CAT® Lift Trucks

Service Manual

6D16 Diesel Engine

DP80	**T32B-00011-up**
DP90	**T32B-50001-up**
DP100	**3DP-00001-up**
DP115	**4DP-00001-up**
DP135	**5DP-00001-up**
DP150	**6DP-00011-up**

For use with Chassis Service Manual. **99709-68130**

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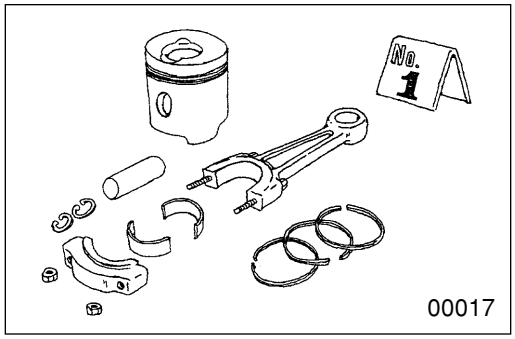
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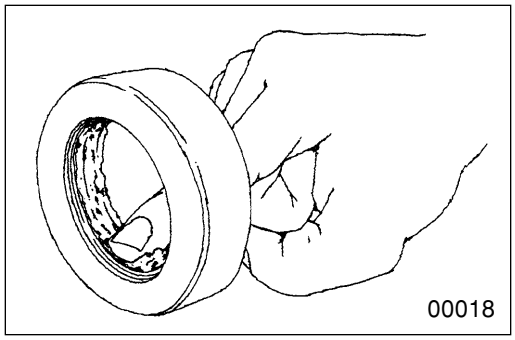
PRECAUTIONS FOR MAINTENANCE OPERATION



Put alignment marks on part combinations before disassembly and arrange the disassembled parts neatly. This will help avoid mismating of the parts later.
Put the alignment marks, punch marks, etc. where performance and appearance will not be affected.
Cover the area left open after removal of parts to keep it free from dust.

CAUTION ⚠

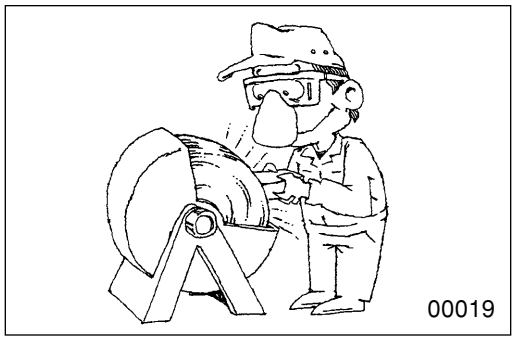
- **Take care to avoid mixing up numerous parts, similar parts, left and right, etc.**
- **Keep new parts for replacement and original (removed) parts separate.**



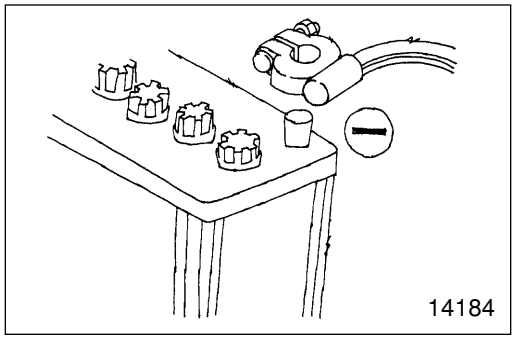
Apply the specified oil or grease to U-packings, oil seals, dust seals and bearings during assembly.
Use only the specified oil, grease, etc. for lubricant, remove the excess immediately after application with a piece of waste, etc.

CAUTION ⚠

When the specified lubricant, fluid and sealant is not available, you may use an equivalent.



Wear goggles when using a grinder or welder. Pay full attention to safety by wearing gloves when necessary. Watch out for sharp edges, etc. that might injure your hands or fingers.



Before carrying out maintenance work on the electric system, disconnect the negative terminals of the batteries to prevent them from short-circuiting and burning-out.

CAUTION ⚠

Be sure to turn starter and lighting switches, etc. off before disconnecting or connecting battery terminals, because the semiconductors can be damaged.

Symptoms / Possible causes	Low power output	Abnormal engine noise	Remarks
Incorrect oil viscosity	○		🕮 Gr 11
Incorrect/defective fuel	○		🕮 Gr 13
Incorrect valve clearance	○	○	
Defective cylinder head gasket	○	○	
Worn valve/valve seat, and carbon deposits	○	○	
Weakened valve spring	○	○	
Worn/damaged piston ring(s)	○	○	
Worn/damaged piston ring groove(s)	○	○	
Incorrect injection timing	○	○	🕮 Gr 13
Defective injection pump	○	○	🕮 Gr 13
Defective cooling system	○		🕮 Gr 14
Defective injection nozzle(s)	○	○	🕮 Gr 13
Air trapped in fuel system	○		🕮 Gr 13
Clogged air cleaner	○		🕮 Gr 15
Clogged muffler	○		🕮 Gr 15
Defective turbocharger	○	○	🕮 Gr 15
Incorrectly fitted pipe(s)/hose(s)		○	🕮 Gr 13
Injection pump, alternator, or other auxiliary device(s) defective/incorrectly fitted		○	🕮 Gr 13, 54
Loose/damaged V-belt		○	🕮 Gr 14
Incorrectly fitted crankshaft pulley		○	
Defective air cleaner or muffler		○	🕮 Gr 15
Defective valve spring(s)		○	
Defective rocker shaft and bracket		○	
Incorrect lubrication of rocker shaft bracket		○	
Incorrect backlash in timing gears		○	
Incorrect lubrication of timing gear peripheries and idler shafts		○	
Worn connecting rod small end bushing and piston pin		○	
Worn/damaged crankshaft pin and connecting rod big end bearing		○	
Worn/damaged crankshaft journal and main bearing		○	
Excessive end play in crankshaft and camshaft		○	
Worn tappet(s) and camshaft		○	

Tightening torques

Unit: N·m (kgf·m) [lbf·ft]

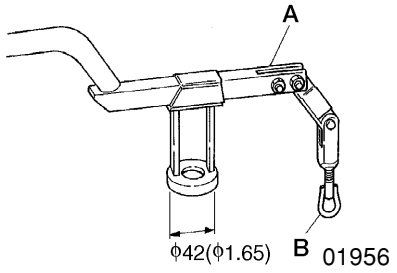
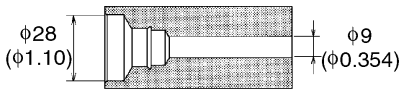
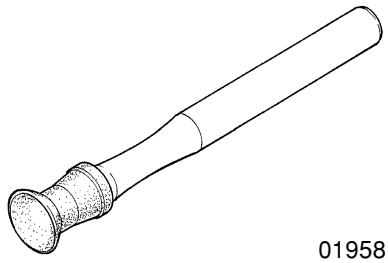
Location	Parts to be tightened	Tightening torque	Remarks
14	Glow plug	15 to 20 (1.5 to 2.0) [11.1 to 14.8]	–
19	Exhaust manifold mounting stud	29 (3) [21.4]	–

Lubricant

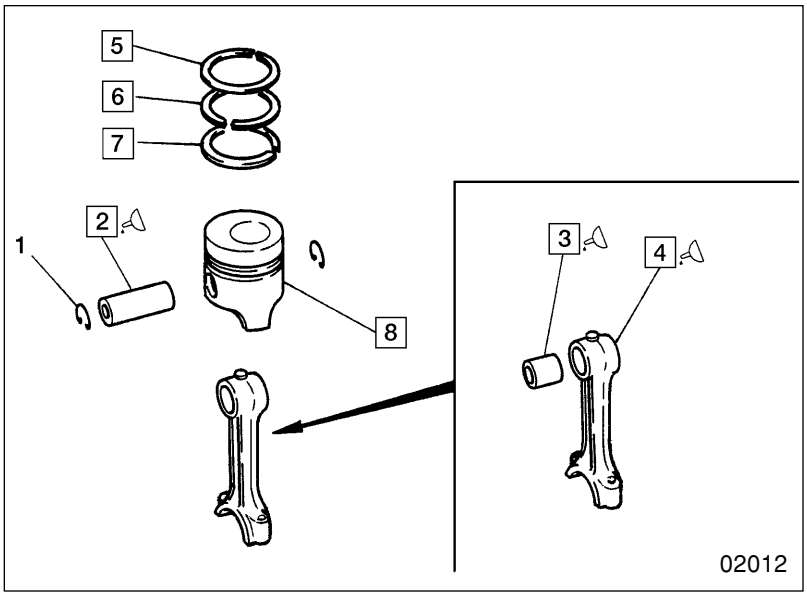
Location	Points of application	Specified lubricant	Quantity
1	Rocker contact surface on valve cap top	Engine oil	As required
6	Lip of valve stem seal	Engine oil	As required
7, 8	Valve stem	Engine oil	As required

Special tools

Unit: mm (in.)

Location	Tool name and shape	Part No.	Application
2	A: Valve Lifter B: Valve Lifter Hook 	A: MH061668 [with ϕ42 (ϕ1.65) valve lifter seat] B: MH061679	Removing and installing valve cotters
6	Valve Stem Seal Installer 	MH061293	Installing valve stem seals
7, 8	Valve Lapper 	30091-07500 (inlet, exhaust)	Lapping valves and valve seats

Piston and Connecting Rod Assembly



- **Disassembly sequence**
  1 Snap ring
  2 Piston pin
  3 Connecting rod bushing
  4 Connecting rod
  5 1st compression ring
  6 2nd compression ring
  7 Oil ring
  8 Piston

- **Assembly sequence**

Reverse the order of disassembly.

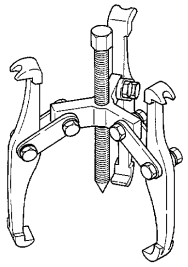
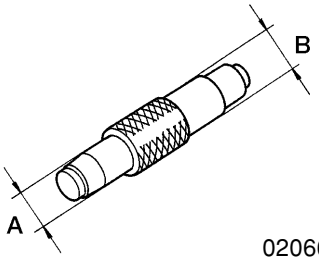
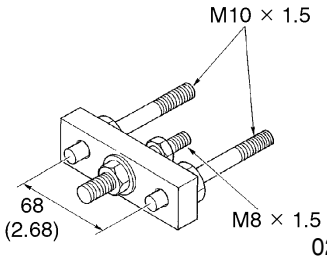
Service standards

Unit: mm (in.)

Location	Maintenance item			Standard value	Limit	Remedy
2, 3	Piston pin-to-connecting rod small end bushing clearance		6D16	[38] 0.02 to 0.05 (0.000787 to 0.00197)	0.1 (0.00394)	Replace
			6D16-TLE	[42] 0.02 to 0.05 (0.000787 to 0.00197)		
2, 8	Piston pin-to-piston clearance		6D16	[38] 0.004 to 0.02 (0.000157 to 0.000787)	0.05 (0.00197)	Replace
			6D16-TLE	[42] 0.004 to 0.02 (0.000157 to 0.000787)		
4	Connecting rod bend and torsion			–	0.05 (0.00197)	Correct or replace
5 to 7	Piston ring end gap	1st compression ring	6D16	0.35 to 0.55 (0.0138 to 0.0217)	1.5 (0.0591)	Replace
			6D16-TLE	0.35 to 0.55 (0.0138 to 0.0217)		
		2nd compression ring	6D16	0.35 to 0.55 (0.0138 to 0.0217)	1.5 (0.0591)	Replace
			6D16-TLE	0.45 to 0.6 (0.0177 to 0.0236)		
		Oil ring		0.35 to 0.55 (0.0138 to 0.0217)	1.5 (0.0591)	Replace
5 to 8	Piston ring-to-piston ring groove clearance	1st compression ring	6D16	0.11 to 0.15 (0.00433 to 0.00591)	0.2 (0.00787)	Replace
			6D16-TLE	0.13 to 0.18 (0.0512 to 0.00709)		
		2nd compression ring	6D16	0.05 to 0.08 (0.00197 to 0.00315)	0.15 (0.00591)	Replace
			6D16-TLE	0.07 to 0.10 (0.00276 to 0.00394)		
		Oil ring		0.03 to 0.06 (0.00118 to 0.00236)	0.15 (0.00591)	Replace

Special tools

Unit: mm (in.)

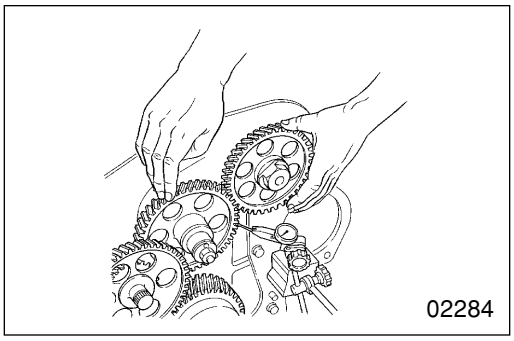
Location	Tool name and shape	Part No.	Application
2, 4	Gear Puller  02065	MH061326	Removing No. 1 idler shaft and gear
3, 11	Idler Gear Bushing Puller A: No. 1 idler gear bushing: ϕ37 (ϕ1.46); No. 2 idler gear bushing: ϕ32 (ϕ1.26) B: No. 1 idler gear bushing: ϕ40 (ϕ1.57); No. 2 idler gear bushing: ϕ35 (ϕ1.38)  02066	<No. 1> MH062601 <No. 2> MH061779	Removing and fitting idler gear bushings
13	Idler Shaft Puller  02067	MH062405	Removing No. 2 idler gear shaft

◆ Service procedure

● Pre-disassembly inspection

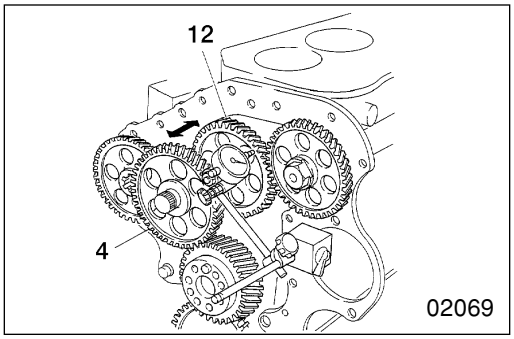
(1) Gear backlash

For each gear pair, measure backlash at three or more points. If any measurement exceeds the specified limit, replace the defective part(s).

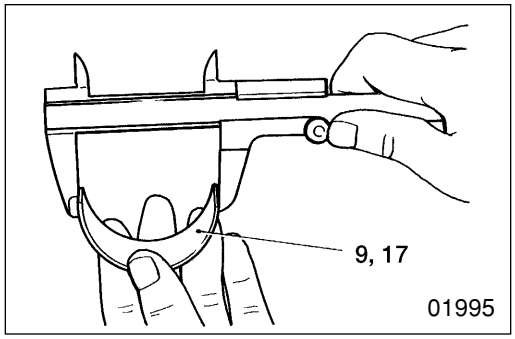

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(2) Idler gear end play

If the measurement exceeds the specified value, replace the defective part(s).



02069



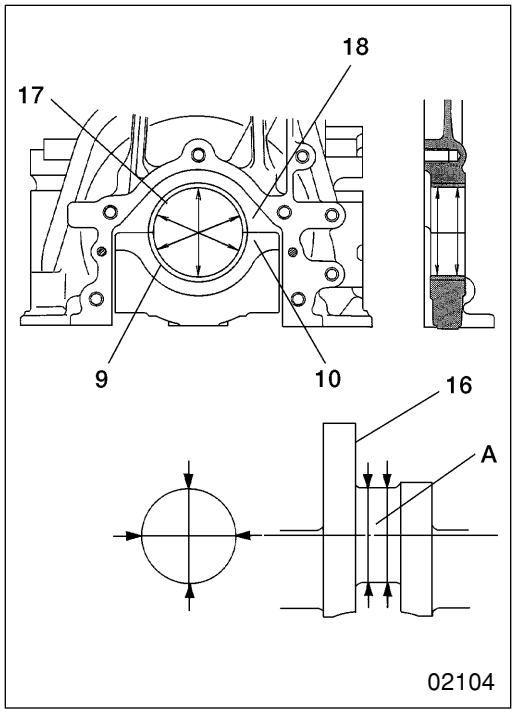
[Inspection]

CAUTION

- **Do not attempt to manually expand either bearing 9, 17 if its span is insufficient.**
- **Upper and lower bearings 9, 17 must be replaced as a set.**

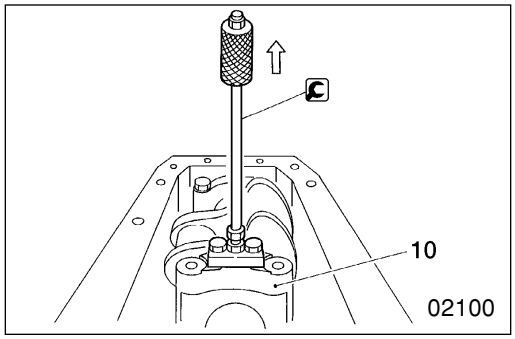
(1) Span when free

If either bearing's span when free exceeds the specified limit, the bearings **9**, **17** must be replaced.



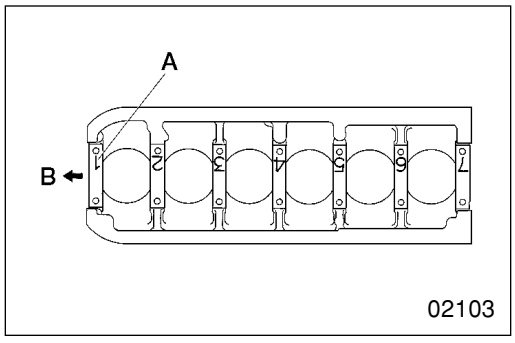
(2) Main bearing-to-crankshaft clearance

- Fit the upper main bearing **17** into the crankcase **18** and the lower main bearing **9** into the main bearing cap **10**. Then, tighten the bolts 8 to their specified torque.
- Measure the internal diameters of the main bearings **9**, **17** and the outside diameter **A** of the crankshaft journal. If the clearance exceeds the specified limit, replace the defective part(s).



10 Main bearing caps

[Removal]



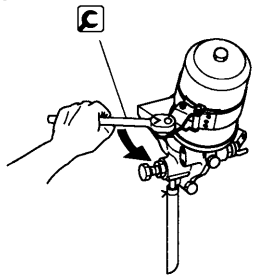
[Installation]

- Starting at the front of the engine **B**, fit the main bearing caps 10 in the order of the numbers **A** embossed on them and such that the numbers are in the positions illustrated.
- The bolts **8** can be reused only three times. Before fitting the bolts, make a punch mark on the head of each bolt to indicate times of reuse.

CAUTION

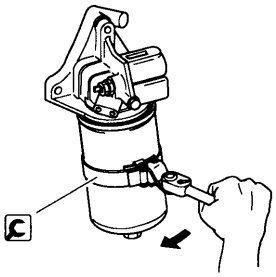
If any bolt already has three punch marks, it must not be reused any more; replace it with a new one.

<A type>



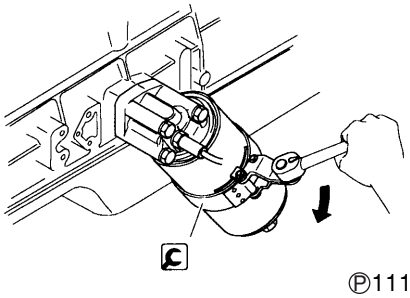
Ⓟ47030

<B type>



Ⓟ47031

<C type>



Ⓟ11109

[Removal]

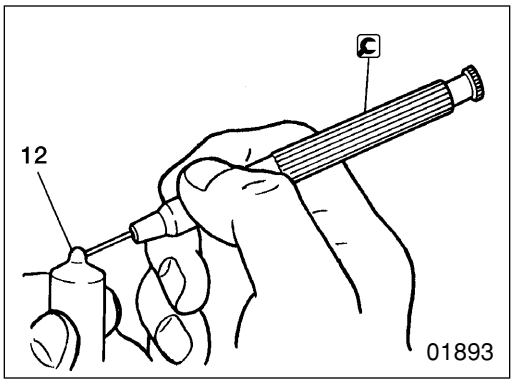
: Oil Filter Wrench

M E M O

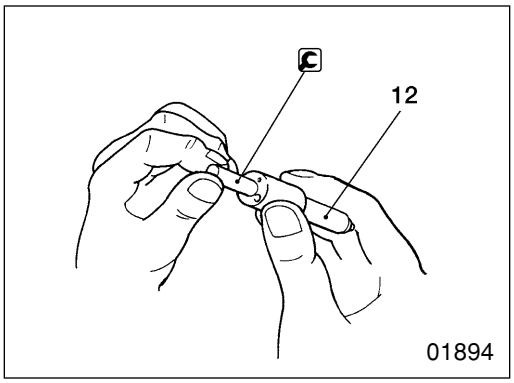
M E M O

CAUTION ⚠

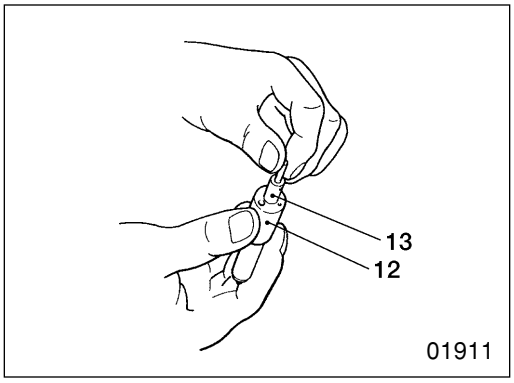
- Fuel is highly flammable; keep it away from flames and sources of heat.
- To minimize the risk of fire, wipe up any spilled fuel.
- For maintenance of the injection pump assembly 23, please contact a Bosch Automotive Systems service station or Denso service station.
- Dirt particles in the injection pump assembly 23 can seriously detract from engine performance. To prevent the ingress of dirt, cover all pipes, hoses, and other parts after removal.
- Never carry around the injection pump assembly 23 by holding it at the lever or the engine speed sensor *b. Removing the lever may result in deteriorated pump performance.
- Do not remove the injection pump bracket 25 unless it is faulty.



- Remove carbon from the injection orifice of the nozzle **12** using the Needle Cleaner of the Cleaning Tool Set. Insert the Needle Cleaner and rotate it to dislodge the carbon.



- Clean the seat of the nozzle **12** using the Cleaning Scraper of the Cleaning Tool Set.
- To remove burned and hardened carbon, use FUSO Carbon Remover.

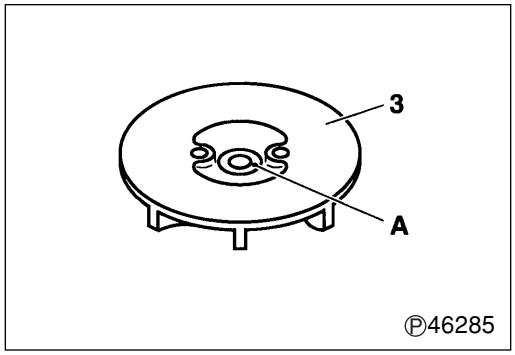


[Inspection]

- Wash the needle valve **13** and nozzle **12** in gas oil, then fit them together.
- Pull up the needle valve **13** by approximately 1/3 of its entire stroke, then check that it drops under its own weight. Repeat this test several times, turning the needle valve each time.
- If the needle valve **13** does not drop as required, wash it in gas oil and carry out this test again. If the needle valve is still defective, replace the needle valve and nozzle **12** as a set.

NOTE

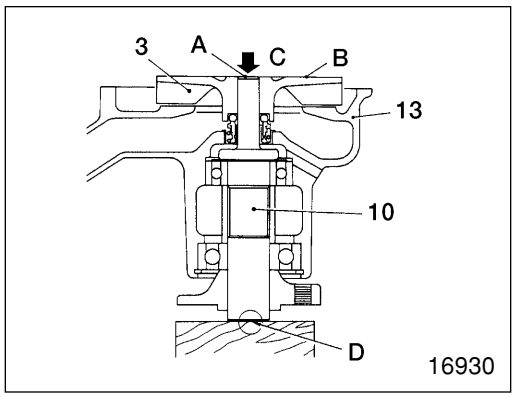
Whenever a nozzle 12 is replaced, the nozzle and needle valve 13 must be replaced as a set using Nozzle Service Kit. (This applies to BOSCH AUTOMOTIVE SYSTEMS products only.)



[Installation]

CAUTION ⚠

- **Before refitting impeller 3, check the number of punch marks in location A shown in the illustration. If there is no or only one punch mark in location A, the impeller can be refitted. Ensure to punch a mark in location A for future reference before refitting the impeller.**
- **The punch mark is used to show how many times in the past impeller 3 is removed and refit. If there are two punch marks (i.e. removed and refit twice in the past), do not refit the impeller again. Replace it with a new impeller.**



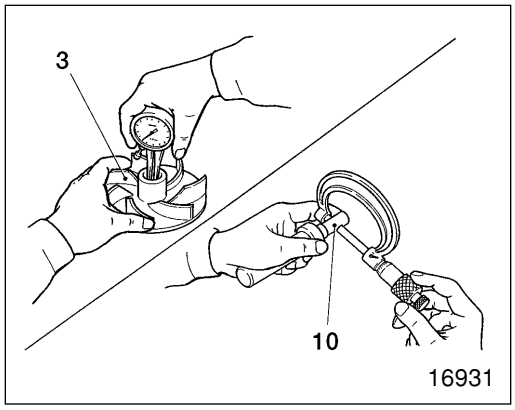
[Press-fitting]

Press-fit impeller **3** until its end face **B** is in line with end face **A** of water pump shaft **10**.

C: Press

NOTE

Press-fit the impeller such that flange side D of water pump shaft 10 is the load receiving surface.

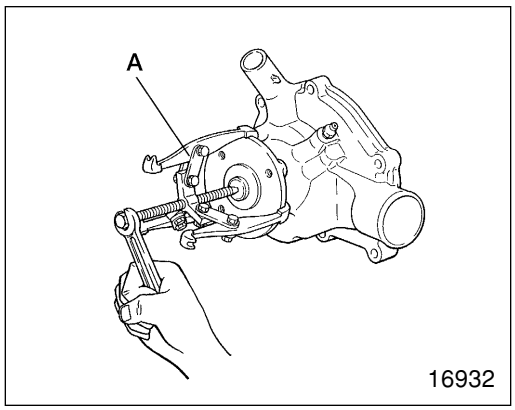


3 **10** **Impeller-to-water pump shaft interference**

If the measurement does not conform with the standard value, replace the defective part(s).

CAUTION ⚠

Even if the standard value is satisfied, reassembly must not be carried out more than twice.



4 **Flange**

[Removal]

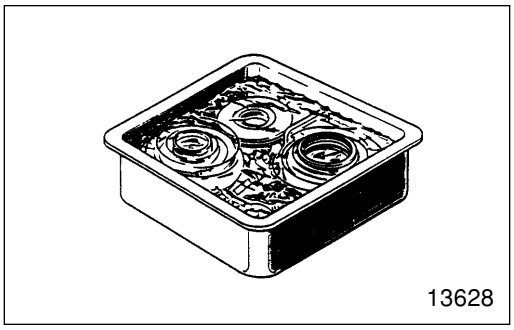
A: Gear puller

● **Cleaning after disassembly**

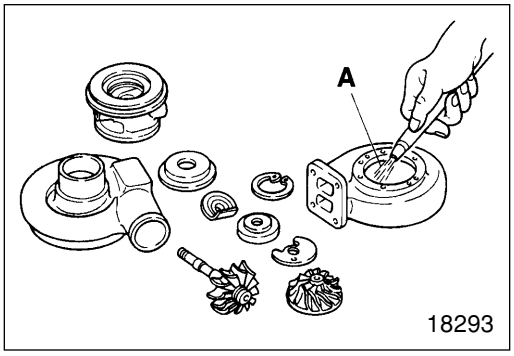
• Before cleaning, visually check the individual parts for burns, rubbed stains, etc. which might disappear after cleaning. If there is anything wrong, replace.

CAUTION ⚠

Do not immerse the actuator assembly 6 in the solvent. Clean it with a cloth dipped in kerosene.

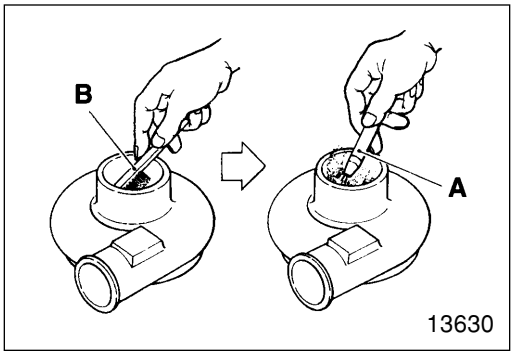

13628

• Immerse the disassembled parts in a non-combustible solvent (DAIDO CHEMICAL INDUSTRY CO., LTD. DAI CLEANER T-30).



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• Take out the parts from the solvent and blow compressed air **A** against them.

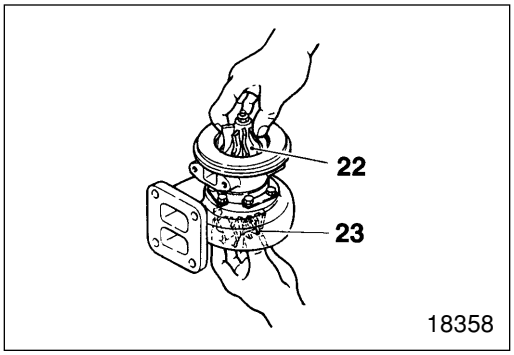


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• Scrape off deposits.

B: Plastic scraper or stiff brush

• Re-immerse in the solvent.
• Blow compressed air **A.**



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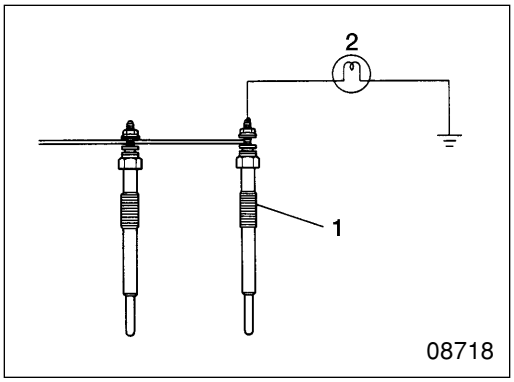
● **Inspection after reassembly**

(1) Manually rotate the compressor wheel **22** and turbine wheel **23** to check whether they rotate smoothly.

SPECIFICATIONS

Item		Specifications		
Alternator	Manufacturer	MITSUBISHI ELECTRIC CORP.		
	Type	Alternator with built-in regulator, fan externally mounted type		
		Brushless		
	Vacuum pump	Provided	Not provided	
	Model	A4TU 3186	A4T4 0286	A4T4 0386
	Output V–A	24–40	24–50	
Starter	Manufacturer	MITSUBISHI ELECTRIC CORP.		
	Model	M8T60071		
	Output V–kW (HP)	24–5 (6.7)		
	Magnet switch operating voltage V	16 or less		
Starter relay	Model	U001T35383	U1X15076	
	Exciting current V–A	24–2.3		
	Closed magnetic voltage V	16 or less		
	Opened magnetic voltage V	4 or less		
	Allowable breaking voltage V	200		
Intake air heater	Manufacturer	Hiyoshi Denso		
	Voltage – capacity V–kW	22–2.9		
	Fuse capacity A	127		
Heater relay	Manufacturer	MITSUBISHI ELECTRIC CORP.		
	Model	U1T31383		
	Voltage – current V–A	24–2.3		
	Fuse capacity A	127		
Glow plug	Type	Sheathed type		
	Voltage – current V–A	23–3		
Glow relay	Model	U1T06670		
	Voltage – current V–A	24–2.3		
	Fuse capacity A	127		

1. Inspection of Preheater System <Glow Plug Specification>



- Set the starter switch to OFF.
- Connect the inspection lamp **2** (24V–1.8W or thereabouts) to the glow plug **1**.
- Set the starter switch to the HEAT position.
- If the inspection lamp **2** does not come on, check the glow plug or heater relay.

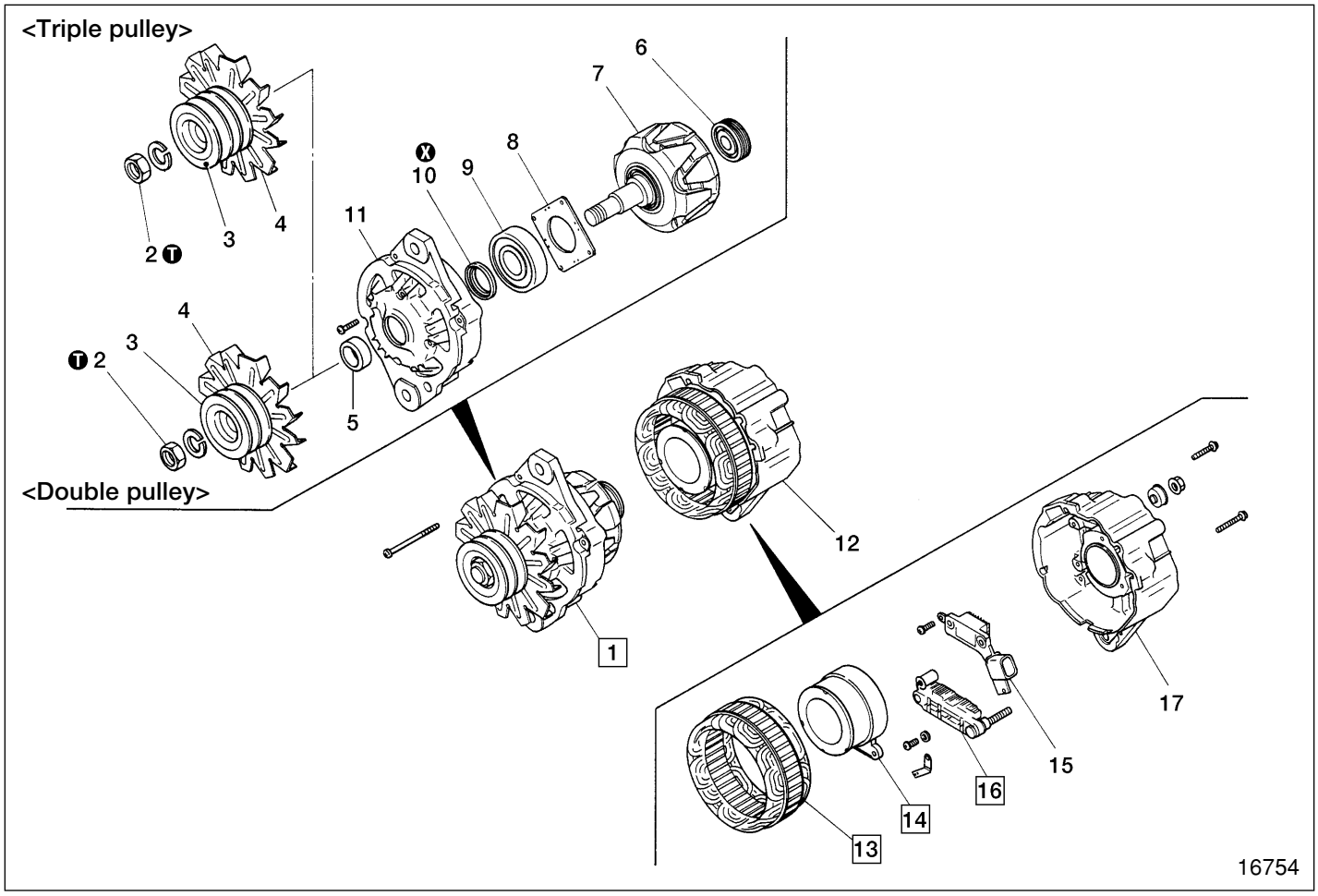
2. Inspection of Safety Relay

Service standards

Location	Maintenance item		Standard value	Limit	Remedy
6	Output voltage at terminal P	When engine is stationary	1V or less	–	Replace alternator or wiring.
		While engine is running (at idle, 600 rpm or more)	12 – 16V	–	Check and replace wiring.
	Output voltage at terminal R	When engine is running	Approx. 24V	–	Check and replace wiring.
	Output voltage at terminal S	When engine is started (in cranking state)	1V or less	–	• If the output voltage is close to the battery voltage, replace the safety relay. • If the output voltage is 0V, check and replace parts.
	Output voltage at terminal L	When engine is running	5V or less (but not 0V)	–	• Replace. • If the output voltage is close to the battery voltage, inspect the alternator and herness and replace if necessary.

