Foreword

This manual is to provide data and directions for the personnel responsible for repairing Hualing series truck chassis, and it also includes the methods for adjustment and repair operation. By referring to this manual, you will be able to correct the fault quickly; there may be some parts that are different from those described in the manual due to improvement of the product; when using this manual, please make sure that the data in this manual are identical with the physical goods, if there is any shortcoming, you are kindly invited to point them out so that we will be able to correct them in the next edition.

Overseas Operation: 86-555-8323597
E-mail: fr@camc.biz, grj@camc.biz

Anhui Hualing Automobile Co., Ltd.

Before reading this manual

- Various data are indicated herein on the basis of the model number of the trucks, the motor vehicle type, engine number, etc. Therefore, you are kindly requested to confirm the model number, etc., of the truck that you have purchased.
- You are kindly requested to understand that the contents of the descriptions and sketches in this manual differ somewhat from the actual truck in some cases that you have purchased because of different specifications, improvements made, etc.
- The meanings of the marks used in this manual are described as follows:

: It stands for special accessories.

- In this manual, the following four items of prompts describe the important precautions and give supplement notes. Each item contains important contents, and therefore, they shall be read and observed carefully.

Danger ⚠ — It describes the operation that shall be paid attention to when appending such dangerous materials as the battery fluid or the additives to cooling fluid, etc.

Warning ⚠ — It means that when this precaution is not observed, a serious injury, a fire or even a fatal accident may be resulted from sometimes.

Caution ⚠ — It means that if this precaution is run counter to, dangerous conditions or damages to equipment and parts, etc., may be caused wherefrom sometimes.

Note — It describes the recommendations, supplementary knowledge, etc., necessary for effectively operating the motor vehicle.

- In this manual, the numerical values are shown in SI unit (Standard International Unit) with the conventional unit (Metric unit) indicated in { }after it. In case the numerical values are not indicated in both units, it means the value in SI unit is the same as that in the Metric unit. SI unit is the abbreviation of Le système Intemational d'Unitès,。

  e.g. 686kpa{7kgf/cm^2}
  - 7kgf/cm^2} — Conventional unit (Metric Unit)
  - 686kpa — SI unit (Standard International Unit)

Table of Contents

Volume I

Volume II

1 Precautions of Maintenance Operations

Precautions of Maintenance and Operations

- To truly understand status of the vehicle, before start of maintenance, check and record accumulated mileage, operation conditions, user's requirements on the vehicle, and other information necessary for maintenance operations. Operation steps shall be planned for highly efficient maintenance and avoid waste of labor and materials.

19870

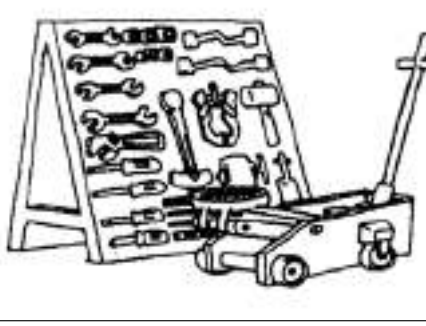
- Locate faulty position, identify causes of the problem, so as to decide replacement of parts. Later, perform operations specified in this manual.

00008

Carry out maintenance on horizontal ground.

Preparations are as follows:

- Cover cab seats, trims, floor, and paint on vehicle body with protective hood to prevent contamination and damage.

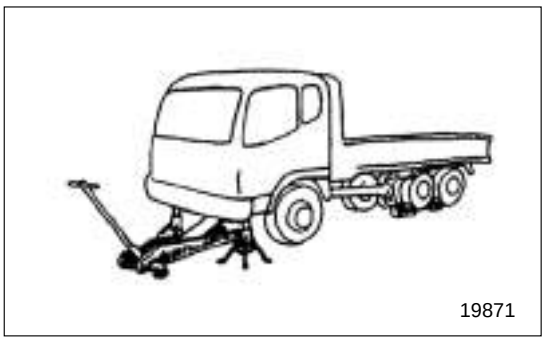


00009

- Prepare general purpose tools and special tools necessary for maintenance.

Warning ⚠

When the use of special tool is specified in this manual, never try to use other tools; otherwise parts may be damaged and it will cause personnel injury.

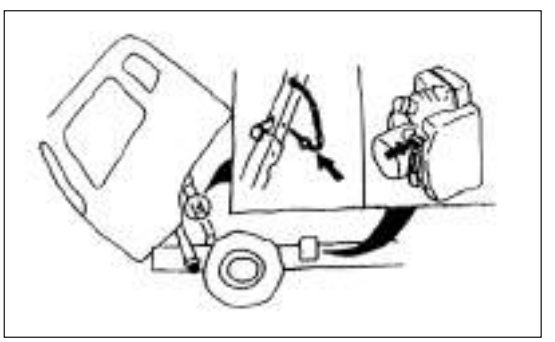


In case jack needs to be used for operations under the vehicle, take the following measures:

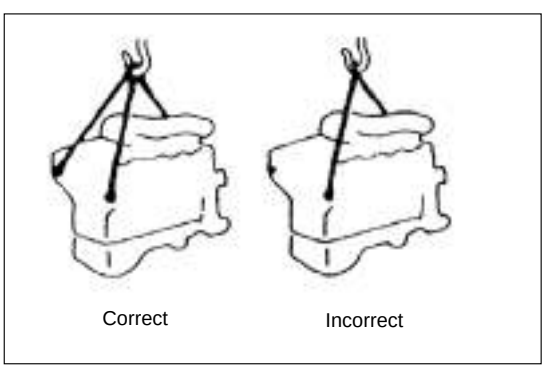
- Add wheel catch under wheels on both sides of the vehicle;
- Use garage jack to jack up the vehicle;
- Use robust tripod as auxiliary support for jack.

Warning ⚠

- Wheel catches shall be firmly inserted to prevent moving of vehicle.
- Only remove wheel catches after completion of maintenance operations.
- It is extremely dangerous to rely solely on the jack; it is necessary to use robust tripods at both sides to fix the frame.
- Always use robust tripods till end of maintenance operations; do not remove them before completion of maintenance.



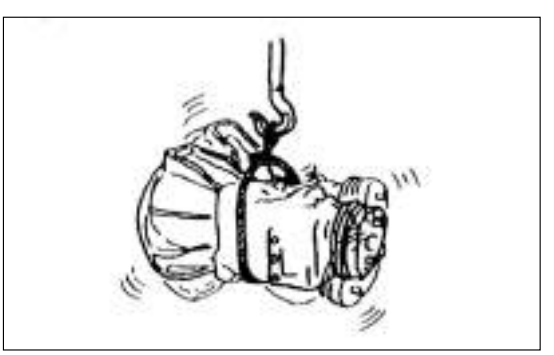
- After the cab is tilted, remember to insert safety pin into cab support rod to prevent loosening. On vehicles with electronic - hydraulic tilting system, it is necessary to place control rod on "UP" pedestal, to prevent accidental fall of cab due to incorrect operation of hydraulic system.



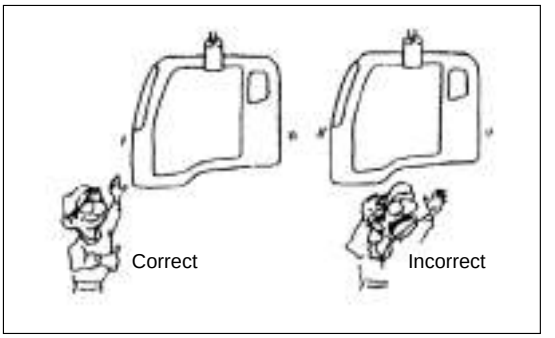
- Pay special attention to safety when removing or installing heavy pieces, e.g. engine and transmission.

When lifting heavy parts using steel wire rope, pay special attention to the following:

- Check weight of the lifted part and if wire rope used can bear this weight.

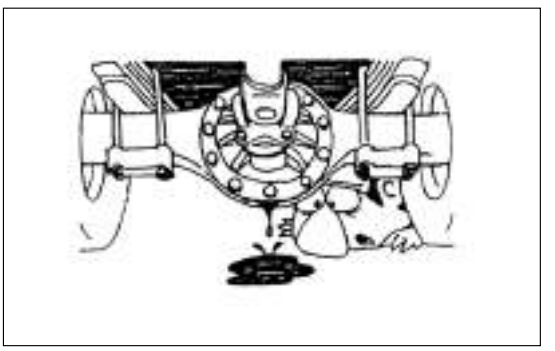


- If there is no specified lifting ring on the part, steel wire rope can be used to bind this part, but balance of the part shall be considered.

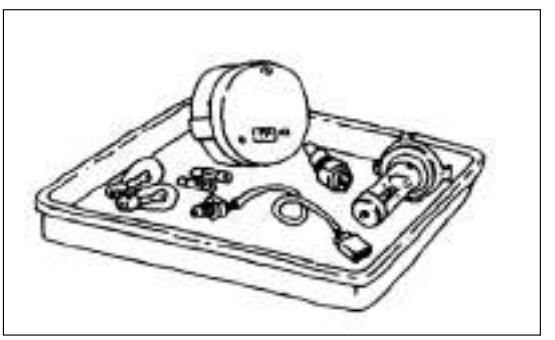


● While working, you must stand at a safe place, so that loosening of wire rope and drop of lifted object will not cause injury or death.

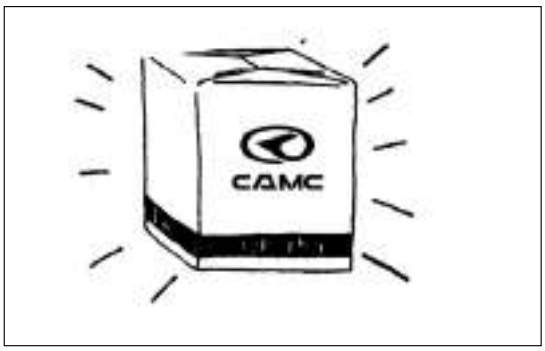
● Pay special attention not to wear shoes with oil on them or subject to slipping during work. When working in a team (2 or more persons), make covenants on signals before operation to ensure safety. Pay attention to avoid incorrect operation of switch or handle.



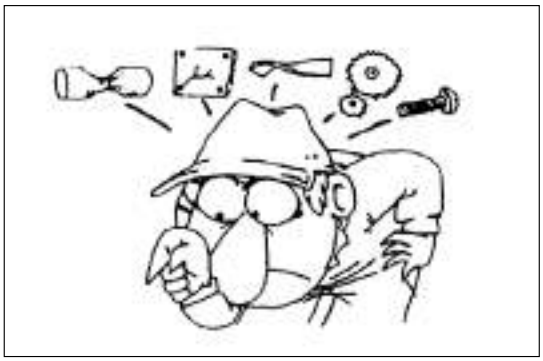
● Before cleaning faulty part, check for oil leakage; otherwise you may neglect inspection of oil leakage.



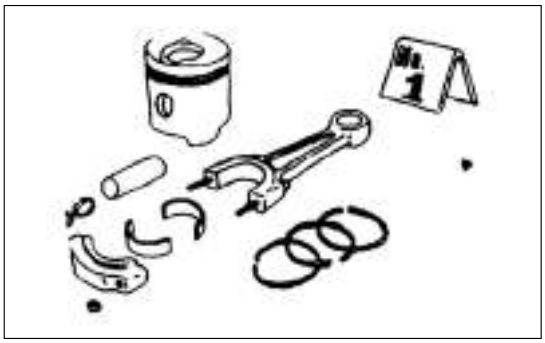
● Prepare replacement parts in advance.



- Once removed, oil seals, gaskets, O rings and other rubber parts, sealing gaskets and split pins shall be replaced with new parts. Genuine Hualing parts must be used.



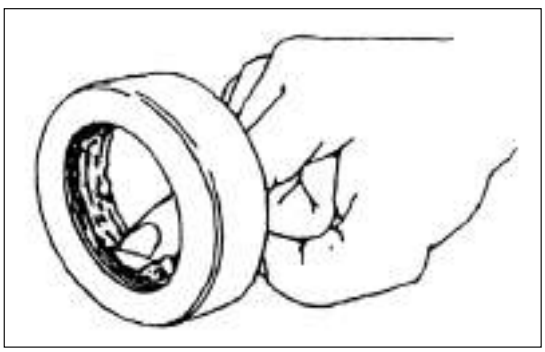
- After decomposition, visually check all parts for wear, breakage, crack, damage, deform, aging, rusting and corrosion, as well as free rotation, fatigue, blocking and any other possible defects.



- Before disassembling, make fitting marks at junctions. Neatly place removed parts. This can help prevent wrong installation in the future.
- Fitting marks and printed marks shall be made where part performance and appearance are not affected.
- Cover openings on removed parts to prevent ingress of dust.

Caution ⚠

- Take care not to mix the many parts, similar parts, and left/right parts.
- Separate prepared replacement new parts and reused (removed) parts.

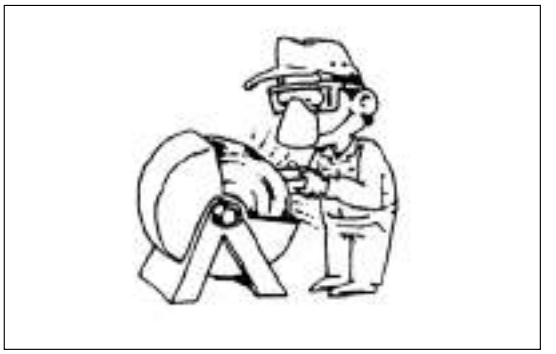


For assembling, apply specified engine oil and lubricating grease on U-shaped seal, oil seal, dust seal ring and bearings.

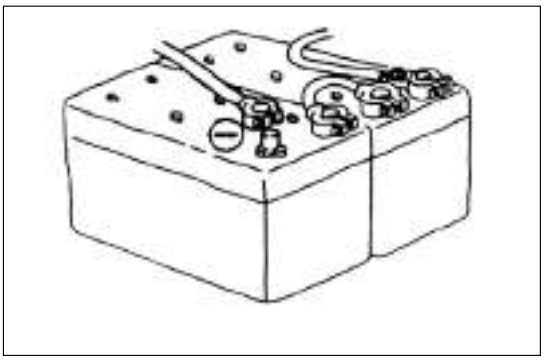
Only specified engine oil and grease can be used as lubricant. After application, immediately remove excessive lubricant using thread waste.

Caution ⚠

In case specified engine oil, grease or sealant is not available, equivalents can be used.



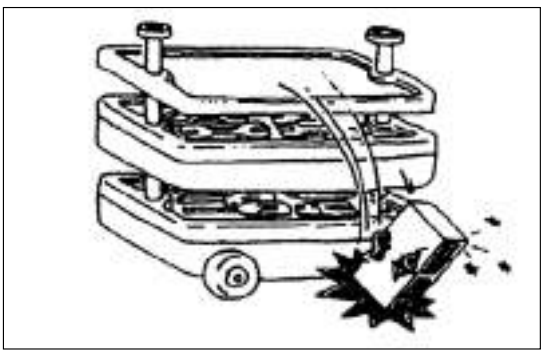
- Wear sunglasses when using grinding disc or welding machine. When gloves must be worn, pay special attention to safety. Pay close attention to sharp edges etc., to avoid hurting hands and fingers.



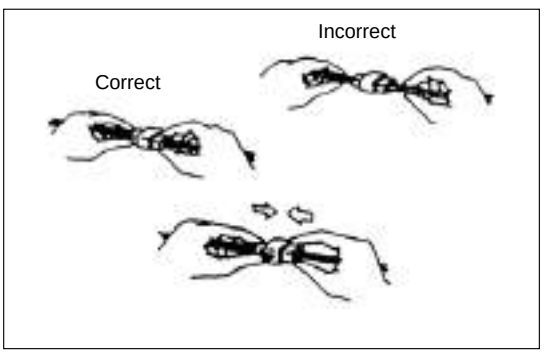
- Before maintenance of electrical system, disconnect negative pole of batteries to prevent short circuit between terminals and burn.

Caution ⚠

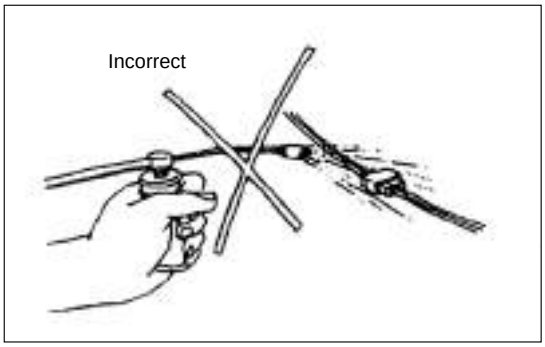
Before disconnecting or connecting battery terminals, make sure to turn off engine and light switches etc. first, as semi-conductor devices may be burnt otherwise.



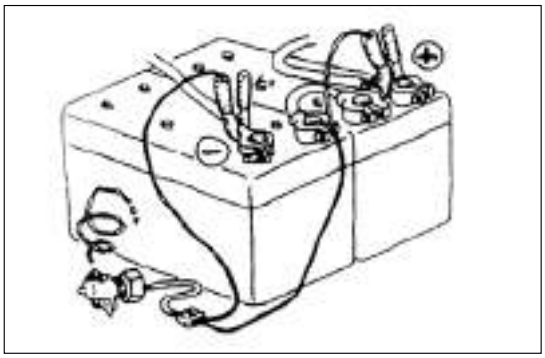
- When operating transducer, relay, and other elements subject to damage by impact and heating, exercise care. Never try to remove controller cover plate or apply paint on controller.



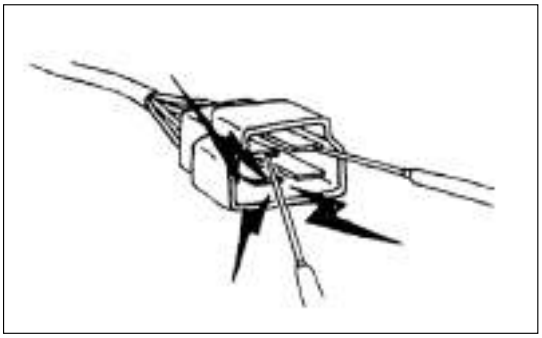
- To disconnect a connector, pull by connector proper and not wire. When disconnecting lock type connector, first press in the direction shown by arrow. For connection of lock type connector, insert the part till a sound of “kata” is heard.



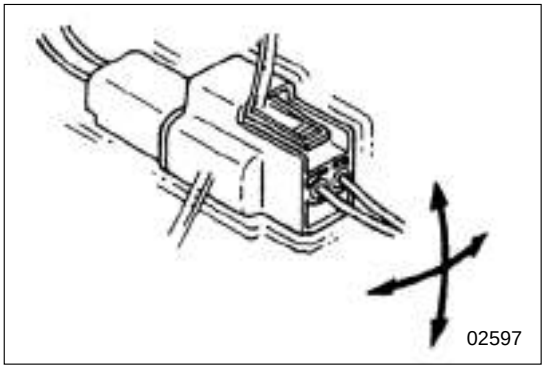
- To wash the vehicle, first cover parts and instruments of electrical system with waterproof material (cloth coated with ethylene or similar). Do not leave wiring connector and transducer in touch with water. If these devices are wet, wipe dry at once.



- To apply voltage for the purpose of testing, check for correct connection of positive pole and negative pole cables. Then, gradually increase voltage from 0V. Never apply a voltage higher than specified value.
- Above all things, pay close attention to controllers and transducer, as these devices cannot always withstand battery voltage (24V).

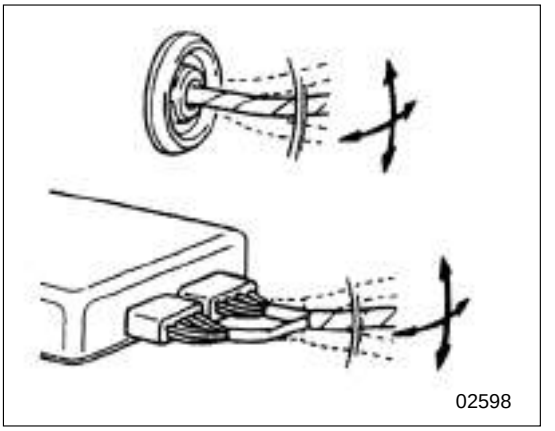


- When using multimeter to test for conduction, take care not to connect the wrong terminal by the measuring bar.

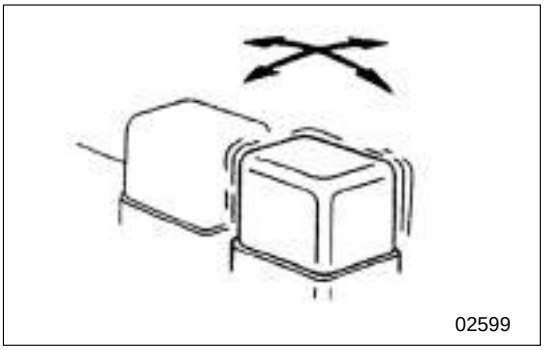


►Intermittent failure

Normally, intermittent failure only occurs under some operating conditions. Once such conditions are identified, the causes of such failure can be easily found. First of all, ask user such failure occurs under what vehicle running conditions and climate conditions, and what frequency and symptoms. Later, enable reappearance of the failure according to such information. This can determine conditions of failure and if the failure is due to vibration and high temperature or other causes. If it is due to vibration, check if it can appear again via the following inspections of each connector and other parts:

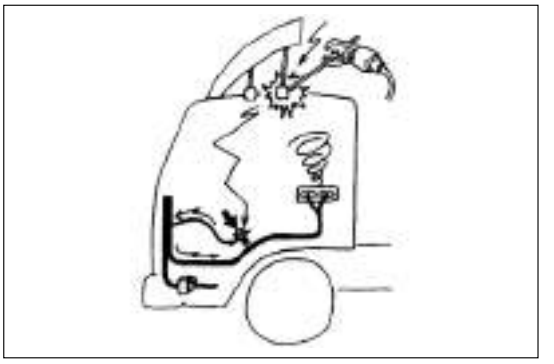

02598

- Slowly move connector up-and-down, left-and-right.
- Slowly move wiring up-and-down, left-and-right.
- Use hand to slowly rock transmitters and other devices.
- Slowly swing wiring on suspension system or other moving parts.
- Connectors and other devices to be inspected include connectors and related devices inspected according to diagnosis codes and/or failure symptoms, and places where failure is deemed possible.


02599

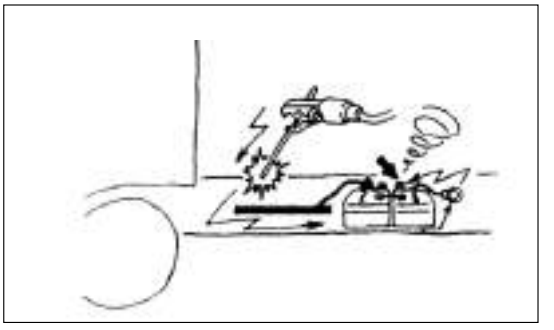
►Precautions on arc welding

- During arc welding, electric current flows from welding machine to ground via metal parts of vehicle. If no suitable measures are taken, this current may damage controller, other electrical devices, and electric wiring.
  In addition, any electrical device near connection point between welding machine negative pole cable and the vehicle is subject to damage.
- Return of electric current is described below.



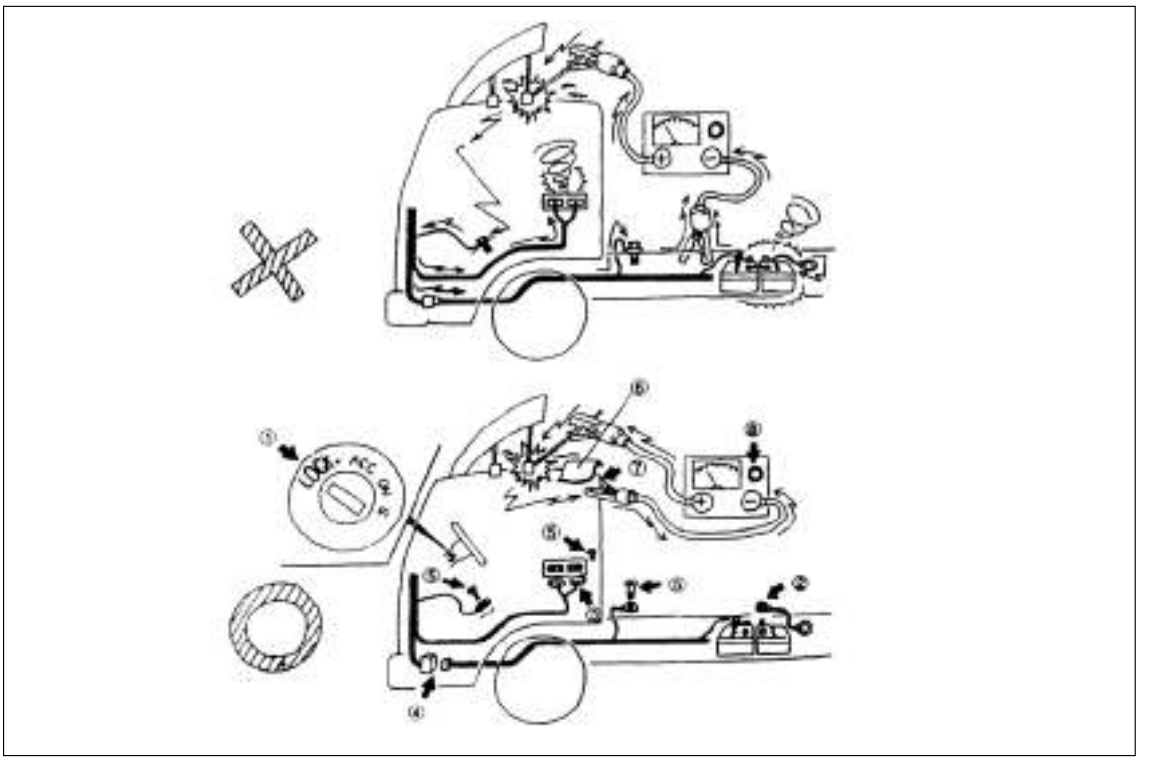
►Return flow from grounding point of cab and frame

To prevent damage, remove grounding point bolt and disconnect vehicle ground wire. In this way, all connectors containing ground wire are disconnected.



►Return flow via battery ⊖ pole terminal

To prevent damage of batteries and electric devices directly connected to batteries, it is necessary to disconnect battery pole ⊖ terminal.



►Method of operation

① Turn starter switch to LOCK position.

↓

② Disconnect batteries ⊖ pole terminal of electrical system.

↓

③ Disconnect controller connector of electrical system.

↓

④ Disconnect the connector connecting cab, chassis and door wiring.

↓

⑤ Disconnect all grounding points of electric system.

↓

⑥ Cover all parts on vehicle that may be damaged by welding spark.

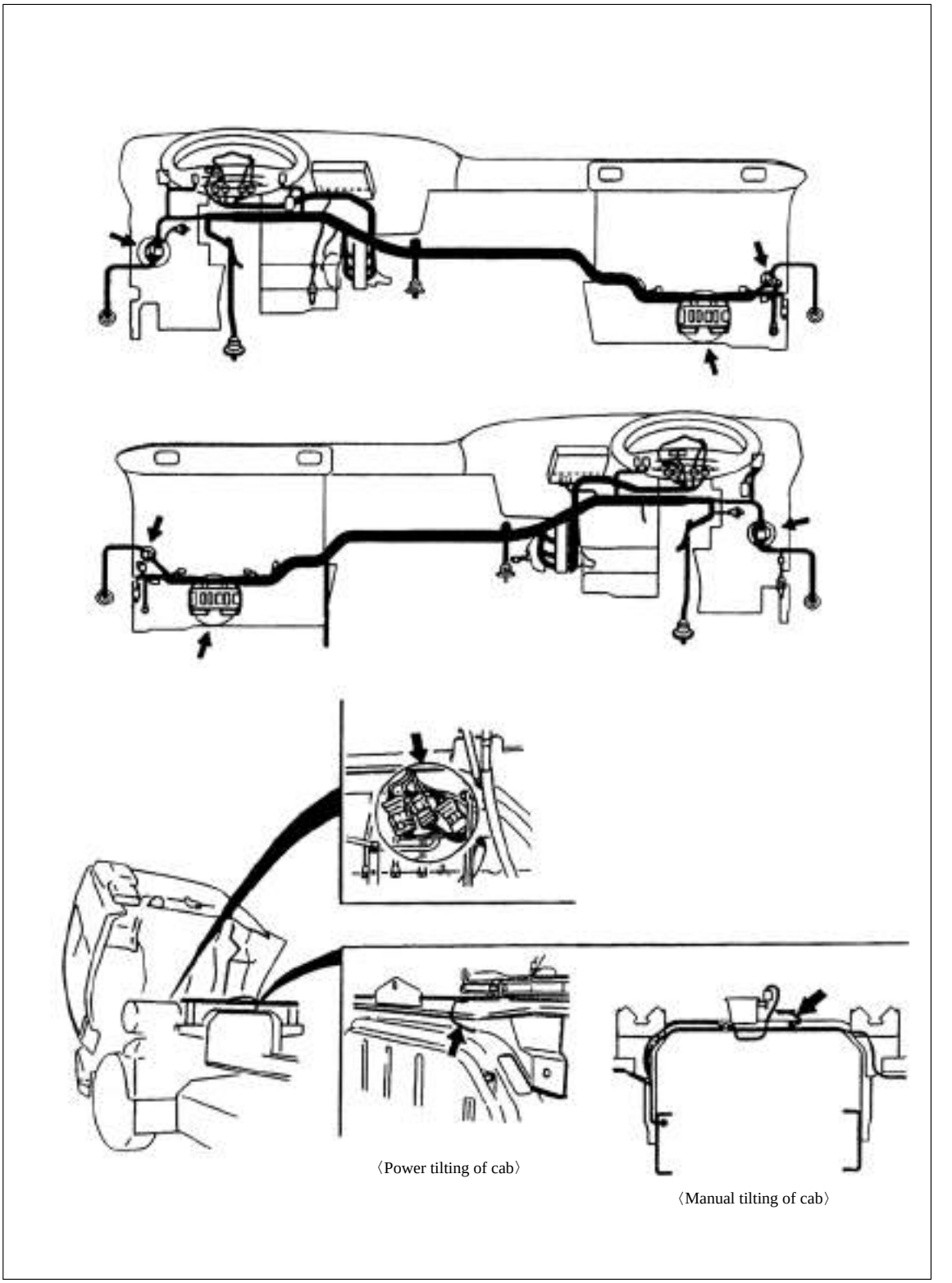
↓

⑦ Connect welding machine pole ⊖ cable to the vehicle and as near welded part as possible. For welding on frame, do not connect welding machine pole ⊖ cable to cab, and vice versa..

↓

⑧ Adjust welding current according to parts to be welded.

►Position of wiring connection from cab to chassis and from cab to doors



〈Power tilting of cab〉

〈Manual tilting of cab〉

Memo

Table of Standard Tightening Torque

- Use specified bolts and nuts and tighten using suitable torque listed in the table below (except otherwise specified).
- Threads and contact surfaces must by dry.
- In case of difference in strength class for nut and bolt, torque specified for bolt shall be adopted.

►Tightening torque for threaded fasteners used for vehicle

1.1 For bolts and screws of grade 4.6 mechanic performance, tightening torque shall be as specified in Table 1.

Table 1

Thread dia. mm	pitch mm	Tightening torque					
		Standard value		Maximum value		Minimum value	
		N.m	(kgf.m)	N.m	(kgf.m)	N.m	(kgf.m)
6	1	4.0	(0.4)	5.5	(0.6)	2.5	(0.3)
8	1.25	8.0	(0.8)	11.0	(1.1)	5.0	(0.5)
8	1	8.5	(0.9)	11.5	(1.2)	5.5	(0.6)
10	1.5	19.7	(2.0)	24.7	(2.5)	14.3	(1.5)
10	1.25	20.8	(2.1)	25.8	(2.6)	16.7	(1.7)
10	1	21.8	(2.2)	26.5	(2.7)	17.0	(1.7)
12	1.75	37.3	(3.8)	43.3	(4.4)	28.0	(2.9)
12	1.5	38.5	(3.9)	45.0	(4.6)	29.0	(3.0)
12	1.25	(39.6)	(4.0)	48.0	(4.9)	30.0	(3.1)
14	2	61.2	(6.2)	75.0	(7.6)	46.8	(4.8)
14	1.5	74.6	(7.6)	92.0	(9.4)	56.0	(5.7)
16	2	95	(9.7)	115.0	(11.7)	73.0	(7.4)
16	1.5	105.0	(10.7)	133.0	(13.6)	76.0	(7.7)
18	2.5	142.9	(14.6)	178.0	(18.1)	107.4	(10.9)
18	1.5	157.6	(16.1)	190.0	(19.4)	124.5	(12.7)
20	2.5	188.0	(19.2)	230.0	(23.4)	135.0	(13.8)
20	1.5	203.7	(20.8)	243.0	(24.8)	149.0	(15.2)

1.2 For bolts and screws of grade 5.6 mechanic performance, tightening torque shall be as specified in Table 2.

Table 2

Thread dia. mm	pitch mm	Tightening torque					
		Standard value		Maximum value		Minimum value	
		N.m	(kgf.m)	N.m	(kgf.m)	N.m	(kgf.m)
6	1	4.5	(0.5)	6.0	(0.6)	3.0	(0.3)
8	1.25	10.6	(1.1)	14.0	(1.4)	7.0	(0.7)
8	1	11.0	(1.1)	15.0	(1.5)	8.0	(0.8)
10	1.5	26.0	(2.7)	33.0	(3.4)	19.0	(1.9)

Thread dia. mm	pitch mm	Tightening torque					
		Standard value		Maximum value		Minimum value	
		N.m	(kgf.m)	N.m	(kgf.m)	N.m	(kgf.m)
10	1.25	28.0	(2.9)	34.0	(3.5)	22.0	(2.2)
10	1	29.0	(3.0)	35.0	(3.6)	23.0	(2.3)
12	1.75	45.0	(4.6)	53.0	(5.4)	37.0	(3.8)
12	1.5	47.0	(4.8)	56.0	(5.7)	38.0	(3.9)
12	1.25	50.0	(5.1)	60.0	(6.1)	40.0	(4.1)
14	2	81.0	(8.3)	95.0	(9.7)	62.0	(6.3)
14	1.5	90.0	(9.2)	105.0	(10.7)	68.0	(6.9)
16	2	124.0	(12.6)	150.0	(15.3)	98.0	(10.0)
16	1.5	132.0	(13.5)	160.0	(16.3)	101.0	(10.3)
18	2.5	190.0	(19.4)	220.0	(22.4)	161.0	(16.4)
18	1.5	200.0	(20.4)	230.0	(23.4)	165.0	(16.8)
20	2.5	231.6	(23.6)	272.0	(27.7)	190.0	(19.4)
20	1.5	246.6	(25.1)	285.0	(29.1)	197.3	(20.1)

1.3 For bolts and screws of grade 8.8 mechanic performance, tightening torque shall be as specified in Table 3.

Table 3

Thread dia. mm	pitch mm	Tightening torque					
		Standard value		Maximum value		Minimum value	
		N.m	(kgf.m)	N.m	(kgf.m)	N.m	(kgf.m)
6	1	9	(0.9)	12	(1.2)	6	(0.6)
8	1.25	23	(2.3)	26	(2.7)	16	(1.6)
8	1	25	(2.5)	28	(2.9)	17	(1.7)
10	1.5	59	(6.0)	75	(7.6)	37	(3.8)
10	1.25	63	(6.4)	79	(8.1)	45	(4.6)
10	1	64	(6.5)	80	(8.2)	46	(4.7)
12	1.75	95	(9.7)	111	(11.3)	73	(7.4)
12	1.5	97	(9.9)	113	(11.5)	75	(7.6)
12	1.25	99	(10.1)	115	(11.7)	78	(8.0)
14	2	160	(16.3)	185	(18.9)	122	(12.4)
14	1.5	180	(18.3)	205	(20.9)	146	(14.9)
16	2	215	(21.9)	245	(25.0)	182	(18.6)
16	1.5	240	(24.5)	270	(27.5)	199	(20.3)
18	2.5	268	(27.3)	298	(30.4)	229	(23.3)
18	1.5	316	(32.2)	346	(35.3)	287	(29.3)
20	2.5	430	(43.8)	470	(47.9)	389	(39.7)
20	1.5	440	(44.9)	480	(48.9)	396	(40.4)

1.4 For bolts and screws of grade 10.9 mechanic performance, tightening torque shall be as specified in

Table 4.

Table 4

Thread dia. mm	pitch mm	Tightening torque					
		Standard value		Maximum value		Minimum value	
		N.m	(kgf.m)	N.m	(kgf.m)	N.m	(kgf.m)
10	1.5	74	(7.5)	90	(9.2)	52	(5.3)
10	1.25	78	(8.0)	93	(9.5)	63	(6.1)
10	1	80	(8.2)	95	(9.7)	65	(6.6)
12	1.75	140	(14.3)	156	(15.9)	105	(10.7)
12	1.5	142	(14.5)	158	(16.1)	106	(10.8)
12	1.25	145	(14.8)	161	(16.4)	108	(11.0)
14	2	175	(17.8)	200	(20.4)	141	(14.4)
14	1.5	210	(21.4)	235	(24.0)	178	(18.1)
16	2	280	(28.5)	310	(31.6)	200	(20.4)
16	1.5	305	(31.1)	335	(34.1)	240	(24.5)
18	(2.5)	437	(44.5)	467	(47.6)	380	(38.7)
18	1.5	467	(47.6)	507	(51.7)	397	(40.5)
20	2.5	528	(53.8)	568	(57.9)	450	(45.9)
20	1.5	558	(56.9)	598	(61.0)	475	(48.4)

2 L Series Engine

Chapter 1—— Parts Diagram

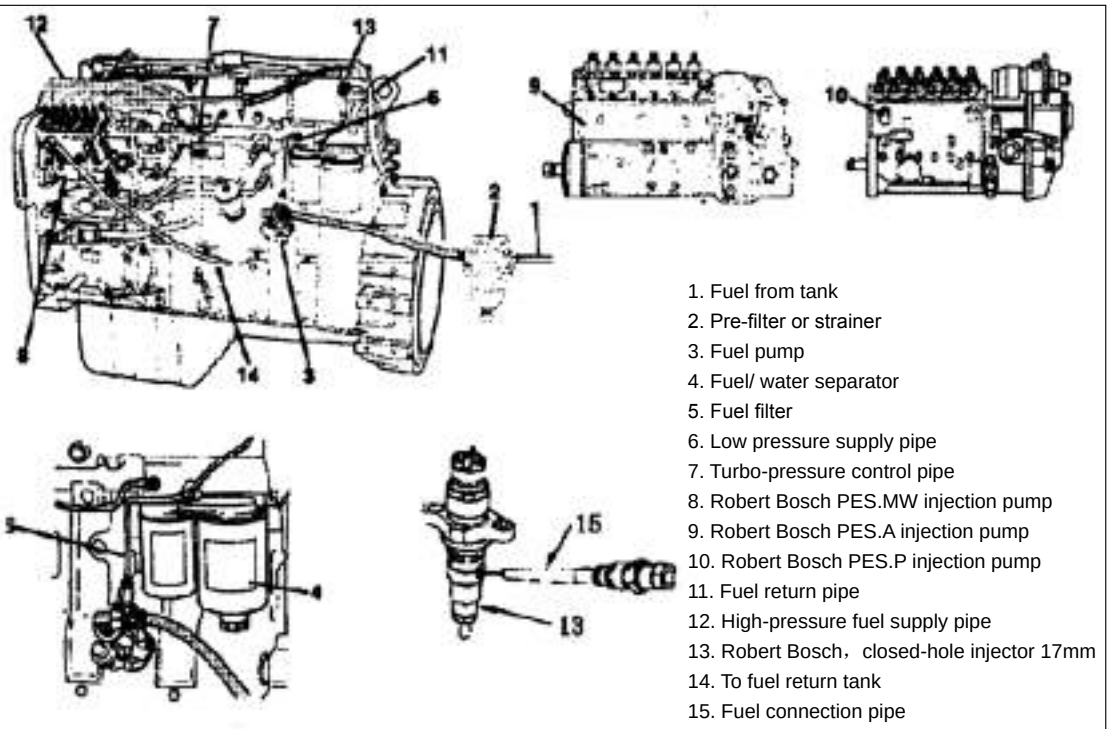
General Information

Flow chart of engine system is following. Even if parts are different in different assembly or application, the similar flow chart of systems is:

- Fuel System
- Lubrication System
- Cooling System
- Intake System
- Exhaust System

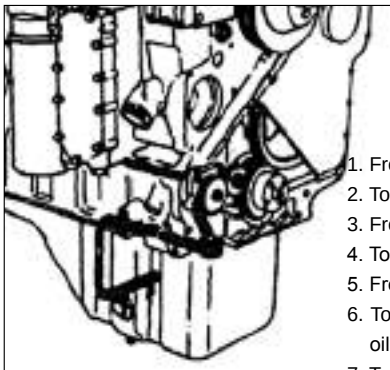
Engine knowledge will help you know better about the troubleshooting, general maintenance and repair.

