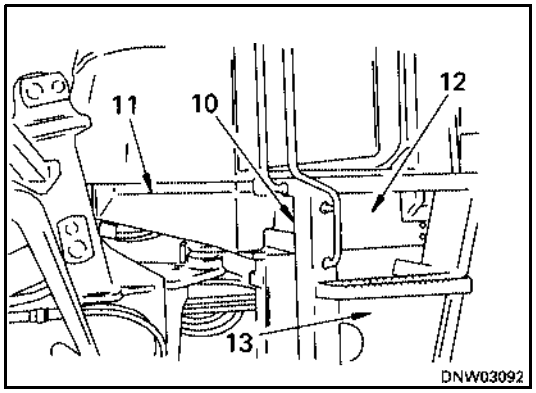


   F. Remove ladder fender assembly (10).

※1

   G. Remove covers (11) and (12) under cab.

   H. Remove rear frame inspection cover (13).



INSTALLATION

- Carry out installation in the reverse order to removal.

※1

Hose mount bolt: 9.8 ± 1.96 Nm (7.2 ± 1.44 lbf ft)

※2

★ Adjust the fuel control cable.
For details, see TESTING AND ADJUSTING, adjusting accelerator pedal.

※3

★ Check that there is an O-ring assembled at the torque converter mating surface.
★ When connecting the engine assembly to the torque converter, adjust the height so that the torque converter pilot can enter smoothly. Never use force to connect them.

Engine mount bolt: 745 ± 83 Nm (350.3 ± 61.2 lbf ft)

★ When assembling the cushion to the bracket, do not use oil or soapy water under any circumstances.

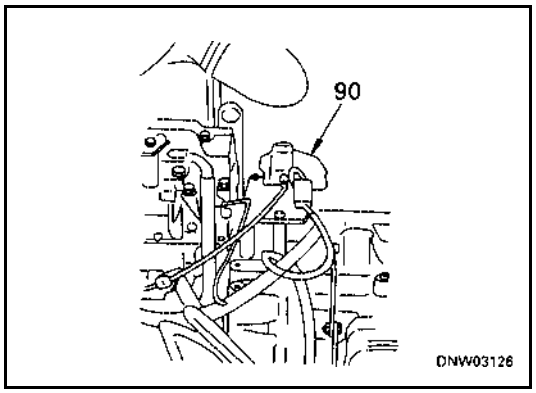
- Charging with gas
  ★ Before charging with refrigerant, always use the repeat vacuum method to completely evacuate.
  ★ Do not use the can of refrigerant upsidedown or use any other mistaken method which will let liquid freon get into the refrigerating system.
  ★ Do not operate the compressor before charging with refrigerant.
  ★ Charge the air conditioner with gas (RI34a).
  ★ Check that the refrigerant level is correct.

- Refilling with coolant
  ★ Add water through the coolant filler to the specified level.
  Run the engine to circulate the coolant through the system. Then check the coolant level again.

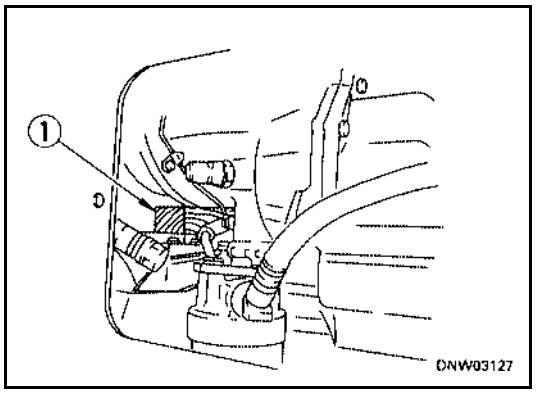
- Refilling with oil (transmission case)
  ★ Add oil through the oil filler to the specified level.
  Run the engine to circulate the oil through the system. Then check the oil level again.

18. Torque converter, transmission

A. Remove mount bracket of engine stop motor (90) from engine flywheel housing, and move towards engine.

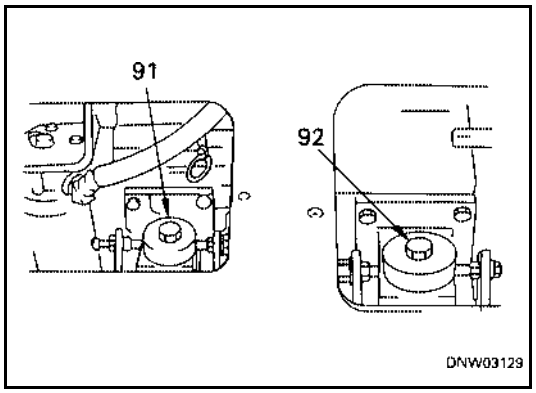


B. Set block ① between engine and axle housing and adjust height.



C. Using eye bolts, sling torque converter and transmission, then remove bracket mount bolts (91) and (92).

※12

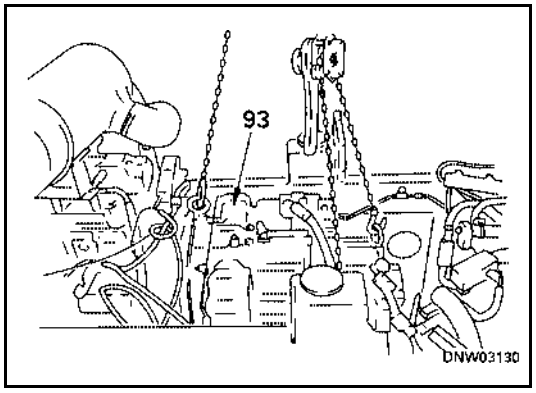


D. Remove mount bolts connecting to engine, and lift off torque converter and transmission (93).

★ Be careful of the mating of the pilot cover and lift off slowly.

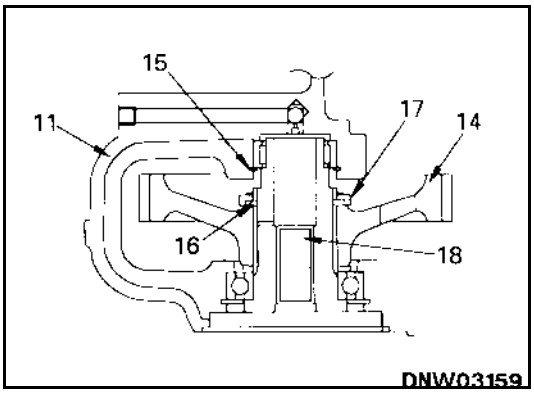
★ Check that there is no interference between the piping and any other parts before lifting off.

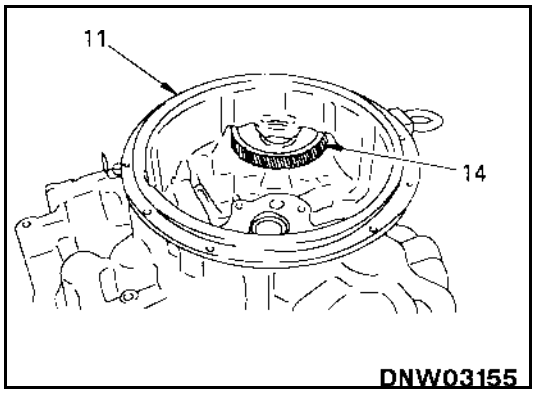
※13



kg Torque converter, transmission: 557 kg (1228 lb)

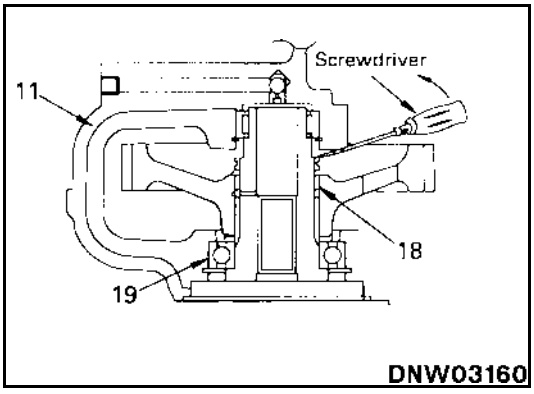
B. Turn over rear housing (11), remove snap ring (15) of pump gear (14), then remove ring washer (16) and split spacer (17).

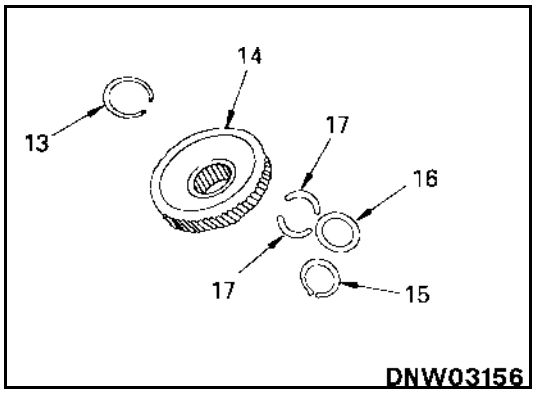


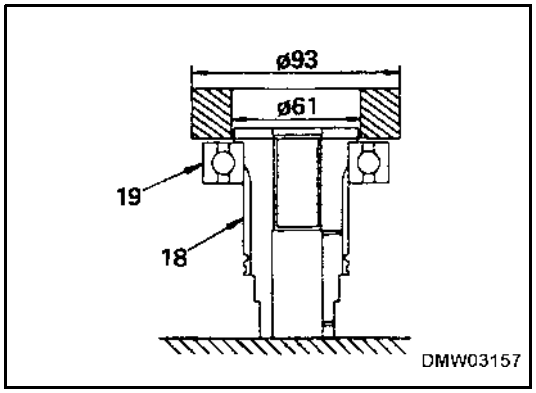


C. Insert screwdriver between rear housing (11) and shaft (18), then lever shaft and push down to remove.

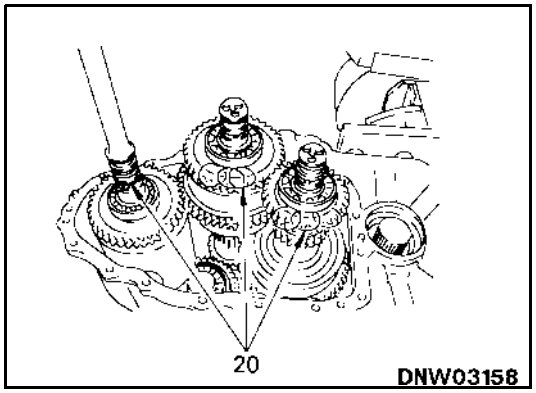
D. Remove bearing (19) from shaft (18).
★ Carry out the same procedure at the loader pump end.