ALTERNATOR <24V–40A (without vacuum pump)>

Alternator Assembly



● Disassembly sequence

1 Rotor & front bracket assembly
2 Nut
3 Pulley
4 Fan
5 Spacer
6 Rear bearing
7 Rotor assembly
8 Cover
9 Front bearing
10 Oil seal
11 Front bracket
12 Stator & rear bracket assembly
13 Stator assembly
14 Field coil
15 Regulator
16 Rectifier
17 Rear bracket

X : Non-reusable part

NOTE

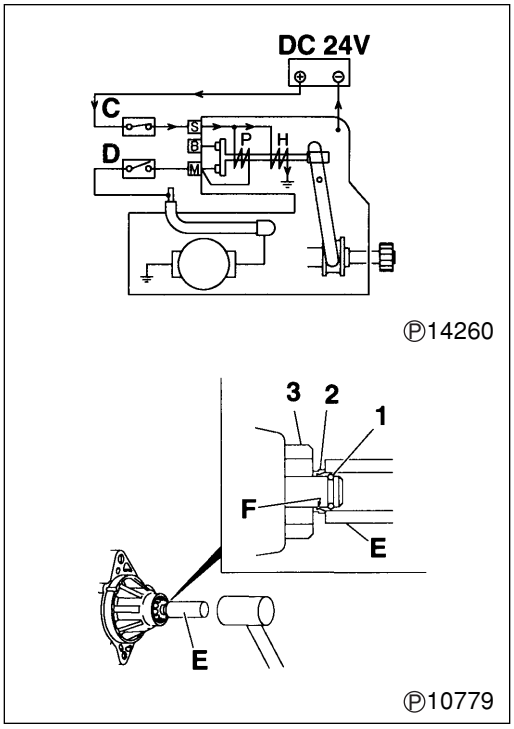
Do not remove parts 6, 9 and 13 unless they are found to be defective.

● Reassembly sequence

12 → 1

12: 17 → 16 → 15 → 14 → 13

1: 11 → 10 → 9 → 8 → 7 → 6 → 5 → 4 → 3 → 2



- Immediately (in less than 5 seconds) after the pinion **3** has started rotating, set the switch **C** to OFF to stop rotation of the pinion.

CAUTION ⚠

When the switch A and switch C are set to ON, current is supplied to both the pull-in coil P and holding coil H. Since wiring is such that no voltage is applied to terminal B of the starter, current flows to the pull-in coil during rotation of the pinion 3.

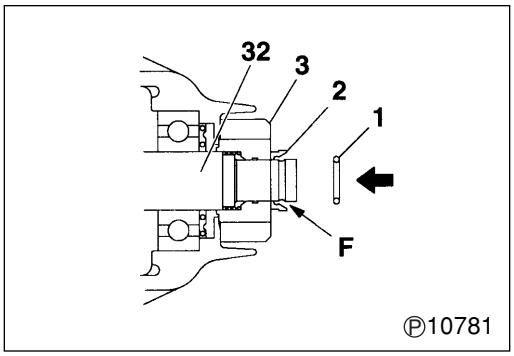
To prevent baking the pull-in coil, therefore, it is necessary that the switch C is set to OFF immediately (in less than 5 seconds) after the pinion has started rotating.

- Set the pipe-like tool **E** on the pinion stopper **2**.
- Lightly strike the tool **E** with a hammer to remove the stopper ring **1** from the ring groove **F** of the pinion stopper **2**.
- Remove the stopper ring **1** and remove the pinion **3**.
- Set the switch **A** to OFF to stop supplying current to the starter.

CAUTION ⚠

When the power supply to the starter is stopped, the pinion 3 may move in and the stopper ring 1 may fit in the ring groove F of the pinion stopper 2 again.

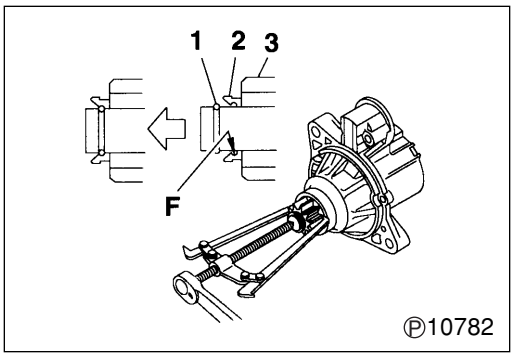
In this case, repeat the operations by supplying current to the starter.



[Installation]

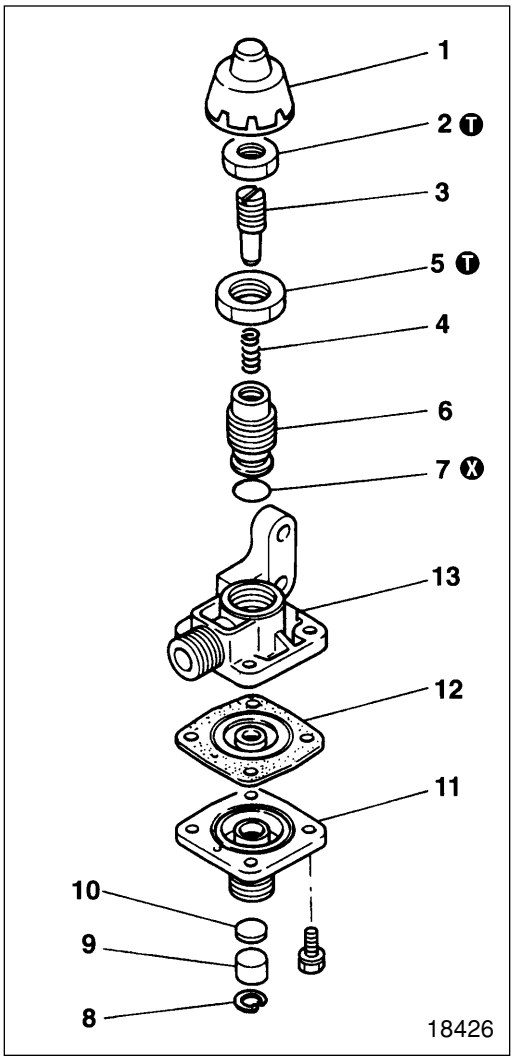
To install the pinion **3**, it is not necessary to supply current to the starter.

- Install the pinion stopper **2** and pinion **3** on the overrunning clutch **32** in the direction shown.
- Set the stopper ring **1** in the ring groove **F** of the overrunning clutch **32**.



- Pull the pinion **3** strongly to make sure that the stopper ring **1** securely fits in the ring groove **F** of the pinion stopper **2**.

M E M O



● **Disassembly sequence**

1 Cover
2 Nut
3 Adjusting screw
4 Spring
5 Nut
6 Sleeve
7 O-ring
8 Snap ring
9 Filter
10 Screen
11 Cap
12 Diaphragm

X : Non-reusable parts

● **Reassembly sequence**

Reverse the order of disassembly.

● **Adjustment after reassembly**

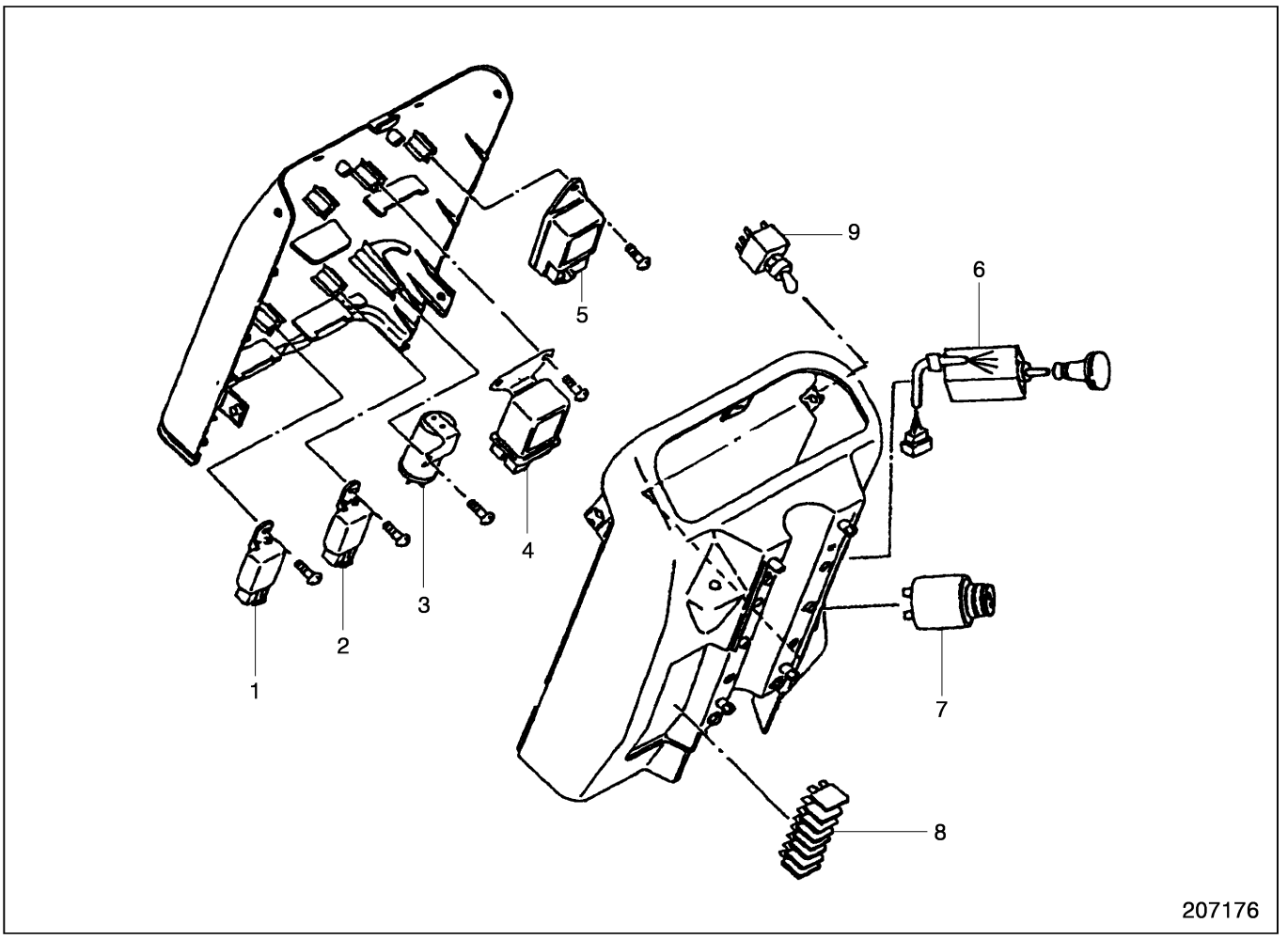
🕮 P.61-8

T Tightening torque

Unit: N·m (kgf·m) [lbf·ft]

Location	Parts to be tightened	Tightening torque	Remarks
2	Nut (for tightening of adjusting screw)	9.8 to 15 (1 to 1.5) [7.2 to 11.1]	–
5	Nut (for tightening of sleeve)	15 to 20 (1.5 to 2) [11.1 to 14.8]	–

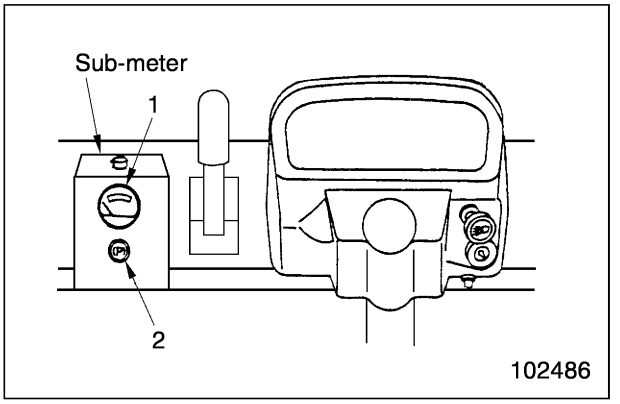
Components



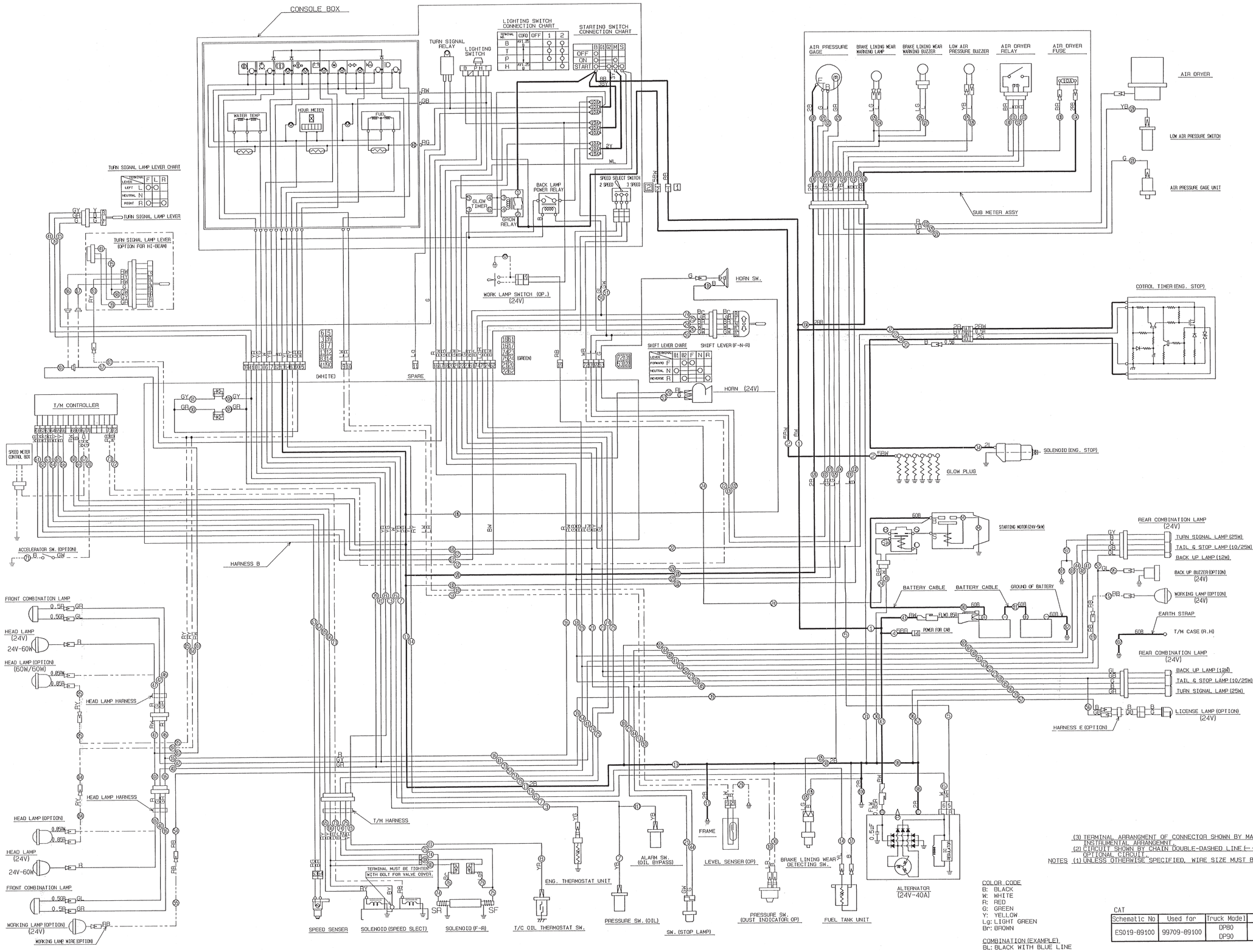
1. Power relay
2. Power relay
3. Turn signal relay
4. Glow plug relay
5. Glow plug timer
6. Lighting switch
7. Starter switch
8. Fuses
9. Travel speed select switch

Sub-Meter

1. Air pressure gauge
2. Brake lining warning light (red)



Electrical System Schematic



(3) TERMINAL ARRANGMENT OF CONNECTOR SHOWN BY MARK ___ MUST BE INSTRUMENTAL ARRANGEMNT.
(2) CIRCUIT SHOWN BY CHAIN DOUBLE-DASHED LINE (— — —) MUST BE OPTIONAL CIRCUIT.
NOTES (1) UNLESS OTHERWISE SPECIFIED, WIRE SIZE MUST BE 1.25mm².

COLOR CODE
B: BLACK
W: WHITE
R: RED
G: GREEN
Y: YELLOW
Lg: LIGHT GREEN
Br: BROWN

COMBINATION (EXAMPLE)
BL: BLACK WITH BLUE LINE

CAT

Schematic No	Used for	Truck Model	Serial No.
ES019-89100	99709-89100	DP80	T32B-00011-up
		DP90	T32B-50001-up

Pub.No. 99709-89100

(10) Fill the brake fluid reservoir, and bleed the brake lines.

(11) Prime the fuel system.

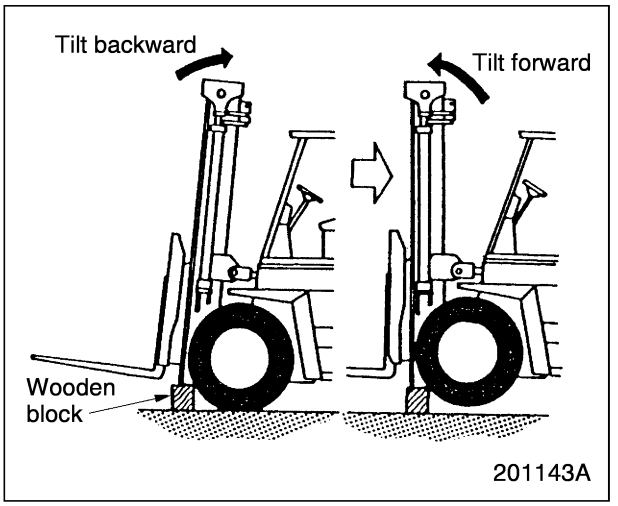
(12) After having checked the various parts, start the engine, and observe its running condition. If the engine vibrates excessively, retighten the mounting bolts to see if this retightening has any effect. Operate the mast, forks and steering, and check the oil level in the hydraulic tank, adding oil if necessary. Recheck the engine oil, coolant and transmission oil levels, and refill if necessary.

(13) Test the transmission as follows:

(a) Tilt the mast all the way backward. Position wooden blocks under the mast and tilt the mast forward to raise the front wheels until they clear the ground. After raising the wheels, support the frame by stand. Block the rear wheels.

(b) Start the engine and operate it at low idle. Move the transmission shift lever to FORWARD position to make sure the front wheels rotate in the correct direction. Move the transmission shift lever to REVERSE position and do the same step.

(c) Move the travel speed select switch on the console box to each position to make sure the front wheels rotate at the correct speed in each position.



⚠ CAUTION

During testing, the front wheels rotate. Set up a fence around the truck to prevent anyone from entering into the testing area.

2. Stator

(1) Check the blades for cracks. Also check the fit of the stator on the clutch cam.

(2) Check the clutch hub and cam for wear or flaws.

(3) Check the springs for damage. Also check the spring caps for wear or distortion.

(4) Check the rollers for flaws, distortion or flat spots due to wear.

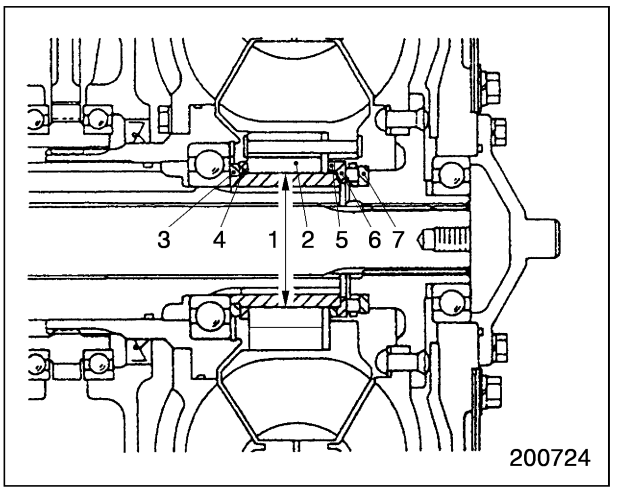
(5) Check the clutch hub splines for defects.

(6) Check the thrust washers for wear or other defects.

A: Standard value B: Repair or service limit

Unit: mm (in.)

Outside diameter of clutch hub 1	A	67.97 to 67.951 (2.6760 to 2.67523)
	B	67.8 (2.669)
Diameter of clutch rollers 2	A	10.185 to 10.2 (0.40098 to 0.402)
	B	10.1 (0.398)
Thickness of thrust washer 3	A	4.95 to 5 (0.1949 to 0.197)
	B	4.8 (0.189)
Thickness of thrust washer 4	A	3.95 to 4 (0.1555 to 0.157)
	B	3.8 (0.150)
Thickness of thrust washer 5	A	2.9 to 3 (0.114 to 0.118)
	B	2.8 (0.11)
Thickness of thrust washer 6	A	4.9 to 5 (0.193 to 0.197)
	B	4.8 (0.189)
Thickness of thrust washer 7	A	4.95 to 5 (0.1949 to 0.197)
	B	4.8 (0.189)



7. Gears

Check each gear for worn teeth or splines.

8. Magnet strainer assembly

Disassemble and clean the strainer. Replace the strainer if defective.

9. Transmission cover and torque converter housing oil seals

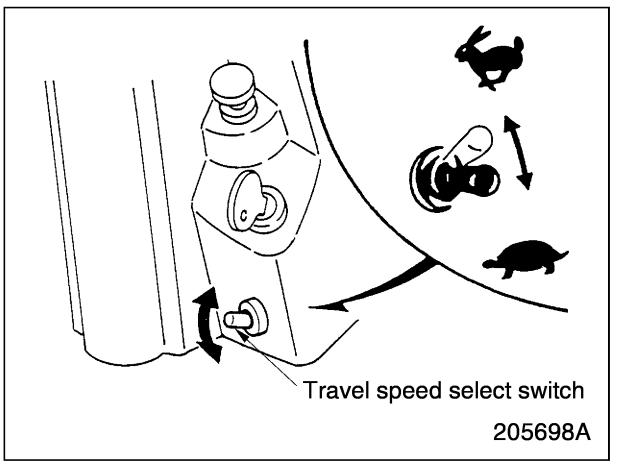
Replace the oil seals by new ones.

"Automatic 2-speed"/"Fixed 1st Speed" Test

Move the travel speed select switch mounted on the console box to each position, and make sure that the speed selector system functions properly. Move the switch when the truck is at standstill.

In the "Fixed 1st speed" position, the truck runs at a maximum speed of 12 km/hr (7.5 mph) and a greater torque is available.

In the "Automatic 2-speed" position, the transmission automatically shifts from the 1st to the 2nd speed when the travel speed reaches 10 km/hr (6.2 mph) to allow the truck to run at a maximum speed of 27 km/hr (16.8 mph).



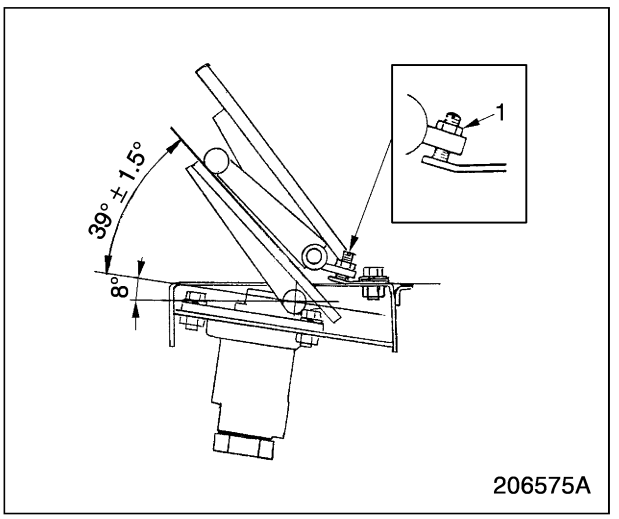
Inching Pedal Adjustment

(1) Adjust the brake pedal before adjusting the inching pedal.

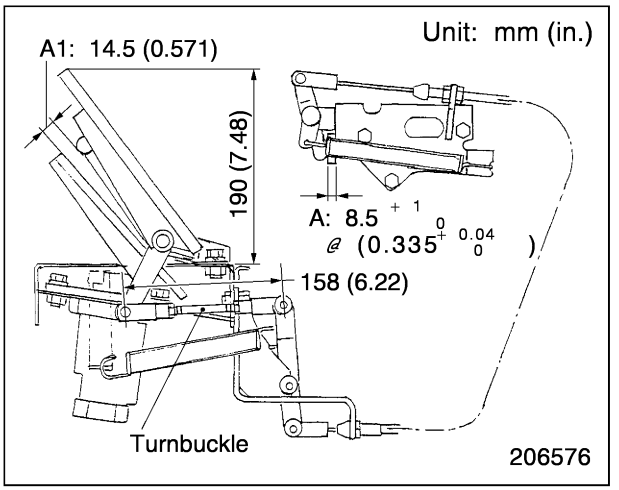
(2) Bring the brake pedal cam follower into contact with the brake control valve pedal by means of adjusting bolt 1.

NOTE

Do not vary set angle (39° ± 1.5°) of the brake valve pedal.

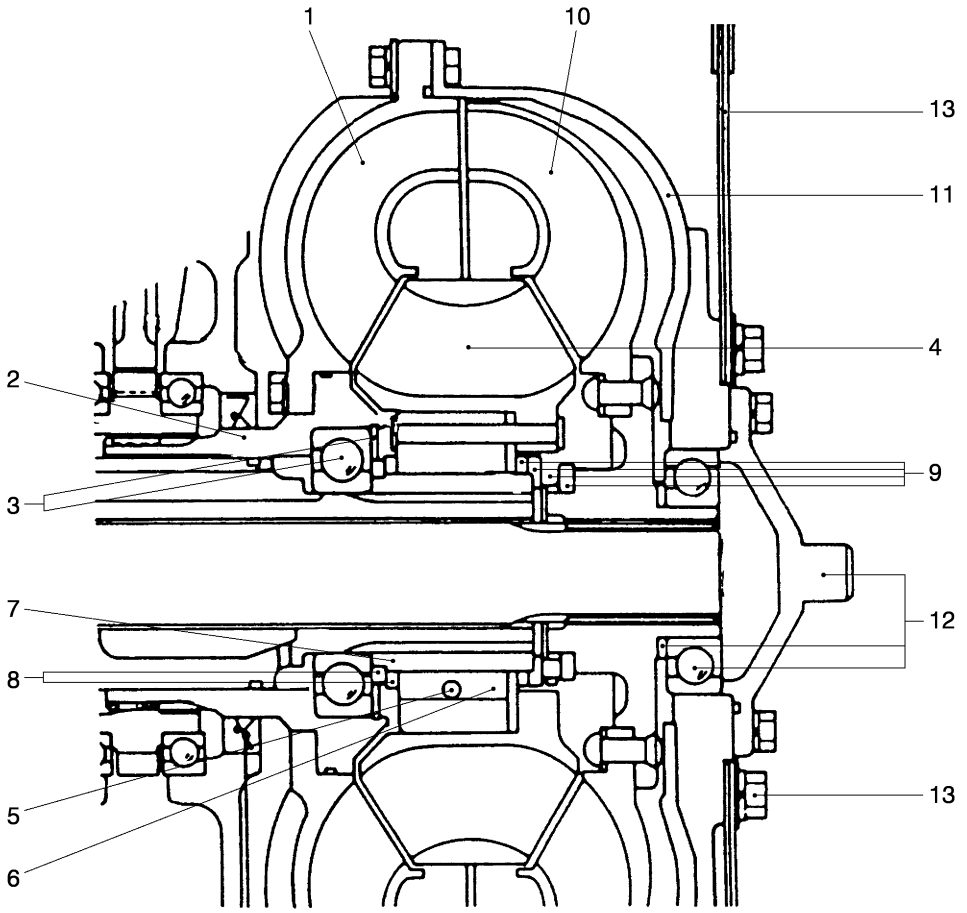


(3) Adjust the clearance A1 between the inching pedal cam follower and brake control valve pedal to 14.5 mm (0.571 in.). Adjust the protrusion A of the inching plunger to 8.5 $^{+1}_{0}$ mm (0.335 $^{+0.04}_{0}$ in.) with the turnbuckle. Under this condition, the turnbuckle will be approximately 158 mm (6.22 in.) in length and the inching pedal approximately 190 mm (7.48 in.) in height.



Testing and Adjusting ..... 6 – 43
Oil Pressure Measurement ..... 6 – 43
Clutch Pressure Measurement ..... 6 – 44
Stall Speed Measurement ..... 6 – 44
10 m (33 ft) Start Acceleration Test ..... 6 – 45
Travel Speed Select Switch ..... 6 – 46
Inching Pedal Adjustment ..... 6 – 46
Troubleshooting ..... 6 – 49
Service Data ..... 6 – 54

Assembly



Sequence

1. Pump (impeller)
2. Pump boss, O-ring, Bolts, Washers
3. Ball bearing, Snap ring
4. Stator assembly
5. Springs, Spring caps
6. Rollers
7. Hub
8. Thrust washer
9. Thrust bearing, Thrust washers
10. Turbine
11. Drive cover, O-ring, Bolts, Washers
12. Spacer, Ball bearing, Pilot boss, O-ring, Bolts, Washers
13. Flexible plates, Plate, Bolts, Washers

Suggestions for Assembly

1. Piston installation

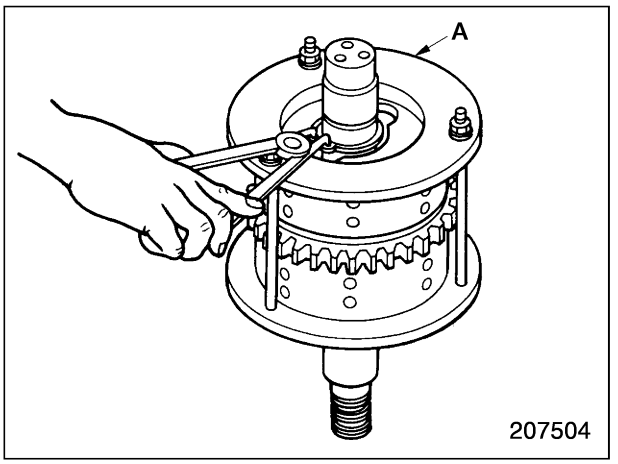
When putting pistons 3 in the clutch drum, apply ATF (automatic transmission fluid) to their seal ring contact surfaces.

2. Return spring installation

Using the Piston Tool A (special tool) or an arbor press, compress springs 4 and retainers 5, and install snap rings 6.

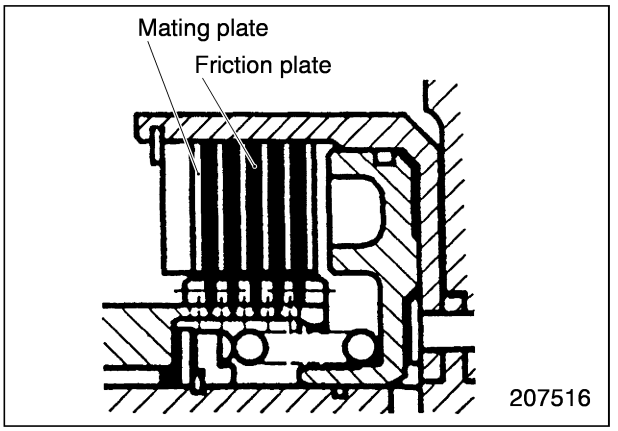
Special tool needed

Piston tool A	92267 - 00300



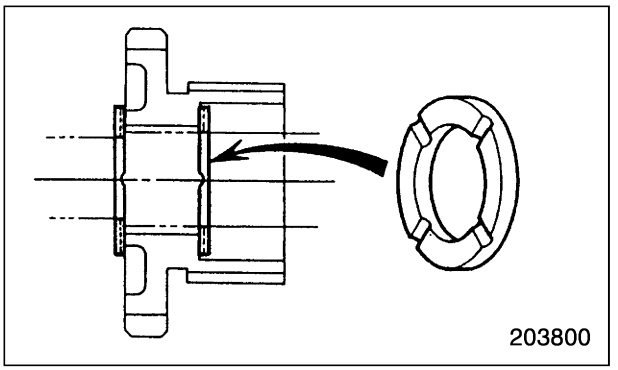
3. Friction and mating plate installation

(1) Make sure that the position and number of the plates are correct. Install the plates while applying ATF to them. When replacing the friction plates, replace the mating plates, too.



(2) Thrust washer installation

Install thrust washers 11, 14, 16 and 19 with the side that has oil grooves toward the gear.