Fuel System



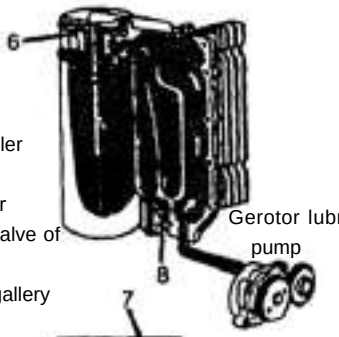
1. Fuel from tank
2. Pre-filter or strainer
3. Fuel pump
4. Fuel/ water separator
5. Fuel filter
6. Low pressure supply pipe
7. Turbo-pressure control pipe
8. Robert Bosch PES.MW injection pump
9. Robert Bosch PES.A injection pump
10. Robert Bosch PES.P injection pump
11. Fuel return pipe
12. High-pressure fuel supply pipe
13. Robert Bosch，closed-hole injector 17mm
14. To fuel return tank
15. Fuel connection pipe

Lubrication System



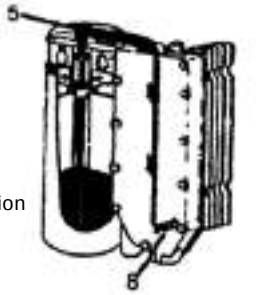
1. From pump
2. To oil cooler
3. From oil cooler
4. To oil filter
5. From oil filter
6. To bypass valve of oil filter
7. To main oil gallery
8. To oil sump

Oil cooler combined full flow and bypass filter

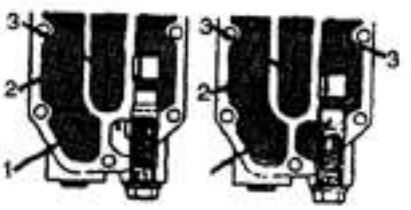


Gerotor lubrication pump

Bypass filter flow chart

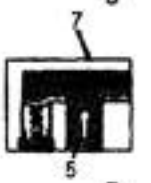


Off On

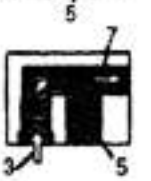


Pressure regulation valve

Valve off

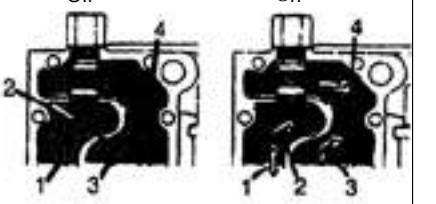


Valve on



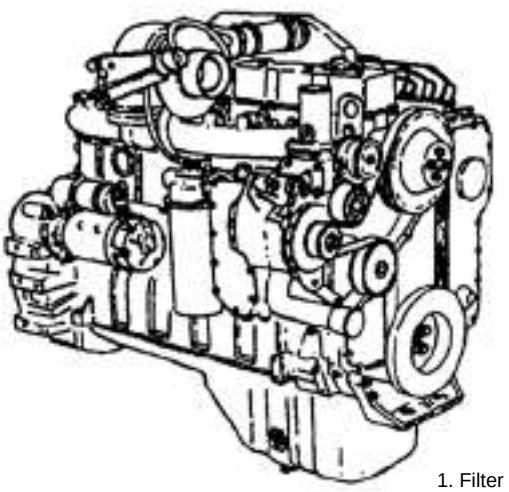
Bypass valve of oil filter

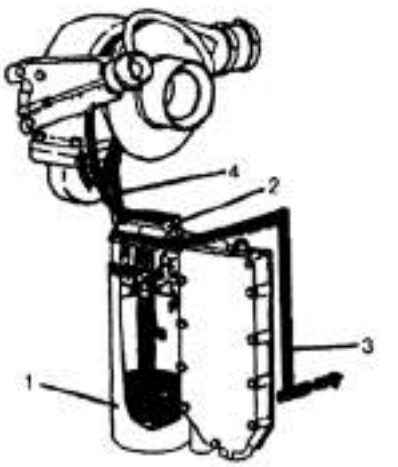
Off On



Oil cooler to bypass thermostat

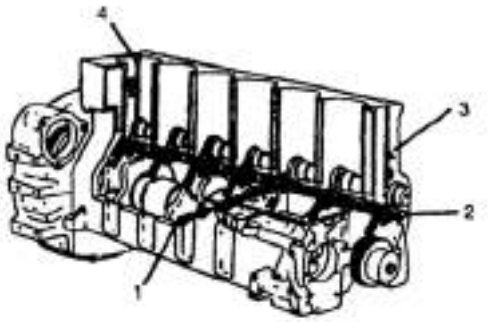
Turbocharger Lubrication

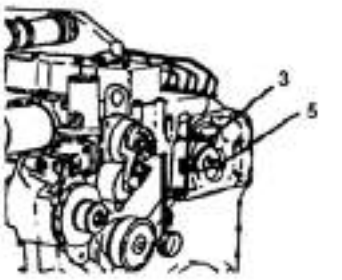


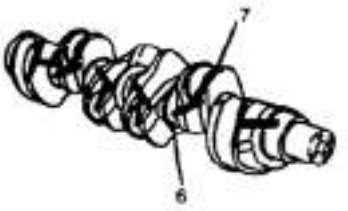


1. Filter
2. Turbocharger supply oil
3. To main oil gallery
4. To sump

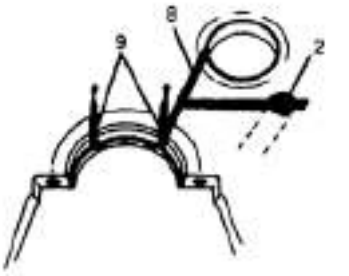
Powertrain Lubrication



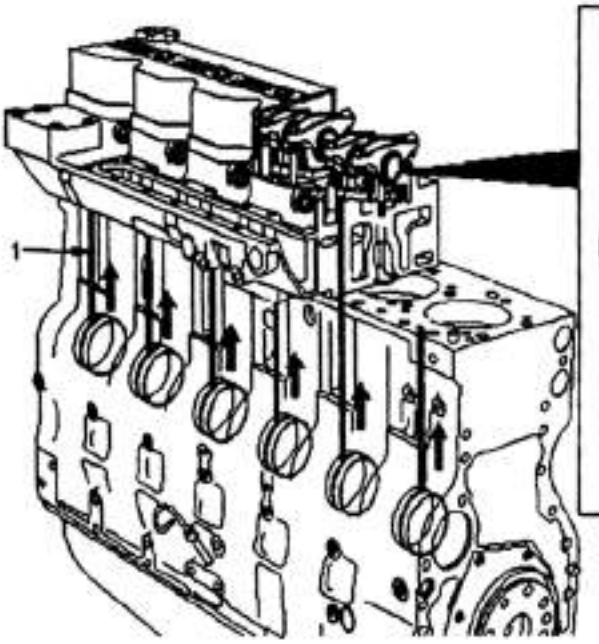


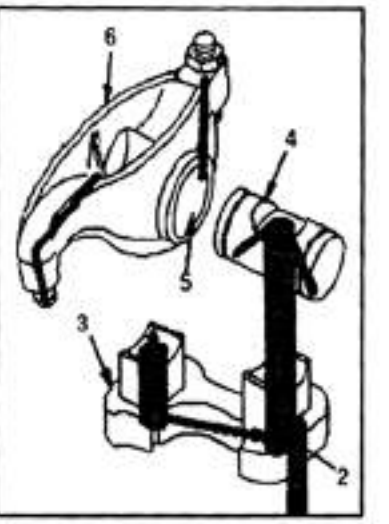


1. From oil cooler
2. To main oil gallery
3. To injection pump
4. To overhead mechanism
5. Injection pump release
6. Main journal of crankshaft
7. Connecting-rod journal
8. To camshaft
9. Cooling nozzle of piston



Overhead Mechanism Lubrication

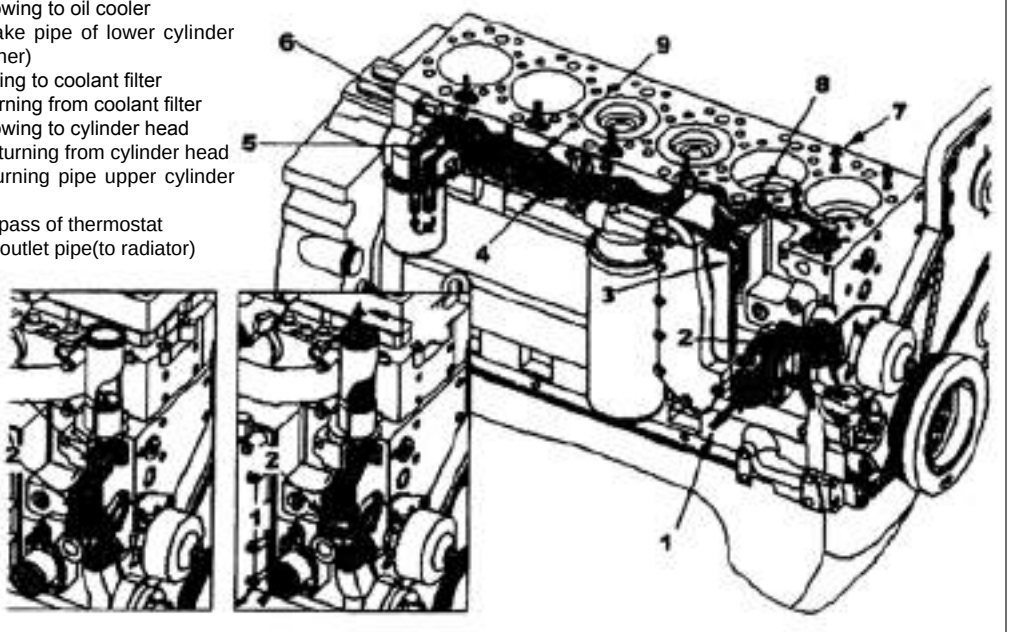




1. Oil to cylinder head through cylinder block oil passage above camshaft sleeve
2. Oil passage of the cylinder head
3. Oil to pitman arm seat
4. Lubricating pitman shaft
5. Oil to pitman arm
6. Lubricating valve rod and push rod

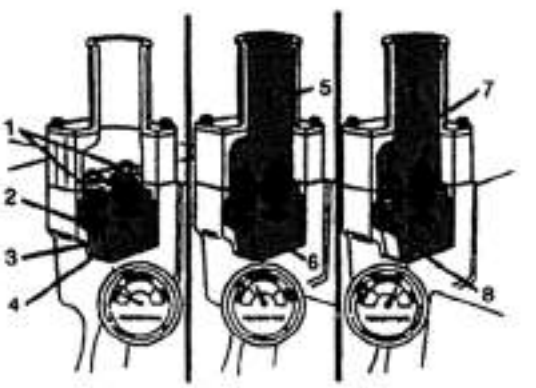
Cooling System

1. Coolant from radiator to water pump
2. Water pump
3. Coolant flowing to oil cooler
4. Water intake pipe of lower cylinder block (to liner)
5. Water flowing to coolant filter
6. Water returning from coolant filter
7. Coolant flowing to cylinder head
8. Coolant returning from cylinder head
9. Water returning pipe upper cylinder block
10. Lower bypass of thermostat
11. Ccoolant outlet pipe(to radiator)



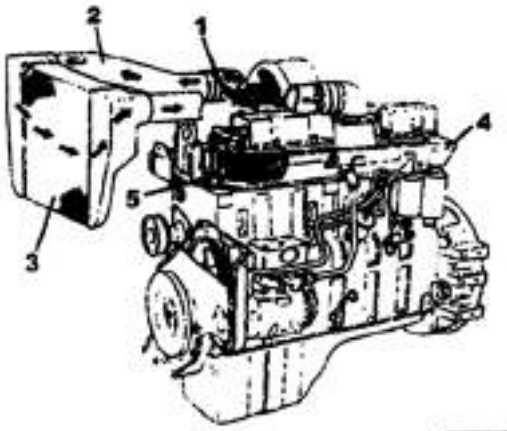
Cooling System

Thermostat



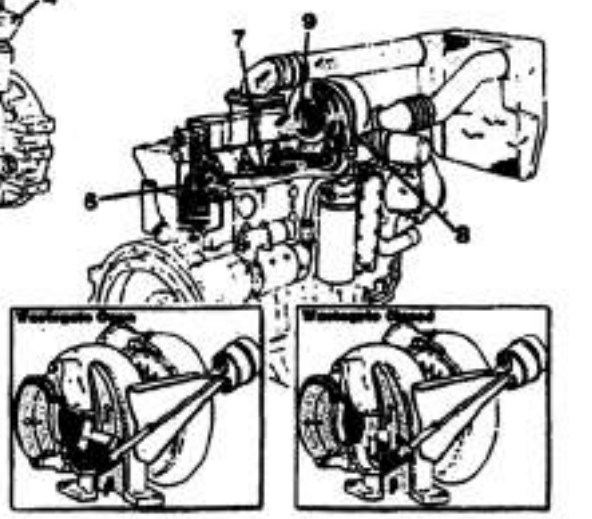
1. Tthermostat
2. Coolant flowing to pump
3. Bypass
4. Coolant from cooling pipe
5. Partial coolant flowing to water tank
6. Restricted coolant flowing to bypass valve
7. Coolant flowing to water tank
8. Bbypass valve off

Air System



Air Intake System
1. Air intake opening to turbocharger
2. Air in turbocharger to turbocharger cooler
3. Charger air cooler
4. Intake manifold (part of cylinder head)
5. Intake valve

Exhaust System
6. Exhaust valve
7. Exhaust manifold (pulse type)
8. To double-inlet of turbocharger
9. Exhaust opening of turbocharger



Chapter 2——Troublesh ng

Troubleshooting Procedure and Techniques

The guide describes some representative troubles, causes and acceptable solutions during engine operation. The troubles listed herein are all that can be diagnosed and repaired by the operator unless being noted. For the troubles and diagnosis and repair not listed, please consult with the service station authorized by DONGFENG HUALING AUTO.

Exploit the favorable troubleshooting program according to following recommendations:

● Study the trouble prior to action.

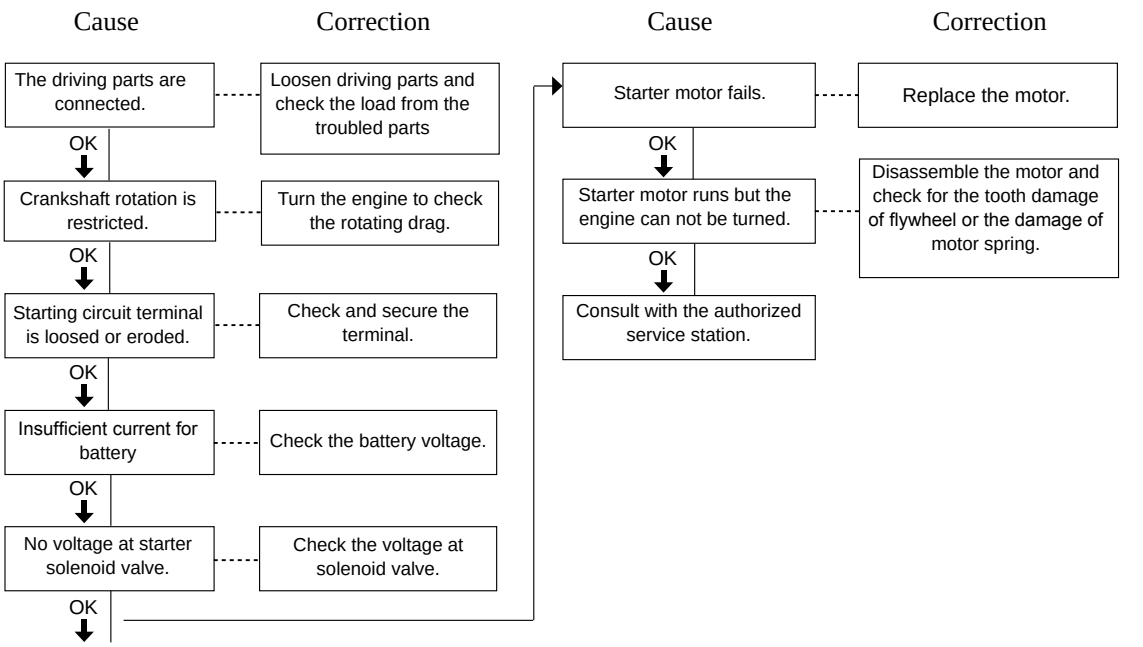
● Do the the easiest and more clear matters.

● Find out the root cause and solve the trouble.

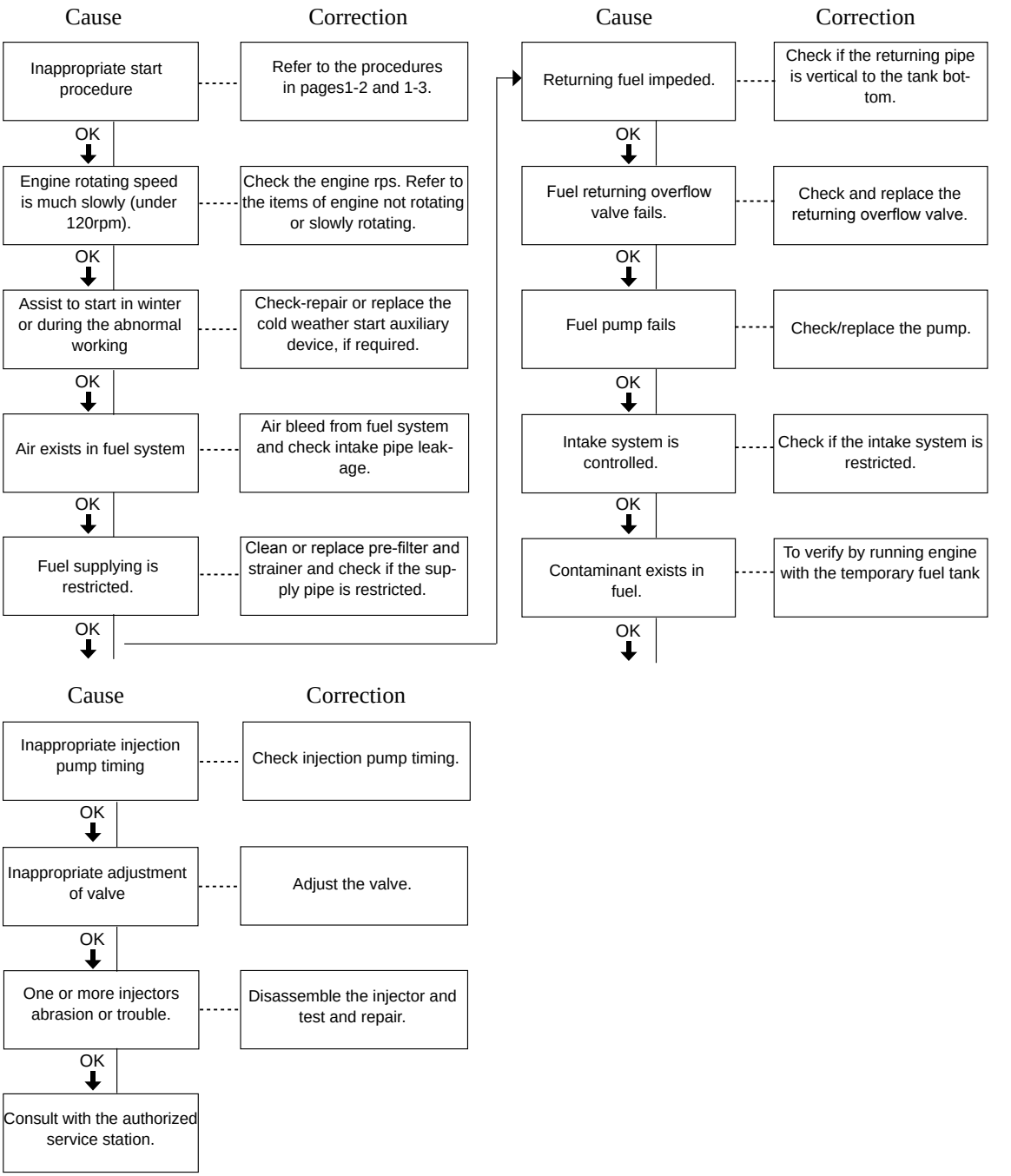
Troubleshooting Symptoms

The tables are very helpful to diagnose and solve the engine troubles. Study items one by one carefully and judge the action to solve the problems following the arrow.

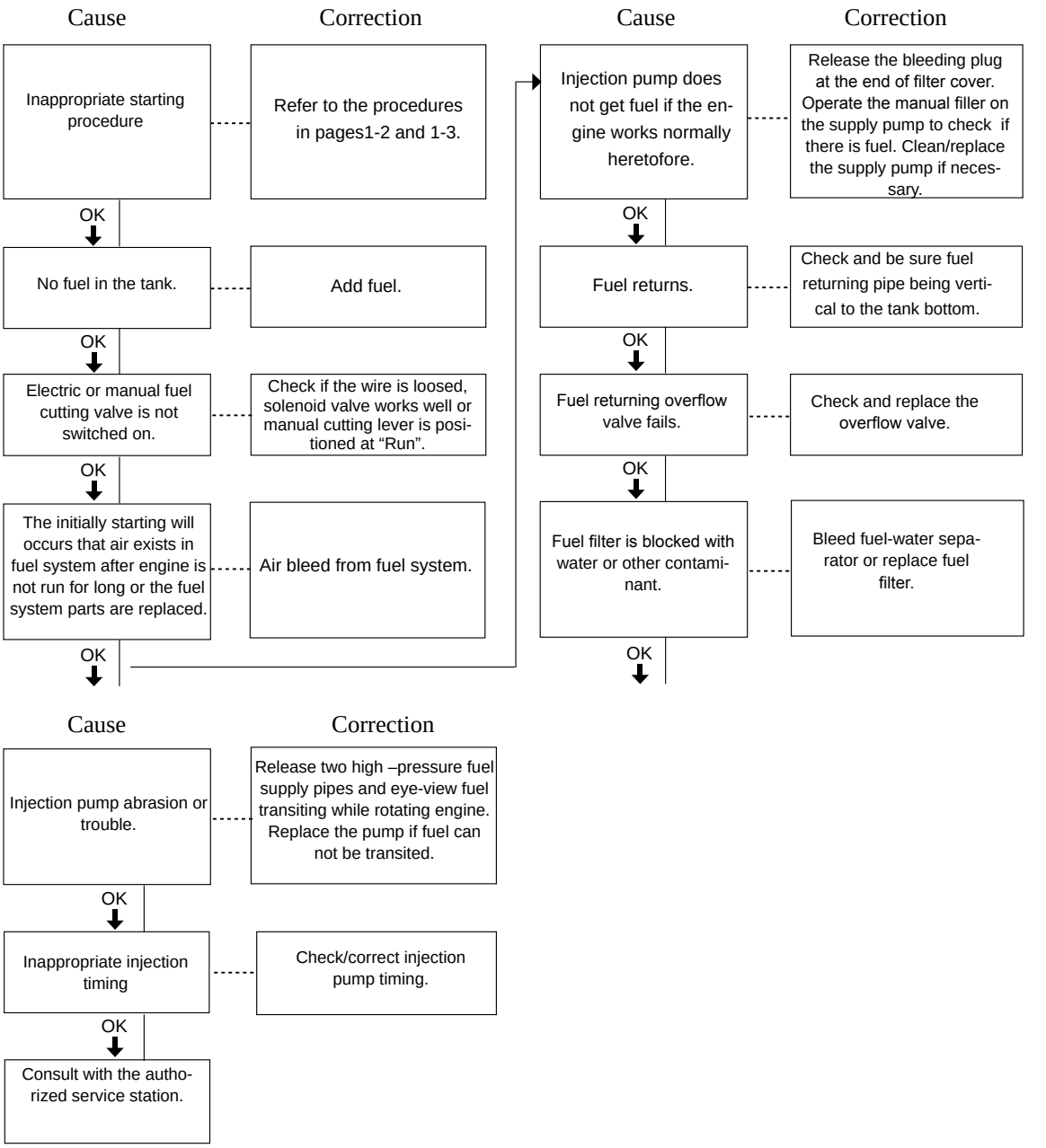
Engine Stopping or Running Slowly



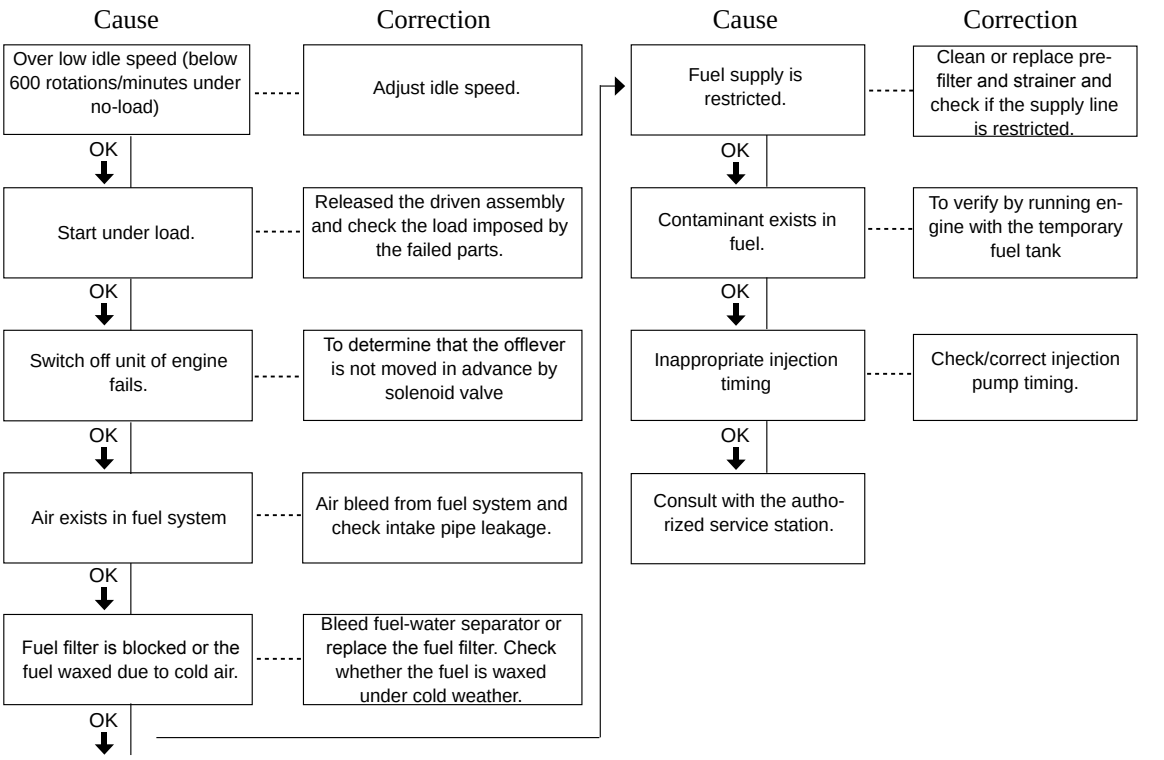
Engine Starting Hard or Not Starting(Smoke Exhausted)



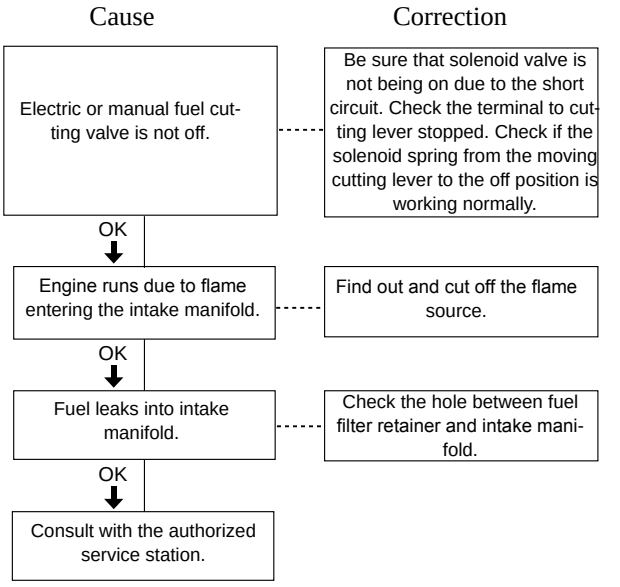
Engine Rotating, Not Starting(No Smoke Exhausted)



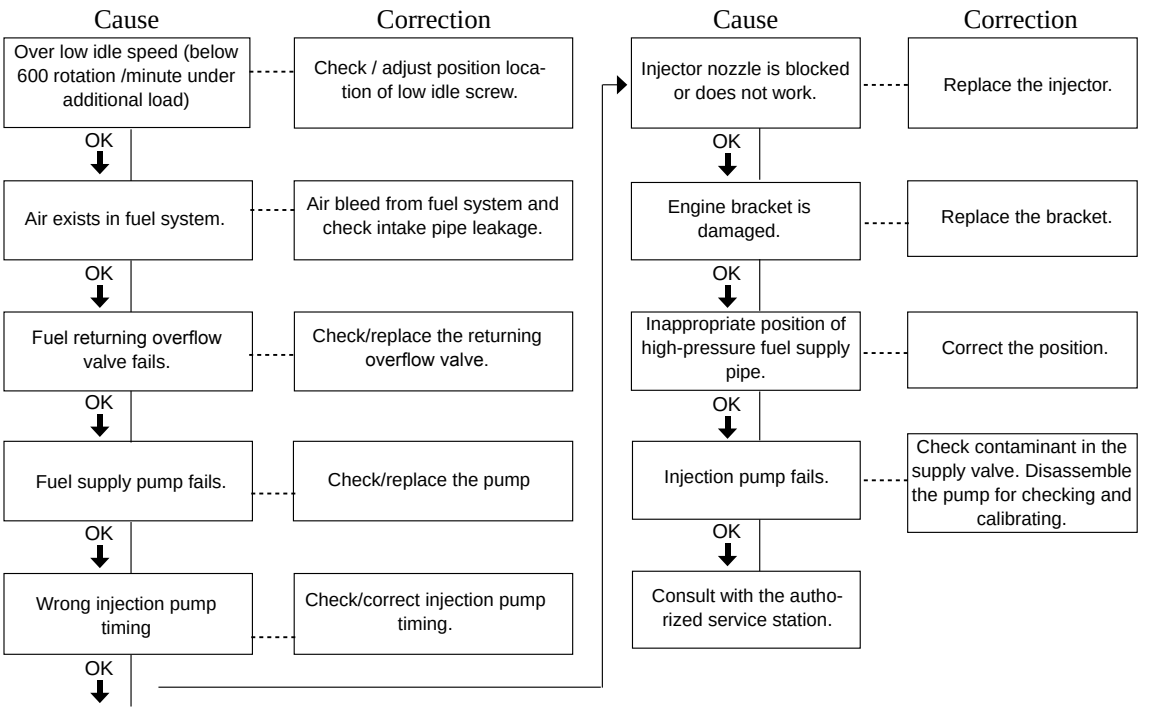
Engine Starting, Not Continuously Rotating



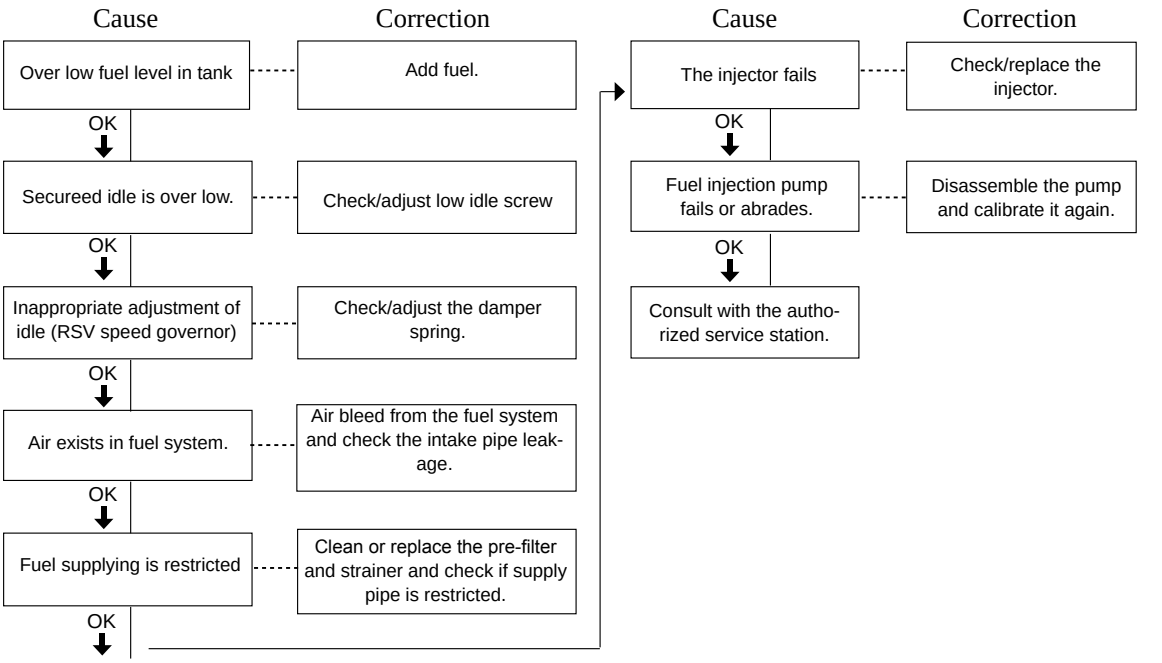
Engine Can Not Be Stopped



Unstable Idle, Warm Engine



Unstable Engine Idle



Engine can be started but not continuously run.

Cause	Correction
Inappropraite oil level.	Add or drain engine oil.
OK ↓	
Oil pressure indicator fails.	Check oil pressure indicator.
OK ↓	
Oil is diluted with fuel, but engine works normally.	Disassemble and check plunger seal of supply pump. Replace the leaked pump and oil.
OK ↓	
Oil is diluted with fuel. Engine unstably works or weak power.	Check the injector nozzle blockage. If the injector works normally, replace injection pump or replace oil.
OK ↓	
Oil is diluted with water.	Check if the rain cap, oil filler cap or dipstick is lost. Replace oil.
OK ↓	

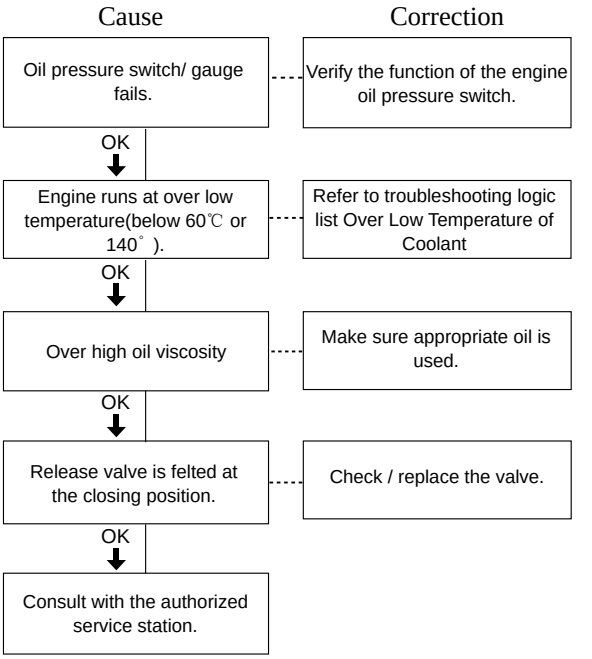
Cause	Correction
Inappropriate oil specification	Check oil specification.
OK ↓	
Tube stopper loosed or lost.	Check crack in rear cylinder head, side supply pump of cylinder block, oil cooler cover and gear box housing.
OK ↓	
Low viscosity of oil due to working temperature above normal coolant range of 100℃(212°).	Refer to Table Over High Coolant Temperature.
OK ↓	
Regulator valve opening is felted at the start position or the spring is damaged.	Check and clean the spring. Replace the spring if damaged.

Lubricant Loss

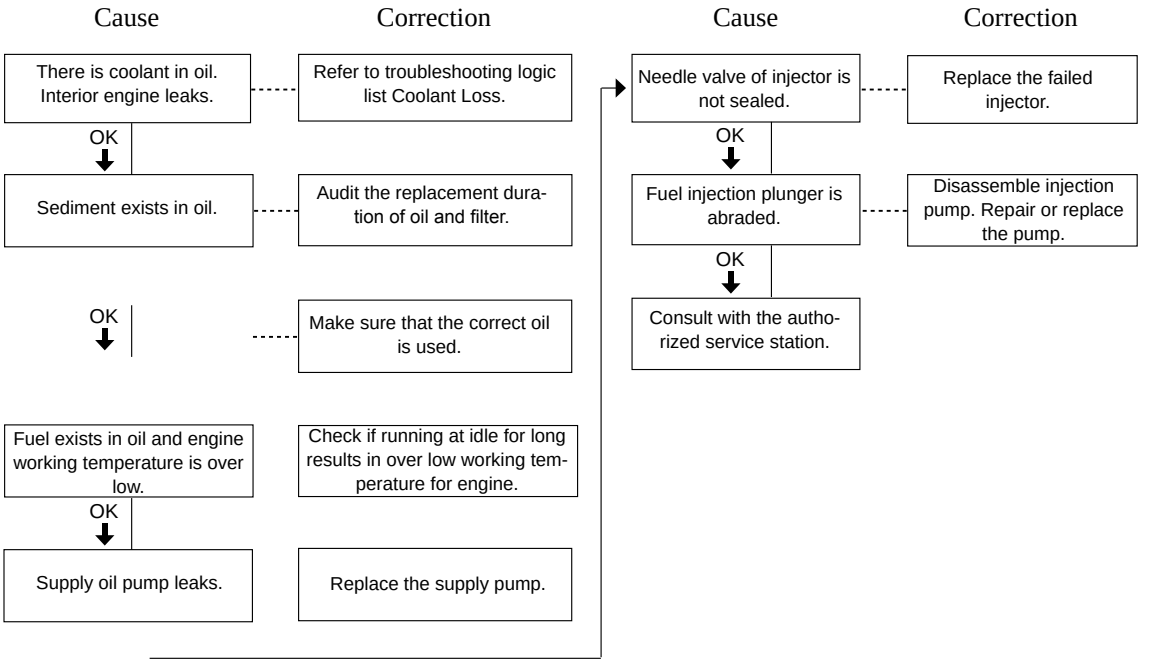
Cause	Correction
It is leaked at outside	Eye view if oil leaks.
OK ↓	
Excessive oil is added in crankshaft case.	Make sure dipstick at appropriate position.
OK ↓	
Inappropriate oil is used (specification or viscosity).	Be sure using correct oil
OK ↓	
	Check if the viscosity of oil is low due to fuel dilution.
	Audit/ shorten oil replacement duration.

Cause	Correction
Oil cooler leaks	Check if there is oil in coolant.
OK ↓	
Air compressor pumps oil, if equipped.	Check / replace air compressor.
OK ↓	
Bypass air bleeds oil away from vent pipe.	Check wether there is oil loss around the vent pipe. Measure air bleeding and repair it.
OK ↓	
Turbocharger leaks oil into intake or exhaust system.	Check oil leakage from turbocharger intake and export ports.
OK ↓	
Consult with the authorized service station.	

Excessive High Lubricant Pressure



Contaminant in Lubricant



Excessive High Temperature for Coolant

Cause	Correction
Over low coolant level	Add coolant.
OK ↓	
Radiator section is damaged or blocked	Check radiator section-clean or repair if necessary.
OK ↓	
Hose is broken.	Check the hose-replace it if necessary.
OK ↓	
Inappropriate oil level	Add or drain oil.
OK ↓	
Fan housing is damaged or lost.	Check the housing and repair it. Replace or assemble it if necessary.
OK ↓	

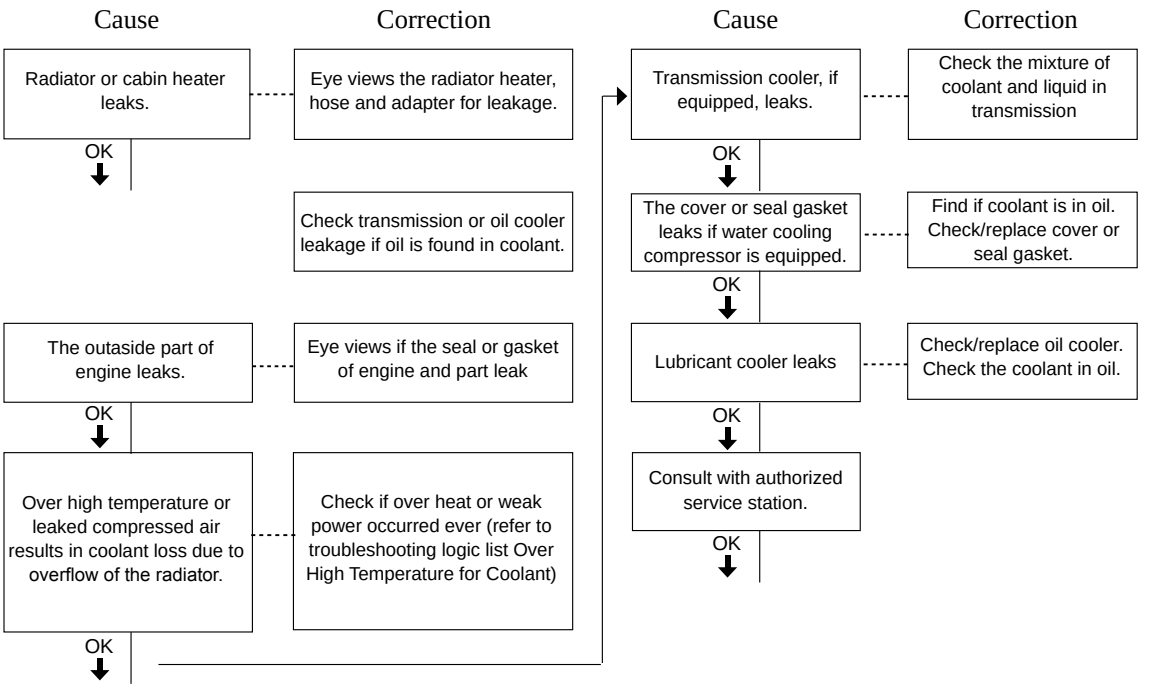
Cause	Correction
Fan belt loosens.	Check belt tension pulley.
OK ↓	
Fan does not work.	Check fan sensor.
OK ↓	
Radiator cover fails or is positioned wrongly	Check radiator cover. Replace it if necessary.
OK ↓	
Radiator grill is not opened completely or the cover is closed in winter.	Check the grill. Open the cover or replace the grill if necessary.
OK ↓	
Temperature gauge fails.	Test the gauge. Repair or replace it if necessary.

