CEBM001102

Shop Manual

WA180-3
WA180L-3

WHEEL LOADER

SERIAL NUMBERS WA180-3L - A80001 and up
WA180L-3 - 54001

September 2000

FOREWARD

GENERAL

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

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

GENERAL

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

STRUCTURE AND FUNCTION

This section explains the structure and function of each component. It serves not only to give an understanding of the structure, but also serves as reference material for troubleshooting.

TESTING AND ADJUSTING

This section explains checks to be made before and after performing repairs, as well as adjustments to be made at completion of the checks and repairs. Troubleshooting charts correlating "Problems" to "Causes" are also included in this section.

DISASSEMBLY AND ASSEMBLY

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

MAINTENANCE STANDARD

This section gives the judgement standards when inspecting disassembled parts.

NOTICE

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

kgm to ft. lb

1 kgm = 7.233 ft. lb

kgm	0	1	2	3	4	5	6	7	8	9
0	0	7.2	14.5	21.7	28.9	36.2	43.4	50.6	57.9	65.1
10	72.3	79.6	86.8	94.0	101.3	108.5	115.7	123.0	130.2	137.4
20	144.7	151.9	159.1	166.4	173.6	180.8	188.1	195.3	202.5	209.8
30	217.0	224.2	231.5	238.7	245.9	253.2	260.4	267.6	274.9	282.1
40	289.3	296.6	303.8	311.0	318.3	325.5	332.7	340.0	347.2	354.4
50	361.7	368.9	376.1	383.4	390.6	397.8	405.1	412.3	419.5	426.8
60	434.0	441.2	448.5	455.7	462.9	470.2	477.4	484.6	491.8	499.1
70	506.3	513.5	520.8	528.0	535.2	542.5	549.7	556.9	564.2	571.4
80	578.6	585.9	593.1	600.3	607.6	614.8	622.0	629.3	636.5	643.7
90	651.0	658.2	665.4	672.7	679.9	687.1	694.4	701.6	708.8	716.1
100	723.3	730.5	737.8	745.0	752.2	759.5	766.7	773.9	781.2	788.4
110	795.6	802.9	810.1	817.3	824.6	831.8	839.0	846.3	853.5	860.7
120	868.0	875.2	882.4	889.7	896.9	904.1	911.4	918.6	925.8	933.1
130	940.3	947.5	954.8	962.0	969.2	976.5	983.7	990.9	998.2	1005.4
140	1012.6	1019.9	1027.1	1034.3	1041.5	1048.8	1056.0	1063.2	1070.5	1077.7
150	1084.9	1092.2	1099.4	1106.6	1113.9	1121.1	1128.3	1135.6	1142.8	1150.0
160	1157.3	1164.5	1171.7	1179.0	1186.2	1193.4	1200.7	1207.9	1215.1	1222.4
170	1129.6	1236.8	1244.1	1251.3	1258.5	1265.8	1273.0	1280.1	1287.5	1294.7
180	1301.9	1309.2	1316.4	1323.6	1330.9	1338.1	1345.3	1352.6	1359.8	1367.0
190	1374.3	1381.5	1388.7	1396.0	1403.2	1410.4	1417.7	1424.9	1432.1	1439.4

FUEL, COOLANT AND LUBRICANTS

PROPER SELECTION OF FUEL, COOLANT AND LUBRICANTS

Reservoir	Kind of fluid	Ambient Temperature								Capacity	
		-22 -30	-4 -20	14 -10	32 0	50 10	68 20	86 30	104°F 40°C	Specified	Refill
Engine oil pan	Engine oil	SAE 5W-30								22 ℓ 5.8 US gal 4.8 UK gal	19.5 ℓ 5.1 US gal 4.3 UK gal
			SAE 10W-30								
				SAE 15W-40							
Brake										1 ℓ 0.26 US gal 0.22 UK gal	1 ℓ 0.26 US gal 0.22 UK gal
		SAE 5W									
Transmission case										28 ℓ 7.4 US gal 6.6 UK gal	23.5 ℓ 6.2 US gal 5.2 UK gal
		SAE 10W									
Hydraulic system										80 ℓ 21.1 US gal 17.6 UK gal	41 ℓ 10.8 US gal 9.0 UK gal
		SAE 10W									
Axle (front & rear) (each)	Axle oil	See Note 1								14 ℓ 3.7 US gal 3.1 UK gal	14 ℓ 3.7 US gal 3.1 UK gal
Pins	Grease									-	-
		NLGI No. 2									
Fuel tank	Diesel fuel									170 ℓ 44.9 US gal 37.4 UK gal	-
				ASTM D975 No. 2							
Cooling system	Coolant	See 20.3 Coolant specification on page 3-13								38.5ℓ 10.1 US gal 8.5 UK gal	35 ℓ 9.2 US gal 7.7 UK gal

ASTM D975 No. 1

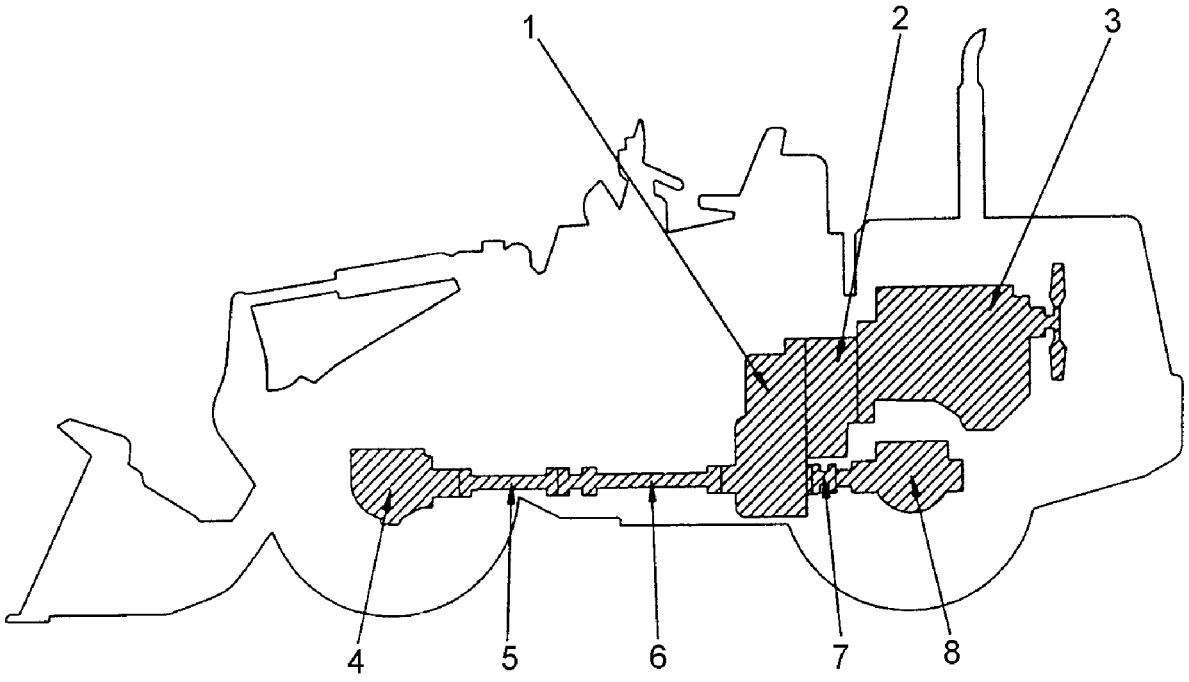
Other equipment will be necessary, when operating the machine at temperatures below -20°C (-4°F),therefore consult your distributor for your needs.

Note 1: For 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

It is permissible to substitute engine oil SAE 30 API classification CD for axle oil. Although an increased in brake noise may occur, the durability of the axle is not be affected.

POWER TRAIN

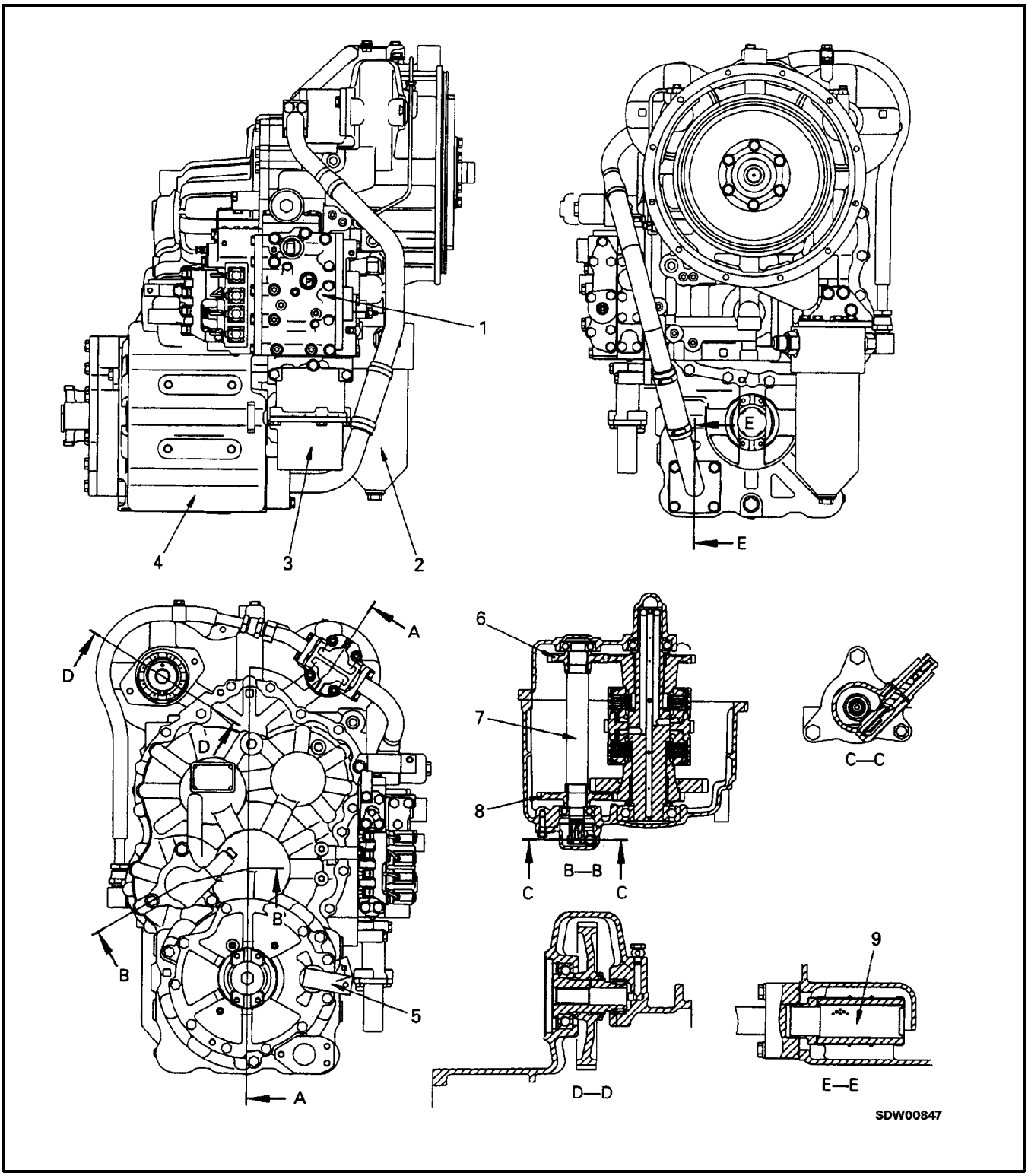


1. Transmission
2. Torque converter
3. Engine
4. Front axle
5. Front drive shaft
6. Center drive shaft
7. Rear drive shaft
8. Rear axle

SEW00839

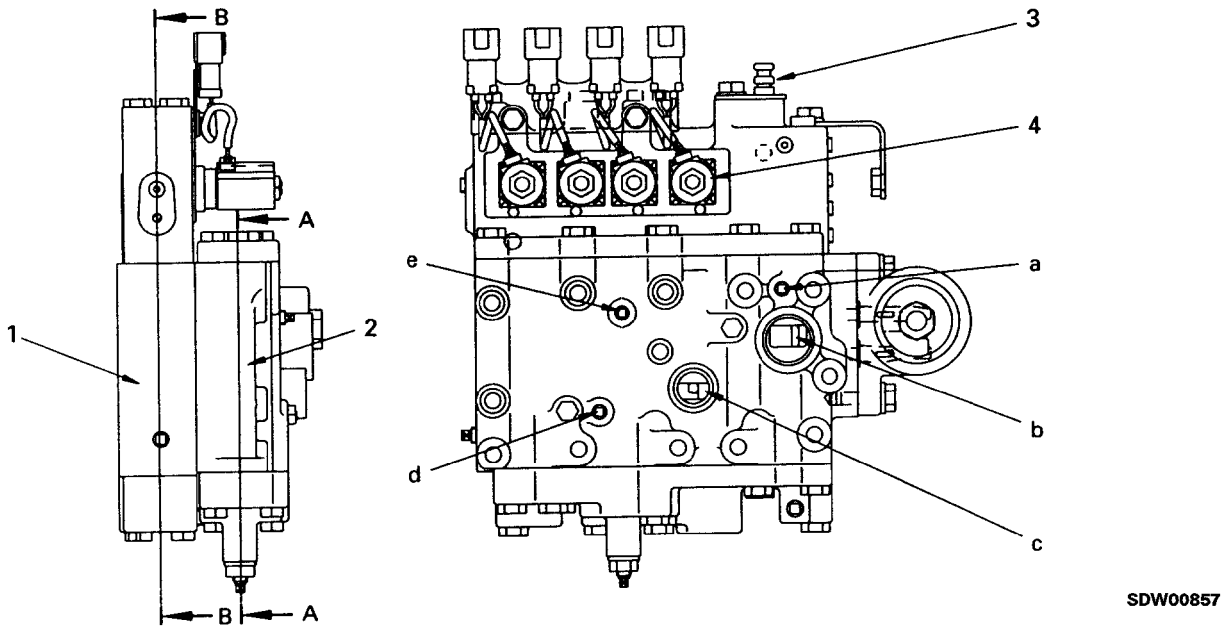
Outline

- The motive force from engine (3) passes through the engine flywheel and is transmitted to torque converter (2), which is connected to the input shaft of transmission (1).
- The transmission has six hydraulically actuated clutches, and these provide four speed ranges for both FORWARD and REVERSE. The transmission speed ranges are selected manually.
- The motive force from the output shaft of the transmission passes through center drive shaft (6), front drive shaft (5) and rear drive shaft (7), and is then transmitted to front axle (4) and rear axle (8) to drive the wheels.



1. Transmission control valve
2. Oil filter
3. Accumulator valve
4. Transmission
5. Parking brake lever
6. 4th gear (Teeth 33)
7.
8.
9.

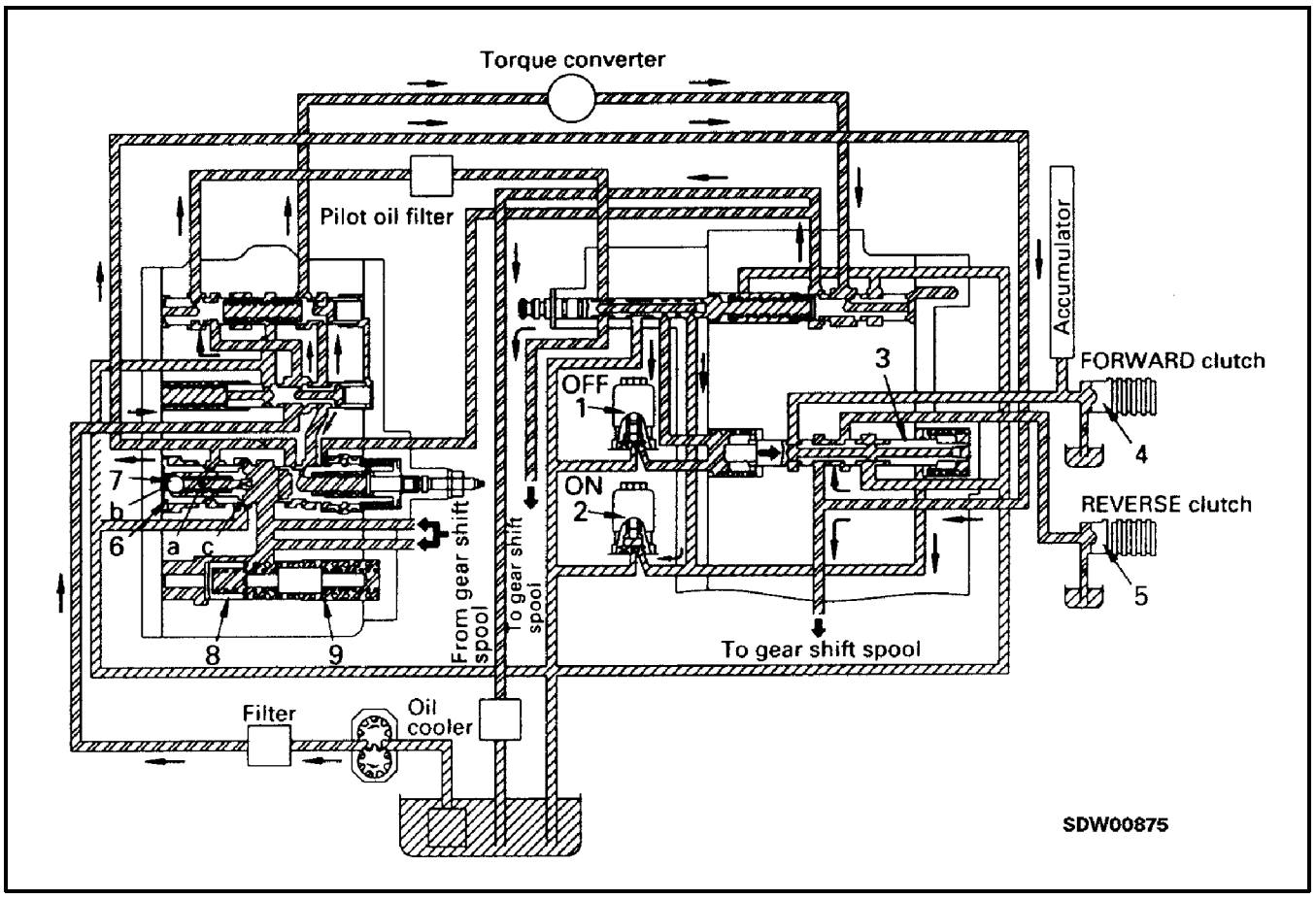
TRANSMISSION CONTROL VALVE



1. Lower valve
2. Upper valve
3. Emergency manual spool
4. Solenoid valve port

a. Pilot oil pressure measurement port
b. To oil cooler
c. From pump
d. Pump oil pressure measurement port
e. Clutch oil pressure measurement port

2. When shifting from FORWARD to REVERSE
(clutch pressure at point B)



- When the directional lever is moved from FORWARD to REVERSE, FORWARD solenoid (1) closes, REVERSE solenoid (2) opens, and directional spool (3) moves to the right in the direction of the arrow. FORWARD clutch (4) is connected to the drain circuit and the oil is drained.
- At the same time, the oil from the pump flows to REVERSE clutch (5), but while the oil is filling the clutch, the clutch pressure is low. As a result, the oil pressure at port a of quick return valve (6) also drops, so check valve (7) opens and the oil at port b flows to port a. At the same time, quick return valve (6) is moved to the left in the direction of the arrow by the pressure of the accumulator, and the oil from accumulator (8) is suddenly drained from port c.
- Accumulator (8) is returned fully to the left by the force of spring (9).