9. Seal rings
Remove seal rings (20) from each clutch shaft.



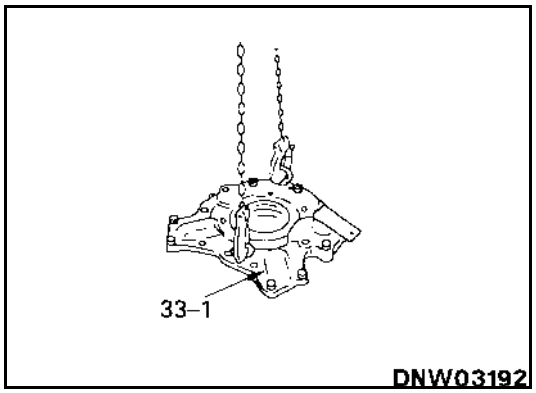
4. Parking brake assembly

A. Assemble gasket to parking brake retainer assembly (33).

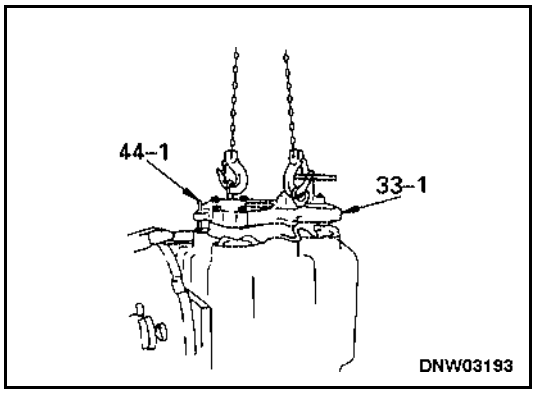
B. Raise housing and piston assembly (33-1) and install to parking brake retainer.

★ Be careful not to damage the oil seal retainer portion when assembling.

N·m Mount bolt: 110.3 ± 12.3 Nm (81.1 ± 9.0 lbf ft)

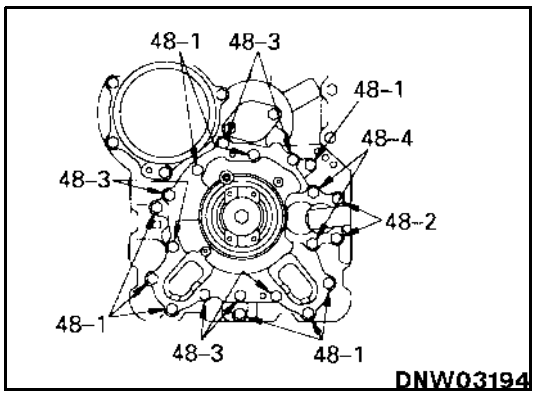


C. Remove guide pin (44-1), then assemble mount bolts (48) and tighten bolts uniformly.



★ The length of the mount bolts are different. The lengths are as follows.

(48-1) = 35 mm
(48-2) = 50 mm
(48-3) = 60 mm
(48-4) = 75 mm



D. Remove lock set bolt (49) and assemble plug.

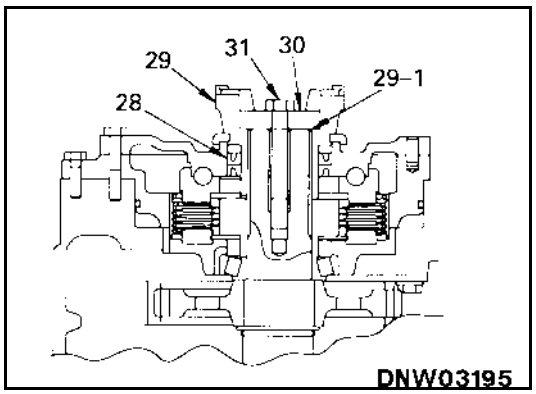
E. Coat lip of oil seal (28) thinly with grease and assemble coupling (29), then tighten O-ring (29-1), holder (30), and mount bolt (31).

Lip of oil seal:Grease (G2-LI)

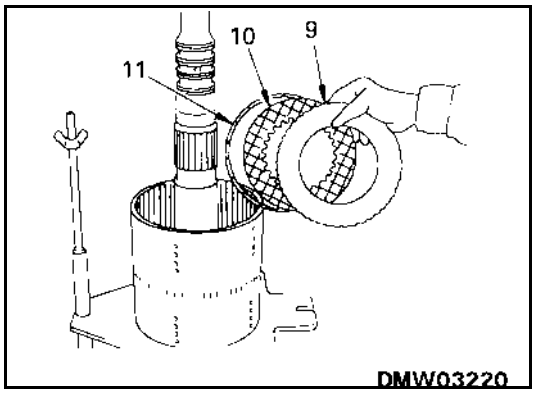
N·m Mount bolt: 270 ± 31.9 Nm (199.1 ± 23.5 lbf ft)

★ Push O-ring (29-1) into the shaft groove, and be careful not to get it caught.

★ Remove lock set bolt (49), and check that it has been interchanged with the plug.



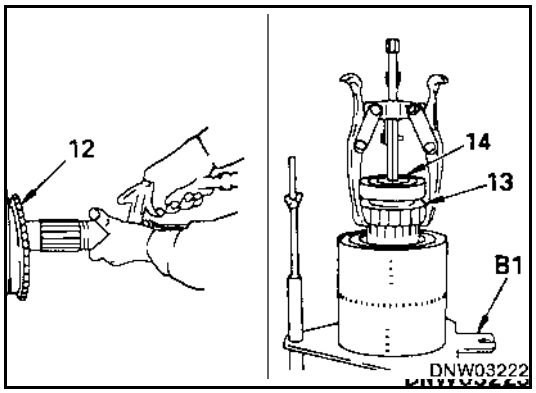
4. Clutch plate
   Remove plate (9), disc (10), and spring (11) from housing.



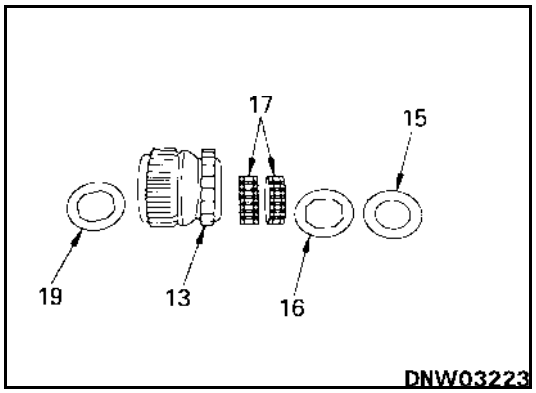
5. Piston
   Blow air in FORWARD oil hole of shaft and remove piston (12).
   - ★ If the piston is at an angle and cannot be removed, push the piston in and try to remove it again.
   - ★ Do not use force to remove it. The inside circumference of the cylinder will be damaged.

6. Bearing
   - ★ Set on tool **B1** with the REVERSE clutch side at the top.

   Using puller, remove gear (13) and bearing (14).



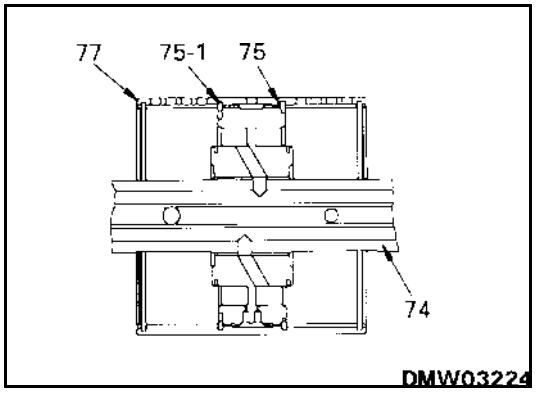
7. REVERSE gear
   Remove spacer (15), thrust washer (16), needle bearing (17), REVERSE gear (13), thrust washer(19).
   - ★ Repeat Steps 3 - 5 for the FORWARD clutch to disassemble the other parts.



8. Shaft, cylinder

   A. Remove snap ring (75) from shaft and housing, then remove housing (77).

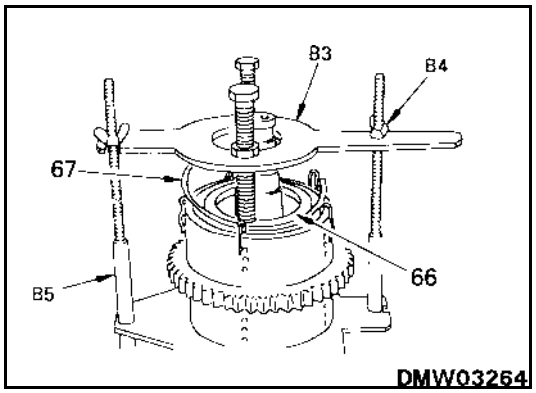
   B. Remove snap ring (75-1), then remove housing (77).



4. End plate

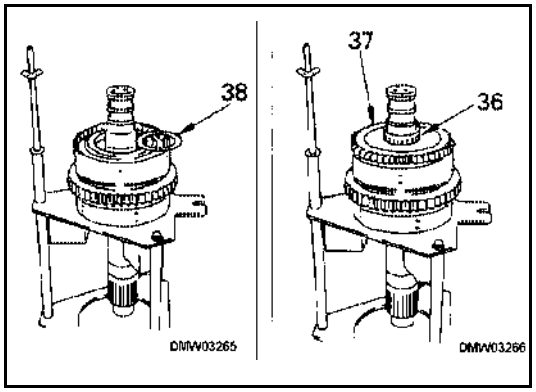
   A. Install tools **B3** and **B5**, then tighten tool **B4** to push in end plate (66).

   B. Assemble ring (67) and remove tool **B3**.
   - ★ Check that ring (67) is fitted securely in the groove.
   - ★ Check that the disc rotates smoothly by hand.

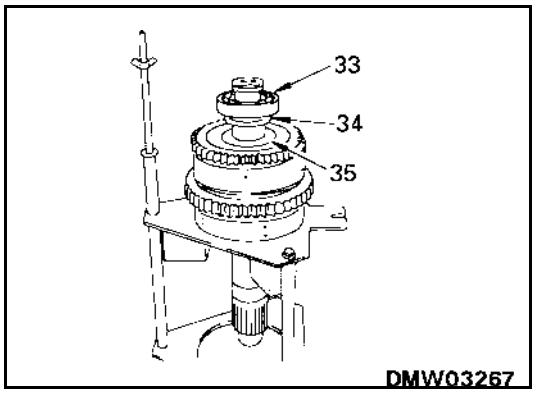


   C. Assemble thrust washer (38).

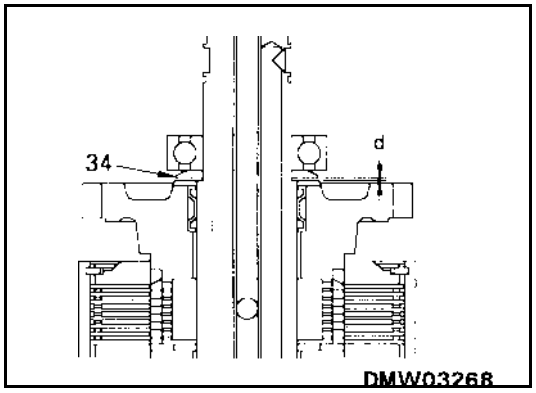
5. 3rd gear
   Assemble 3rd gear, then assemble needle bearing (36).
   - ★ If the gear spline does not match, turn lightly when assembling. Never use force to push it in.
   - ★ Assemble the needle bearing at the bottom first.