Over Low Coolant Temperature

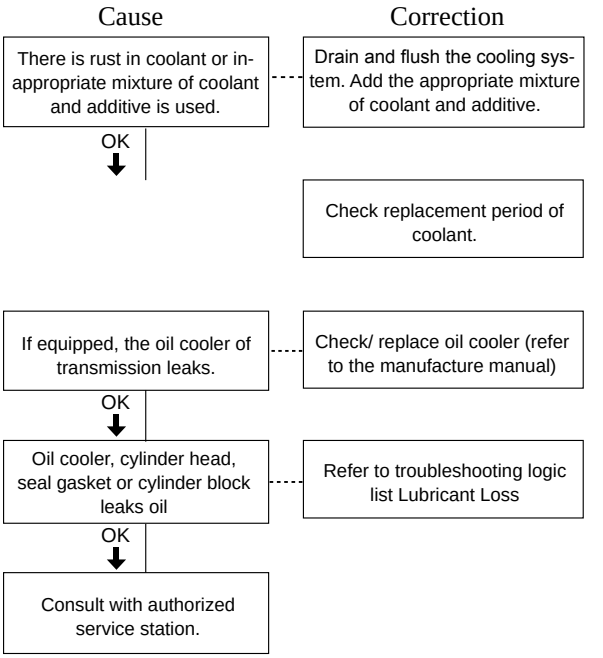
Cause	Correction
Radiator grill is felted at the start position.	Check the grill and replace it necessary.
OK ↓	
Fan conks out.	Check if the fan works continuously.
OK ↓	
Temperature sensor conks out.	Check / clean the sensor and coolant passage.
OK ↓	
	Test/ replace the sensor.
Temperature gauge conks out	Test the temperature gauge. Repair or replace it if necessary.
OK ↓	

Cause	Correction
Inappropriate thermostat or failure	Check the thermostat and replace it if necessary.
OK ↓	
Consult with authorized service station.	

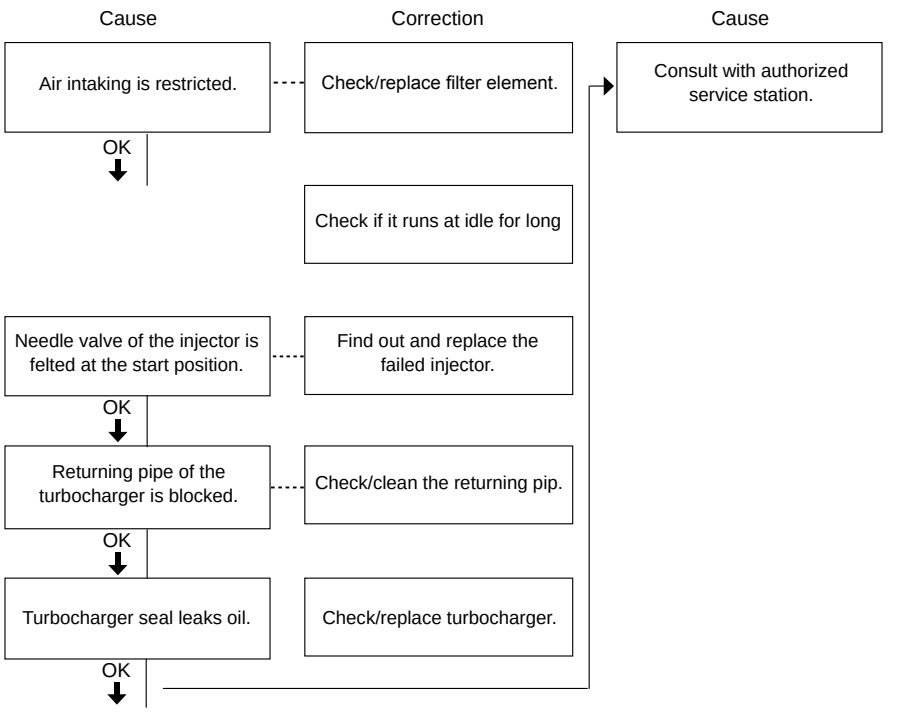
Coolant Loss



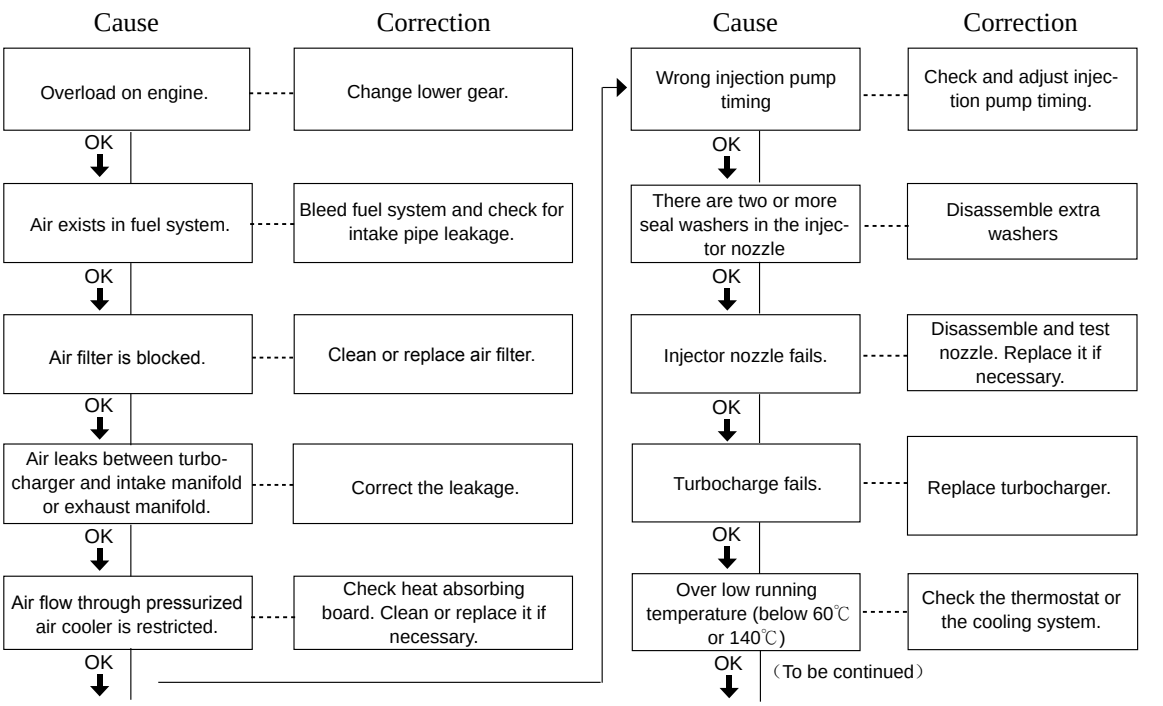
Contaminant in Lubricant



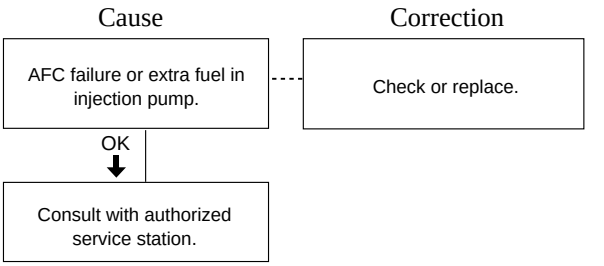
Fuel/ Oil Leakage from Exhaust Manifold



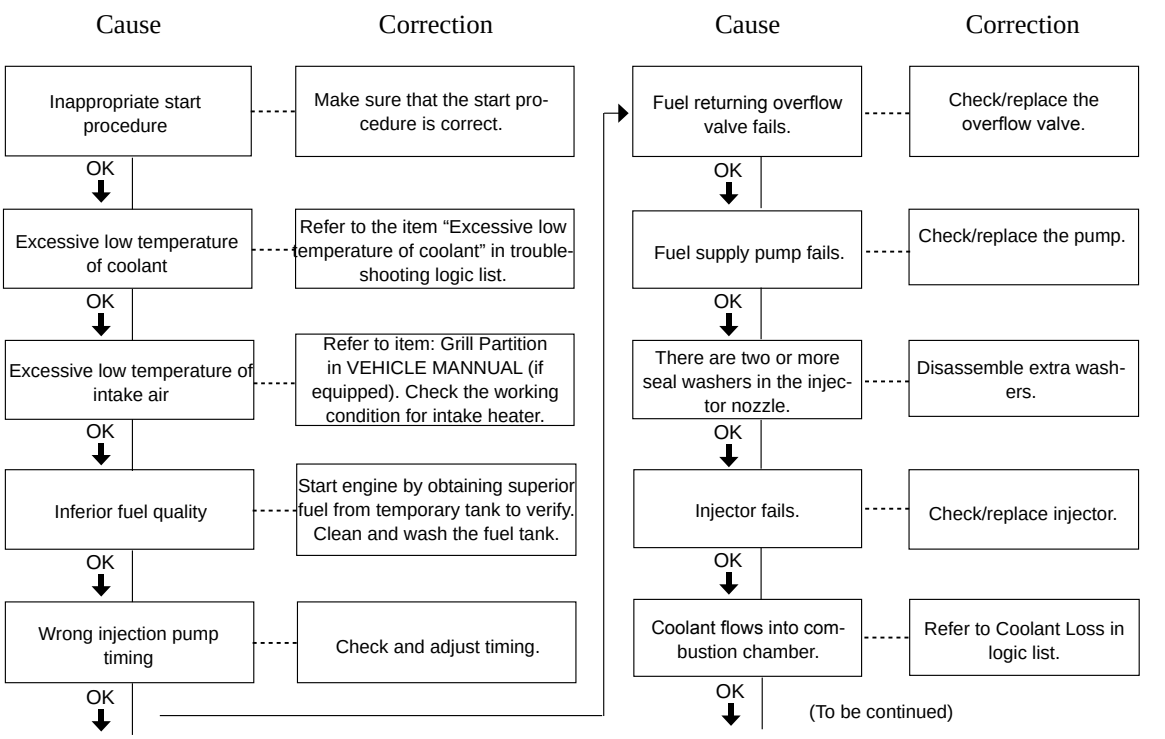
Excessive Smoke under Loading



Excessive Smoke under Loading(continuing)



Excessive White Smoke



Excessive White Smoke (continuing)

Cause	Correction
Injection pump fails.	Disassemble the pump to check and calibrate it. Check the contaminant in supply pipe.
OK ↓	
Consult with authorized service station.	

Not Up to Engine Rated Speed under Load

Cause	Correction
Vehicle overloaded.	Reduce load or shift to the lower gear.
OK ↓	
Wrong adjustment of accelerator lever	Check the whole stroke of adjustment from accelerator lever to high idle stopper screw.
OK ↓	
Tachometer fails.	Check with hand or digital tachometer.
OK ↓	
Pneumatic fuel controlling pipe leaks and /or is restricted.	Secure the adapter or replace if necessary.
OK ↓	
Air flowing through pressurized cooler is restricted.	Check radiator section. Clean or repair it if necessary.
OK ↓	
Fuel supplying is restricted.	Replace fuel filter and check fuel supplying if pre-filter and strainer is restricted.
OK ↓	
Wrong adjustment of high speed screw	Check/adjust high speed screw.
OK ↓	
Cut-off lever is affected	Check/adjust the cut-off lever.
OK ↓	
Fuel returning overflow valve fails.	Check/replace the overflow valve.
OK ↓	
Fuel supply pump fails.	Check/repair or repair the pump.
OK ↓	（To be continued）

Not Up to Engine Rated Speed under Load(continuing)

Cause	Correction
Fuel injection pump fails.	Replace the pump.
OK ↓	
Consult with authorized service station	

Weak Power

Cause	Correction
Vehicle is overloaded.	Reduce load or shift the lower gear.
OK ↓	
Lubricant level is over high.	Drain oil to appropriate level.
OK ↓	
Inappropriate adjustment of accelerator lever	Check and adjust the stroke from accelerator lever to fuel controlling lever.
OK ↓	
Intake or exhaust system is restricted.	Check if intake or exhaust system is restricted. Check the air filter. Replace it if necessary.
OK ↓	
Cut-off lever of the fuel is affected	Check/ adjust the cutting lever.
OK ↓	

Cause	Correction
Pneumatic fuel controlling pipe leaks and/ or is restricted.	Secure the adapter. Replace the pipe if necessary.
OK ↓	
Air flows through pressurized air cooler is restricted.	Check radiator section. Clean or repair if necessary.
OK ↓	
Air leaks from between the turbocharger and intake manifold.	Eliminate leakage.
OK ↓	
Exhausted Air leaks from between the turbocharger and intake manifold.	Eliminate leakage.
OK ↓	
Air exists in fuel system.	Exhaust from fuel system. Check the leakage of intake pipe.
OK ↓	

(To be continued)

Weak Power (Continuing)

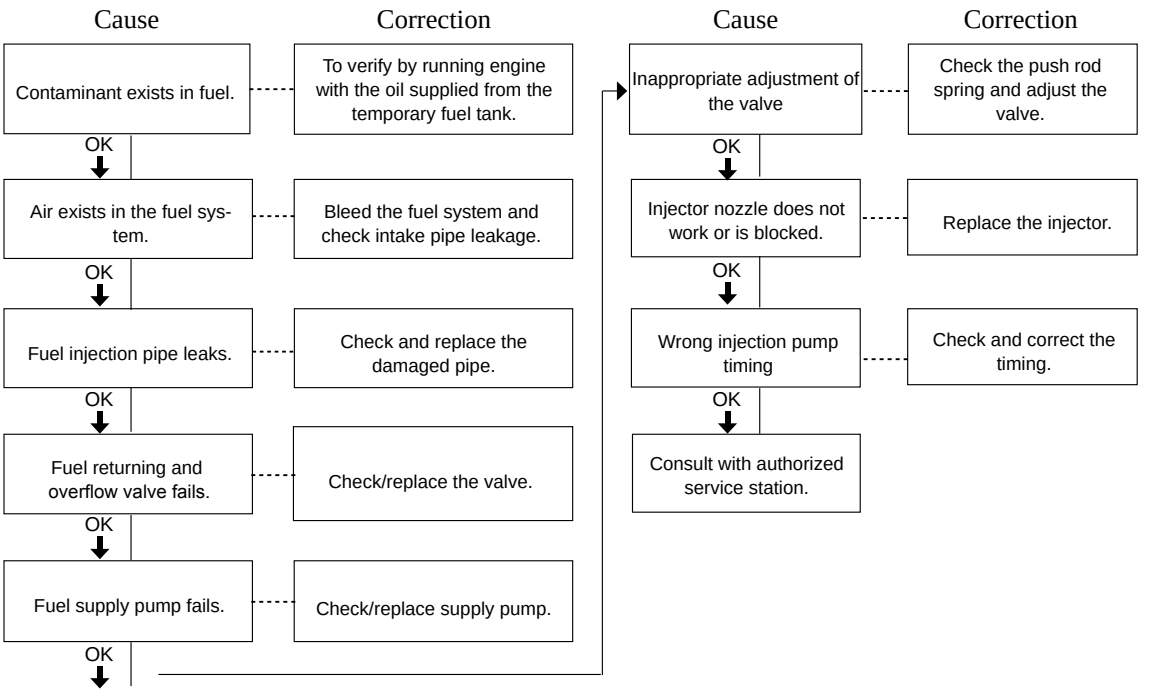
Cause	Correction
Inferior fuel quality	Start engine by obtaining superior fuel from temporary tank to verify and refer to the specification of diesel oil.
OK ↓	
Fuel supply is restricted.	Clean the filter and strainer and check if the supply pipe is restricted. Replace the fuel filter if necessary.
OK ↓	
Fuel returning of injection pump is restricted.	Check damage or restriction of the returning pipe from the pump to fuel tank. Replace the pipe if necessary.
OK ↓	
Fuel supply pump fails.	Check/replace the pump.
OK ↓	
Fuel returning overflow valve	Check/replace the overflow valve.
OK ↓	

Cause	Correction
Over high temperature of intake air(above 36℃ or 168° F).	Turbocharger absorbs air outside in warm climate.
OK ↓	
Over low temperature of intake air (below 0℃ or 32°)	Turbocharger intakes air through engine cover.
OK ↓	
Over high fuel temperature (above70℃,or168° F).	Add fuel into the tank. Switch off the fuel heater.
OK ↓	
Wrong injection pump timing.	Check and correct the injection pump timing.
OK ↓	
The catalyst is blocked.	Check the back pressure on the catalyst. Replace it if necessary.
OK ↓	(To be continued)

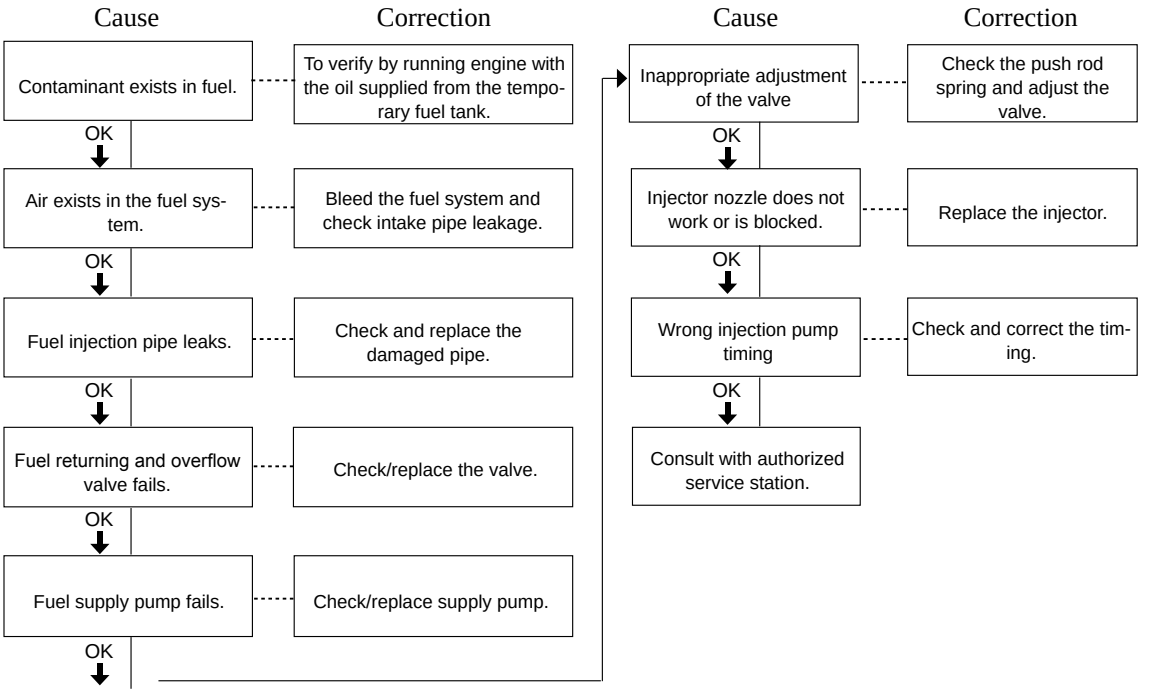
Weak Power

Cause	Correction	Cause
Waste gate of turbocharger fails.	Check damage or leakage of the sensor wire. Check /adjust the waste gate lever.	Consult with authorized service station.
OK ↓		
Turbocharger is abraded or fails.	Replace the turbocharger.	
OK ↓		
Inappropriate adjustment of the valve	Adjust the valve. Check the push rod and spring.	
OK ↓		
Injector nozzle is abraded or fails.	Disassemble and test the nozzle. Repair or replace it if necessary.	
OK ↓		
Injection pump is abraded or fails.	Check the injection pump calibration.	
OK ↓		

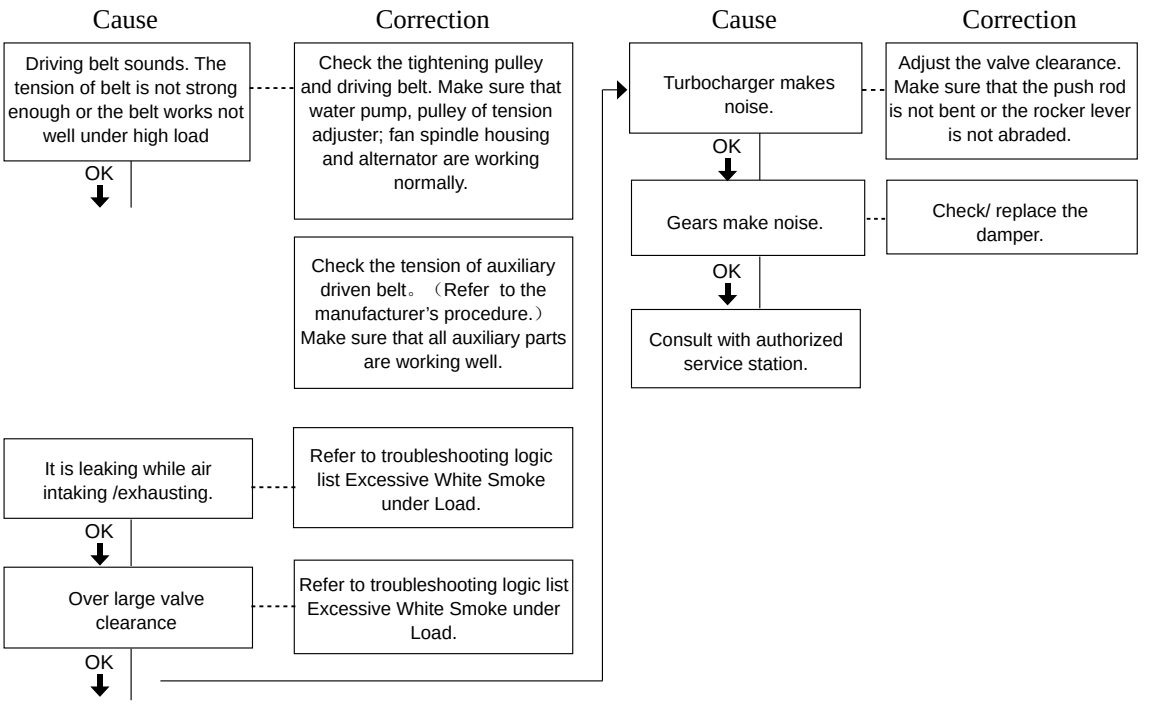
Engine Stopped



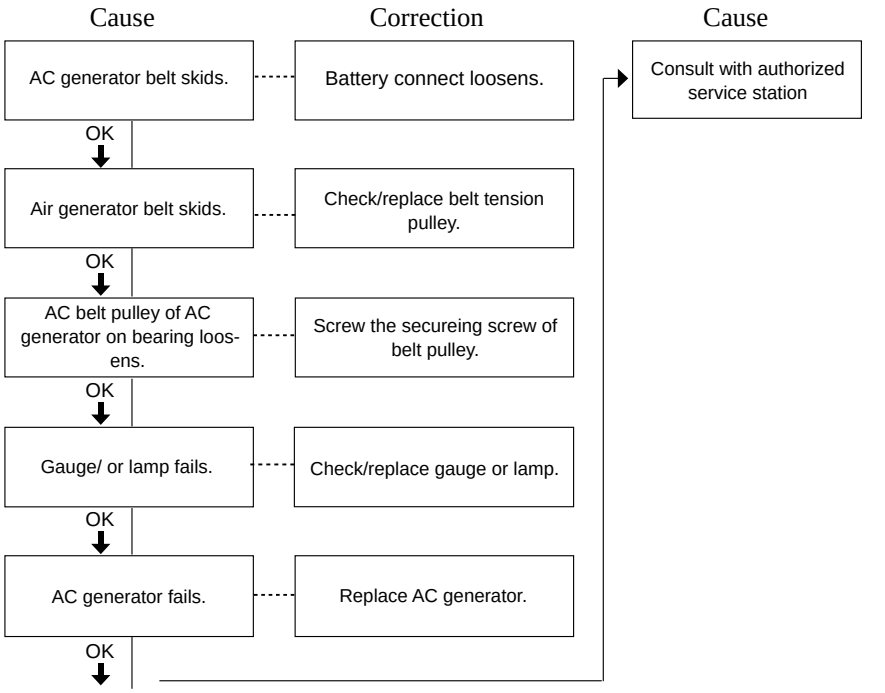
Excessive Fuel Loss



Excessive Noise



No/ weak Current Recharging of AC Generator



Chapter 3——Adjustment, Replacement and

Repair Procedure

The repair procedures are arranged in engine systems. The tools needed to replace the parts and the procedures listed will be useful to estimate the work load.
Follow the appropriate diagrams to finish the repair.

Necessary Tools

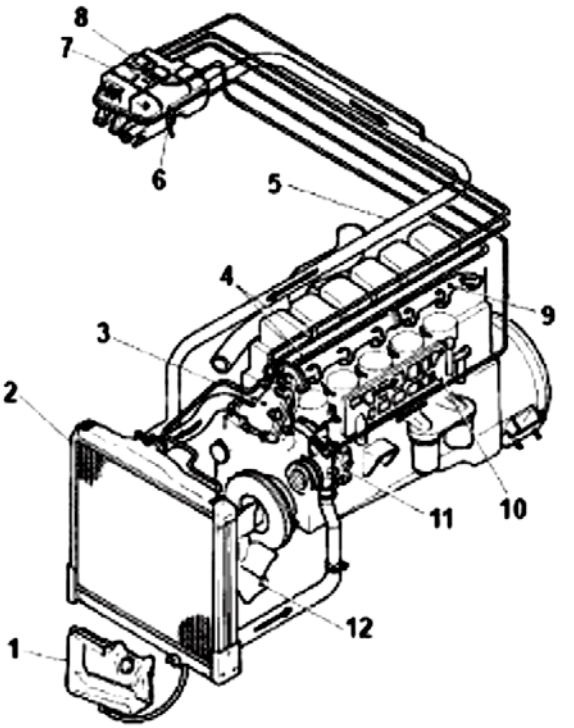
Socket	Wrench	Others
10mm		（8mm）hexagon socket Wrench
12mm	8mm	Square Head wrench（3/8inch Square Head）
13mm	10mm	Slotted Screwdriver
15mm	13mm	Ratchet（3/8inch Square Head）
17mm	15mm	Ratchet（1/2inch Square Head）
18mm	17mm（open-end ）	Filter Wrench（75-80mm, 90-95mm and 118-131mm)
19mm	19mm	(75mm)T type Wrench Puller
22mm	22mm	Torque Wrench
27mm	24mm	Pliers Einge rotate gear, part No.3377371

Cooling System Repair Summary

Replaced Parts	Wrench	Others
Driving Belt	Square-head Wrench(3/8inch Square Head)	Hexagon socket Wrench(8mm)
Belt Tension Pulley	Ratchet(3/8inch),15mm socket and torque wrench	
Fan Bearing	10mmsocket/wrench	Disassemble driving fan and fan pulley.
Water Pump	10mm socket/wrench	Drain coolant and disassemble driving belt.
Thermostat	10mm,18mm and 19 mm socket/wrench	Drain coolant, disassemble driving belt, unscrew retaining screw of AC generator and disassemble thermostat case.

Structure and Principle

►Cooling System (Coolant flowchart)

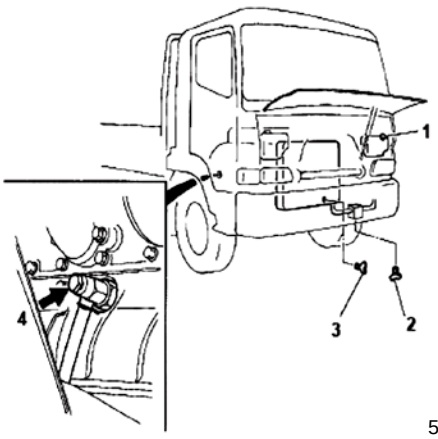


1. Water Tank
2. Radiator
3. Thermostat
4. Air Pipe
5. Water Intake Pipe
6. Water Level Sensor
7. Pressure stabilizer
8. Gland
9. Water Outlet
10. Oil Cooler
11. Pump
12. Cooling Fan

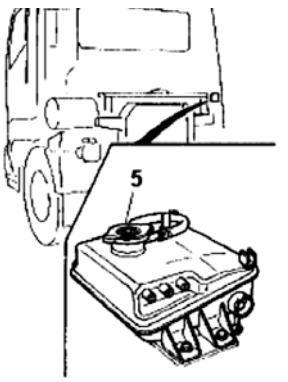
Troubleshooting

Symptoms / Possible Causes		Overheat(insufficient coolant)	Over low temperature	Abnormal noise	Over high loss of coolant	Remark
V-type belt	Loosen or damaged	○		○		
	Over tension			○		
	The belt is stained with grease.	○				
Pump	Inappropriate pump assembling	○			○	
	Bearing damaged	○		○		
	Blade damaged	○				
	Combined seals damaged	○			○	
	Engagement loosen between shaft and flange and/or blade	○		○		
Thermostat	Inappropriate assembling of case	○			○	
	washer damaged	○			○	
	Over high temperature of valve opening and the valve constantly closed	○				
	Over low temperature of valve opening and the valve constantly opened		○			
	Water temperature gauge, overheat unit/ or water temperature gauge unit leaking	○			○	
Radiator	The space between radiator core and sections blocked	○				
	Core cracked/or welding apart	○			○	
Pressure stabilizer	Bad sealing of gland	○				
	Water level sensor leaking	○			○	
Cooling Fan Housing	Inappropriate assembling of fan housing	○		○		
Oil cooler	Inappropriate assembling of oil cooler	○			○	
	Washer damaged	○			○	
Cylinder Head	Inappropriate assembling of cylinder head	○			○	
	Washer damaged	○			○	
Insufficient coolant/or coolant is polluted						
Coolant passage polluted /or blocked						
Inappropriate assembling of hose				○		
Over low ambient temperature		○				

Check and Adjust in Vehicle



54514



25779

►Replace the coolant and clean cooling system

1. Tank Cover
2. Drain Valve of hose for warm water
3. Drain Valve of radiator
4. Drain Valve of Crank Case
5. Gland

The cooling system should be cleaned regularly otherwise the rust deposit will result in the system overheating.

- Release the gland 5 to reduce the pressure in the cooling system prior to cleaning.

Warning ⚠

- Drain coolant after it cools for not being scalded.
- Open the gland 5 when coolant is warm. Press the gland with a piece of cloth, release it slowly to release the pressure and then open it completely.

► Flushing Procedures

- Start the generator and warm coolant up to 90 ℃. The thermostat valve is switched on at the moment and the coolant is circulating in the radiator.
- Put a piece of paper board or the similar objects to cover the front end of the radiator so that the temperature of coolant can be raised quickly.
- The radiator will be leaking after it is rusted greatly. Test the radiator for leakage after flushing the cooling system.

Caution ⚠

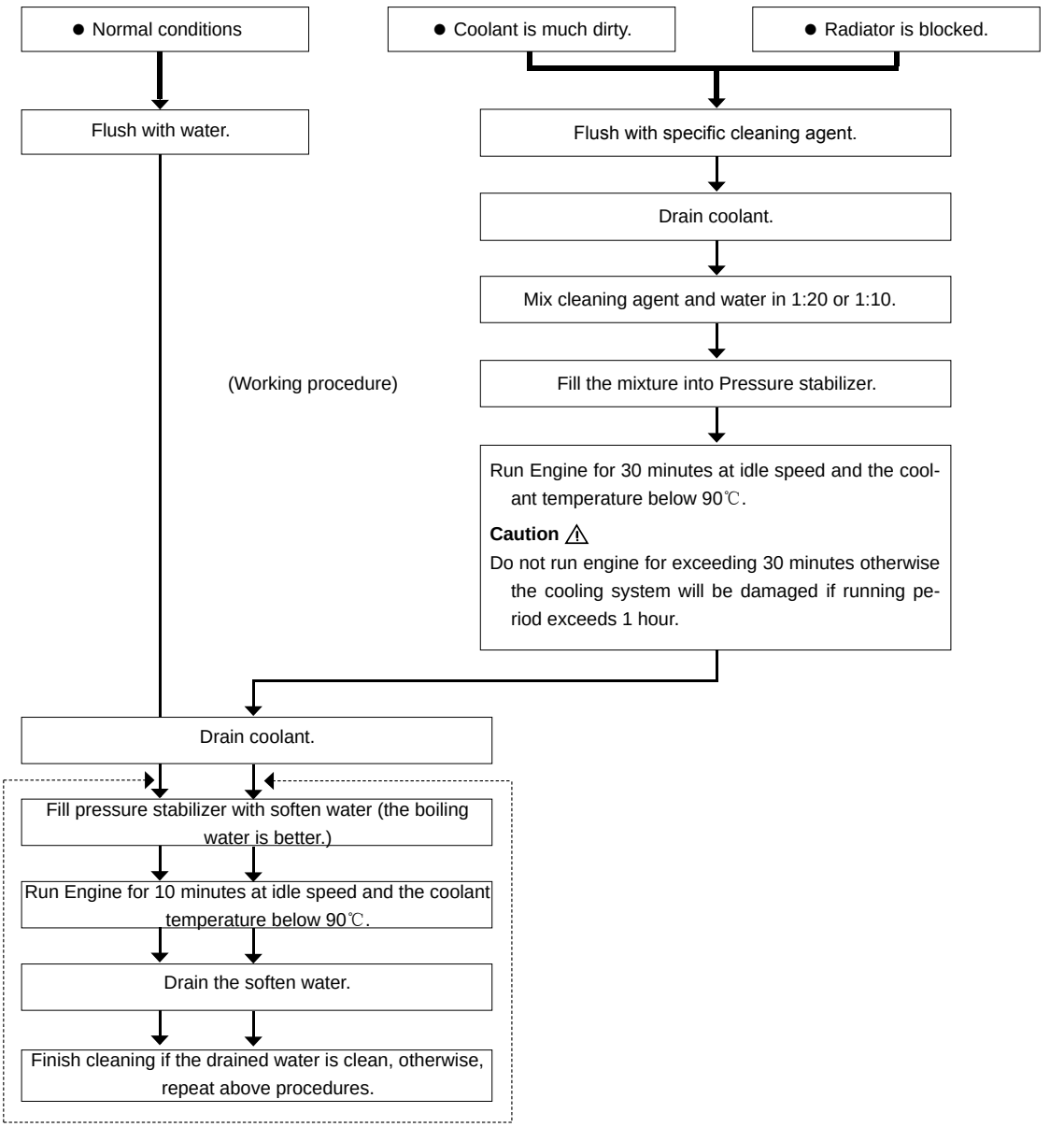
Do not flush with hard water otherwise the deposit or rust will appear.

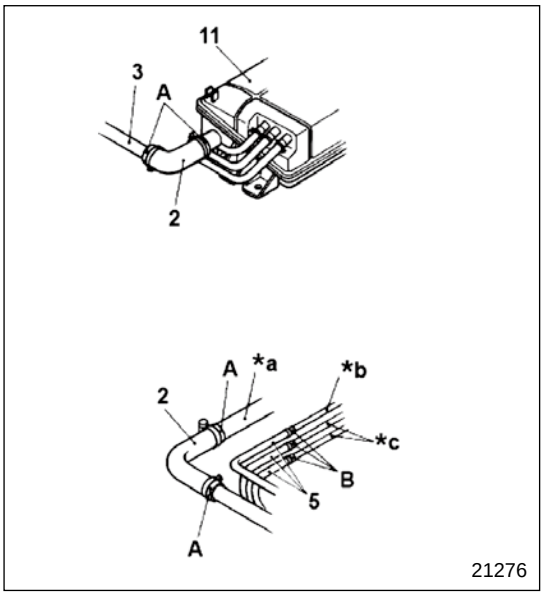
Required Soften Water

Gross hardness	Below 300ppm
Sulfate SO	Below 100ppm
Chloride CL	Below 100ppm
Non-soluble solid gross content	Below 500ppm
PH value	6-8

Check and Adjust in Vehicle

►Clean procedure depends on the working conditions of cooling system, showing as following figures:





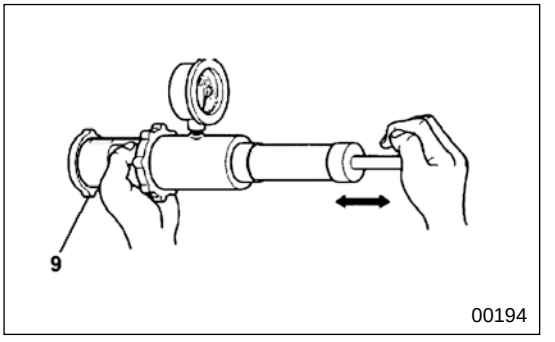
◆Repair Procedure

2 5 Assemble the hose

Press the hose into following depths:

A:30mm

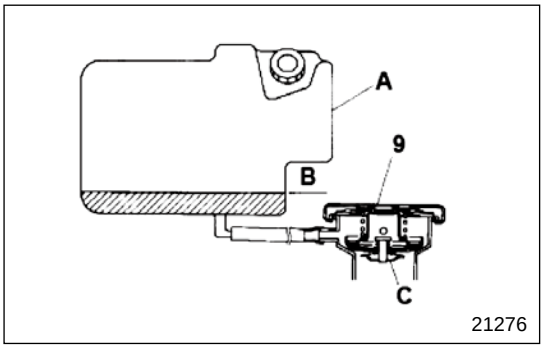
B:20mm



8 Check gland

(1) Opening pressure of the gland

Measure opening pressure of pressure valve. If the measurement is not in the standard range, replace the gland 9.



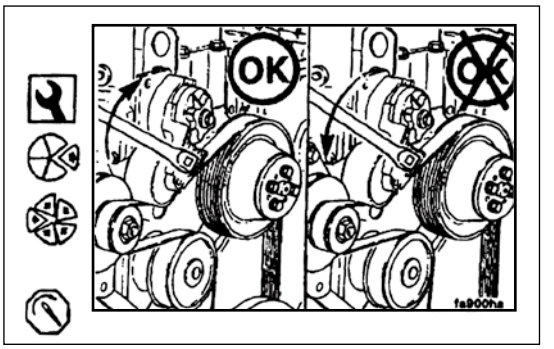
(2) Check vent valve

- Inspect water level B in radiator A.
- Run engine at high speed. Stop engine as soon as the coolant flows over radiator A.
- Wait for a while and check if water level of radiator A returns back the level before engine runs when coolant cools down to ambient temperature.
- Level B not decreasing means that the vent valve C is damaged. Replace gland 8.

Note:

If disassemble the gland 8 prior to the temperature of coolant being below ambient temperature, the vacuum in radiator will disappear that coolant is stopped returning back the gland A.

Replace Driving Belt



3/8 inch Square Head

Lift tensioning pulley arm and lower belt pulley and disassemble and assemble the belt.

Caution ⚠

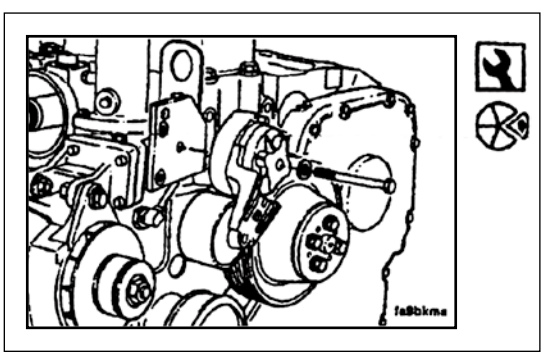
Belt tension pulley shall be moved away since it is imposed with spring force. Wrong moving direction will result in belt tension pulley damage.

Caution ⚠

Check the torque of secureing screw of tension pulley after lifting pulley arm and disassemble/ assemble the belt.

Torque Value : 43N.M(32 F.P)

Belt Tension Pulley

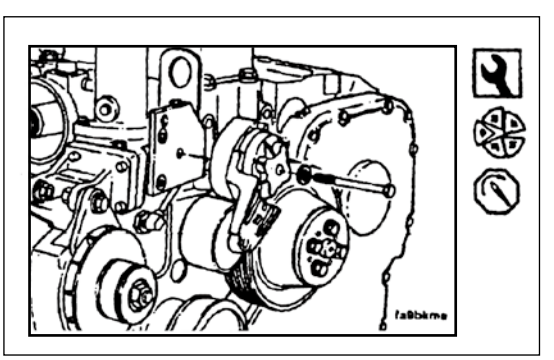


Preparation Process:

- Drive belt.

13mm

Move the belt tension pulley from the bracket.



13mm

Assemble belt tension pulley.

Torque Value: 43N•M[32F-P]

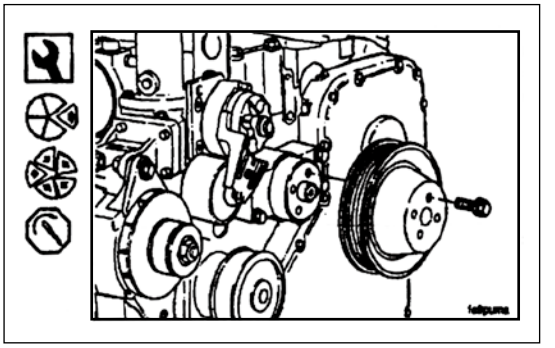
Replace Fan Belt Pulley

Prepare Process:

● Disassemble driving belt.

Caution ⚠

Release secureing screw before disassembling the belt. Tighten secureing screw to standard torque after assembling the belt.



13mm

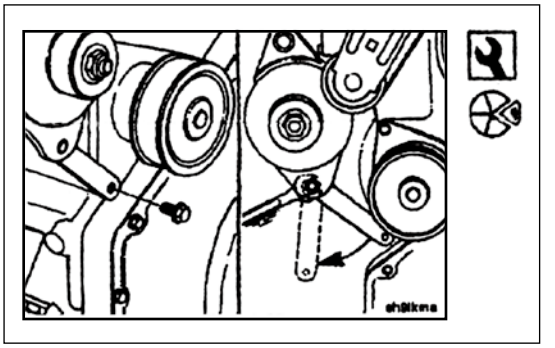
Disassemble four secureing screws, fan and gasket. Replace fan belt pulley.
Torque Value: 24N•M[32F-P]

Replace Water Pump

Prepare Process:

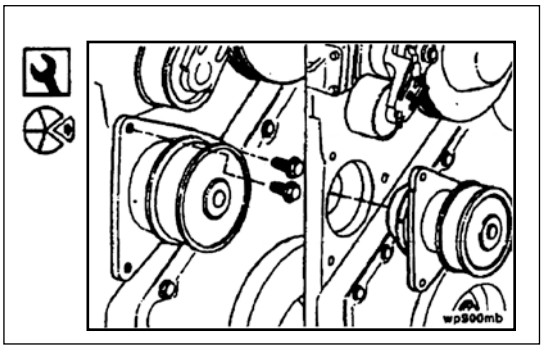
● Drain Coolant

● Disassemble Driving Belt



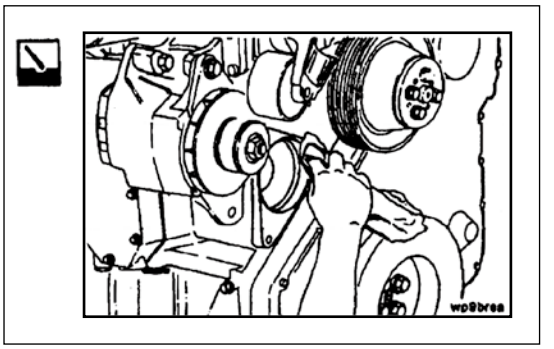
10mm,19mm

Disassemble strut bar of AC generator.