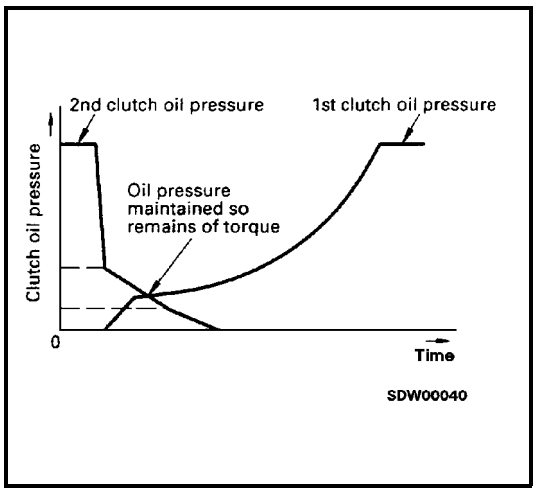
★ To reduce the shock when shifting gear, the pressure in the clutch circuit must be completely lowered and accumulator (8) must move fully to the left.

Operation

1. Shifting down when digging (kick-down F2 Fl)

When the transmission is in F2, oil pressure is stored in the 2nd clutch accumulator.

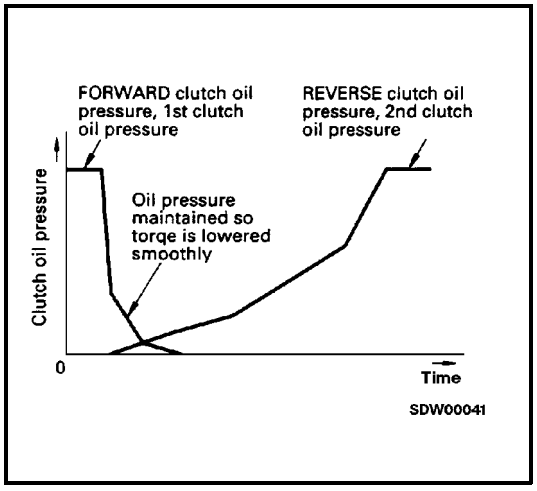
When the kick-down is operated, the Fl clutch is engaged, but the oil pressure in the accumulator is maintained for the 2nd clutch until the torque is transmitted to the 1st clutch. In this way, it is possible to shift gear smoothly without losing the torque.



2. Moving out after digging (Fl R2)

When the transmission is in Fl, oil pressure is stored in the accumulator for the FORWARD clutch and 1st clutch.

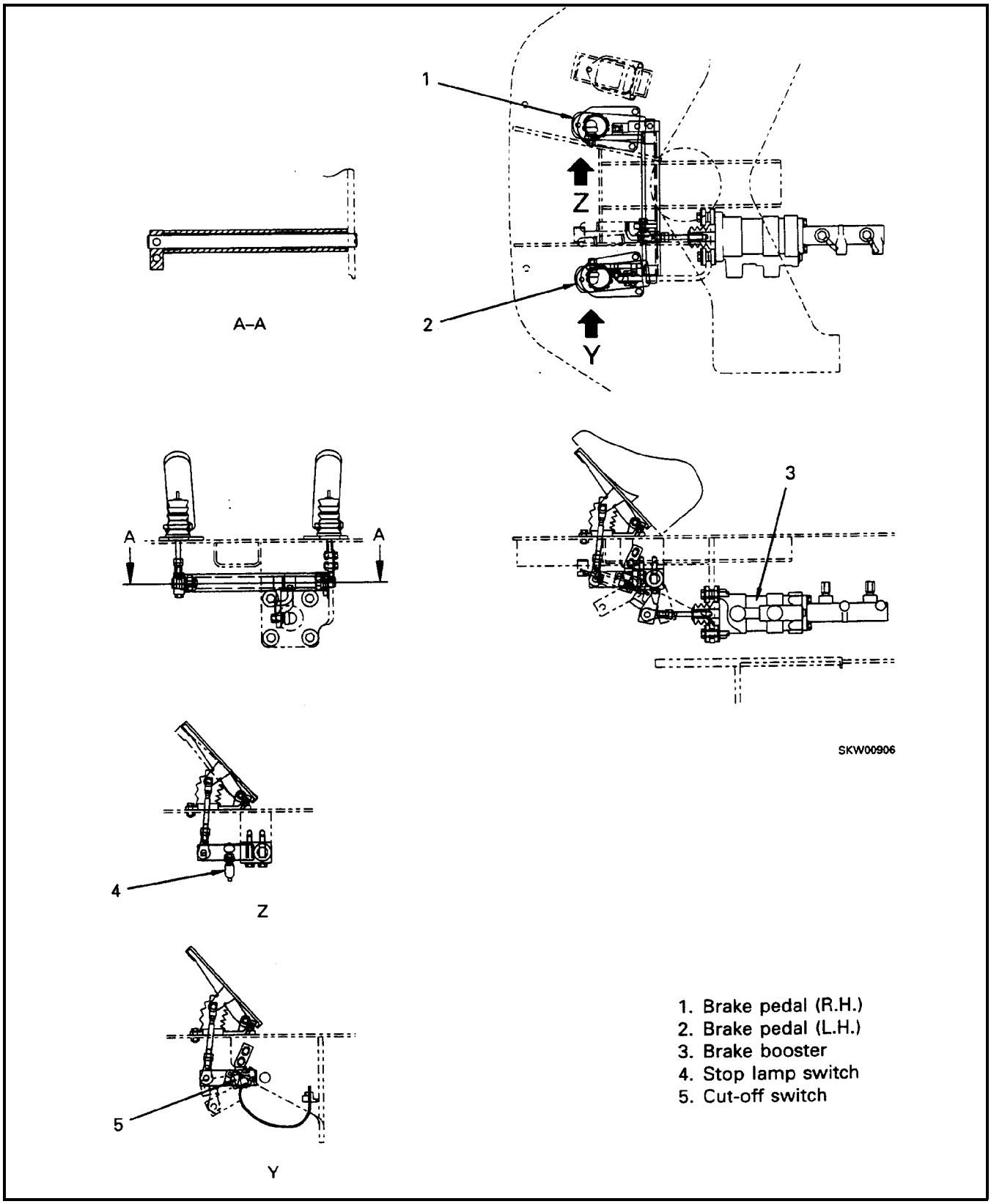
When shifting to R2 after completing digging operations, the R2 clutch is engaged, but the oil pressure for the FORWARD Clutch and 1st clutch is maintained in the accumulator. This makes it possible to reduce the loss of torque due to the reaction force to the product being handled, and to move back smoothly without shock.



MEMORANDA

MEMORANDA

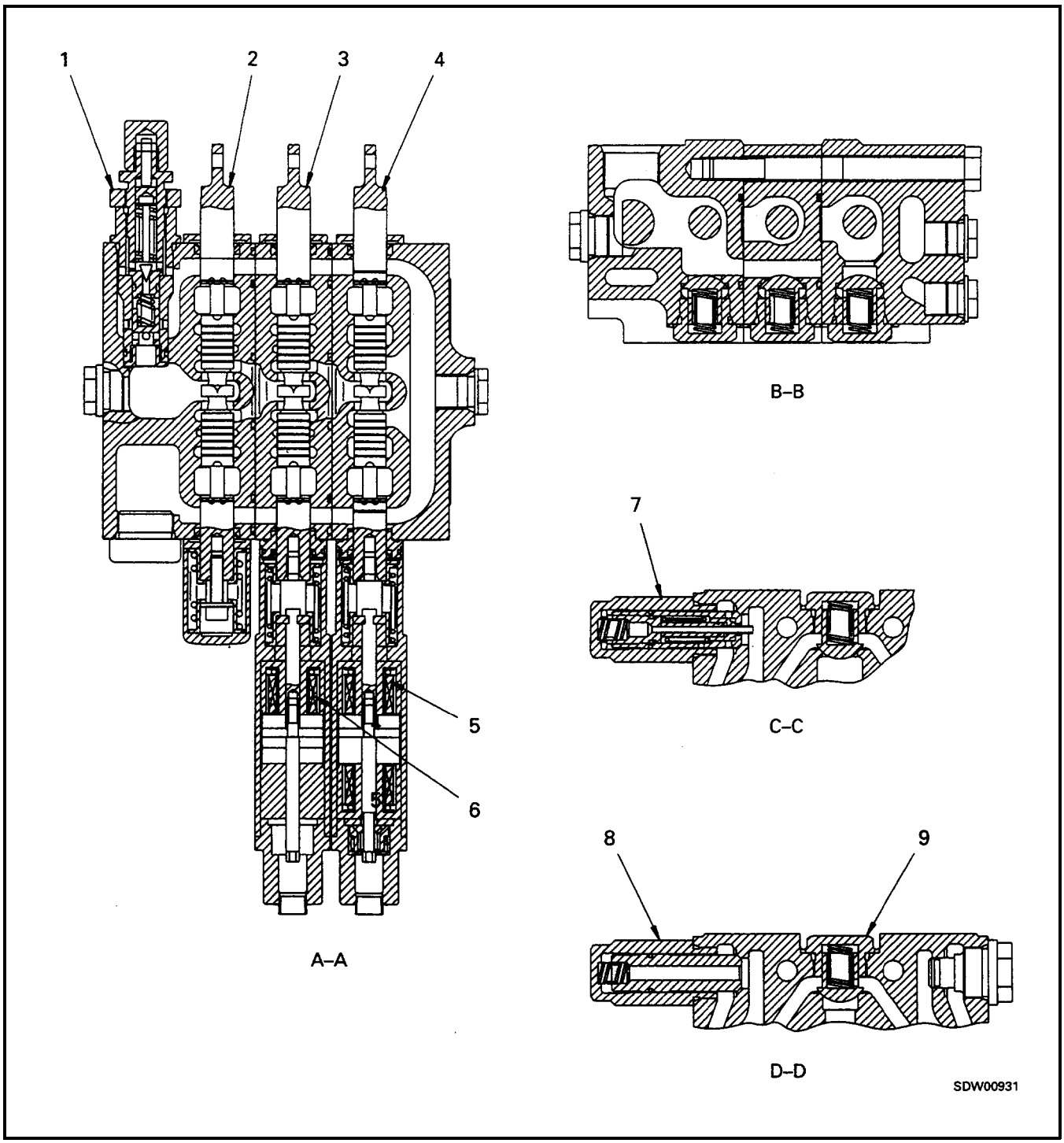
BRAKE CONTROL



Outline

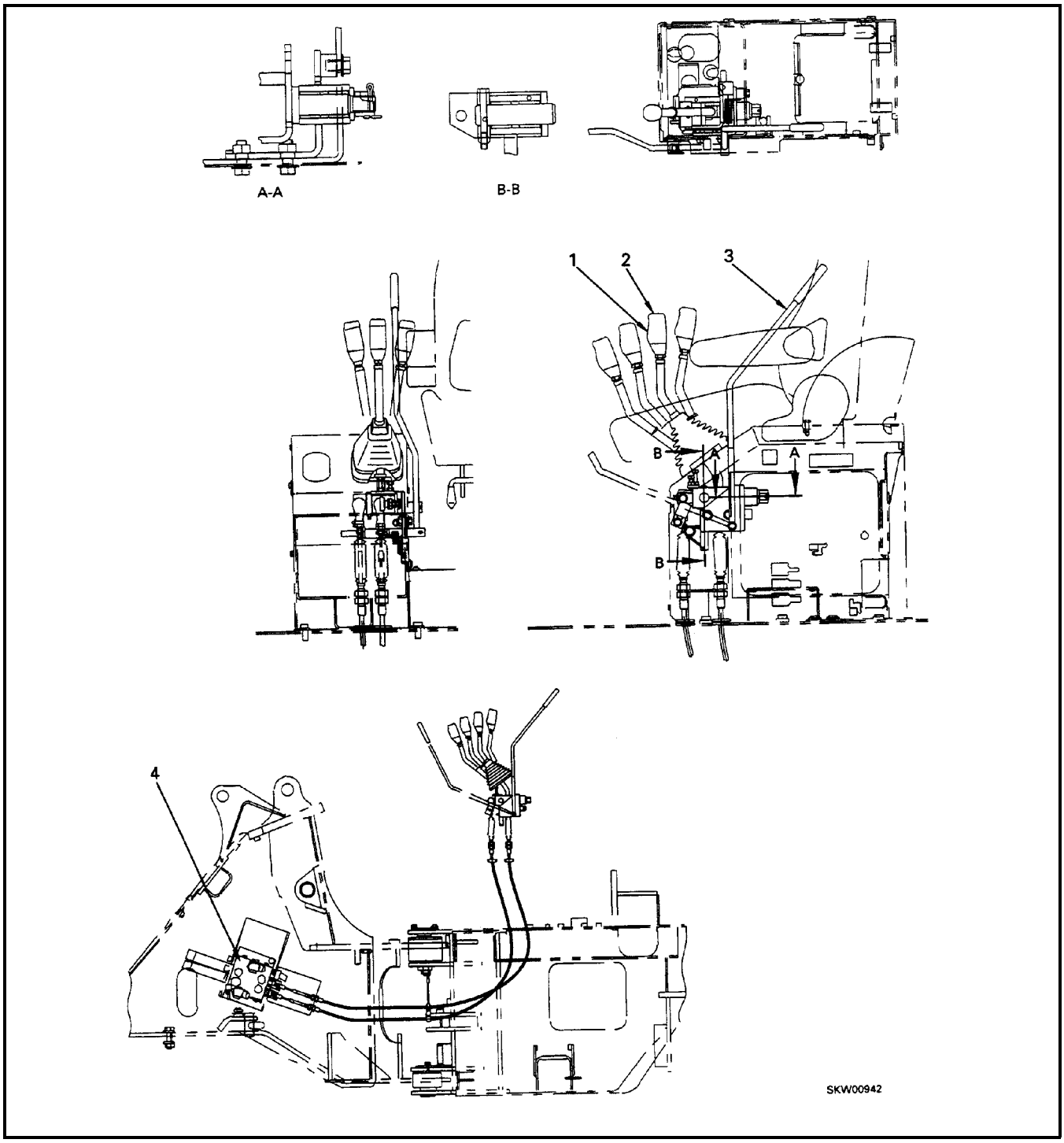
- The hydraulic system consists of the work equipment circuit and the steering circuit. The work equipment circuit controls the operation of the boom, bucket, or other attachments.
- The oil from the hydraulic tank (4) is sent from the hydraulic and steering pump (6)and steering pump (7) to the priority valve (5). The amount of oil flow is controlled and sent to main control valve (8). If the bucket and boom spools of main control valve are at neutral, the oil passes through the drain circuit of the main control valve, is filtered by the filter inside hydraulic tank (4), and returns to the tank.
- When the work equipment control lever is operated, the bucket or boom spool of main control valve (8) move, oil flows from main control valve (8) to the boom cylinders (2) and (9) or to bucket cylinder (1), and operates the boom or bucket.
- The maximum pressure of the hydraulic circuit is controlled by priority valve (5) and the relief valve inside the main control valve. A safety valve (with suction) is installed in the bucket cylinder circuit to protect the circuit.

- Hydraulic tank (4) is a pressurized sealed typed and has a breather with a relief valve. It pressurizes the inside of the tank and also prevents negitive pressure in order to prevent cavitation of the pump.



1. Main relief valve
2. Attachment spool
3. Bucket spool
4. Boom spool
5. Magnet for boom
6. Magnet for bucket
7. Safety valve (with suction)
8. Suction valve
9. Check valve

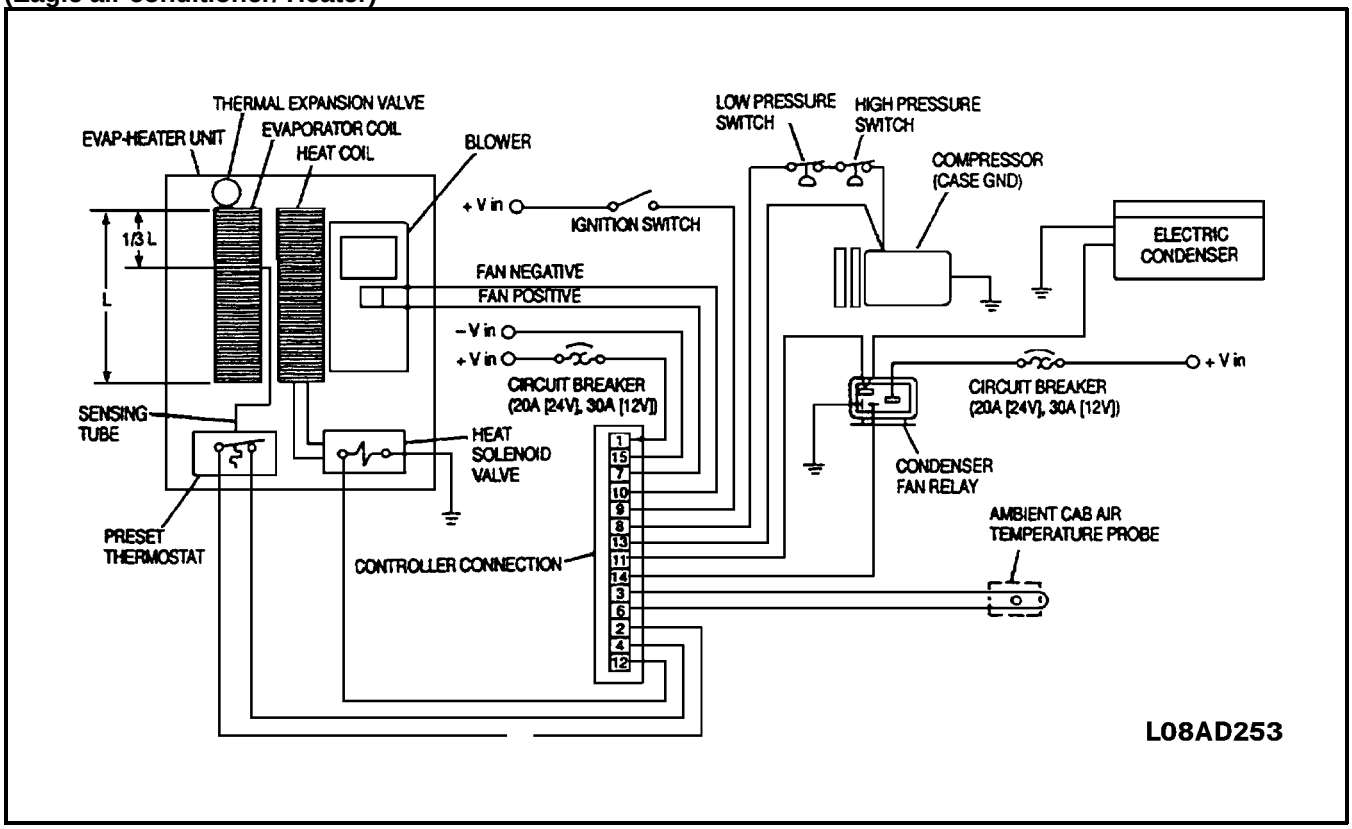
WORK EQUIPMENT LEVER LINKAGE



1. Bucket boom control lever
2. Kick-down switch
3. Lock lever
4. Main control valve

ELECTRIC CIRCUIT DIAGRAM

(Eagle air conditioner/ Heater)



NOTES:

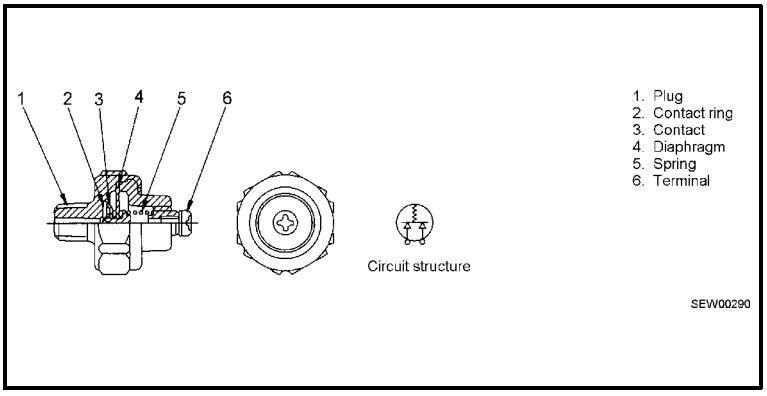
1. Position the ambient temperature probe near waist high level, out of air flow and sun load.
2. Insert the sensing tube from present thermostat down into the evaporator coil, parallel to the coil face, between the 1st and 2nd rows, to a depth of the coil height minus 1 inch.