4. Piston testing

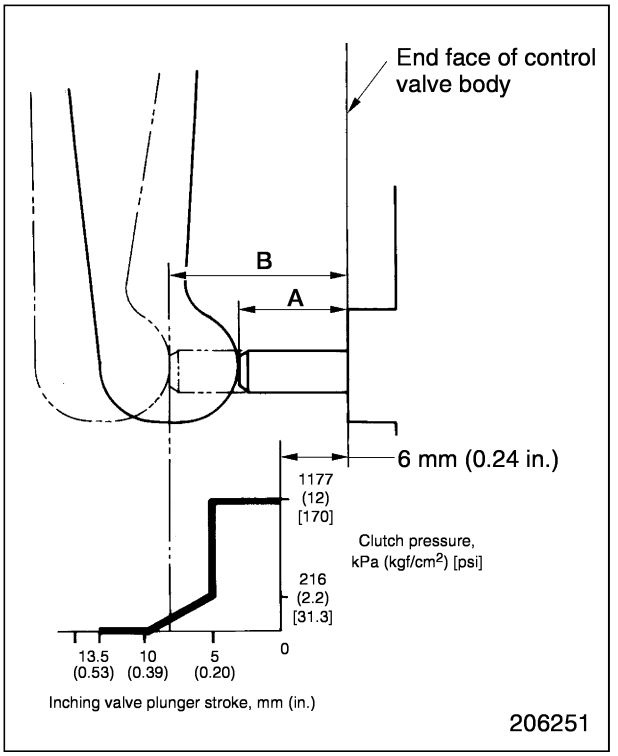
After having assembled the clutch, apply pressure air of approximately 690 kPa (7 kgf/cm^2) [100 psi] to the oil hole to make sure that the piston move freely without any sign of air leaks.

(8) Release the inching pedal and make sure the protrusion A of the inching plunger is 8.5 $^{+1}_{0}$ mm (0.335 $^{+0.04}_{0}$ in.) and the pressure gauge reading is 1079 to 1275 kPa (11 to 13 kgf/cm²) [156 to 185 psi]. If the protrusion A is incorrect, readjust the brake and brake pedal, make an adjustment again.

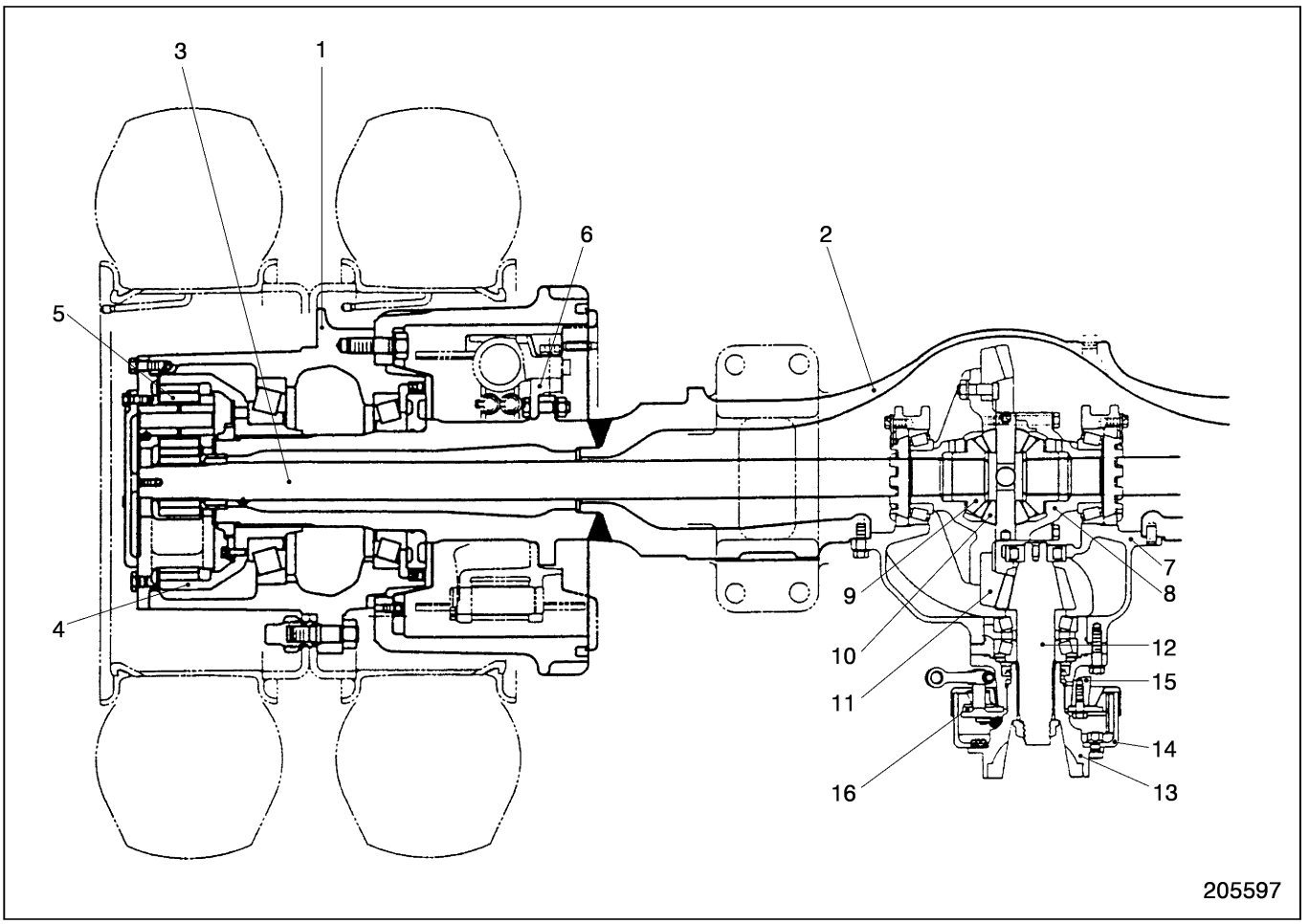
- If the protrusion A is more than 9.6 mm (0.378 in.), the brake shoe clearance is too small.

Unit: mm (in.)

Inching pedal height (from frame to top end of pedal)	190 (7.48)
Clearance between inching pedal cam follower and brake control valve pedal	14.5 (0.571)
Protrusion of inching plunger with inching pedal released A	8.5 (0.335)
Protrusion of inching plunger when brake starts to be applied B	14.9 (0.587)



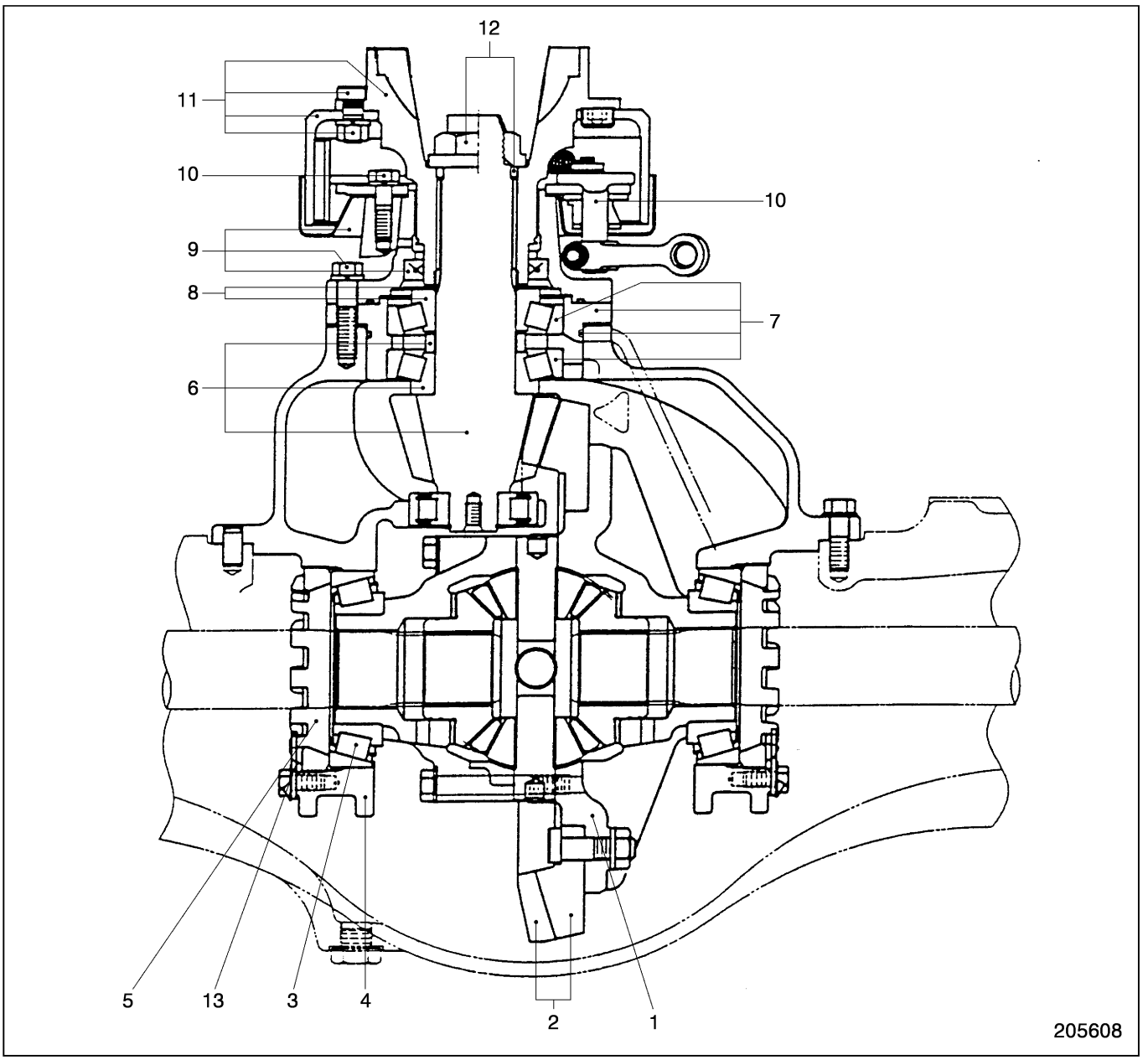
Description



1. Front wheel hub
2. Front axle housing
3. Axle shaft
4. Ring gear
5. Planet gear
6. Wheel brake assembly
7. Reduction and differential assembly
8. Differential case
9. Differential bevel gear
10. Differential bevel pinion
11. Reduction bevel gear
12. Reduction bevel pinion
13. Input flange
14. Parking brake drum
15. Parking brake bracket
16. Parking brake assembly

The front axle is of full-floating type with banjo-type axle housing of all-welded construction. It is bolted to the front side of the frame. The final drives are of planetary gear type. The wheel brake assemblies are mounted on the axle housing. The parking brake assembly is mounted on the input flange fitted to the reduction bevel pinion.

Assembly

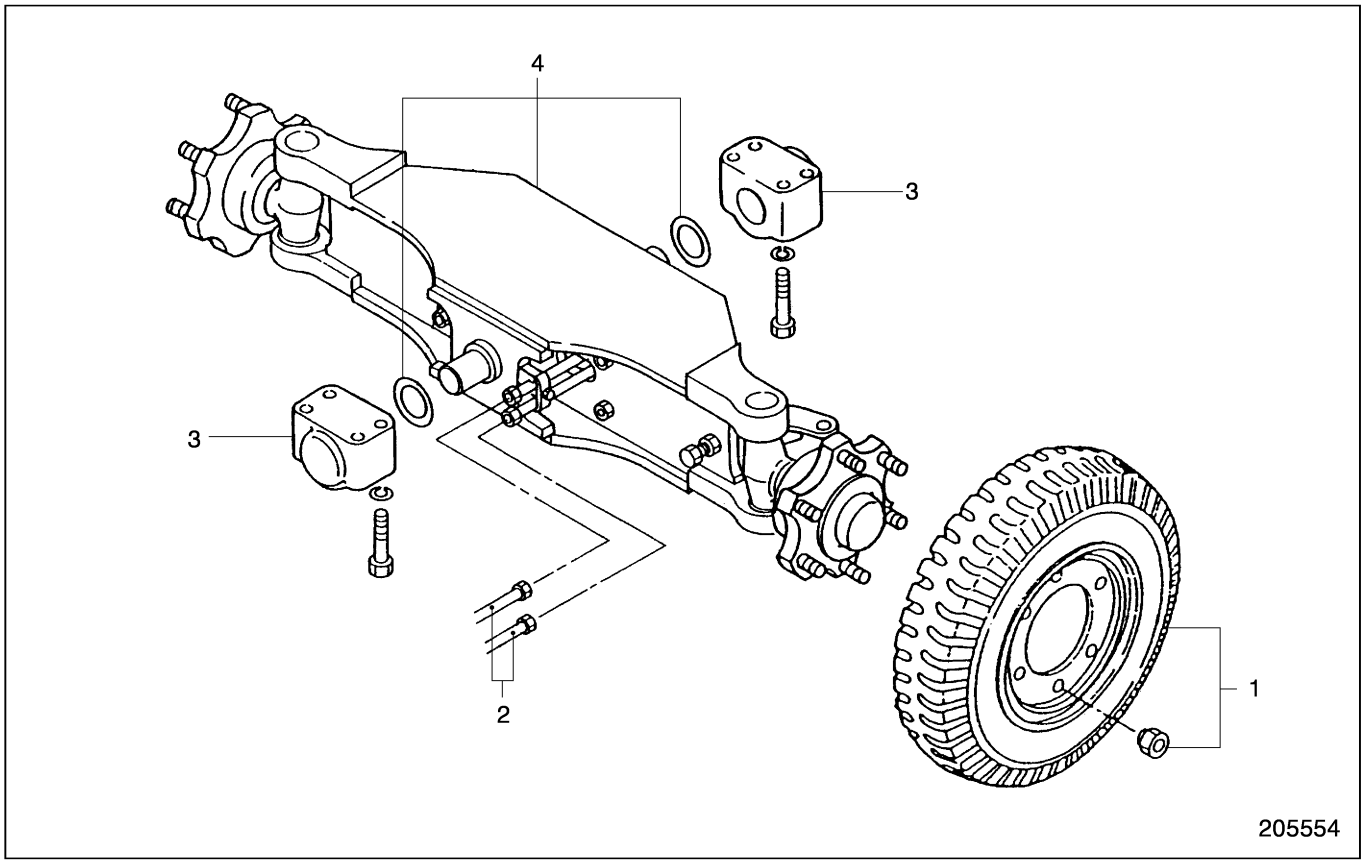


Sequence

1. Differential case assembly, Differential case, Washers, Differential bevel gears, Differential bevel pinions, Pinion shafts, Washers , Bolts
2. Reduction bevel gear, Bolts, Nuts
3. Taper roller bearings
4. Differential carrier, Cap set, Differential carrier, Bearing caps, Lock washers, Bolts
5. Side bearing nuts
6. Reduction bevel pinion, Taper roller bearing (inner race), Collar
7. Bearing retainer, Taper roller bearing (outer race), O-ring, Shim(s)
8. Taper roller bearing (inner race), Oil separator
9. Parking brake bracket, Oil seal, O-ring, Bolts, Washers
10. Parking brake assembly, Bolts, Washers
11. Input flange, Parking brake drum, Reamer bolts, Washers, Nuts, Plug
12. Self-lock nut, O-ring
13. Lock plates, Bolts, Washers

Rear Axle

Removal



Sequence

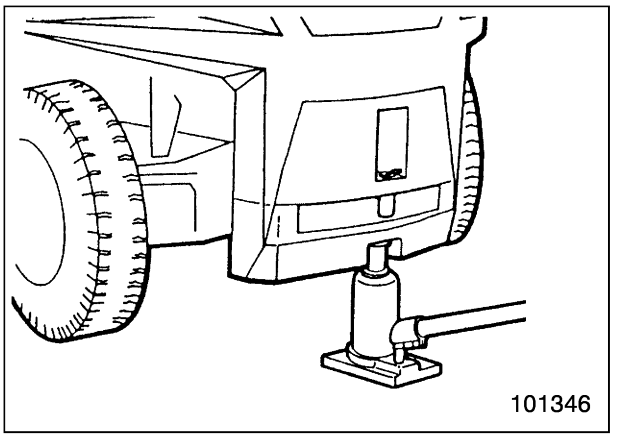
1. Rear wheel (tire), Wheel nuts
2. Steering hoses
3. Rear axle supports
4. Rear axle assembly, Thrust washers

Start by:

(a) Set the parking brake and block the front wheels.

(b) Raise the rear end of the truck with a jack and put supporting stands or blocks of wood under the frame on both sides so the bottom of the counterweight is 400 to 500 mm (16 to 20 in.) from the ground.

Capacity of jack	6000 kgf (13200 lbf)



Specifications

Item \ Truck Model		DP80	DP90
Wheel brake	Type	Hydraulically actuated, internal-expanding, with leading and trailing shoes, effective on front wheels	
	Drum diameter mm (in.)	410 (16.14)	
	Lining dimensions (length x width x thickness) – number mm (in.)	207.5 x 220 x 16 (8.2 x 8.7 x 0.63) – 4	
	Wheel cylinder inside diameter mm (in.)	55.56 (2.187)	
	Brake booster	Air master (pneumatic booster)	
Parking brake	Type	Mechanically actuated, internal-expanding, effective on reduction bevel pinion	
	Drum diameter mm (in.)	203.2 (8.00)	
	Lining dimensions (length x width x thickness) – number mm (in.)	426 x 50 x 4 (16.8 x 2.0 x 0.16) – 2	

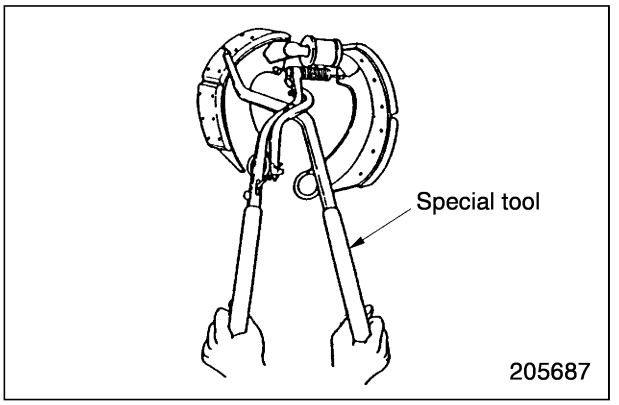
Suggestions for Disassembly

1. Return spring removal

Turn the adjusting cams to move the shoes all the way inward and away from the drum. Using the Spring Setter (special tool), remove the return springs from the shoes.

Special tool needed

Spring setter	03727 - 10001

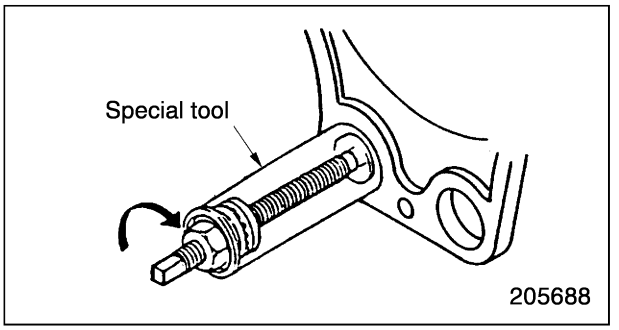


2. Anchor pin removal

Using the Anchor Pin Puller (special tool), remove the anchor pins from the shoes.

Special tool needed

Anchor pin puller	03727 - 60000



Inspection

1. Dust cover

(1) Check for cracks.

(2) Check to make sure the bolts have been tightened to the specified torque before removing the dust cover.

Tightening torque for dust cover bolts	20 ± 4 N·m (2.0 ± 0.4 kgf·m) [14.5 ± 3 lbf·ft]

2. Shoe and lining assemblies

(1) Check the shoes and linings for cracks.

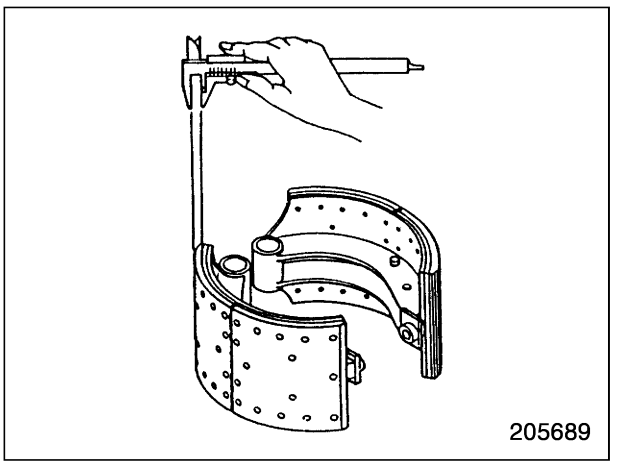
(2) Replace the linings if they are badly soaked with oil, hardened or defective.

(3) Measure the thickness of the linings, and replace the linings if it is in excess of the service limit.

A: Standard value B: Repair or service limit

Unit: mm (in.)

Thickness of lining	A	16 (0.63)
	B	10 (0.39)



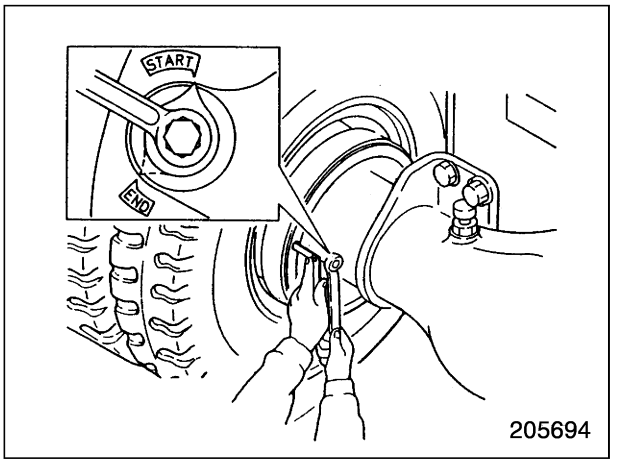
Testing and Adjusting

Wheel Brakes

1. Clearance adjustment

(1) Remove the grommet from the inspection hole in the dust cover.

(2) Insert different feeler gauges one by one into between the drum and lining through the inspection hole to find a gauge that gives a slight resistance when it is inserted. Check to see if the thickness of this gauge coincides with the standard value.



Standard value	0.3 to 0.5 mm (0.01 to 0.02 in.)

⚠ CAUTION

Check the clearance at two places on each wheel.

(3) If the clearance is incorrect, adjust it by turning the adjusting cam.

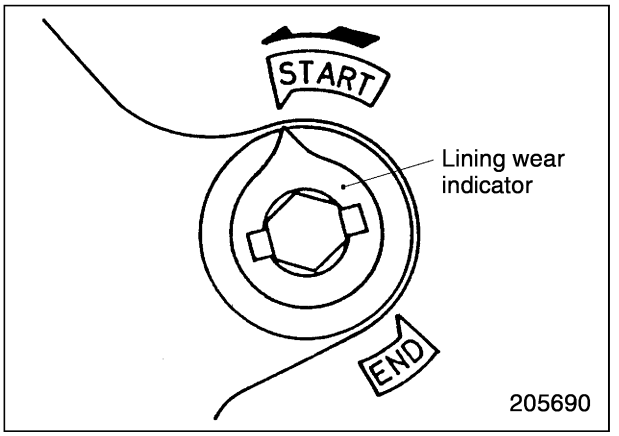
2. Lining (shoe assembly) replacement

If the adjuster indicator shows that the linings have reached the service limit, replace the shoe assembly. The shoe assembly should also be replaced:

(1) If the linings are improperly installed (riveted) to the shoes.

(2) If the linings are badly soaked with oil or grease, burnt or deteriorated (hardened).

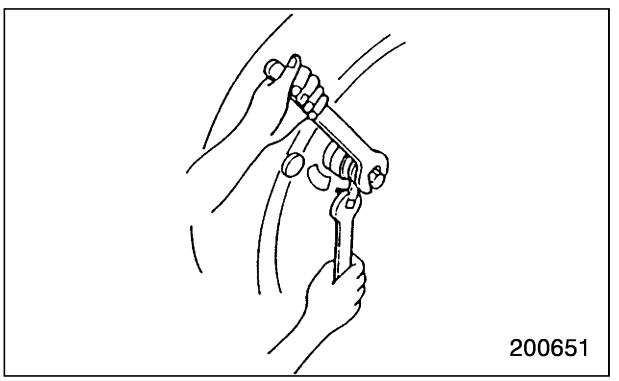
(3) If the linings are cracked or broken.



3. Lining wear indicator setting

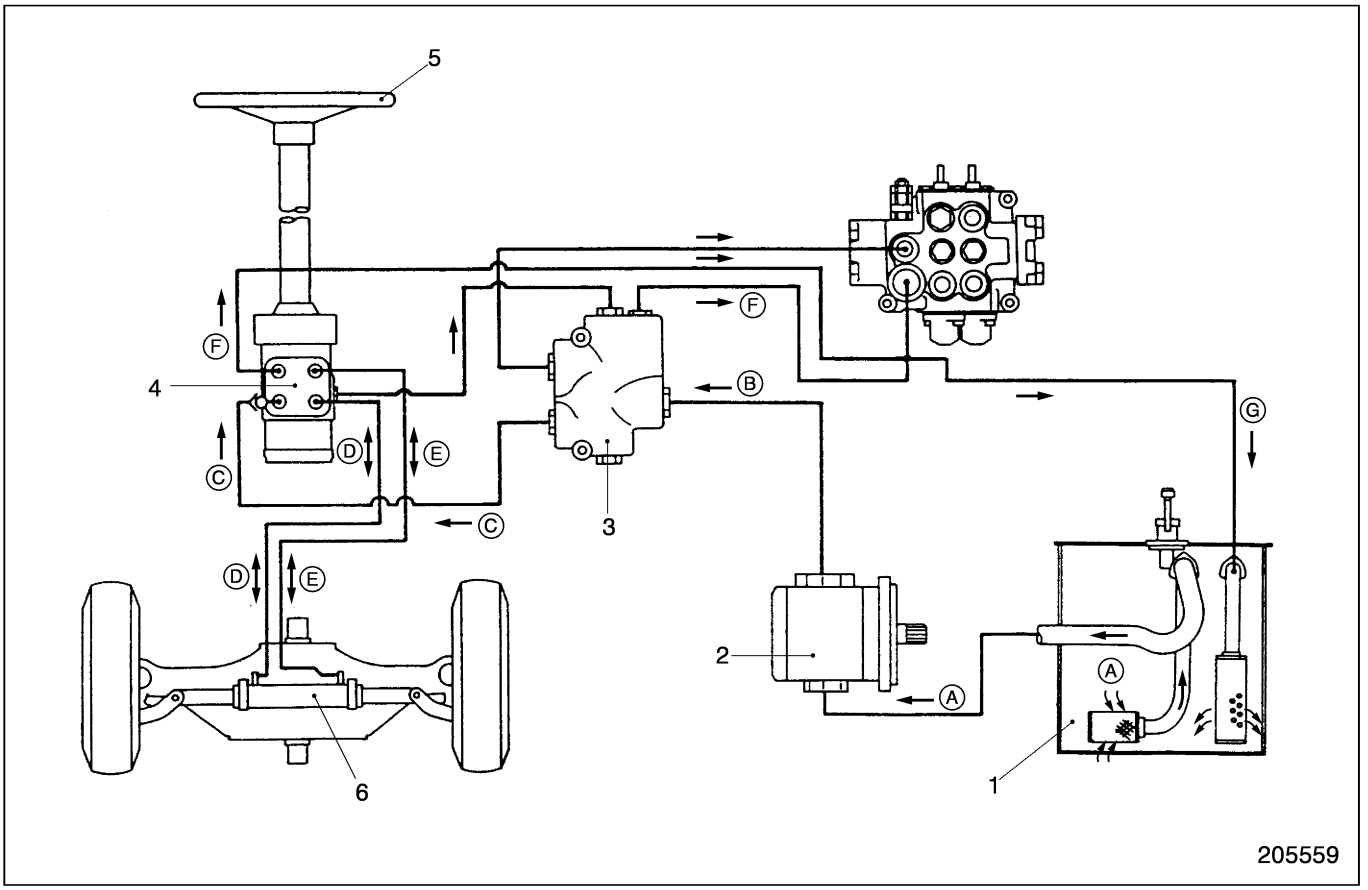
(1) Using a wrench, turn the washer to set the pointer as far at inside of the service range scale as possible.

(2) In setting the indicator, set the adjusting cam with the shoes contracted all the way, and hold the adjusting cam with another wrench to prevent it from rotating when turning the washer.



Description

General



1. Hydraulic tank
2. Oil pump
3. Priority valve
4. Steering control valve
5. Steering wheel
6. Power cylinder

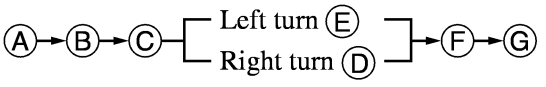
The steering system features a load sensing system. This system consists essentially of a steering control valve ("Orbitrol"), a priority valve, and other components to provide the operator with quick steering response and effortless control.

When the steering wheel is turned, the control valve is actuated to send the pressure oil to the power cylinder for turning the rear wheels.

The priority valve is a metering valve and controls the volume of the oil to the steering control valve at a rate required for steering action. The excess of the oil flows to the hydraulic system control valve.

When the steering wheel is at standstill, the greater part of the oil flows through this priority valve to the hydraulic system control valve.

Oil flow:

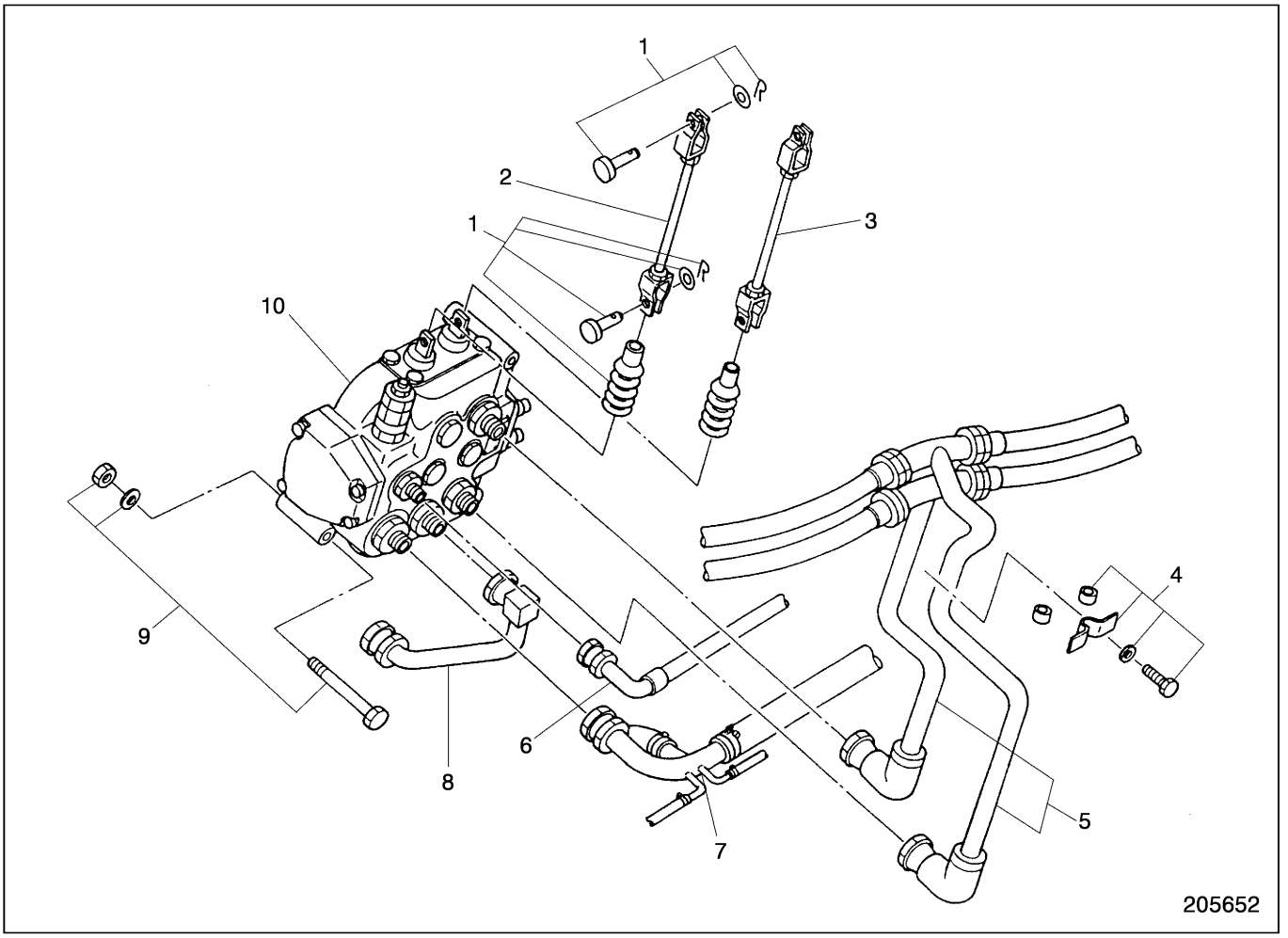


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Control Valve

Removal



Sequence

1. Clevis pins, Washers, Pins, Boot
2. Lift rod
3. Tilt rod
4. Clamp, Cushions, Washers, Bolts
5. Tilt pipes
6. Delivery hose
7. Return pipe (Hose)
8. Lift pipe
9. Bolts, Nuts, Washers
10. Control valve

Start by:

(a) Remove floor mat and floor plates.