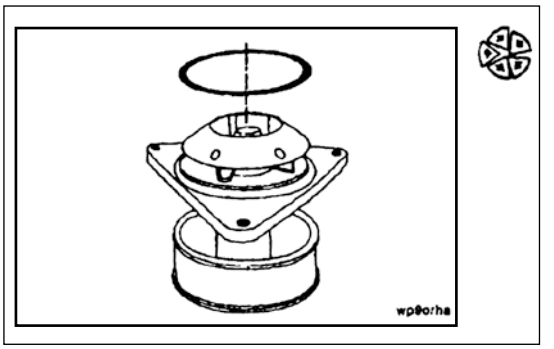


10mm

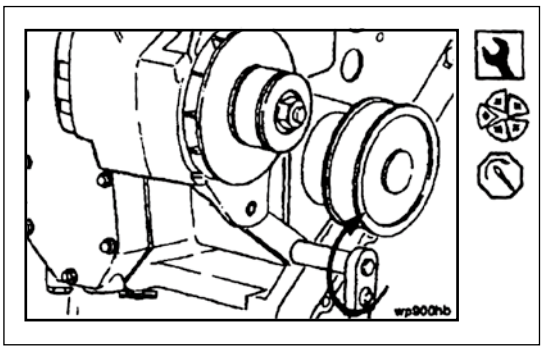
Disassemble water pump.



Clean sealing surface of cylinder block.



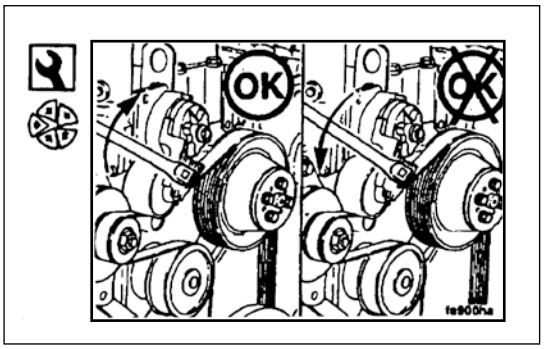
Install a new O ring in pump groove.



10mm,19mm

Assemble water pump and strut bar of AC generator.

Torque Value:
(Water Pump)24N•M [18F-P]
(AC generator terminal)43 N•M [32 F-P]

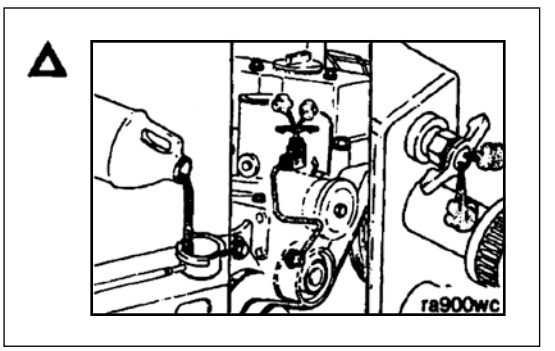


3/8inch Square Head

Lift tension pulley arm and lower belt pulley and assemble the belt.

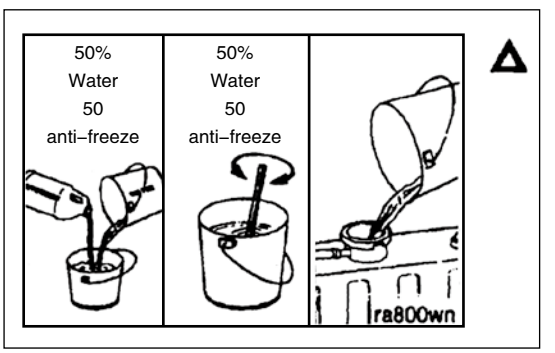
Caution ⚠

Belt tension pulley shall be moved away since it is imposed with spring force. Wrong moving direction will result in belt tension pulley damage.



Caution ⚠

Bleed air from engine coolant passage prior to filling. Open the venting cock of engine. Be sure that pressurized cooler cock is opened for the pressurized cooling of engine. Fill slowly for preventing air staying in system. Wait for 2-3 minutes to bleed air and add coolant until the level up to the bottom of filling neck of water tank.



Caution ⚠

Never take only water as the coolant or the part will be corroded and damaged.

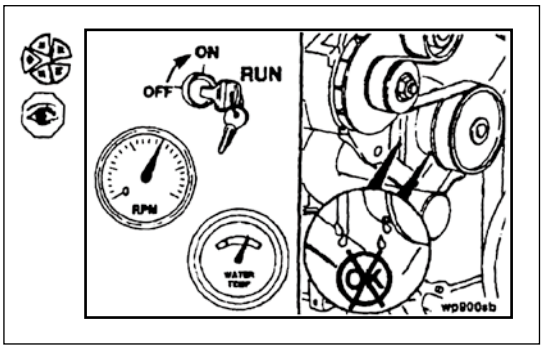
Caution ⚠

Mix water and anti-freeze with 50% respectively prior to filling the system. Endothermic capability of anti-freeze is less than water. If anti-freeze seperately is filled into engine, engine will be overheated.

Close all the bleed valves and fill the coolant. Mixutre of water and ethene-glycol of respective 50% will provent engine from freezing below -36 ℃(-34° F).

Coolant Capacity(only the engine)
L
1.11

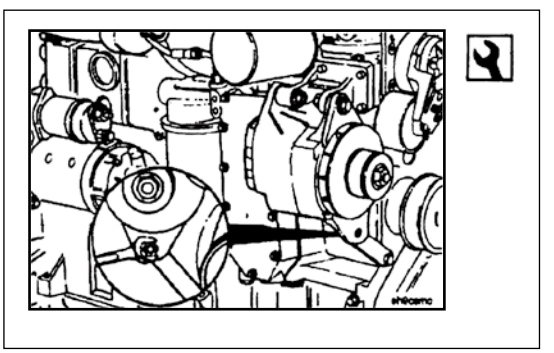
★The coolant capacity of supercharging cooling engine.



Use the stipulated corrosion inhibitor DCA4 to protect the cooling system.

Fix the gland. Run the engine until the temperature is up to 80℃(176° F) and check coolant leakage.

Replace Coolant Thermostat

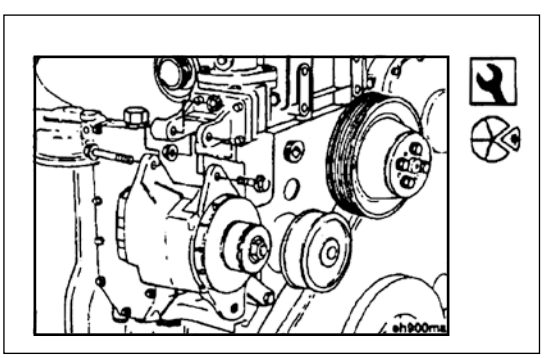


prepare process:

- Drain coolant 2L(20 Quart of American unit)
- Disassemble hose of water tank from outlet adapter.
- Disassemble driving belt.

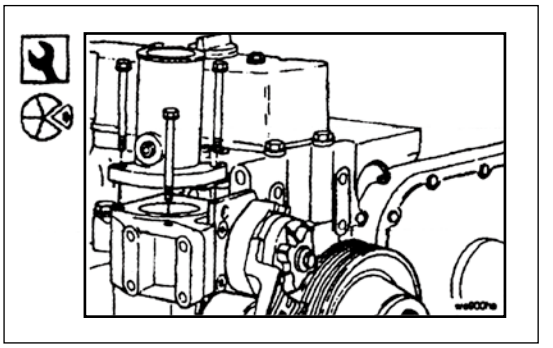
19mm

Unscrew retaining screw of strut bar of AC generator.



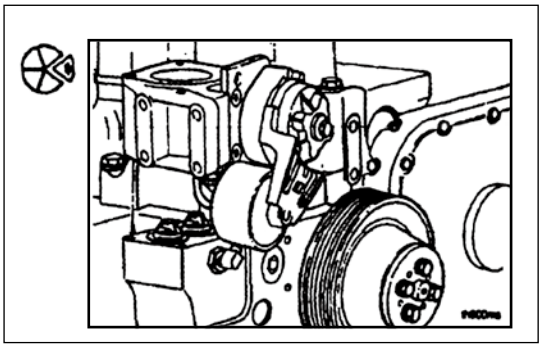
18mm,19mm

Disassemble retaining bolt and nut and lower the AC generator.

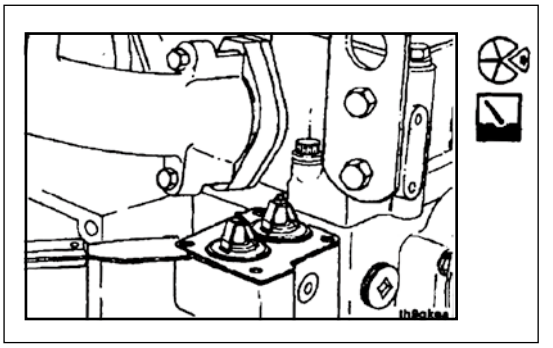


10mm

Unscrew retaining screw of thermostat housing and outlet adapter. Disassemble the water outlet adapter.



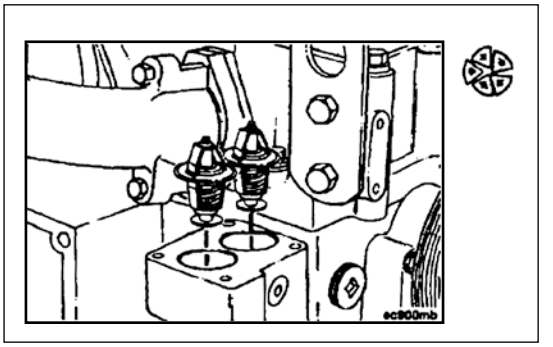
Disassemble the thermostat housing and belt tightening pulley assembly.



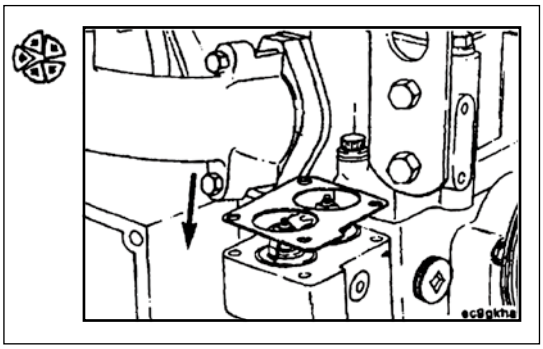
Disassemble thermostat and clean the washer surface.

Caution ⚠

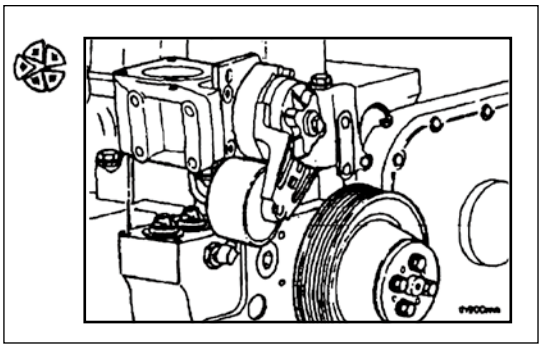
Do not drop any impurities into thermostat chamber when clean the washer surface.



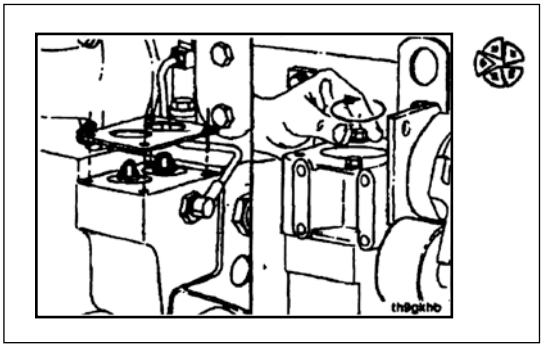
Replace with new thermostat.



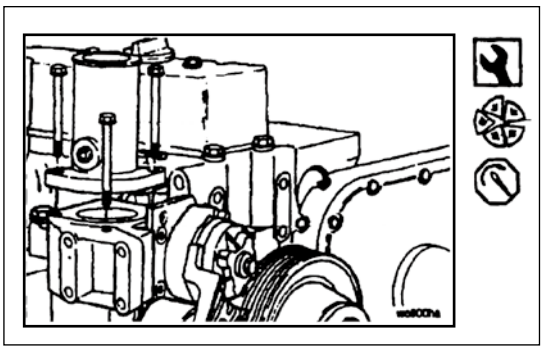
Put a new washer on the thermostat.



Put the thermostat housing and the belt tightening pulley on the thermostat and the washer.

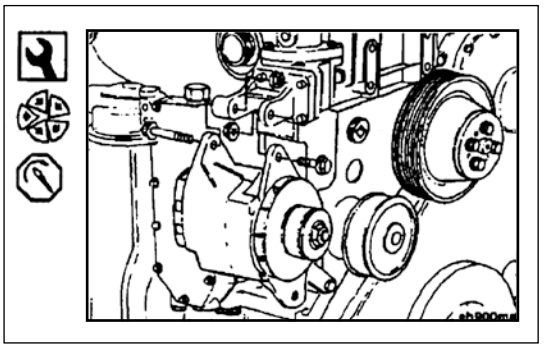


Make sure that the washer and the retaining screw hole are matched.
Fix the retaining screw and screw it with fingers.



10mm

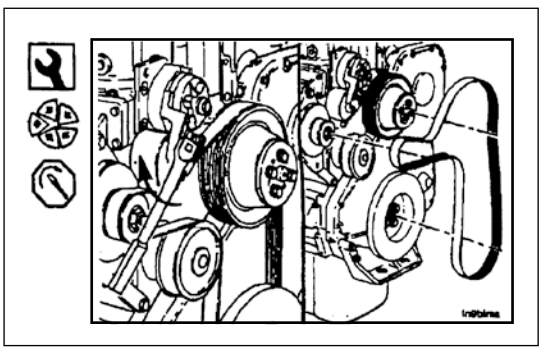
Assemble water outlet adapter.
Screw all the retaining screws.
Torque Value: 24N•M[18F-P]



18mm,19mm

Put the AC generator and assemble the retaining bolt and screw.

Torque Value:
(Secure AC generator)77 N•M [57 F-P]
(Strut bar of AC generator)43 N•M [32 F-P]

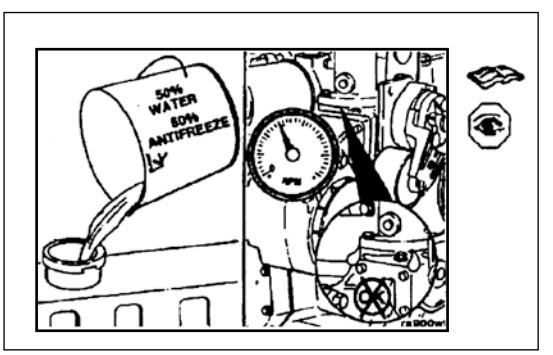


3/8inch Square Head

Assemble driving belt

Caution ⚠

Check torque of retaining screw of the tightening pulley after lifting pulley arm and disassemble/ assemble the belt.
Torque Value: 43 N•M [32 F-P]

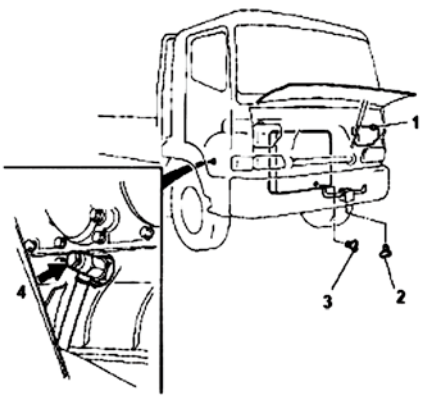


Fill coolant into the cooling system referring to page 7-7. Run the engine and check (for) leakage.

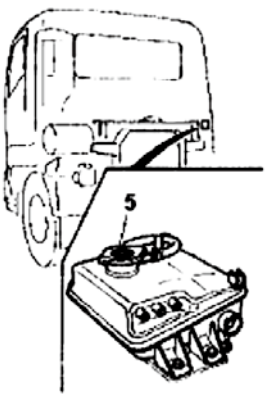
Caution ⚠

Make sure that air in engine and pressurized cooler is bled.

Replace Coolant and Clean Cooling System



54514



25779

1. Water Tank Cap
2. Drain Valve of Warm Water Hose
3. Drain Valve of Radiator
4. Drain Valve of Crankcase
5. Gland

► Flushing Procedures

- Start the generator and warm coolant up to 90 ℃. The thermostat valve is switched on at the moment and the coolant is circulating in the radiator.
- Put a piece of paper board or the similar objects to cover the front end of the radiator so that the temperature of coolant can be raised quickly.
- The radiator will be leaking after it is rusted greatly. Test the radiator carefully for leakage after flushing the cooling system.

Caution ⚠

Do not flush with hard water otherwise the deposit or rust will appear.

Required Soften Water

Gross hardness	Below 300ppm
Sulfate SO	Below 100ppm
Chloride CL	Below 100ppm
Non-soluble solid gross content	Below 500ppm
PH value	6-8

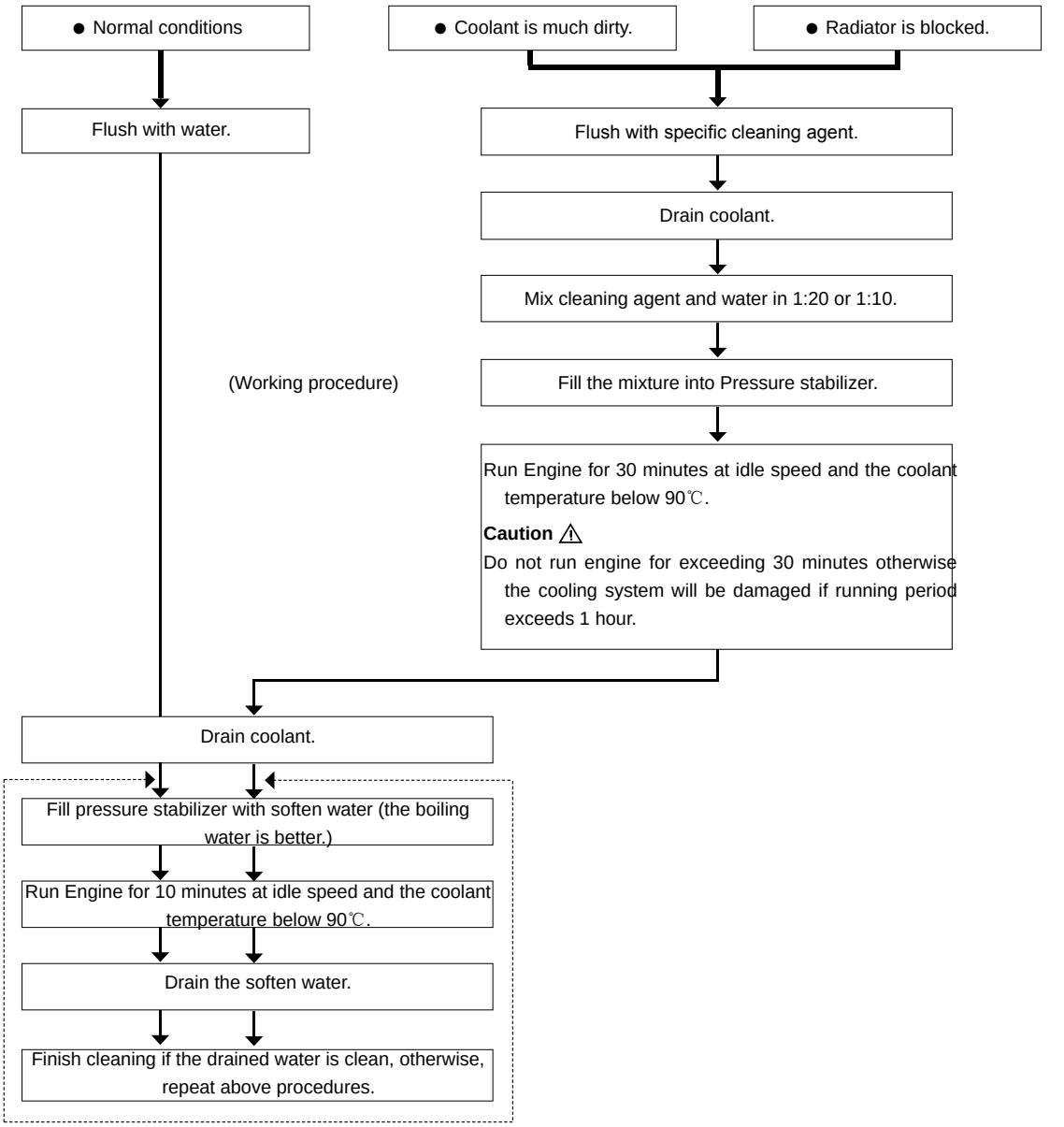
The cooling system should be cleaned regularly otherwise the rust deposit will result in the system overheating.

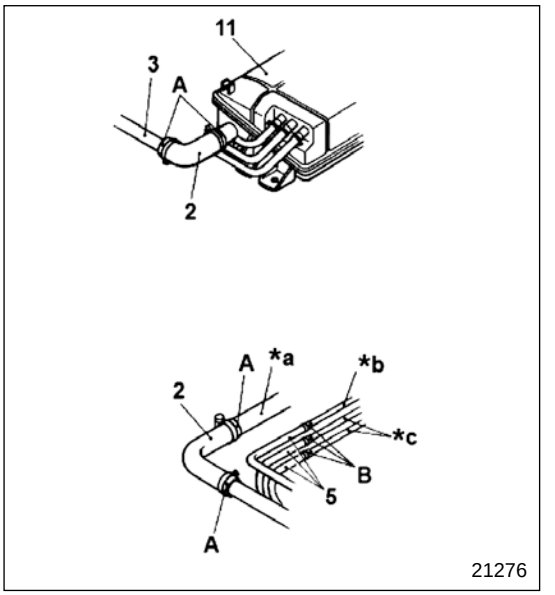
- Release the gland 5 to reduce the pressure in the cooling system prior to cleaning.

Warning ⚠

- Drain coolant after it cools for not being scalded.
- Open the gland 5 when coolant is warm. Press the gland with a piece of cloth, release it slowly to release the pressure and then open it completely.

► Clean procedure depends on the working conditions of cooling system, showing as following figures:





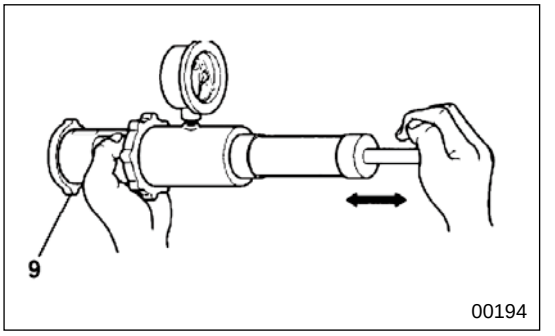
◆ **Repair**

2 5 Assemble the hose

Press the hose to the following depths:

A：30mm

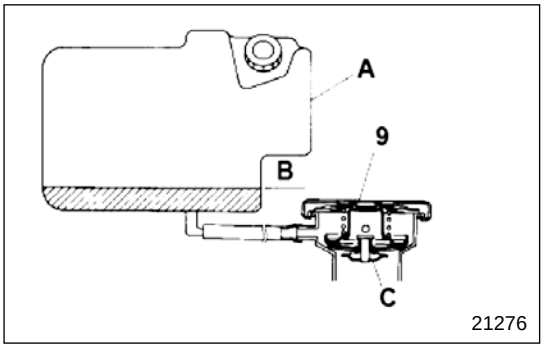
B：20mm



2 Check Gland

(1) The opening pressure of the gland

Measure the opening pressure of pressure valve. If the measurement value is not in the standard range, replace the gland 9.



(2) Check vent valve

- Inspect water level B in radiator A.
- Run engine at high speed. Stop engine as soon as water flows over radiator A.
- Wait for a while and check if water level of radiator A returns back the level before engine runs when coolant cools down to ambient temperature.
- Level B not decreasing means that the vent valve C is damaged. Replace gland 8.

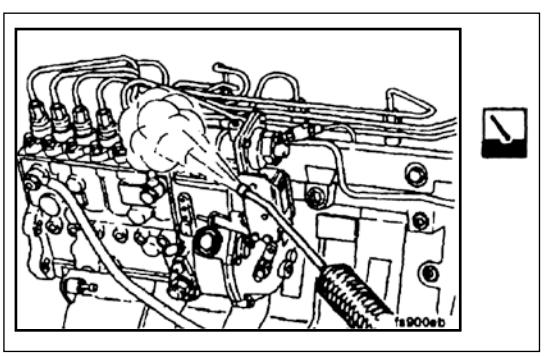
Note:

If disassemble the gland 8 prior to the temperature of coolant being below ambient temperature, vacuum in radiator will disappear that coolant is stopped returning back the gland A.

Fuel System Repair

Replaced Parts	Tools	Prepare process
Fuel Supply Pump	10，14，17 and 20 mm wrenches，10mm socket	Delete the contaminant.
High-pressure Fuel Supply Pipe	17mm，19mm open-end wrench	Delete the contaminant.
Injector Fuel	10mmsocket and a torque wrench	Delete the contaminant.
Fuel Returning Pipe	10mm and 19mm wrenches，10mm and 19mm sockets,and a torque wrench	Delete the contaminant.
Injector	17mm,19mm,10mm,13mm and a torque wrench, 3823276 injector puller, bore cleaning brush	Disassemble high-pressure fuel supply pipe and returning pipe.
Injection Pump	ratchet,22mm socket,27mm socket,30mm socket,75mmT wrench puller,(W/28mm retaining screw)1/2inch open-end wrench,15mmsocket,17mm ,19mm wrench and a torque wrench	Disassemble high-pressure, fuel pipe, fuel returning pipe, AFC air pipe line and exterior oil pipe line.
Fuel Solenoid Valve	8mm,10mm wrench	Mark the wire and disassemble the wire.
Fuel Filter Cap	24mm,75-80mm and 90-95mm filter wrench	Clean the impurities.

Clean Fuel System Parts

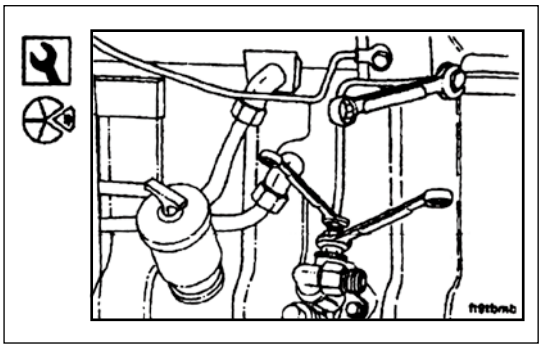


Clean thoroughly all the adapters and parts before disassembly. Be sure that impurities, vapor or detergent does not exist in the fuel system.

Replacement of Low–pressure Pipe

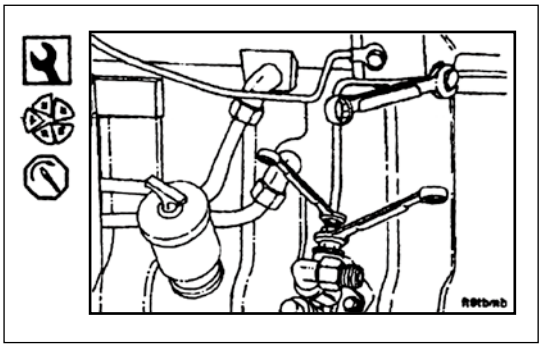
Prepare process:

● Clean the impurities on the adapter.



14mm,17mm,20mm

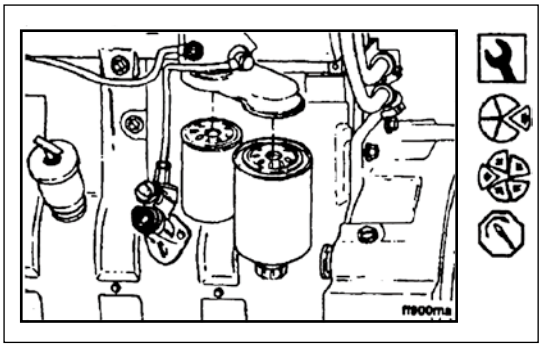
Release the fuel pipe from the pump with two wrenches and the fuel filter.



14mm,17mm,20mm

Connect the fuel supply pipe to the pump and the fuel filter cap. Screw the adapter to the pump with two wrenches. Do not over tight it or the fuel will leak.

Replacement of Fuel Filter Cap Adapter



Prepare process:

- Clean the impurities.
- Disassemble the fuel filter.

24mm

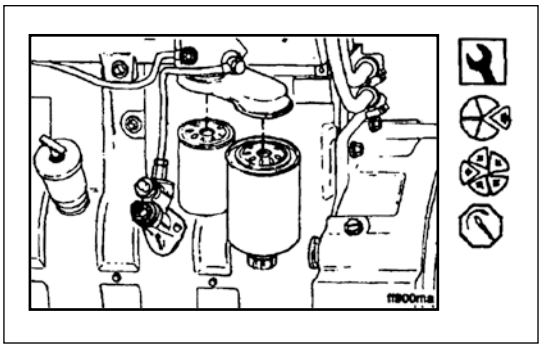
Unscrew the screw of stopping plate, fuel filter cap adapter and sealing washer. Assemble it in the sequence of disassembly.

Torque Value: 32N•M[24F-P]

Fuel Pipe Replacement

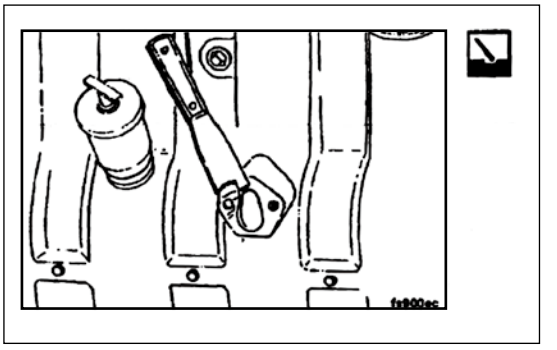
Preparing Process:

- Clean impurities.
- Disassemble fuel pipe. 14mm,17mm,20mm wrench.

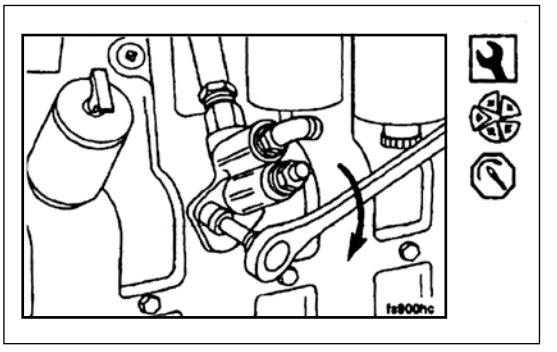


10mm

Disassemble the pump.



Clean the pump surface on the cylinder.

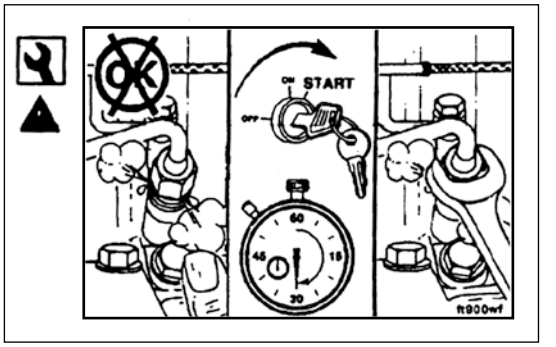


10mm

Set new washer and fuel supply pump.

Connect the fuel pipe.

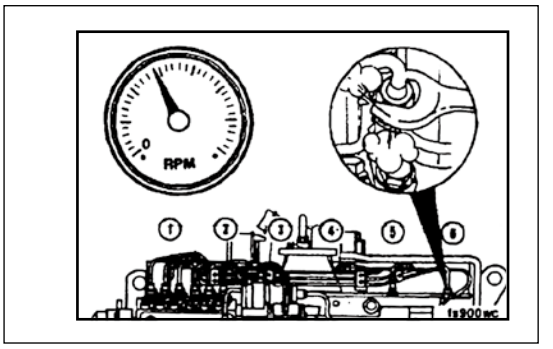
Torque Value: 24 N•M [18F-P]



High–pressure Fuel Supply Pipe Replacement

Prepare process:

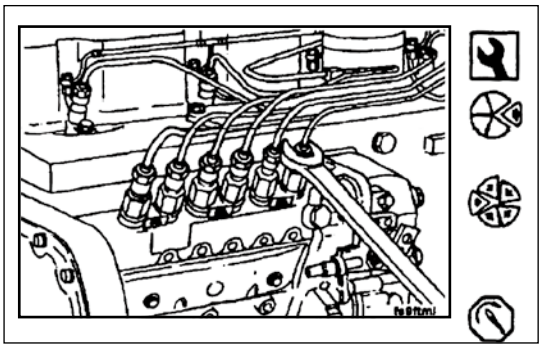
- Clean impurities.



8mm,10mm,17mm,19mm

Note: If replace any high-pressure fuel supply pipe, remove the supporting pipe clamp from a unit of pipe of the replaced pipe line/high-pressure fuel supply pipe from injector. Make sure to prevent impurities from inlet of injector.

Caution ⚠



17mm(PES.A, PES.MW),19mm(PES.P)

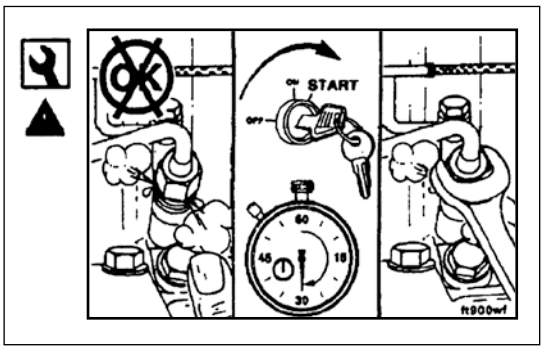
Remove high-pressure fuel supply pipe from injector pump. Make sure to prevent impurities from the fuel supply valve.

Assemble the support clamp at the original position and be sure no touching between the high-pressure fuel supply pipes and parts. Not bend the pipe.

Assemble high-pressure fuel supply pipe and support clamp with hands in the counter sequence of disassembly. Screw pipe line adapter and pipe clamp.

Torque Value:
(Pipe line adapter)30N•M[32F-P]
(Support Pipe Clamp)6 N•M [4 F-P]

Breathing

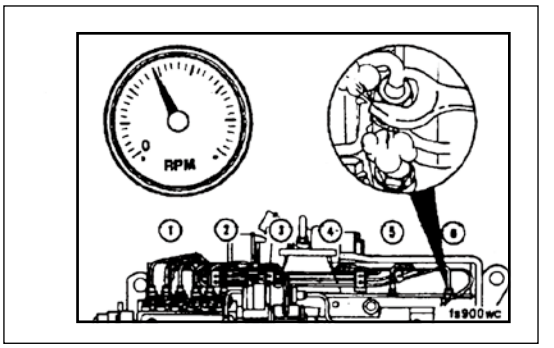


17 mm(PES.A, PES.MW),19mm(PES.P)

Warning ⚠

The fuel pressure in the pipe line is high enough to pierce the skin and damage the body.

Unscrew high pressure fuel supply pipe adapter of injector and run the engine to bleed air out of pipe. Screw the high pressure fuel supply pipe adapter to the above given torque value.

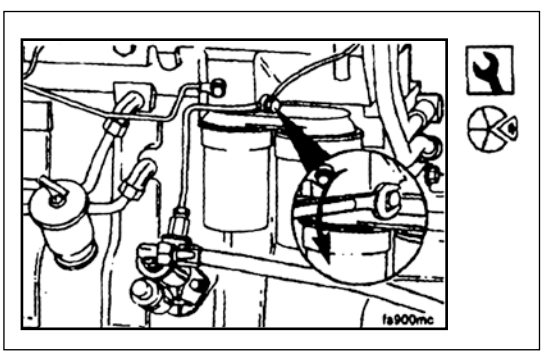


Start engine and bleed air from one pipe once until engine runs steadily.

Replace Returning Pipe

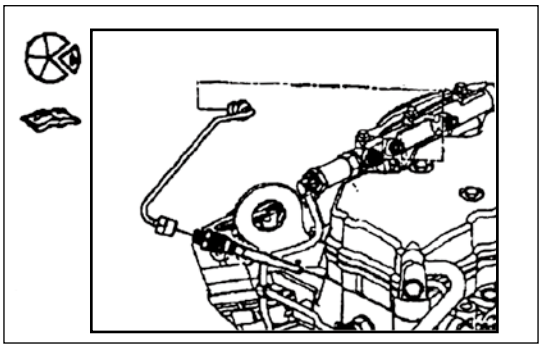
Prepare Process:

● Clean impurities.



10mm

Unscrew returning pipe and retaining screw from fuel filter cap.



Injector

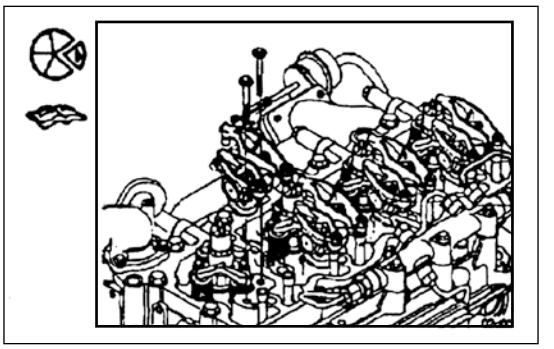
Seven-port injector OUYA of WUXI is used. The engine power varies with injector parts.

Disassembly

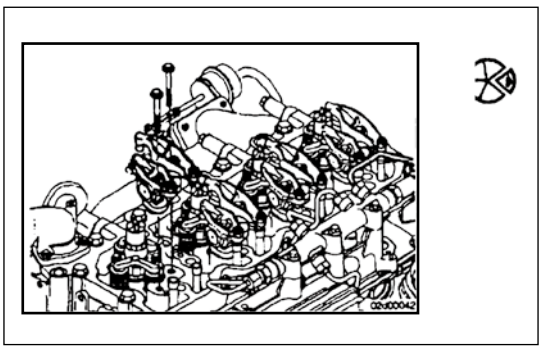
Disassemble the high-pressure fuel pipe between fuel rail and high pressure connecting parts. Remove the connecting parts.

Note:

Remove the fuel connecting parts before removing injector or the connecting parts will be damaged.



Disassemble Valve Exhaust Rocket Arm

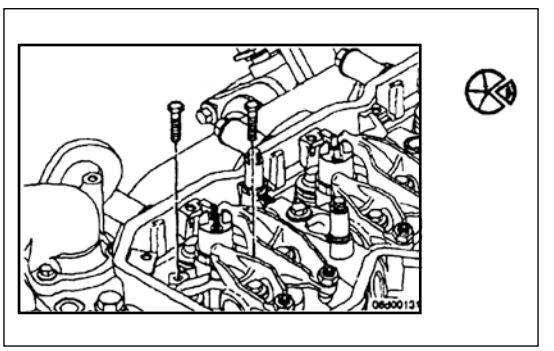


Disassembly

Disassemble the high-pressure fuel pipe between fuel rail and high pressure connecting parts. Remove the connecting parts.

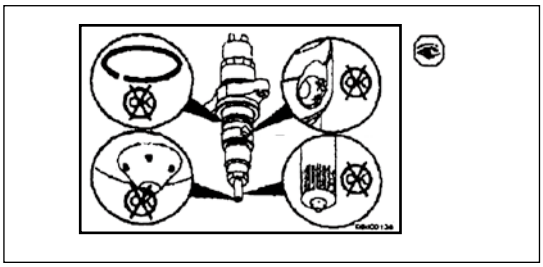
Note :

Remove the fuel connecting parts before removing injector or the connecting parts will be damaged.



Disassemble Valve Exhaust Rocket Arm

Disassemble 8mm screw of the press plate of the injector.

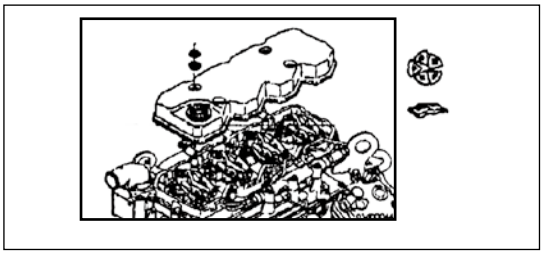


Check if it can be used continuously.

Check the end of injector for corrosion or carbonization

Check solenoid terminal for damage.

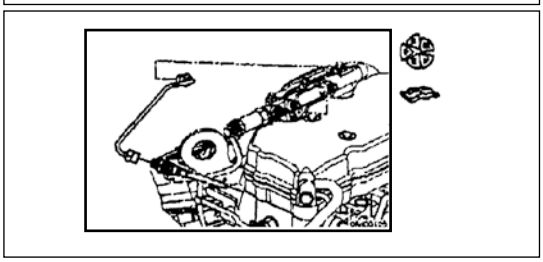
Check the inlet of injector, the high-pressure connecting ends and inlet for damage.



Note:

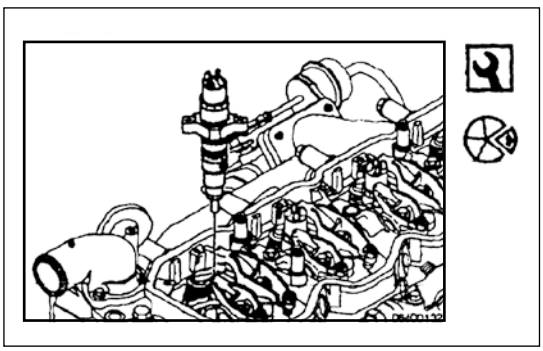
The injector will turn into dark yellow or brown due to overheat that the color varies with the degree of heating.

Check O ring of the injector for damage.



Assemble fuel oil connector

Assemble high-pressure fuel pipe of injector.