Wire chart

Socket	Size	Color	Wire function
1	10GA	Red	Battery positive in
2	18GA	Red	½ evap coil thermostat in
3	18GA	Black	½ ambient thermistor in
4	18GA	Red	½ evap coil thermostat in
5	N/A	N/A	Not used
6	18GA	Black	½ ambient thermistor in
7	14GA	Orange	Fan positive out
8	16GA	Dk. Green	Clutch out
9	18GA	DK. Blue	Ignition switch in
10	14GA	Black	Fan negative out
11	18GA	Brown	Condenser blown fuse in
12	16GA	White	Heat solenoid out
13	18GA	Tan	Pressure switch detect in
14	16GA	Yellow	Condenser fan relay out
15	12GA	Black	Battery negative in
16	N/A	N/A	Not used

SENSOR

ENGINE OIL PRESSURE

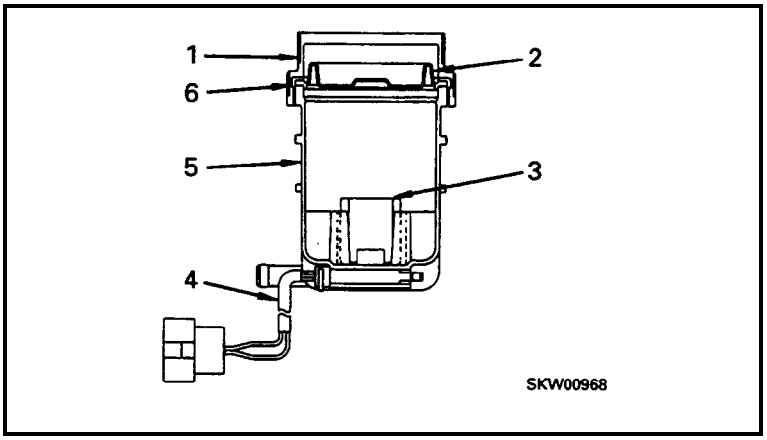


1. Plug
2. Contact ring
3. Contact
4. Diaphragm
5. Spring
6. Terminal

Function

- The engine oil pressure sensor is installed to the engine block and detects the oil pressure. If the oil pressure goes below the specified pressure, it lights up the engine oil pressure warning pilot lamp on the cluster gauge to warn the operator of the abnormality.

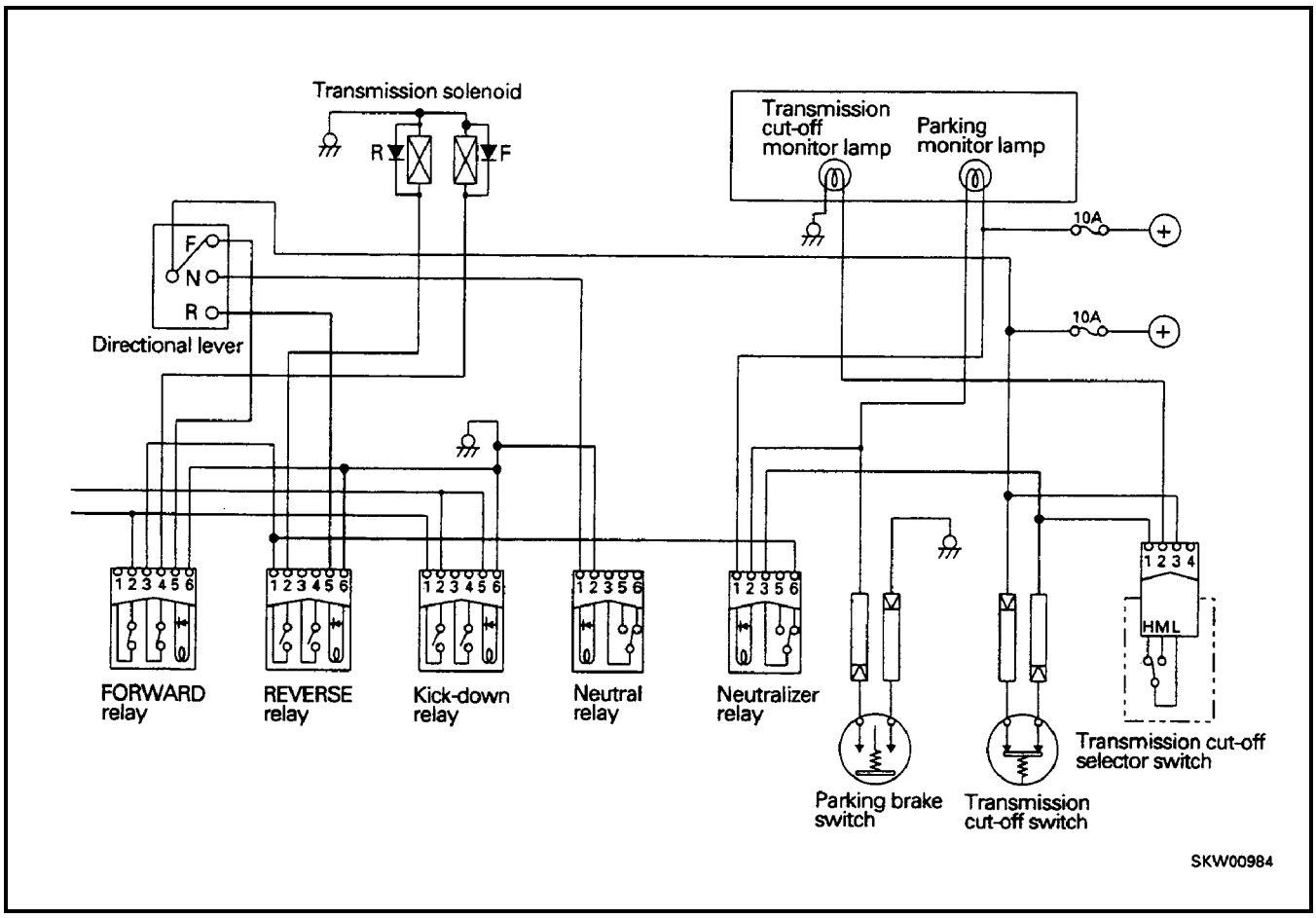
BRAKE OIL LEVEL



1. Cap
2. Ring
3. Float
4. Connector
5. Tank
6. Diaphragm

Function

- The brake oil level sensor is installed to the top of the brake oil tank. When the brake oil goes below the specified level, the float goes down and the switch is turned on. This lights up the brake oil level lamp on the cluster gauge to warn the operator of the abnormality.



2. Transmission cut-off selector switch OFF

- If the transmission cut-off selector switch is turned OFF, a voltage of +24V is applied to the transmission F solenoid or R solenoid from the transmission cut-off selector switch neutralizer relay FORWARD relay or REVERSE relay. The transmission cut-off switch does not form part of this circuit.
- If the left brake pedal is depressed, the transmission is not shifted to neutral. The brake is simply applied as a normal brake.

Machine model			WA180-3L	
Engine model			Komatsu S6D102E-1	
Item	Measurement condition	Unit	Standard value for new machine	Service limit value
Valve clearance	Engine cold: Intake valves Exhaust valves	mm	0.25 0.51	0.25 0.51
Engine stall speeds: Torque converter	• Coolant temperature in operating range • Torque converter oil temperature in operating range • Hydraulic oil at normal operating temperature	rpm	2500 ± 100	2500 ± 200
Hydraulic			2500 ± 100	2500 ± 200
Full			1950 ± 200	1950 ± 300

✯ For further detailed information, refer to Engine Shop Manual.

MEASURING EXHAUST COLOR

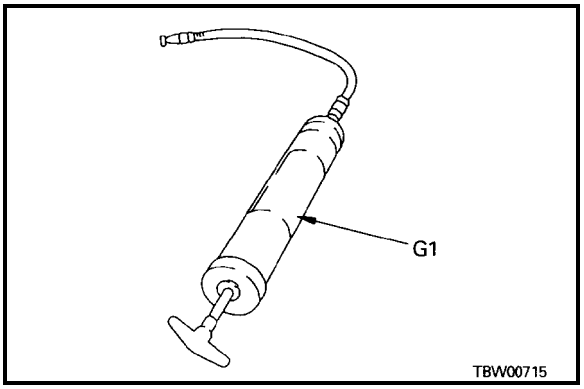
★ When measuring in the field when there is no air or power supply, use smoker the checker; when recording official data, use the smoke meter.

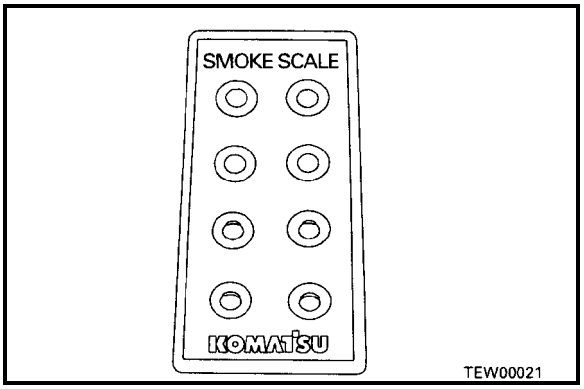
Measuring with handy smoke checker G1

⚠ When measuring the exhaust gas color, be careful not to touch the exhaust pipe or any other high temperature part.

★ Warm up the engine (oil temperature: 60°C 140°F) before measuring the exhaust gas color.

1) Fit filter paper in too[**G1**.
2) Insert the exhaust gas intake port into the exhaust pipe, accelerate the engine suddenly, and at the same time operate the handle to catch the exhaust gas on the filter paper.
3) Remove the filter paper and compare it with the scale provided to judge the condition.



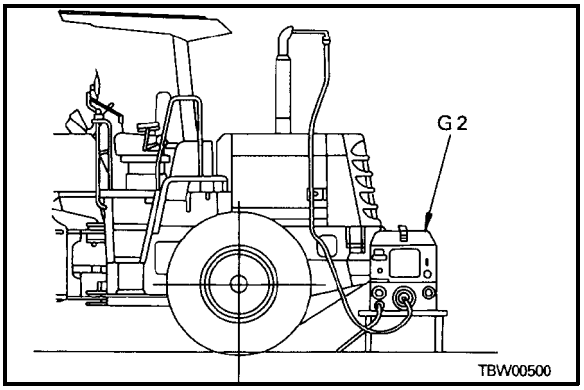


Measuring with smoke meter G2

⚠ When measuring the exhaust gas color, be careful not to touch the exhaust pipe or any other high temperature part.

★ Warm up the engine (oil temperature: 60°C 140°F) before measuring the exhaust gas color.

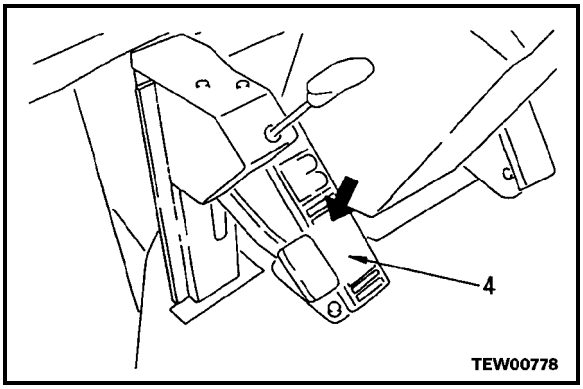
1) Insert the probe into the outlet port of the exhaust pipe, then tighten the clip to secure it to the exhaust pipe.
2) Connect the probe hose, accelerator switch plug, and air hose to tool **G2**.
   ★ The pressure of the air supply should be less than 1.5 MPa (15 kg/cm²).
3) Connect the power cord to the AC100V outlet.
   ★ When connecting the cord, check first that the power switch is **OFF**.
4) Loosen the cap nut of the suction pump, then fit the filter paper.
   ★ Fit the filter paper securely so that the exhaust gas does not leak.
5) Turn the power switch.
6) Accelerate the engine suddenly, and at the same time, depress the accelerator pedal and operate the relief valve to catch the exhaust gas color on the filter paper.
7) Lay the filter paper used to catch the exhaust gas color on top of unused filter papers (10 sheets or more) inside the filter paper holder, and read the indicated value.



4. Check that the area around the machine is safe, then remove the blocks from under the tires.

5. Sit in the operator's seat and depress the left brake pedal (4) fully.

6. Start the engine, then release the parking brake and slowly let the brake pedal out to start the machine.



⚠ When the engine is started, the transmission is also engaged and the machine will start, so always check carefully that the area around the machine and in the direction of travel is safe and keep the brake pedal depressed fully when starting the engine.

7. After moving the machine, stop the engine, then apply the parking brake and put blocks under the tires.

8. Return the manual spool to the neutral position and install the lock plate.

TESTING FOR BRAKE DISC WEAR

Apply the parking brake and chocks under the tires.

Measuring

1. Loosen drain plug (1) and drain the axle oil.

Axle oil: 14

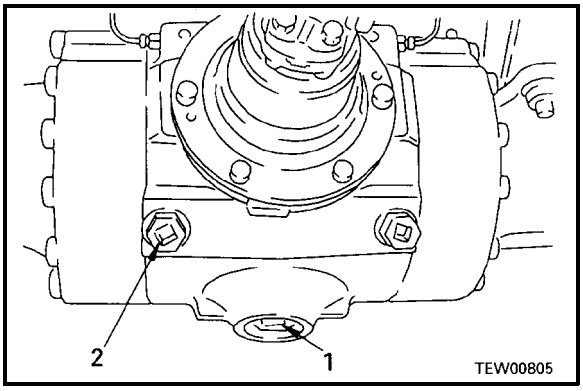
2. Install measuring plug (2).

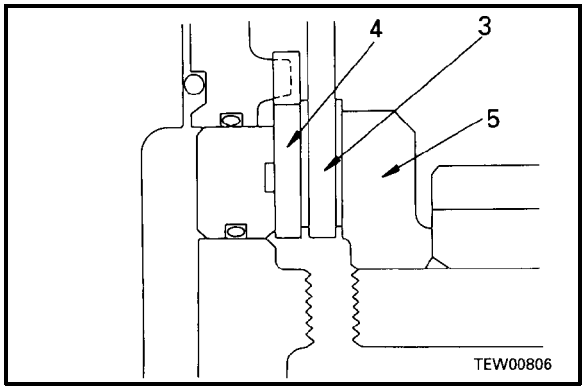
3. Lightly press the brake pedal.
★ Check that plate (4) and plate (5) are in tight contact with disc (3).

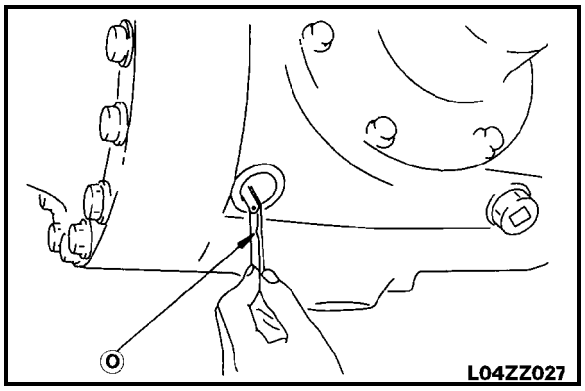
Insert feeler gauge (**O**) between disc (3) and plate (4), and measure the clearance.

4. Fasten the drain plug and supply axle oil to the specified level through the oil supply port.

Axle oil: 14

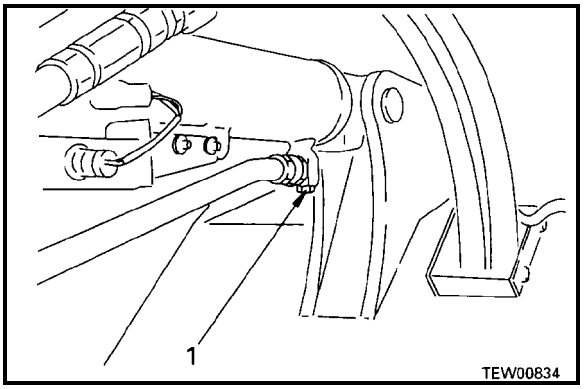






MEASURING WORK EQUIPMENT HYDRAULIC PRESSURE

★ **Measurement conditions**
- Engine water temperature: Within white range on engine water temperature gauge
- Hydraulic oil temperature: 45 - 55°C
- Engine speed: High idle



Work equipment relief valve pressure measuring procedure

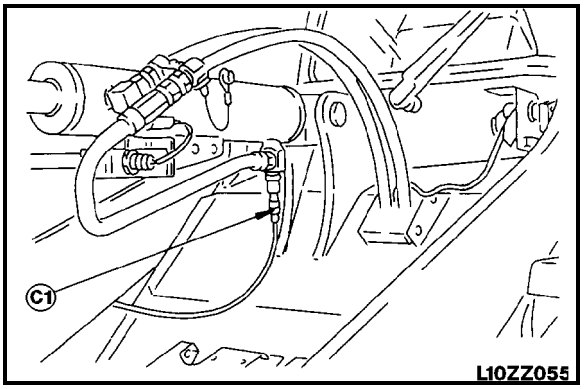
⚠ Loosen the oil supply cap to release the pressure inside the hydraulic oil tank, then operate the control levers two or three times to release any pressure remaining in the piping.