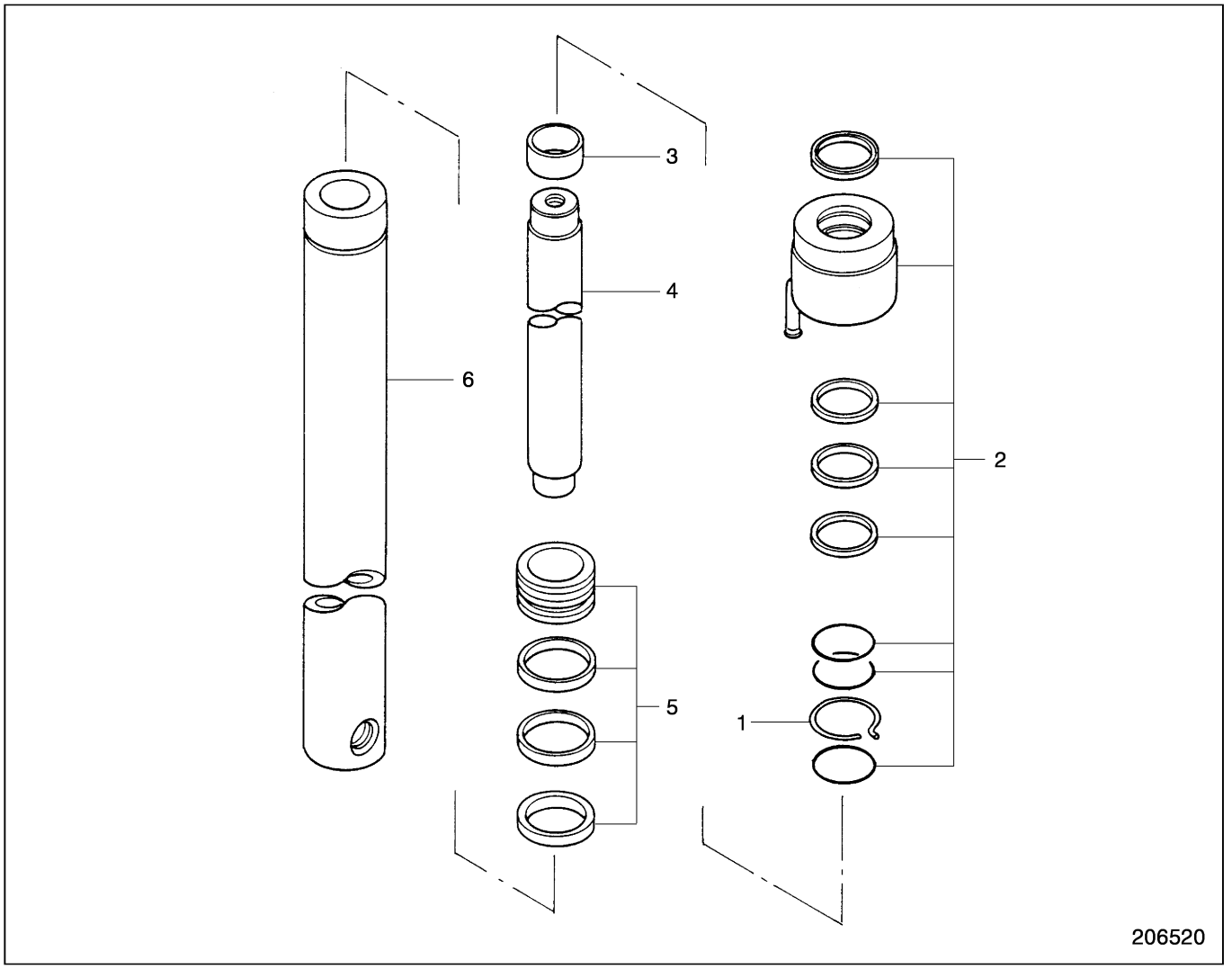
(b) Tilt the mast to vertical position, lower the forks all the way, and relieve the pressure from the hydraulic lines.

NOTE

When disconnecting the pipes and hoses, place a dip pan. Cover the openings of the control valve and connectors to prevent entrance of dirt.

Lift Cylinders (Simplex mast)

Disassembly



Sequence

1. Stopper
2. Cylinder head, Wiper ring, Bushing, U-ring, Bushing, O-ring, Back-up ring, O-ring
3. Spacer
4. Piston rod
5. Piston, Bushings, Piston seal
6. Cylinder tube

NOTE

On an 8-ton class trucks, if the mast lift height is within the range from 2.5 to 4.5 m (8.2 to 14.8 ft), the lift cylinders have no spacer **3** attached to the piston rods.

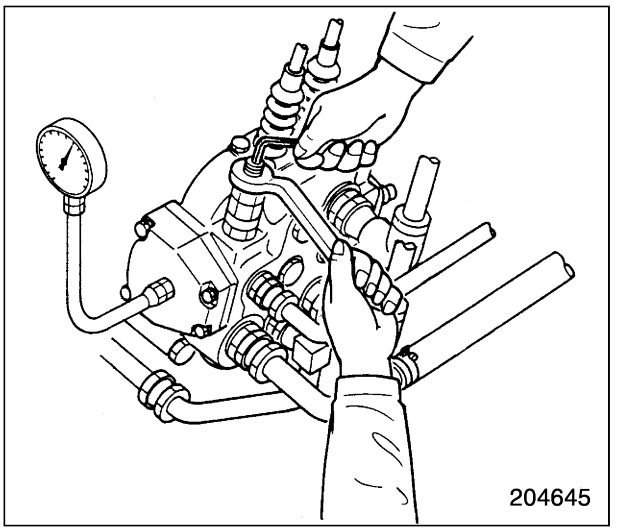
Spacer **3** is built in the lift cylinders of 5 m (16.4 ft) or higher masts.

(3) Increase the engine speed to 1500 to 2000 rpm, and run the engine for another 10 minutes in the no-load condition.

(4) With the pump being so run, loosen the adjusting screw, and shift the transmission shift levers into operating positions. Next, set the pressure to 2942 kPa (30 kgf/cm^2) [427 psi], and run the pump for 5 minutes at this pressure. Following this, increase the pressure by changing the setting of adjusting screw in increments of 1961 kPa (20 kgf/cm^2) [284 psi] and run the pump for 5 minutes at each increased pressure until, finally, the prescribed set pressure of the relief valve is reached.

(5) Pay attention to the temperatures of oil and pump surfaces and to the running noise while increasing the pressure. If any abnormal condition is noticed, bring the pump to no-load condition to cool the oil or pump or, as necessary, discontinue the test run, and overhaul the pump once again. Do not keep on increasing the pressure when an abnormal condition is noticed.

(6) After doing Steps (2) thru (5) above, reset the relief valve as specified and operate the forks and mast to see if the tilt and lift cylinders work with the specified speeds.



Control Valve

- **External leakage**

(1) Check for oil leaks from the joint between adjacent valve housings sealed by O-ring.

(2) Check for oil leaks from the scrapers sealed by O-rings.

(3) Check for oil leaks from the screw connections.

MASTS AND FORKS

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3. Lateral clearance between outer and inner masts

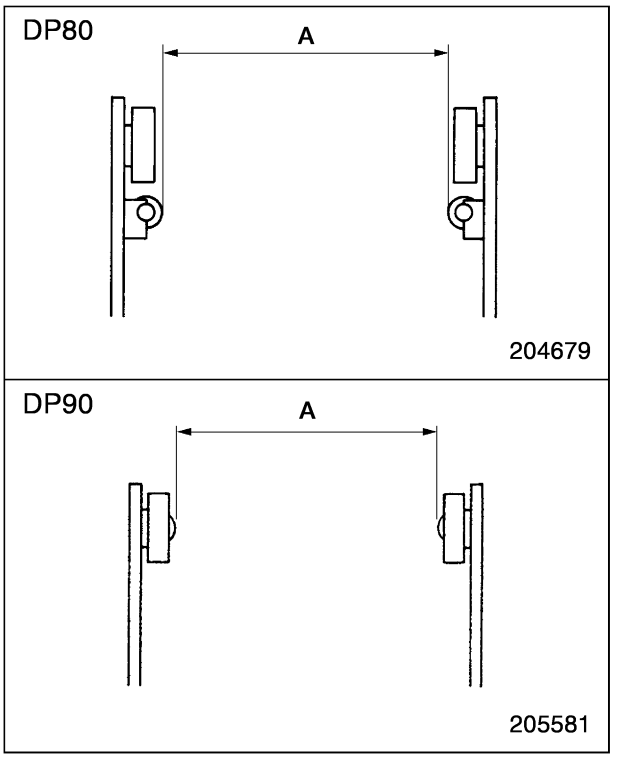
(1) Measure the distance A between the side rollers, left and right, of the outer mast, and adjust this distance to the specification.

Unit: mm (in.)

Item \ Truck Model	DP80	DP90
Distance A	768 ± 0.5 (30.24 ± 0.020)	754 ± 0.5 (29.69 ± 0.020)

NOTE

Measure the distance A between the innermost points of the rollers.



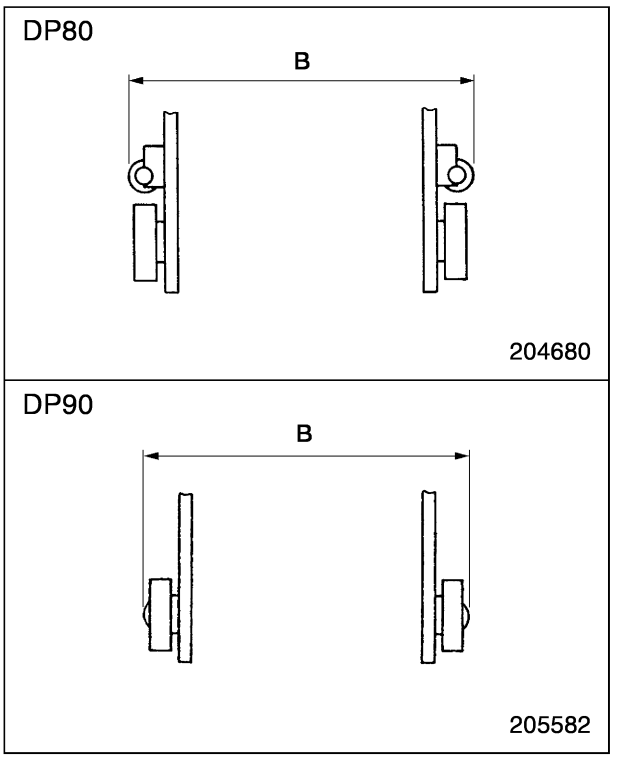
(2) Measure the distance B between the side rollers, left and right, of the inner mast, and adjust this distance to the specification.

Unit: mm (in.)

Item \ Truck Model	DP80	DP90
Distance B	896 ± 0.5 (35.28 ± 0.020)	890 ± 0.5 (35.04 ± 0.020)

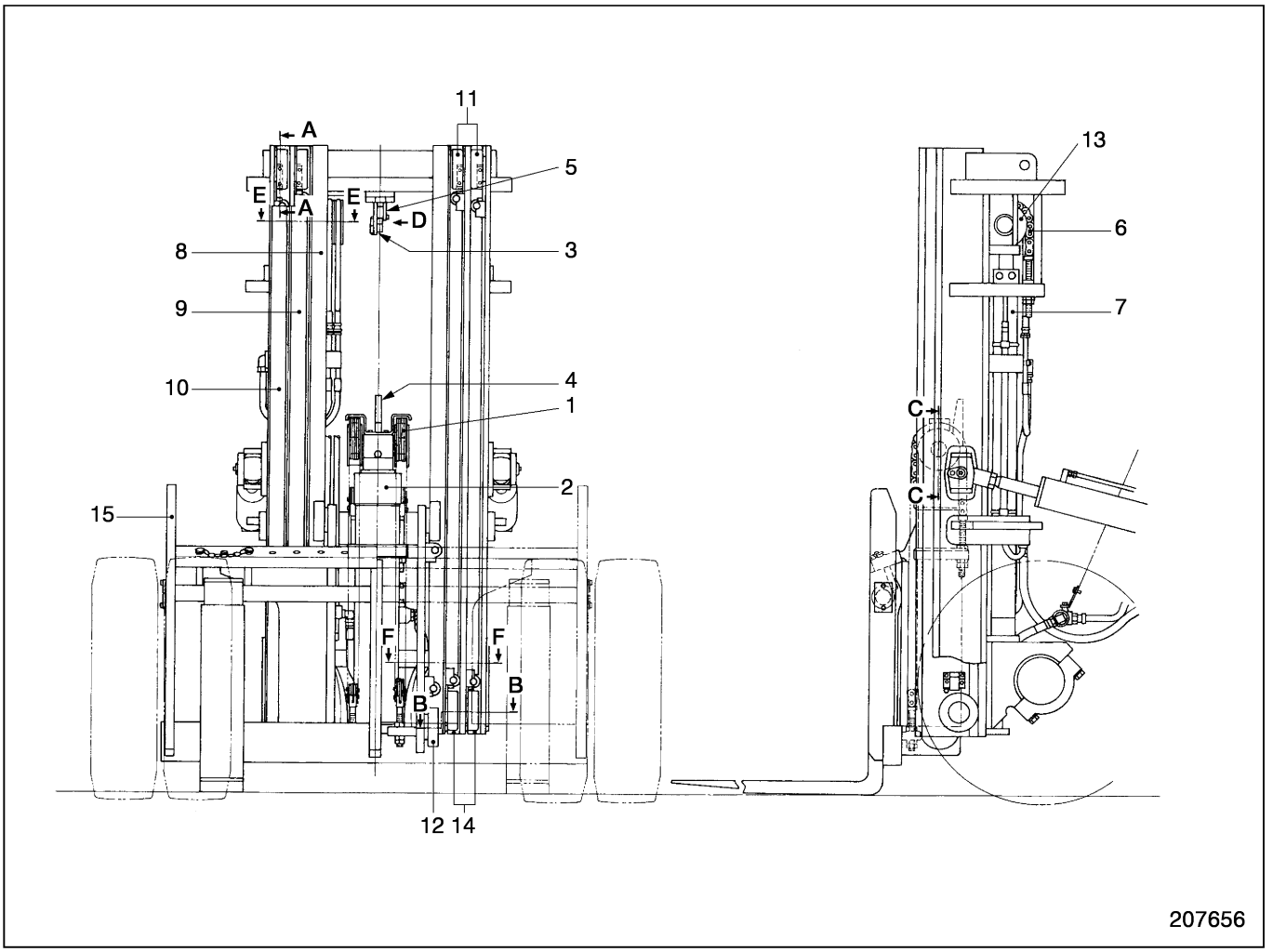
NOTE

Measure the distance B between the outermost points of the rollers.



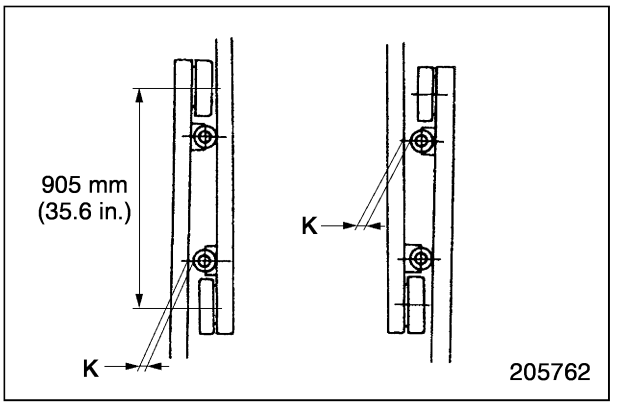
Description

Triple-stage Panoramic Mast (Triplex Mast)



1. 1st lift chain
2. 1st lift cylinder
3. Movable hook
4. Hook stopper
5. Fixed hook
6. 2nd lift chain
7. 2nd lift cylinder
8. Inner mast
9. Middle mast
10. Outer mast
11. Mast top main roller
12. Lift bracket main roller
13. 2nd chain wheel
14. Mast bottom main roller
15. Lift bracket

(3) Slide the inner mast out the top of the outer mast until the span of the main rollers (center-to-center distance between the upper main roller of outer mast and the lower main roller of inner mast) is as listed below. Push the inner mast to one side of the outer mast and check clearance K with a feeler gauge on the other side.



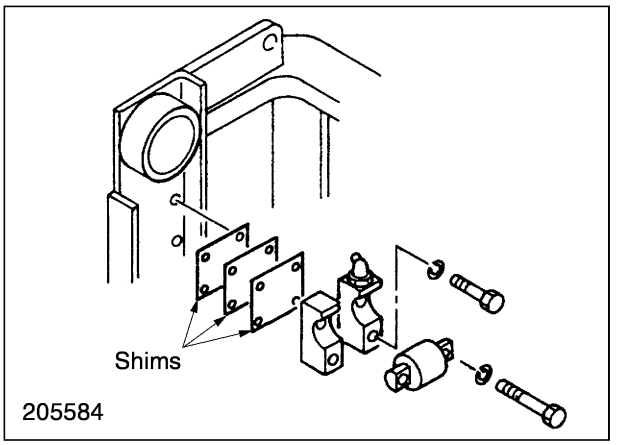
Unit: mm (in.)

Mast model	Main roller span
3M80B	905 (35.6)

Unit: mm (in.)

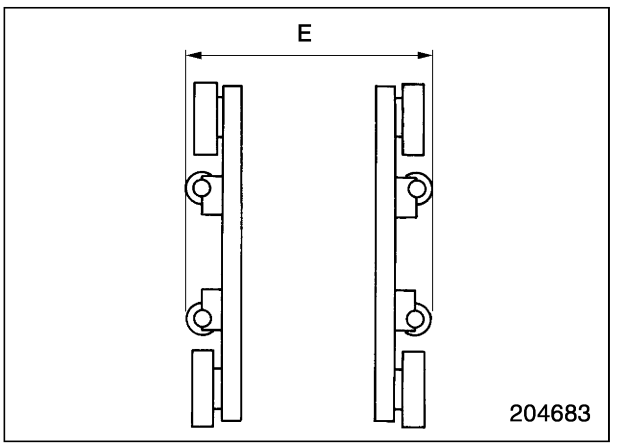
Clearance K	0.2 to 1.0 (0.008 to 0.039)

- To adjust the clearance K, increase or decrease the amount of the side roller bracket shims.



5. Lateral clearance between lift bracket and inner mast

(1) Measure the distance E between side rollers.



Unit: mm (in.)

Distance E	552 ± 0.5 (21.73 ± 0.020)

Item		How to check	Intervals					Service data
			Daily (pre-start)	Every 50 hours or weekly	Every 200 hours or monthly	Every 1200 hours or 6 months	Every 2400 hours or 1 year	
Brake pedal	Free play and height above floor plate with pedal depressed	Measure	○	○	○	○	○	Free play (angular): 4°30' Free play: 15 mm (0.6 in.) Pedal height (to top of pedal pad): 190 mm (7.5 in.)
	Truck stopping distance	Test/ measure	○	○	○	○	○	5 m (16 ft), maximum with rated load Effective stroke (after free play): 13 ± 1°
Parking brake	Application (holding)	Test/spring scale	○	○	○	○	○	Lever swing angle: 71° to 76° Operating effort: 245 to 294 N (25 to 30 kgf) [55 to 66 lbf]
Brake hoses and pipes	Fluid leaks, damage or installation	Visual	○	○	○	○	○	
Brake fluid	Level in reservoir	Visual	○	○	○	○	○	200 cc (12.2 cu in.)
Brake booster	Operation	Test	○	○	○	○	○	
Wheel brakes	Master cylinder and wheel cylinders – operation, wear and damage	Overhaul/ visual					⊗	
Brake drums and shoes	Clearance between drum and linings	Feeler gauge			○	○	○	0.2 mm (0.008 in.)
	Sliding surfaces of shoes and lining – wear	Overhaul/ calipers					○	10 mm (0.39 in.), maximum
	Drum – wear or damage	Visual/scale					○	ID: 411 mm (16.18 in.)
	Return springs – free length	Measure					○	260.5 mm (10.26 in.), maximum
	Shoes – operation	Test					○	
	Anchor pins – seizure	Visual					○	

Special Tools

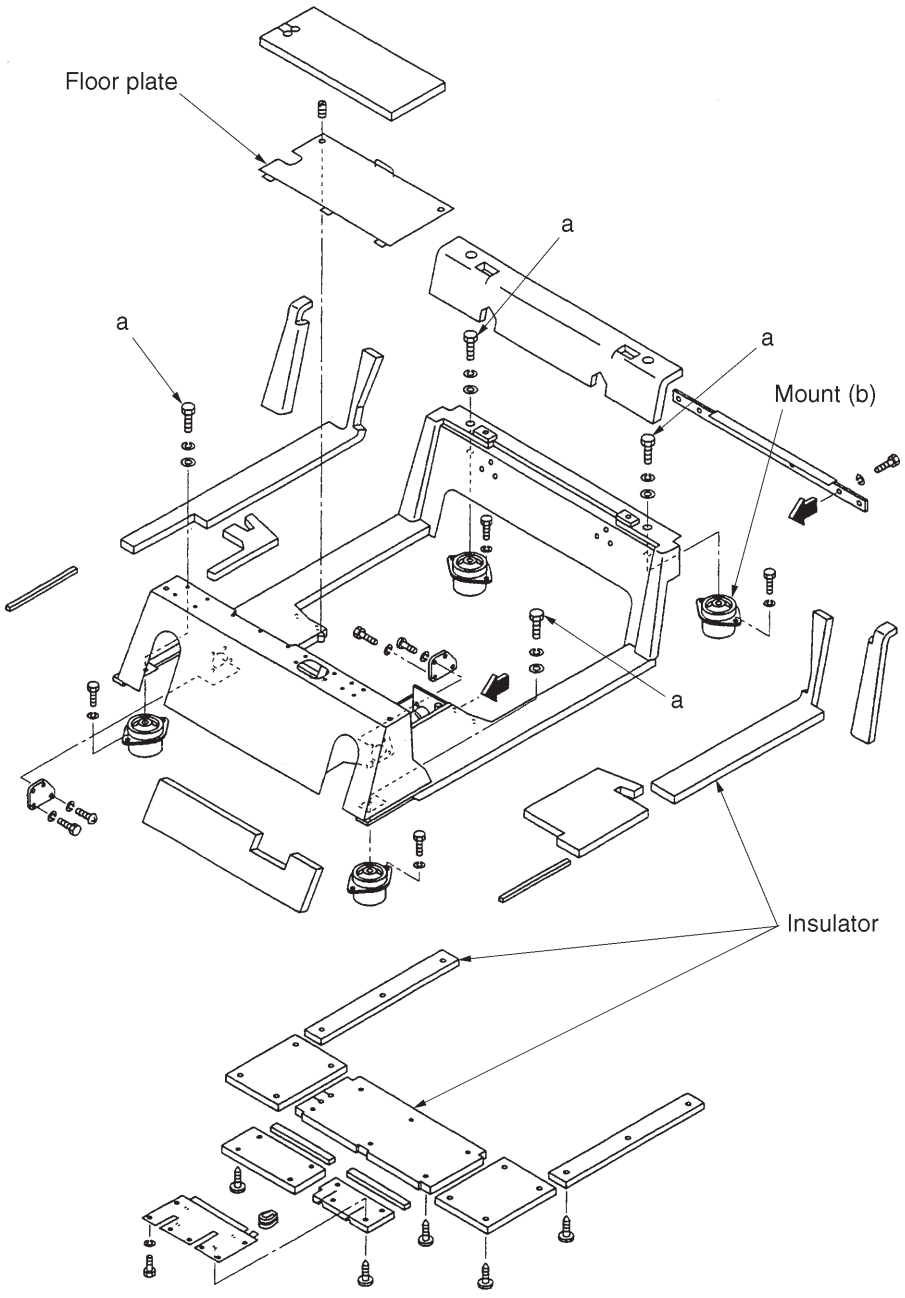
Ref. No.	Part number	Part name	Application	DP80	DP90
1	91268 - 00701	Socket wrench	Rear wheel nut and counterweight bolt removal/ installation	○	○
2	67284 - 15400	Bolt	Powershift transmission cover and shifter shaft removal	○	○
3	92267 - 00300	Piston tool	Powershift transmission clutch return spring removal/installation	○	○
4	91268 - 00500	Ring puller	Powershift transmission snap ring removal/ installation	○	○
5	64309 - 17701	Gauge kit	Powershift transmission hydraulic pressure testing	○	○
6	03727 - 60000	Anchor pin puller	Wheel brake anchor pin removal	○	○
7	03727 - 10001	Spring setter	Wheel brake return spring removal/installation	○	○
8	91268 - 10600	Puller	Steering wheel removal	○	○
9	91268 - 03200	Puller	Steering column needle roller bearing removal	○	○
10	91268 - 01700	Connector	Power steering main pressure testing (to be used in combination with 64309 - 17701 gauge kit)	○	○
11	05312 - 11000	Hook wrench	Tilt cylinder bushing removal/installation	○	○
	05312 - 10800	Hook wrench	Power cylinder head removal/installation	○	○
	05312 - 10800	Hook wrench	Lift cylinder head removal/installation	○	–
	05312 - 11000	Hook wrench	Lift cylinder head removal/installation	–	○
12	92267 - 00500	Hook wrench	Lift cylinder removal/installation	○	–
13	92267 - 00600	Hook wrench	Lift cylinder removal/installation	–	○
14	92267 - 00200	Socket wrench	Front axle nut removal/installation	○	○
15	92367 - 02100	Wrench	Wheel brake mounting bolt holding	○	○
16	92367 - 02200	Torque wrench	Wheel brake mounting nut tightening	○	○
17	92367 - 02300	Socket			

7. Seat frame

(1) A seat frame with insulator is used to impede transmission of engine and transmission noise and dampen engine vibration before being transmitted to the cab. The seat frame also serves as a cab mount.

(2) The standard version does not use the seat frame or any other similar structure.

(3) The seat frame is installed via four mounts (b) onto the truck frame using four bolts (a). To the seat frame, the steering column, parking brake lever, heater and other components are attached. The seat frame can be removed by removing the bolts (a) while supporting it with a hoist.



208995

SAFETY

⚠WARNING

The proper and safe lubrication and maintenance for this lift truck, recommended by Cat Lift Truck, are outlined in the OPERATION & MAINTENANCE MANUAL for these trucks.

Improper performance of lubrication or maintenance procedures is dangerous and could result in injury or death. Read and understand the OPERATION & MAINTENANCE MANUAL before performing any lubrication or maintenance.

The serviceman or mechanic may be unfamiliar with many of the systems on this truck. This makes it important to use caution when performing service work. A knowledge of the system and/or components is important before the removal or disassembly of any component.

Because of the size of some of the truck components, the serviceman or mechanic should check the weights noted in this Manual. Use proper lifting procedures when removing any components.

Following is a list of basic precautions that should always be observed.

1. Read and understand all warning plates and decals on the truck before operating, lubricating or repairing the product.
2. Always wear protective glasses and protective shoes when working around trucks. In particular, wear protective glasses when pounding on any part of the truck or its attachments with a hammer or sledge. Use welders gloves, hood/goggles, apron and other protective clothing appropriate to the welding job being performed. Do not wear loose-fitting or torn clothing. Remove all rings from fingers when working on machinery.
3. Do not work on any truck that is supported only by lift jacks or a hoist. Always use blocks or jack stands to support the truck before performing any disassembly.
4. Lower the forks or other implements to the ground before performing any work on the truck. If this cannot be done, make sure the forks or other implements are blocked correctly to prevent them from dropping unexpectedly.

⚠WARNING

Do not operate this truck unless you have read and understand the instructions in the OPERATION & MAINTENANCE MANUAL. Improper truck operation is dangerous and could result in injury or death.

5. Use steps and grab handles (if applicable) when mounting or dismounting a truck. Clean any mud or debris from steps, walkways or work platforms before using. Always face truck when using steps, ladders and walkways. When it is not possible to use the designed access system, provide ladders, scaffolds, or work platforms to perform safe repair operations.
6. To avoid back injury, use a hoist when lifting components which weigh 23 kg (50 lb.) or more. Make sure all chains, hooks, slings, etc., are in good condition and are of the correct capacity. Be sure hooks are positioned correctly. Lifting eyes are not to be side loaded during a lifting operation.
7. To avoid burns, be alert for hot parts on trucks which have just been stopped and hot fluids in lines, tubes and compartments.
8. Be careful when removing cover plates. Gradually back off the last two bolts or nuts located at opposite ends of the cover or device and pry cover loose to relieve any spring or other pressure, before removing the last two bolts or nuts completely.
9. Be careful when removing filler caps, breathers and plugs on the truck. Hold a rag over the cap or plug to prevent being sprayed or splashed by liquids under pressure. The danger is even greater if the truck has just been stopped because fluids can be hot.

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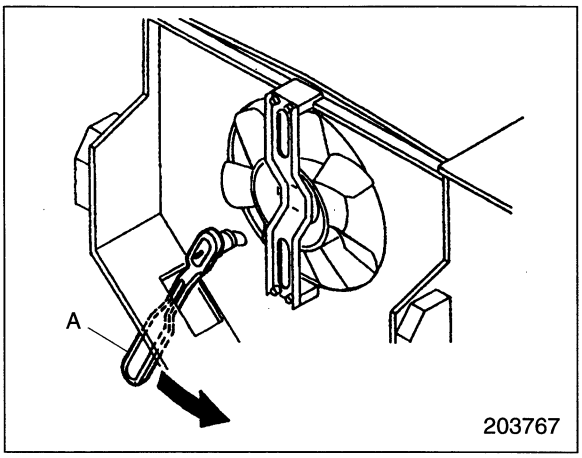


- Please note: If there is no response to CLICKING the link, please download this PDF first and then click on it.

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Suggestion for Removal

Loosen the tension pulley bolt one to two full turns with Ratchet Wrench A through the access hole in the frame. Using a bar, force the tension pulley toward the fan as far as it will go and tighten the pulley bolt, then remove the fan belts.



Installation

Follow the reverse of removal sequence and do the following steps:

1. Fan belt

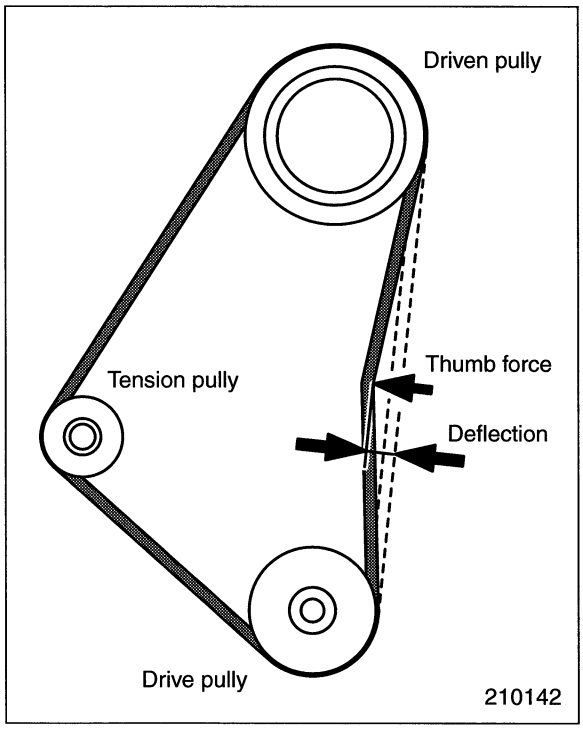
(1) Turn the fan with the fan belt removed to make sure that it rotates smoothly. Replace the bearings if they have noise.

(2) After putting the fan belt, push it midway between the drive and driven pulleys to the specified value listed below to check for the deflection amount.

A: Standard value B: Repair or service limit

Unit: mm (in.)

Thumb force	A	19.6 N (2.0 kgf) [43 lbf]
Deflection amount	A	20 to 25 (0.79 to 0.98)
	B	28 (1.10)



(3) If the deflection amount is out of the specified value, adjust it with the tension pulley.

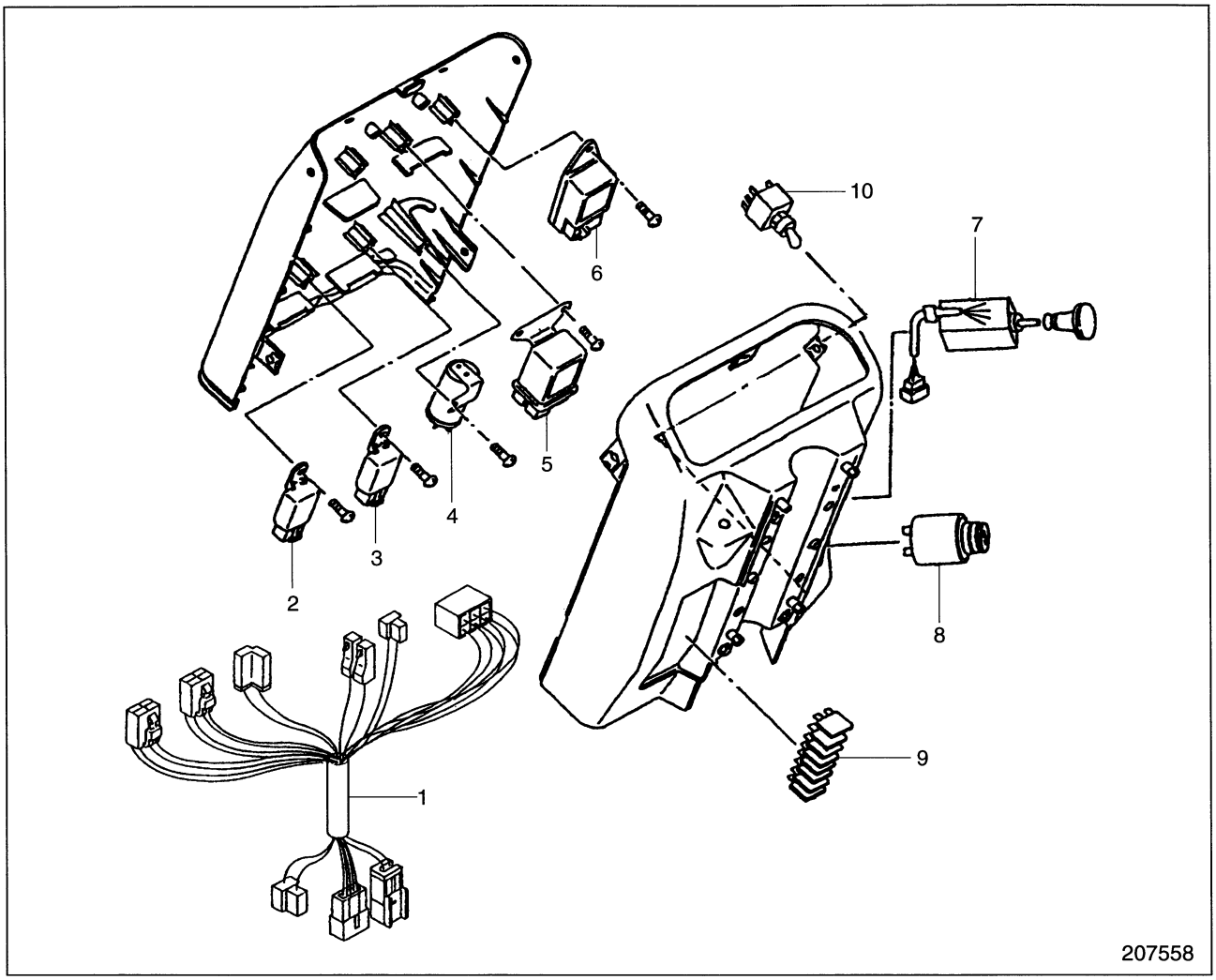
(4) After having adjusted the fan belt properly, be sure to tighten the tension pulley bolt.

2. Radiator

(1) Refer to the section "Radiator and Intercooler." (Refer to page 2-3.)