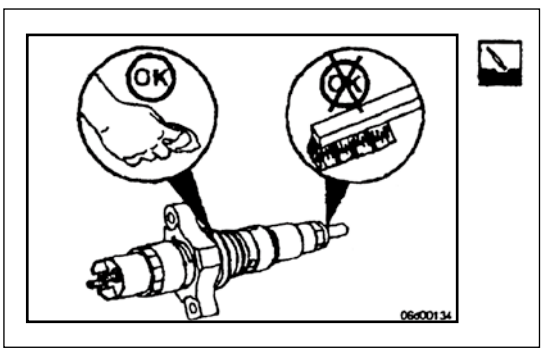


Disassemble the injector from cylinder head with specific tool.

Flushing

Warning ⚠

Follow the instruction recommended by the manufacture when flushing with solvent, acidoid or basic substance. Put on the protection uniform and wear the protection glasses for preventing from hurt the human body.



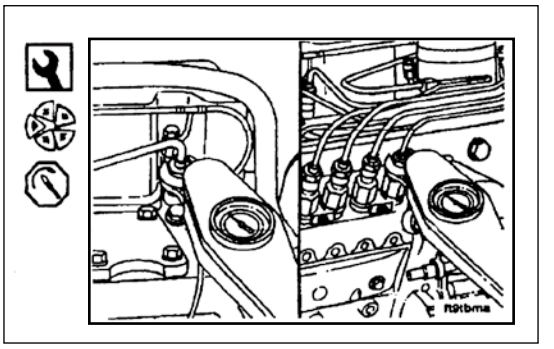
Caution ⚠

Does not clean injector with steel brush or glass shot blasting or the injector will be damaged.

Clean injector ends and injector with safe solvent or soft cloth.

Note:

Delete carbon deposition with bronze brush if necessary.



17mm(PES.A, PES.MW), 19mm(PES.P)

Assemble high-pressure fuel pipe.

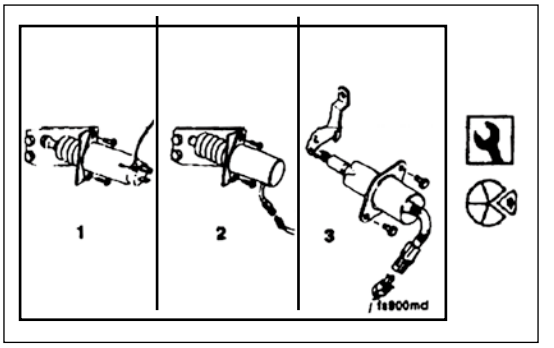
Torque Value: 30N•M[22T-P]

Replace Oil Cut–off Solenoid Valve

prepare process:

Mark the wire and disconnect the wire.

RSV Oil Cut–off Solenoid Valve of Speed Governor



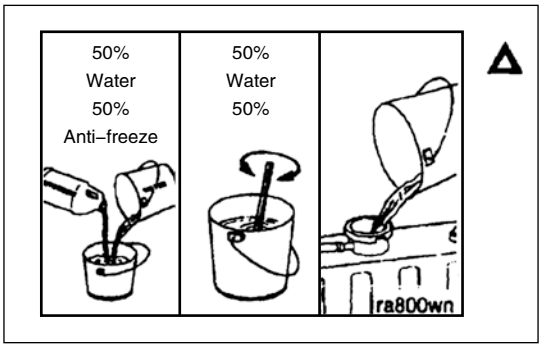
Disassemble

Cylinder block is secured.

10mm

Remove two retaining screws and solenoid valve.

1. Synchronously start.
2 Trombetta oil cut-off valve
3. Direct-acting lever



Assembling

10mm

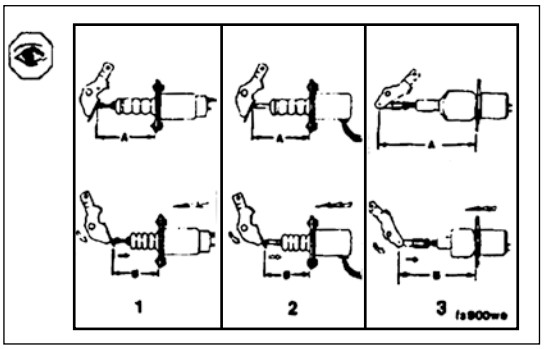
Note:

Make sure that the acorn nut is secured on oil cut-off solenoid valve shaft(only when synchronously start.)

Assemble new oil cut-off solenoid valve on the bracket and connect the wire. Make sure that wire harness of Trombetta oil cut-off solenoid valve is at 6 o'clock.

Torque Value: 10 N•M[84F-P]

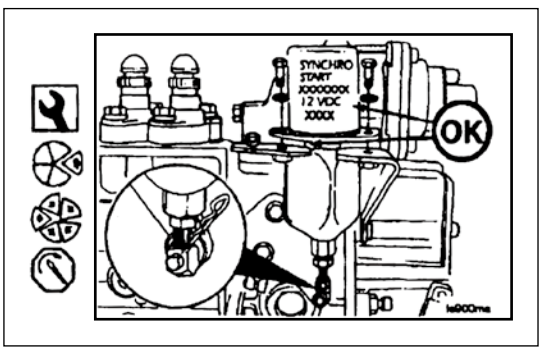
1. Synchronously start.
2 Trombetta oil cut-off valve
3. Direct-acting lever



Slide the switch and check the plunger moving.

1. Synchronously start.
   A=86.6mm[3.4inch]
   B=60.2mm[2.4inch]
2. Trombetta oil cut-off valve
   A=91.4mm[3.6inch]
   B=63.5mm[2.5inch]
3. Direct-acting lever
   B=117.1mm[4.61inch]

RQVK Oil Cut–off Solenoid Valve of Speed Governor

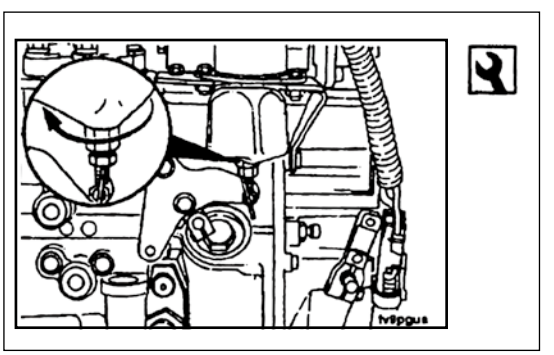


Disassemble and Assemble

8mm

Release the connecting lock, retaining screw and oil cut-off solenoid valve and assemble new solenoid valve in the counter sequence of assembling and connect the wire.

Torque Value: 10N•M[84F-P]



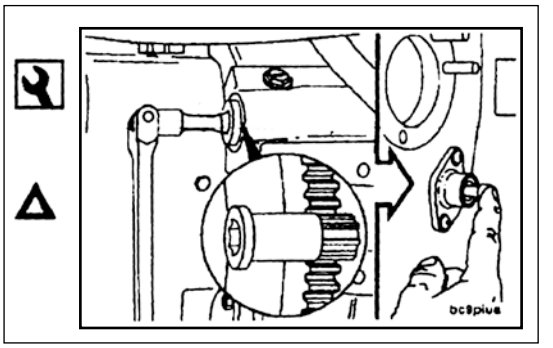
10mm,16mm

Adjust the solenoid valve clutch in order that the plunger is dragged by the magnetic force and meanwhile the cut-off lever is at the position for when the engine runs at the highest power. Turn big-end hexagon bolt on the plunger to adjust and the nut is secured with nut.

Replace Fuel Injector Pump

Prepare process:

- Delete impurities.
- Release all the fuel pipes.
- Remove control switch
- Remove solenoid oil cut-off valve
- Release AFC air pipe line.
- Release oil pipe of speed governor.



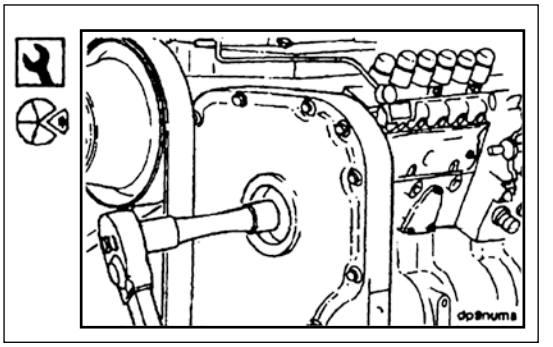
Disassembling

Four gears of engine part No. 3824591

Run cylinder No.1 at the TDC. Rotate crankshaft slowly and push appropriate pin into the hole of cam gear. Insert the turning gear into the flywheel housing and mesh with the gear of the flywheel. Then turn engine with ratchet 1/2inch or square head wrench.

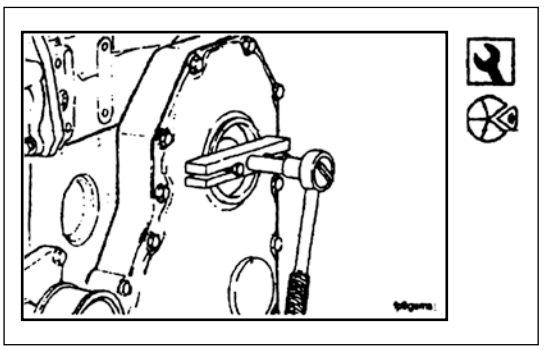
Caution ⚠

Make sure to release the timing pin for avoiding damage when it is at the TDC.



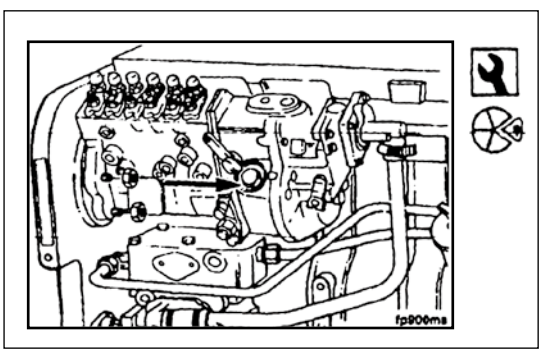
22mm(PES.A, pump),19mm (PES.MW, pump),30mm (PES.P, pump) Disassemble gear cover plate.

Release nut and washer from injection pump spindle.



75mmT Type lever puller

Pull and loosen driving gear of injection pump from the spindle.

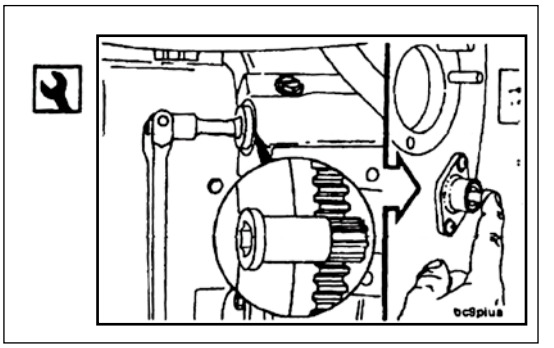


10mm,15mm

Unscrew four retaining nuts and fixed bolts to cylinder block and injection pump bracket.

Remove the rear bracket of injection pump PES6P.

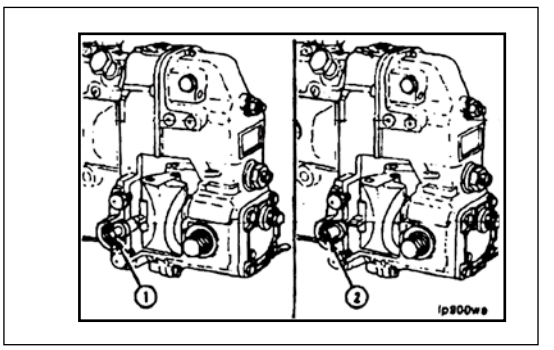
Remove the injection pump.



Assembling

Engine turning gear part No. 3377371.

Make sure that the cylinder No.1 is at TDC.

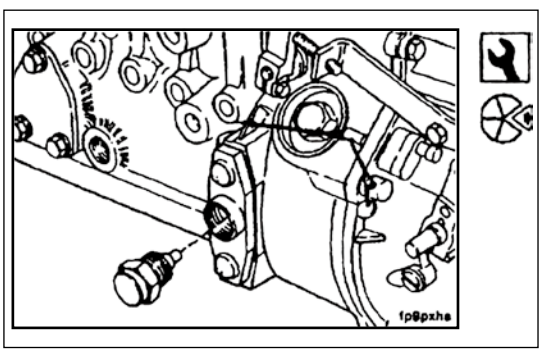


Fuel Injection Pump-Timing

The timing pin (1) of injection pump is in the speed governor housing. Make the fuel injection pump shaft correspond with the TDC of No.1 cylinder. Reverse turn the timing pin and put into the housing (2) after assembling fuel injection pump.

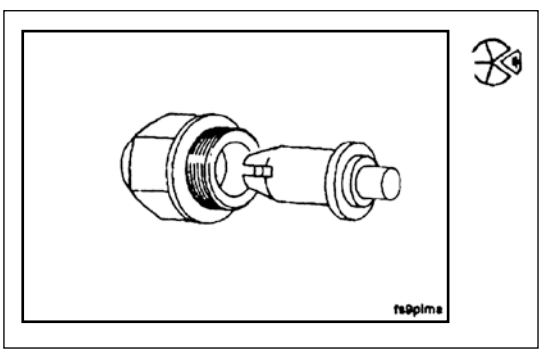
Note:

The program of industrial speed governor in the diagram is the same as the vehicle governor.

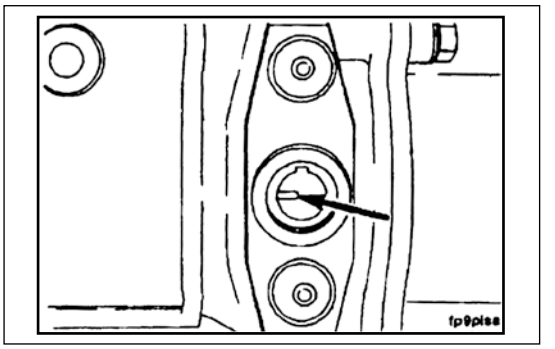


24mm

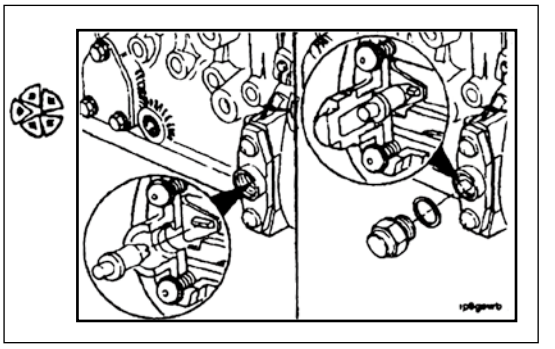
Remove the advancing-plug of the timing pin.



Remove the timing pin.

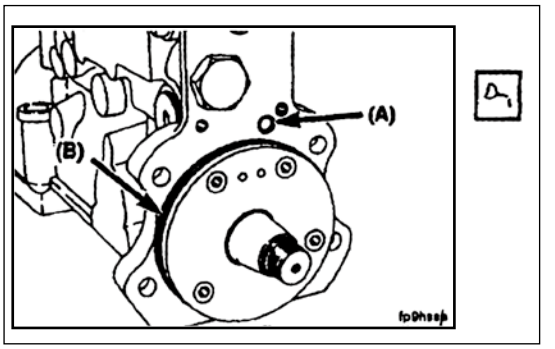


Rotate pump spindle until it aligns with timing gear tooth.



Reverse rotate the timing pin and align the timing pin groove in the injection pump to timing gear tooth.

Assemble the advancing-plug and fix the timing pin.

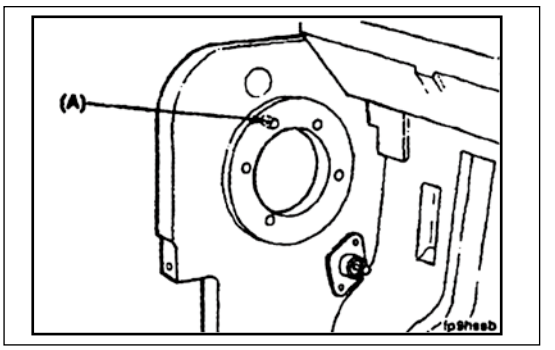


Make sure that O-ring of filler port(A)and guide disc(B)is fitted correctly on the injection pump and not damaged.

Lubricate fixed flange with clean engine oil of15W-40. If the stripe of the O-ring has color, the O-ring cannot be used again. When install a new O-ring with stripe, lubricate gear housing hole instead of O-ring.

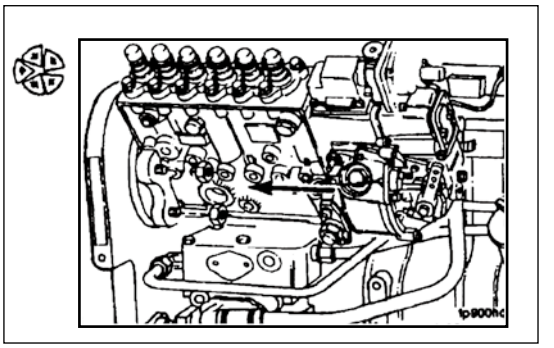
Caution ⚠

Clean and dry driving pump of injection pump in the interior bore and shaft at the exterior bore before fitting the pump.

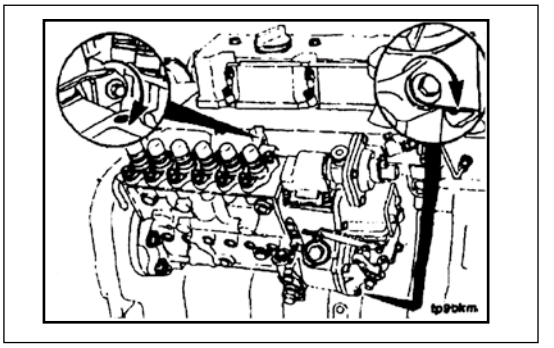


Caution ⚠

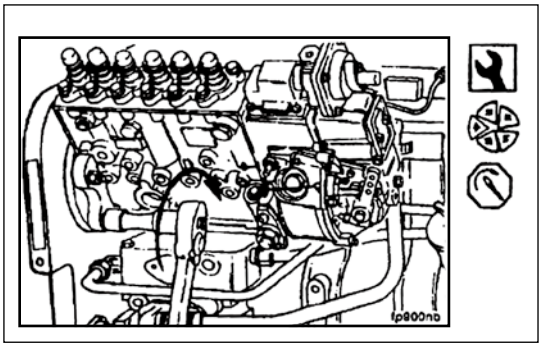
The O-ring (A) of PESP injection pump is located in gear housing



Slide the injection pump spindle into driving gear , put the injection pump flange onto the retaining bolt and secure the retainging nut with hand.



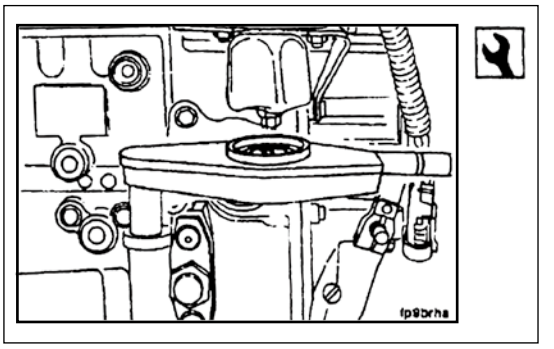
Secure the reatining bolt of the bracket with fingers.



15mm

Secure the retaining nut.

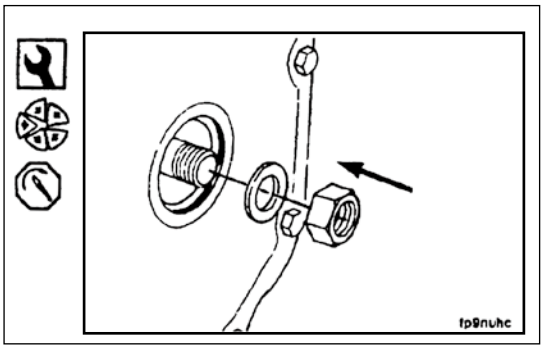
Torque Value: 43N•M[32F-P]



10mm (PES6P Injection Pump)

Secure the retainging screw of the rear bracket.

Torque Value: 24N•M[18F-P]



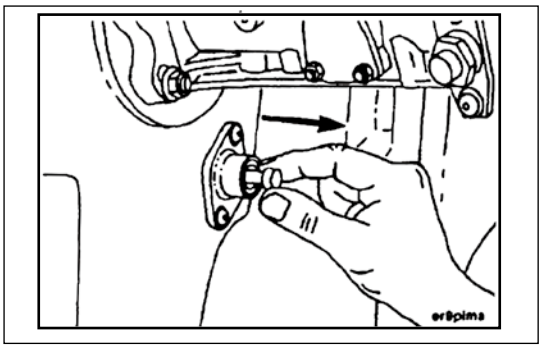
32mm(PES,A Pump),27mm(PES,MW Pump),30mm(PES,P Pump)

Fix the retaining nut and washer of the injection pump.

Initial Torque Value:11 N•M [108 F-P]

Caution ⚠

The torque does not exceed the stipulated value. This is not the last torque value of retaining nut of injection pump.

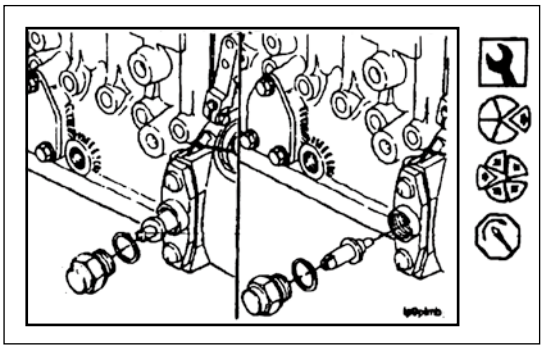


Release the engine timing pin.

24mm

Remove the timing pin of injection pump. Reverse rotate the timing pin and asssemble it, plug and washer.

Torque Value: 15 N•M [11F-P]

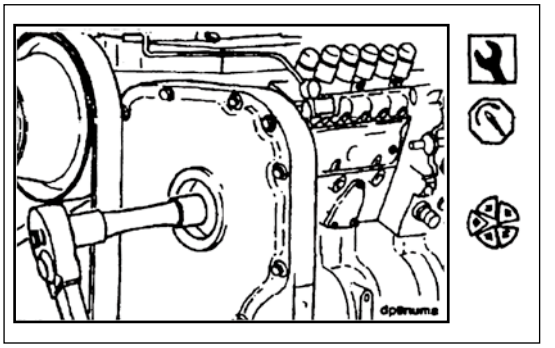


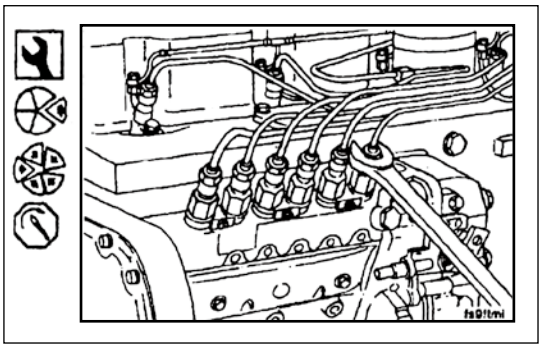
22mm,27mm,30mm

Secure the driving nut of injection pump.

Torque Value: PES.Ppump165 N•M [22 F-P]

Assemble the accessory cover of gear cover plate and secure it with hand.





19mm(PES.P)

Fix the high-pressure fuel pipe onto the fuel pump.

Assemble fuel supplying pipe and returning pipe.

Caution ⚠

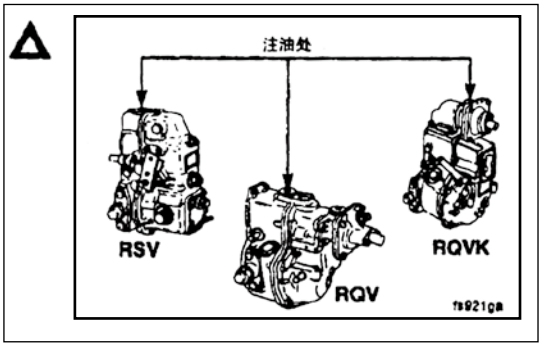
Fix the support clamp, if disassemelbed, at the former position and ensure the high-pressure supplying pipes do not touch with each other or other part.

Torque Value:

(Pipe Line Adapter)43 N•M [32 F-P]

(Supporting Pipe Clamp)6 N•M [48 F-P]

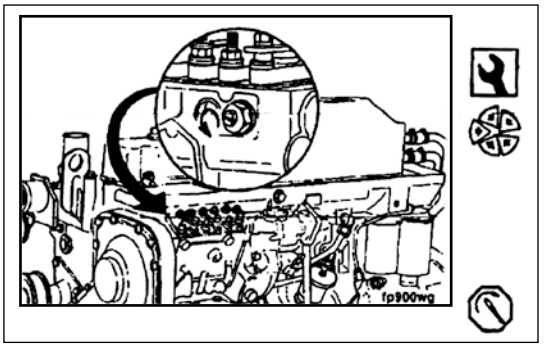
(Supplying and returning Banjo)24 N•M [18 F-P]



Caution ⚠

Fill clean engine oil 15W40 into speed governor housing after replacing or repairing. Otherwise, camshaft of fuel pump and speed governor will be damaged.

Oil Volume of Speed Governor		
ml		liquid volume ounce
450	RSV	15.2
750	RQV, RQVK	25.4
500	RSV-H	16.9



Injection Pump-Breathing 10mm,17mm

PES.MW pump should be breathed after assembling. Unscrew the front bleeding bolt nearest engine. Rotate engine to inject air from fuel injection pump and secure the bleed bolt.

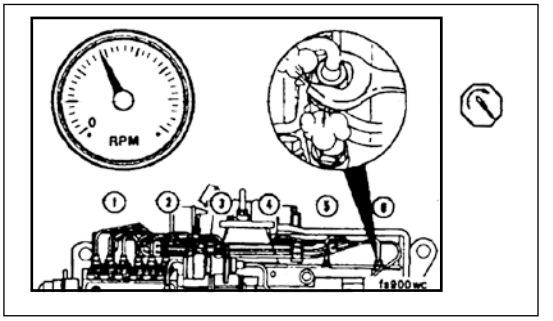
Caution ⚠

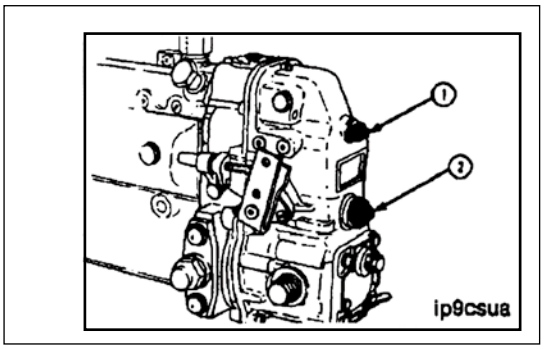
The PES.MW fuel injection pump made ever is not equipped the bleed bolt. Remove the big plug and bleed air from fuel pump. PES.MW pump bleeds air automaticly.

Torque Value: 9N•M[80F-P]

Bleed air from each high-pressure supplying pipe respectively until engine runs steadily. Secure high-pressure supplying pipe.

Torque Value:30 N•M [22 F-P]

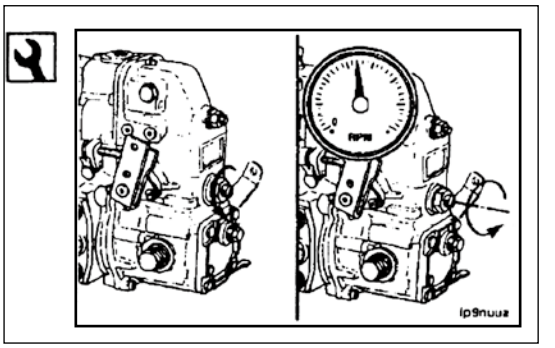




Injection Pump– Idle Adjustment

RSV Speed Governor

Low idle bolt(1)and damper spring bolt(2)should be adjusted for idle adjustment of the industrial engine.

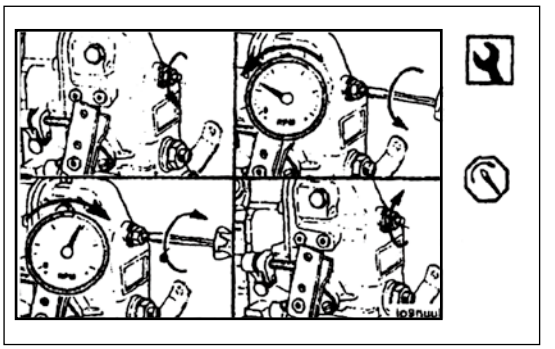


19mm Screwdriver and Rotating Speed

Rotate nut and adjust damper spring bolt until engine rpm does not change.

Caution ⚠

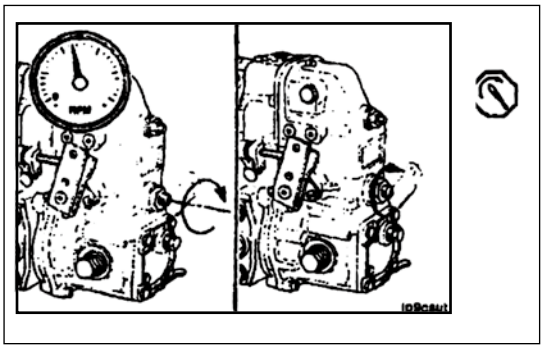
Rotation speed should decrease 30-40rps while adjusting damper spring bolt.



13mm Screwdriver and Rotating Speed

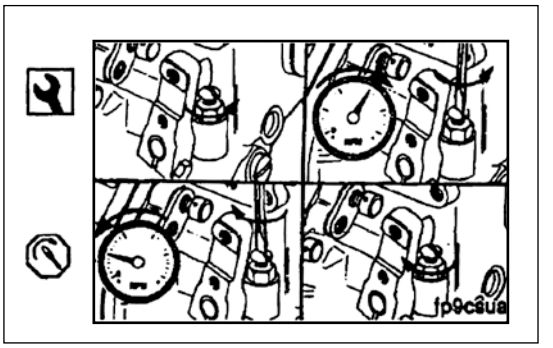
Unscrew nut and adjust idle bolt until rpm is less 30-40 rpm than ideal rpm. Rotate idle bolt to reduce speed counter-clockwise and increase speed clockwise. Secure idle bolt and nut.

Torque Value: 8 N•M [72 F-P]



Rotate damper spring clockwise until the idle speed up to the rotated value noted on data plate containing additional loading (such as A/C, hydraulic loading and transmission) at normal idle speed. Secure the nut.

Torque Value: 8 N•M [72 F-P]



RQV and RQVK Speed Governor

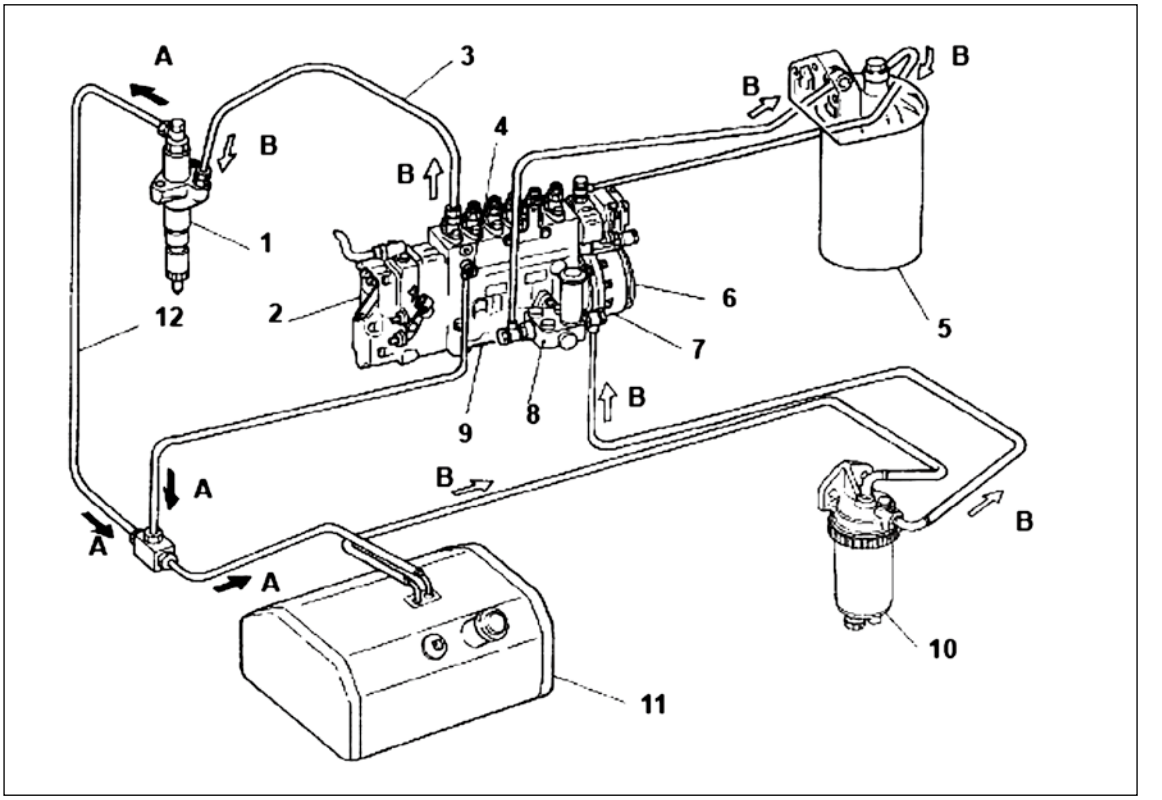
10mm Screwdriver and Rotating Speed

Adjust the idle adjusting bolt when adjust fuel injection pump. Unscrew nut and rotate idle adjusting bolt counter-clockwise to increase rotating speed. Rotate idle adjusting bolt clockwise until the idle speed up to the rotated value noted on data plate containing additional loading (such as A/C, hydraulic loading and transmission) at normal idle speed. Secure the nut.

Torque Value: 8 N•M [72 F-P]

Structure and Principle

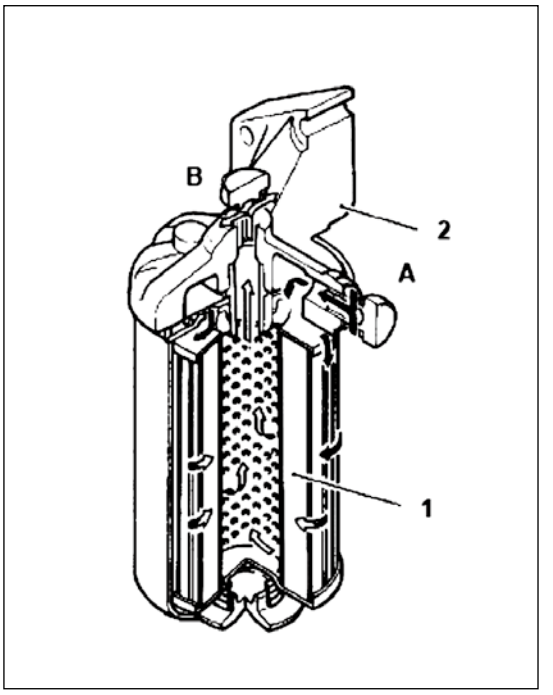
►Fuel System



1. Injector
2. Speed Governor
3. High-pressure Pipe
4. Overflow Valve
5. Fuel Filter
6. Coupling
7. Damper
8. Fuel Supply Pump
9. Injection Pump
10. Water Seperator
11. Fuel Tank
12. Returning Pipe

A: Extra Fuel
B: Supplied Fuel

- Fuel is sucked from fuel tank 11 by supplying pump 8 driven by cam 9 by injector and water in it is separated with water separator 10. Then feul is filtered 5 through fuel filter.
- Filtered fuel enters injection pump 9 which supplies fuel at high pressure to injector 1.The injector 1 injects fuel into the combustion chamber.
- If the fuel pressure of injection pump 9 exceeds the pre-fixed range, overflowing fuel will flows into fuel tank 11.



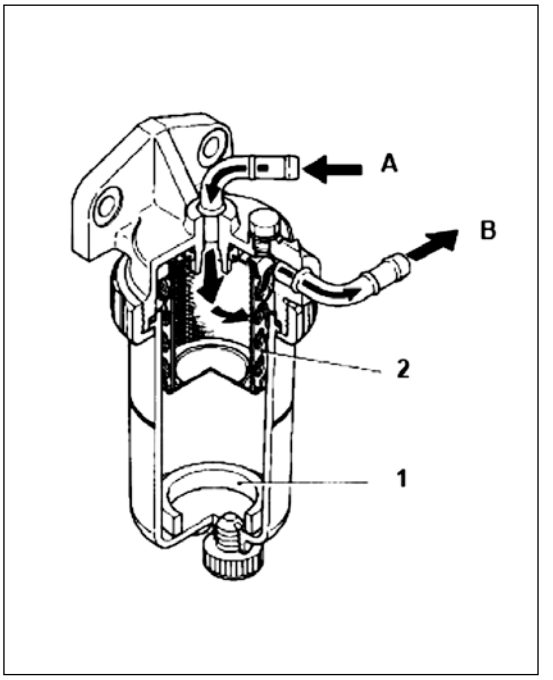
► Fuel Filter

1. Fuel Filter
2. Fuel Filter Case

A：From supplying pump

B：To injection pump

Water in fuel from injection pump and supplying pump is separated. The impurites is filtered by filter element.



► Water Separator

1. Water Level Ring
2. Stopper Plate and Filter Element Assembly

A: From fuel tank

B: To supplying pump

Water separator is assembled in the front of fuel tank and supplying pump. Water in fuel is separated by stopper plate and filter element assembly 2.

Troubleshooting

Possible Causes \ Symptom		Engine can not be started.	Engine starts difficultly.	The cylinder is knocked.	Engine output is unsteadily.	Engine output is unsufficient.	Max. rpm of engine is over high.	Engine idle is unsteady.	Engine starts and then sudden stops.	Can not be up to the max. engine rpm	Engine can not stop.	Acceleration pedal is heavy.	Unsufficient supplying oil.	Elec-injection system warning indicator flashes.
Injection Pump Body	Plunger clogged		○											
	Control push lever clogged		○											
	Oil Outlet valve clogged		○											
	Tappet abraded.		○											
	Camshaft abraded.		○											
	Inappropriate timing of injection.			○		○	○		○					
	Plunger abraded.						○		○					
	Oil valve seat damaged.						○							
	Excessive advance of injection timing.				○									
	Overshort slide stroke of plunger.					○								
	Plunger spring broken.				○			○						
	Inappropriate sliding of control pull lever		○		○		○	○						
	Tappet abraded or inappropriate slide.				○									
	Oil outlet valve spring broken				○	○								
	Inappropriate seal due to oil outlet valve seat loosening				○	○								
	Oil outlet valve fails.				○									
	Control pinion loosens.							○						
	Inappropriate assembling of plunger spring							○						
	Oil outlet valve seat over secured							○						
	Ununiform injection of cylinders		○					○						
Oil Supplying Pump	Screen filter blocked	○						○	○					
	One-way inlet/outlet valves do not work.	○												
	Piston clogged.	○												
	Push lever clogged	○												
	Tappet abraded	○												
	One-way inlet/outlet valves fail.		○		○			○						
	Piston abraded		○		○			○						

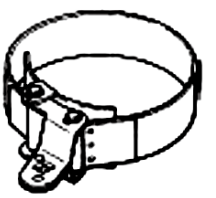
Symptom / Possible Causes		Engine can not be started.	Engine starts difficultly.	The cylinder is knocked.	Engine output is unsteadily.	Engine output is unsufficient.	Max. rpm of engine is over high.	Engine idle is unsteady.	Engine starts and then sudden stops.	Can not be up to the max. engine rpm.	Engine can not stop.	Acceleration pedal is heavy.	Unsufficient supplying oil.	Elec-injection system warning indicator flashes.
Injector	Needle valve clogged	○												
	Over low opening pressure of needle valve	○												
	Injection hole blocked	○		○		○		○		○				
	Bad seal of injector	○		○		○		○		○				
	Over high opening pressure for needle valve			○										
	Spring broken				○	○								
	Bad sliding of needle valve				○									
	Inappropriate opening pressure of needle valve				○									
	Unsufficient pressure of spring/ damaged							○						
Fuel filter	Filter blocked	○			○			○	○					
Fuel tank is empty.		○												
Fuel pipe blocked/or adapter leaks.		○												
Air or water exists in fuel system.		○			○			○	○					
Inferior fuel is used.			○	○		○		○						
Engine controlling	Inappropriate adjustment of limit bolt of acceleration pedal					○				○				
	Acceleration pedal arm rusted											○		
	Engine stop cable broken or lengthened.										○			
	Inappropriate adjustment of engine stop cable										○			
Fuel pipe broken													○	
Fuel tank leaking													○	
Inappropriate mechanical viscosity			○											
Electrinic-controlled injection pump system fails.														○
Inappropriate cylinder clearance			○					○						
Cylinder head gasket damaged			○					○						
Valve abraded and/or carbon deposited			○					○						
Valve spring defromed /force unsufficient			○					○						
Piston ring abraded/damaged			○					○						
Piston ring groove abraded/damaged			○					○						
Cylinder liner or piston abraded			○											
Cooling system fails.			○					○						
Start switch fails			○											

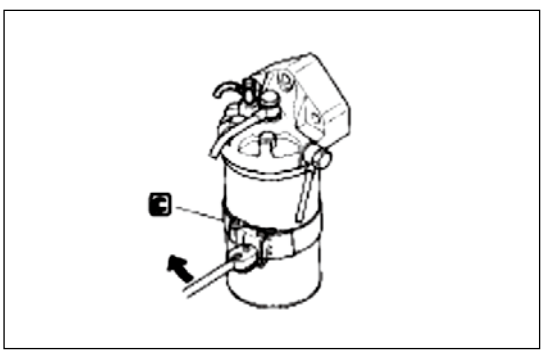
Fuel Filter Replacement

Lubricant

Position	Supplied Position	Stipulated Lubricant	Volume
1	Washer between fuel filter and seat	Engine oil	Depending on requirement

Specific Tools

Position	Tools Names and Appearance	Part No.	Purpose
1			Disassemble fuel filter

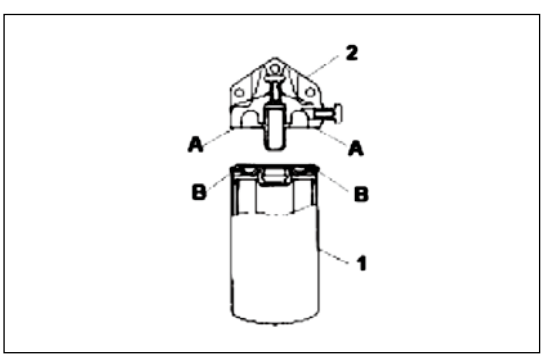


[Disassemble]

Filter Wrench

Warning ⚠

- Fuel should be apart from fire and heat source because of its flammability.
- Clean all overflowing fuel for reducing the burning hazzard.