1. Remove bucket cylinder circuit oil pressure measuring plug (1).

2. Install hydraulic test kit C1 to the measuring port.
   ★ Check that there is no oil leakage from any joints.
   ★ Use a hose which is long enough to reach the operator's seat.

3. Start the engine, raise the boom about 400 mm, tilt back the bucket using the control lever, and measure the pressure when the relief valve is activated.

   ★ Be careful not to apply any sudden pressure to the pressure gauge.



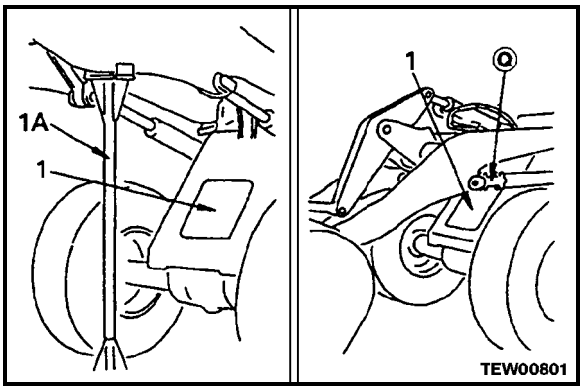
⚠ When removing the hydraulic pressure gauge, release the pressure inside the circuit in the same way as when it was installed.

Adjusting

⚠ Apply the parking brake and put blocks under the tires.

⚠ Always stop the engine before adjusting the oil pressure.

1. Raise the boom, set support (1A) or tool Q in position, then remove front cover (1).



POINTS TO REMEMBER WHEN TROUBLESHOOTING

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

⚠ 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.

⚠ 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.

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

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

⚠ 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.
   1. Have any other problems occurred apart from the problem that has been reported?
   2. Was there anything strange about the machine before the failure occurred?
   3. Did the failure occur suddenly, or were there problems with the machine condition before this?
   4. Under what conditions did the failure occur?
   5. Had any repairs been carried out before the failure? When were these repairs carried out?
   6. Has the same kind of failure occurred before?
3. Check before troubleshooting.
   1. Check the oil level.
   2. Check for any external leakage of oil from the piping or hydraulic equipment.
   3. Check the travel of the control levers.
   4. Check the stroke of the control valve spool.
   5. Other maintenance items can be checked externally, so check any item that is considered to be necessary.
4. Confirming the failure.
   1. Confirm the extent of the failure yourself, and judge whether to handle it as a real failure or as a problem with the method of operation, etc.

   ★ When operating the machine to reenact the troubleshooting symptoms, do not carry out any investigation or measurement that may make the problem worse.
5. Troubleshooting
   1. Use the results of the investigation and inspection in Steps 2 - 4 to narrow down the causes of the failure, then use the troubleshooting flowchart to locate the position of the failure exactly.

   b The basic procedure for troubleshooting is as follows.
      1. Start from the simple points.
      2. Start from the most likely points.
      3. Investigate other related parts or information.
6. Measures to remove root cause of failure.
   1. Even if the failure is repaired, if the root cause of the failure is not repaired, the same failure will occur again.
   2. To prevent this, always investigate why the problem occurred. Then, remove the root cause.

CHECKS BEFORE TROUBLESHOOTING

		Item	Standard value	Remedy
Checks before starting	Lubricating oil, cooling water	1. Check fuel level	--	Add fuel
		2. Check for dirt or water in fuel	--	Clean, drain
		3. Check hydraulic oil level	--	Add oil
		4. Check hydraulic oil strainer	--	Clean, drain
		5. Check brake oil level	--	Add oil
		6. Check engine oil level	--	Add oil
		7. Check cooling water level	--	Add water
		8. Check condition of dust indicator	--	Clean or replace
		9. Check air pressure	--	Refer to troubleshooting
Item	Electrical Equipment	10. Check for loose or corroded battery terminals	--	Tighten or replace
		11. Check for loose or corroded alternator terminals	--	Tighten or replace
		12. Check for loose or corroded stating motor terminals	--	Tighten or replace
Other check items	Hydraulic mechanical components	13. Check for abnormal noise or smell	--	Repair
		14. Check for oil leakage	--	Repair
		15. Bleed air from system	--	Bleed air
	Electrical components	16. Check battery voltage (engine stopped)	23 - 26 V	Replace
		17. Check level of battery electrolyte	--	Add or replace
		18. Check for discolored, burnt, or bare wires	--	Replace
		19. Check for missing wiring clamps, hanging wires	--	Repair
		20. Checks for water leaking onto wiring (checks carefully water leakage at connectors and terminals)	--	Disconnect connector and dry connection
		21. Check for broken or corroded fuses	--	Replace
		22. Check alternator voltage (engine running at over half throttle)	27.5 - 29.5 V	Replace
		23. Noise when battery relay is operated (switch starting switch from ON to OFF)	--	Replace

MEMORANDA

(3) Exhaust gas comes out but engine does not start. (Fuel is being ejected)

General causes why exhaust gas comes out but engine does not start
- Lack of rotating force due to defective electrical system
- Insufficient supply of fuel
- Insufficient intake of air
- Improper selection of fuel

Legend
○ : Possible causes (judging from Questions and check items)
◎ : Most probable causes (judging from Questions and Check items)
△ : Possible causes due to length of use (used for a long period)
● : Items to confirm the cause.

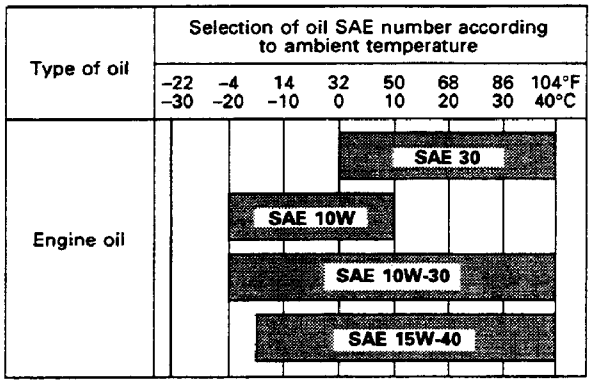
		Causes: Defective, broken valve system (valve, rocker lever, etc.)	Defective injection pump (rack, plunger stuck)	Worn piston ring, cylinder	Clogged fuel filter, strainer	Clogged feed pump strainer	Clogged air cleaner element	Defective ribon heater	Defective or deteriotated battery	Leakage, clogging, air in fuel system	Clogged injection nozzle, defective spray	Clogged fuel tank air breather hole	Improper fuel used
Questions	Confirm recent repair history												
	Degree of use: Operated for long period			△	△	△				△			
	Suddenly failed to start	◎	◎										
	When engine is cranked, abnormal noise is heard from around head	◎											
	Engine oil must be added more frequently			◎									
	Non-specified fuel has been used		○							○			
	Replacement of filters has not been carried out according to operation manual				◎	◎	◎						
	Rust is found when fuel is drained				◎	◎							
	Dust indicator is red						◎						
	Indicator lamp does not light up							◎					
	Starting motor cranks engine slowly								◎				
	Mud is stuck to fuel tank cap										○		
Check items	When fuel lever is placed at FULL position, it does not contact stopper		○										
	When engine is cranked with starting motor, 1) Little fuel comes out even when injection pump sleeve nut is loosened		◎										
	2) Little fuel comes out even when fuel filter air bleed plug is loosened				◎	◎							○
	There is leakage from fuel piping								◎				
	When exhaust manifold is touched immediately after starting engine, temperature of some cylinder is low									◎			
	When fuel filter is drained, no fuel comes out												◎
Troubleshooting	Remove head cover and check directly	●											
	When control rack is pushed, it is found to be heavy, or does not return		●										
	When compression pressure is measured, it is found to be low			●									
	When fuel filter, strainer are inspected directly, they are found to be clogged				●								●
	When feed pump strainer is inspected directly, it is found to be clogged					●							
	When air element is inspected directly, it is found to be clogged						●						
	Engine Preheater mount does not become warm							●					
	Either specific gravity of electrolyte or voltage of battery is low								●				
	When feed pump is operated, there is no response, or pump is heavy									●			
	Stop fuel injection to one cylinder at a time. If there is no change in engine speed, that cylinder is not working										●		
	When fuel cap is inspected directly, it is found to be clogged											●	
	Remedy	Replace	Replace	Replace	Clean	Clean	Clean	Repair	Replace	Repair	Clean	Clean	-

SM20204

S-12 Oil pressure lamp lights up (drop in oil pressure)

General causes why oil pressure lamp lights up
- Leakage, clogging, wear of lubricating system
- Defective oil pressure control
- Improper oil used (improper viscosity)
- Deterioration of oil due to overheating

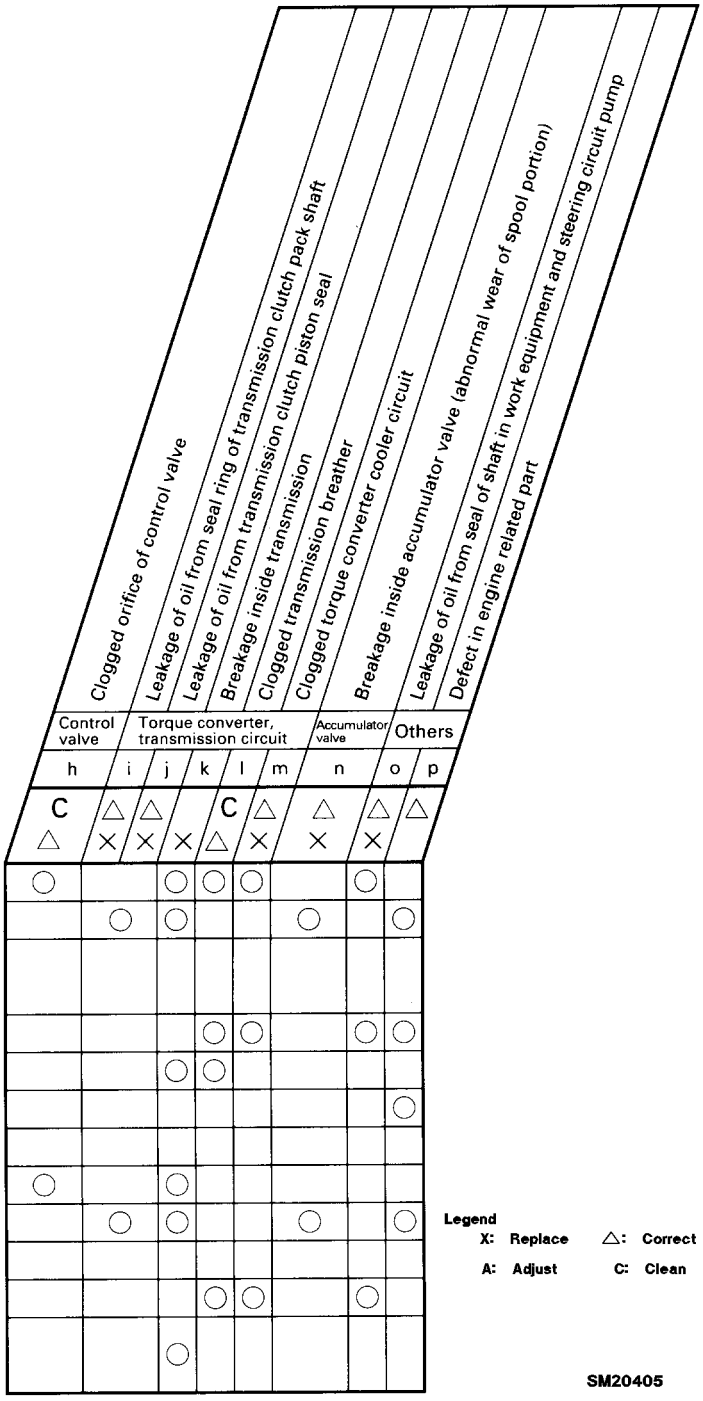
★ Standards for use of oil



Legend
- ○ : Possible causes (judging from Questions and check items)
- ◎ : Most probable causes (judging from Questions and Check items)
- △ : Possible causes due to length of use (used for a long period)
- ● : Items to confirm the cause.

			Causes: Clogged oil filter	Worn bearing journal	Clogged strainer inside oil pan	Clogged, broken oil pipe inside oil pan	Broken suction pipe brazing	Defective oil pump	Insufficient oil in oil pan	Defective regulator valve	Defective relief valve	Leaking, crushed hydraulic piping	Defective oil level sensor	Defective oil pressure sensor	Water, fuel in oil	Clogged oil cooler
Questions	Confirm recent repair history															
	Dregree of use	Operated for long period	△	△				△								△
	Replacement of filter has not been carried out according to operation manual		◎													
	Caution lamp lights up		◎							○						
	Non-specified fuel has been used		○	○												
	Condition when oil pressure lamp lights up	Lights up at low idling		◎						○						○
		Lights up at low, high idling			◎	◎	◎	◎	○	○	○					○
		Lights up on slopes						◎								
		Sometimes lights up							◎	◎		○	○			
Check items	There is clogging, leakage from hydraulic piping (external)										◎					
	Oil level sensor lamp lights up							◎				◎				
	When oil level in oil pan is checked, it is found to be low							◎								
	Metal particles are found when oil is drained			◎												
	Metal particles are stuck to oil filter element			◎				○								
	Oil is cloudy white or smells of diesel oil													◎		
	Back of head cover is black with carbon from oil															○
Troubleshooting	When oil filter is inspected directly, it is found to be clogged		●	●												
	Remove oil pan and check directly				●	●	●									
	Oil pump rotation is heavy, there is play							●								
	There is catching of relief valve or regulator valve, spring, or valve guide is broken								●	●						
	When oil level sensor is replaced, oil pressure sensor lamp goes out											●				
	When oil pressure is measured, it is found to be within standard value												●			
	When oil cooler is inspected, it is found to be clogged															●
		Carry out troubleshooting for "Oil level rises"												-		
	Remedy		Clean	Clean	Clean	Clean	Repair	Replace	Add	Adjust	Adjust	Repair	Replace	Replace	-	Replace

SM20214


Clogged orifice of control valve
Leakage of oil from seal ring of transmission clutch pack shaft
Leakage of oil from transmission clutch piston seal
Breakage inside transmission
Clogged transmission breather
Clogged torque converter cooler circuit
Breakage inside accumulator valve (abnormal wear of spool portion)
Leakage of oil from seal of shaft in work equipment and steering circuit pump
Defect in engine related part
Control valve
Torque converter, transmission circuit
Accumulator valve
Others
h
i
j
k
l
m
n
o
p
C
△
×
Legend
X: Replace
△: Correct
A: Adjust
C: Clean
SM20405

WORK EQUIPMENT

H-1 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?

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

No.	Problems	Remedy	C	△	△	△		
			△	×	×	×	×	×
		Causes						
				Tank – pump			Main control valve	Cylinder
			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						○	○

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

SM20415

TROUBLESHOOTING

Troubleshooting

Setup:
Controller on Temp. 60° F
Defrost "off", Fan on high

Abbreviations:
EC - Electric Condenser

(A) Problem - **EO** error message display on the controller:

Possible Cause	Inspection	Remedy
1. Open EC power circuit	Check the EC circuit breaker for power, voltage, and continuity	a) Repair the wiring b) Replace open circuit breaker
2. Defective EC relay (circuit)	Check for output voltage on the yellow wire, at the relay coil. Check the voltage and continuity across the relay contacts.	a) Repair the connections / wiring b) Replace the defective relay
3. Open EC voltage detection circuit	Check for input voltage on the brown wire, at the controller.	a) Repair the wiring or connector
4. Improper wiring installation	Applicable to systems without an EC	a) See note #3
5. Defective controller	Check for output voltage on the yellow wire, at the controller.	a) Replace the controller

(B) Problem - **E1** error message display on the controller:

Possible Cause	Inspection	Remedy
1. Abnormal A/C refrigerant pressure(s). * Cool weather operation may cause low pressure short cycling	Check the refrigerant pressures with gauges. High side greater than: 320 psig (R12), or 350 psig (R134a). Low side less than: 3 - 6 psig.*	a) Check the condenser operation for air and refrigerant blockage b) Leak check system, repair the leaks and recharge the system c) Relocate the low pressure switch to the evaporator outlet
2. Opened compressor clutch circuit	Check for output voltage on the green wire at the compressor. Check the wire connections. Check for continuity across the pressure switch(es) and thermostat. Check the continuity of the clutch solenoid to ground.	a) Repair the connections/wiring b) Replace the defective switch(es) or the thermostat c) Replace the defective compressor clutch
3. Opened pressure switch detection circuit	Check for an input voltage on the tan wire, at the controller.	a) Repair the connections/ wiring
4. Defective controller	Check for output voltage on the green wire, at the controller.	a) Replace the controller

PRECAUTIONS WHEN CARRYING OUT OPERATION

[When carrying out removal or installation (disassembly or assembly) of units, be sure to follow the general precautions given below when carrying out the operation.]

1. Precautions when carrying out removal work

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

★ **Precautions when handling piping during disassembling**

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

1. Hoses and tubes using sleeve nuts

Nominal number	Plug (nut end)	Sleeve nut (elbow end) Use the two items below as a set
02	07376-50210	07221-20210 (Nut), 07222-00210 (Plug)
03	07376-50315	07221-20315 (Nut), 07222-00312 (Plug)
04	07376-50422	07221-20422 (Nut), 07222-00414 (Plug)
05	07376-50522	07221-20522 (Nut), 07222-00515 (Plug)
06	07376-50628	07221-20628 (Nut), 07222-00616 (Plug)
10	07376-51034	07221-21034 (Nut), 07222-01018 (Plug)
12	07376-51234	07221-21234 (Nut), 07222-01219 (Plug)

2. Split flange type hoses and tubes

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

NOZZLE HOLDER

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.