Components in Console Box

Disassembly



Sequence

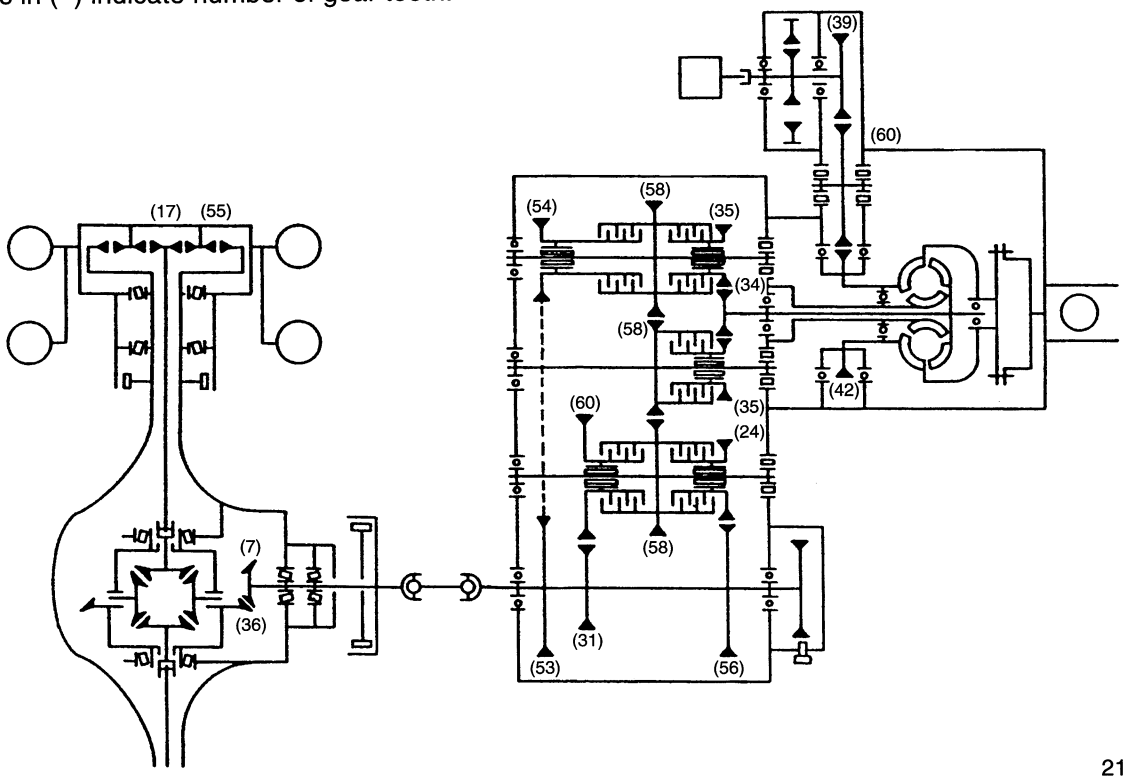
1. Harnesse
2. Power relay
3. Power relay
4. Turn signal relay
5. Glow plug relay
6. Glow plug timer
7. Lighting switch
8. Starter switch
9. Fuses
10. Travel speed select switch

Reassembly

To reassemble the console box, follow the reverse of disassembly sequence.

Gear Ratios (3-speed Transmission)

Figures in ( ) indicate number of gear teeth.



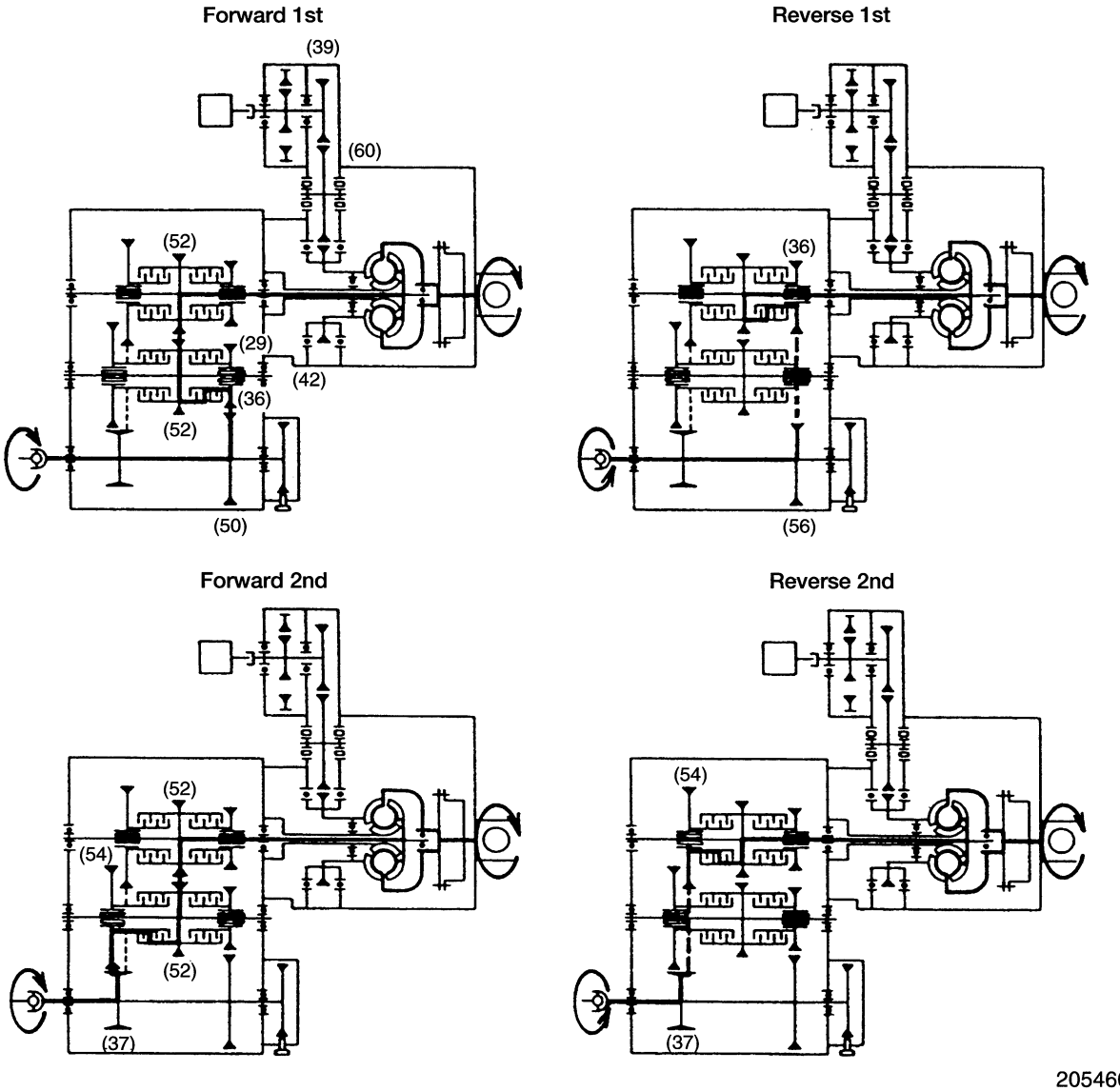
210201

Speed		Transmission	Reduction bevel gear	Final drive	Total gear ratio
Forward	1st	$2.402 \left(\frac{35}{34} \times \frac{58}{58} \times \frac{58}{58} \times \frac{56}{24} \right)$	$5.142 \left(\frac{36}{7} \right)$	$4.235 \left(\frac{55}{17} + 1 \right)$	52.318
	2nd	$1.010 \left(\frac{35}{34} \times \frac{53}{54} \right)$			22.007
	3rd	$0.532 \left(\frac{35}{34} \times \frac{58}{58} \times \frac{58}{58} \times \frac{31}{60} \right)$			11.585
Reverse	1st	$2.402 \left(\frac{35}{34} \times \frac{58}{58} \times \frac{56}{24} \right)$			52.318
	2nd	$1.010 \left(\frac{35}{34} \times \frac{58}{58} \times \frac{53}{54} \right)$			22.007
	3rd	$0.532 \left(\frac{35}{34} \times \frac{58}{58} \times \frac{31}{60} \right)$			11.585

PTO gear ratio: $0.929 \left(\frac{60}{42} \times \frac{39}{60} \right)$

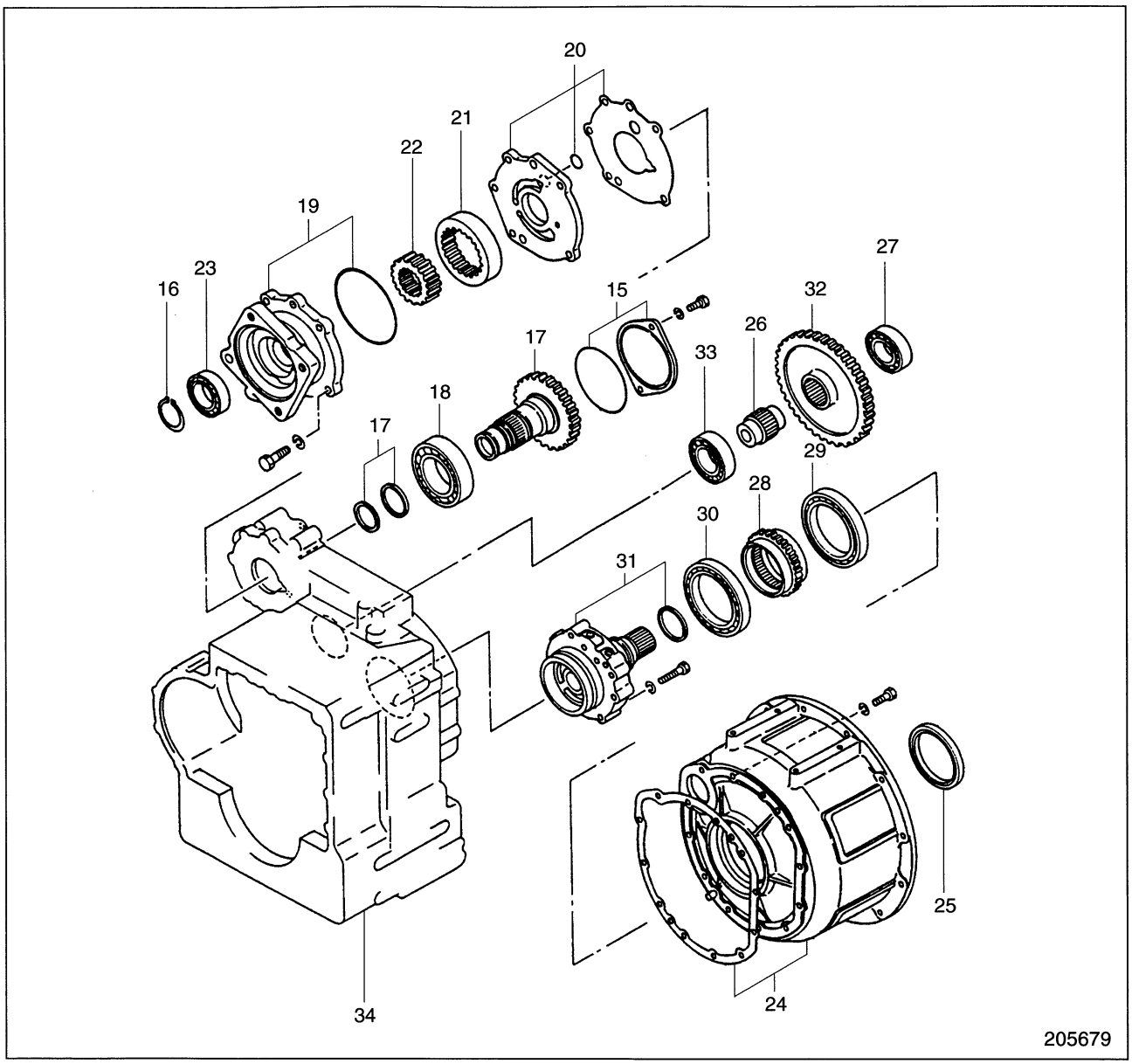
Power Flow

Figures in ( ) indicate number of gear teeth.



Speed		Gears engaged	Gear ratio
Forward	1st	$\frac{52}{52} \times \frac{56}{36}$	1.556
	2nd	$\frac{52}{52} \times \frac{37}{54}$	0.685
Reverse	1st	$\frac{56}{36}$	1.556
	2nd	$\frac{37}{54}$	0.685
PTO gear		$\frac{60}{42} \times \frac{39}{60}$	0.929

3. Stator shaft and oil pump

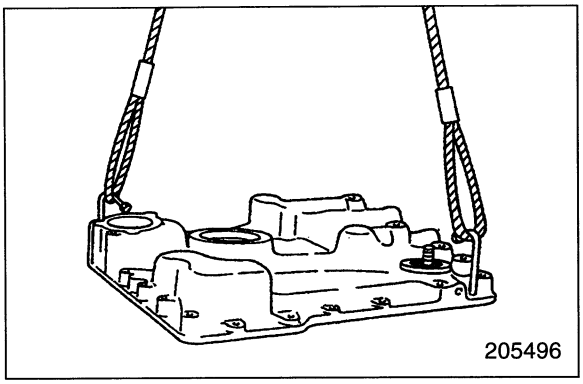


Sequence

15. PTO cover, O-ring, Bolts, Washers
16. Snap ring
17. Pump drive gear, Seal rings
18. Ball bearing
19. Pump case, O-ring, Bolts, Washers
20. Pump plate, O-ring, Gasket, Bolts, Washers
21. Internal gear
22. Pump gear
23. Ball bearing
24. Torque converter housing, Gasket, Bolts, Washers
25. Oil seal
26. Idler gear shaft
27. Roller bearing
28. PTO drive gear
29. Ball bearing
30. Ball bearing
31. Stator shaft, Seal ring, Bolts, Washers
32. Pump idler gear
33. Roller bearing
34. Transmission case, Dowels

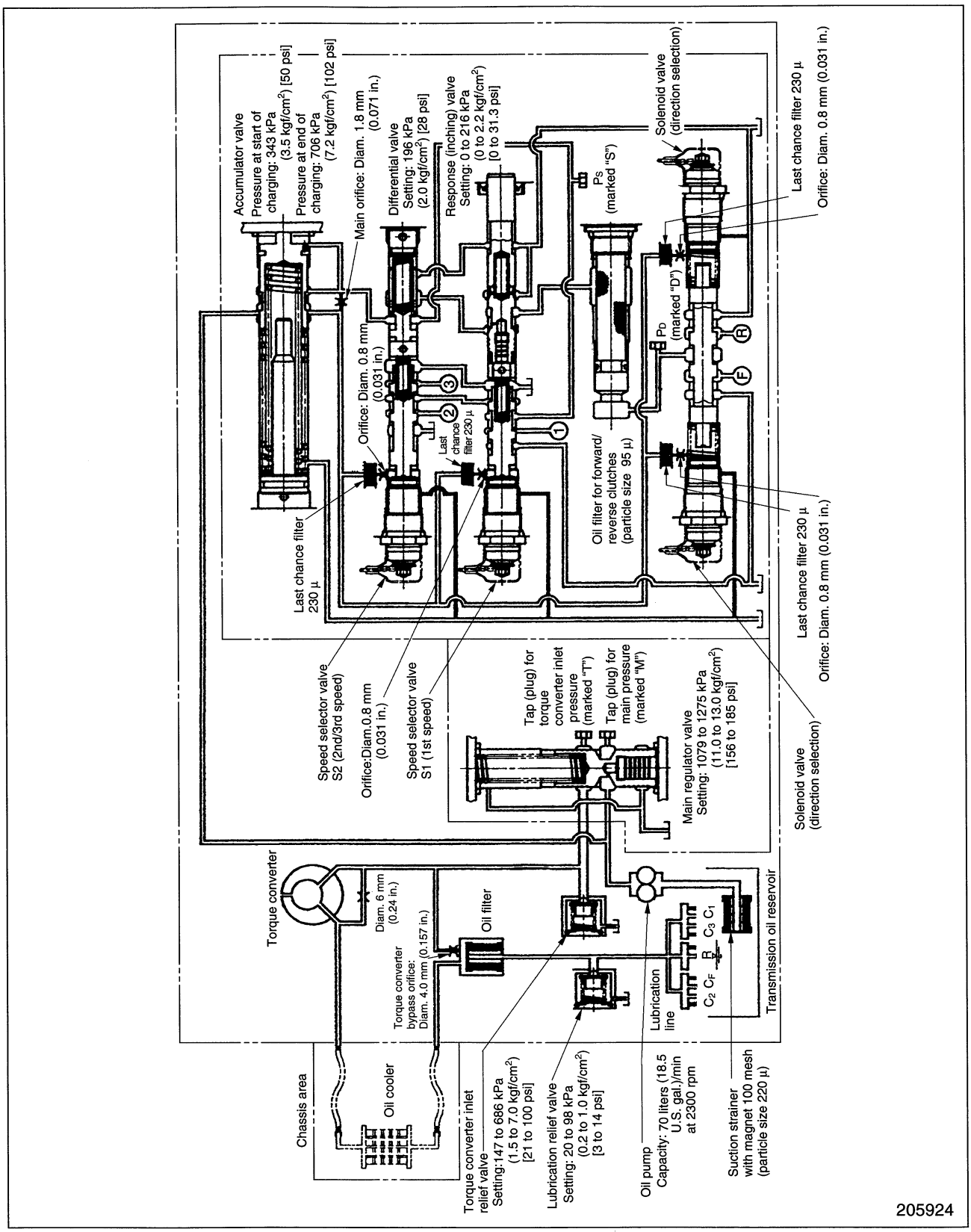
4. Transmission cover installation

Install hooks in the jack bolt holes in the transmission cover and hitch slings to these hooks. Put the gasket on the transmission case. Hoist the cover and install it in position. Apply oil to the servo cases formed of the cover when installing the cover. Do not forget to put the O-rings in the oil holes.



Clutch pressure is too low	Magnet strainer clogged	— Clean or replace.
	Oil pump worn or defective	— Replace.
	Coil spring defective in main regulator valve	— Replace.
	Main regulator valve spool defective	— Repair or replace.
	Air being sucked in	— Retighten or replace packing.
	Oil level too low	— Refill.
	Control linkage out of order	— Repair or replace.
	Inching valve defective	— Repair or replace.
	Seal ring broken in servo case	— Replace.
	Clutch seal rings broken	— Replace.
Stall speed out of specification	Lack of engine power if the speed is slightly low in both forward and reverse drive	— Tune up engine.
	Stator and freewheel defective if the speed is excessively low in both forward and reverse drive	— Replace stator assembly.
	Inching pedal linkage defective, or clutch slipping if the speed is too high	— Repair or replace.
No automatic shifting	Travel speed select switch in "Fixed 1st speed" position	— Move switch to "Automatic 2-speed" position.
	Solenoid valve defective	— Replace.
	Solenoid valve inlet orifice clogged	— Clean or replace.
	Solenoid valve spool or spring defective	— Repair or replace.
	ECU control box internally defective	— Check or replace.
Transmission shifts up when travel speed select switch is in "Fixed 1st speed" position	Harness open	— Repair.
	Travel speed select switch defective	— Replace.

Hydraulic Controls



5. Stator shaft 41 removal

Turn two Bolts (jack bolts) (special tool) in the M10 x 1.25 holes in one end of the shaft evenly, or hit the other end by using a protective plate.

Special tool needed

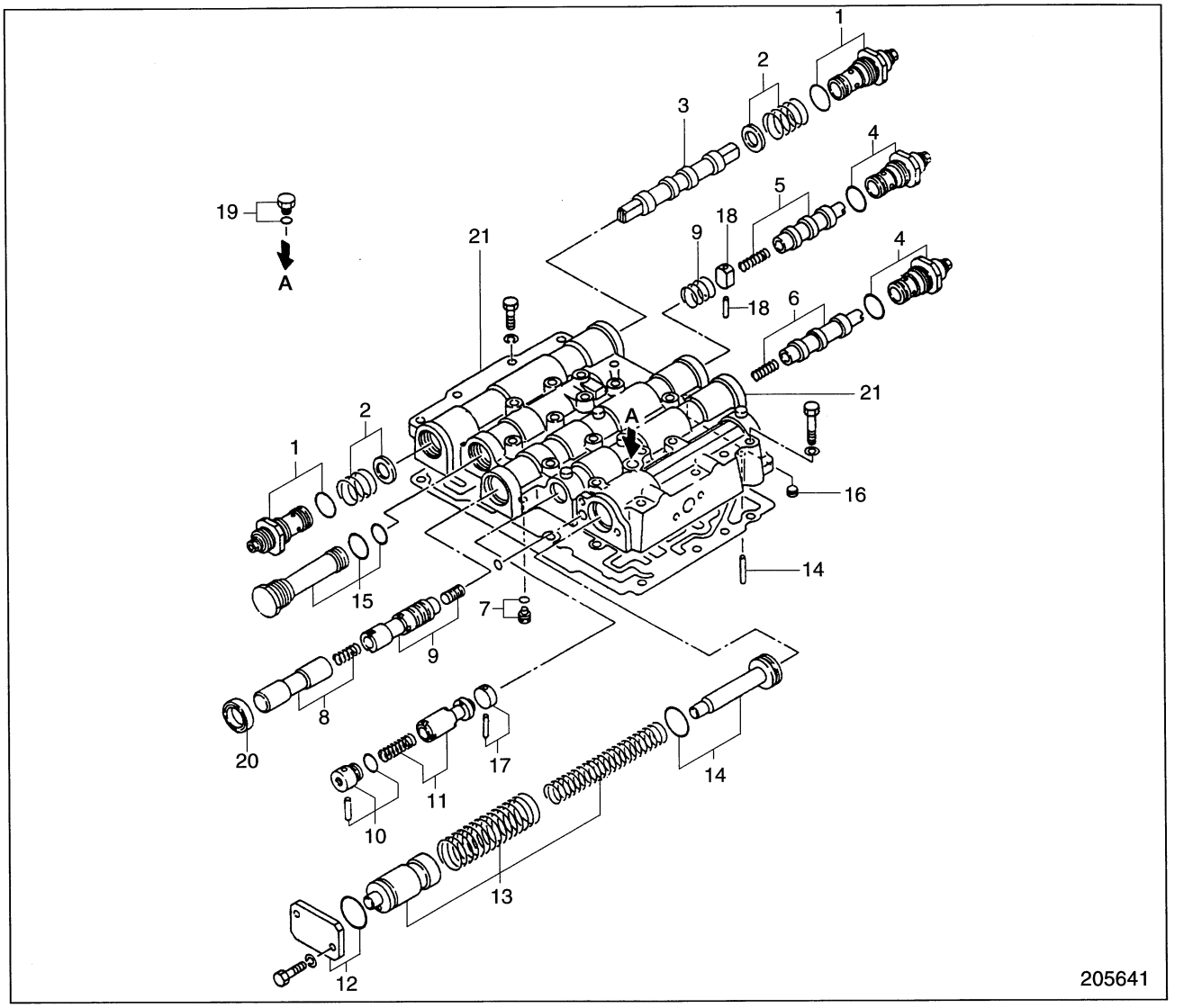
Bolt	67284 - 15400

6. Roller bearing outer race removal

Do not remove the outer races 44, 45 and 46 of the roller bearings installed in the transmission case and the outer race of roller bearing 43 installed on idler gear shaft 36 unless they are defective.

Control Valve

Disassembly



Sequence

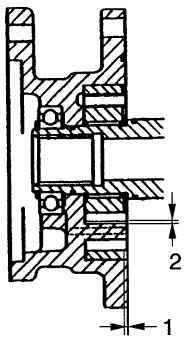
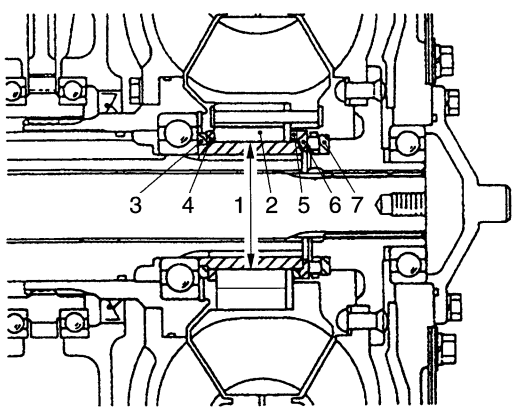
1. Solenoid valves, O-rings (two)
2. Springs, Spring seats
3. Direction valve
4. Solenoid valves, O-rings (two)
5. 2nd-speed/3rd-speed valve, Spring
6. 1st-speed valve, Spring
7. Stopper pin, O-ring
8. Inching valve plunger, Spring
9. Inching valve, Slug, Spring
10. Roller bearing, Plug, O-ring
11. Spring, Differential valve
12. Plate, O-ring, Bolts, Washers
13. Accumulator valve piston, Springs (inner and outer)
14. Pin, Seat, O-ring
15. Oil filter, O-rings
16. Last chance filters (four)
17. Roller bearing, Plug
18. Roller bearing, Plug
19. Plug, O-ring
20. Oil seal
21. Valve body, Gasket

⚠ CAUTION

Slowly loosen each bolt and solenoid valve so that the spring and plunger do not suddenly jump out.

A: Standard value B: Repair or service limit

Unit: mm (in.)

Item		Truck Model	DP80	DP90
Oil pump	Side clearance 1	A	0.040 to 0.078 (0.00157 to 0.00307)	
		B	0.09 (0.0035)	
	Top clearance 2	A	0.3 to 0.345 (0.0118 to 0.0136)	
		B	0.35 (0.0138)	
	 205486			
Stator	Outside diameter of clutch hub 1	A	67.951 to 67.97 (2.67523 to 2.6760)	
		B	67.8 (2.669)	
	Diameter of clutch rollers 2	A	10.185 to 10.2 (0.40098 to 0.402)	
		B	10.1 (0.398)	
	Thickness of thrust washer 3	A	4.95 to 5 (0.1949 to 0.197)	
		B	4.8 (0.189)	
	Thickness of thrust washer 4	A	3.95 to 4 (0.1555 to 0.157)	
		B	3.8 (0.150)	
	Thickness of thrust washer 5	A	2.9 to 3 (0.114 to 0.118)	
		B	2.8 (0.110)	
	Thickness of thrust washer 6	A	4.9 to 5 (0.193 to 0.197)	
		B	4.8 (0.189)	
	Thickness of thrust washer 7	A	4.95 to 5 (0.1949 to 0.197)	
		B	4.8 (0.189)	
	 200724			

3. Hub and drum assemblies

(1) Check the oil seal for wear or damage.

(2) Check the inside surface of the brake drum for wear or damage.

A: Standard value B: Repair or service limit

Unit: mm (in.)

Inside diameter of wheel brake drum	A	410 (16.14)
	B	411 (16.18)

(3) Check the taper roller bearings (outer races) for wear or damage.

4. Planet carriers

(1) Measure the inside diameter of the planet gear bushings and the diameter of the planet pins.

A: Standard value B: Repair or service limit

Unit: mm (in.)

Inside diameter of planet gear bushings	A	$48\ ^{+0.025}_{+0.009}$ ($1.89\ ^{+0.00098}_{+0.00035}$)
	B	48.1 (1.894)
Diameter of planet pins	A	$40\ ^{0}_{-0.011}$ ($1.57\ ^{0}_{-0.00043}$)
	B	39.9 (1.571)

(2) Check the thrust washers for wear or damage.

A: Standard value B: Repair or service limit

Unit: mm (in.)

Thickness of thrust washer	A	1.6 (0.063)
	B	1.2 (0.047)

5. Others

(1) Check the outer surface of oil seal retainer for wear or damage.

(2) Check the taper roller bearings (inner races) for wear or damage.

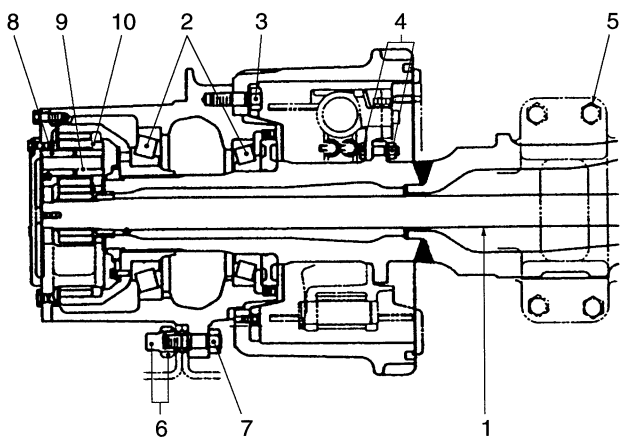
Service Data

Front Axle

A: Standard value B: Repair or service limit

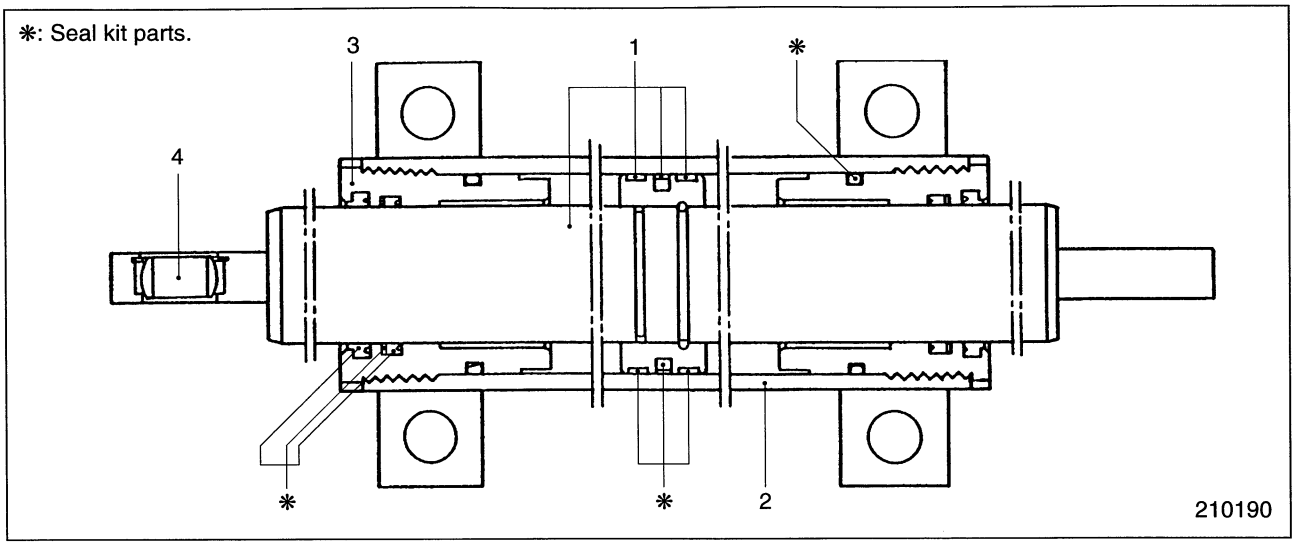
Unit: mm (in.)

Item \ Truck Model			DP80	DP90
Axle shaft runout 1 (1/2 of dial indicator reading)		A	0.05 (0.0020)	
		B	0.2 (0.008)	
Preload for hub bearings 2 (force applied to hub bolt in tangential direction) N (kgf) [lbf]		A	127 to 167 (13 to 17) [29 to 38]	
Tightening torque for brake drum nuts 3 N·m (kgf·m) [lbf·ft]		A	359±36 (36.6±3.7) [265±27]	
Tightening torque for brake backing plate mounting nuts 4 N·m (kgf·m) [lbf·ft]		A	156±16 (15.9±1.6) [115±12]	
Tightening torque for front axle housing mounting nuts 5 N·m (kgf·m) [lbf·ft]		A	640±96 (65.3±9.8) [472±71]	
Tightening torque for wheel nuts 6 N·m (kgf·m) [lbf·ft]	Inner	A	382±38 (39±3.9) [282±28]	
	Outer	A		
Tightening torque for wheel nuts 7 N·m (kgf·m) [lbf·ft]		A	294±29 (30±3) [217±21]	
Diameter of planet pin 8		A	$40\ ^{0}_{-0.011}$ ($1.57\ ^{0}_{-0.00043}$)	
		B	39.9 (1.571)	
Inside diameter of planet gear bearing 9		A	$48\ ^{+0.025}_{+0.009}$ ($1.89\ ^{+0.00098}_{+0.00035}$)	
		B	48.1 (1.894)	
Thickness of thrust washer 10		A	1.6 (0.063)	
		B	1.2 (0.047)	



205613

Assembly



Sequence

1. Piston rod, Wear rings, Piston seal
2. Cylinder tube
3. Cylinder head, Dust seal, Back-up ring, Rod seal, O-ring
4. Stopper ring, Bearing

Suggestions for Assembly

(1) Replace the seal kit parts.

(2) Thoroughly wash all parts and components.

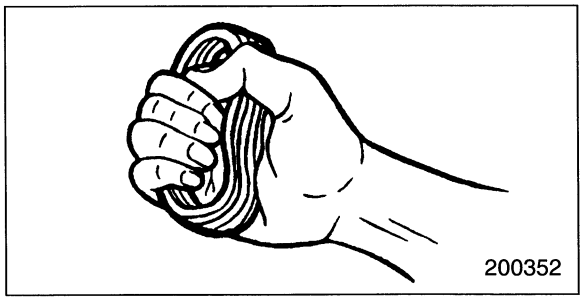
(3) Apply hydraulic oil to the sealing parts and the inside surfaces of the cylinder.

(4) Wrap the cylinder tube with rag or cloth, and hold it in a vise. Pay attention not to deform the cylinder.

(5) Install the piston seal to the piston as follows:

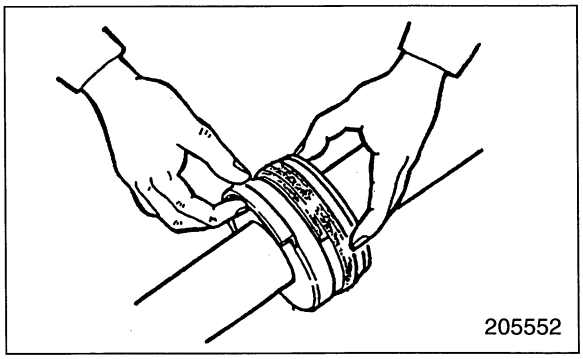
(a) Squeeze the piston seal by hand five or six times to soften it. Hold the piston rod in vise. Apply a small amount of hydraulic oil to the piston seal. Fit a portion of the seal in the groove of the piston, then push the other portions into the groove.

(b) Install the wear rings in position.