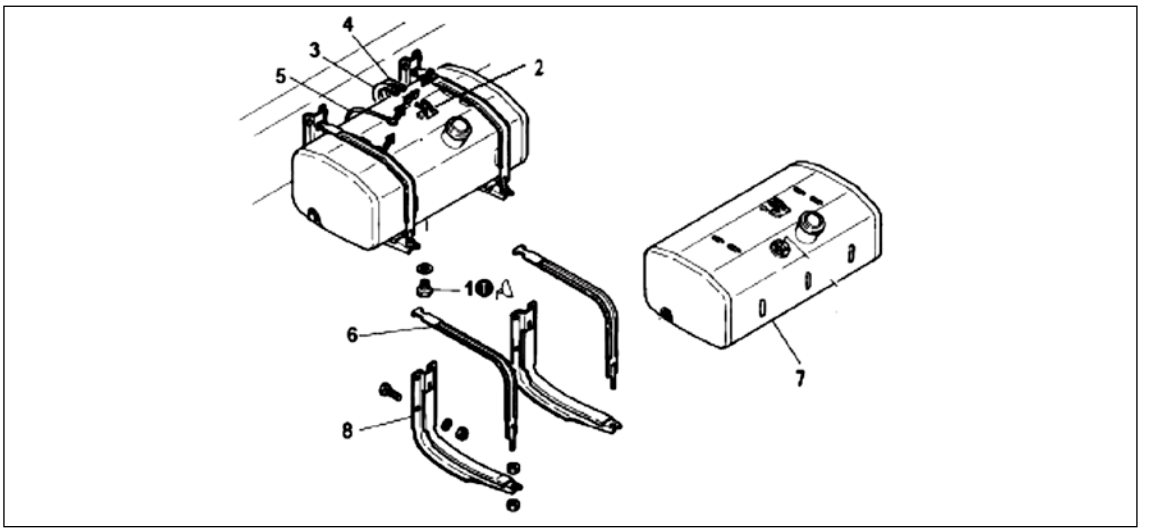
[Assembly]

- Assemble fuel filter 1 and turn it until washer B touches the surface A of filter seat. Secure filter at 1-1% rotation with hands.
- Bleed all air from fuel system

Warning ⚠

Start engine and check for fuel leakage after assembling fuel filter1.Any fuel leakage will probably cause fire.

Fuel Tank



● Operation before disassembling

Warning ⚠

- Drain all oil in tank before working.
- Clean all overflowing fuel for reducing fire hazard.
- Fuel tank and fuel should be apart from fire and heat source to prevent explosion.

● Disassembling Sequence

1. Drain Plug
2. Inlet/returning ports and oil-quantity transducer assembly
3. Oil suction hose
4. Oil returning hose
5. Chassis electric wire
6. Fuel tank band

Electric system

7. Fuel Tank
8. Fuel tank bracket

●Assembling Sequence

Follow the counter sequence of disassembling.

Tightening Torque

Position	Tools Names and Appearance	Part No.	Purpose
1	Drain plug	125±9.8{13±1}	-

Sealant

Position	Supplied Position	Stipulated Lubricant	Volume
1	Drain plug seat	Sealed end No.22	Depending on requirement

Air System Repairing

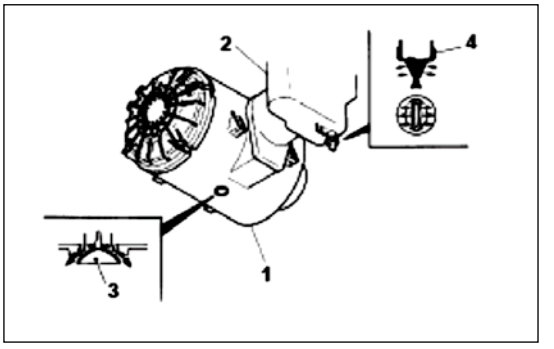
Replaced Parts	Tools	Prepare Process
Air inlet passage	8mm socket, common screwdriver and torque wrench	
Inlet manifold plate and washer	10mm socket	Disassemble auxiliary equipment and air tube of cold start.
Turbocharger and/or washer	10mm, 15mm, 16mm, 7/6inch wrench	Disassemble inlet and exhaust passages.
Exhaust manifold and/or washer	15mm socket	Disassemble inlet and exhaust passages and remove the turbocharger.

- It is necessary to remove some parts on chassis for touching some engine parts.Disassemble the chassis parts following the instruction of manufacturer.

Types

Items	Types
Air Cleaner Element	Paper
Dust Indicator	Mechanics

Structure and Principle

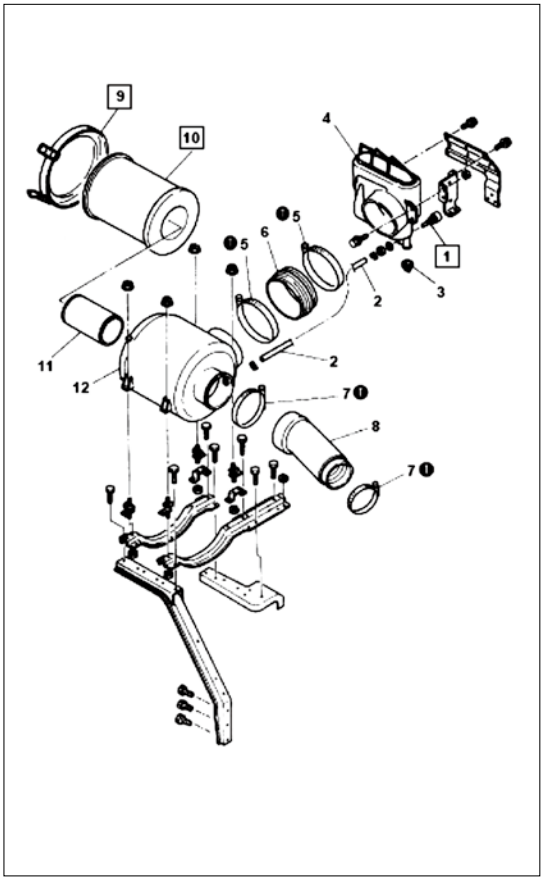


► Air Cleaner

1. Air Cleaner
2. Lower Air Pipe
3. Drain Valve
4. Vacuum Valve

- Double-element is adopted in air cleaner assembly 1.
- Air cleaner assembly 1 includes drain valve 3. Lower air pipe includes vacuum valve 4.
- Drain valve 3 and vacuum valve 4 open automatically when engine rpm is less than pre-fix range and the deposited dust and dirt is drained.

Air Cleaner



● Disassembling Sequence

1. Dust Indicator
2. Pipe
3. Vacuum Valve
4. Lower Air Pipe
5. Clamp
6. Connecting Hose of Pipe
7. Clamp
8. Inlet Hose
9. Cover
10. Exterior Filter Element
11. Interior Filter Element
12. Housing

Caution ⚠

- Do not disassemble interior filter element 11 unless replace it.
- Do not clean interior filter element 11.

● Assembling Sequence

Follow the reverse disassembling sequence.

Check and Repair Standard

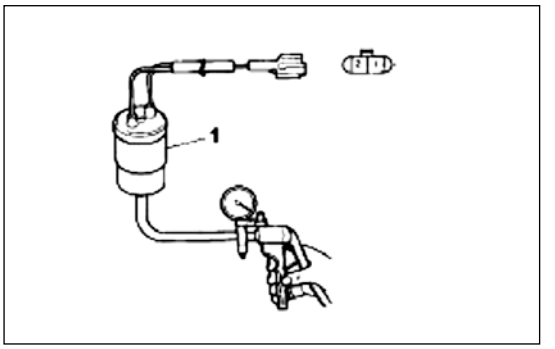
Position	Repaired Items	Standard Value	Limit Value	Correction
1	Vacuum level of dust indicator	6.2±0.7kPa(620±70mmH2O)	-	Replace

Tightening Torque

Position	Tighened Part	Tightening Torque	Remark
5.7	Clamp	2.94-3.43(0.3-0.35)	-

Troubleshooting

Symptom / Pssible Causes		Engine starts difficultly.	Exhaust black smoke.	Exhaust white smoke.	Insufficient power of engine.	Consume more oil.	Abnormal noise and vibration intle/exhaust system.	Remark
Air Cleaner	Air cleaner element blocked	○	○		○			
Turbocharger	Bearing damaged		○		○		○	
	Shaft and turbine rotor assembly carbon deposited		○		○			
	Interference between shaft and turbine rotor assembly and turbine backboard		○		○		○	
	Interference between shaft and turbine rotor assembly and turbine		○		○		○	
	Shaft and turbine rotor assembly bended		○		○		○	
	Shaft and turbine rotor assembly damaged		○		○		○	
	Interference between Air compressor rotor and Air compressor housing		○		○		○	
	Thrust sleeve and/or thrust bearing clogged		○		○		○	
	Air compressor rotor damaged		○		○		○	
	Fuel leaking due to piston ring and/or bush damaged			○		○		
	Inappropriate assembling of piston ring					○		
	Part sliding failed due to lubricant pipe and bolt blocked.		○		○			
	Oil seal damaged due to returning pipe blocked			○		○		
	Inappropriate assembling of compressor housing		○		○	○	○	
	Inappropriate assembling of turbine housing				○		○	
Intercooler	Foreign substance deposited on the front core of intercooler				○			
Front pipe/silencer/tail pipe deformed						○		
Inappropriate assembling of front pipe/silencer/tail pipe						○		
Incorrect valve clearance		○						
Cylinder head gasket damaged		○						
Valve and valve seat abraded/ carbon deposited		○						
Insufficient valve spring force		○						
Piston ring abraded/damaged			○		○			
Piston ring groove abraded/damaged			○		○			
Cooling system fails.		○						
Excessive oil			○					
Main motion part clogged		○						
Ununiform injection or excessive oil		○						

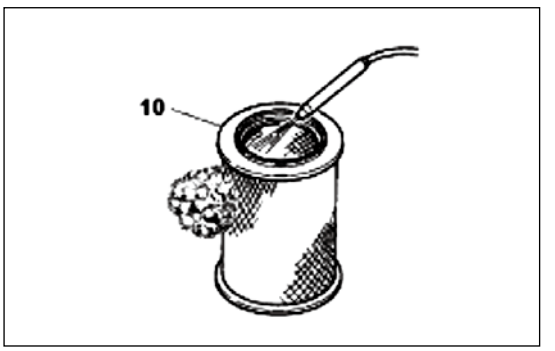


◆ **Repairing**

1 Check Dust Indicator

Check following items. Replace dust indicator 1 if damaged.

- Make sure terminals of ① and ② are not connected without vacuum pressure imposing on dust indicator 1.
- Impose given vacuum pressure 6.2±0.7kPa (620 ±70mmH2O) on the dust indicator 1 and check if terminals of ① and ② are connected.
- Check system. Electric system.



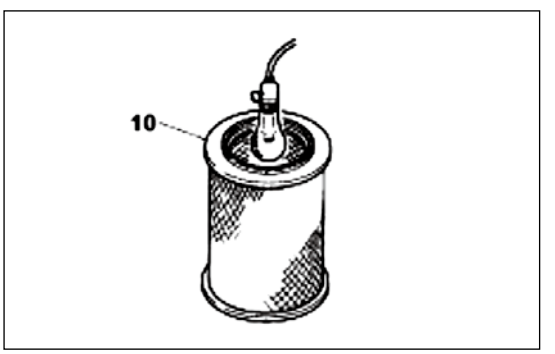
10 Exterior Filter Element

[Cleaning]

- Blow exterior filter element 10 with compressed air (pressure below 685kPa {7kPf/m2}).
- Blow repeatly along filtering paper pleat up and down with compressed air.

Caution ⚠

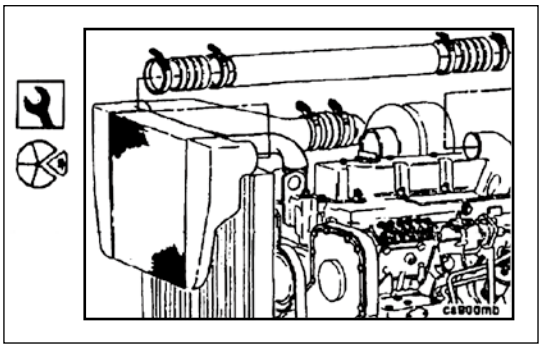
- Do not knock the filter element 10 when eliminating dust.
- Don't blow filter element 10 from outside to inside with compressed air.



[Check]

- Put a light inside the exterior element 10.
- Replace filter element 10 once filtering paper damaged or scratched or top seal of element damaged.

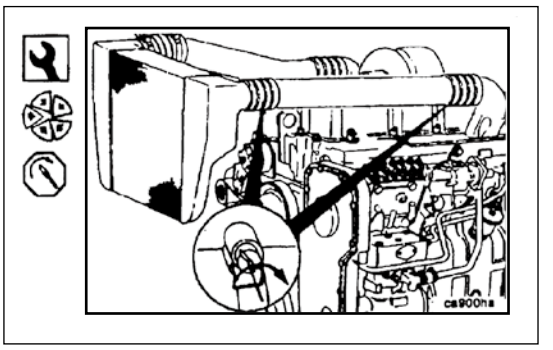
  Replace filtering element 10 regardless replacement period if there is lampblack or carbon deposit.



Inlet Passage Replacement

8mm or screwdriver

Loosen hose clamp and disassemble air passage.



8mm or screwdriver

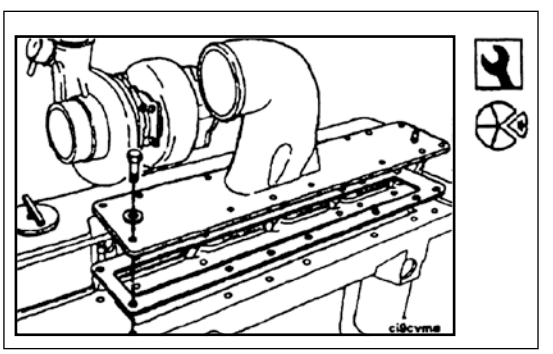
Use new hose and clamp if necessary. Secure hose clamp.

Refer to the specification of torque value made by manufacturer.

Replacements of Intake Manifold Plate and Sealing Gasket

Prepare Process:

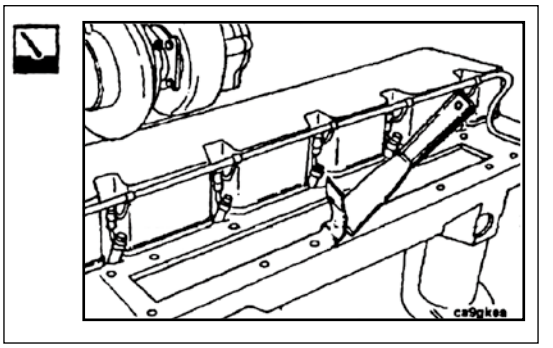
- Disassemble auxiliary unit of cooling start, if equipped.
- Disassemble air elbow.
- Disassemble high-pressure fuel supplying pipe.



10mm

Disassemble intake manifold plate cover and sealing gasket.

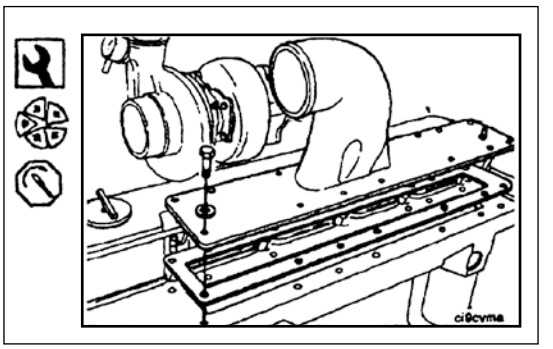
Block the intake opening with clean cloth to keep impurities out of system.



Clean Sealing Surface

Caution ⚠

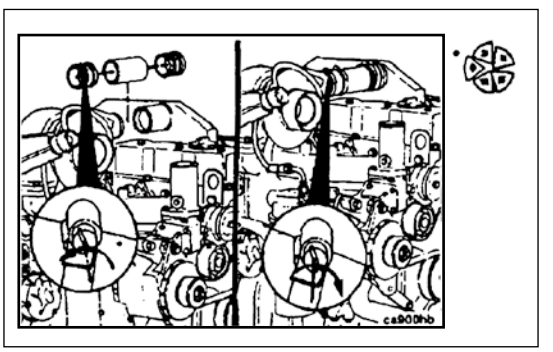
Keep sealing gasket material and other substance out of manifold.



10mm,19mm

Assemble intake manifold plate cover and a new sealing gasket. Fix high-pressure fuel supplying pipe.

Torque Value: 24N•M[18F-P]



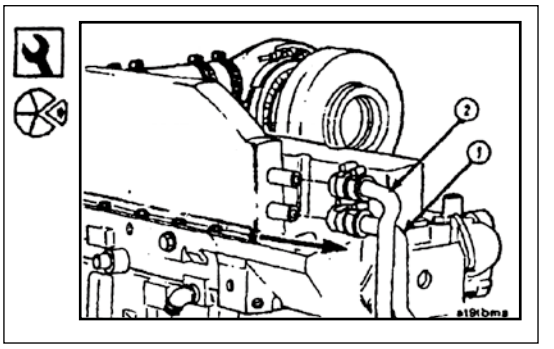
Combine intake passage and connect auxiliary unit of cooling start if used. Bleed air for high-pressure fuel supplying passage.

Rear Supercharger Cooler and Sealing Gasket Replacement

(Water-cooling intercooler and gasket)

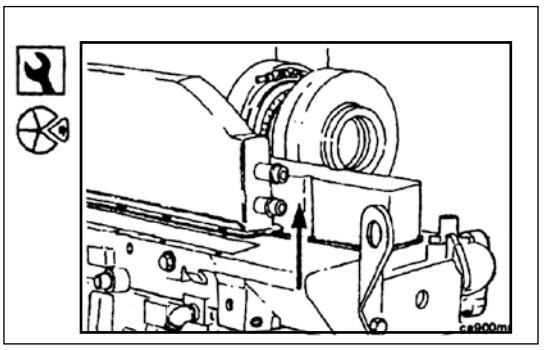
Prepare Process:

- Disassemble auxiliary unit of cooling start, if equipped.
- Disassemble air elbow.
- Drain coolant 2 L(2.1 American Quart)
- Disassemble high-pressure fuel supplying pipe.



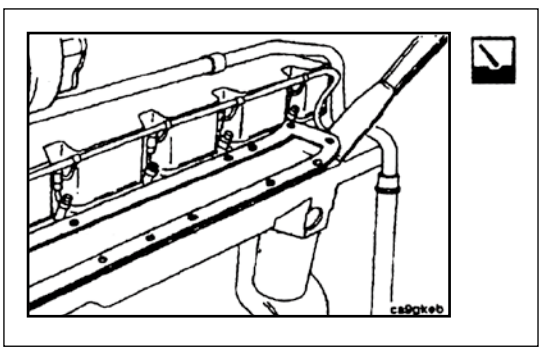
8mm

Remove coolant supplying passage(1) and coolant returning passage(2)(cross-country vehicle engine)



10mm

Disassemble rear superchargercooler housing (water-cooling intercooler housing) and sealing gasket. Block the intake opening with clean cloth to keep impurities out of system.

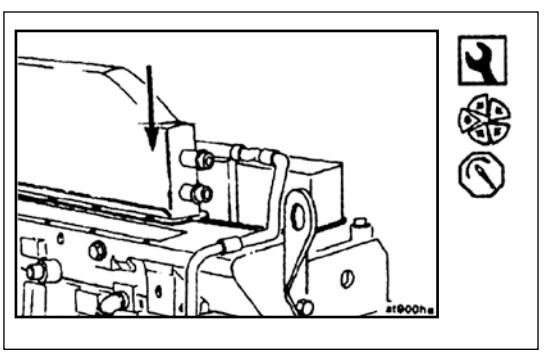


Rear Supercharger Cooler and Sealing Gasket

Clean Sealing Surface

Caution ⚠

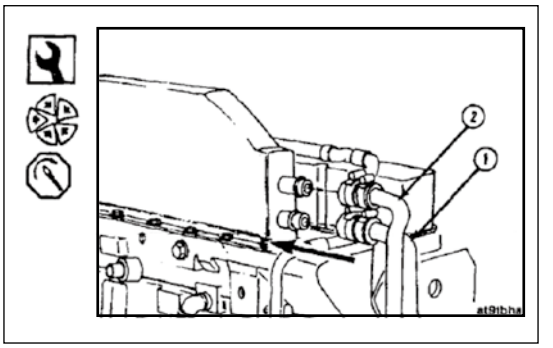
Keep sealing gasket material and other substance out of manifold.



10mm,19mm

Assemble rear supercharger cooler housing (water-cooling inter-cooler housing) and a new sealing gasket. Fix high-pressure fuel supplying pipe.

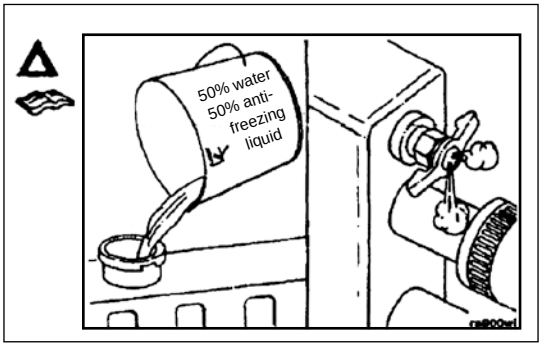
Torque Value: 24N•M[18F-P]



8mm

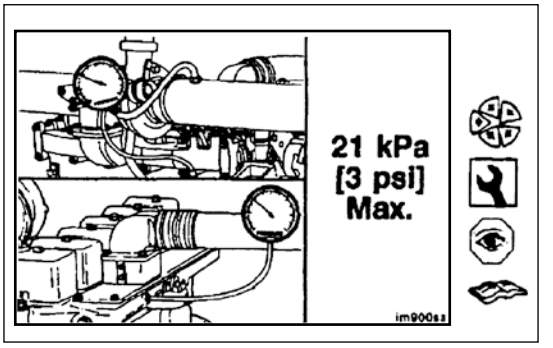
Assemble coolant supplying passage(1) and coolant returning passage(2). Assemble air elbow.

Torqu: 8N•M[72F-P]



Caution ⚠

Ensure opening the vents of engine and rear supercharger cooler when filling coolant into system. Bleed air from the system referring to the procedure in page 7-7. Bleed air from high-pressure fuel supplying passage.



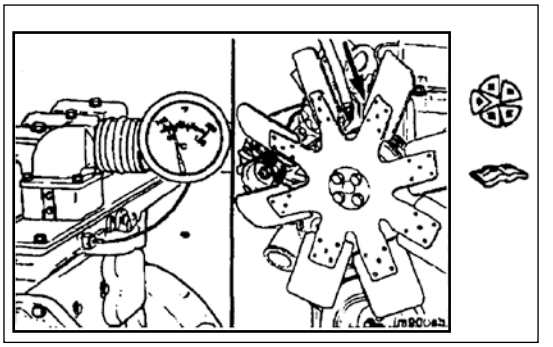
Supercharger Cooler(air-air intercooler) intake manifold pressure -check

Fix pressure gauge of part No. ST-1273 on outlet joint of turbocharger.

Assemble another pressure gauge of part No. ST-1273 inside inlet manifold.

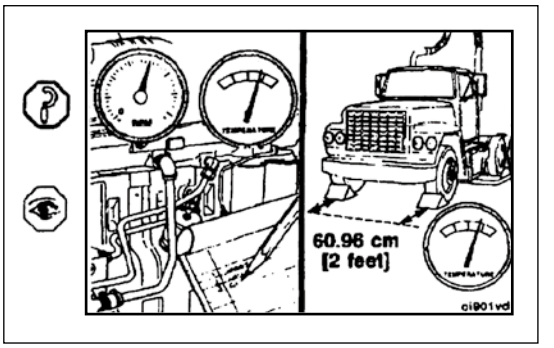
Run engine at rated rpm and load. Record the readings of two pressure gauges.

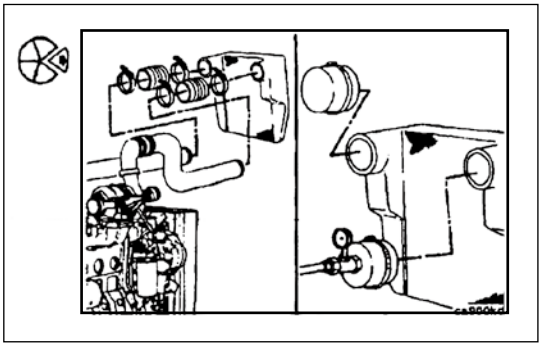
If pressure difference is more than 21k pascal[3pound/square inch], check supercharger cooler for blockage. Clean or replace it if necessary referring to procedure （3-07）.

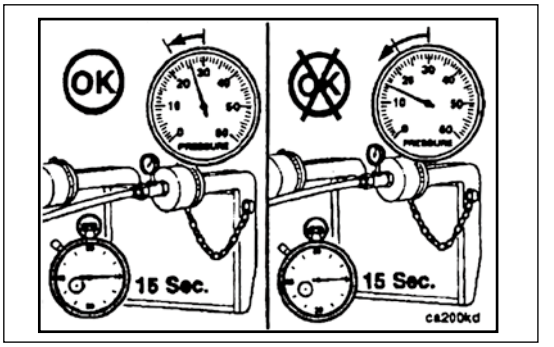


Intake Manifold Tempearture - Check

Put a temperature gauge into intake manifold. Lock fan at ON to prevent occuring unsteady test result. Fix a jumper on the temperature switch or blow to fan with compressed air to lock fan. referring to fan manufacturer relative procedure.







Caution ⚠

Manual switch of locking fan is equipped with some trucks.

Run engine at rated rpm and load. Record intake manifold temperature. Measure the ambient temperature at 60.96 cm [2.0]in front of vehicle.

Max. temperature difference should not be higher than 7℃[45° F].If temperature difference is higher than this value, check radiator sections of turbocharging air cooler for dirty or impurities and clean it if necessary. If trouble still exists, check the interior cooler for pollutant or blockage.

Check hose or pipe of turbocharging air cooler for breakage. Disassemble inlet and outlet hoses of the cooler.

Disassemble turbocharging air cooler.

Assemble a cap at outlet of the cooler. Assemble a pressure gauge and compressed air supplying pipe at inlet of the cooler.

Check for Leakage

Check cooler with air pressure of 276k pascal[40pound/square inch]. If pressrue reduction equals or lower than 35 k pascal [5pound/square inch]within 15 seconds, the cooler is normal.

If pressrue reduction higher than 35k pascal [5pound/square inch]within 15 seconds, the cooler should be repaired or replaced. Refer to Repair Mannual of CAC manufacturer.

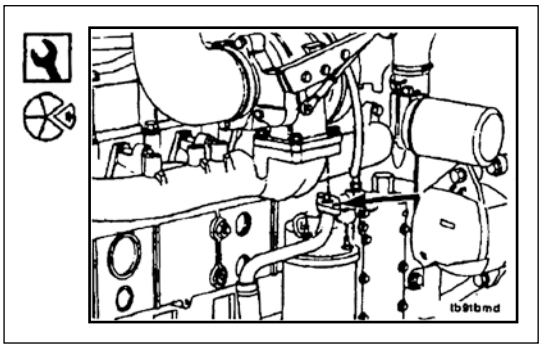
Caution ⚠

Detect air leakage with a leaked tank.

Turbocharger Replacement

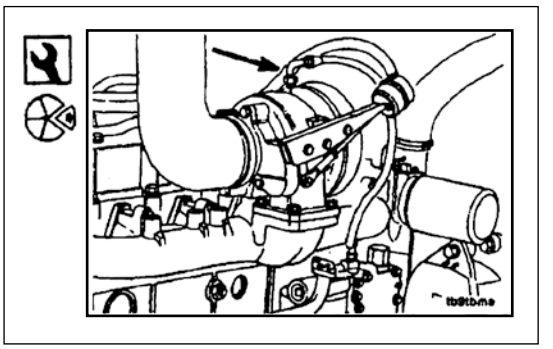
Prepare Process:

- Disassemble inlet passage.
- Disassemble inlet and exhaust passage.
- Remove pipe line of waste gate regulator.



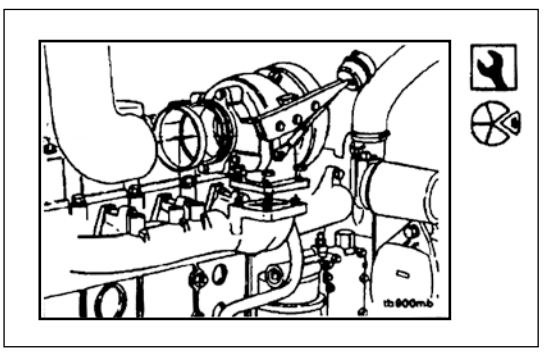
10mm

Unscrew the retaining screw from returning pipe.



16mm

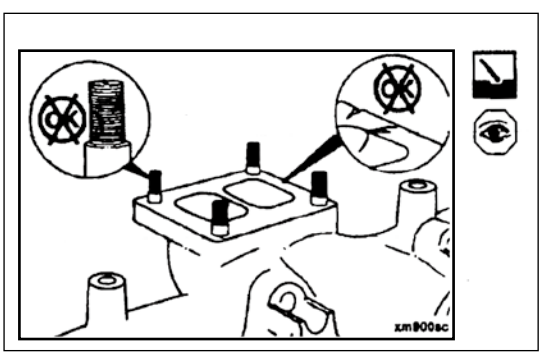
Disassemble oil supplying pipe.



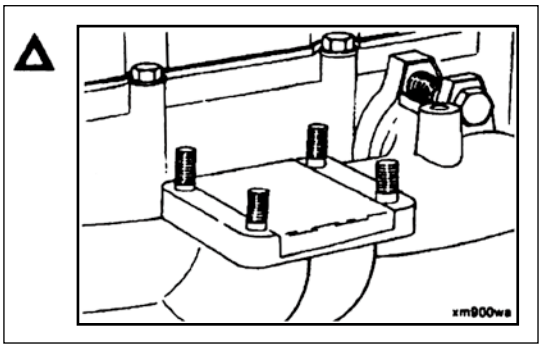
15mm and 11mm

Remove exhaust pipe clamp, turbocharger and gasket.

Block the exhaust flange with clean cloth to keep impurities out of manifold.

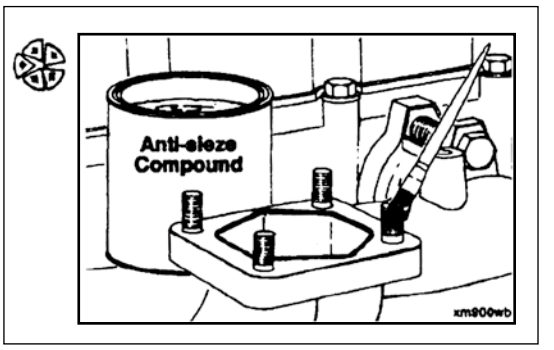


Clean sealing surface. Check sealing surface and retaining bolt for damage.

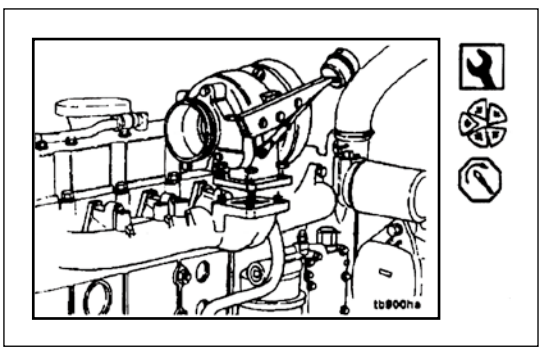


Caution ⚠

Cover the open end for keeping foreign substances away from the manifold if the turbocharger is not replaced at moment.

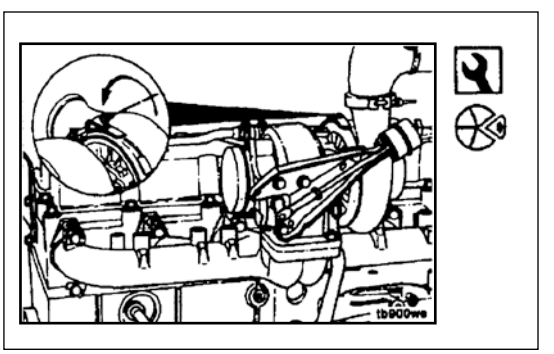


Put a new washer on the retaining bolt and smear anti-clogging paste on retaining bolt.



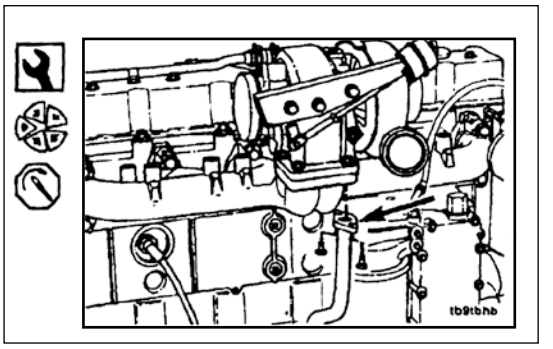
15mm

Assemble turbocharger.
Torque Value: 32N•M[24F-P]



11mm

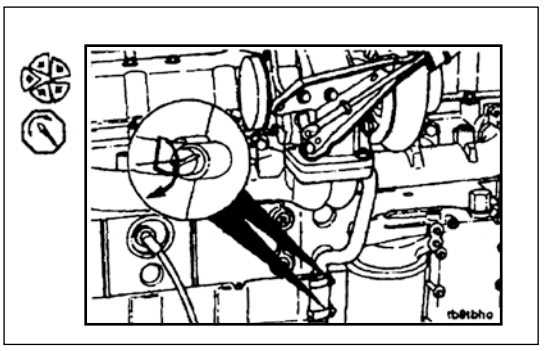
Release retaining bolt of turbo housing and assemble oil returning pipe of turbocharger aligning with bearing housing if necessary.



10mm

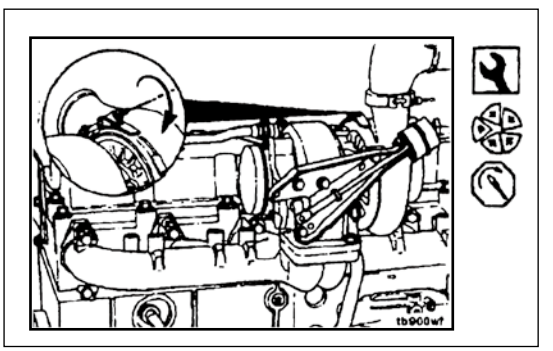
Secure hose and clamp through oil returning pipe of turbocharger freely. Assemble oil returning pipe and washer on turbocharger.

Torque Value: 24N•M[18F-P]



Connect oil return pipe to the return hose of turbocharger: screw pipe clamp.

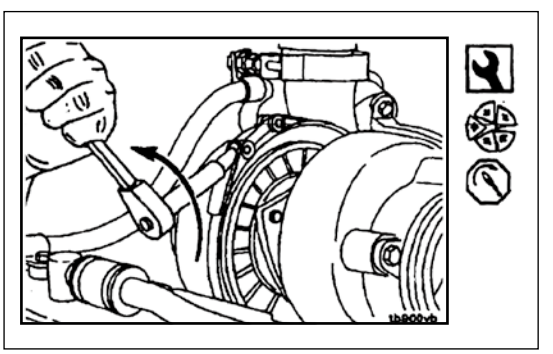
Torque Value: 5 N•M [44 F-P]



11mm，Puncher, Hammer

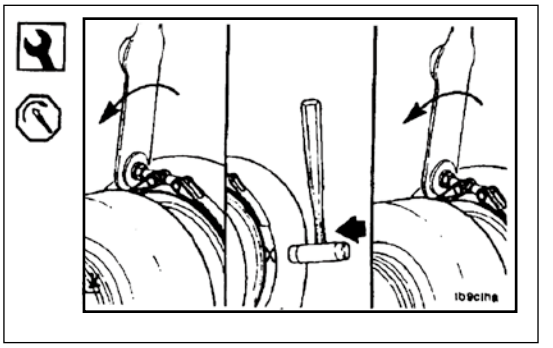
Secure the retaining screw of turbine housing if it is loose.

Torque Value: 11 N•M [100 F-P]



11mm

Calibrate air elbow by loosening compressor housing and align to housing if necessary.



11mm， Plastic Hammer

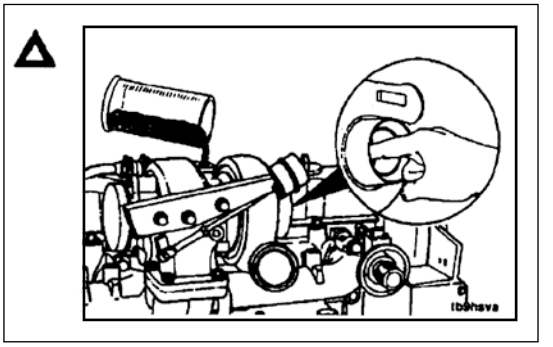
Secure strip clamp. Knock around the clamp with a plastic hammer and secure it again.

Torque Value: 8 N•M [71 F-P]

Caution ⚠

Silver-plated nut should be used on V type strip clamp for all Holset turbochargers since Dec.1st,1990.

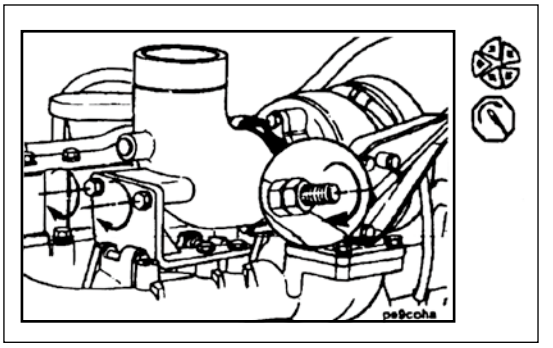
Torque of Silver-plated nut is less than that of satinless steel nut under the same load.



Caution ⚠

New turbocharger should be pre-lubricated before starting to prevent from damage.

Fill clean engine oil 15W-40 of 50 to 60ml (2-3ounce) into supply pipe joint. Rotate turbine and flow oil into bearing housing.

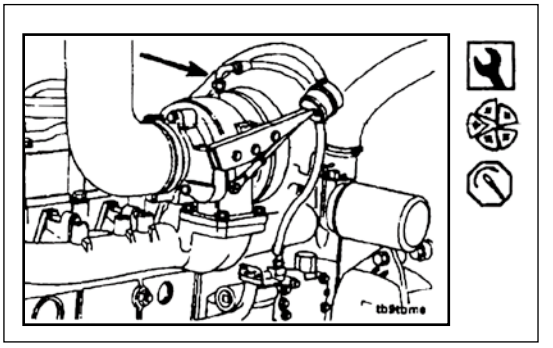


Assemble exhaust outlet joint.

NOT secure the second retaining screw before securing strip clamp.

Torque Value: Strip Clamp -8 N•M [71F-P]

Torque Value: Retaining Screw-43 N•M [71 F-P]



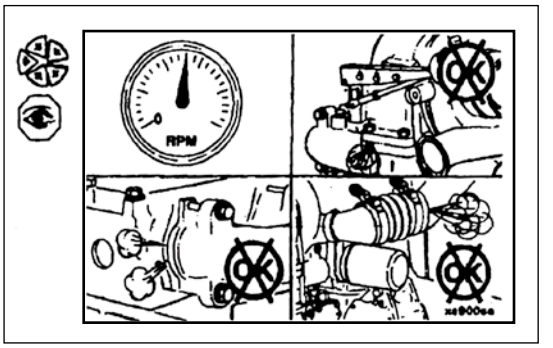
16mm

Assemble oil supply passage.

Torque Value: 15 N•M [11 F-P]

Caution ⚠

Not touch oil supply pipe with the turbine or the oil pipe will burn and cause damage of vehicle and equipment and hurt human body.

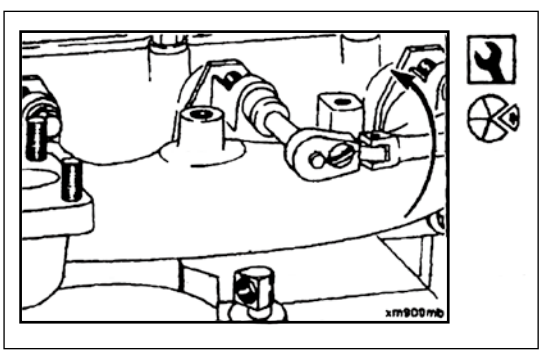


Assemble air inlet and exhaust passages. Assemble the pipe line of waste gate regulator. Start engine and check for leakage.

Exhaust Manifold and Gasket Replacement

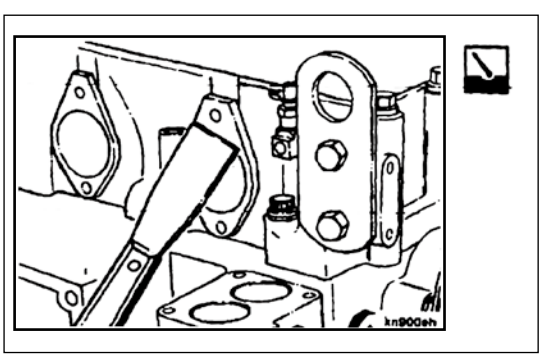
Prepare Process:

- Disassemlbe Air Elbow
- Disassemble air inlet and exhaust passages.
- Disassemble turbocharger if equipped.