REMOVAL

1. Remove hood.
   Refer to “HOOD REMOVAL”.

2. Remove air cleaner (1) and bracket (2).
   Refer to “AIR CLEANER”.

3. Remove muffler (3) and mount bracket (4).
   Refer to “MUFFLER”.

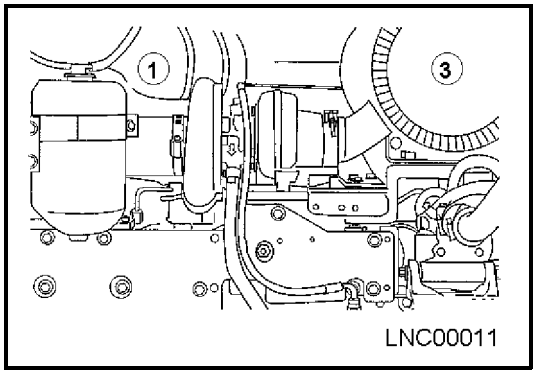
   NOTE: When the muffler bracket is removed, the air conditioner compressor and mount bracket comes off with it.

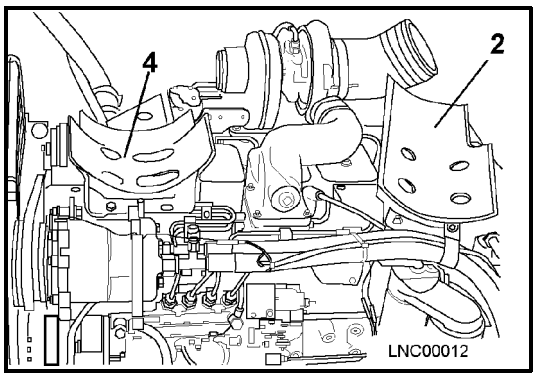
4. Remove turbocharger crossover tube (5) (air intake).

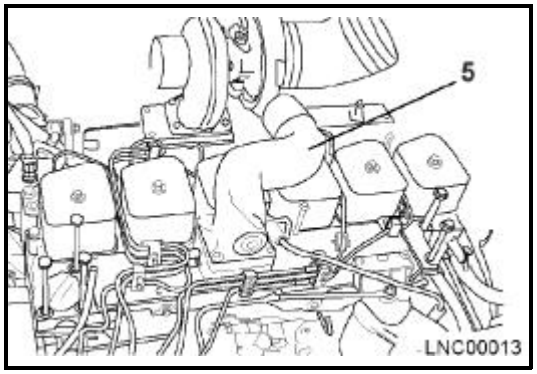
5. Remove nozzel holder (6).
   Refer to “ENGINE SHOP MANUAL”.

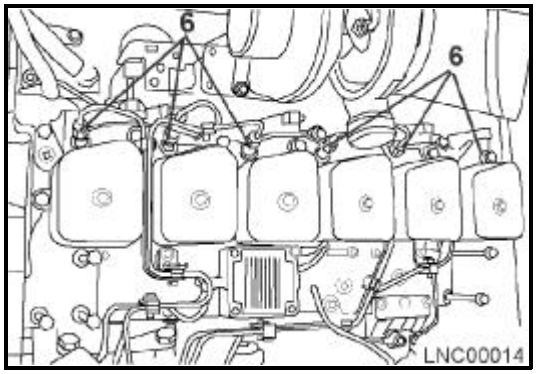
INSTALLATION

Install nozzel holder in reverse order of removal. Refer to “ENGINE SHOP MANUAL”.

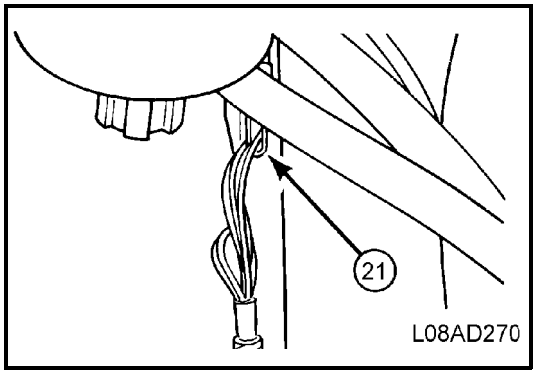




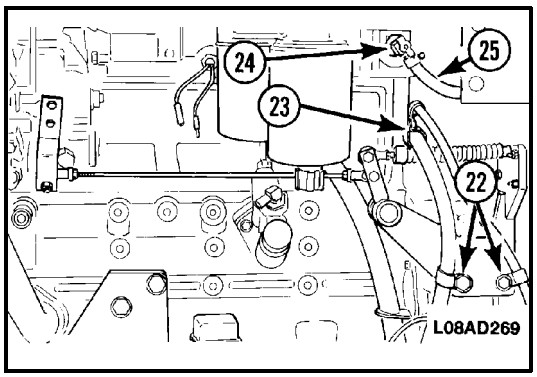




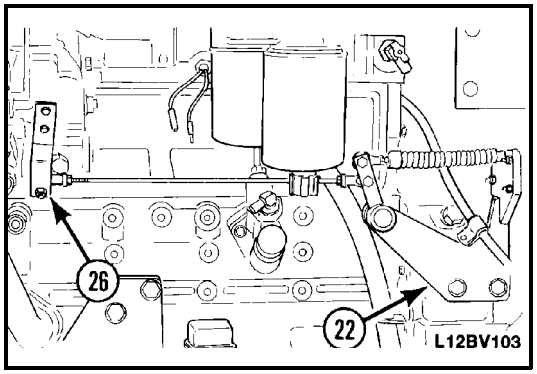
E) Unclip engine harness from floor harness (21).



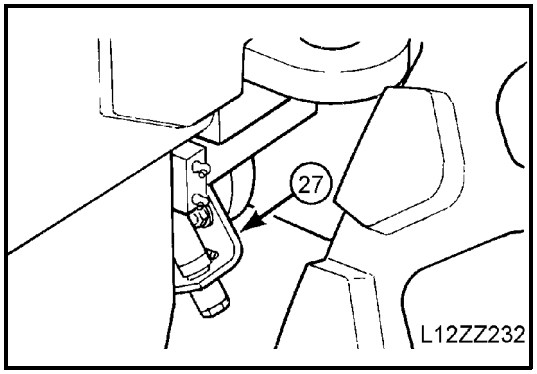
F) Unclip harness and cranking motor cable at throttle bracket (22) at rear of engine (23), and shut off petcock (24), and disconnect heater hose (25).



G) Disconnect throttle linkage rod at fuel pump lever (26), remove throttle bracket (22) and position assembly out of way.



H) Remove remote engine oil drain bracket (27) from trunnion.

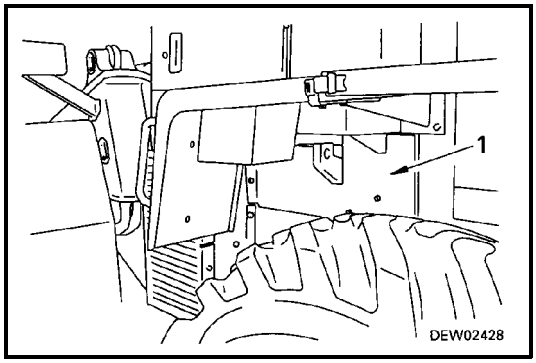


TORQUE CONVERTER CHARGING PUMP

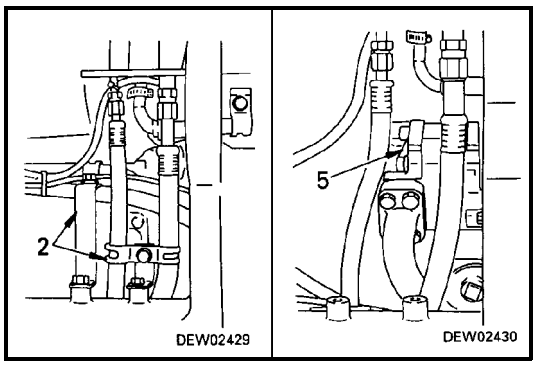
REMOVAL

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.

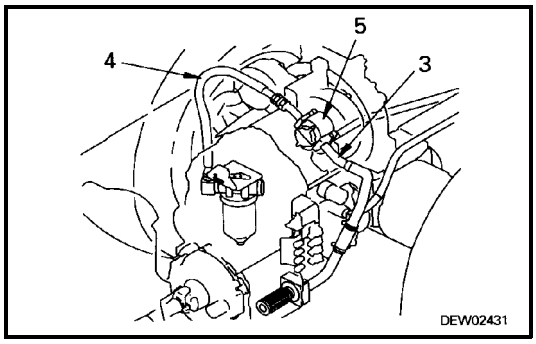
1. Cover, wiring
1) Remove cover (1) under left center fender.
2) Remove clamp and wiring clamp (2) of air conditioner hose.



2. Hydraulic piping
1) Disconnect hose (3) between transmission strainer and torque converter charging pump from torque converter charging pump. ※1
2) Disconnect tube (4) between torque converter charging pump and filter from torque converter charging pump. ※2



3. Torque converter charging pump
Remove mounting bolts, then remove torque converter charging pump (5). ※3



INSTALLATION

- Carry out installation in reverse order to removal.

※1 Tube flange mounting bolt:
66.2 ± 7.4 Nm (6.75 ± 0.75 kgm)

※2 Tube flange mounting bolt:
30.9 ± 3.4 Nm (3.15 ± 0.35 kgm)

※3 Mounting bolt:

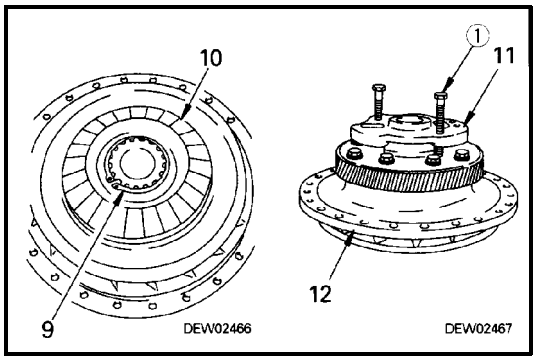
Be careful not to get the O-ring Caught when installing
66.2 ± 7.4 Nm (6.75 ± 0.75 kgm)

2. Stator

1) Remove snap ring (9).

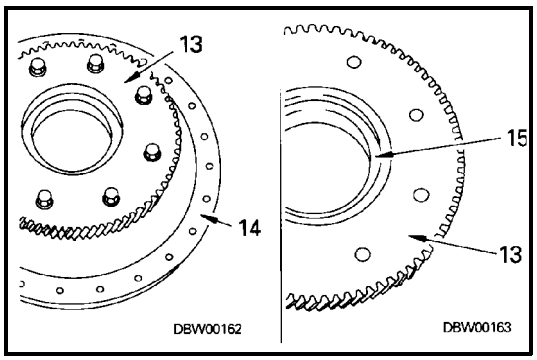
2) Remove stator (10).

3. **Stator shaft**
Using forcing screws (1), push from stator shaft (11) end, and disconnect from pump assembly (12).

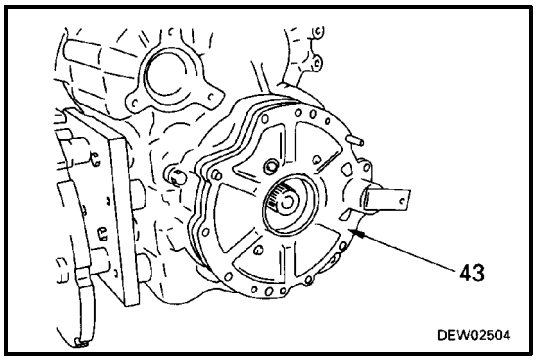


4. **Gear**
Remove gear (13) from pump (14).

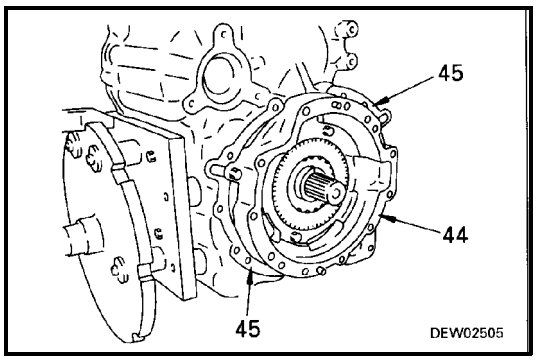
5 Bearing
Remove bearing (15) from gear (13).



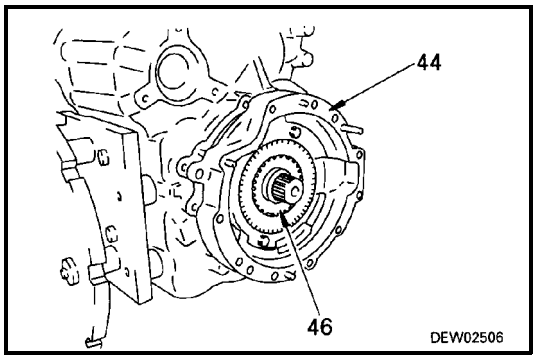
4) Tighten 2 forcing screws in forcing screw hole, and remove housing and piston assembly (43).
   Check that a set bolt is installed to hold the part in position.
   Using housing mounting bolts as forcing screws.



5) Loosen mounting bolts of parking brake retainer assembly (44), and pull out left and right shims (45).
   For reference when installing, check the number and thickness of the shims.

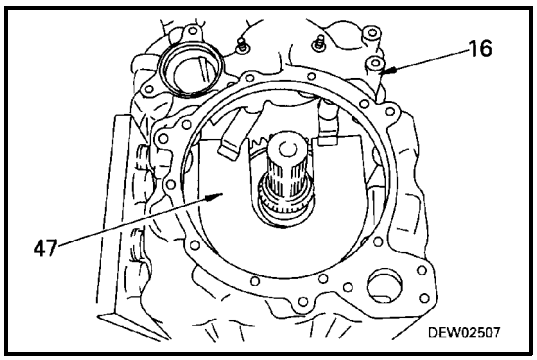


6) Remove hub spline (46), then remove parking brake retainer assembly (44).



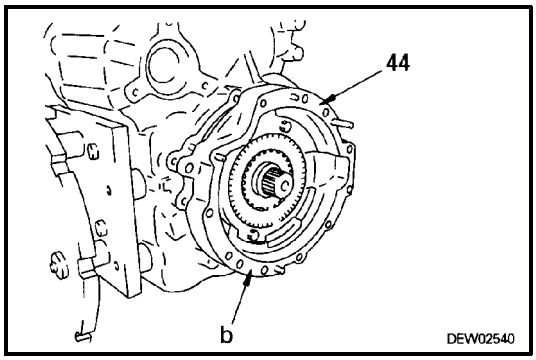
17. Output shaft gear

1) Loosen mounting bolts of gear cover (47) and leave them fitted temporarily, then turn over front housing (16).



4. Parking brake assembly

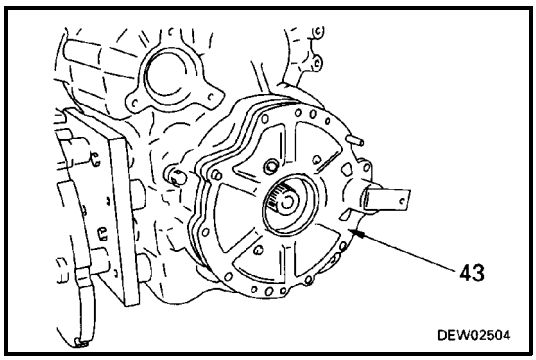
1) Assemble new gasket to mounting surface **"b"** for housing and piston assembly on parking brake retainer assembly (44).



2) Align housing and piston assembly (43) with guide bolt and assemble.

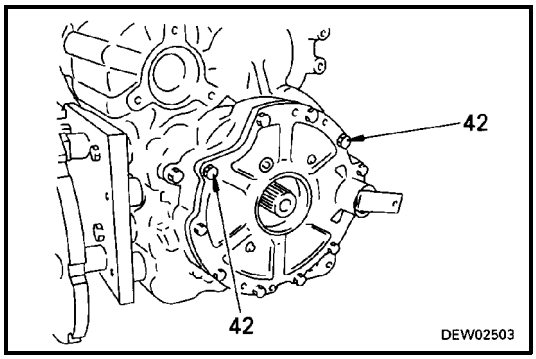
   Check that the lock set bolt is assembled.

   When assembling, be careful not to damage the oil seal lip.

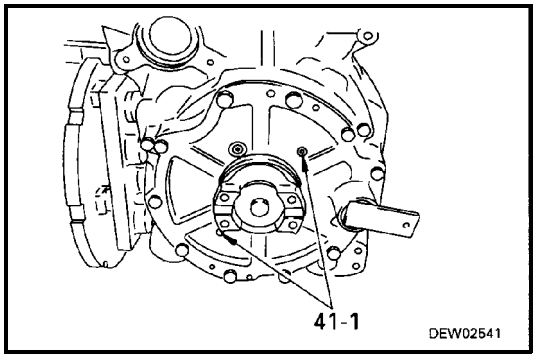


3) Tighten mounting bolts (42) of housing and piston assembly (43) on diametrically opposite sides.

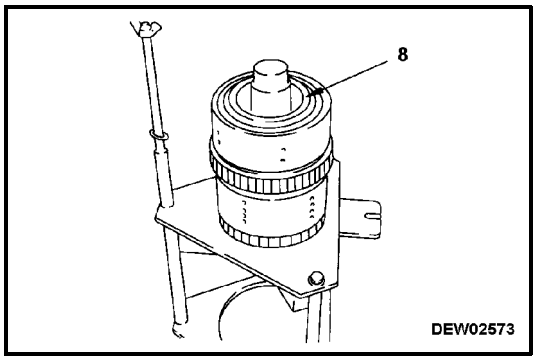
   Mounting bolt: **110.3 ± 12.3 Nm (1 1.25 ± 1.25 kgm)**



4) Remove lock set bolt and install plugs (41-1).

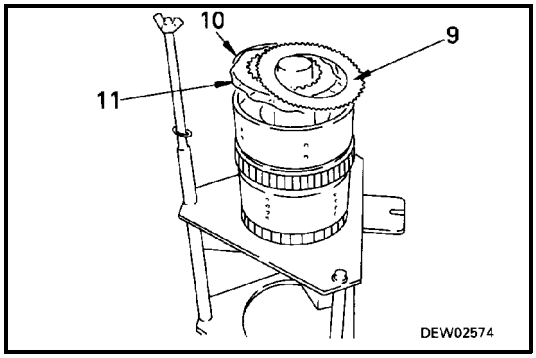


2) Remove end plate (8).