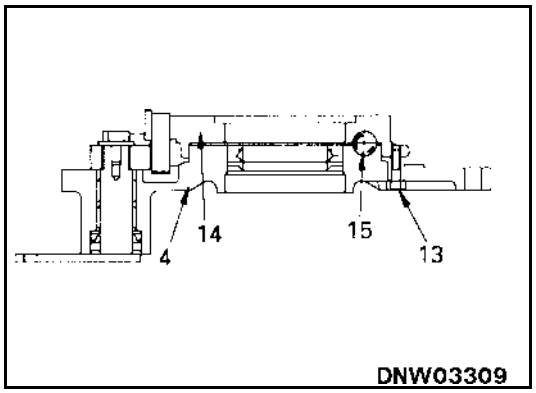
6. Bearing
   Assemble thrust washer (35) and spacer (34), and press fit bearing (33).
   - ★ Check that the end face of the thrust washer is below the surface of the stepped portion of the shaft.
   - ★ Press fit completely so that the spacer is in tight contact with bearing (33) at the stepped portion of the shaft.



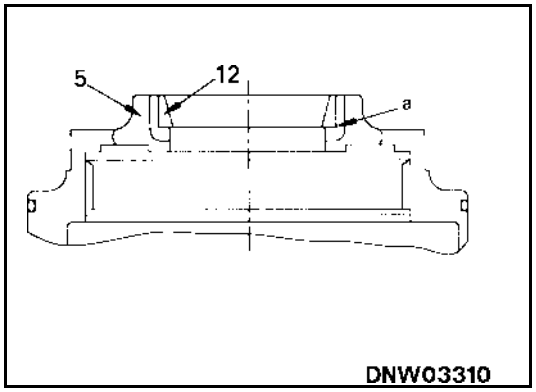
   - ★ After press fitting the bearing, check that clearance "**d**" between the thrust washer and spacer is within the specified range.
     d = 0.1 - 0.9 mm



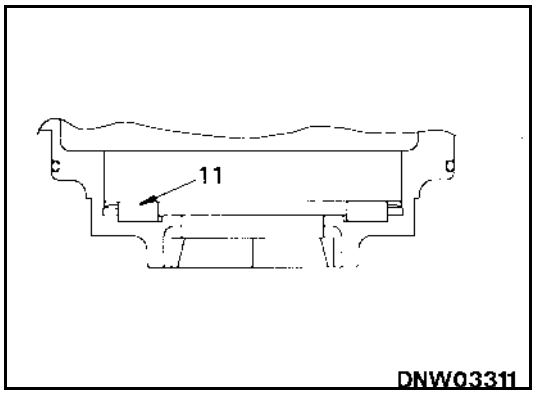
F. Assemble ball (15) in groove of housing (4), install piston (14) from above, then tighten lock set bolt (13) temporarily.
   ★ Temporarily assemble the two set bolts to prevent the piston from falling out during assembly.
   ★ Set bolt length: 8 mm, L = 30 mm



2. Retainer
   Press fit bearing cup (12) to retainer (5).
   ★ After press fitting the cup, check that there is no clearance at portion "**a**".

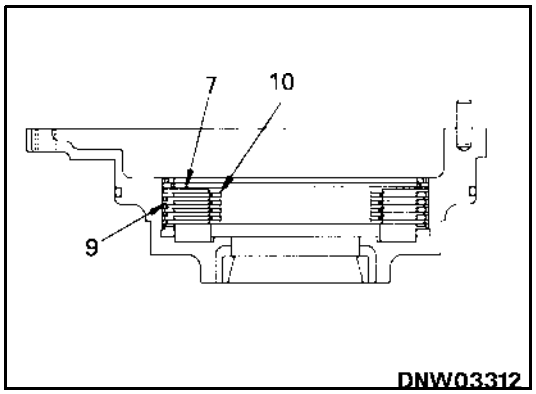


3. End plate
   Assemble end plate (11).

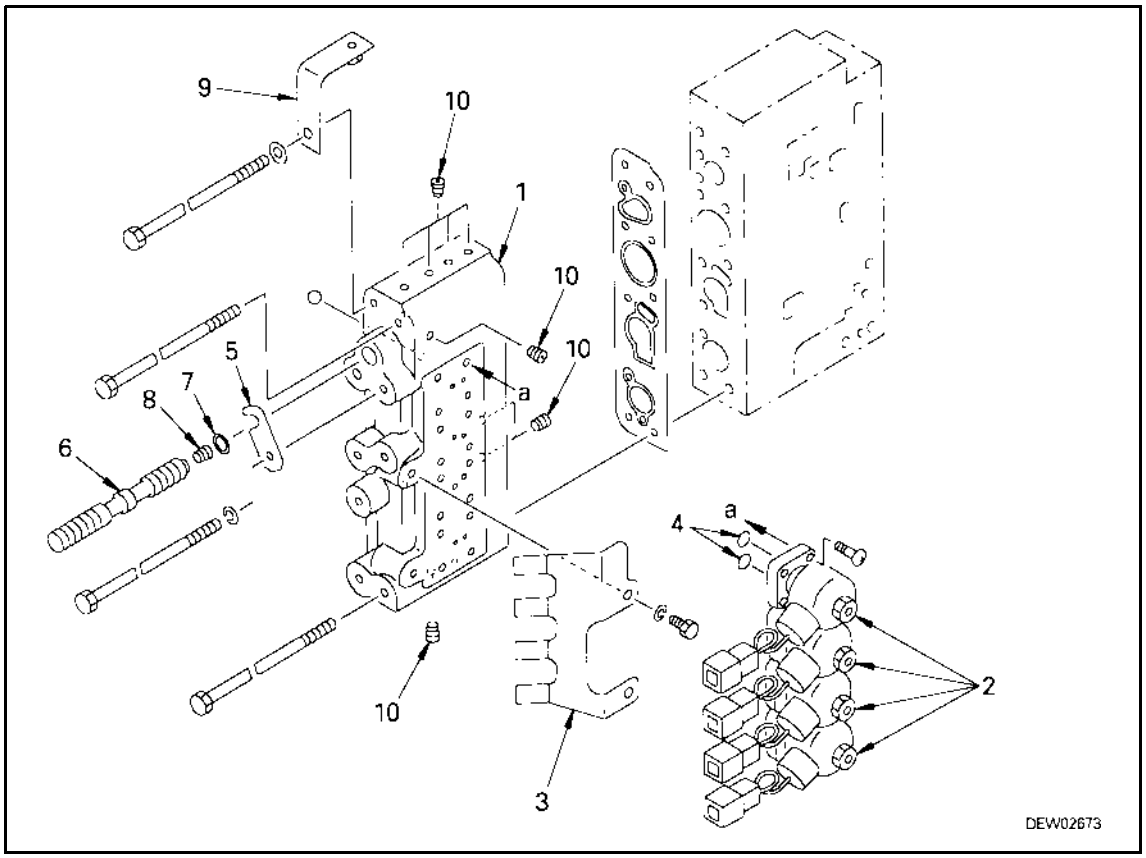


4. Separator plate

   A. Assemble separator plate (7), wave spring (9), and disc (10) in turn.
      ★ Soak disc (10) in clean transmission oil for at least 2 minutes before assembling.
      ★ Use one spring.



TRANSMISSION SOLENOID VALVE



DISASSEMBLY

1. Remove mount bolts from solenoid valve body (1), then remove solenoid (2) and O-ring (4).
   ★ Remove the connector from plate.
2. Remove plate (3) from valve body (1).
3. Remove lock plate (5), then remove emergency manual spool (6) and O-ring (7).
   A. Remove orifice (8) from emergency spool (6).
   B. Remove plate (9).
4. Remove plug (10) from solenoid valve body (1).

INSTALLATION

- Carry out installation in the reverse order of removal.

※1

★ Raise the front frame slightly with the bucket, and remove block.

※2

★ Raise tire and wheel (1) and set to the mount position, then tighten mount bolts.

N·m Mount bolt: 926.7 ± 103.0 Nm (686.4 ± 75.9 lbf ft)
(Width across flats: 36 mm)

※3

★ Connect front drive shaft (2).

N·m Drive shaft: 66.2 ± 7.4 Nm (48.8 ± 5.4 lbf ft)

※4

★ Be careful not to tighten the tube nut too far.

N·m Tube nut: 11.8 ± 2.9 Nm (8.7 ± 2.1 lbf ft)

※5

★ Use the bolts as a guide and align the mount position.

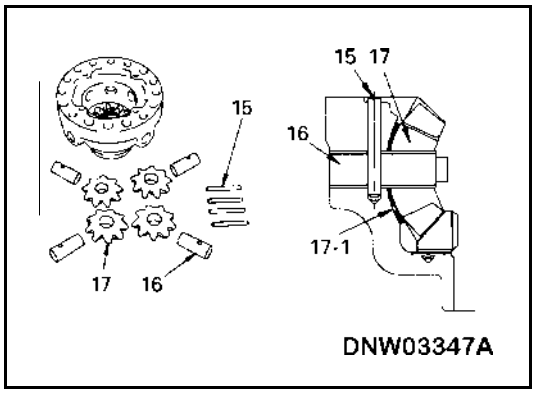
N·m Mount bolt: 676.7 ± 68.6 Nm (499.1 ± 50.5)
(Width across flats: 36 mm)

※6

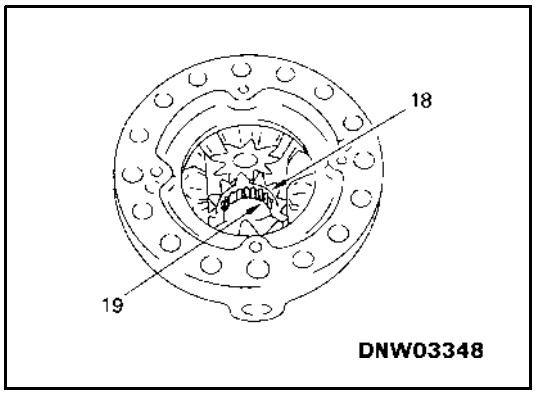
★ Use a hoist and jack for the operation.

- Bleeding air from brake system
  ★ Bleed the air from the brake system. For details, see TESTING AND ADJUSTING, Bleeding air from brake system.

D. Remove lock pin (15) and pull out shaft (16), then remove pinion gear (17).
   ★ Remove together with spherical surface washer (17-1) at the pinion gear portion.



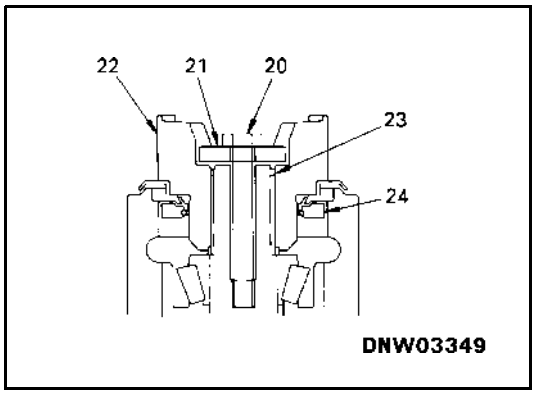
E. Remove side gear (18) and thrust washer (19).