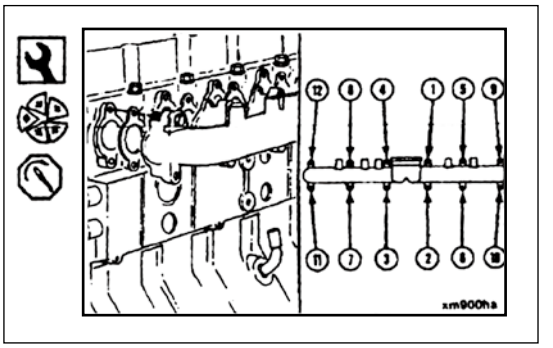


16mm

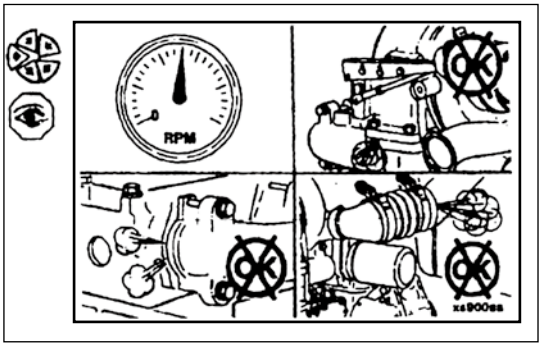
Disassemble exhaust manifold and gasket.



Clean sealing surface of exhaust manifold.

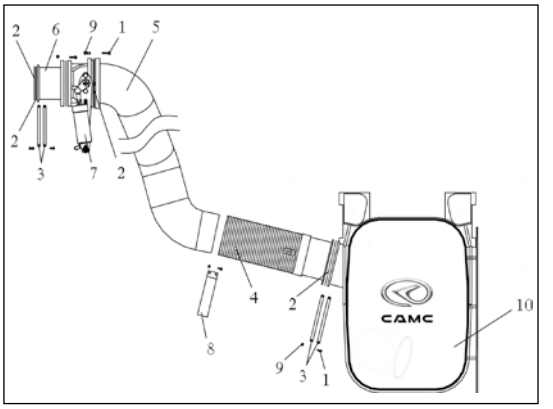


Assemble exhaust manifold, new sealing gasket and lock plate.
Torque Value: 43N•M[32F -P]
Secure manifold exhaust following the instruction in the diagram.



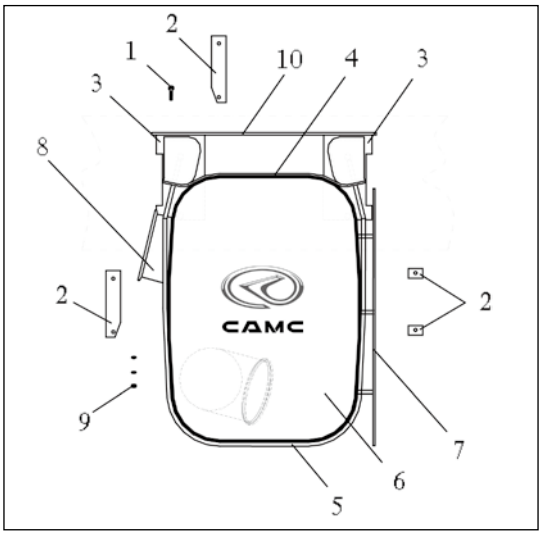
Assemble the disassembled parts. Start engine and check for leakage.

Exhaust Pipe and Silencer



● Disassemble Sequence:

1. Bolt
2. Sealing Gasket
3. Clamp
4. Metal Hose
5. Center Pipe
6. Front Pipe
7. Exhaust Brake
8. Variable Section Clamp
9. Nut
10. Silencer



►Silencer Assembly

● Disassemble Sequence:

1. Bolt
2. Heel Block
3. Bracket
4. Limiting Stopper
5. Clamp
6. Decoration Plate
7. Heat Isolation Board
8. Silencer
9. Nut
10. Silencer Foot Pedal (for trailing vehicle)

Assembling Sequence

Assembling follows the reverse sequence of disassembly.

Decoration Plate Assembling:

Mark direction is shown as diagram.

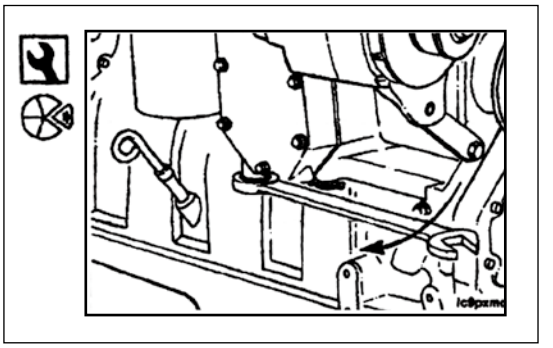
Lubrication System Repair

Replaced Parts	Tools	Prepare Process
Oil pressure regulator valve and/or spring	22mm socket，ratchet and torque wrench	Eliminate impurities
Lubricant thermostat	32mm socket，ratchet and torque wrench	Eliminate impurities.
Oil cooler core and / or washer	16mm wrench，ratchet 10mm socket and torque wrench	Drain coolant and disassemble oil filter.

Replacements of Lubricant Oil Pressure Governor,Valve and Spring

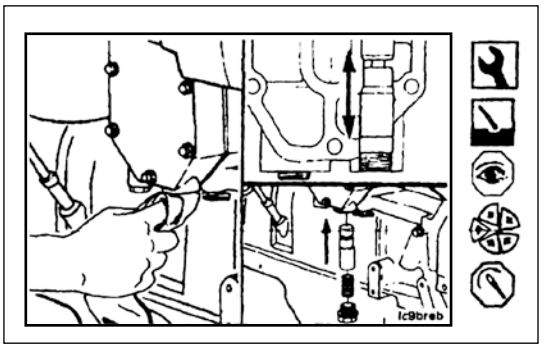
Prepare Process:

● Eliminate impurities.



32mm

● Remove stopcock, spring and governor valve.



32mm

Check the bore and the governor valve before combination.

The valve should be moving freely in the bore. Assemble governor, spring and stopcock.

Torque Value: 80 N•M [60F-P]

Lubricant Thermostat Replacement

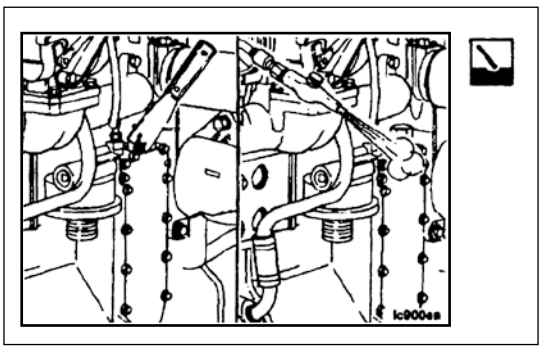
Prepare Process:

● Eliminate impurities.

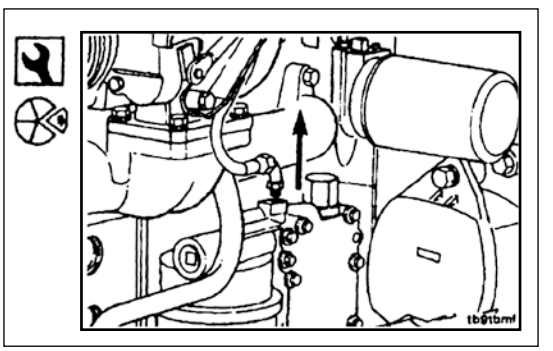
Lubricant Cooler Core and Gasket Replacement

Prepare Process:

- Drain coolant.
- Remove oil filter.

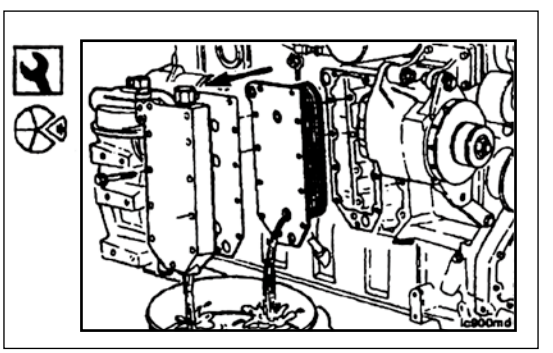


Eliminate all impurities around lubricant cooler.



16mm

Release oil supplying pipe of turbocharger from oil filter case.

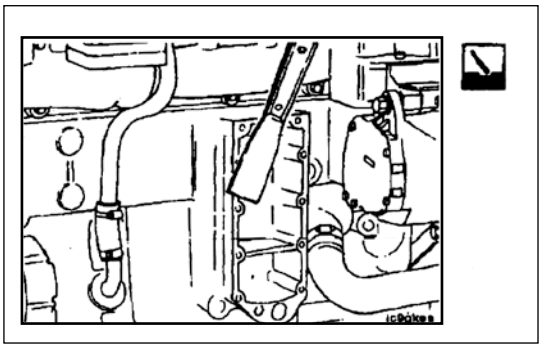


10mm

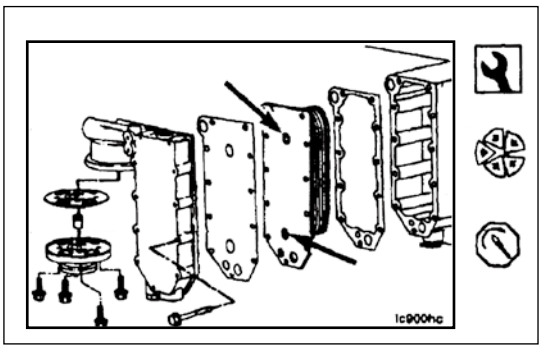
Disassemble oil cooler plate, core and gasket.

Caution ⚠

Core contains lubricant about 0.74L (0.75 American Quart). The lubricant will flow out when disassembling the cooler from engine.



Clean sealing surface of oil cooler.



10mm

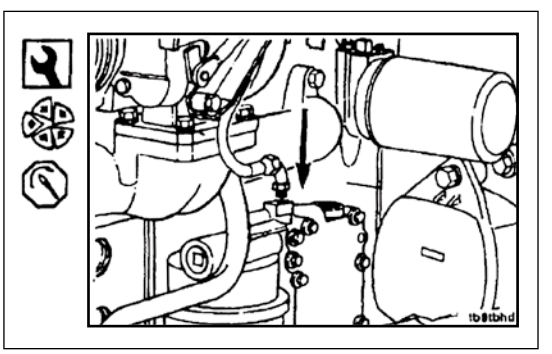
Combine lubricant cooler gasket, core, cooler plate gasket, lubricant thermostat and oil cooler plate to cylinder.

Assemble filter case and washer if removed.

Note: Disassemble assembling plug from lubricant cooler core.

Torque Value: Retaining bolt of lubriacant cooler plate. 24N•M[18F-P]

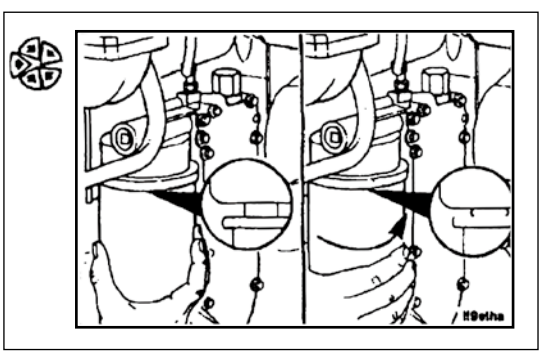
Retainging bolt of oil filter cover. 24 N•M [18 F-P]



16mm

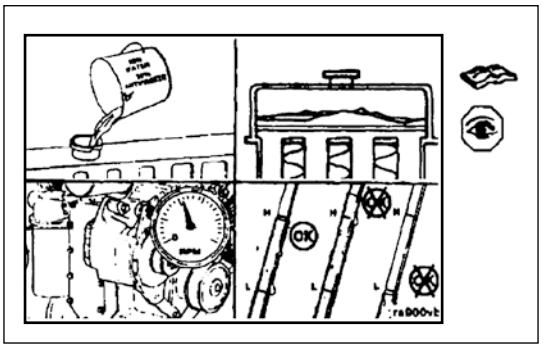
Connect oil supplying pipe of turbocharger.

Torque Value: 15 N•M [11 F-P]



Assemble a new oil filter.

Secure it following manufacturer's instruction.



Caution ⚠

Run engine and open rear vent of charging cooler to bleed air from system. Refer to the prescribed procedure page7-7.

Fill cooler system and run engine to check for leakage.

Stop engine and check levels of coolant and lubricant.

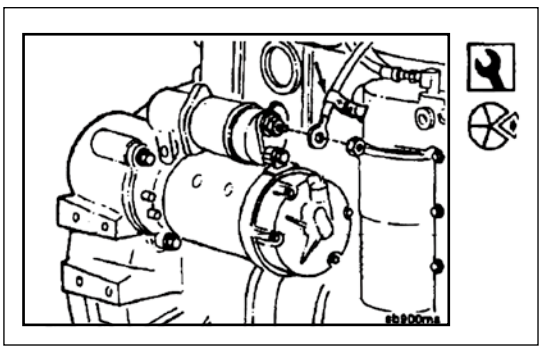
Electric System Repairing Summary

Replaced Parts	Tools	Prepare Process
Start Motor	Ratchet, 16mm socket 19mm wrench and torque wrench	Disconnect earth-wire of battery.
Alternator	Ratchet, 8mm, 13mmand and 17mm socket and torque wrench, 1/2inch Square Headwrench	Disconnet earth-wire of battery and disassemble driving belt.

Start Motor Replacement

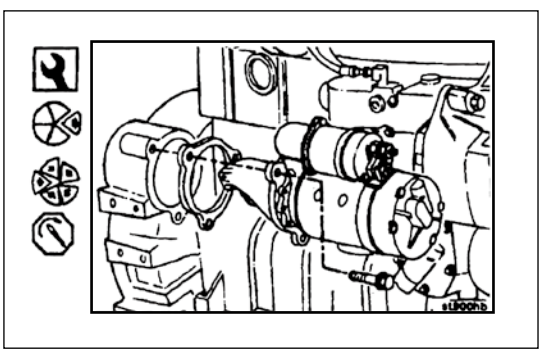
Prepare Process:

- Disconnect earth-wire from battery.
- Stick a tag marking position to each wire.



19mm

Disconnect battery cable from coil.



16mm

Disassemble start motor and washer.

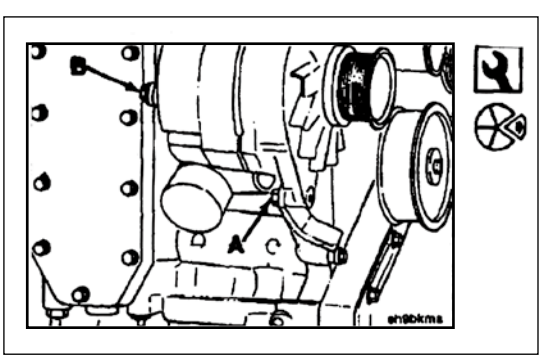
Assemble start motor in the reverse sequence of disassembling.

Torque Value: 77N•M[57F-P]

Alternator Replacement

Prepare Process:

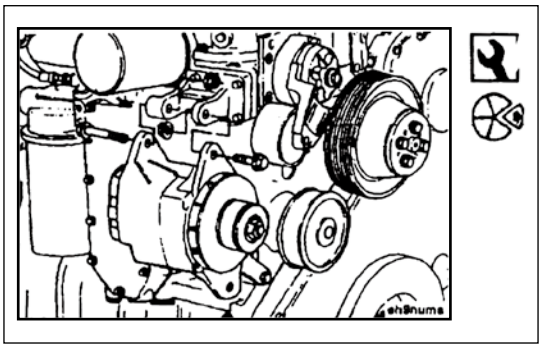
- Disconnet the earth-wire from battery terminal.
- Stick a tag marking position to each wire.
- Disassemble driving belt.



19mm

Unscrew the retaining bolt（A）from the alternatorstrut bar.

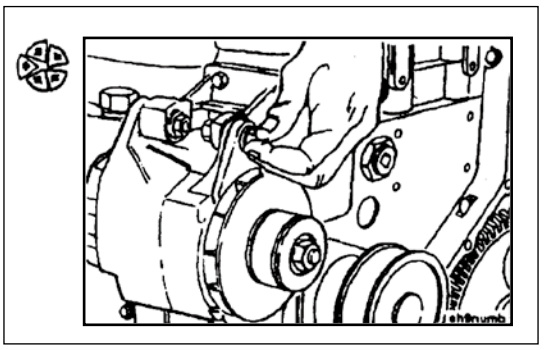
Remove the retaining bolt（B）from the bracket.



18mm, 19mm

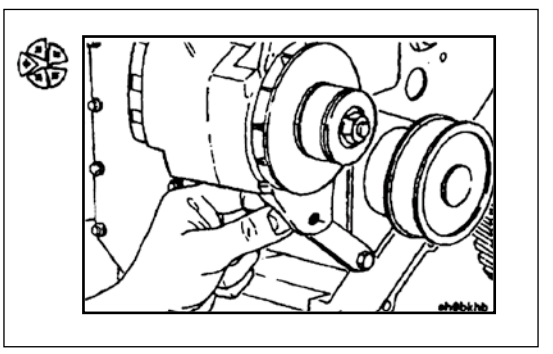
Disassemble the retaining bolt and nut from alternator.

Disassemble the alternator.



Put the alternator on the bracket and hold it with retaining bolt.

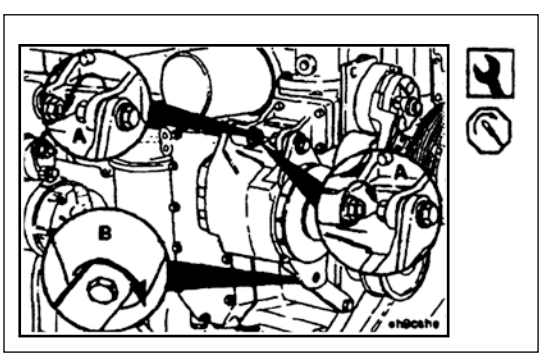
Not secure it at the moment.



Connect strut bar to the alternator and secure it with hands.

Caution ⚠

Make sure that the alternator strut bar is at appropriate position to adjust belt.



15,18,19mm

Secure the retaining screw of the alternator strut bar.

Torque Value:

A:43N•M[32F-P]

B:24 N•M [18 F-P]

Assemble driving belt.

Chapter 4 —— Specification and Torque Value

General Specifications

General Parameters -Engine	L345 20	L375 20
Bore – mm[inch]	114[4.49]	
Stroke – mm[inch]	144.5	
Displacement – L[Cubic Inch]	8.9	
Weight- (Dry Weight)	650	
(Wet Weight)	680	
Injection Sequence	1-5-3-6-2-4	
Valve Clearance		
Inlet – mm[inch]	0.30	
Exhaust – mm[inch]	0.61	
Compression Ratio	16.6	
Rotate Direction-View from the front of engine	clockwise	

►Aspiration Method

Nature Aspiration
Turbocharging
Cooling after Supercharging (water-air intercooling)
Supercharging Air Cooling(air-air intercooling)
* High torque(max torque700inch/pound and above)
** Low Torqe(max torque700inch/pound and below)

General Parameters -Engine	L345 20	L375.20
Engine Oil Pressure at Idle-(Allowed min. value)k pascal	69[10]	
Calorie[pound/square inch]	207[30]	
Oil pressure at rated speed	518[75]	
pascal [pound/ square inch]		
The opening pressure of regulator valve k pascal [pound/ square inch]	172[25]	
Bypass valve opening pressure difference of oil filter- k pascal [pound/ square inch]	18.9[20]	
Oil capacity of the sump(high-low)-L(American Quart)	19~23	
Cooling Sytem		
Coolant Capacity(only for engine body) -L(American Quart)	11.1	
Standard Regulating Range of Thermostat-℃(° F) Pressure	Wide Opened 95[203]	
Cover –k pascal [pound/ square inch]min.	50[7]	
Allowed max. temperature of expansion tank℃(° F)	100℃ [212° F]	
Allowed min. temperature of expansion tank℃(° F)	70℃[158° F]	

Inlet and Exhaust System	L345 20	L375.20
Allowed max intake drag for dirty air cleaner element at rated speed and load Kpa(mmH20)	6.2[536]	
Allowed max exhaust drag at rated speed and load Kpa(mmHg)	10.0[750]	
Max. pressure reduction between fuel filters Kpa [pound/saure inch]	34[5]	
Allowed max. return pipe drag- mm mercury [inch mercury]	520[20.4]	
Max. intake drag to oil supply pump-mm mercury [inch mercury]	100[4]	

* Using catalyst.

►Electric System

Recommended Min. Battery Capacity

Battery			Ambient Temperature	
-18℃ [° F]			0℃[32° F]	
	Cold Rotate Ampere	Storage Capacity Ampere	Cold Rotate Ampere	Storage Capacity Ampere
12Volt	1800	640	1280	640
24Volt	900	320	480	240

* Storage capacity is determined with a given inboard number of a battery. Storage capacity determines the running duration.

**The CCA grade determination of each battery (two tandem batteryies of 12 volt) bases on minus18℃ [0° F]

Specific Gravity at 27℃,[80° F]	Battery
1.260-1.280	100%
1.230-1.250	75%
1.200-1.220	50%
1.170-1.190	25%
1.110-1.130	Not Charged.

Recommended Fuel/Specification

Warning ⚠

Never mix diesel with gasoline or alcohol or resulting explosion.

Caution ⚠

It is very important to keep fuel cleaness and water or impurities free because of requirements of diesel injection system procision. Water or impurities in the system will damage severely the fuel pump and injection nozzle.

Caution ⚠

It is not accepted to use the mixture of diesel and engine oil for engine with catalyst converter.

Generally, fuel ASTM2 and diesel of No.2 with cetane number of more than 40 may result in best economy and performance. Fuel with cetane number of 40 probably is used at high altitude or low ambient temperature to prevent from stopping or excessive smoke.

Follow the national stipulation for lubricant at working temperature below 0℃(32° F).

The cloud point of the fuel with low sulfur should be lower 10℃ than the expected fuel temperature. The clound point means the temperature at wax crystal in diesel start to form.

The fuel viscosity should be kept above 1.3% at 40℃ (104° F) to supply sufficient lubrication to the fuel system..

Recommended Engine Oil

Superior engine oil and appropriate periods of oil draining and filter replacement are the key factors for good excellent engine performance and durability.

Dongfeng Cummins Engine Co., Ltd. recommends using superior heavy-duty oil of SAE15W-40 complying with grades of CG4/SH and CF4/SJ of API (such as Cummins Lan Brand: oil used above the standard of CF4/SAS15W-40; Graded oil of CD.CE is prohibited using in Cummins engine.).

Note:

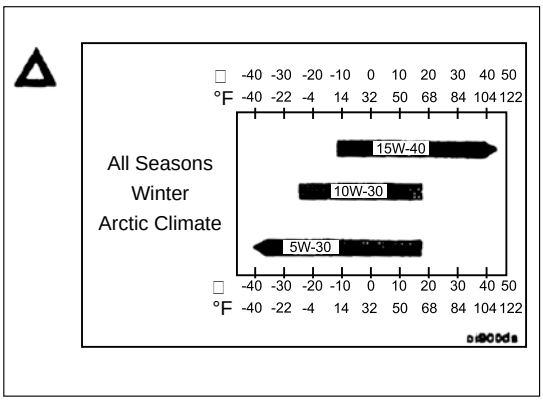
Enigne oil CE/SG/SF can be used where CF4 can not be found, but the the replacement period should be the half of that listed in the maintenance schedule table.

To control optimally the carbon deposit and oil consumption, it is recommended to use sulfate dust with 1.0 mass percentage. The sulfate dust can not excess 1.85 mass percentages.

Recommended Oil Viscosity

It is proven that multi-viscosity oil can improve oil consumption, engine starting performance at low temperature and lubrication performance at high temperature.

At general climate conditions, oil 15W-40 is recommended. The oil viscosity at extreme climate conditions is listed below:



Caution ⚠

Low viscosity oil, which is limited to be used, such as 10W-30, can help to start and supply sufficient oil flow at ambient temperature below 5℃[23° F]. However, continuous usage of low-viscosity oil will reduce engine life due to abration. Refer to annex.

Is your vehicle used on the highway?

Yes

Your vehicle is
- Short-distance tractor
- Motor Coach
- Accumulative total mileage 8,000mile/month or above

Yes

Replacement Period:

km	mile	hour	month
17,000	10,000	250	3

No

Oil draining period for your vehicle（1）：

Vehicle/Device	km	mile	hour	month
Refuse Collector	10,000	6,000	250	3
Mixer Truck/Dump Truck	10,000	6,000	250	3
Cargo Truck	10,000	6,000	250	6
Suburb/Coach	10,000	6,000	250	3
School Car	10,000	6,000	250	6
Fire-extinguishing Tanker	10,000	6,000	250	3
Vacation Car	10,000	6,000	250	6

(1) Or taking the prior. If the accumulated hour is more and less milage, the replacement periods is determined through hour.

Such as, the average speed of motor coach and refuse collector being run on the city road is 16 km (10 miles/hour), the oil draining period is 4,800km (3,000 miles) or less.

Is your vehicle used on the highway?

Yes

Oil draining period for your vehicle（1）：

Vehicle/Device	km	mile	hour	month
Truck Crane	10,000	6,000	250	3
Spot Truck	10,000	6,000	250	3
Paver	Missed	Missed	250	6
Crane	Missed	Missed	250	6
Excavator	Missed	Missed	250	6
Bulldozer	Missed	Missed	250	6
Road scraper	Missed	Missed	250	6
Logging Tractor	Missed	Misse	250	6

No

IIs your vehicle used forr aagriculture or powerr device?

Yes

Oil draining period for your vehicle（1）：

Vehicle/Device	Hour	Month
Agriculture Tractor	250	6
Combine Harvester	250	6
Irrigating Device	250	6
Generator Unit	250	6
Air Compressor	250	6
Fire Pump	250	6
Yacht	250	6
Working Plate	250	3

No

Replacement Peroid
km: 10,000
mile: 6,000
hour: 250
month: 3

Arctic Climate Work Conditions

Synthesized engine oil CC/CE with sufficient cryogenic nature, such as 50W-20 or 5W-30, should be used when engine coutinously works below- 23℃[-10° F] for long or no heat protection measures to stopped engine.

Oil supplier should meet the relative repqirement.

Caution ⚠

Synthesized-base oil is not proven that replacement period of oil can be prolonged. Replacement period of oil is determined by erode, deposit and abration.

For new or retreaded Cummins engine, it is not recommended to use special “run-in”engine oil. Use the same oil as general when running in engine.

Caution ⚠

All recommended oil for Cummins engine confines the sulfate dust of 1.85%. Oil with high sulfate dust will result in valve and/or piston damage and excessive oil consumption.

For CNG engine, the sulfate dust recommended should be of mass percentage 0.03 and 0.85. Cummins does not recommend using none-dust oil for CNG engine.

Recommended Coolant

Anti–freeze

Specification – Freezing point and boiling point protective measures should be adopted for concerning climate conditions with anti-freeze. Cummins recommends using ethylene glycol or acryl glycol with concentration of 50% (range: 40% to 60%) in general climate conditions. Antifreeze supplies max freezing point protection and the concentration never exceeds 68%, or protection efficiency will be reduced.

Ethylene glycol	Acryl glycol
40%=-23℃[-10° F]	40%=-21℃[-6° F]
50%=-37℃[-34° F]	50%=-33℃[-27° F]
60%=-54℃[-65° F]	60%=-49℃[-56° F]
68%=-71℃[-90° F]	68%=-63℃[-82° F]

Add Coolant Addtitive

Add coolant additive（SCA） - is recommended to be used for Cummins cooling system. For heavy-duty diesel engine, only coolant can not meet the requirements for anti-corrision.

SCA DCA4 is recommended to all Cummins engine. If other brand of SAC can supply with efficient engine protection, sealing and washer sealing, it can be used for preventing form corrosion or blockage. SAC concentration – The recommended concentration level of DCA4 is 1.5 units per 3.7 L [1American Gallon].The concentration level range is between 3.0 units per 3.7 L [1American Gallon] and 1.2 units per 3.7 L [1American Gallon].

DCA filter replacement period –Added coolant additive will be consumped gradually when engine works normally. Cummins recommends the replacement period at each 10,000 km [6,000mile], 250 hours or 3 months and replace a service coolant filter for the engine to keep concentration.

►Coolant Testing Package

DCA4concentration testing – As above described, the best way to obtain appropriate DCA centration level is to replace service coolant filter at each 10,000 km[6,000mile],250 hours or 3 months.

The band part No. CC2626 of Fleetguard DCA4 or Fleetguard monitor C part No. CC2700 should be used to test because:

- Add no processed synthetic coolant more than 5.7L [6American Quart] between two maintenance periods.
- Inter-cooling system troubleshooting (such as corrosion or sealing leakage).
- In some caravan, monitoring SCA level determines if the maintenance period is acceptable.

Caution ⚠

It is not recommended when to use additive or replace coolant filter determined by testing package. Other testing package (such as Fleetguard titration testing package part No.3300846-S or 3825379-S) is not allowed to be used for Cummins engine.

DCA4 Maintenance Directory

Maintenance Period		
		3 Months
Cooling System		250 Hours
Gross Capacity(L)		10,000 km
[American Gallon]	Initially Filling（B）	（6,000 mile）
30 to 57（6-12）	WF-2074	WF-2070

Note:

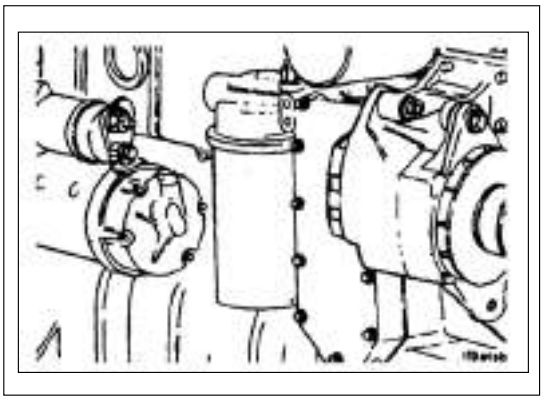
A: Refer to the maintenance instruction of vehicle manufacturer about the gross capacity of cooling system.

B: Assemble new coolant filter after draining and replacing coolant to meet the requirements of recommended DCA4 concentration.

C: Replace coolant filter in the stipulated period to protect cooling system.

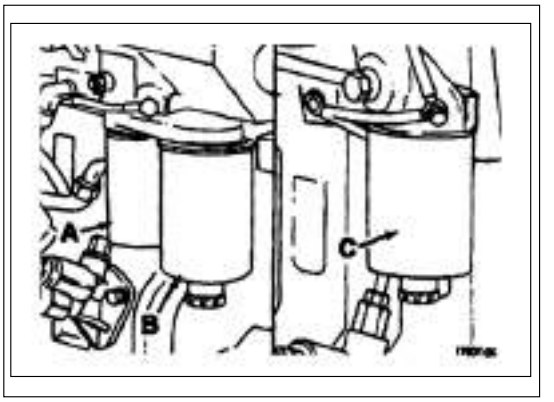
D: Check coolant additive frequently. Check the cooling system with Fleetguard ® part No. CC-2626 of DCA4 cooling system testing package.

Oil Filter Selection



►Oil Filter

For standard six-cylinder of LF300.



►Fuel Filter

A=The standard filter taking as the second filter when using two stage filter

B= The basic filter taking as fuel-water separator when using two stage filter

C= The basic filter taking as fuel-water separator when using single stage filter

Engine Part Torque Value

Socket or wrench dimension: mm		N•M	[inch-pound]
10	Secure rear supercharger cooler	24	[18]
8	Water hose clamp of rear supercharger cooler	5	[48inch-pound]
13	Alternator strut bar	24	[18]
13	Retaining bolt of alternator(10-15 51)	43	[32]
10	Alternator bracket (upper part)	24	[18]
13	Belt tightening pulley of bracket	43	[32]
5 Hexagon	Belt tightening pulley bracket to cylinder block	24	[18]
18	Damper	200	[148]
8	Elbow clamp	5	[48inch-pound]
15	Secure exhaust manifold passage	43	[32]
11	Exhaust air outlet pipe, V strip clamp	5	[48inch-pound]
10	Secure fan bracket	24	[18]
13	Fan spindle housing	43	[32]
16	Fan spindle housing(60mm bolt)	43	[32]
24	Auxiliary unit of flame initiation	40	[30]
19	Flywheel	140	[101]
18	Flywheel Housing	77	[57]
(1/2)	Drain plug of Flywheel Housing	43	[32]
--	Cover plate cap of front gearbox	Secure with hands.	
15	Front bracket of engine	112	[82]
17	Banjo fuel screw(on filter case)	24	[18]
10	Banjo bleed screw	9	[80inch-pound]
75-80	Fuel filter	3/4	Connect and rotate another 3/4.turn
19	Low-pressure supply pipe and returning pipe of injection pump	24	[18]
10	Low-pressure fuel returning pipe of filter case	9	[80inch-pound]
24	Adapter nut of fuel filter	32	[24]
17	Fuel pipe line adapter(high pressure)	30	[22]
30	Driving gear of fuel injection pump(P)	178	[122]
24	Lock the fuel injection pump	15	[11]
15	Retaining nut of fuel injection pump	43	[32]
10	Fuel injection pump to bracket	24	[18]
10	Bleed bolt of fuel injection pump(PES,MW)	5	[48inch-pound]
15	Fuel solenoid valve bracket	43	[32]

Engine Parts Torque Value(continuing)

Socket or wrench dimension: mm		Torque	
N•M	[inch-pound]		
15	Secure rear supercharger cooler	43	[32]
8	Water hose clamp of rear supercharger cooler	10	[84inch-pound]
10	Alternator strut bar	24	[18]
18	Retaining bolt of alternator(10-15 51)	77	[57]
10	Alternator bracket(upper)	24	[18]
10	Belt pulley of bracket	9	[80inch-pound]
10	Belt pulley to cylinder block	24	[18]
10	Damper	24	[18]
118-131	Elbow clamp	Connecting and secure	3/4 rotation
10	Secure exhaust manifold passage	24	[18]
17	Exhaust outlet passage, V strip clamp	80	[60]
17	Secure fan bracket	80	[60]
32	Fan spindle housing	80	[60]
32	Fan spindle housing(60 mm round bolt)	50	[37]
15	Auxiliary unit of flam initiation	77	[57]
13	Flywheel	43	[32]
15	Flywheel Housing	77	[57]
(3/4)	Drain Plug of Flywheel Housing	100	[74]
(15/16)	Cover plate cap of front gearbox	134	[100]
(11/16)	Secure front bracket of engine	85	[63]
14	Banjo fuel screw(on filter case)	24	[18]
15	Banjo bleed screw	77	[57]
10	Fuel filter	3	[24inch-pound]
10	Low-pressure supply pipe and returning pipe of injection pump	24	[18]
T-25 Torx	Low-pressure fuel returning pipe of filter case	5	[48inch-pound]
13	Adapter nut of fuel filter	11	[96inch-pound]
11	Fuel pipe line adapter(high pressure)	6	[50inch-pound]
15	Driving gear of fuel injection pump(P)	32	[24]
10	Lock the fuel injection pump	24	[18]
16	Retaining nut of fuel injection pump	15	[11]
8	Fuel injection pump to bracket	5	[48inch-pound]
(3/8)	Bleed bolt of fuel injection pump(PES,MW)	34	[25]
13	Fuel solenoid valve bracket	24	[18]
15	Fuel solenoid valve bracket	24	[18]
--	[32]	Secure with hands	

Lubricator Parts and Sealant–Engine Assembly

►Supply following sealants or with the same nature:

Description	Sealing
Tube Stopper	Teflon pre-sealing or passage sealant
Sealing Gasket	No need sealant
Cup plug	LoctiteTM277or Cummins sealant3375068
O-seal ring	No need sealant
Expansion plug of rear camshaft	LoctiteTM277or Cummins sealant3375068
Through the double end bolt of fuel pump	LoctiteTM242
Turbocharger(inside the cylinder block)	LoctiteTM277or Cummins sealant3375068
Fuel dipstick pipe(inside the cylinder block)	LoctiteTM277or Cummins sealant3375068
Wet flywheel housing to cylinder block	Thhree Bind sealant 3823494
Rear Sealing(rear cover plate)	No need sealant
Screw of timing pin	No need sealant
Side oil filling hole	LoctiteTM277or Cummins sealant3375068

►Supply following lubricants or with the same nature:

Parts	Lubricant
Connecting Bearing	Lubricate 105or oil 15W-40
Main Bearing	Lubricate 105 or oil 15W-40
Cam and journal of camshaft	Lubricate 105 or oil 15W-40
Tappet	Lubricate 105 or oil 15W-40
Piston	Engine Lubricant 15W-40
Piston Ring	Engine Lubricant15W-40
Piston Pin	Engine Lubricant15W-40
Rocket Arm Assembly	Engine Lubricant15W-40
Push Rod	Engine Lubricant 15W-40 +cupped Lubricate 105
O-seal ring of Cylinder Liner	Engine Lubricant 15W-40

►Bolt-below the head and upper the threads, such as:

Part	Lubricant
Main Bearing Bolt	Engine Oil 15W-40
Cylinder Head Bolt	Engine Oil 15W-40l
Connecting Rod Bolt	Engine Oil 15W-40
Retaining Bolt of Flywheel	Engine Oil 15W-40
Damper Bolt	Engine Oil 15W-40
All Other Bolts	Engine Oil 15 W-40 or Protective Lubricant
Valve Stem Sealing	Engine Oil 15W-40
Lubricant Pressure Regulator	Engine Oil 15W-40

Bolt Mark and Torque Value

Caution ⚠

Always replace with the bolt with the same dimension and strength as the replaced one.

The bolt and nut being used should be marked with grade identification of metric system on the screw head or on the surface of nut. The bolt with radial identification mark of American system on the head should be used.

The following example shows how to identify the screw:

Metric System-M8-01.25×25			American System[5/16×18×11-1/2]		
M8	1.25	25	5/16	18	1-1/2
Main thread diameter: mm	Thread Pitch: mm	Length: mm	Main thread diameter: inch	Thread number per inch	Length: inch

Caution ⚠

1.When the specific torque value can not be obtained,always obtain following torque value listed in the table.

2.Never use the torque value not listed to substitute the content or torque of this manual.

3.The torque value listed in the table is on the basis of the threads supplied with lubricant.

4.If F-P is less than10, transferring F-P value into inch-pound will result in better torque force when inch-pound wrench is used. For example: 6 F-P equals to 72 inch-pounds.