NOTE

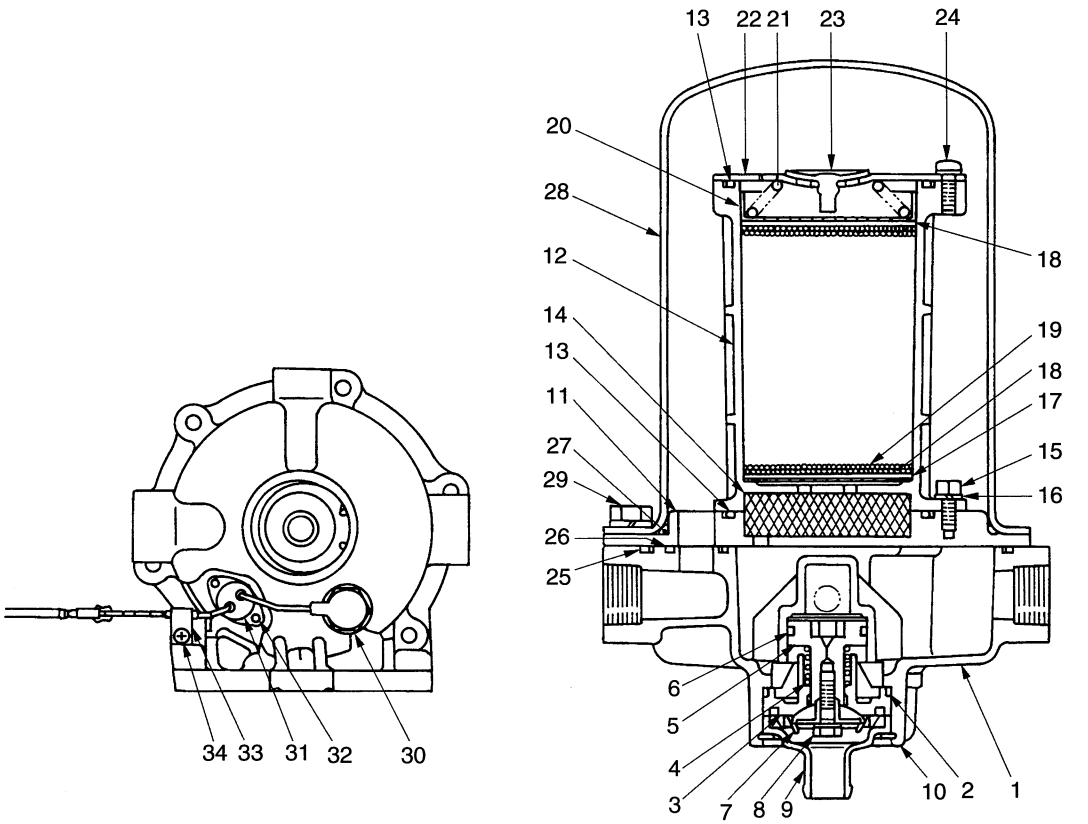
Install the seals and rings on the cylinder head correctly.



(6) Tighten the cylinder head to the specified torque.

Tightening torque for cylinder head	392±49 N·m (40±5 kgf·m) [289±36 lbf·ft]

Air dryer

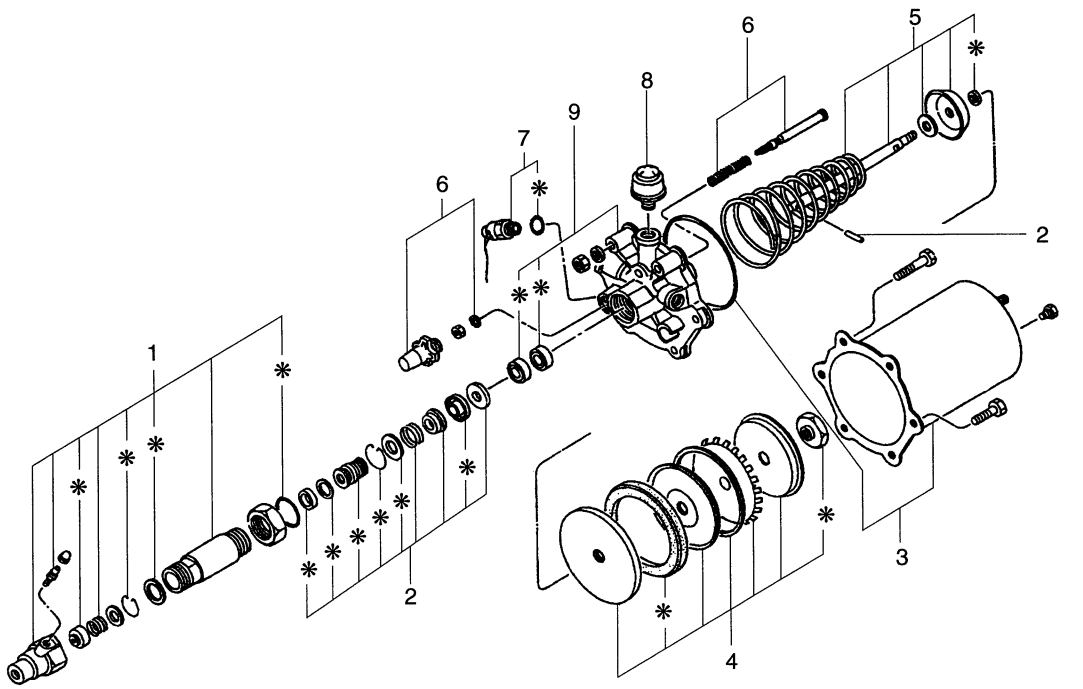


1. Body
2. O-ring
3. Valve body
4. Valve spring
5. Piston
6. O-ring
7. Valve component
8. Bolt and washer
9. Exhaust cover
10. Retaining ring
11. Cover
12. Case
13. O-ring
14. Oil separator filter
15. Hexagon socket head bolt
16. Spring washer
17. Filter plate (1)
18. Filter
19. Desiccant
20. Filter plate (2)
21. Set spring
22. Case cover
23. Check valve
24. Screw and washer
25. Gasket ring
26. Gasket ring
27. O-ring
28. Purge chamber
29. Bolt and washer
30. Heater
31. Thermostat component (A)
32. FT screw
33. Cord clamp
34. Rolling screw

Air Master

Disassembly

✻: Seal kit parts.



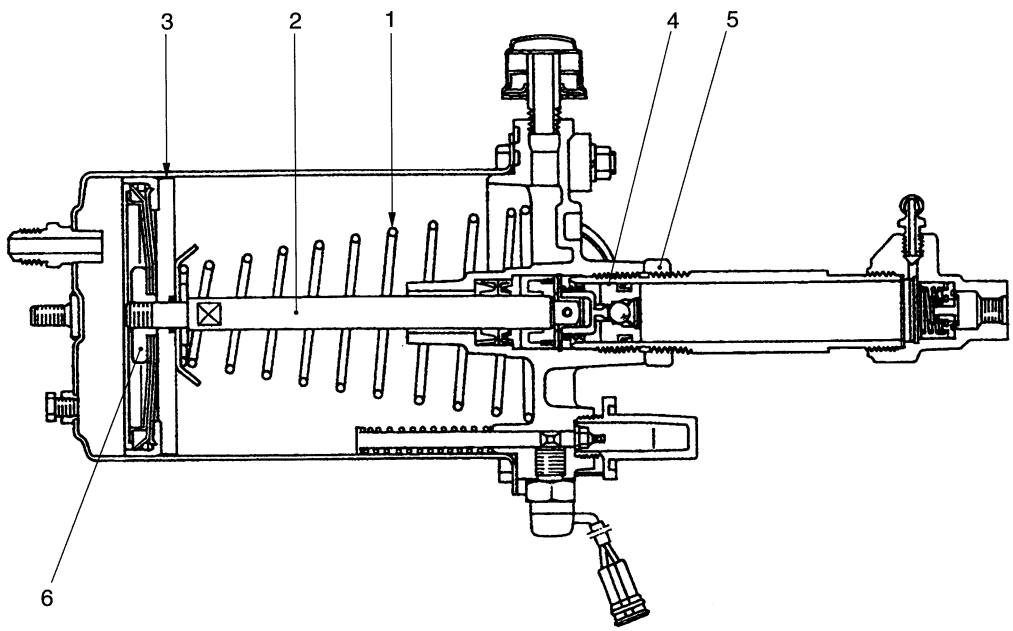
Sequence

1. Hydraulic cylinder, Outlet valve, Cylinder cap, Plug, Spring, O-ring
2. Hydraulic piston, Washer, Spring, Retainer, Cup packing, Thrust pin
3. Cylinder shell, O-ring
4. Piston plate, Nut, Retainer plate, Expander, Wick, Leather packing
5. Push rod, Spring, Plate, Spring retainer, Gasket
6. Rod, Plate, Retainer, Spring
7. Switch, Shim
8. Air breather
9. End plate, Oil seal

A: Standard value B: Repair or service limit

Unit: mm (in.)

Item			Truck Model DP80	DP90
Air master	Power piston return spring 1 (Test force/length under test force) N (kgf) [lbf]	A	196±20 (20±2) [44±4] / 179 (7.05)	
		B	157 (16) [35] / 179 (7.05)	
	Bend of push rod 2	A	0.05 (0.0020), maximum	
	Clearance between power piston and cylinder shell 3	A	0.5 to 1.4 (0.020 to 0.055)	
		B	1.8 (0.071)	
	Clearance between hydraulic piston and cylinder tube 4	A	0.07 to 0.15 (0.0028 to 0.0059)	
		B	0.2 (0.008)	
	Tightening torque for hydraulic cylinder lock nut 5 N·m (kgf·m) [lbf·ft]	A	98 to 147 (10 to 15) [72 to 108]	
	Tightening torque for power piston end nut 6 N·m (kgf·m) [lbf·ft]	A	20 to 29 (2 to 3) [14 to 22]	



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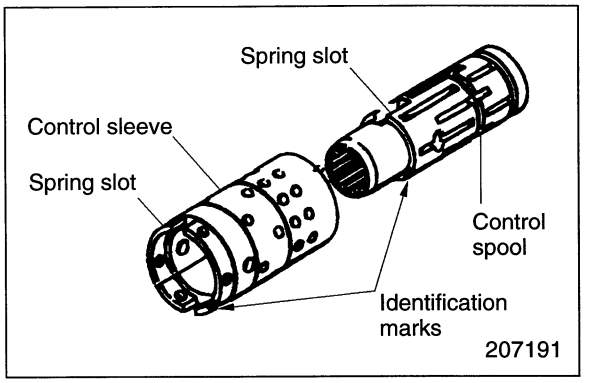
Suggestion for Assembly

Assembly on gerotor side

1. Assembly the spool and sleeve

(1) Assemble the spool and sleeves so that the spring slots line up. Rotate the spool while sliding into the parts together.

Some sets have identification marks. Align these marks. Test for free rotation.

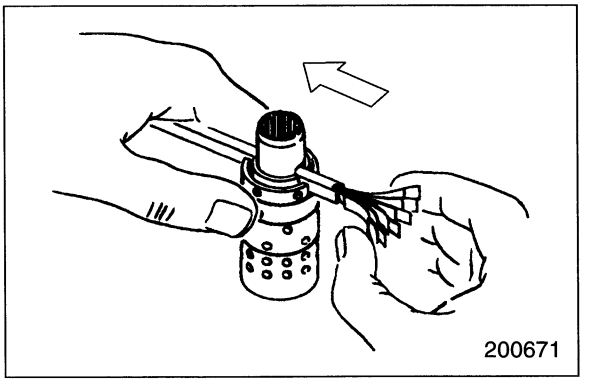


(2) Align spring slots of both parts. Position one end of the centering springs in the Spring Installation Tool (special tool) and compress the other end. Push the spring set into the spool and sleeve assembly while withdrawing the installation tool at the same time.

Special tool needed

Spring installation tool	97157 - 00100

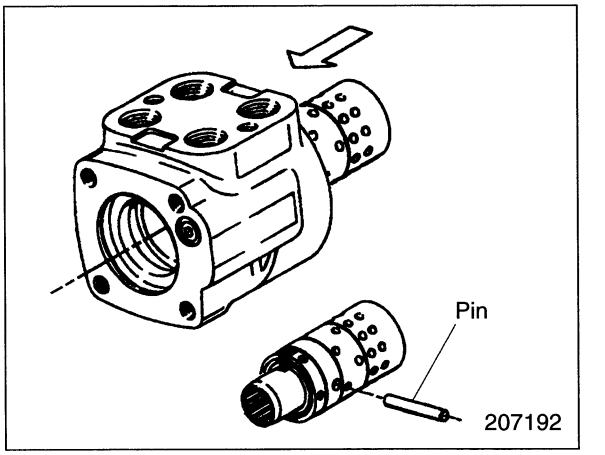
(3) Center the spring set in parts so that they push down evenly and flush with the upper surfaces of the spool and sleeve.



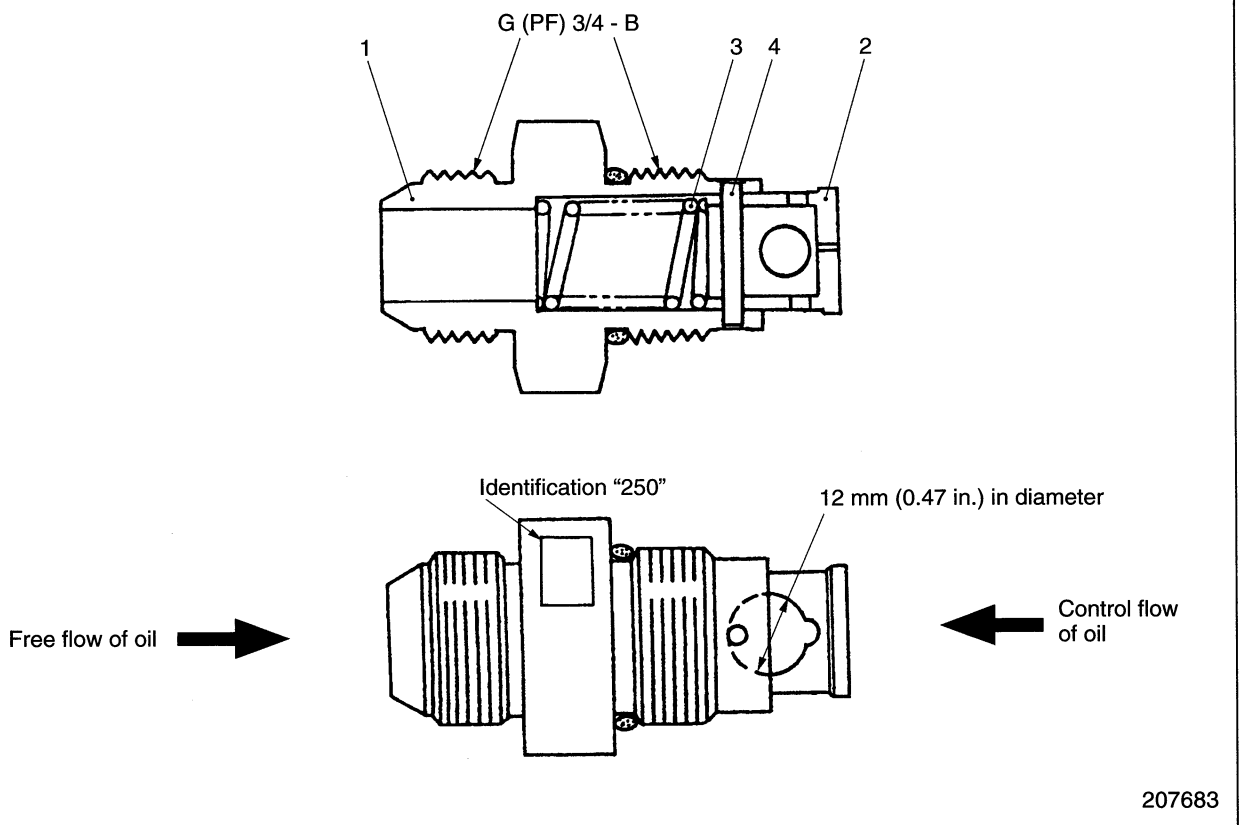
(4) Install the pin through the spool and sleeve to the point where pin ends are flush with the sleeve. Insert the spool and sleeve assembly, placing the splined end to enter the housing first.

NOTE

Be extremely careful that the parts do not jam. Push the parts into place with a slight rotating action. Keep the pin nearly horizontal and check for free rotation without allowing the pin to drop into the discharge groove in the housing.



Down Safety Valve (Simplex mast)

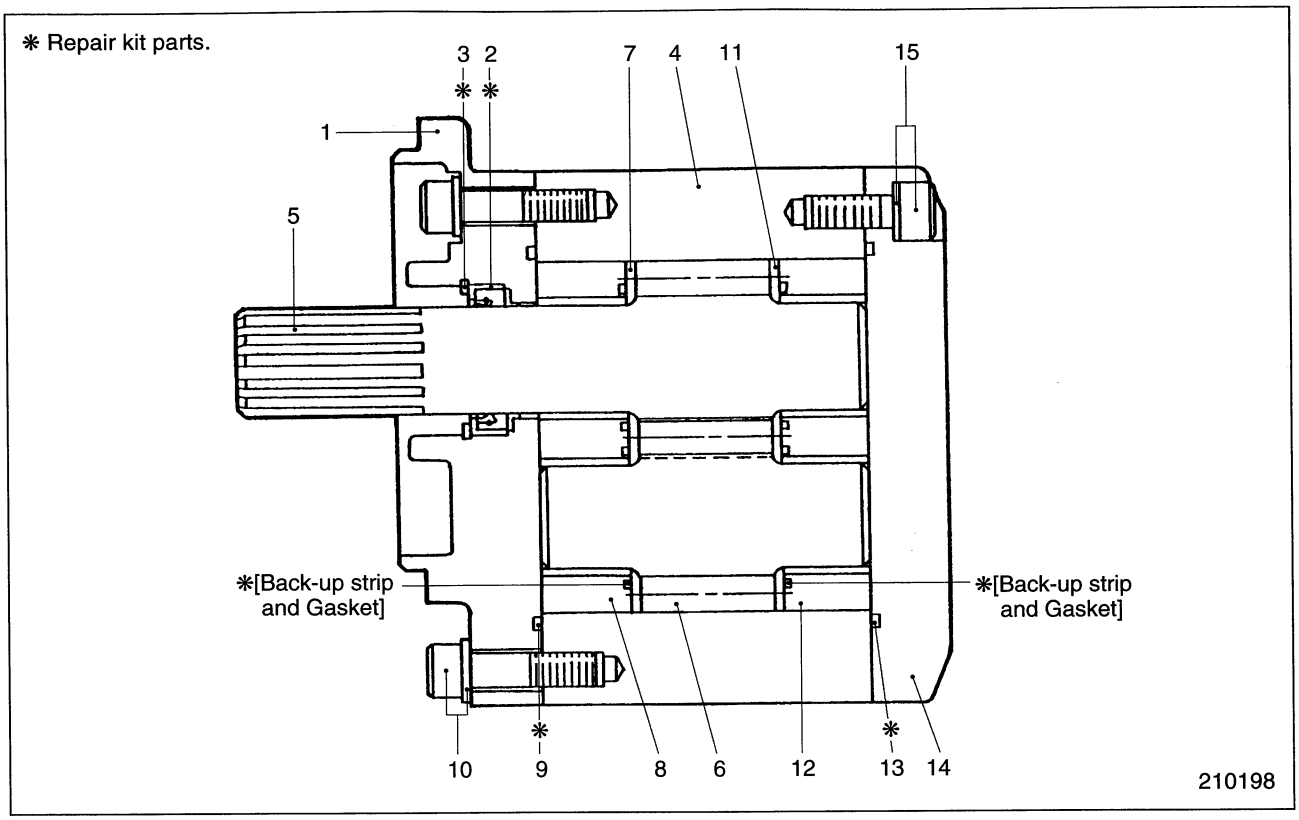


1. Connector
2. Valve
3. Spring
4. Spring pin

The down safety valve is built in the bottom of left-hand lift cylinder. This valve interrupts the flow of oil from the lift cylinder when the hose between the lift cylinder and flow regulator valve is ruptured, thereby preventing loaded forks from unsafely free falling.

Control flow rate	250±10 liters/min (66±2.6 U.S. gal./min)

Assembly



Sequence

1. Front cover
2. Oil seal
3. Snap ring
4. Body
5. Drive gear
6. Driven gear
7. Side plate
8. Bearing, Back-up strip, Gasket
9. O-ring
10. Bolts, Washers
11. Side plate
12. Bearing, Back-up strip, Gasket
13. O-ring
14. Rear cover
15. Bolts, Washers

Suggestions for Assembly

(1) Replace the repair kit parts.

(2) Clean the mating faces of covers 1 and 14 and body 4, making sure they are free from oil and grease.

(3) Apply grease to the lip of the oil seal.

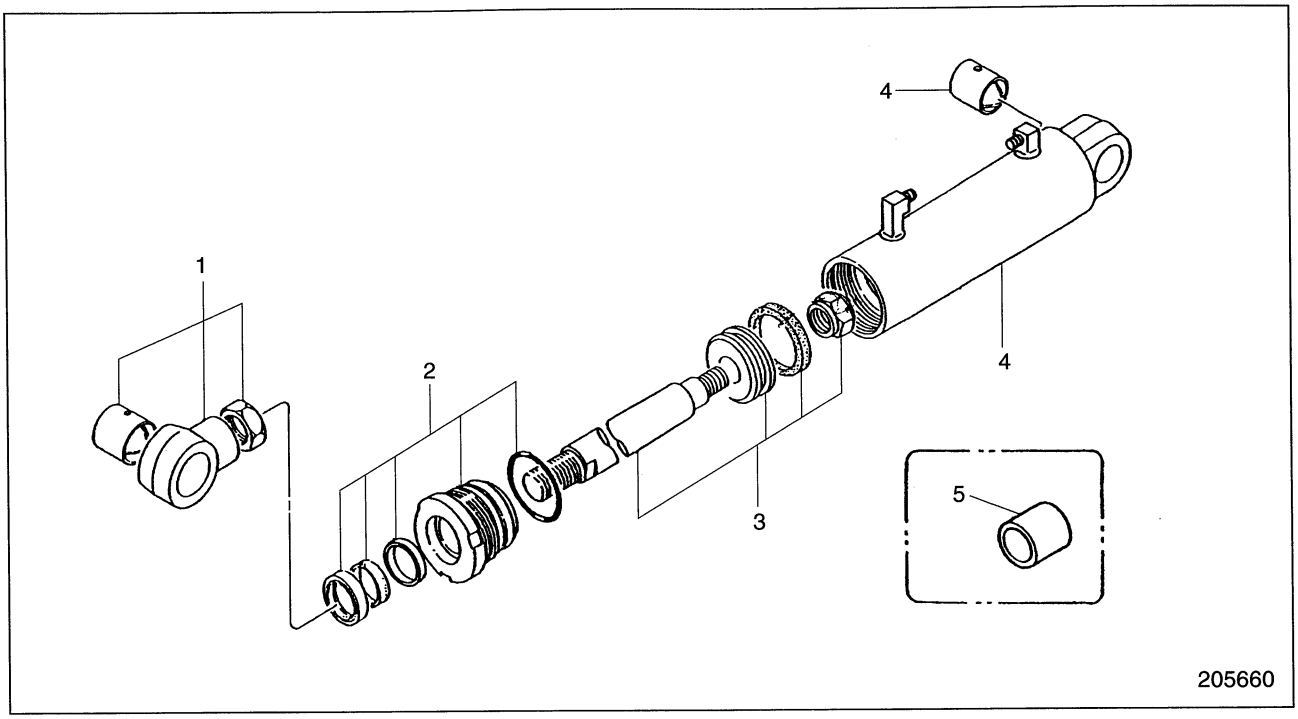
(4) Take care not to rub the lip of the oil seal against the splines of drive gear 5.

(5) Tighten the bolts evenly.

Tightening torque for bolts 10 and 15	56 to 63 N·m (5.7 to 6.4 kgf·m) [41 to 46 lbf·ft]

Tilt Cylinders

Disassembly



Sequence

1. Socket, Bushing, Nut
2. Bushing, O-ring, Dust seal, Buffer ring, Packing
3. Piston rod, Piston, Nut, Piston seal
4. Cylinder tube, Bushing
5. Collar

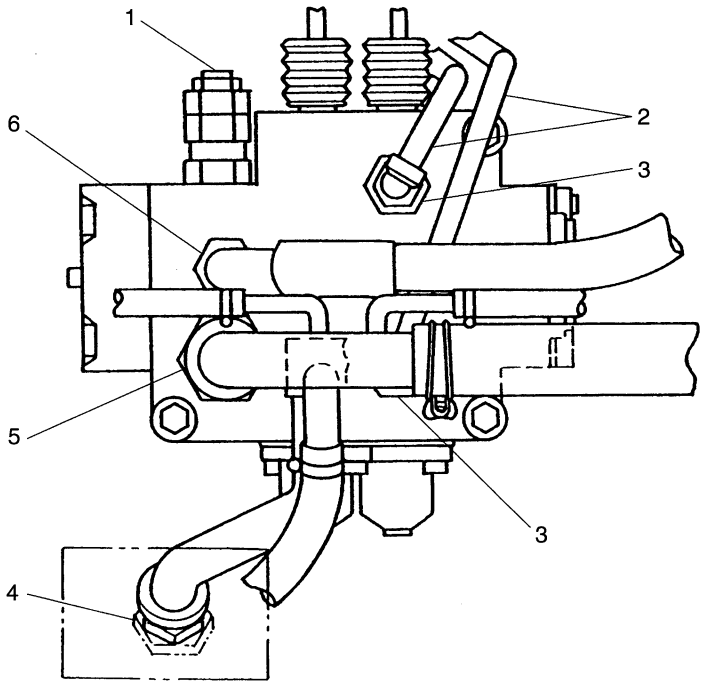
NOTE

(1) Collar 5 is not used in the tilt cylinders for 6° – 10° tilt angle.

(2) Do not remove the bushings fitted to cylinder tube 4 and socket 1 unless they are defective.

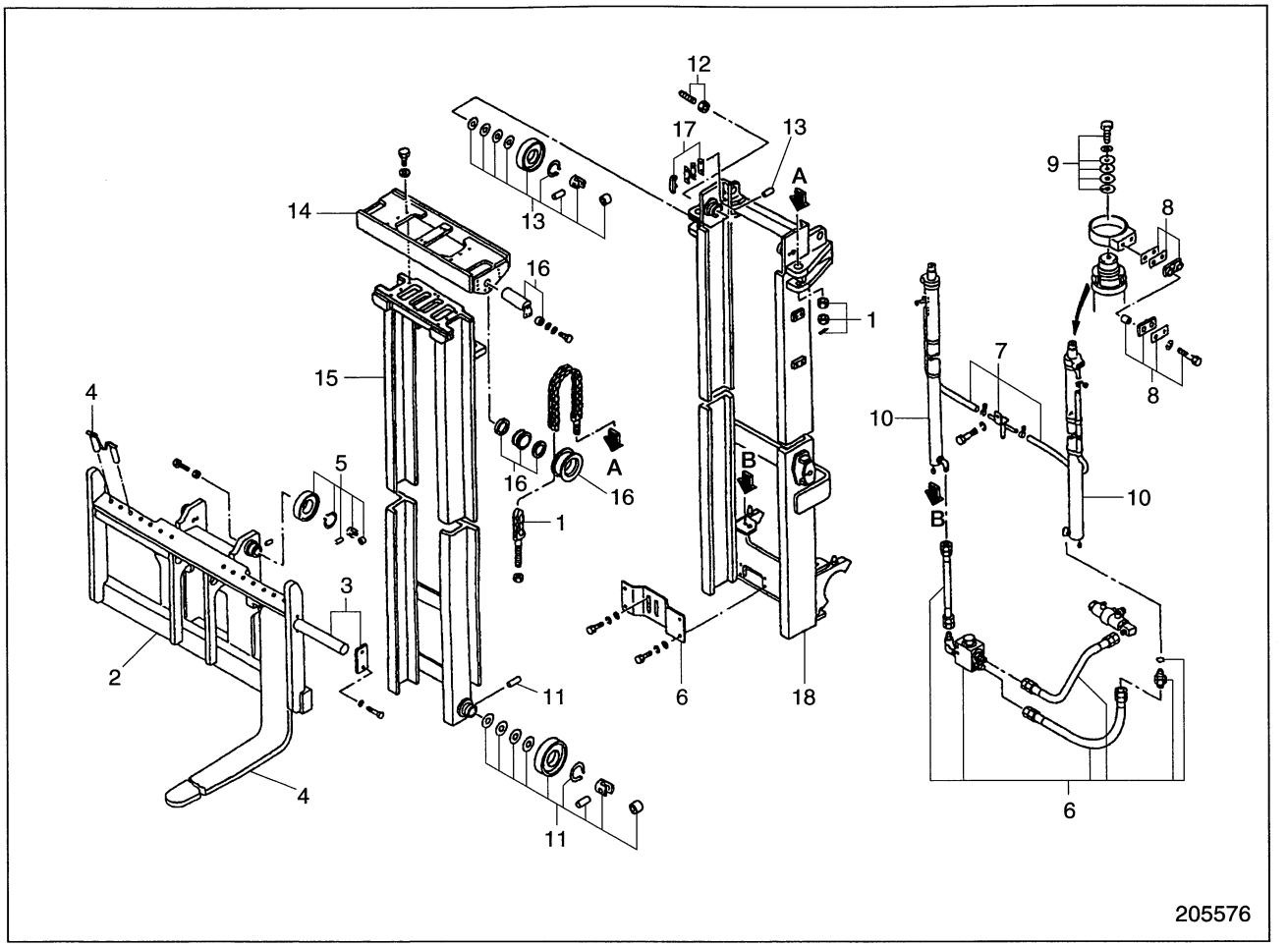
A: Standard value
Unit: mm (in.)

Item			Truck Model	DP80	DP90
Control valve	Main relief valve setting 1 kPa (kgf/cm²) [psi]		A	18142 $^{+490}_{0}$ (185 $^{+5}_{0}$) [2631 $^{+71}_{0}$]	
	Spool operating effort	Neutral N (kgf) [lbf]	A	160 (16.3) [36]	
		Full stroke N (kgf) [lbf]	A	187 (19.1) [42]	
	Tightening torque for tilt pipe joints 2 N·m (kgf·m) [lbf·ft]		A	98±9.8 (10±1) [72±7.2]	
	Tightening torque for tilt pipe connectors 3 N·m (kgf·m) [lbf·ft]		A	59±5.9 (6±0.6) [43±4.3]	
	Tightening torque for lift pipe connector 4 N·m (kgf·m) [lbf·ft]		A	118±12 (12±1.2) [87±9]	
	Tightening torque for return pipe connector 5 N·m (kgf·m) [lbf·ft]		A	167±17 (17±1.7) [123±12]	
	Tightening torque for delivery hose connector 6 N·m (kgf·m) [lbf·ft]		A	98±9.8 (10±1) [72±7.2]	



205665

Disassembly (DP90)



Sequence

1. Lift chains, Nuts, Split pins
2. Lift bracket
3. Stopper plates, Guide bars
4. Forks, Stopper pins
5. Main rollers, Side rollers, Bolts, Nuts, Snap rings, Pins
6. Hoses, Cover, Joints, O-rings, Down safety valve
7. Hoses, Clamps
8. Cylinder clamps, Bolts, Seats, Shims, Cushions, Collars
9. Bolts, Shims
10. Lift cylinders
11. Main rollers, Side rollers, Snap rings, Side roller bracket shims, Pins
12. Bolts, Nuts
13. Main rollers, Side rollers, Snap rings, Side roller bracket shims, Pins
14. Chain wheel supports
15. Inner mast
16. Chain wheels, Pins, Spacers, Collars, Bearings
17. Mast strips, Shims
18. Outer mast

Service Data

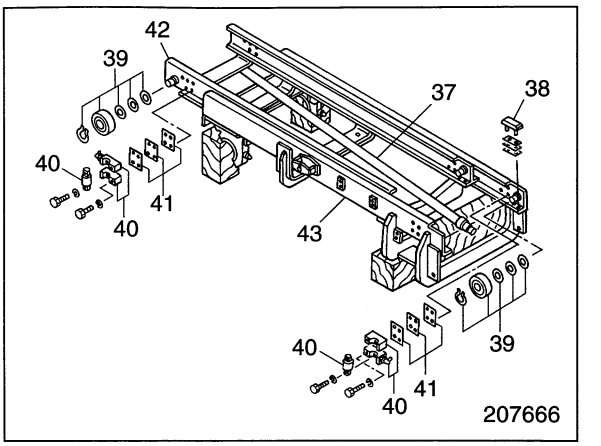
A: Standard value B: Repair or service limit

Unit: mm (in.)

Item				Truck Model DP80	DP90
Forks and chains	Unevenness of two fork tips		A	5 (0.20), maximum	
	Thickness of forks		A	60 (2.36)	70 (2.76)
			B	53 (2.09)	56 (2.20)
	Length of lift chain (20 links)		A	762 (30)	889 (35)
			B	785 (31)	915 (36)
	Tightening torque for nuts of lift chain anchor bolt N·m (kgf·m) [lbf·ft]		A	294 (30) [217]	392 (40) [289]
Rollers	Diameter of main roller	Size S	A	169 (6.65)	203 (7.99)
		Size M	A	170 (6.69)	205 (8.07)
		Size L	A	171 (6.73)	207 (8.15)
	Diameter of side rollers		A	$58\ {}^{0}_{-0.1}$ $(2.28\ {}^{0}_{-0.004})$	
Outer mast		X1	A	$896\ {}^{+0.5}_{-1.0}$ $(35.28\ {}^{+0.020}_{-0.039})$	$890\ {}^{+0.5}_{-1.0}$ $(35.04\ {}^{+0.020}_{-0.039})$
		X2	A	$896\ {}^{+1.0}_{-0.5}$ $(35.28\ {}^{+0.039}_{-0.020})$	$890\ {}^{+1.0}_{-0.5}$ $(35.04\ {}^{+0.039}_{-0.020})$
		A	A	768±0.5 (30.24±0.020)	754±0.5 (29.69±0.020)
Inner mast		Y1	A	$724\ {}^{+1.0}_{-0.5}$ $(28.50\ {}^{+0.039}_{-0.020})$	$704\ {}^{+0.5}_{-1.0}$ $(27.72\ {}^{+0.020}_{-0.039})$
		Y2	A	$724\ {}^{+1.0}_{-0.5}$ $(28.50\ {}^{+0.039}_{-0.020})$	$704\ {}^{+1.0}_{-0.5}$ $(27.72\ {}^{+0.039}_{-0.020})$
		B	A	896±0.5 (35.28±0.020)	890±0.5 (35.04±0.020)
Lift bracket and inner mast	Clearance P (over the whole lift range)		A	0.5 to 2.1 (0.020 to 0.083)	0.5 to 2.8 (0.020 to 0.110)
	Clearance K (at minimum lift height)		A	0.2 to 1.0 (0.008 to 0.039)	
	Mast strip clearance L		A	0.2 to 1.0 (0.008 to 0.039)	
	Lift bracket C		A	724±0.5 (28.50±0.020)	704±0.5 (27.72±0.020)
	Clearance M (over the whole lift range)		A	0.5 to 2.1 (0.020 to 0.0827)	0.5 to 2.8 (0.020 to 0.1102)
	Clearance N (at maximum lift height)		A	0.2 to 1.0 (0.0078 to 0.0394)	
	Tightening torque for mast cap bolts N·m (kgf·m) [lbf·ft]		A	490 (50) [362]	

4. Removing rollers, etc. of middle mast 42 and outer mast 43

Remove the bolts tightening 2nd lift cylinder 37, and place the cylinder on the outer mast. Move middle mast 42 downward so that main roller 39, side rollers 40 and 41 can be removed, and remove the rollers and the like and mast strip 38.



5. Removing middle mast 42

Lift the middle mast upward and let it pass beyond the shaft portion of the outer mast to remove middle mast 42.