4. Clutch plate

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

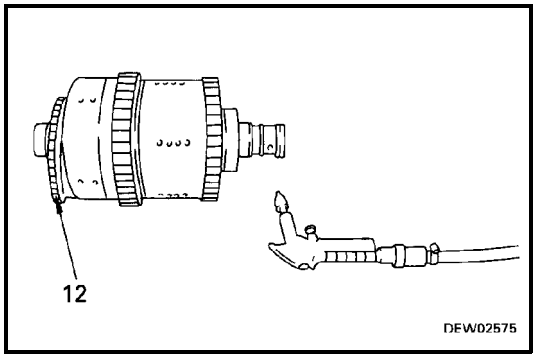


5. Piston

Blow air in through oil hole at 1st end of shaft and remove piston (12).

If the piston is at an angle and does not come out, push the piston in and try again.

If force is used to remove the piston, the inside circumference of the cylinder will be damaged.



6. Bearing

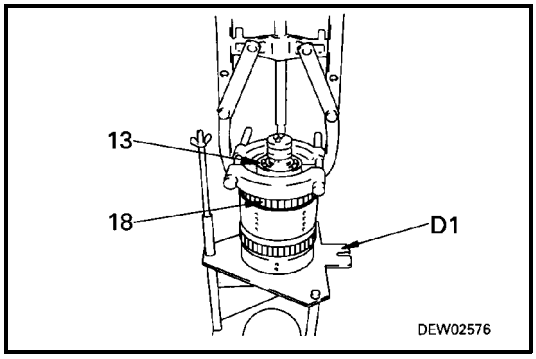
Set with the REVERSE side facing up, and set on tool **D1.**

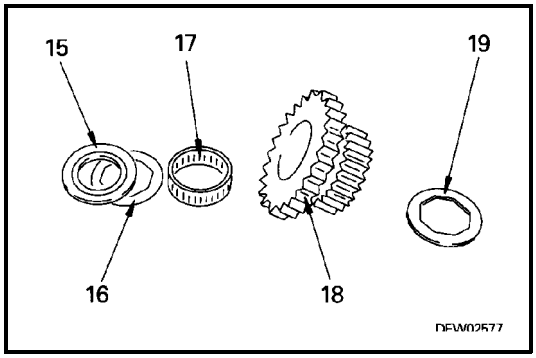
Remove bearing (13) with puller.

7. REVERSE gear

Remove spacer (15), thrust washer (16), needle bearing (17), REVERSE gear (18), and thrust washer (19).

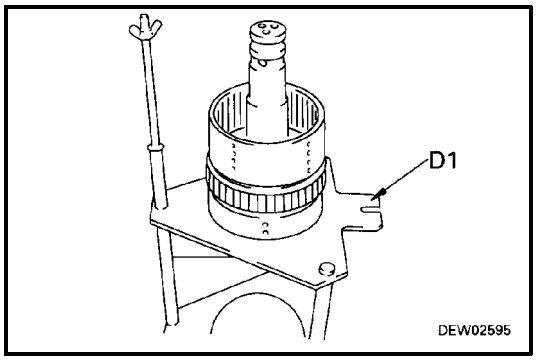
Disassemble the REVERSE gear in the same way as in Steps 3 - 5 for the 1st gear.





II. ASSEMBLY OF FORWARD, 2ND CLUTCH PACK

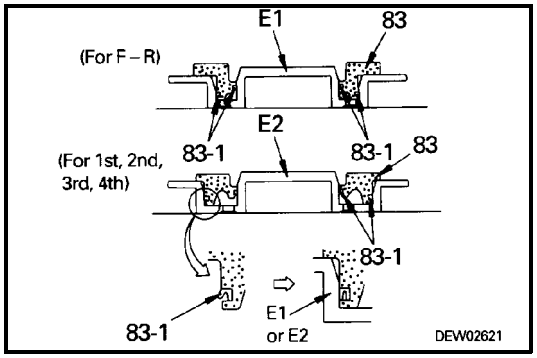
WARNING!When setting the clutch pack on the stand, be careful not to let your hands slip because of oil, and be extremely careful not to get your fingers caught between the stand and the clutch pack.
Set with the FORWARD side facing up, and set the shaft and housing assembly on tool **D1.**



1. Piston seal

Assemble piston seal (83-1) to piston (83).
When assembling a new piston seal, use seal shaping jig **El** or **E2** for approx. 2 - 3 minutes, then assemble the piston seal.
If the seal is installed to the piston without being shaped, the seal will be damaged.

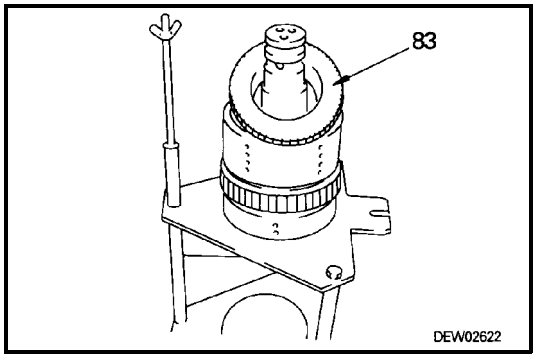
Inside surface of shaping jig:
Oil (transmission oil)



2. FORWARD piston

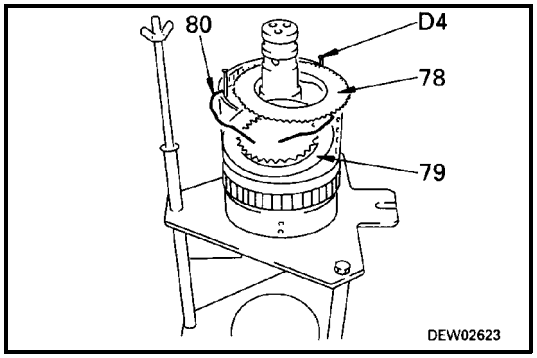
Assemble FORWARD piston (83).
Be careful not to damage the piston seal.

Sliding surface of piston seal:
Oil (transmission oil)



3. Clutch plate

Insert tool **D4** in housing, then assemble plate (78), disc (79), and spring (80) in turn.
Soak disc (79) in clean transmission oil forat least 2 minutes before assembling.
Be careful not to let spring (80) and plate (78) rest on top of each other.
Be careful not to let the plate or spring get caught in the ring groove of the clutch housing when assembling.
A 3 x 85 mm nail can also be used for tool **D4.**



TRANSMISSION CONTROL VALVE
INSTALLATION

- Carry out installation in the reverse order to removal.

WARNING! The working space is confined, so be extremely careful.

※1

Connect the wiring connector securely.

※2

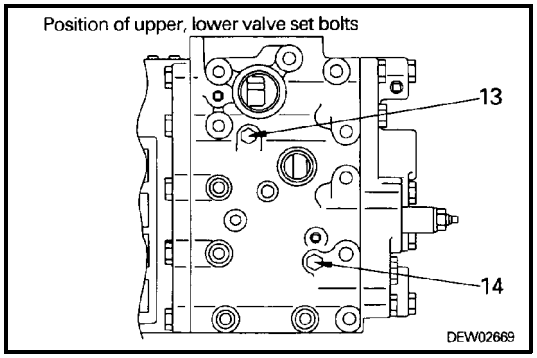
Install the hoses without twisting or interference.

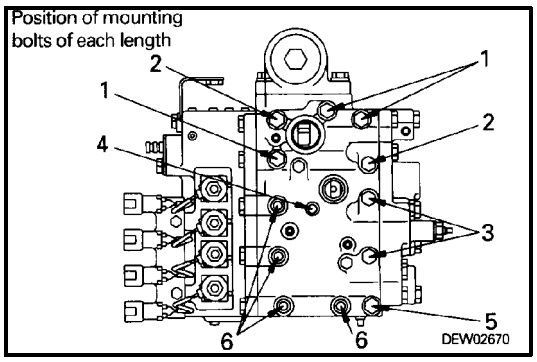
Nut of hose mouthpiece:
176.5 ± 29.4 Nm (18 ± 3 kgm)

- Width across flats of hose mouth piece nut: 36 mm

※3

When installing the transmission valve, replace the gasket with a new part.
When installing the transmission valve, use guide bolts to prevent it from falling.
Secure with upper and lower valve set bolts (13) and (14).
Remove all oil and grease from the valve mounting bolts and mounting bolt holes.
The length of the mounting bolts is different, so be careful when using them.
(1) **L** = 120 mm (2) **L =** 130 mm (3) **L** = 135 mm
(4) **L =** 115 mm (5) **L** = 100 mm (6) **L** = 100 mm

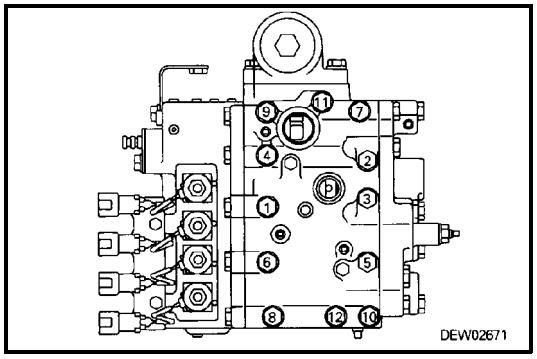




To prevent distortion of the valve, tighten the transmission valve mounting bolts in the order shown in the diagram.

Mounting bolt:
Thread tightener (LT-2)

Mounting bolt: **34.3 ± 4.9 Nm**
(3.5 ± 0.5 kgm)

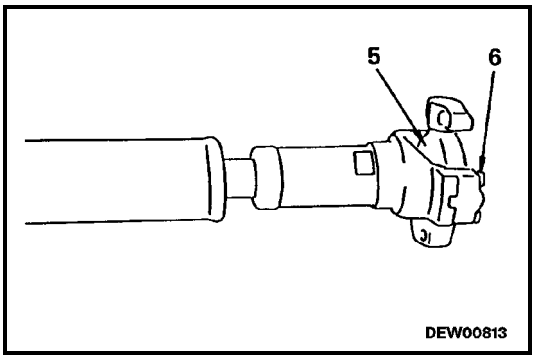


2. Center drive shaft, rear drive shaft

1) Shaft slip spline is permanently lubricated, and should not be disassembled.

3. Spider, bearing

1) Remove bolts (6) of spider and bearing assembly (5), and tap with plastic hammer to remove.

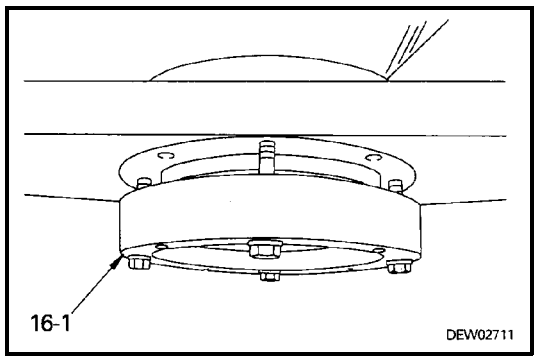


To make axle and pivot parallel, turn over trunnion cap (16-1) and tighten down with 8 bolts uniformly.

Mounting bolt: **68.6 9.8 Nm (7 ± 1 kgm)**

Check that the clearance between the pivot and trunnion cap is uniform.

Set on the mount on the machine body with the cap still reversed.



3. Axle

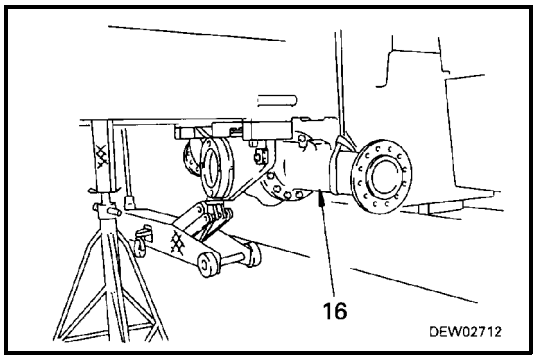
Raise axle (16) with jack and hoist, set in mounting position and tighten mounting bolts.

Use the bolts as guides when setting in the mounting position.

When tightening the mounting bolts, do not tighten in one pass. Tighten the mounting bolts in three stages.

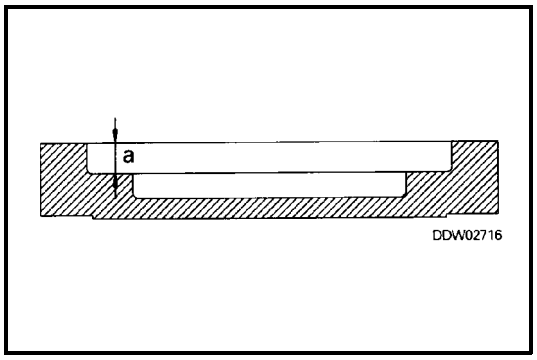
After installing the axle assembly, remove the wire.

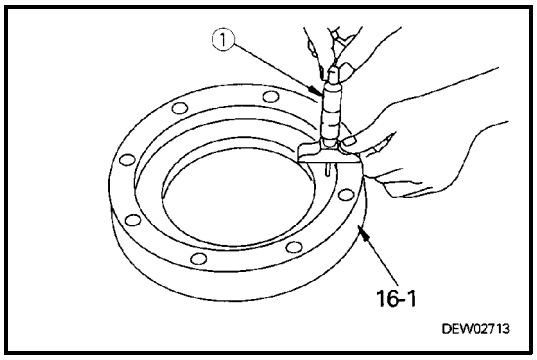
Mounting bolt:
549 ± 58.8 Nm (56 ± 6 kgm)
(Width across flats: **30 mm)**



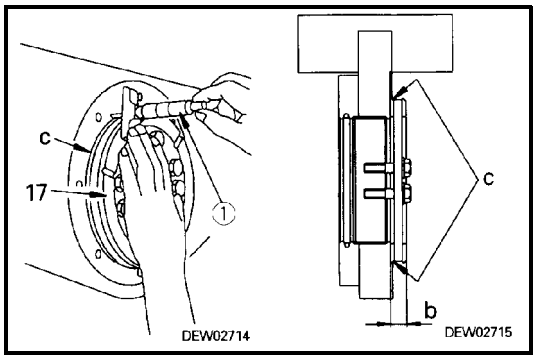
4. Adjusting shim at rear pivot

1) Using depth micrometer (1), measure dimension **"a"** of trunnion cap (16-1). Measure at 4 places at 90 angles and take the average.
   Clean the probe contact surface before measuring.
   - Standard value **"a":** 12.2 - 12.33 mm





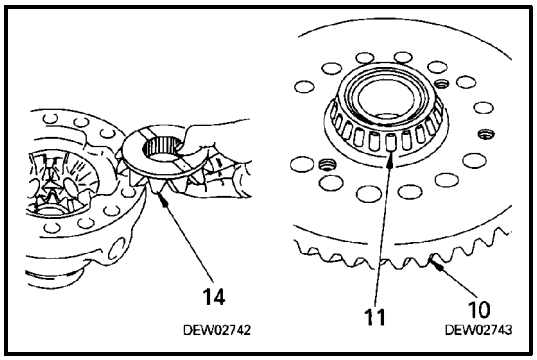
2) Assemble thrust washer (17) at rear pivot. Using depth micrometer (1), measure dimension **"b"** at 4 places at 90 angles and take the average.
   Clean the contact surfaces of the thrust plate.
   Clean the probe contact surface before measuring.
   - Reference value **"b":** 12.10 - 12.30 mm
     Insert a feeler gauge around circumference **"c"** and at the joint of the thrust plate, and check that there is no clearance.



3) Assemble side gear (14) and thrust washer (13).

Sliding surface of thrust washer:
Oil (axle oil)

4) Press fit bearing (11) on bevel gear (10).

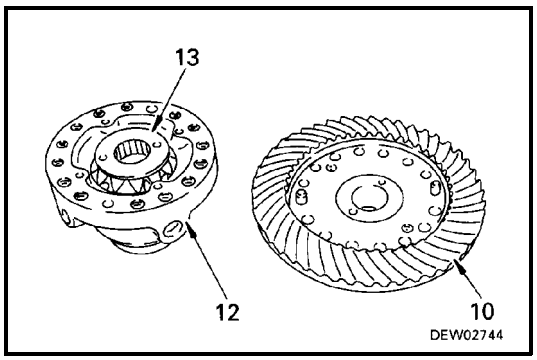


5) Assemble bevel gear (10) in differential carrier (12), then tighten mounting bolts.

Mounting bolts:
Thread tightener (LT-2)

Mounting bolts: **279 ± 29 Nm**
(28.5 ± 3.0 kgm)

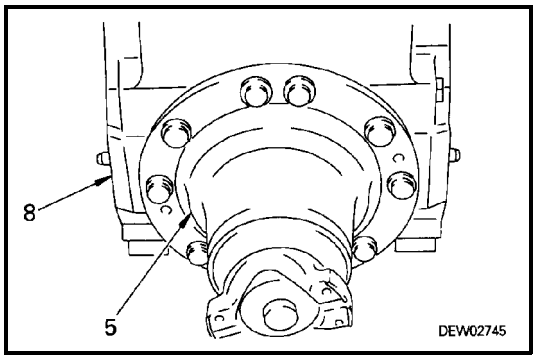
Coat the thrust washer with grease and stick it to the bevel gear to prevent it from falling off during installation.
Align the lock of the washer correctly with the groove in the bevel gear.



4. Adjusting shim of cage

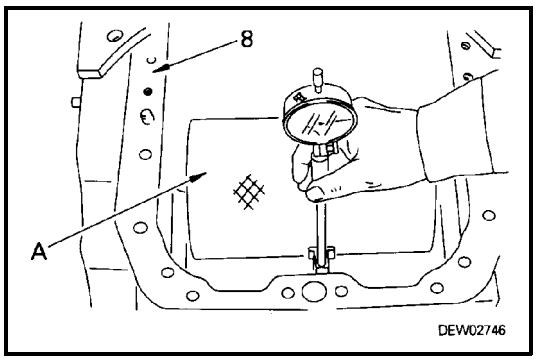
1) Assemble cage (5) without shims in differential housing (8).

Mounting bolts: **112.8 ± 9.8 Nm**
(11.5 ± 1.0 kgm)

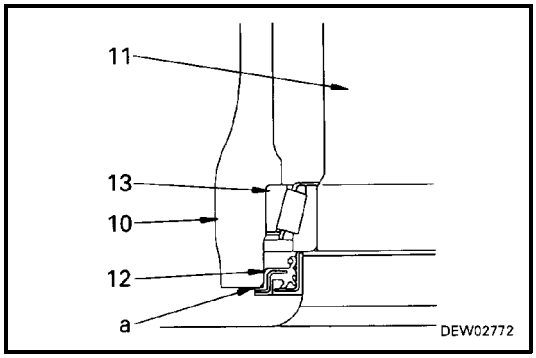


2) Insert measuring tool **A** in differential (8), and measure distance between end face of bevel pinion gear and tool **A** with an inside micrometer or a cylinder gauge.