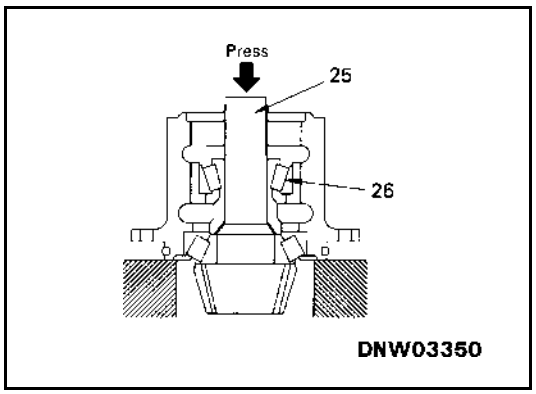
7. Coupling

A. Remove mount bolts (20), then remove coupling (22) and O-ring (23).
   ★ Do not remove the protector press fitted to the coupling unless necessary.

B. Remove oil seal (24).



C. Using press, remove pinion gear (25) from cage and remove bearing (26).

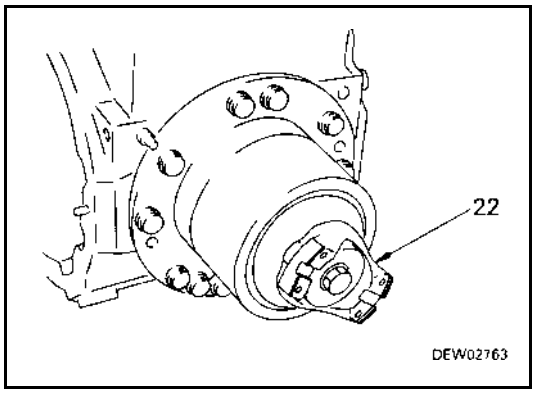


E. If the test shows that there is no leakage of oil, raise pressure to 42 kg/cm^2 (597.38 lbf/in^2)
   - ★ If there is any leakage of oil, remove the brake piston and check the O-ring for damage, then reassemble and re-test.
   - ★ After checking for leakage of break oil, insert piston fully.

13. Coupling
    Tighten mount bolts of coupling (22).

Mount bolt: Adhesive (LT-2)

Mount bolt: 279.5 ± 29.4 Nm (206.1 ± 21.6 lbf ft)

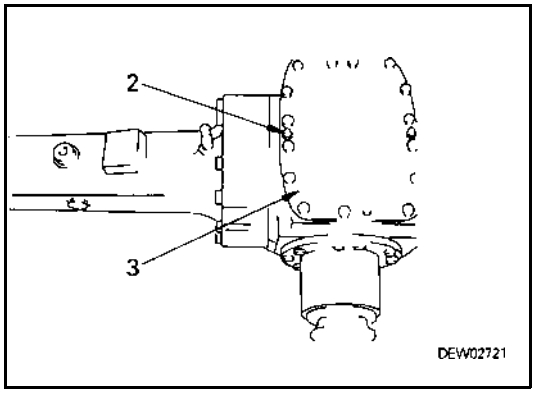


14. Differential cover

A. Install differential cover (3) on differential, housing.
   - ★ Install a guide bolt in the mount hole of the bleeder screw to prevent gasket sealant from entering the hole.

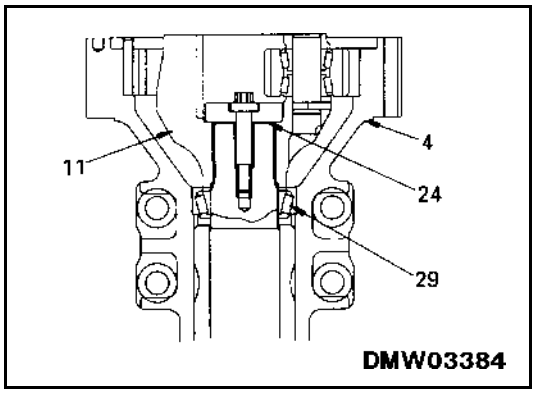
Cover contact surface: Gasket sealant (Loctite 515)

Mount bolt: 112.8 ± 9.8 Nm (83.1 ± 7.2 lbf ft)



B. Remove guide bolt and install bleeder screw (2).
   - ★ Check that there is no gasket sealant in the screw hole when installing.
   - ★ The front and rear axle housings are different, so be careful not to mistake them when installing the housing assemblies.

7. Planetary carrier



A. Assemble shim (24) selected in Step 5) to end face of axle shaft, then install planetary carrier assembly (11) and install mount bolts.
   ★ Wash and remove all oil and grease from mount bolts and mount bolt holes of axle shaft.

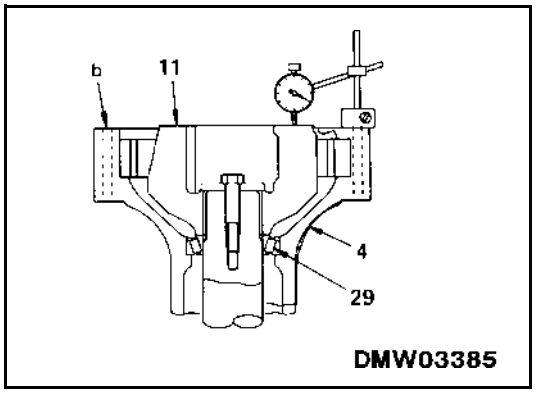
Mount bolt: Thread tightener (LT-2)

Mount bolt: 549.2 ± 58.8 Nm (405.0 ± 43.6 lbf ft)

   ★ Clean the end face of the shaft and the planetary carrier spline before assembling.

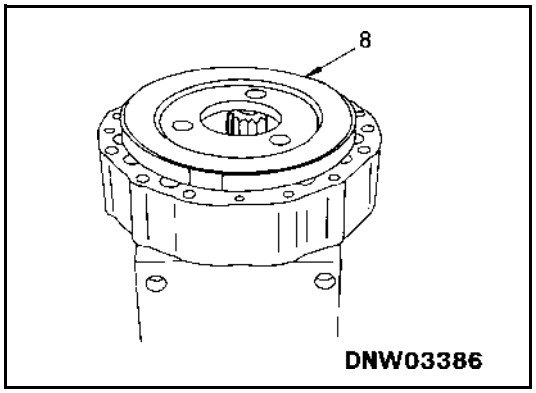
WARNING! When assembling the planetary carrier, be extremely careful not to get your fingers caught in the gear.

B. Make sure that bearing (29) is fully settled, then check starting turning force "**X**" at drill hole **b** of axle housing assembly (4). Starting turning force **X**: 18.6 - 70.6 N (4.18 - 15.87 lbf)



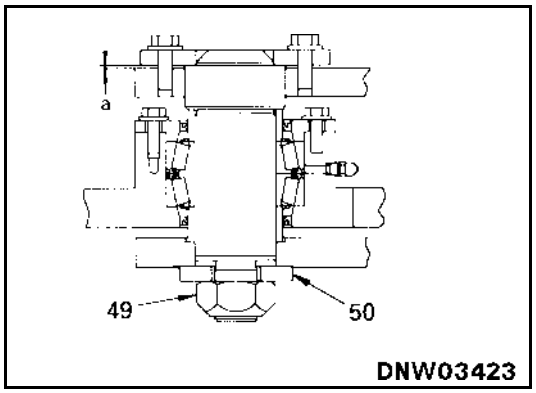
C. Install stand of dial gauge to axle housing (4), then measure end play of planetary carrier at end face of planetary carrier.
   • End play of planetary carrier: 0 - 0.1 mm
   ★ If the starting turning torque and end play are not within the standard range, carry out the adjustment in Step 5 again.

8. Brake outer ring



A. Assemble brake outer ring (8) to axle housing.
   ★ Align outer ring pin hole and pin, then assemble.
   ★ Be careful not to damage the surface of the brake outer ring.

※11



★ Tighten washer (49) and lockout (50) to the specified torque, then select shim so that the clearance **a** between the rear frame and pin is the specified value.
★ When tightening the lockout, tighten the mount bolt temporarily to prevent turning.
★ Clearance **a**: Max. 0.1 mm

N·m Lockout: 568.8 ± 58.8 Nm (419.5 ± 43.3 lbf ft)
(width across flats: 55 mm)

★ Assemble the selected shim, and tighten the pin mount bolts.
★ Before tightening the mount bolts, tighten the lockout to the specified torque again.

N·m Lockout: 568.8 ± 58.8 Nm (419.5 ± 43.3 lbf ft)

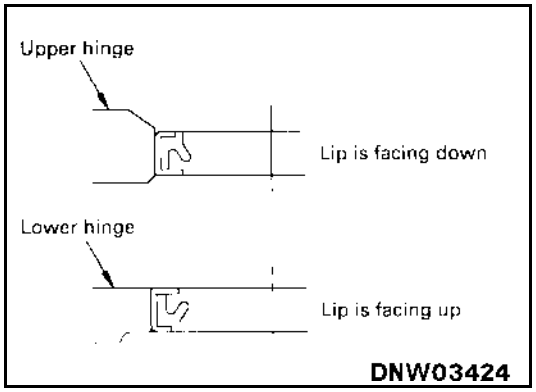
N·m Mount bolt: 112.8 ± 9.8 Nm (83.1 ± 7.2 lbf ft)

※12

WARNING! When aligning the position of the pin hole, use a bar. Never insert your fingers in the pin hole.

★ When joining, be careful not to get the spacer at the bottom of the upper hinge caught.
★ Align the pin holes securely.
★ Install the safety bar.

※13 ※14



★ Be careful not to damage the seal lip, and assemble with the lip on the outside.

Lip of seal: Grease (G2-L1)

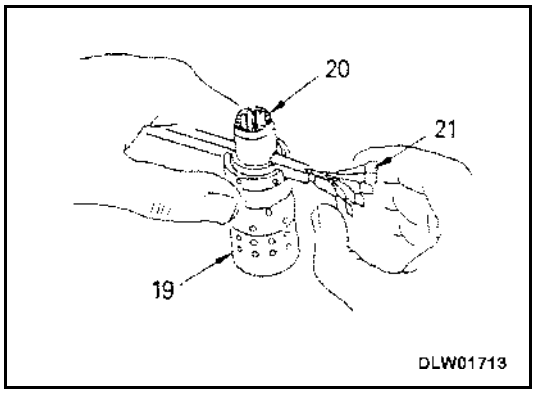
Inside circumference of spacer: Grease (G2-L1)

※15

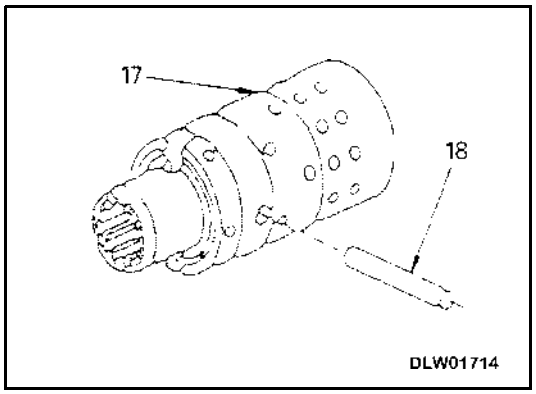
A. Tighten the retainer with 3 bolts.