Inspection

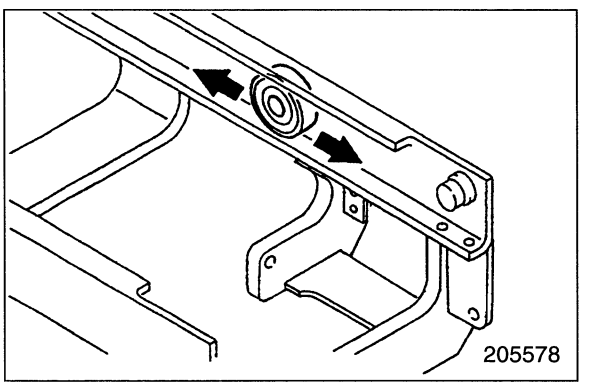
1. Mast

(1) Check each roller for binding, wear or cracks.

(2) Check each roller for flat spots on rolling surface.

(3) Check the mast member and the welds of crossmembers, pins and supports for cracks.

(4) Check the mast support bushings for wear or other defects.

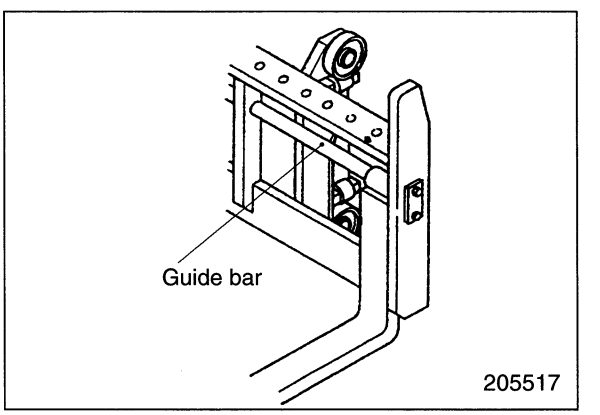


2. Lift bracket

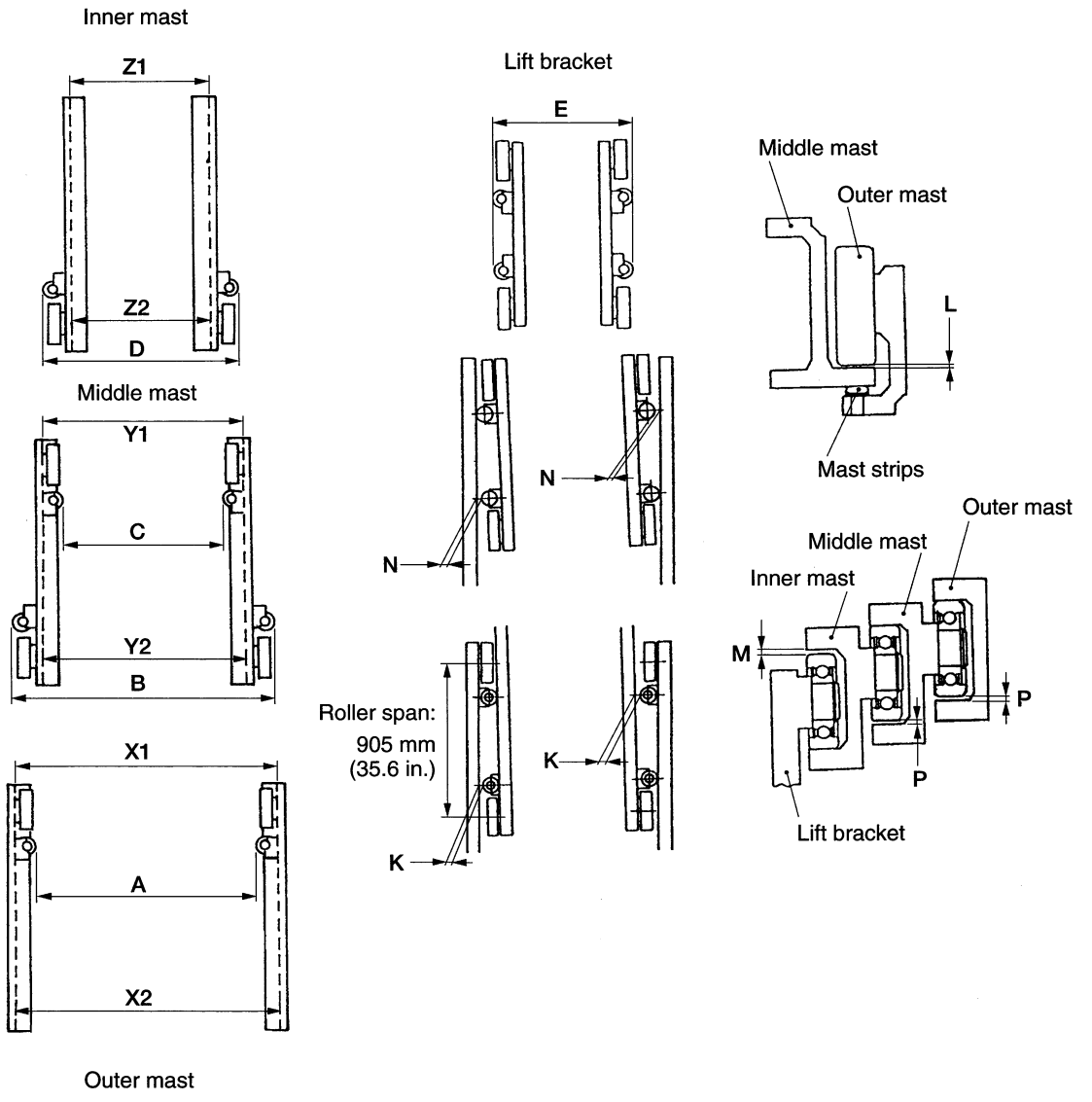
(1) Check the main and side rollers for binding, wear or cracks.

(2) Check the welds for cracks.

(3) Check the guide bars for distortion.



Item \ Truck Model	DP80

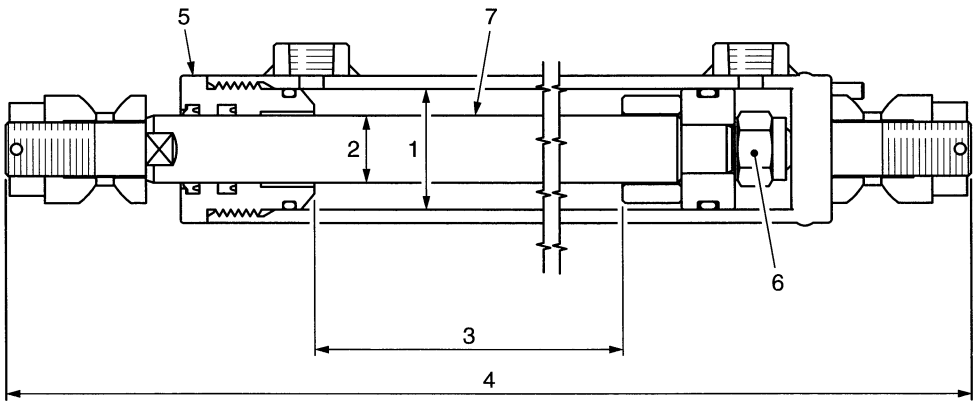


Service Data

A: Standard value B: Repair or service limit

Unit: mm (in.)

Item	Attachment Model			3HP80BVB
Fork positioner cylinder	Bore diameter of cylinder tube 1		A	45 (1.77)
	Outside diameter of piston rod 2		A	25 (0.98)
	Stroke 3	W1700	A	607 (23.90)
		W2050	A	782 (30.79)
		W2200	A	857 (33.74)
	Overall length when fully contracted 4	W1700	A	850 (33.46)
		W2050	A	1025 (40.35)
		W2200	A	1100 (43.31)
	Guide bushing tightening torque 5 N·m (kgf·m) [lbf·ft]		A	250 (25) [184]
	Self-locking nut tightening torque 6 N·m (kgf·m) [lbf·ft]		A	200 (20) [148]
	Deflection of piston rod 7		A	0.5 (0.020) or less
			B	1.0 (0.039) or less



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SERVICE DATA

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Lubrication Chart ..... 14 – 14
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Recommended Brands of Lubricants

Engine oils (gasoline)

Specification / Viscosity / Manufacturer	API service classification CD or MIL-L-2104E equivalents	
	SAE 10W	SAE 30
Mobil	Mobil Delvac 1210	Mobil Delvac 1230
Shell	Shell Rotella T10W	Shell Rotella T30
Exxon	XD-3 10W	XD-3 30
Castrol	Castrol Syntec 10W-30	

Front axle oils (gear oils)

Specification / Viscosity / Manufacturer	API service classification GL-4or GL-5	
	SAE 80	SAE 90
Mobil	Mobilube HD 80W-90	
Shell	Shell Spirax HD 80W-90	
Exxon	Gear Oil GX80W-90	
Castrol	Castrol Hypoy 80W-90	

Hydraulic oils (powershift)

ISO VG32
—
Mobiltrans HD 10W
Tellus oil 32
Nuto H32
Castrol Hyspin AWH-M32

Powershift transmission oils

Specification / Viscosity / Manufacturer	Dexron
	—
Mobil	Mobil ATF
Shell	Shell Donax TC
Exxon	Exxtrans
Castrol	Castrol Dexron® III/Mercon®

Brake fluids

—
SAE J1703
Mobil Universal Brake Fluid
Shell Advance Brake Fluid
Brake Fluid DOT-3
Castrol GT LMA Brake Fluid

Greases

Specification / Viscosity / Manufacturer	NLGI No.1	NLGI No.2
	Consistency 310 to 340	Consistency 265 to 295
Mobil	Mobilux EP 1	Mobilux EP 2
Shell	Retinax HD NLGI 1	Retinax HD NLGI 2
Exxon	Ronex Extra Duty 1	Ronex Extra Duty 2
Castrol	Castrol EPL 1	Castrol EPL 2

Antifreeze/Summer Coolant

Full Force
USI Chemical
Marcus
Peak

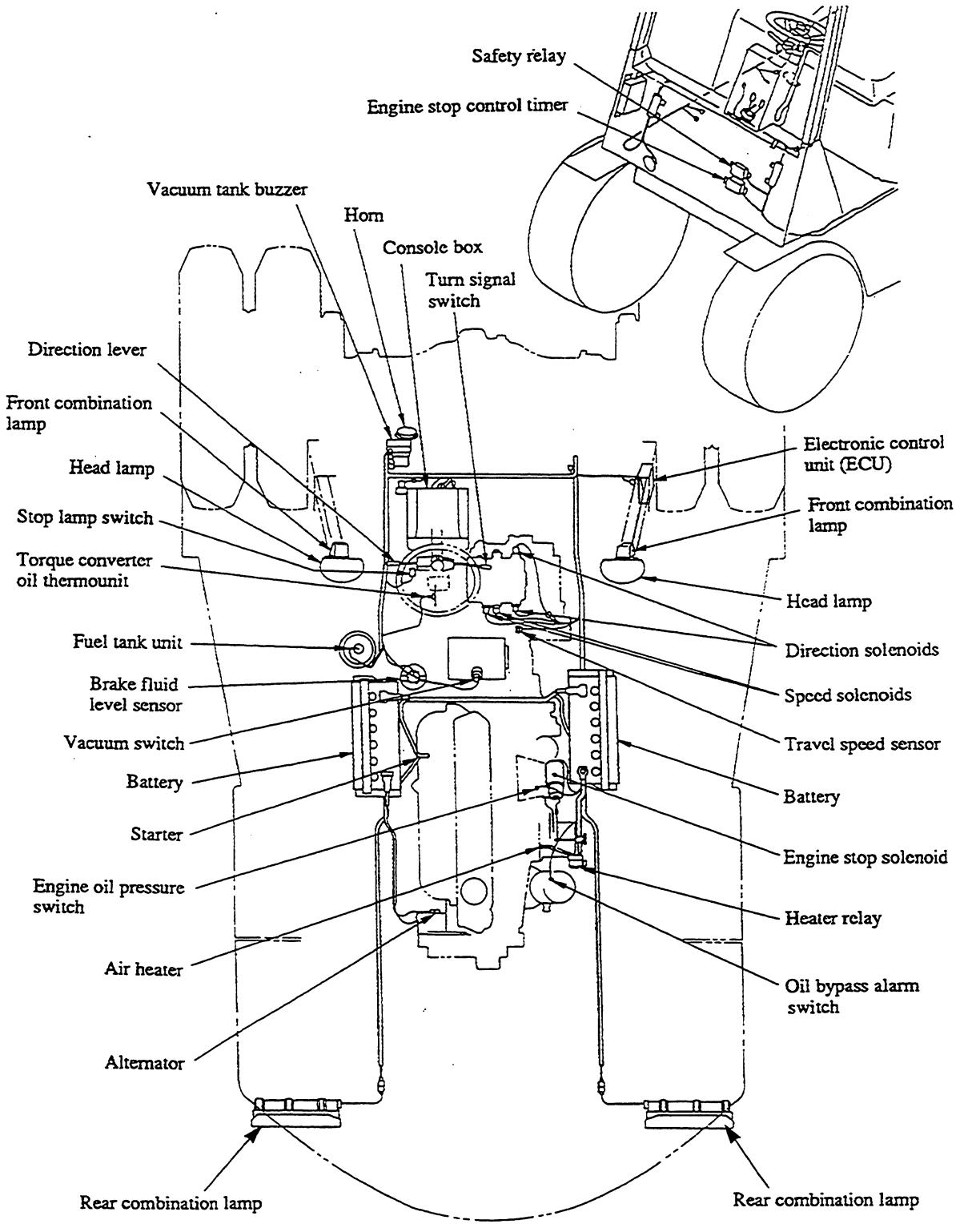
Remarks: Brands of oils are subject to change without notice. When you buy oils, select recommended brands and check specification (for example API service classification CD, SAE 10W).

GENERAL INFORMATION

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⚠ CAUTION Clamp the harnesses away from moving parts or sharp edges. Repair a frayed harnesses with vinyl tape.

POWER TRAIN

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- 3-speed Transmission 38
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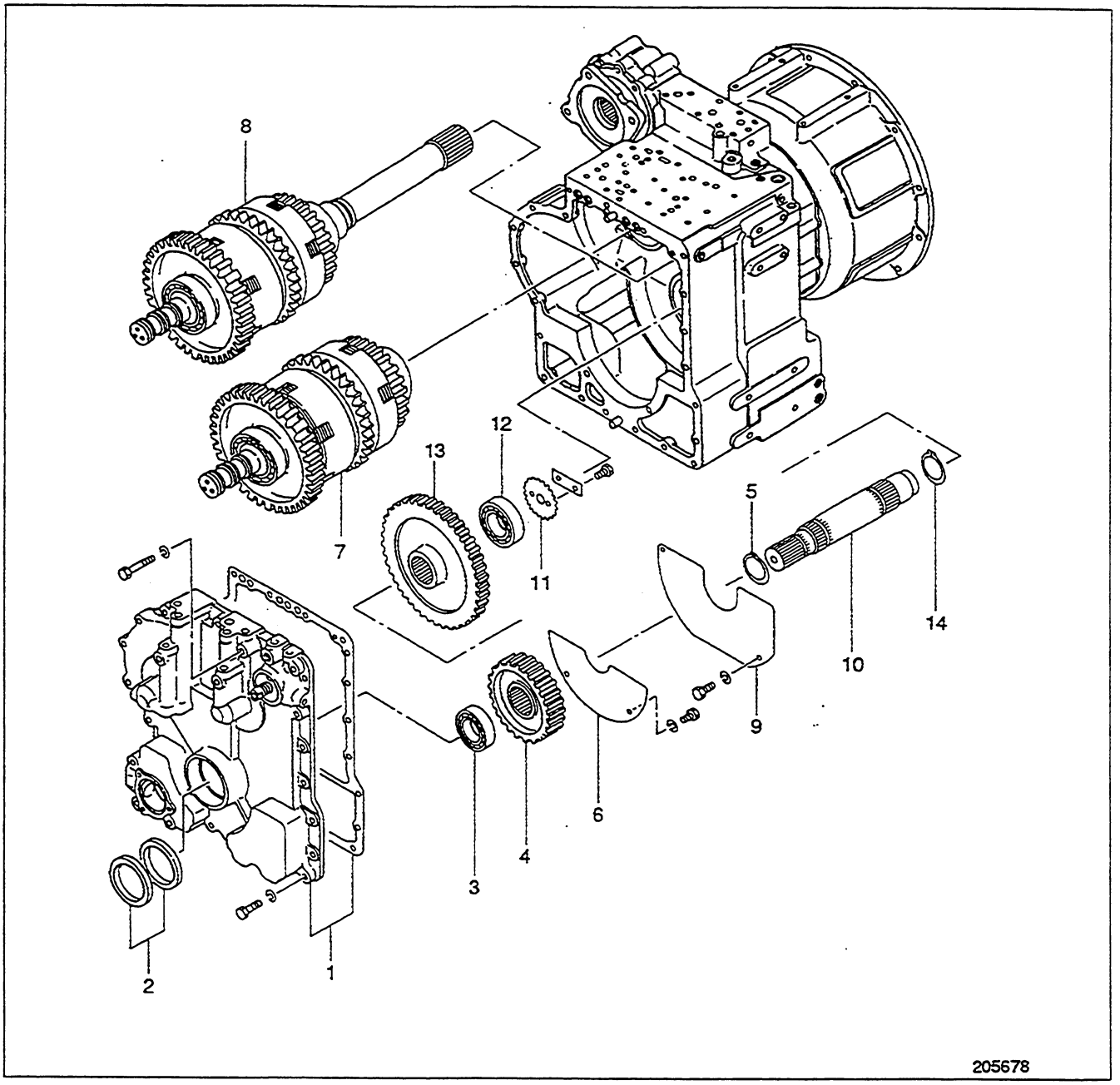
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SPECIFICATIONS

Item \ Truck model			DP80	DP90
Torque converter	Type		3-element, 1-stage, 2-phase	
	Model		MI16	
	Stall torque ratio		2.88	
Transmission	Control		Direction control: Electric, column shift Speed control: Automatic	
	Gear ratio	Forward	1st: 1.556 2nd: 0.685	
		Reverse	1st: 1.556 2nd: 0.685	

2. Transmission cover and shafts



Sequence

1 Transmission cover subassembly and gasket [O-rings, bolts and washers
2 Oil seals
3 Ball bearing
4 Output gear
5 Snap ring
6 Baffle plate [Bolts and washers]
7 Countershaft subassembly
8 Input shaft subassembly
9 Baffle plate [Bolts and washers]
10 Output shaft
11 Speed sensor gear [Lock plate and bolts]
12 Ball bearing
13 Output gear
14 Snap ring

Suggestions for assembly

(1) Output shaft 21 assembling and installation

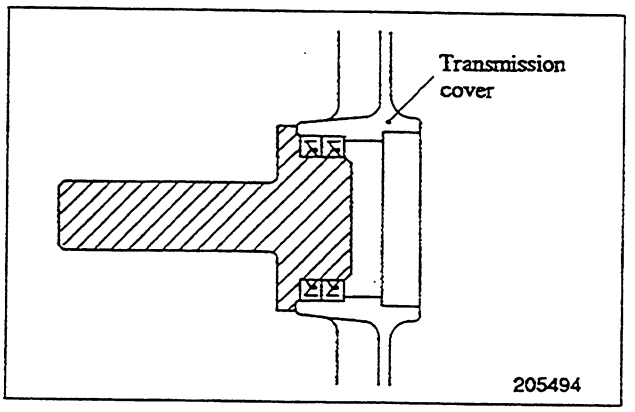
Assemble output shaft 21, snap rings 22 and 26, output gear 23, ball bearing 24 and speed sensor gear 25 in a subassembly. Install the subassembly in the transmission case. Use a new lock plate for the bolts that hold the speed sensor gear.

(2) Input shaft subassembly installation

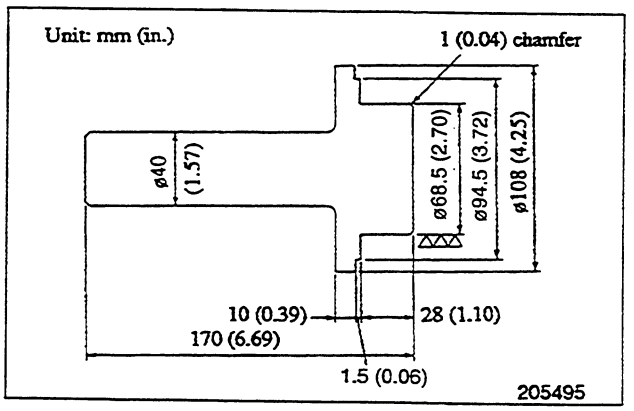
Install a total of four seal rings, one on the front side and three on the rear side. Apply oil to these rings when installing them.

(3) Oil seal 33 installation

Replace two oil seals by new ones. To install these seals, apply grease to their lips and install them with Oil Seal Installer (special tool) with their main lips toward inside.

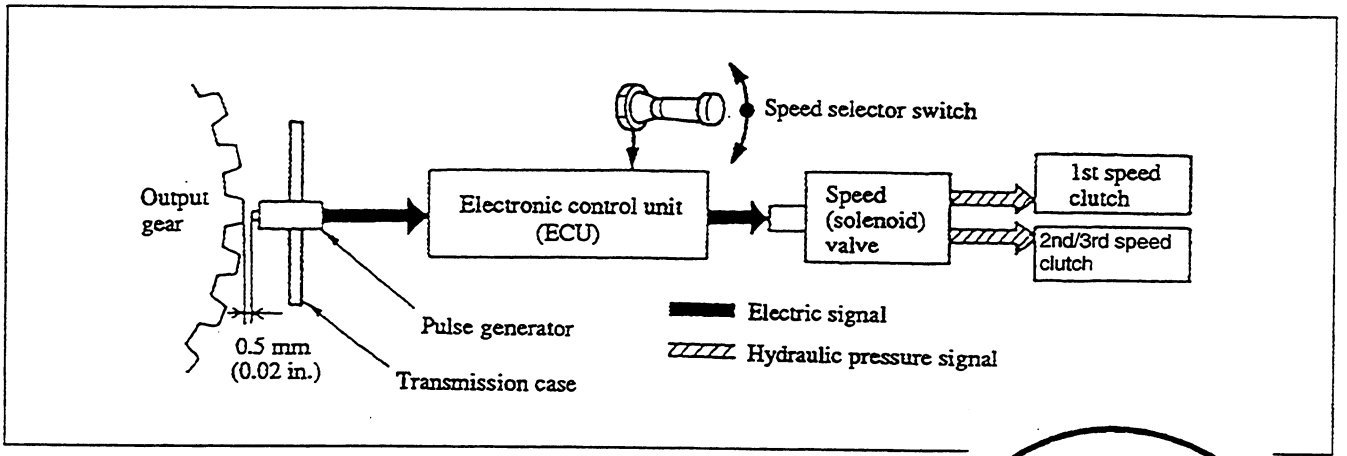


Special tool:
Oil seal installer (to be made by dealer)

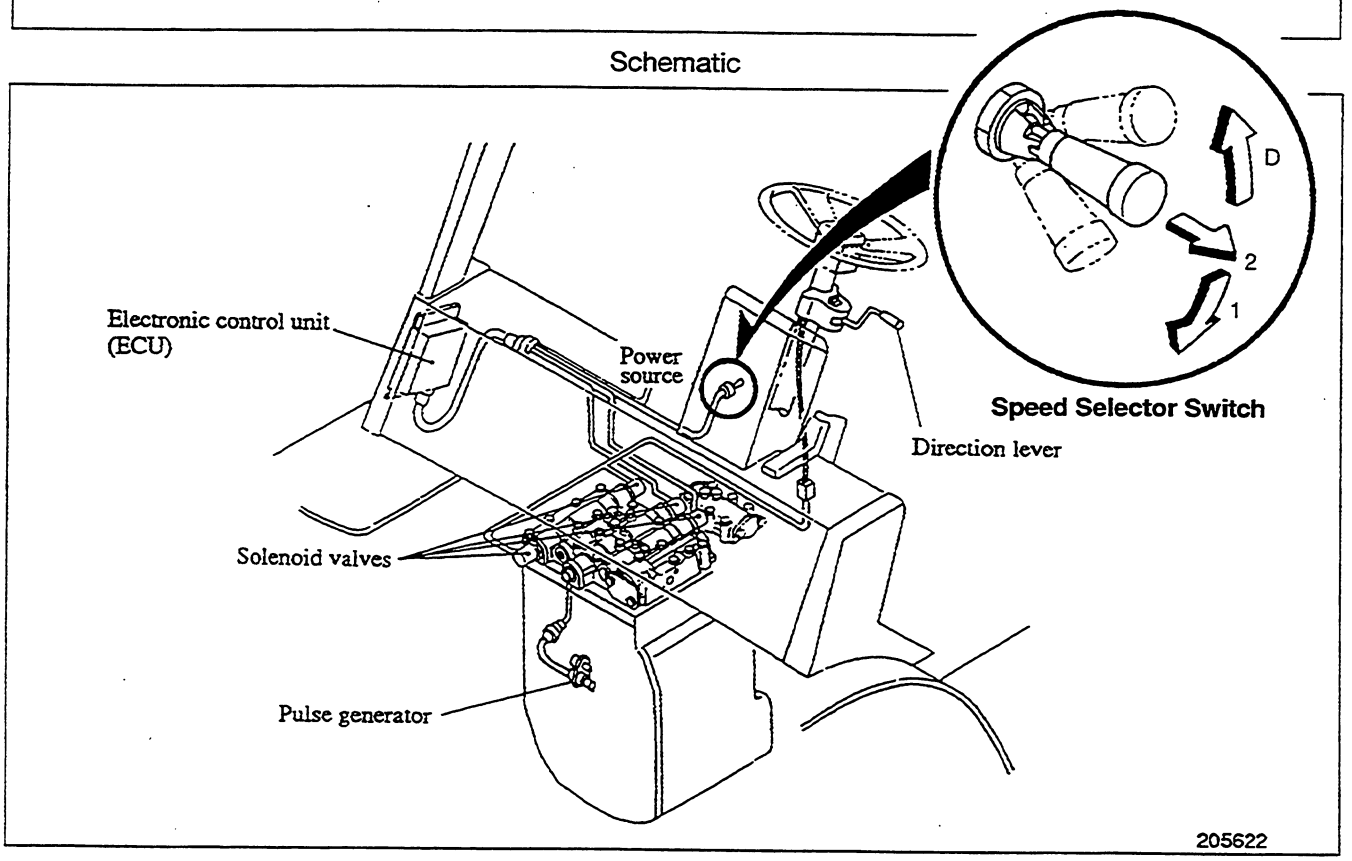


Problem	Cause	Correction
Main pressure is too low	a) Magnet strainer clogged	Clean or replace.
	b) Oil pump worn	Replace.
	c) Coil spring defective in main regulator valve	Replace.
	d) Main regulator valve spool defective	Repair or replace.
	e) Air being sucked in	Retighten or replace packing.
	f) Not enough oil	Refill.
	g) Control linkage defective	Repair or replace.
	h) Clutch valve out of order	Repair or replace.
Clutch pressure is too low	a) Magnet strainer clogged	Clean or replace.
	b) Oil pump worn or otherwise defective	Replace.
	c) Coil spring defective in main regulator valve	Replace.
	d) Main regulator valve spool defective	Repair or replace.
	e) Air being sucked in	Retighten or replace packing.
	f) Not enough oil	Refill.
	g) Control linkage out of order	Repair or replace.
	h) Clutch valve defective	Repair or replace.
	i) Seal ring broken in servo case	Replace.
	j) Clutch seal rings broken	Replace.
Stall speed out of specification	a) Lack of engine power if the speed is slightly low in both forward and reverse drive	Tune up engine.
	b) Stator and freewheel defective if the speed is excessively low in both forward and reverse drive	Replace stator assembly.
	c) Inching pedal linkage defective, or clutch slipping if the speed is too high	Repair or replace.
No automatic shifting	a) Speed selector switch in "fixed 1st speed" position	Move switch to "Automatic 2-speed" position.
	b) Solenoid valve defective	Replace.
	c) Solenoid valve inlet orifice clogged	Clean or replace.
	d) Solenoid valve spool or spring defective	Repair or replace.
	e) E.C.U. control box internally defective	Check or replace.
Transmission shifts up when speed selector switch is in "fixed 1st speed" position	a) Harness open	Repair.
	b) Speed selector switch defective	Replace.

Speed Selector System



Schematic



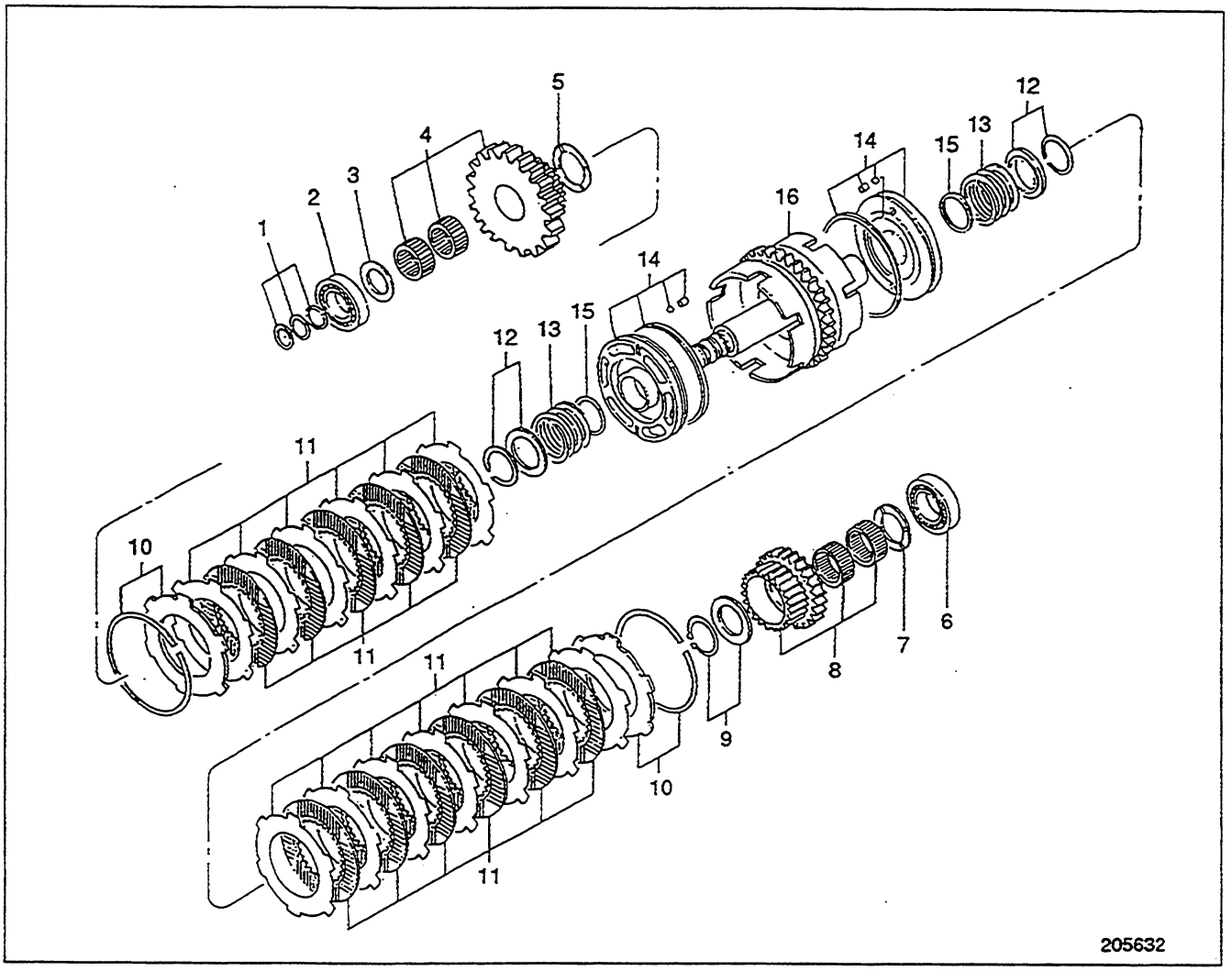
Location of components

The speed selector system is made up of an electronic control unit (ECU), a pulse generator and two speed selector valves, one for 2nd and 3rd speeds and the other for 1st speed.

The selection of three modes "Fixed 1st speed", "Automatic 2-speed" and "Automatic 3-speed" is done manually by means of the speed selector switch.

Selector switch position (mode)	Travel speed	
D (automatic 3-speed)	1st	0 to 6.5 km/h (0 to 4.0 mph)
	2nd	6.5 to 15 km/h (4.0 to 9.3 mph)
	3rd	15 to 33 km/h (9.3 to 20.5 mph)
2 (automatic 2-speed)	1st	0 to 6.5 km/h (0 to 4.0 mph)
	2nd	6.5 to 18.5 km/h (4.0 to 11.5 mph)
1 (fixed 1st speed)	0 to 8 km/h (0 to 5.0 mph)	

4. Forward shaft subassembly



Sequence

1 Seal rings
2 Ball bearing
3 Thrust washer
4 Gear (2nd-speed drive) and needle roller bearings
5 Thrust washer and snap ring
6 Ball bearing
7 Thrust washer
8 Gear (forward drive) and needle roller bearings
9 Thrust washer and snap ring
10 Snap rings and pressure plates
11 Friction plates and mating plates
12 Snap rings and retainers
13 Clutch springs
14 Clutch pistons [Steel balls, screws and piston seals]
15 Seal rings
16 Forward clutch shaft

NOTE

Do not attempt to remove the screws from the forward clutch shaft. It is not necessary to disassemble clutch pistons 14 if the balls move freely in the pistons when the pistons are shaken.

Suggestions for disassembly

Stopper pin 7 removal

Turn a screw in the M4 x 0.7 hole in the stopper pin and carefully remove the pin because removal of the stopper pin will cause clutch valve plunger 8 to fly out.

Inspection

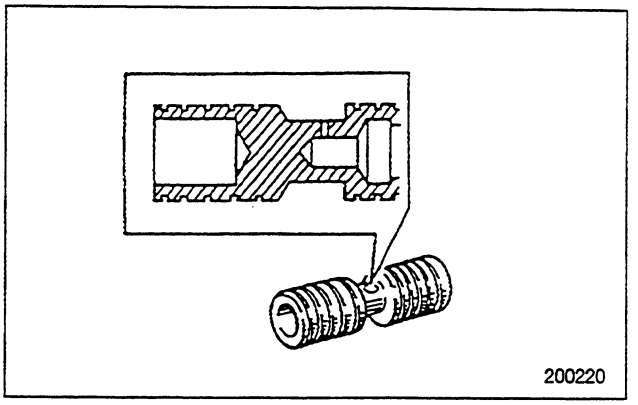
(1) Check the oil holes in the valve body for restriction.