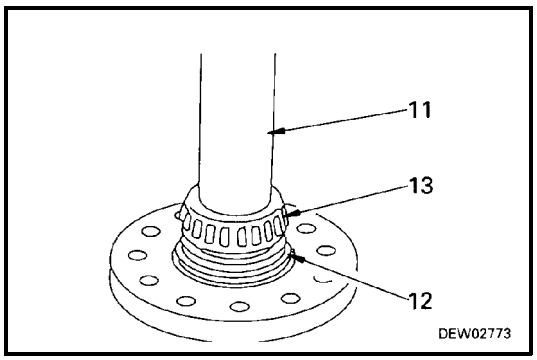
When inserting tool **A** in the differential housing, coat thinly with oil, and insert straight without twisting.



When the axle shaft has been pulled out a little way, pull out portion **"a"** of oil seal (12) with a screwdriver to prevent the oil seal from being damaged by bearing (13).

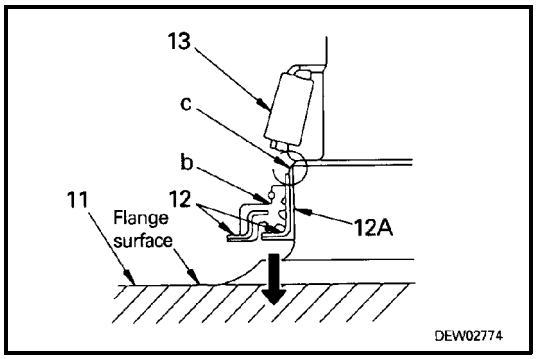


3) Remove bearing (13) and seal (12) from shaft (11)
Never apply heat or use gas cutting to remove the bearing. (This will affect the hardening of the shaft and reduce the strength.)

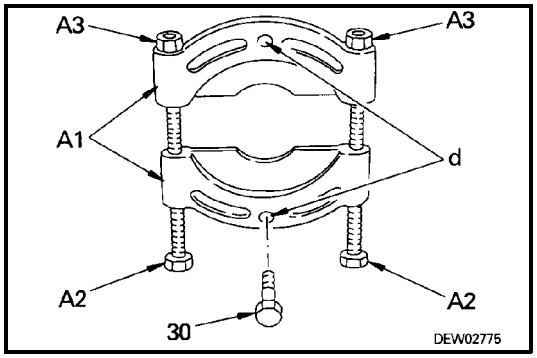


Remove the bearing as follows.

4) When removing bearing (13) of shaft (11), use a screwdriver at point **"b"** of oil seal and sleeve (12), and push towards flange uniformly around circumference.
5) Make clearance **"c"** in order to fit claws of puller to connection of bearing (13) and sleeve (12A).

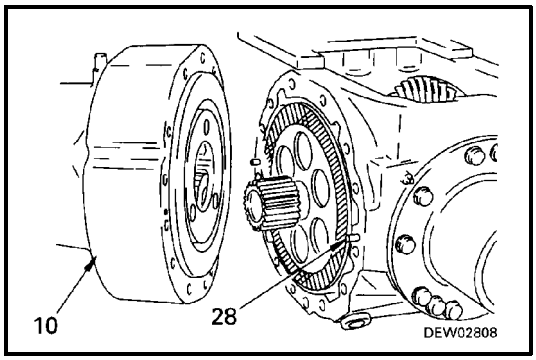


6) Install bolt (30) (5/8 - 18UNF, = approx. 60mm) at point **"d"** to bearing puller **A1.**
Screw in the bolt thread fully.



2) Raise axle housing (10) horizontally, align spline groove and hole of pin (28), then assemble carefully.
   When assembling, be careful not to let the brake ring or disc come out of place.
   Remove all oil and grease, and clean the mounting surface to the differential housing and axle housing, then coat with an unbroken film of gasket sealant.
   Contact face of housing:
   Gasket sealant (Loctite 515)

   Mounting bolt of housing:
   279 ± 29 Nm (28.5 ± 3.0 kgm)

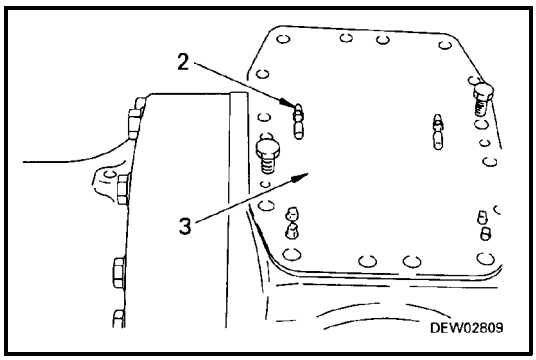


10. Differential cover

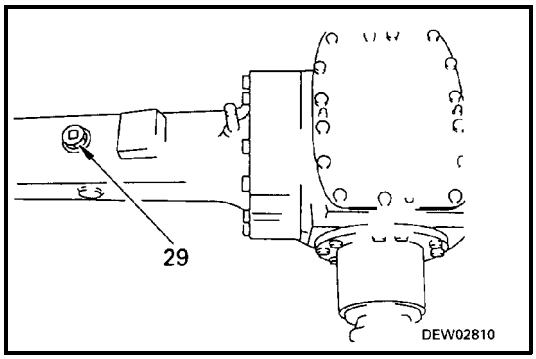
1) Install differential cover (3) to differential housing.
   Coat with an unbroken film of gasket sealant.
   Be careful not to let the gasket sealant enter the mounting hole of the bleeder screw when assembling.

   Contact face of cover:
   Gasket sealant (Loctite 515)

   Mounting bolt of cover:
   113 ± 9.8 Nm (11.5 ± 1.0 kgm)

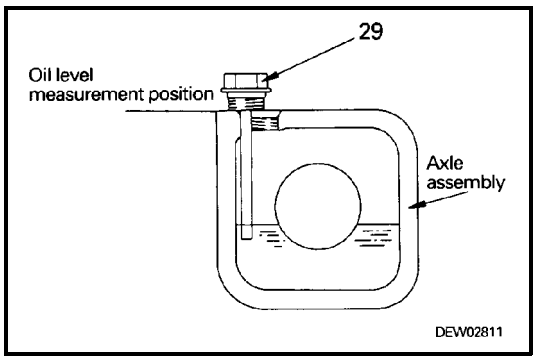


2) Install bleeder screw (2).



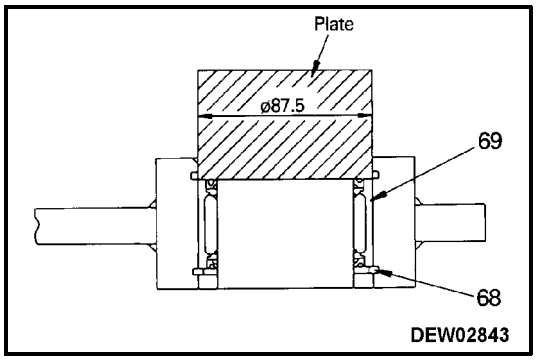
11. Refilling with oil

Tighten drain plug and add engine oil through oil filler and gauge (29) to the specified level.

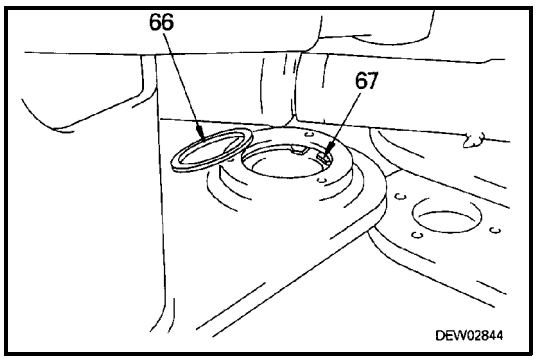


2. Lower hinge

1) Install snap ring (68), and press fit bearing (69).



2) Install snap ring (67), and install washer (66).

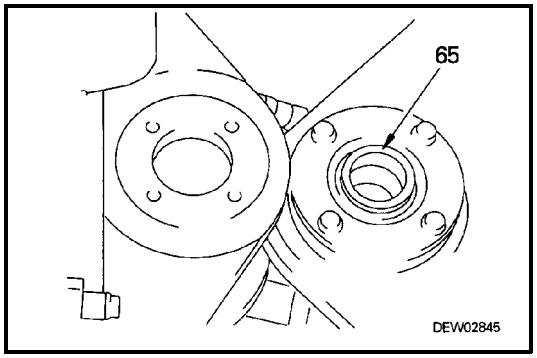


3. Connecting frame

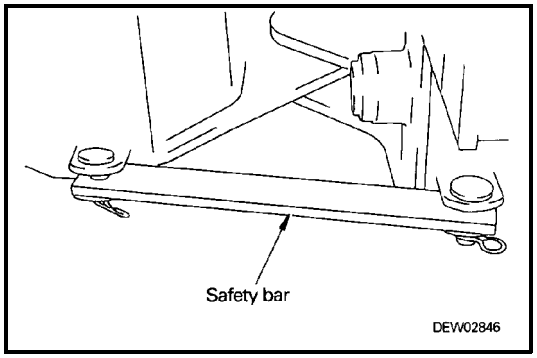
Jack up front differential, move front frame towards rear frame and align pin holes.

WARNING! Use a bar to align the pin holes. Never use your fingers.

Be careful not to bite into the lower spacer (65) of the upper hinge when connecting the frames.
Align the pin holes correctly.



Install the safety bar.

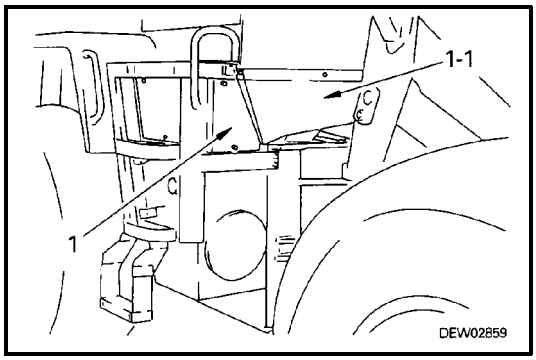


STEERING VALVE

REMOVAL

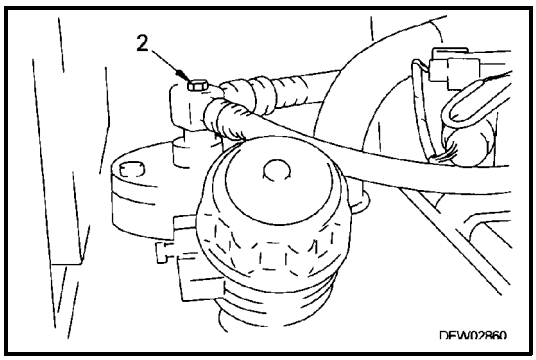
WARNING! Stop the machine on level ground and install the safety bar on the frame. Lower the bucket to the ground and stop the engine. Then apply the parking brake and put blocks under the wheels to prevent the machine from moving.

Remove cover (1) at the top of the hydraulic tank on the right side, then remove covers (1-1) on the left and right under the floor.



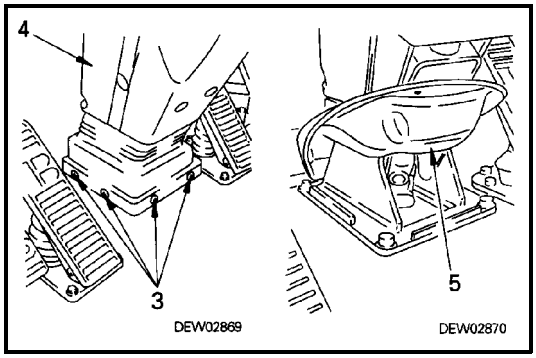
WARNING! Loosen the oil filler cap slowly to release the pressure inside the hydraulic tank. Then operate the control levers several times to release the remaining pressure in the hydraulic piping.

- Loosen plug (2) to prevent the oil inside the hydraulic tank from flowing out.



1. Column cover

Remove steering column cover (4), then remove plugs (3) of bottom boot (5), and roll up.

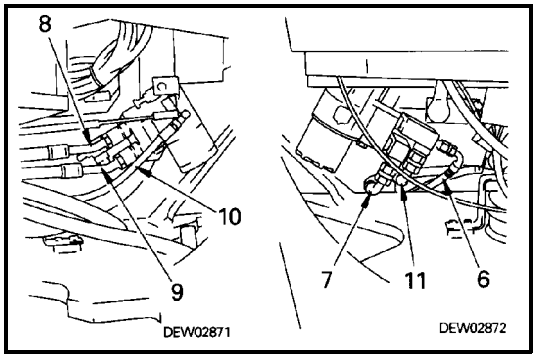


2. Hydraulic piping ※1

Disconnect following hydraulic piping.

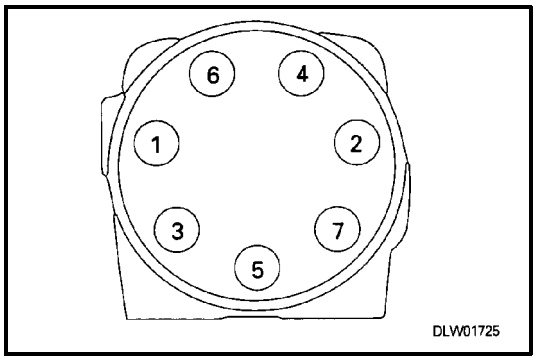
- Hose (6) between steering valve and priority valve
- Hose (7) between priority valve and steering valve
- Tubes (8) and (9) between steering valve and steering cylinder
- Hose (10) between steering valve and priority valve
- Hose (11) between steering valve and hydraulic tank

Fit tags to identify the piping.



23. Coat thread of screw with grease, and tighten end cap. Install the handle to the spool, and check that the spool rotates.

End cap mounting screw
First step: **14.7 Nm (1.5 kgm)**
Second step: **27.0 ± 1.5 Nm (2.75± 0.15 kgm)**

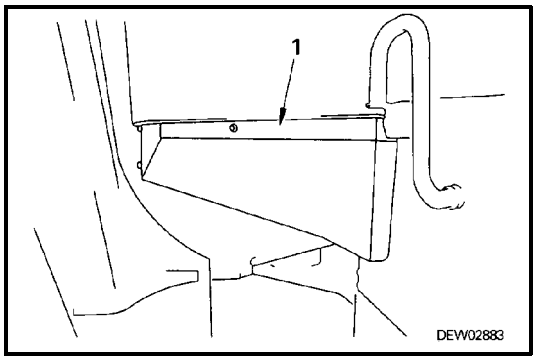


BRAKE BOOSTER

REMOVAL

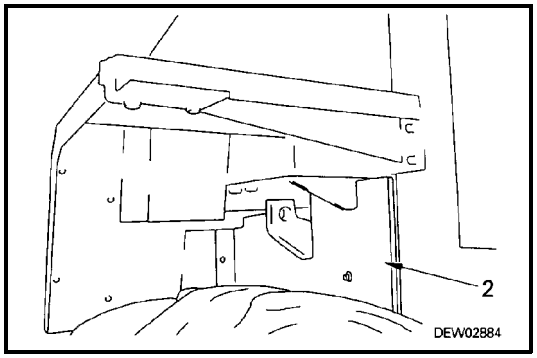
WARNING! Stop the machine on level ground and install the safety bar on the frame. Lower the bucket to the ground and stop the engine. Then apply the parking brake and put blocks under the wheels to prevent the machine from moving.

- Turn the steering wheel to the right to articulate the chassis.



1. Covers

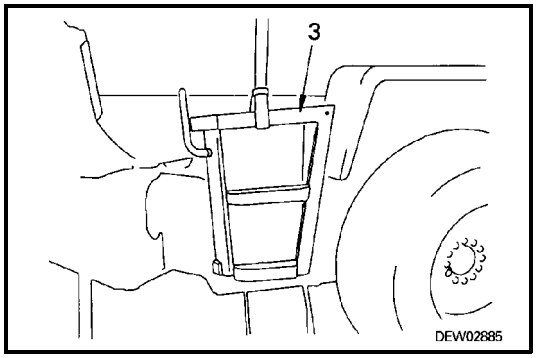
1) Remove cover (1) under cab or on left and right sides of floor.
2) Remove cover (2) at left side of rear frame.

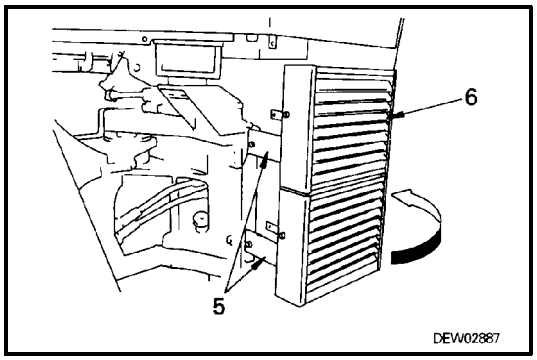


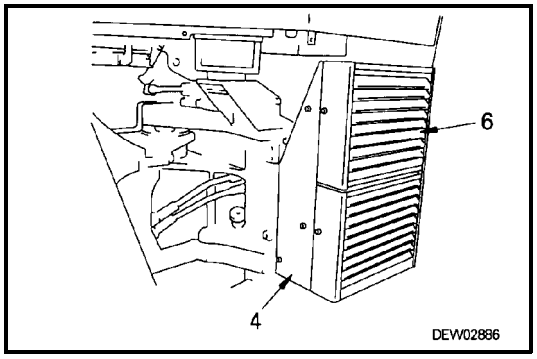
2. Machines equipped with air conditioner

1) Remove left ladder rail (3). ※1

   Be careful not to catch the brake hose when removing the ladder rail.
2) Remove condenser front cover (4).
   Remove the hose clamp.
3) Remove condenser mounting brackets (5), and open condenser (6) to rear.



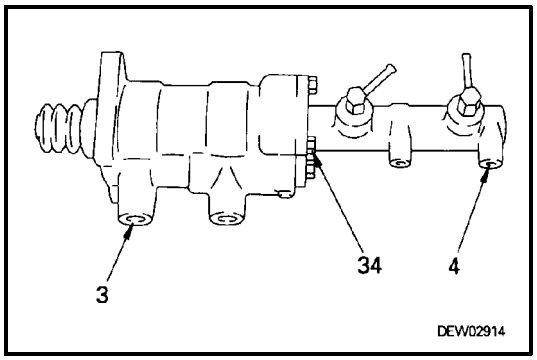




5. Power master cylinder

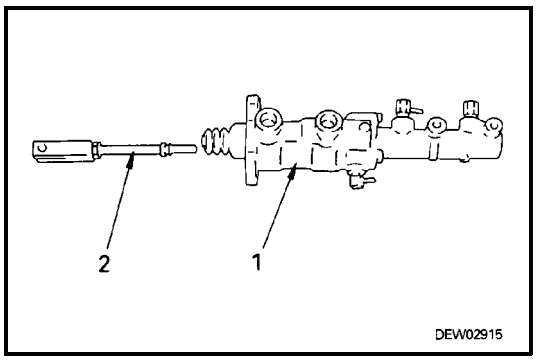
1) Connect power master cylinder (3) and master cylinder (4). Use a new O-ring for the connection of the master cylinder.