N·m Mount bolt: 14.7 ± 1.5 Nm (10.8 ± 1.1 lbf ft)
(when adjusting shim)

6. Align spring groove positions of spool (20) and sleeve (19), and set on flat plate, then insert spring (21) in spring groove.
   ★ Set so that the notches at both ends are at the bottom.



7. Insert pin (18) in spool and sleeve assembly (17).

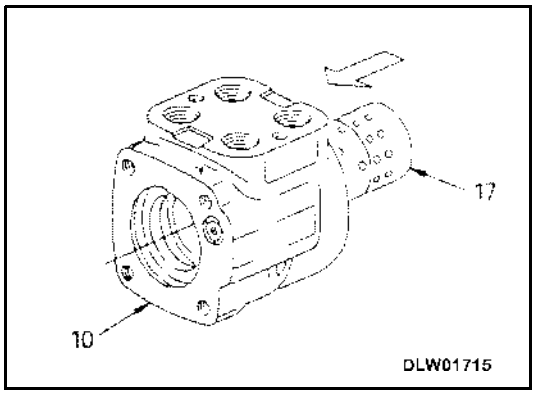


8. Insert spool and sleeve assembly (17) in housing (10) in the direction of the arrow.

   A. Keep pin horizontal and rotate to left and right a little at a time to insert.
      ★ Be extremely careful not to get it caught.

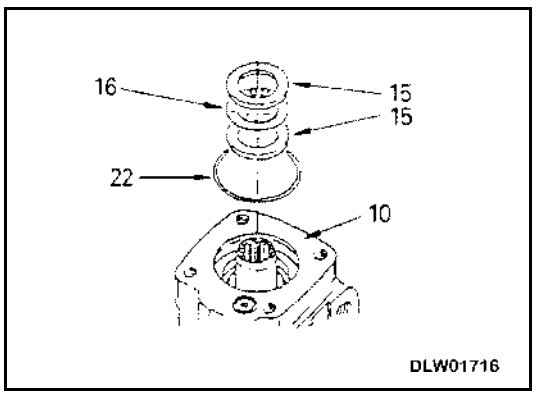
   B. Make the spool and sleeve assembly flush with the rear end face of the housing.
      ★ If it is inserted beyond the end face, the pin will fall out.

   C. Check that spool and sleeve rotate smoothly inside housing.



9. Install O-ring (22) to housing (10).

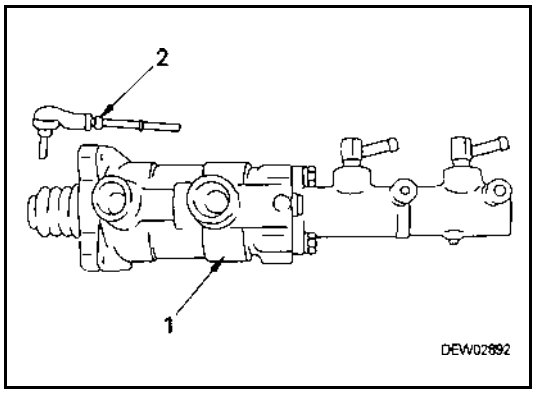
10. Fit two bearing races (15) and thrust needle (16) in case (10).



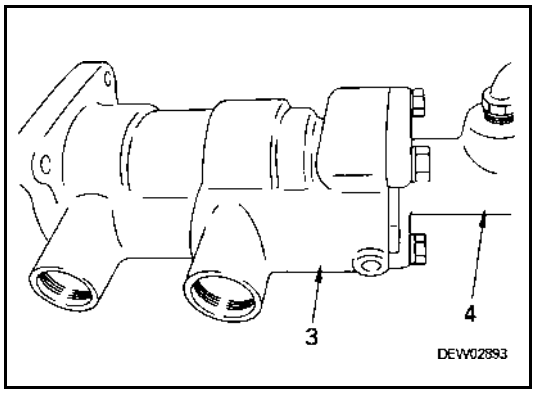
DISASSEMBLY

1. Power master cylinder

   A. Remove linkage rod (2) from power master cylinder (1).
      ★ Protect and store insertion end of piston of linkage rod from damage with masking tape.

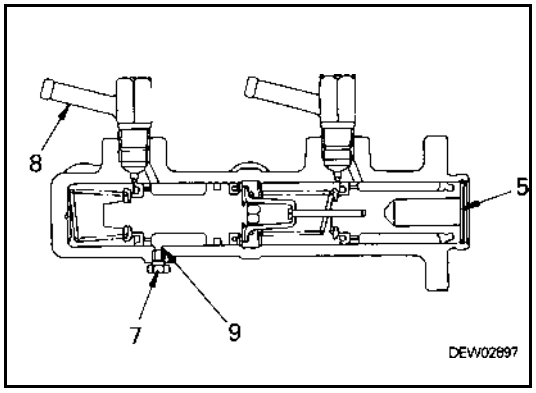


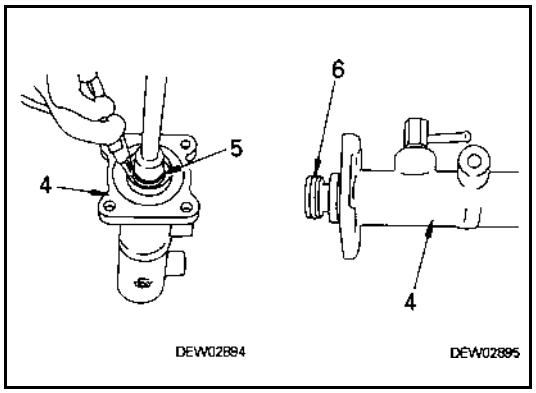
   B. Disconnect power cylinder (3) and master cylinder (4).



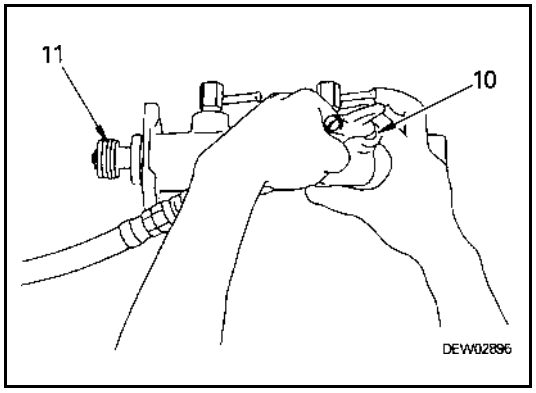
2. Disassembly of master cylinder

   A. Remove C-ring (5) from body (4) and take out secondary piston (6).



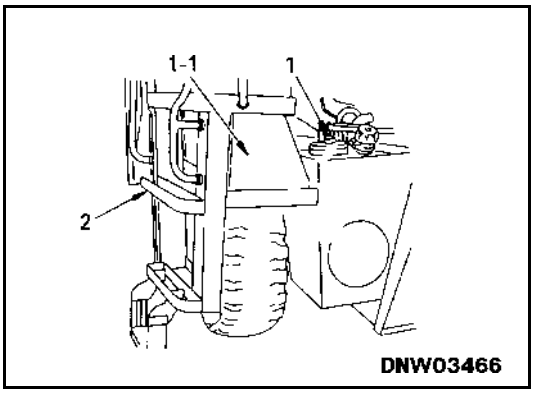


   B. Remove stopper bolt (7). Hold brake oil hole (8) and stopper bolt hole (9) with finger, then blow air from brake oil hole (10) to take out primary piston (11).
      ★ Do not blow air in suddenly as the piston will fly out.

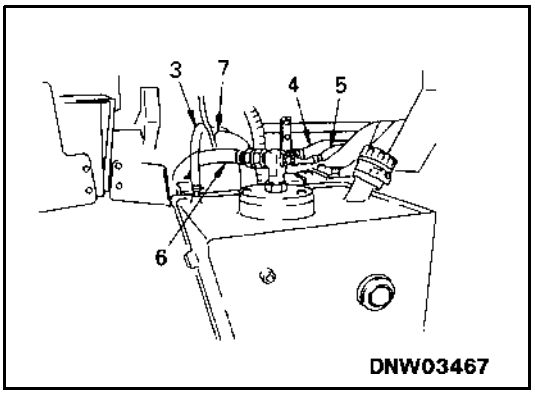


HYDRAULIC TANK

REMOVAL



WARNING! Stop the machine on level ground and install the safety bar on the frame. Lower the bucket to the ground and stop the engine. Then apply the parking brake and put blocks under the wheels to prevent the machine from moving.

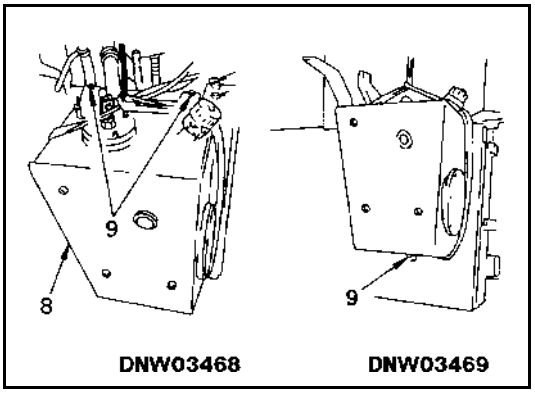


WARNING! Loosen the oil filler cap slowly to release the pressure inside the hydraulic tank. Then operate the steering wheel and control levers several times to release the remaining pressure in the hydraulic piping.

- Remove cover (1-1) at the top of the hydraulic tank.
- Loosen plug (1) at the top of the hydraulic tank filter to prevent the oil inside the hydraulic tank from flowing out.

Tank: 64 L (16.9 gal)

1. Remove R.H. ladder, fender, and cover assembly (2).
2. Disconnect hydraulic piping at hydraulic tank end.
   A. Hose (3) between main control valve and hydraulic tank
   B. Hose (4) between steering valve and hydraulic tank
   C. Hose (5) between priority valve and hydraulic tank
   D. Hose (6) between main control valve and hydraulic tank
   E. Hose (7) between hydraulic pump and hydraulic tank
   ★ Disconnect hose (7) when removing the hydraulic tank.