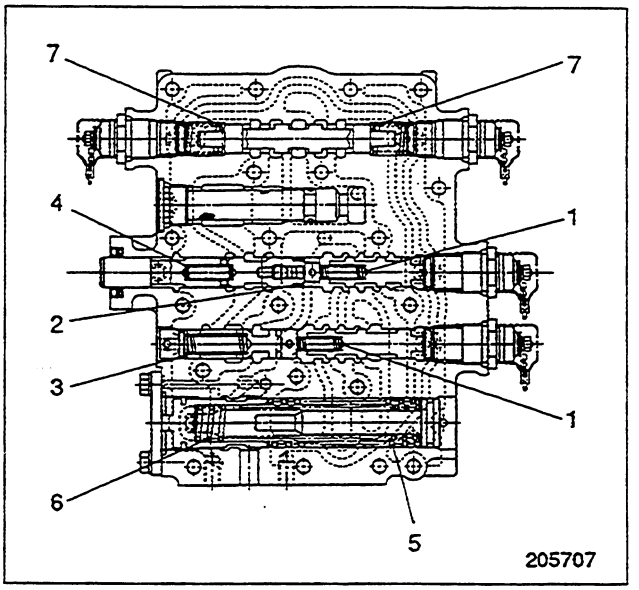
(3) Replace all oil seals by new ones.

(4) Check the clutch valve orifices for restriction. Check the clutch valve springs for fatigue or damage.

(5) Replace oil filter 16 by a new one.

(6) Wash oil filter 15, or replace it by a new one.



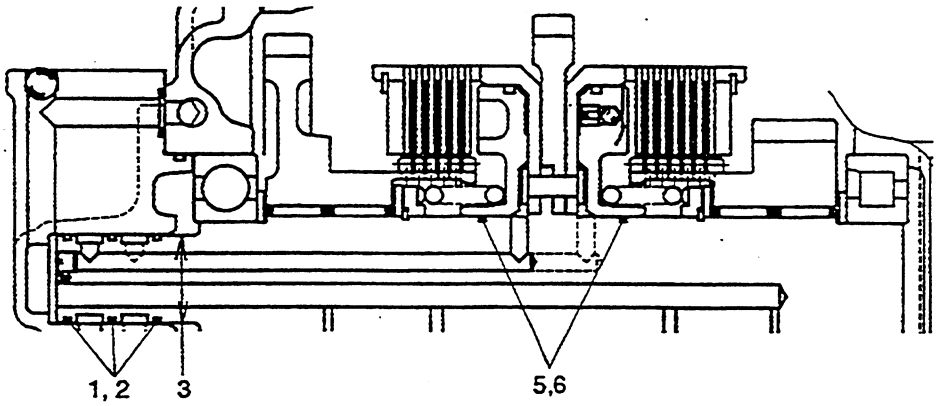


A = Assembly standard
B = Repair or service limit

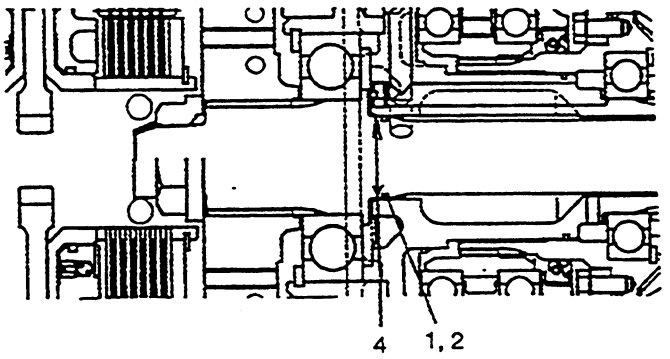
Free length of selector valve spring 1, mm (in.) [k = spring rate, kgf/mm]	A	36.5 (1.44) [k = 0.577]
	B	35.5 (1.40)
Free length of return spring 2, mm (in.) [k = spring rate, kgf/mm]	A	28 (1.10) [k = 0.0488]
	B	26.5 (1.04)
Free length of differential valve spring 3, mm (in.) [k = spring rate, kgf/mm]	A	59.5 (2.34) [k = 0.2357]
	B	57.5 (2.26)
Free length of clutch valve spring 4, mm (in.) [k = spring rate, kgf/mm]	A	39 (1.54) [k = 0.217]
	B	38 (1.50)
Free length of accumulator valve outer spring 5, mm (in.) [k = spring rate, kgf/mm]	A	125.5 (4.94) [k = 0.5469]
	B	123 (4.84)
Free length of accumulator valve inner spring 6, mm (in.) [k = spring rate, kgf/mm]	A	170.5 (6.71) [k = 0.4210]
	B	168 (6.61)
Free length of directional valve springs 7, mm (in.) [k = spring rate, kgf/mm]	A	32.5 (1.28) [k = 0.8786]
	B	31.5 (1.24)

A = Assembly standard B = Repair or service limit

Item		Truck model	DP80	DP90
Forward clutch shaft, reverse clutch shaft, 1st-speed/3rd-speed clutch shaft and servo cases	Width of seal ring for each shaft 1, mm (in.)	A	2.5 ± 0.05 (0.098 ± 0.0020)	
		B	2.0 (0.079)	
	Width of seal ring groove in each shaft 2, mm (in.)	A	$2.5\ ^{+0.2}_{+0.1}$ ($0.098\ ^{+0.008}_{+0.004}$)	
		B	3.0 (0.118)	
	Inside diameter of servo case in contact with seal ring 3, mm (in.)	A	$35\ ^{+0.025}_{0}$ ($1.38\ ^{+0.00098}_{0}$)	
		B	35.2 (1.386)	
	Inside diameter of stator shaft in contact with seal ring 4, mm (in.)	A	$35\ ^{+0.025}_{0}$ ($1.38\ ^{+0.00098}_{0}$)	
		B	35.2 (1.386)	
	Width of clutch piston seal ring for each shaft 5, mm (in.)	A	2.5 ± 0.05 (0.098 ± 0.0020)	
		B	2.0 (0.079)	
	Width of clutch piston seal ring groove in each shaft 6, mm (in.)	A	$2.5\ ^{+0.2}$ ($0.098\ ^{+0.008}$)	
		B	3.0 (0.118)	

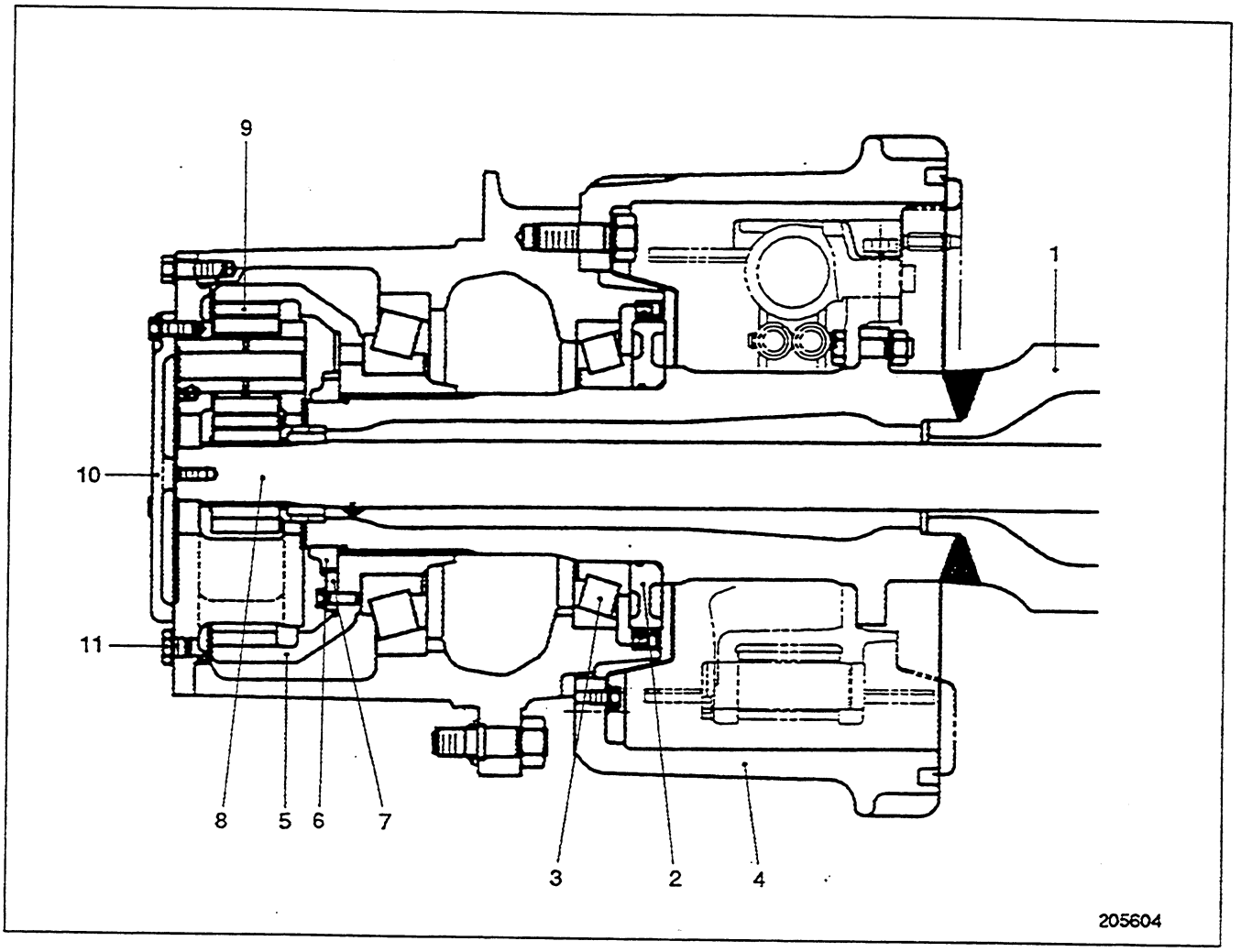


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Assembly



Sequence

1 Front axle housing

2 Oil seal retainer [O-ring]

3 Tapered roller bearing (inner race)

4 Hub and drum assembly [Front wheel hub, wheel bolts, nuts, brake drum, studs, nuts, tapered roller bearing (outer race), oil seal, oil deflector and bolts]

5 Ring gear [Tapered roller bearing (inner race)]

6 Nut

7 Lock plate [Bolts and washers]

8 Sleeve and axle shaft

9 Planet carrier assembly [Planet carrier, planet gears, bushings, thrust washers, planet pins, steel balls and O-ring]

10 Cover and gasket [Bolts and washers]

11 Plug and gasket

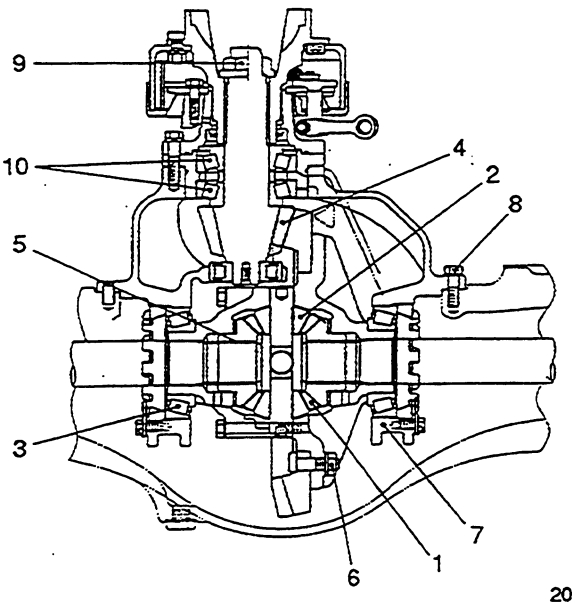
Started by:

a) Assemble the planet carrier.

Reduction Differential

A = Assembly standard B = Repair or service limit

Item \ Truck model			DP80	DP90
Backlash between differential gear and pinion 1, mm (in.)		A	0.19 to 0.25 (0.0075 to 0.0098)	
		B	0.5 (0.020)	
Fit of differential pinion on shaft 2, mm (in.)		A	0.08 to 0.13 (0.0031 to 0.0051)	
		B	0.4 (0.0157)	
Preload for differential case side bearing 3, kgf·cm (lbf·ft) [N·m]		A	15 to 30 (1.1 to 2.2) [1.5 to 3]	
Backlash between reduction gear and pinion 4, mm (in.)		A	0.25 to 0.33 (0.0098 to 0.0130)	
Free movement of differential gear on axle shaft (looseness of mating splines) 5, mm (in.)		A	0.07 to 0.17 (0.0028 to 0.0067)	
		B	0.5 (0.020)	
Tightening torque, kgf·m (lbf·ft) [N·m]	Reduction gear mounting nuts 6	A	23 ± 2 (166 ± 14) [226 ± 20] (Apply LOCTITE No. 271.)	
	Side bearing cap bolts 7	A	16.5 ± 1.7 (119 ± 12) [162 ± 17]	
	Differential carrier mounting bolts 8	A	13 ± 1.3 (94 ± 9) [127 ± 13]	
	Input flange mounting bolt 9	A	50 to 70 (362 to 506) [490 to 686]	
Force applied to bearing retainer in tangential direction 10, kgf (lbf) [N] (preload for reduction pinion bearing)		A	2.5 to 3.8 (5.5 to 8.4) [25 to 37]	



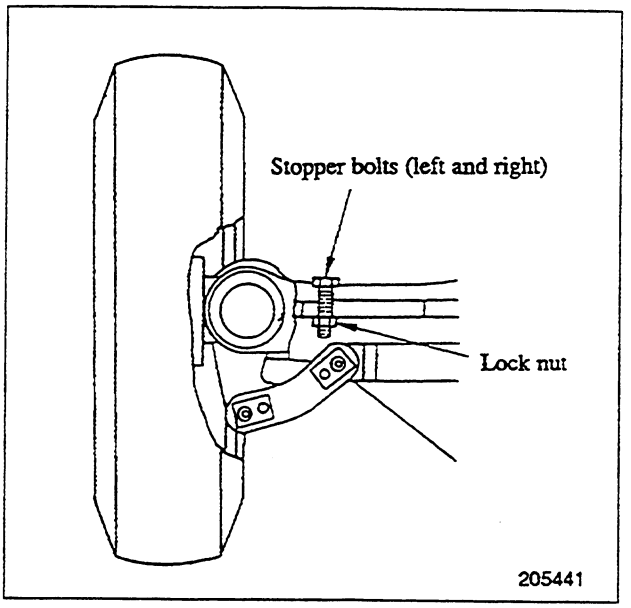
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ADJUSTING

Minimum Turning Radius

(1) Measure the turning angle of the rear wheels, inside and outside, with a turning radius gauge.

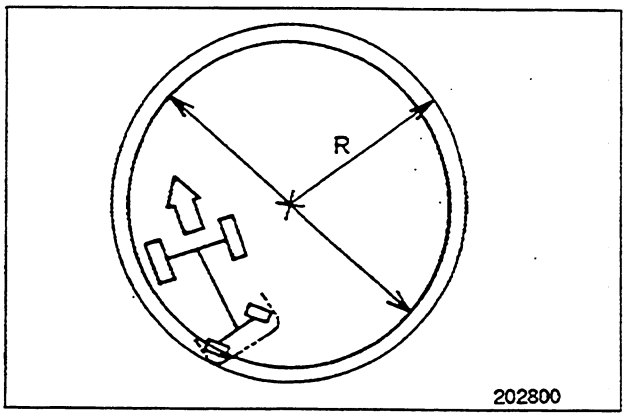
(2) If the turning angle is not correct, adjust it with knuckle stopper bolts.



Turning angle	Inside wheel	74°
	Outside wheel	48°25'
Tightening torque for knuckle stopper bolt lock nut		22.7 kgf·m (164 lbf·ft) [223 N·m]

(3) Drive the machine at low speeds and make the sharpest practicable turn to both sides. After making a turn to each side, measure the distance from the turning center to the center of tire contact with the ground of the outermost rear wheel.

(4) The minimum turning radius R is the distance from the turning center to the center of tire contact with the ground of the outermost rear wheel plus the rear overhang (the distance from the center of rear tire to the outermost end of the counterweight).

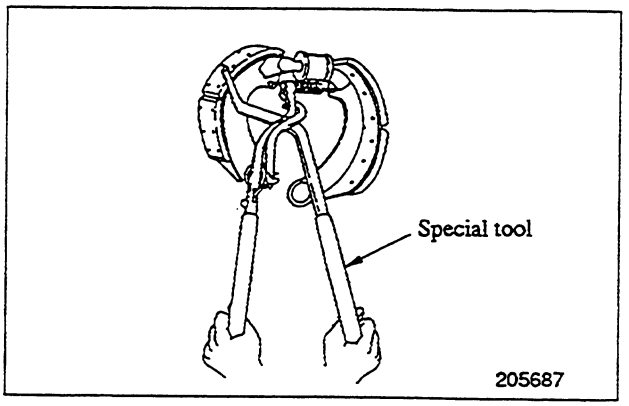


Truck model	Minimum turning radius
DP80	3740 mm (147 in.)
DP90	3835 mm (151 in.)

(5) Return spring installation

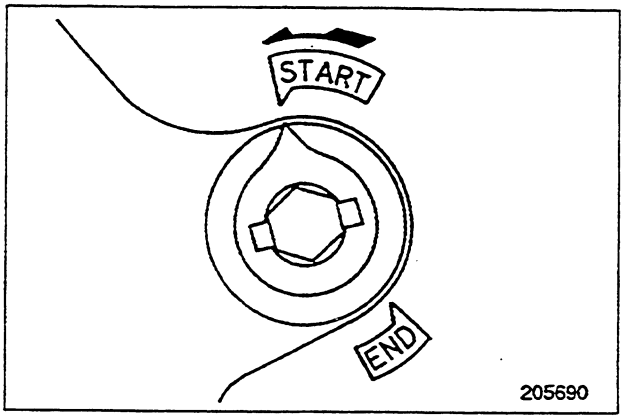
Using Spring Setter (special tool), hook the ends of the return springs to the pins of the shoes.

Special tool:
Spring setter 03727-10001



(6) Lining wear indicator installation

With the adjusting cam in minimum lift position, install each indicator with its needle in alignment with START mark as shown.



(7) Service brake assembly installation

Tighten the bolts that hold the service brake assembly to the front axle to the specified torque.

Tightening torque for service brake assembly bolts	15.9 ± 1.6 kgf·m (115 ± 12 lbf ·ft) [156 ± 16 N·m]

Service Brakes — continued

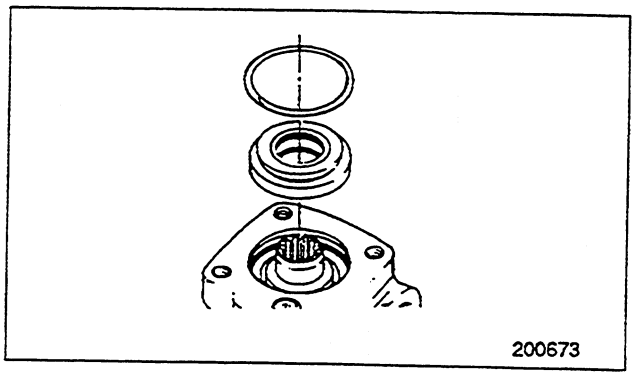
Problem	Cause	Correction
Hard pedal	a) Vacuum hose loose at joint	Retighten.
	b) Vacuum hose flattened or ruptured	Replace.
	c) Vacuum pump inoperative	Repair or replace.
	d) Alternator belt loose	Readjust.
	e) Brake booster vacuum valve and atmosphere valve dirty or defective	Repair or replace.
	f) Brake booster element restricted	Clean or replace.
	g) Brake booster diaphragm defective	Replace.
	h) Foreign matter in wheel cylinders	Wash. Add brake fluid.
Spongy pedal	a) Loss of brake fluid	Add brake fluid.
	b) Wheel cylinders leaky	Repair or replace.
	c) Air in system	Bleed system.

Parking Brake

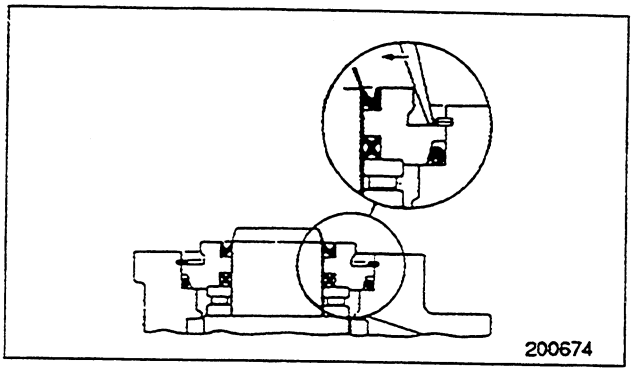
Problem	Cause	Correction
Brake lever stroke too small	Clearance between drum and linings too small	Readjust.
Noisy brake	a) Clearance between drum and linings too small	Readjust.
	b) Brake drum badly distorted	Repair or replace.
Will not hold	a) Linings worn down to service limit	Replace shoes & linings as an assembly.
	b) Clearance between drum and linings too large	Readjust.
	c) Lever lacks operating effort	Adjust to 25 to 30 kgf (55 to 66 lbf) [245 to 294 N].

(5) Seal installation

(a) Put the dust seal in position on the seal gland bushing with the flat side down. Also, put the oil seal in position on the bushing.

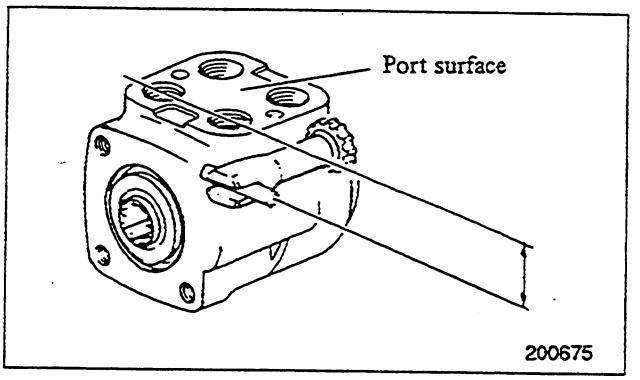


(b) Put the seal gland bushing in position on the spool. Carefully hit the bushing with a plastic hammer until it comes in contact with the bearing inner race. Install the retaining ring in the groove of the housing and expand it with a screw driver.



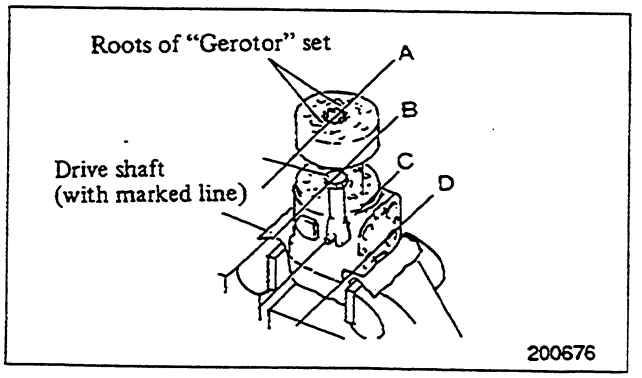
(6) Drive shaft installation

Position the spool and sleeve assembly in the housing so that the pin is even with the port surface of the housing. Before installing the shaft, scribe a line even with the groove in the yoke end of the shaft on the splined end. Put the shaft in position so that the pin fits in the groove in the yoke end of the shaft.

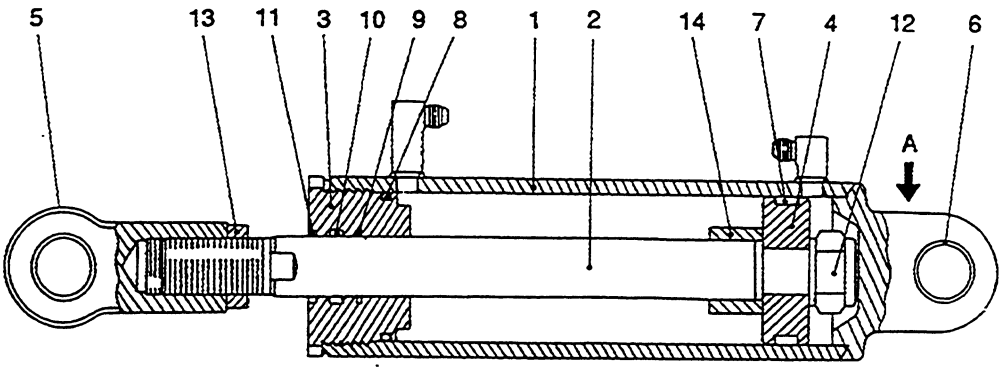


(7) "Gerotor" set installation

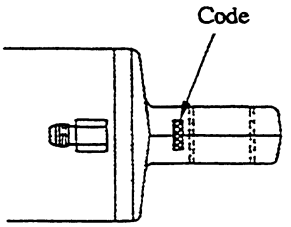
Put the "Gerotor" set in position on the housing with the O-ring toward the housing. Make sure that the line A across the roots of the inner "Gerotor" teeth is even with the line B and that the lines A, B, C and D are even with each other.



Tilt Cylinders



Life height	Tilt angle (forward – backward)	Code stamped on tilt cylinder
3 000 to 5 000 mm (118 to 197 in.)	15°–10°	A15 – 10
5 500 to 7 000 mm (217 to 276 in.)	6°–10°	A6 – 10



View A

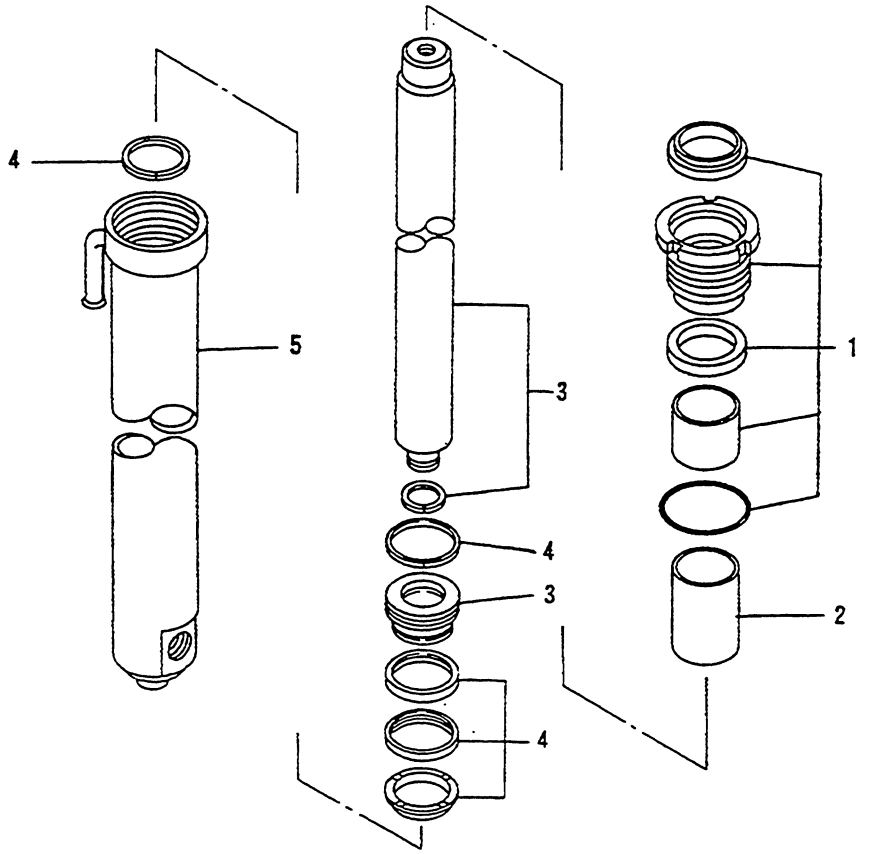
205760

1 Cylinder tube
2 Piston rod
3 Guide bushing
4 Piston
5 Socket kit
6 Bushing
7 Piston seal
8 O-ring
9 Buffer ring
10 Packing
11 Dust seal
12 Self-lock nut
13 Nut
14 Collar

The tilt cylinders are of double-acting type.

Collar (14) is installed in tilt cylinder that is 6° in forward tilt angle.

FD90



Sequence

1 Cylinder head and wiper ring
2 Holder, U-ring, bushing and O-ring
3 Spacer
4 Piston rod
5 Piston ring, U-ring, holder and stopper
6 Cylinder tube

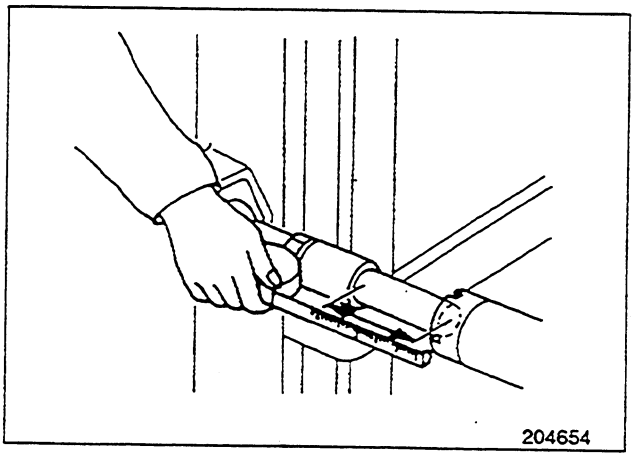
NOTE

Do not remove the U-rings, bushing and wiper ring unless they are defective.

Tilt Cylinder Drift

(1) Pick up a load equal to the rated capacity, tilt the mast to vertical position, lift the forks about 50 cm (20 in.) from the floor, and stop the engine.

(2) Measure the amount of tilt cylinder drift (extension of the piston rods) for 15 minutes.

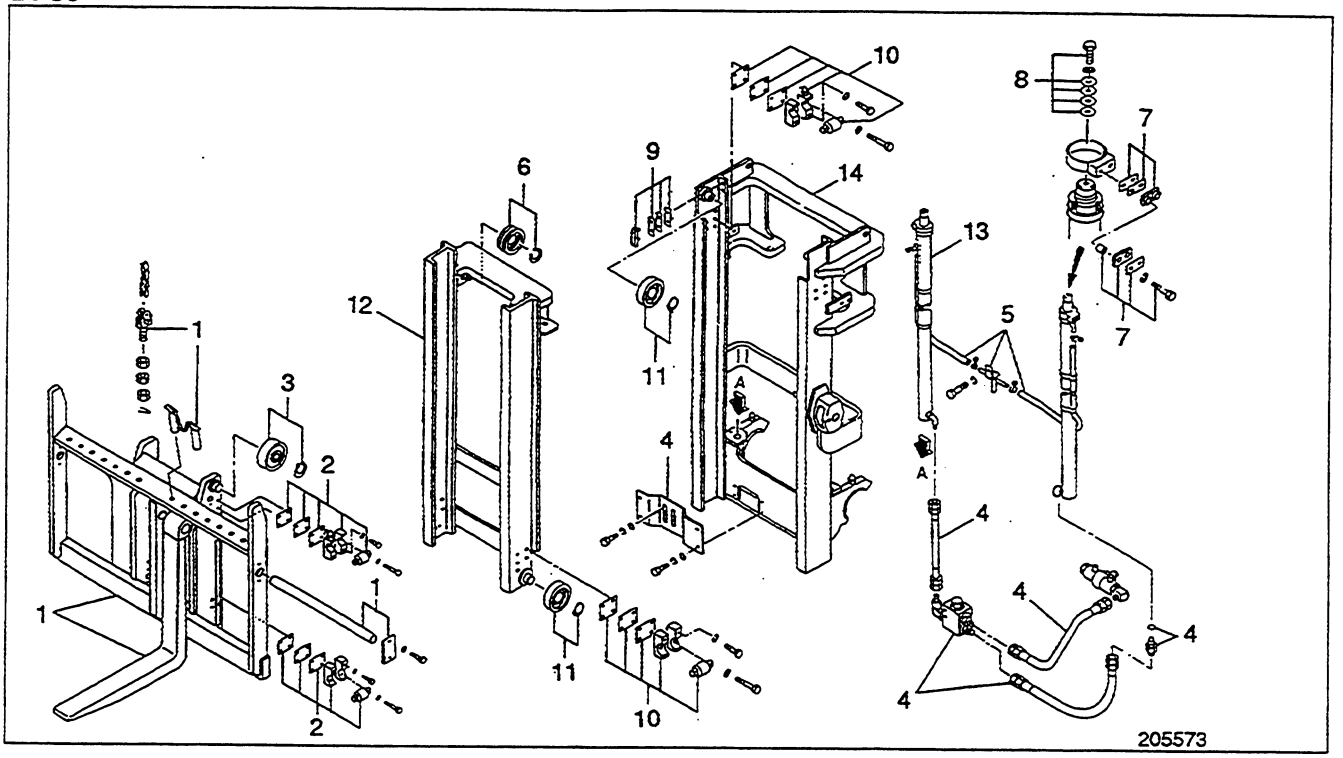


Amount of tilt cylinder drift (extension of piston rods) with rated load for 15 minutes	DP80: 32mm (1.3 in.), maximum DP90: 38 mm (1.5 in.), maximum

MAST ASSEMBLY

Disassembly

DP80



Sequence

1 Forks and lift bracket [Lift chains, stopper pins, guide bars and stopper plates]

2 Side rollers [Brackets, grease fittings and shims]

3 Main rollers [Snap rings]

4 Hoses [Cover, joints, O-rings and down safety valve]

5 Hoses [Clamps]

6 Chain wheels [Snap rings]

7 Cylinder clamps [Bolts, seats, shims, cushions and collars]

8 Bolt [Shims]

9 Mast strips [Shims]

10 Side rollers [Brackets, grease fittings and shims]

11 Main rollers [Snap rings]

12 Inner mast

13 Lift cylinders

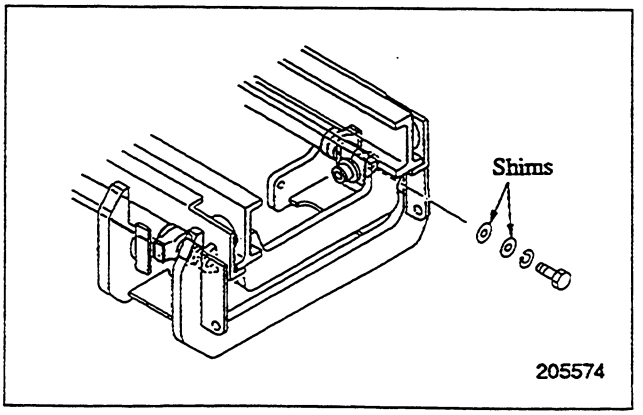
14 Outer mast

Suggestion for disassembly

Inner mast removal

(a) The cylinder stroke is adjusted by means of the shims fitted to the rod end. Before disassembling, write down a cylinder on which shim adjustment has been made and the amount of shims used.

(b) Remove the bolts that hold the cylinder clamp to free each cylinder. Retract the piston rods all the way and cross the top ends of the cylinders.



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