Connecting bolt (34): **31.9 ± 2.5 Nm (3.25 ± 0.25 kgm)**



2) Assemble linkage rod (2) to power master cylinder (1).

For details of adjusting the brake linkage, see TESTING AND ADJUSTING.

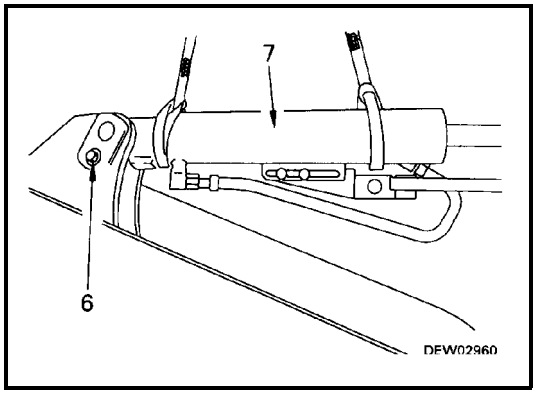


4. Bucket cylinder ※3

1) Remove lock bolt, then remove bottom pin (6).
   If there are shims installed, check the number and thickness of the shims, and keep in a safe place.

2) Lift off bucket cylinder (7).
   Be cafeful not to damage the cylinder rod portion.

kg Bucket cylinder: **56 kg**



INSTALLATION

- Carry out installation in the reverse order of removal.

※1

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

- **Bucket positioner**
  For details of adjusting the bucket positioner, see TESTING AND ADJUSTING (section 20).

※2

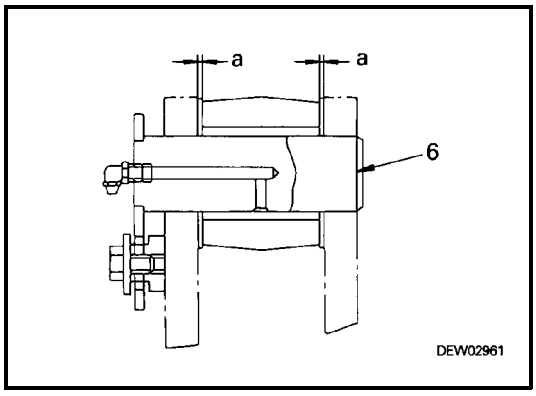
Install the hoses without twisting or interference.

※3

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

Align the pin hole at the cylinder bottom, assemble shims so that the total for clearance **"a"** between the cylinder and frame is within the standard value, then assemble pin (6) and lock with bolt.

Clearance **"a"**: Max. 1.5 mm



WORK EQUIPMENT

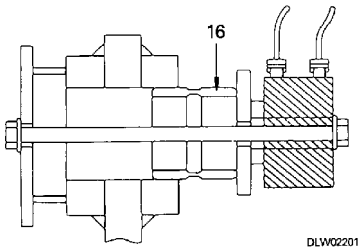
INSTALLATION

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

1. Dust seal, bushing

Press fit bushings (16) to bucket link, bellcrank, and boom with press, and assemble dust seals (15)

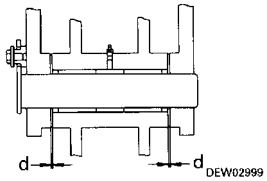
Bushing: **Grease (G2-LI)**



2. Bellcrank, bucket link

1) Align hole of boom (14) and bellcrank (12), and assemble shims so that clearance **"d"** is specified value, then assemble mounting pin (13), and lock with bolt.

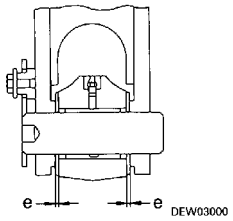
Clearance **"d"**: Max. 2.0 mm

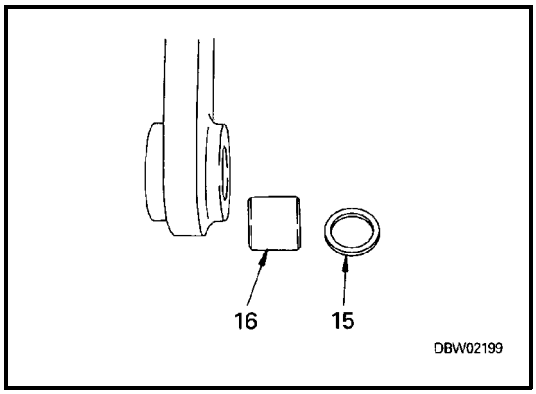


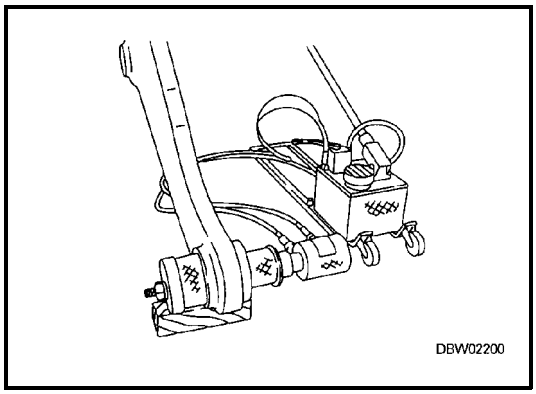
2) Align hole of bellcrank (12) and bucket link (10), and assemble shims so that clearance **"e"** is specified value, assemble mounting pin (11), and lock with bolt.

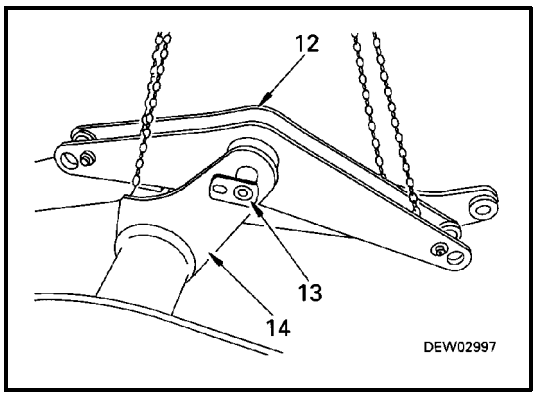
Clearance **"e"**: Max. 2.0 mm

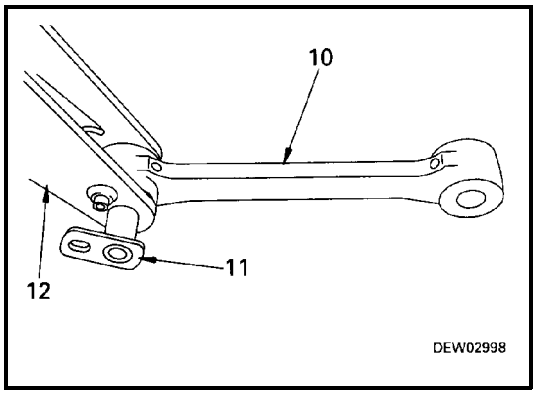
Secure the bucket link to the bellcrank with wire.





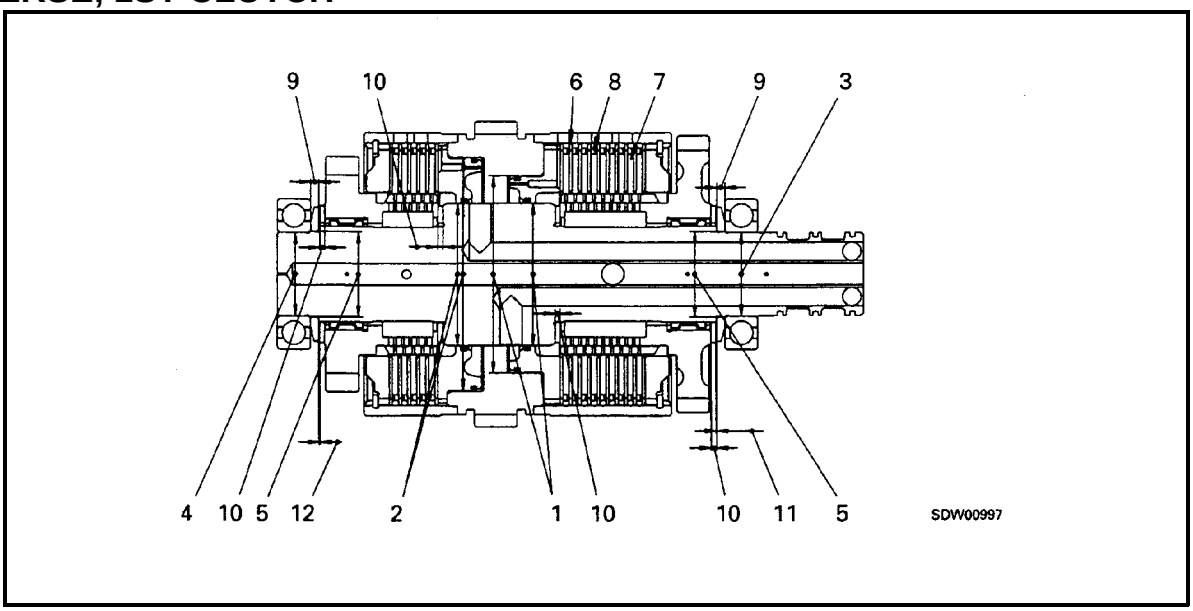






MEMORANDA

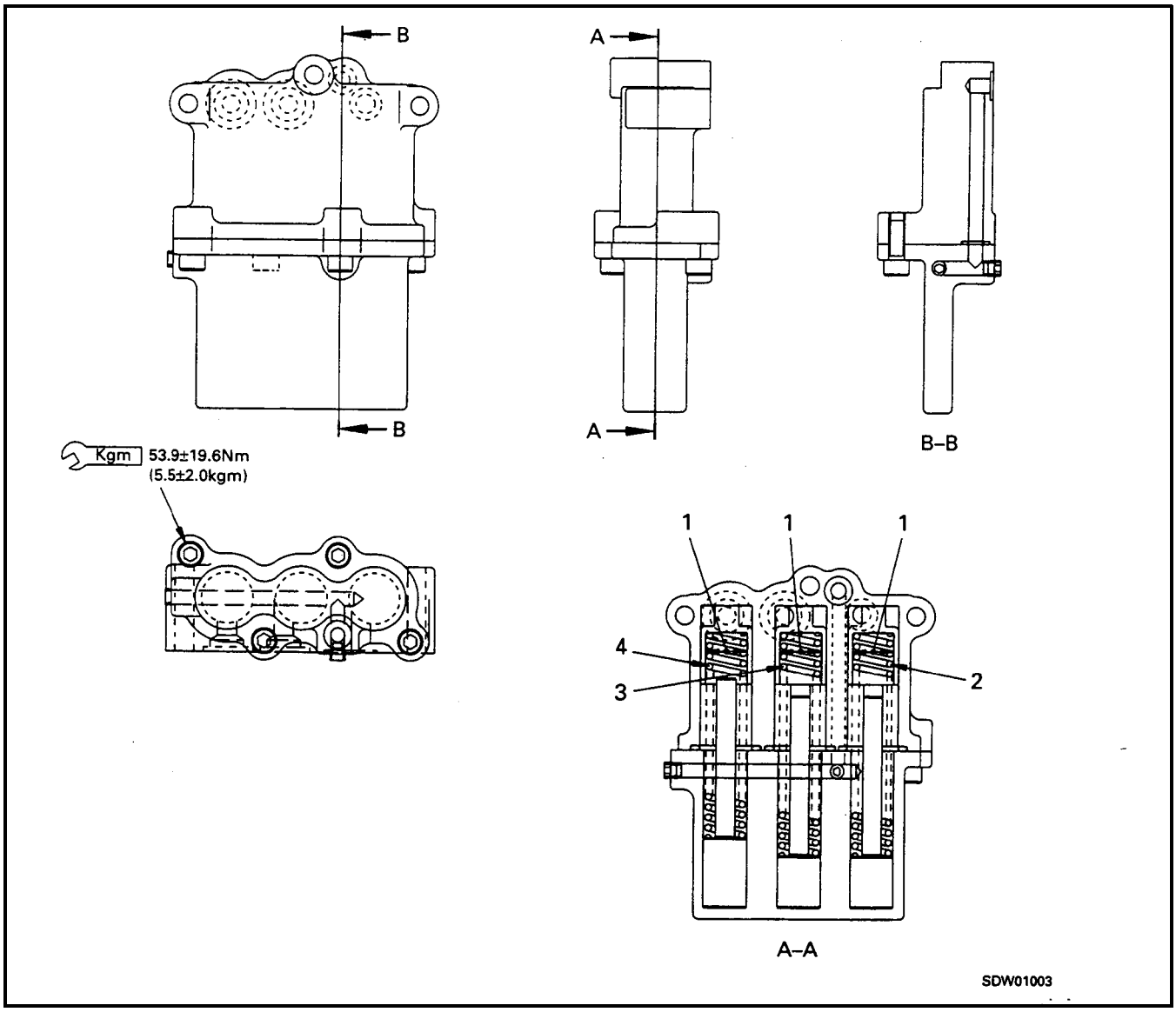
REVERSE, 1ST CLUTCH



Unit: mm

No.	Check item			Criteria					Remedy
				Standard size	Tolerance		Standard clearance	Clearance limit	
					Shaft	Hole			
1	Clearance between piston and cylinder	REVERSE	Inside	85	+0.102 -0.090	+0.28 +0.15	0.048 - 0.19	0.24	Replace
			Outside	118	-0.35 -0.040	+0.08 -0.05	0.30 - 0.48	0.53	
2	Clearance between piston and cylinder	1ST	Inside	85	+0.102 +0.090	+0.28 +0.15	0.048 - 0.19	0.24	
			Outside	140	-030 -0.35	+0.13 0	0.048 - 0.19	0.53	
3	Clearance at bearing press fitting portion of REVERSE clutch shaft			50	+0.025 +0.009	0 -0.012	-0.009 - -0.037	-	
4	Clearancet bearing press fitting portion of 1st clutch shaft			50	+0.025 +0.009	0 -0.012	-0.009 - -0.037	-	
5	Clearance at spacer press fitting portion of REVERSE, 1st clutch shaft			51	+0.025 +0.009	0 -0.012	-0.055 - -0.009	-	

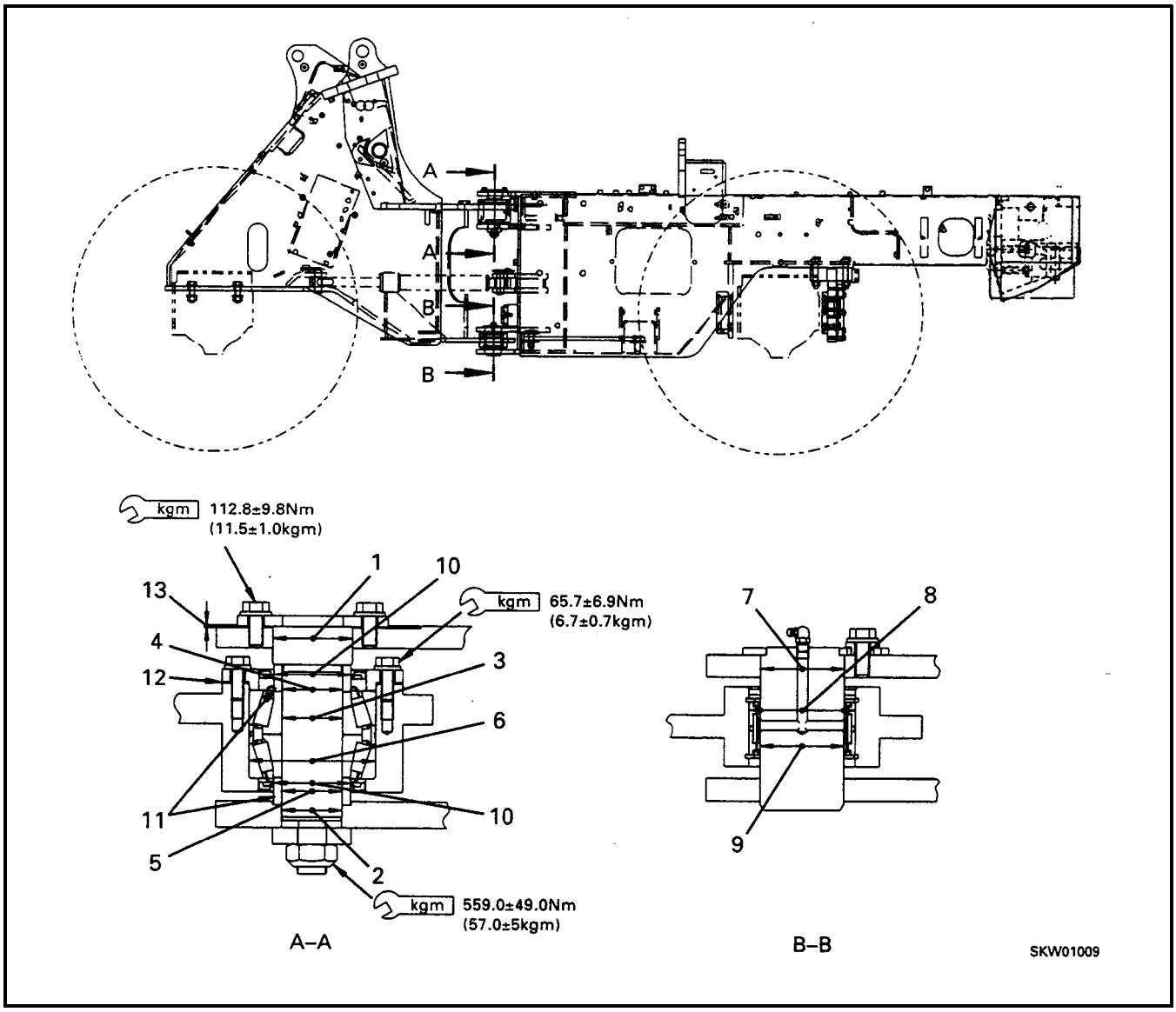
ACCUMULATOR VALVE



Unit: mm

No.	Check item	Criteria					Remedy
		Standard size	Tolerance		Standard clearance	Clearance limit	
			Shaft	Hole			
1	Clearance between piston and body	32	-0.035 -0.045	+0.025 0	0.035 - 0.070	0.08	
		Standard size			Repair limit		
		Free length	Installed height	Installed load	Free length	Installed load	
2	FORWARD clutch accumulator spring	184.8	175	158 N (16.1 kg)	177.4	-	Replace
3	1st clutch accumulator spring	145	135	78.8 N (8.04 kg)	139.2	-	
4	2nd clutch accumulator spring	145	125	157.9 N (16.1 kg)	139+.2	-	

CENTER HINGE PIN



MAIN CONTROL VALVE

2-SPOOL VALVE