※1

DISASSEMBLY

1. Spool assembly

   A. Remove mount bolt (2) and plug (3) of detent assembly (1).

   B. Holding spool (4) from moving, loosen bolt (5) inside detent assembly (1), then remove detent assembly (1).

   C. Remove joint (6) from spool (4).

   D. Remove retainer (7), spring (8), retainer (9), oil seal (10) and plate (11).

   E. Remove plate (12), then remove oil seal (10) and spool (4).

2. Main relief valve assembly

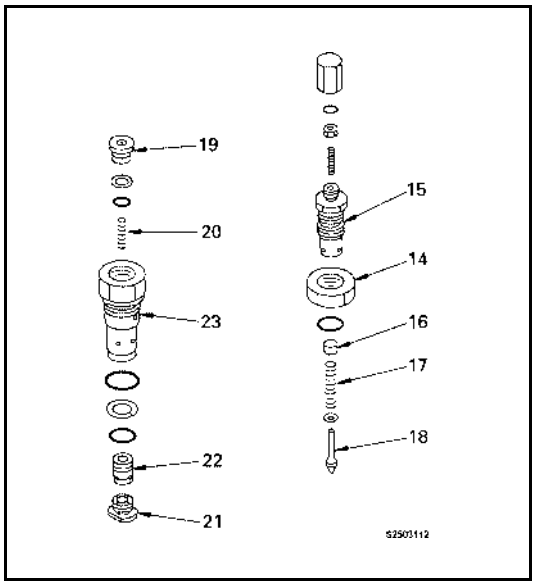
   A. Remove main relief valve assembly (13).

   B. Loosen nut (14), and screw out holder (15), then remove retainer (16), spring (17), poppet (18), seat (19) and spring (20).

   C. Remove plug (21), then remove valve (22) from sleeve (23).
      ★ Valve (22) and sleeve (23) are not available as individual parts, so replace them as a set.

3. Remove safety valve assembly (25) with suction valve and suction valve assembly (24).

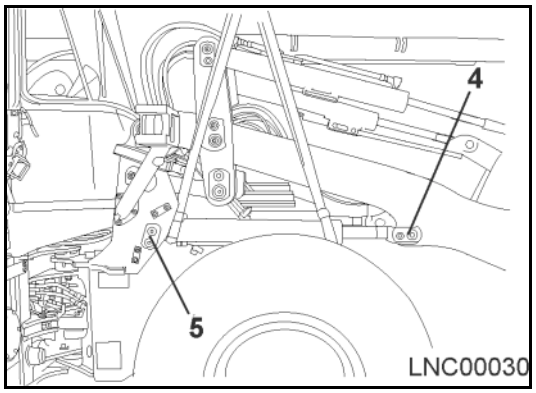
4. Remove plug (26), then remove spring (27) and valve (28).

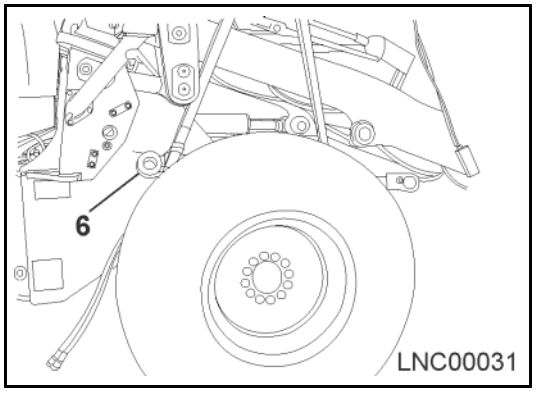


4. Remove lock bolt and pin on both eye end (4) and rear end of cylinder (5).
   ★ If there are shims installed, check the number, position and thickness of the shims, and keep in a safe place.

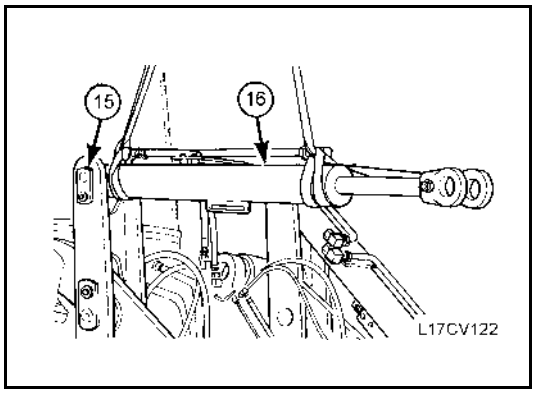
5. Lift off the lift cylinder (6).
   ★ Be careful of the center of gravity and lift off slowly.
   ★ Be careful not to damage the cylinder rod.

kg Lift cylinder: 85 kg (187 lb)



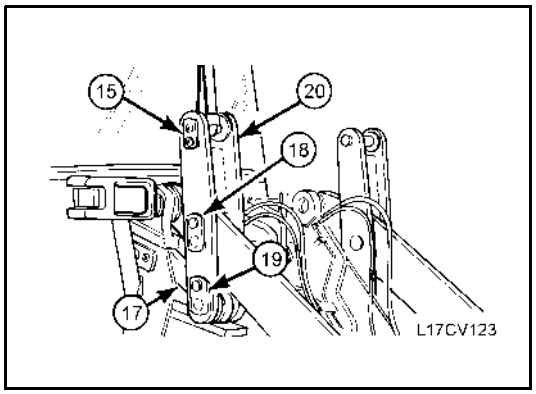


C. Attach hoist and sling to the ends of the cylinder housing, remove pin (15) and cylinder (16).
   ★ There maybe shims installed, so check the number of shims for reference when installing.



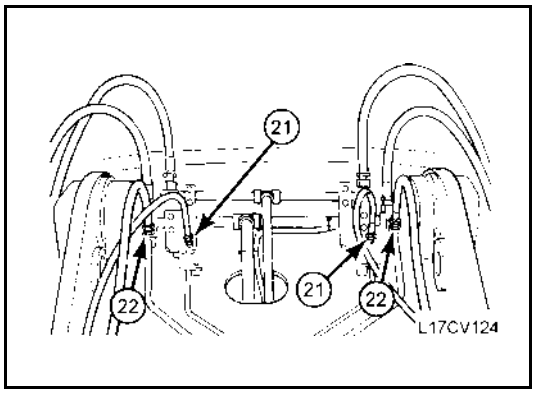
5. Rear tilt lever.

A. Install tilt cylinder mounting pin (15) to lever and attach hoist and sling. Place block under tilt link (17), remove pins (18) and (19), and remove rear tilt lever (20).
   ★ There maybe shims installed, so check the number of shims for reference when installing.

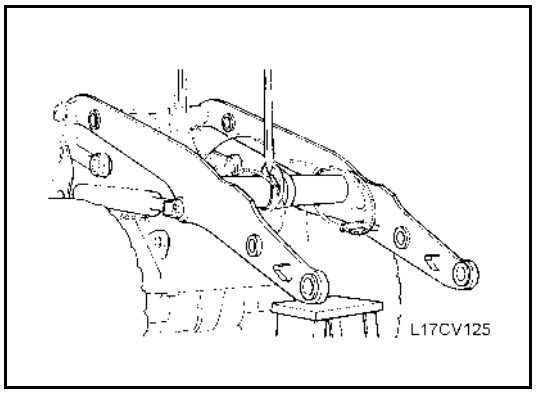


6. Boom.

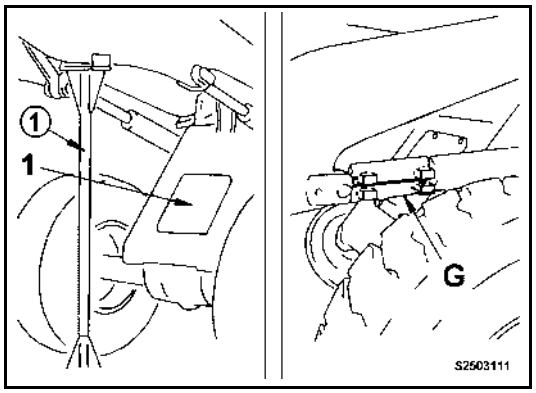
A. Disconnect cap and plug hydraulic hoses (21) and (22).



B. Position boom control lever in float. Using hoist and sling, raise the boom and place on a stand.



ECSS CONTROL VALVE

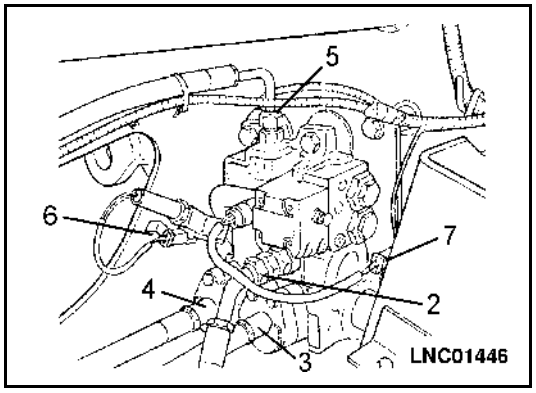


WARNING! Stop the machine on level ground and install the safety bar on the frame. Then apply the parking brake and put blocks under the wheels to prevent the machine from moving

WARNING! Relieve ECSS circuit pressure before removal of solenoid valve - see ECSS CIRCUIT - REMAINING PRESSURE REMOVAL.

REMOVAL

1. Raise boom and set support ① or tool **G** in position, then remove front cover (1).
2. After accomplishing the WARNINGS above, disconnect the hydraulic lines from the ECSS control valve.
3. Disconnect the electrical connectors CND06 (6) and CND07 (7).



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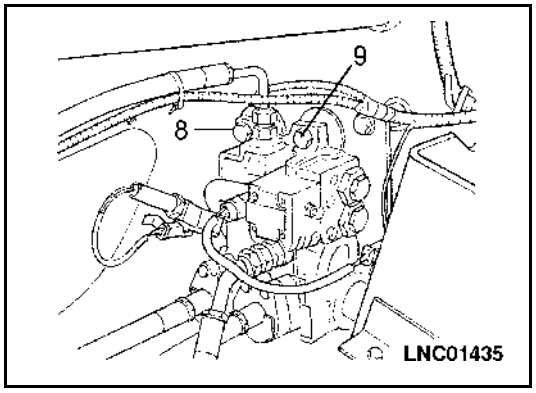
4. Remove the four mount bolts (8) and (9).
   - Bolts (10) and (11) are not depicted.



INSTALLATION

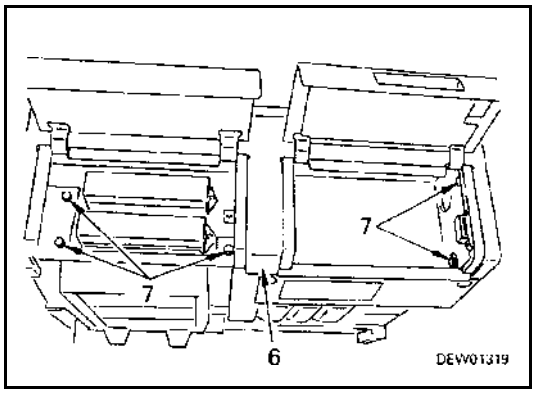
- Carry out installation in the reverse order of removal.

※1

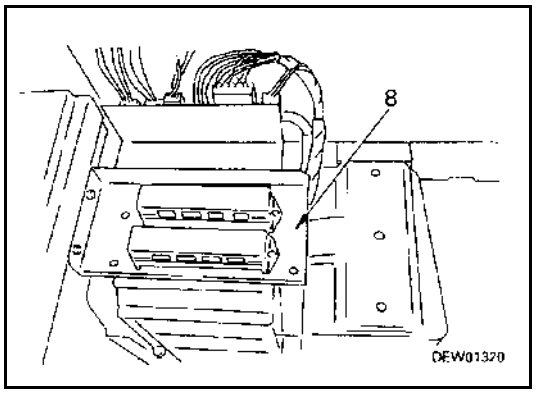
N·m Hose nut (5): 58.8 - 98.0 Nm (43.3 - 72.3 lbf ft)

N·m Hose nut (2): 107.8 - 166.7 Nm (79.5 - 122.9 lbf ft)

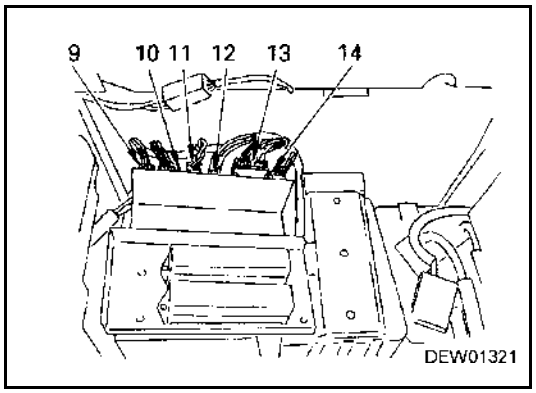
5. Remove cool and hot box assembly (6) and mount bolts (7), then remove cool and hot box assembly.



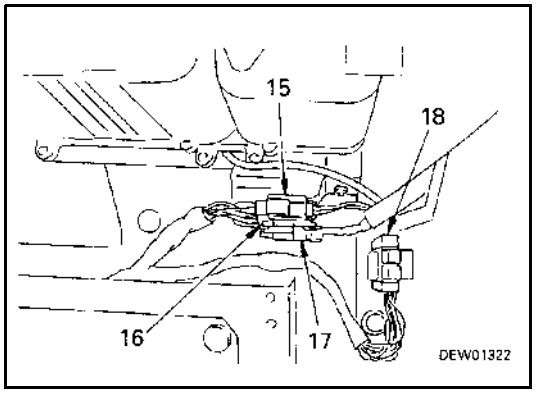
6. Remove fuse box assembly bracket (8) from right console box.



7. Remove connectors (9), (10), (11), (12), (13), and (14) from fuse box assembly bracket, and put fuse box assembly on right console box temporarily.
   - Mark the connectors with a tag to distinguish when installing.

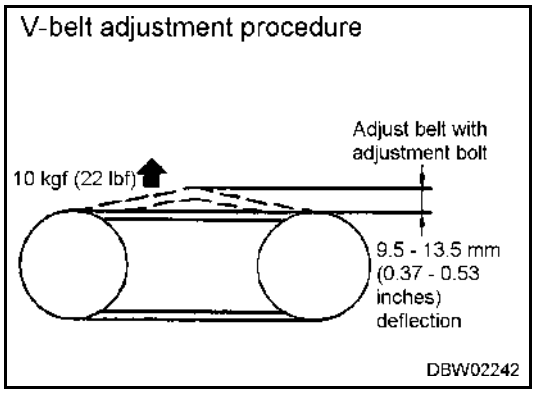


8. Disconnect floor wiring connectors (15), (16), and (17) from air conditioner unit wiring, then disconnect air conditioner relay wiring connector (18).



INSTALLATION

- Carry out installation in the reverse order to removal.



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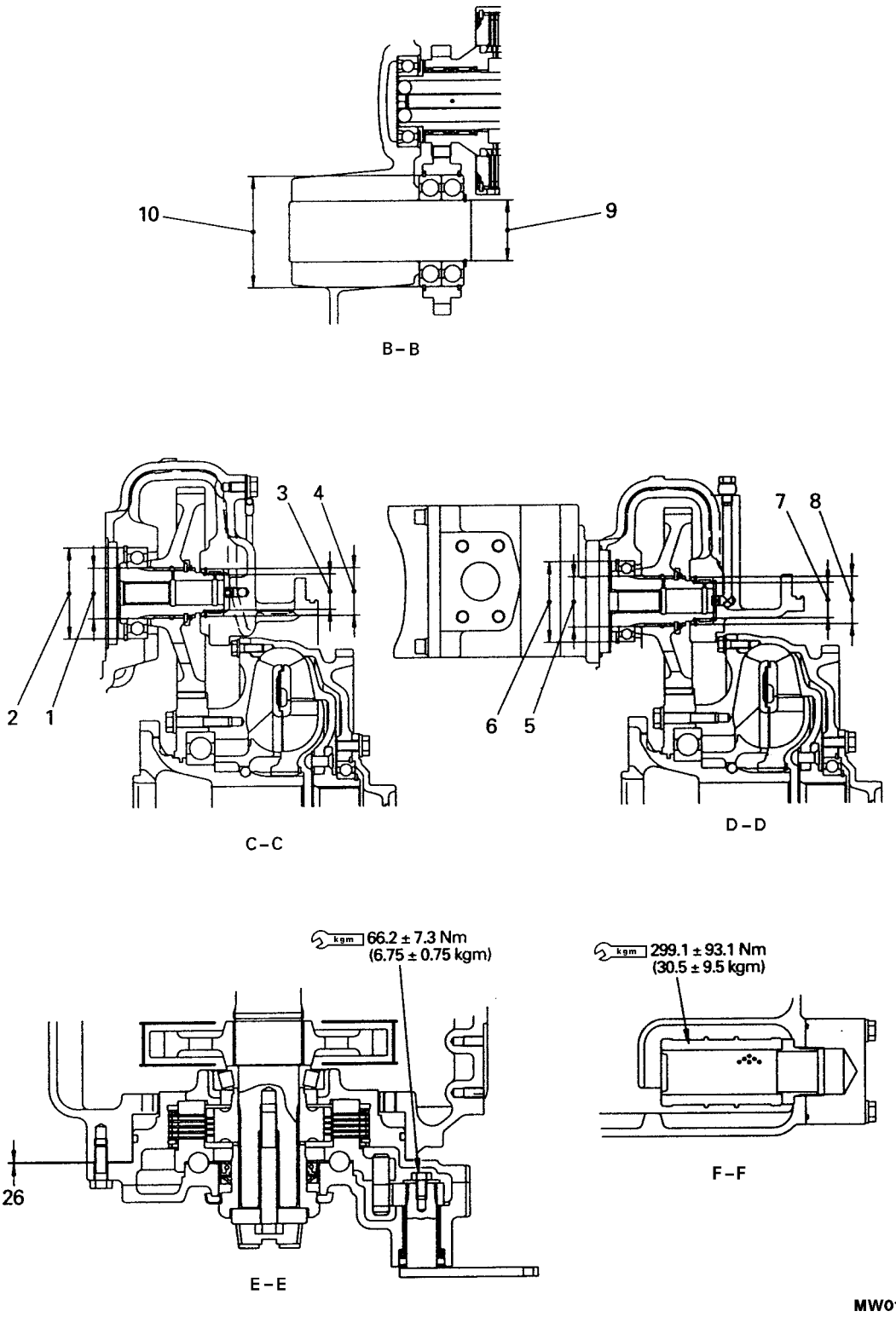
N·m Hose mount bolt: 7.9 - 11.8 Nm (5.8 - 8.7 lbf ft)

※2

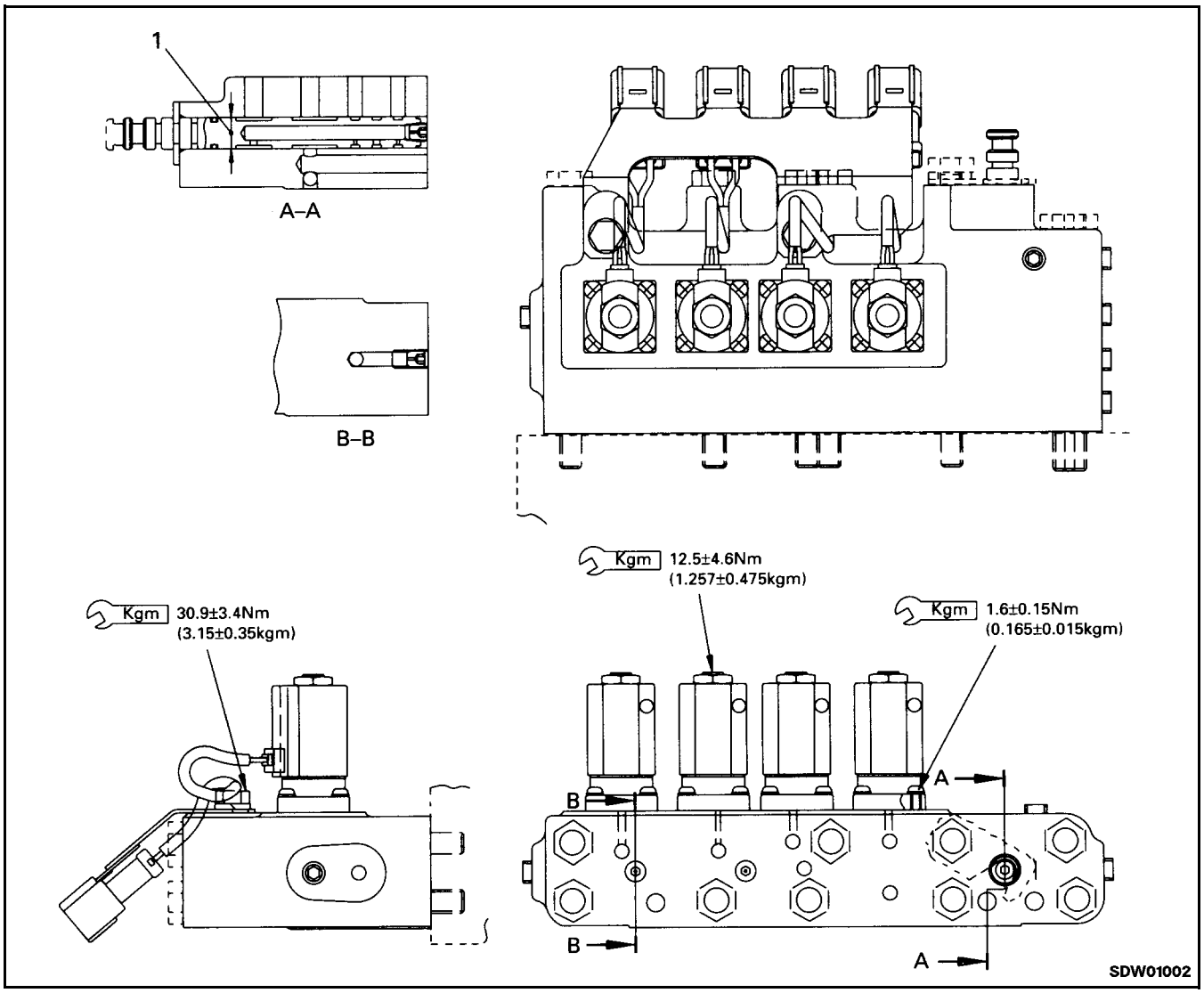
★ Adjust the V-belt as follows.
★ Deflection of belt at approximately:

98.1 N (22.05 lbf)
9.5 - 13.5 mm (0.374 - 0.531 in)

- Filling with gas
  - Fill the air conditioner with gas R134a.
  - Guideline for amount when filling: 1.5 - 1.6 kg (3.30 - 3.52 lb)
  - Before filling with refrigerant, always use the repeat vacuum method to completely evacuate.
  - Do not use the can of refrigerant upsidedown or use any other mistaken method.
  - Be careful not to let liquid freon get into the refrigerating system.
  - Do not operate the compressor before charging with refrigerant.
  - Check that the refrigerant level is correct.
  - Check the oil level in the compressor. (Specified oil level: $150\ ^{+14}_{0}$ cc ND-OIL8)


10
9
B-B
3
4
2
1
C-C
7
8
6
5
D-D
kgm 66.2 ± 7.3 Nm
(6.75 ± 0.75 kgm)
26
E-E
kgm 299.1 ± 93.1 Nm
(30.5 ± 9.5 kgm)
F-F
MW01193R

SOLENOID VALVE



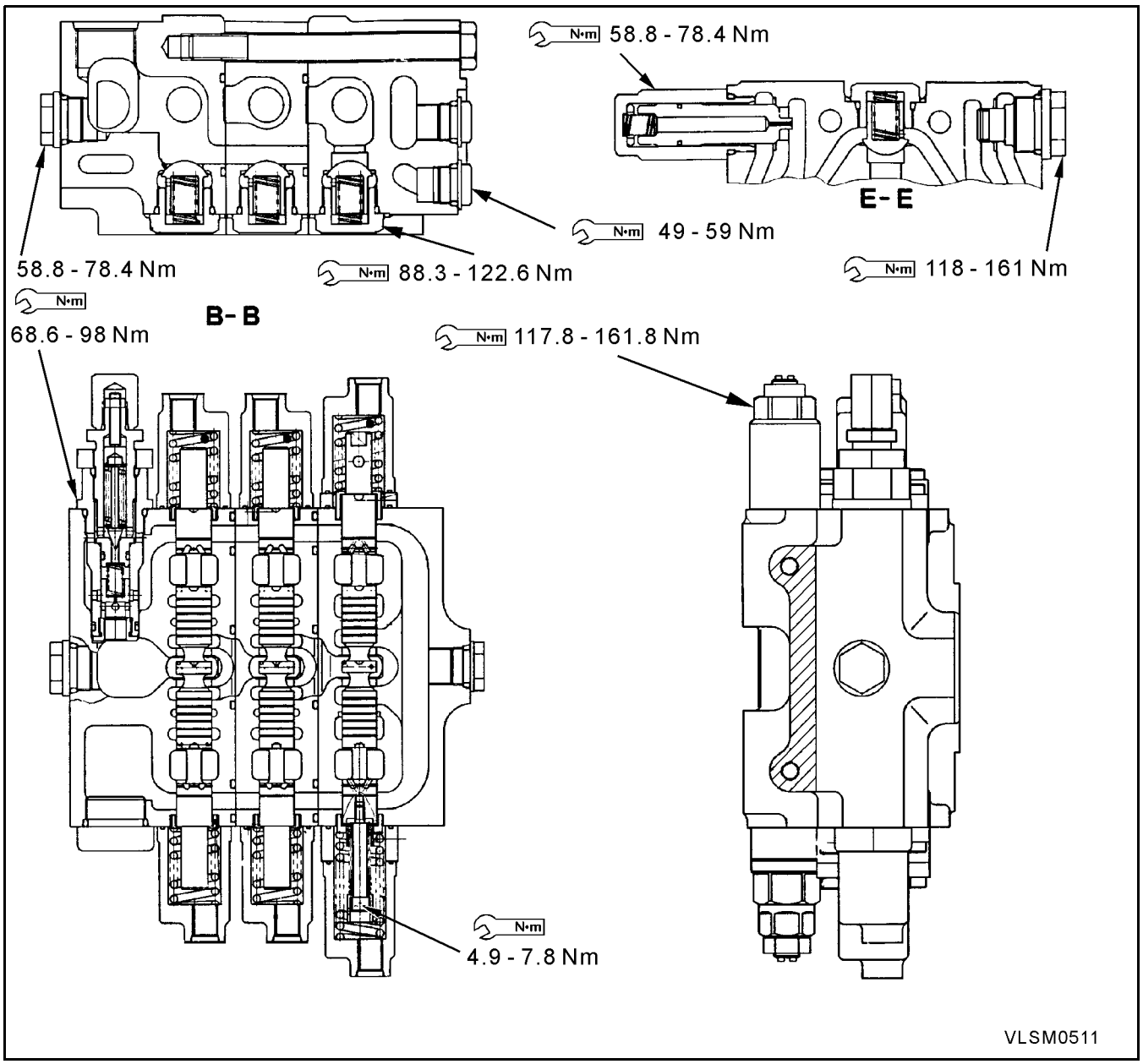
Unit: mm

No.	Check item	Criteria					Remedy
		Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
1	Clearance between emergency manual spool and body	14	-0.02 -0.03	+0.013 0	0.020 - 0.043	0.050	Replace

Unit: mm

<table>
<tr><th>No.</th><th>Check item</th><th colspan="5">Criteria</th><th>Remedy</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Thickness of thrust plate</td><td colspan="2">Standard size</td><td colspan="2">Tolerance</td><td>Repair limit</td><td rowspan="4">Replace</td></tr>
<tr><td colspan="2">10</td><td colspan="2">0
-0.15</td><td>-</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Clearance between hole and shaft at front support end</td><td rowspan="2">Standard size</td><td colspan="2">Tolerance</td><td rowspan="2">Standard clearance</td><td rowspan="2">Clearance limit</td></tr>
<tr><td>Shaft</td><td>Hole</td></tr>
<tr><td>3</td><td>Clearance between hole and shaft at front support end</td><td>170</td><td>-0.043
-0.106</td><td>+0.550
+0.050</td><td>0.093 -
0.656</td><td>★</td></tr>
<tr><td>4</td><td>Thickness of axle mount shim</td><td colspan="5">0.2 (standard shim thickness)</td><td>-</td></tr>
</table>

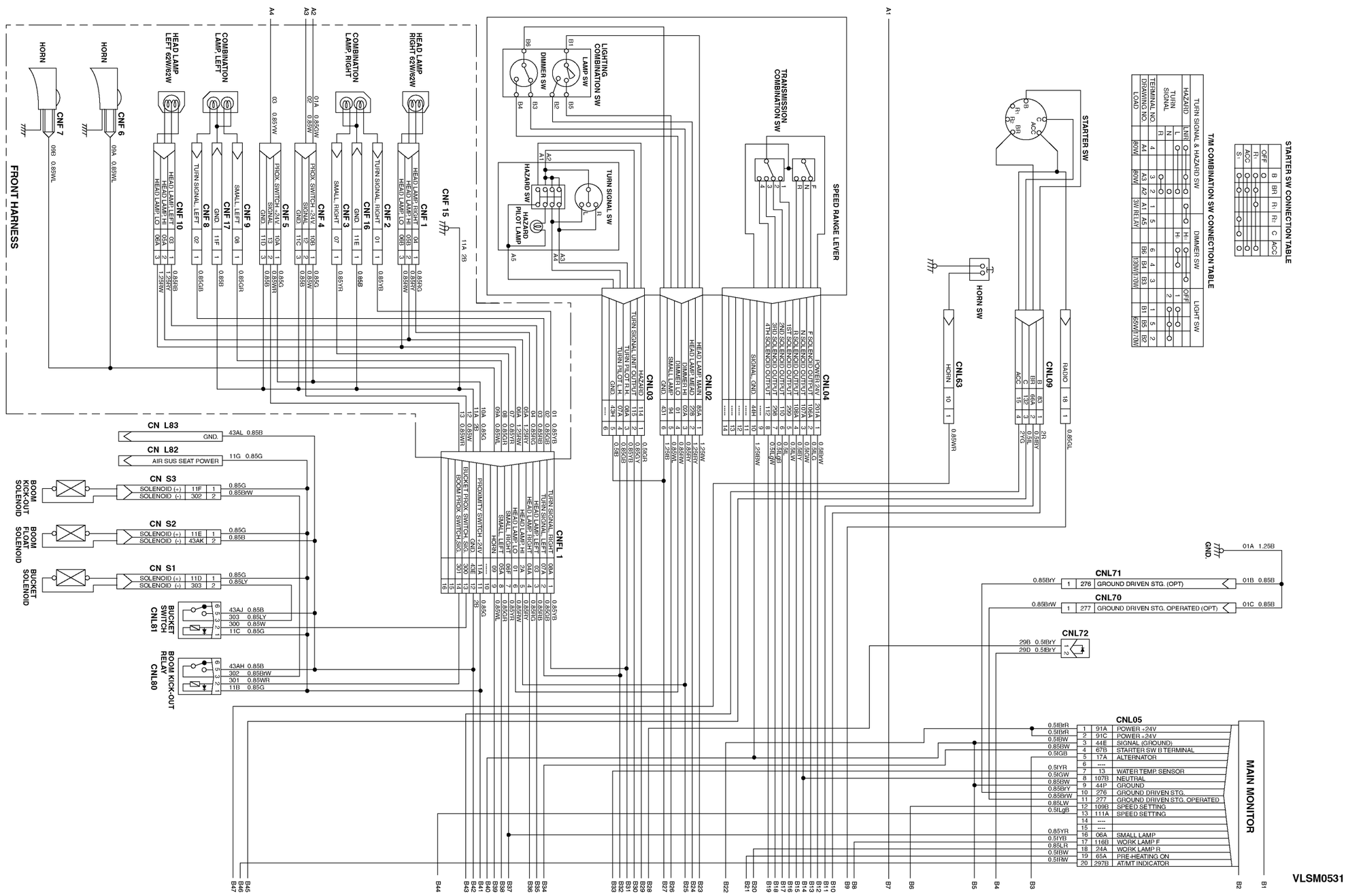
★ With direct contact of axle shaft to hole of axle support.



Unit: mm

Check item	Criteria				
	Standard size			Repair limit	
	Free length	Installed height	Installed load	Free length	Installed load
Relief valve spring	41.1	32.6	258.9 N (26.4 kg)	39.4	206.9 N (21.1 kg)

ELECTRICAL WIRING DIAGRAM (2/7)



ELECTRICAL WIRING DIAGRAM (7/7)