Retaining Bolt Mark and Torque Value: Metric System

►Commercial Steel Grade

	8.8	10.9	12.9
Retaining Screw Mark			
			

►Screw Body

Dimension	Torque				Torque				Torque			
Diameter	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
mm	N•M	F-P	N•M	F-P	N•M	F-P	N•M	F-P	N•M	F-P	N•M	F-P
6	9	7	7	5	12	9	7	5	12	9	7	5
7	14	10	11	8	18	13	11	8	23	18	11	8
8	25	18	18	13	32	23	18	13	40	29	18	13
10	40	30	30	2	60	45	30	22	70	50	30	22
12	70	56	55	40	105	77	55	40	125	95	55	40
14	115	85	90	66	160	118	90	66	195	145	90	66
16	180	133	140	103	240	177	140	103	290	210	140	103
18	230	170	180	133	320	236	180	133	400	290	180	133

3 WD615 Series Engine

WD615 Diesel Engine(EURO II) Performance and Technical Parameter

Table 1

Items	Items \ Model		WD615								
			58	**56**	**50**	**44**	**46**	**64A**	**61A**	**67A**	**68A**
1	IFN(GB/T6070.1),Kw/r/min		175/2200	193/2200	206/2200	35/2200	266/2200	175/2200	193/2200	206/2200	225/2200
2	Max Torque,Nm		1000	1100	1160	1250	1460	1000	1100	1160	1250
3	Max.Torque rpm		1100-1600	1100-1600	1100-1600	100-1600	1100-1600	1300-1600	1300-1600	1300-1600	1300-1600
4	Cylinder Number		6								
5	Mode		Four Stroke, Water Cooling, Inline, Direct Injection, Dry Cylinder Liner								
6	Bore/Stroke,mm		126/130								
7	Displacement，L		9.726								
8	Piston Mean Speed，m/s		9.53								
9	Compression Ratio		17:1								
10	Compression Pressure，kPa		> 2000								
11	Aspiration		Supercharging Intercooling								
12	Ignition Order		1-5-3-6-2-4								
13	Cooling Valve Clearance，mm		Intake 0.3 Exhaust0.4								
14	Valve Phase(Valve Clearance: Intake0.3/Exhaust0.4)		Intake Valve Opened BUDC340-390 Intake Valve Closed ABDC 610-670 Exhaust Valve Opened BBDC 760-810 Exhaust Valve Closed ATDC 260-340								
15	Thermostat Switch Temperature，℃		80or71								
16	Start		Electric Start								
17	Lubrication		Pressurized Lubrication								
18	Lubricant Oil Capacity,(Bottom)，L		23(Initially Filling 25)								
19	Cooling		Forced Circulation and Water-cooling,								
20	Oil Pressure，kPa		350-550								
21	Oil Pressure at Idle，kPa		≥100kPa								
22	Turbo Temperature,℃		≤ 550								
23	AllowedPitching	Front/Rear	Long-term10/10 Short-term 30/30								
24	Allowed Heeling	Side exhaust pipe, side of injection pump	Long-term 45/5 Short-term45/30								
25	Crankshaft Rotating Direction(view from the free end)		Clockwise								
26	Overall Dimension, mm	Length	1557	1542							
		Width	675								
		Height	965								

Fuel System Parts Table

Table 2

Diesel Engine Model	Injection Pump Model	Speed Governor Model	Injector Model	Fuel Pressure kPa	High-pressure Pipe			Supply Fuel Advance Angle
					Length	Outer Diameter	Bore	
WD61558	CB-BHM6P120YAY170 612600083097	CB-TJ300-1100PFM70	61560080305 KBEL132P110					9~10℃A
	BH6P120015 612600087097	TQ300/1100						
	BHT6P120R 612600081097	TRQV-K300-1100P						
WD61556	CB-BHM6P120YAY170 612600083097	CB-TJ300-1100PFM70	61560080305 KBEL132P110					9~10℃A
	BH6P120015 612600087097	TQ300/1100						
	BHT6P120R 612600081097	TRQV-K300-1100P						
	PE6P120A720RS7283-1 612600082082	RQV300-1100PA1061-2K	61560080305 KBEL132P110					
WD61550	PE6P120A720RS7283-1 61560080304	RQV300-1100PA1061-1K	61560080305 KBEL132P110					10~11℃A
	BHT6P120R 6150083304	RQV300-1100PA1061K	61560080305 KBEL132P110					
	CB-BHM6P120YAY170 612600083097	TRQV-K300-1100P	61560080305 KBEL132P110					9~10℃A
	BH6P120015 61560087304	CB-TJ300-1100PFM70						
WD61554	PE6P120A720RS7283 61560080282	TRQV-K300-1100P	61560080305 KBEL132P110					9~10℃A
WD61546	PE6P120A720RS7283 61560080282	CB-TJ300-1100PFM70						
WD61546A	BHT6P120R 612600081097	RQV300-1100PA1061-2K	61560080305 KBEL132P110					9~10℃A
	CB-BHM6P120YAY170 61200083097	RQV300-1100PA1061-1K	61560080305 KBEL132P110					10~11℃A
WD61561A	BHT6P120R 61200081082	TRQV-K300-1100P	61560080305					9~10℃A
	CB-BHM6P120YAY170 612600083082	CB-TJ300-1100PFM70						
WD61567A	PE6P120A720RS7283-1 6150080304	TQ300/1100						
WD61568A	PE6P120A720RS7283 6150080282	RQV300-1100PA1061-2K	61560080305					9~10℃A

Accessories Specifications

Table 3

Item	Accessory	Specification (Parameters) / Item \ Model	WD615								
			58	56	50	44	46	64A	61A	67A	68A
1	Diesel Filter	Model	Double Filter Element								
2	Water Pump	Type	Centrifugal(Integral Turbine Housing & Timing Gear Housing)								
		Nominal rpm，r/min	2585								
3	Oil Pump	Type	Gear (Single pump for general requirements, double pumps for special needs.)								
		Safe Valve Switch Pressure，kPa	1550±150								
4	Crankshaft Damper	Type	Silicon								
		Overall Dimension	Φ 280								
5	Supercharger	Model	K29、CJ90B、CT42、SJ90-2、S3A								
6	Oil Filter	Type	Threaded Paper Element, Parallel Dual Tube								
		Model									
7	Thermostat	Type	Wax, Element-Body Combination								
		Switch Temperature，℃	80±2								
		Full Open Temperature，℃	95								
8	Oil Cooler	Type	Plate-fin								
		By-pass Valve Switch Pressure，kPa	600±36								
		Pressure-resistant Test ，kPa	1500								
9	Starter	Type	DC Self-energizing Magnetic								
		Model	KB-24V 5.4kW								
		Power，kw	5.4								
		Voltage，V	24								
10	Generator	Type	Rectification, adjustable, and integral								
		Model									
		Power，Kw	1000 and 1540								
		Voltage，V	28								
11	Fan	Type	Reinforced Polyamide Integral and Silicon Oil Clutch								
		Outer Diameter，mm	570 620								
		Max Unbalance of Fan Blade, gcm	30								
12	Intercooler	Type	Flat Tube Corrugated Band, Air Cooling								
13	Clutch (Option)	Type	Spring Friction Disc, Dry								
		Model	GF420								

Item	Accessory	Specification (Parameters) Item / Model	WD615								
			58	56	50	44	46	64A	61A	67A	68A
14	Air Compressor	Type	Single Cylinder Piston, Water Cooling								
		Cylinder Bore，mm	90								
		Stroke，mm	46								
		Piston Displacement，cm2	293								
		Working Pressure，kPa	850								
		Max Pressure，kPa	1000								
		Comparing to Engine Speed	1.25								
		Lubrication	Pressure Lubrication								
		Working Mode	Continuously Working								
		Mass，kg	12								
15	Hydraulic Pump (Option)	750									
		Max rpm，r/min	3900								
		Min rpm，r/min									
		Max Pressure，kPa	13000±1000								
		Flow Rate(Swirling Direction)，I/min	16(Left)								
		Max Temperature ℃	100								
		Oil Inlet Thread	M26×1.5								
		Oil Outlet Thread	M18×1.5								
		Inlet Pipe Outer Diameter×Bore，mm	22×19								
		Outlet Pipe Outer Diameter×Bore，mm	15×12								

Fuel, Lubrication Oil, Coolant and Auxiliary Material

►Fuel:

Summer	Light Diesel No. 0	GB252
Winter	Diesel No -10	GB252

Diesel No. -20 should be used at temperature of -150C in winter, and No. -35 when temperature below -30℃.

►Lubrication Oil:

4.2.1 It is recommended to use CD oil for model above 300ps and CF-4 oil for option.

4.2.2 Higher grade oil is allowed to substitute the lower grade one.

4.2.3 CD5W/40 is used at ambient temperature above -15℃, 5W/20 for below-15℃.

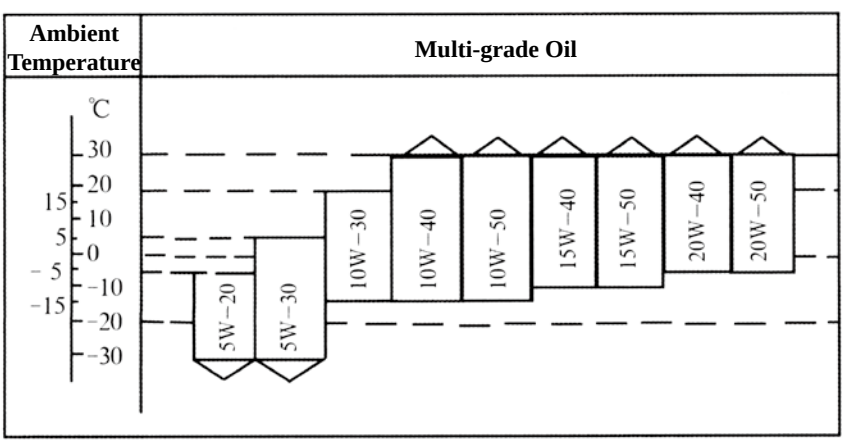
(Recommended Oil: Special Oil for Weichai Power)

Check the oil level in oil pan prior to engine starting.

Caution ⚠

1. Do not check oil level as engine running.
2. Do not mix oil with different grades.

Table 4 Oil Grades Selection



Multi-grade oil is recommended because of its good lubricity at high or low temperature. Viscosity curve of multi-grade oil is smooth.

►Grease:Fill common lithium-base grease complying with standard GB/T5671 into oil cap of water pump.

►Coolant:

Add long-term effect coolant into cooling system because of its antirust and antifreeze capability. Refer to antifreeze instruction for long term coolant proportion.

Table 5 Domestic Long-term Antifreeze

Item \ Brand	JF318	JFL-336	JFL-56
Glycol Content %	33	50	56
Specific Gravity(15.6℃)	1.05	1.074	1.082
Boiling Point ℃	104.5±1	108.5±1	110.0±1
Freezing Point ℃	-18±1	-36±1	-45±1
Choose appropriate min temperature	-10	-26	-35

Caution ⚠

1. Check antifreeze concentration regularly at temperature below 0℃.
2. For vehicle running perennially at temperature above 0℃: processed water for antirust and antifouling may be taking as coolant. Water not processed never used as coolant.

►Auxiliary Materials:

4.5.1 Parts using auxiliary materials is shown in below table:

Table 6 WD615 Series Auxiliary Materials

Item	Description	Color	Purpose and Application
1	Fine Molybdenum Powder	Black	Supply on smooth surface of metal to prevent from clogging. E.g. supply outer surface of cylinder liner.
2	Supramoly Oil	Dark Grey	Lubricating effects before lubrication pressure arose. E.g. Supply on intake valve stem.
3	Loctite242	Black	Supply on threads and bearing surface for avoid loosening, medium strength. E.g.:limit valve threads of main oil passage
4	Loctite262	Red	Supply on threads surface for locking, sealing and anti- vibration. E.g.:bolt threads of cylinder head
5	Loctite275	Green	Supply on the surfaces of pipe and joint for securing. E.g.:outer surfaces of water outlet pipe and water inlet of warm air
6	Loctite510	Red (Orange)	Supply on the smooth surface of metal for sealing. E.g.:Supply on the mating surface of cylinder block and crankshaft case.
7	Loctite277	Red	Supply oil channel or passage for the sealing between core and hole. E.g.:Cup Plug Mating Surface
8	Loctite648	Green	Supply on the smooth surface of metal for securing. E.g.:inner hole of tension pulley and outer surface of bearing.

Fit Clearance and Wear Limit of Diesel Engine Main Parts

Table 7 **Unit:mm**

Item	Description		Theory Value	Wear Limit
1	Main Bearing Clearance		0.095~0.163	0.17
2	Connecting Rod Bearing Clearance		0.059~0.127	0.16
3	Axial Clearance - Crankshaft		0.052~0.255	0.35
4	Clearance Between Big End Surface and Crankshaft		0.15~0.35	
5	Min Clearance of Piston Skirt at Cold State		0.143~0.182	0.35~0.4
6	Clearance between Small End Bush of Connecting Rod and Piston Pin		0.045~0.066	0.1
7	Clearance between of Piston Pin Seat and Piston Pin		0.003~0.013	
8	Piston Ring at Cold State	Top Compression Ring	0.4~0.6	1~1.2
	Open Clearance (Inside Special Die)	No.2 Compression Ring	0.25~0.4	1~1.2
		Oil Ring	0.35~0.55	1~1.2
9	Piston Ring at Cold State End Clearance	Top Compression Ring		
		No.2 Compression Ring	0.07~0.12	0.28
		Oil Ring	0.05~0.085	0.26
10	Clearance between Intake Valve Stem and Guide Hole		0.05~0.086	0.15
11	Clearance between Exhaust Valve Stem and Guide Pipe Hole		0.03~0.066	0.10
12	Concave Value of Valve Bottom in Cylinder Top Surface		1.2~1.4	1.8
13	Nozzle Height above Cylinder Top Surface		3.2~4	
14	Cylinder Liner Top Height above Cylinder Block		0.05~0.10	
15	Camshaft Axial Clearance		0.1~0.4	
16	Camshaft Bearing Clearance		0.04~0.12	
17	Clearance between Lifter and Lifter Hole		0.025~0.089	
18	Clearance between Cylinder Liner and Cylinder Block Hole		-0.01~0.033	
19	Clearance between Rocker Arms		0.04~0.119	
20	Plane Clearance between Piston Top and Cylinder Top surface		1.0	
21	Clearance between Intake/Exhaust Valve at Cold State		0.3/0.4	
22	Lateral Clearance of Gear		0.15~0.33	

Tightening Torques and Tightening Methods of Main Bolts & Nuts

Description		Tightening Torque(N•m)+ Returning Angle(0)	Allowed Repeating Using Times
Main Bearing Bolt	M18	250+ $\frac{25}{0}$ tightening order see figure 4	
Connecting Bolt	M14×1.5	120+(90°±5°) (Up to 170~250Nm at same time)	0
Cylinder Head		tightening order see figures 5 and 6	
Main Nut of Cylinder Head	M16	200 $\frac{10}{0}$+2×(90°±5°) (Up to 260~380 Nm at same time)	3
Sub-nut of Cylinder Head	M12	90 $\frac{10}{0}$ +2×(90°±5°) (Up to 120~160 Nm at same time)	2
Flywheel Bolt	M14×1.5	60 $\frac{10}{0}$ +2×(90°±5°) (Up to 230~280 Nm at same time)	2
Flywheel Housing Bolt	M12	40 $\frac{10}{0}$+2×(120°±5°) (Up to 110~140 Nm at same time)	2
Oil Pump idler shaft Bolt	M10	60 $\frac{\pm5}{0}$	
Gear Bolt of Camshaft	M8	32	
Timing Idler Shaft Bolt	M10	60^{+5} Nm+90° (Up to 100~125Nm at same time)	
Press Bolt of Crankshaft Belt	M10	60 $\frac{+5}{0}$	
Press Plate Nut of Injector	M8	25	
Press Bolt for Steel Plate Injector	M8	15	
Exhaust Pipe Bolt	M10	(50 $\frac{+5}{0}$)+2×(90°±5°)	
Rocker Arm Seat Bolt	M12	100 $\frac{10}{0}$	
Press Nut of Air Compressor Gear	M18×1.5	200	
Press Nut of Injection Pump Gear	M18×1.5	300	
Tightening Bolt of Tensioning Pulley	M16	195	
Tightening Bolt of Bearing Plate-Oil Pump Drive Bearing	M8	25	
Pulling Bolt – Angle Adjusting Plate	M12	130 $\frac{+20}{0}$	
	M14×1.5	300 $\frac{+20}{0}$	
Connecting Bolt-Elastic Connecting Fin of Shaft Coupling	M10	74	
	M12	110	

Note:

① Angle value is in the allowable tolerance range.

② Angle value means the re-turn angle as tightening torque up to standard.

③ The value before the angle means rotating times.

④ Strength grades for all bolts and nuts are stipulated respectively. The bolts or nuts of the same specifications within different strength grades should not be inter-substituted or replaced. Using times should not be extra the stipulation; otherwise, it will lead to serious results.

Following is tightening level:

►Tightening Order Requirements -Main Bearing Bolt

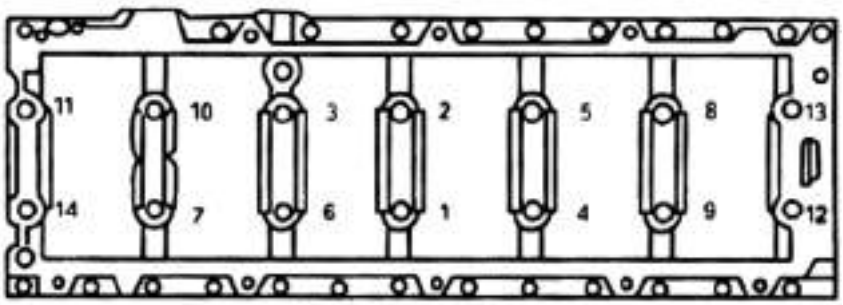


Fig.4 Tightening Order of Main Bearing Bolt

Tightening torque 50N•m firstly and then to 250 $^{+25}_{0}$ N•m following the order shown in figure.

►Tightening Order Requirement- Main Bolt and Nut of Cylinder Head

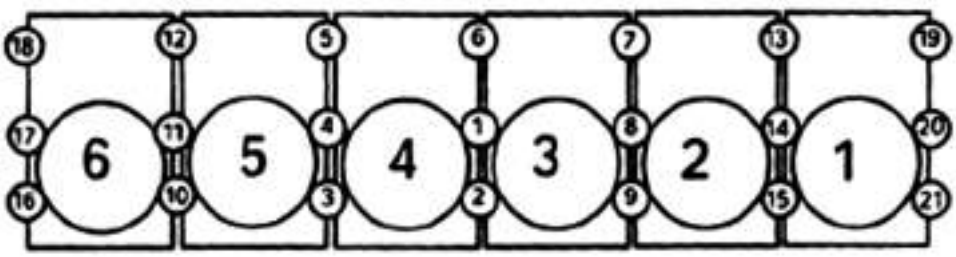


Fig.5 Sub-nut Tightening Order of Cylinder Head

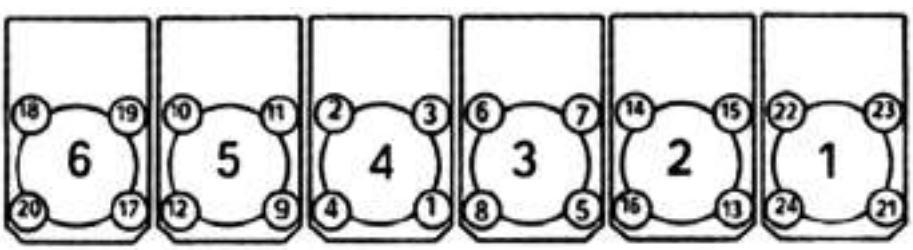


Fig. 6 Main Bolt Tightening Order of Cylinder Head

Tightening order is:

a. Lubricate the threads of main bolt, sub nut and pressed surface, then tighten to 30 $^{+20}_{0}$ N•m.
b. Tighten through bolt to 200+10 N•m in the order shown in fig.4;
c. Tighten sub nut in the order shown in fig.5, and then turn the bolts to 900;
d. Tighten through bolt in the order shown in fig.4, and then turn the nuts to 900;
e. Tighten sub nut in the order shown in fig.5, and then turn the bolts to 900;
f. Tighten through bolt in the order shown in fig.4, and then turn the bolts to 900;
g. Tighten sub nut in the order shown in fig.5, and then turn the bolts to 900;

WD615 Series Diesel Engine Structure and Replacement, Repair and Adjustment Methods

WD516 series diesel engines meet the power requirements of heavy-duty vehicle and multi-purpose requirements of construction equipments. Compact and rigid structure leads to good reliability, durability, capability and economy.

Structure:

a. One block for one head, work reliably, disassemble easily.
b. Left-sided injection pump (view from the free end) makes arrange in the vehicle easily.
c. Safe and reliable inner oil cooler.
d. Rear-mounted charger is compact and the dimensions of various models change little.
e. Six-inline-block is easily being fixed in vehicle.

►Cylinder Block, Crankshaft Case and Flywheel

Cylinder Block and Crankshaft Case:

It is made of high-strength gray pig iron. Being divided into two parts, the upper cylinder block is block and the lower is crankshaft case. Since there is no any gasket between block and crankshaft case, clean the mating faces and supply with sealant (Loctite510) before connecting. Secure 14 main bearing bolts of M18 with given tightening torque when connecting, and then 25 inner hexogen bolts of M8. The tightening methods should follow the requirements shown in table 8 and fig.4. The high rigidity improves reliability and durability of cylinder block.

Seven main bearings are of same width. Thrust washer is on both sides of the second bearing seat.

Transition fitting is between dry liner and block hole. Thin wall of 2mm is made of wear-proof high-boron or copper-boron casting iron. Specific tool should be used when measuring. Inner surface of the liner of special checkered plate is good for fast running-in and wearing resistance. Eliminate grease before assembling and supply a thin film of molybdenum powder. Press it in with hands or tools stably.

The front end of the block connects to the timing gear chamber, and the rear end to flywheel. The mating faces should be applied with sealant and the sealing ring should be made from high boron or copper-boron cast iron, with the wall thickness of 2mm,Inspection should be done with special measuring device. The off-the-shelf flat reticulate pattern is good to facilitate wear-in and wear resistance. Remove grease before

installation and apply a thin film of molybdenum powder. Press in a balancing way with hand or tools.

The front end of the block connects to the timing gear chamber, and the rear end to flywheel. The mating faces should be applied with sealant (Loctite510). There is a through main passage at the middle of right block. A sub oil passage (not through) at the middle of left block supplies oil to six injection nozzles to cool piston efficiently.

Front seven-passage bearing seat is located at right inside of machine body. There is a water chamber for assembling oil cooler at the right of machine body. Six passages inside lower chamber are inlets of cooling water flowing to water interlining of water cylinder barrel. The mating face at lower cylinder block(on crank case) for assembling oil filter should be supplied with sealant (Loctite510)before being secured with four M8 bolts.

The injection pump is assembled on the mating face in the middle of left machine body after assembling the bracket.

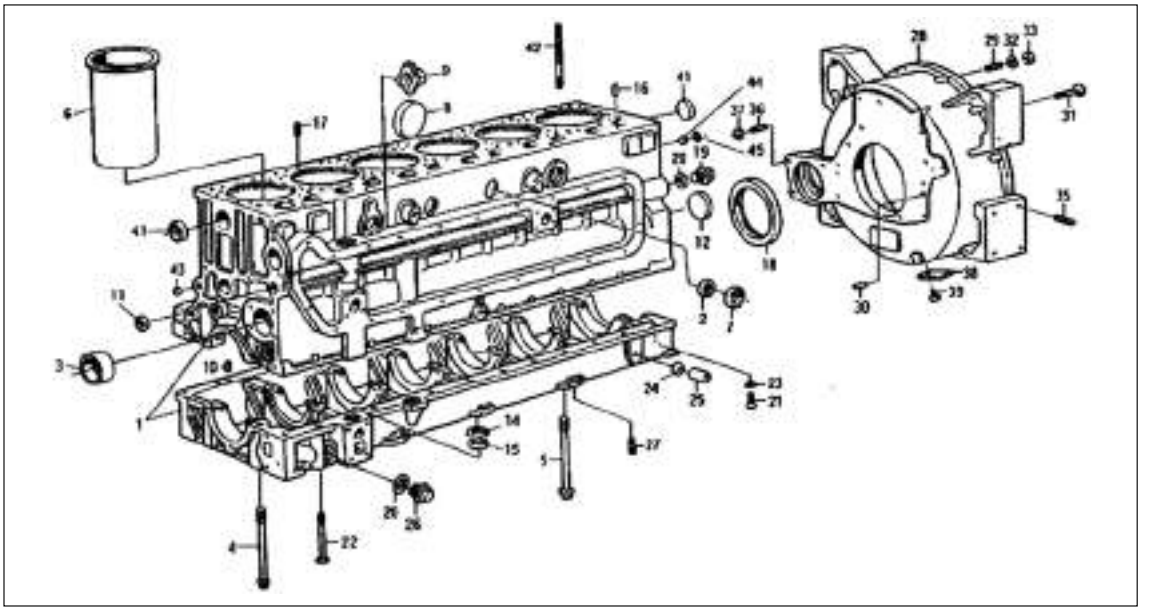


Fig. 7-1 Cylinder Block, Crankshaft Case and Flywheel Case

Main parts:

1.Crankshaft Case 2、7.Cup Plug 3.Camshaft Bush
4、5.Main Bearing Bolt 6.Cylinder Liner 8.Left Side Cup Plug
9. Breather Elbow 10. Cylindrical Pin 11.Cup Plug- Oil Passage
12. Rear End Cup Plug 14、15.Sealing Ring and Socket 16. Cylindrical Pin
17.Elastic Pin 18.Rear Bearing Seal 19、20. Threaded Plug and Washer
21、23.Hexogen Socket Double-ended Bolt, Screw, Washer
24、25. Cup Plug, Short Oil Return Pipe 26. Threaded Plug
27. Stub Bolt 28.Flywheel Housing 29、32、33.Stub bolt, Spring Washer. Hexogen Nut
30. Cylindrical Pin 31.Flywheel Bolt 35.Stub Bolt 36、37. Stub Bolt, Nut 38.Inspection Hole Cover
39.Hexogen Bolt 41. Cup Cover 42.Stub Bolt-Cylinder Head

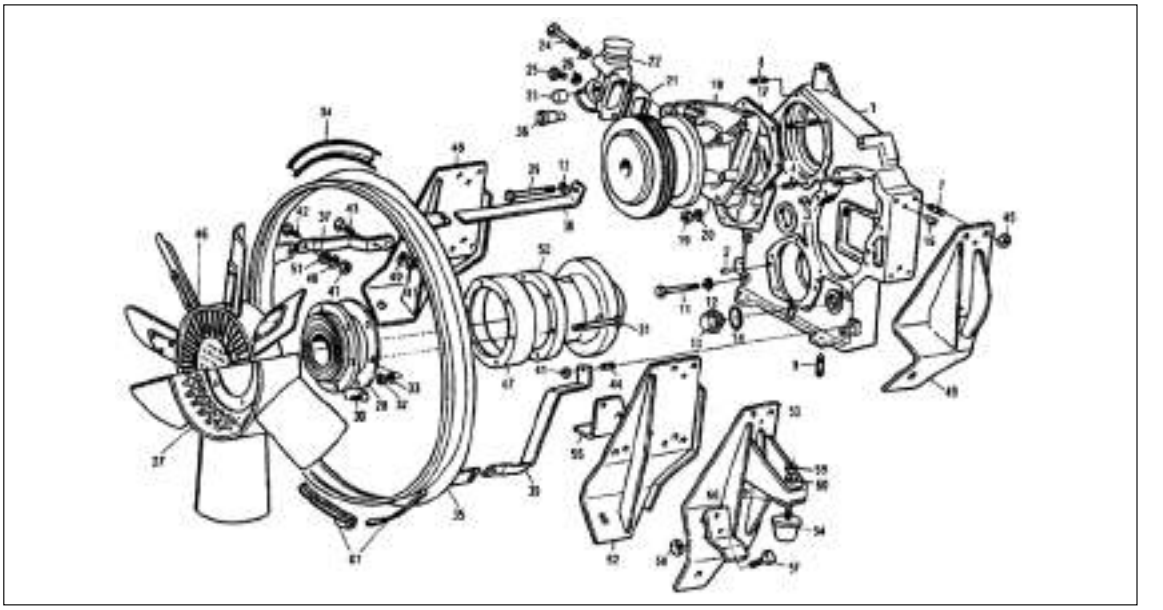


Fig. 7-2 Timing Gear Chamber Fan

Main Parts:

1.Timing Gear	18. Water Pump	22. Water Pipe Joint
27.Fan	28. Fan Hub Assembly	56、52.L/R Brockets

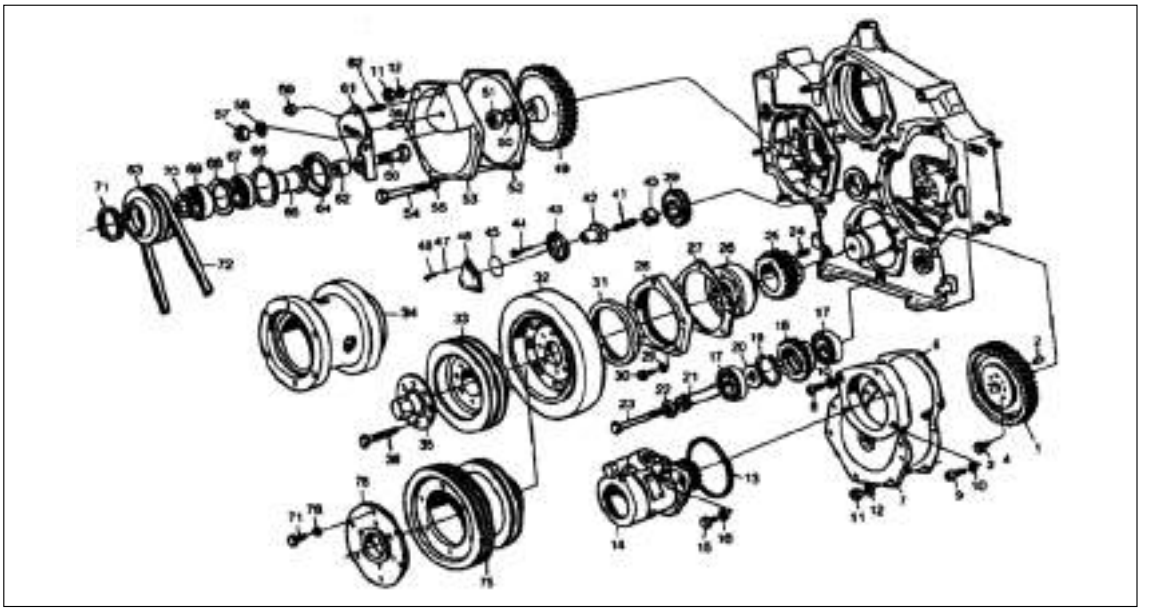


Fig. 7-3 Gear Train and Exterior Parts

Main Parts:

1.Camshaft Gear	7.Camshaft Gear Cover	14.Steering Hydraulic Pump	
18.Oil Pump Idler	25. Crankshaft Gear	28. Front Seal Seat	
31. Front Seal	32. Damper	39. Intermediate Gear	
49.Injection Pump Gear	42. Intermediate Gear Shaft	43. Stop Plate	63. Tensioner

Flywheel Housing:

The flywheel housing SAE1 and flywheel (effective gear diameter: 477mm) and the clutch friction disc diameter 420mm.

►Timing Gear Chamber

It is made of high-strength gray pig iron and the whole structure features with high strength and rigidity. Water pump is assembled the upper gear chamber. Volute housing and timing gear chamber are founded integrally. Water outlet is at the back of timing gear chamber facing to the inlet at the front end of the cylinder body. The front supporting flange is at the left and the right sides of diesel engine.

Air compressor is assembled at the left back of the timing gear chamber. There are two rolling bearings in driving shaft. The front bearing is at the timing gear chamber and the rear bearing is at the crankcase of the air compressor (see the air compressor structure for detail). Steering hydraulic pump is assembled at the camshaft cover of the right front the timing gear chamber shown in fig. 7-3.

►Gear Train

Gear Train and Outer Parts:

Refer to fig.7-3

Drive Gear:

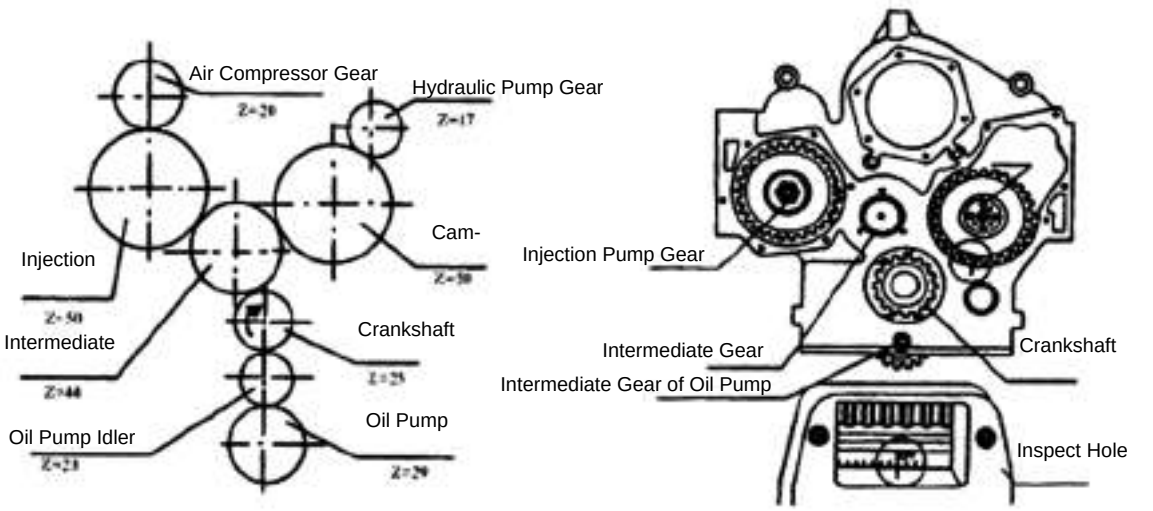


Fig. 7-4 Drive Gear

Drive gear train is composed of 8 gears in WD615 serial diesel engine. The tooth quantity is shown in fig. 7-4. The only one mark on cam gear is half tooth advance to the mark on timing gear chamber (the piston of the first cylinder should at the TDC, viz. flywheel scales 00) when assembling. Injection pump gear needs not align the mark. The advance angle can be adjusted through loosening the strain bolt on angle adjusting plate at the end of drive shaft. While adjusting, align the mark on the flywheel to be adjusted and loosen tensioning bolt to align the marks on the oil pump and connector or loosen the high-pressure oil pipe on the first cylinder pump, rotate camshaft of oil pump at the same rotating direction until oil just comes out from oil valve and stop and secure the strain bolt at torque 130N•m. Supply with Loctite sealant 242 at the threads of retaining bolts when assembling intermediate gear cover plate and secure the bolt at torque of 32N•m. The configuration is simpler than the conventional model. Air compressor gear is assembled on the crankshaft and the gear of steering hydraulic pump is assembled upper tilting camshaft gear.

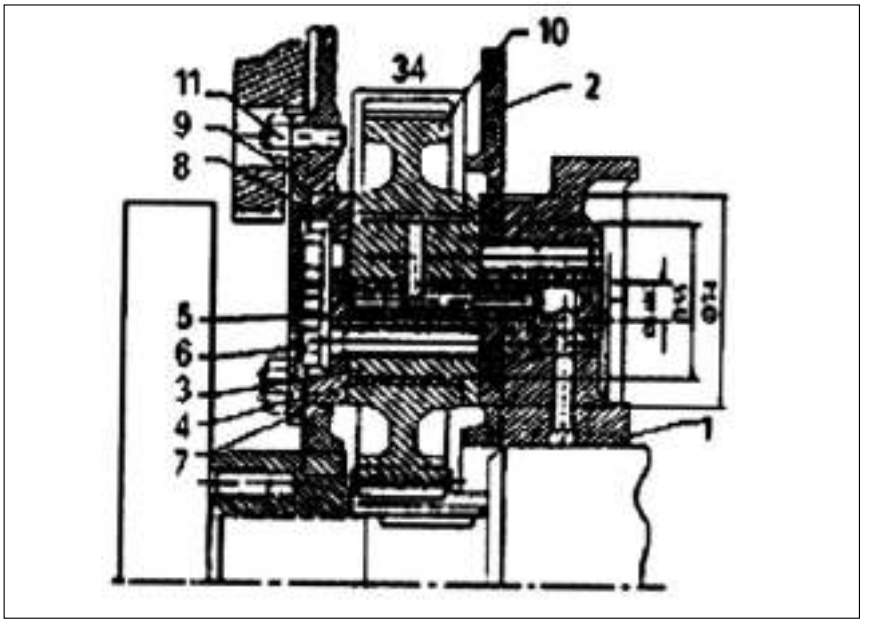


Fig. 7-5 Intermediate Timing Gear Structure

1. Cylinder Block	2. Timing Gear Chamber	3.Intermediate Gear Spindle	4.Bush
5.Spindle	6. Retaining Screw	7.“O”Ring	8. Stop Plate
9.Cover Plate	10.Timing Intermediate Gea	11.Stub Bolt, Hexagon Nut, Wave Spring Washer	

Slide bearing is used for intermediate gear. Slide bearing is composed of intermediate gear shaft 3, bush 4 and gear spindle 5. The function of the spindle is to lubricate the oil passage and position the intermediate gear spindle3. The intermediate gear spindle 3 is fixed on timing gear chamber 2 and cylinder block 1 by four retaining bolts 6 through the baffle 8.The support stiffness of the intermediate gear is increased greatly because of the large diameter of the intermediate gear spindle 3 and securing by four bolts. Since the slide bearing keeps the radial clearance of timing intermediate gear within a small range, the meshing accuracy of the gears is guaranteed and failure frequency reduces, and it increases the service life of timing intermediate gear.

The timing gear chamber is sealed with cover plate 9 and O ring 7 at the intermediate gear.

►Main Moving Parts

Crankshaft:

WD615 diesel crankshaft is of steel die forging. Crankshaft material is selected from two kinds of material according to the strength requirements: superior steel of 45# is used for the model of rated power below 220kW and steel of 42CrNo for that of upper 220kW. There are 12 balance pieces in the crankshaft. The main journals of crankshaft and connecting rod are Φ100 and Φ82 respectively and with the same width of 45MM. The crankshaft is processed by soft nitride that leads to good fatigue strength and resistance to wear.

A flange on the front end of crankshaft is shown in fig. 7-6 -2. The top circle of the flange is a sealing face of crankshaft seal. Eight flange M10 bolts connects to damper and belt pulley. Crankshaft gear should be heated up to 1800C and then put into crankshaft. The flange should be heated up to 2900C and then put into crankshaft.

The front seal of the crankshaft is assembled with frame rubber seal 95×115×12 and the rear seal is frame rubber seal 115×140×12.

Crankshaft Damper:

Silicon damper with diameter Φ280mm is of good performance and effect.

Flywheel:

The gear rim tooth number is 159 of SAE1 flywheel and the matched clutch friction disc diameter is Φ420mm. Note: The fit between SAE1 flywheel and gear rim is of loose fit.

Piston:

The piston is made of casting bridle aluminum alloy. The insert circle made of casting iron of top compression ring is adopted. The ring should be well felted ensuring efficient adhere strength and heat transfer. Two compression rings and one oil ring are in the piston. The first ring is a double-faced trapezoid barrel ring with upper notching. The working face is sprayed with molybdenum good for broom-finish and wearing resistance. The second ring is of chromeplated conical ring and the third one is of casting iron expander ring and the double edges are chromeplated. The diameter of piston pin is Φ50mm and a pressure relief groove on the piston pin base is used for improving the stress distribution. The piston skirt with complicated contour ensures that piston connects with cylinder liner well. Graphite of 0.01mm thickness plated on the skirt surface will be good for damping.
The "ω"combustion capacities and skirt sizes of different models are different. The clearance when piston is inserted into the cylinder is 1mm. The injection hole size of the nozzle varies with diesel requirements. The mass difference of the same group piston is within 10g.

Piston Pin:

The diameter of the pin is about ω50mm. The outer surface with hardness of 57~65HRC is processed through carbon quenching.

Connecting Rod:

Connecting rod is made through die forging. The big end with bevel angle of 450 is located with zigzag gear of 600 and connected by two bolts M14×1.5. The tightening torque of connecting bolt should meet the stipulation (refer to tables 8-9). The performance grade of connecting rod is 12.9 and the material of the rod is 42CrMo. Tighten the turn angle of the connecting rod bolt and take actions to prevent loosening.

Caution ⚠

The connecting rod can only be used only once or bolt is broken to damage the engine.

The bush of small end is made of steel backed copper-lead alloy with thickness of 2.5mm and the lubricating groove is in the shape of T with big bearing surface. The mass difference is stipulated within 29g.

Connecting Rod Bearing Shell:

The steel backed bearing shell with variant thickness is plated with ternary alloy. For the model of power above 220kW, the groove shell structure is adopted in the connecting shell. The advantage of this structure is higher bearing capacity and fatigue resistance comparing with the ternary alloy shell.

Main Bearing Shell:

The steel backed bearing shell with equal thickness is made of high-tin aluminium alloy. Seven main bearing shells are of same width and are universal.

Thrust Washer:

The steel backed low-tin alluniumium alloy is used.

►Cylinder Head and Valve Train

Cylinder Head:

It is made of alloy cast iron, one cylinder matches one head. An intake valve and an exhaust valve are on one cylinder head and the intake/exhaust passages are arranged both sides. Swirling flow in the intake passage is arisen according to the requirement of direct-injection combustion system. Cylinder head adopting the structure of injector inserted in copper bush is good to improve the radiation and the reliability of injection nozzle. After flowing into the cylinder head, cool water passes through the heat area of the cylinder nose and then the copper sleeve of the injector and finally the water outlet pipe. The reliable arrangement of cooling passages can bear cold and hot impacting. The gross height of the cylinder head is 125mm and is good to prevent from the heating area cracking. The valve which is inserted in the intake/exhaust valves of cylinder head are made of special casting iron. The intake-valve seat surface angle is 1100 and the exhaust-valve seat surface angle is 900 . Sink should not excess 1.8mm (the structure is shown in fig. 7-7).

An oil sealing is assembled upper the valve guide to prevent oil from flowing into intake passage through valve guide clearance.

There are four M16 through bolts on each cylinder head, six stub bolts shared with adjacent cylinder. The sub-nut is of suspending compact leap at both ends through pressing the V shape surface. The through bolts and the sub-nut are secured through rotating (refer to table 8).

Injector is assembled on the left cylinder head (intake side), the angle to the bottom of cylinder head is 750 and the top of injection nozzle is about 3.2~4.0mm above the cylinder head surface after installation.

Valve:

Intake valve is welded with two materials of high heat resistance and the valve stem is plated with chromium.

Exhaust valve is welded with two materials of high heat resistance and the valve stem is plated with chromium.

Valve Train:

The camshaft is made of high-carbon steel and seven bearings. High rigidity and sufficient lubrication of valve train is the result of even bearings and integral rocker arm shaft seat. Oil is leaded into the bevel hole in the valve lifter from main journal. When the groove on the valve lift working surface contacts with the oil hole, oil flows to rocker arm bearing from the central hole in the valve lifter through hollow rod and hollow rocker arm screw. In addition, part oil flows into rocker head through the top groove.

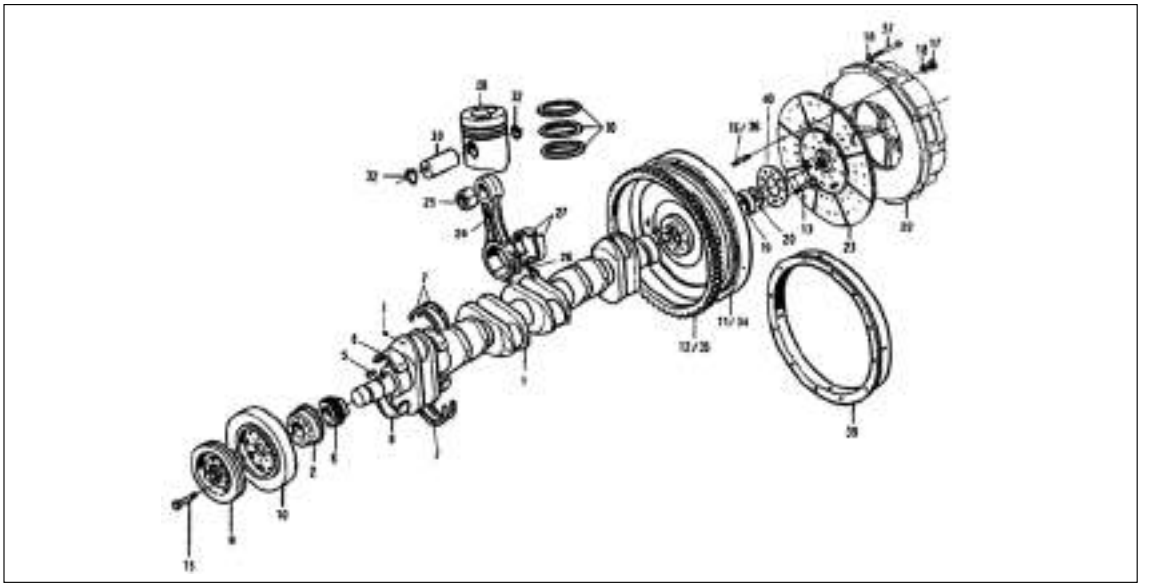


Fig. 7-6 Main Moving Parts

Main parts:

1.Crankshaft	2. Flange	3、4. Cylindrical Pin	5.Plain Key
6.Crankshaft Gear	7. Thrust Washer	8. Main Bearing Shell	9. Pulley
10.Damper	11、34.Flywheel	12、35.Gear Ring	13.Flywheel Bolt
15.Hexagon Bolt	16. Stub Bolt	19. Rolling Bearing	
20. Elastic Retainer Ring for Hole		24. Connecting Rod	25. Connecting Rod Bush
26. Connecting Rod Bolt	27. Connecting Rod Shell		28. Piston 30. Piston Ring
33. Piston Pin	39. Intermediate Flange		

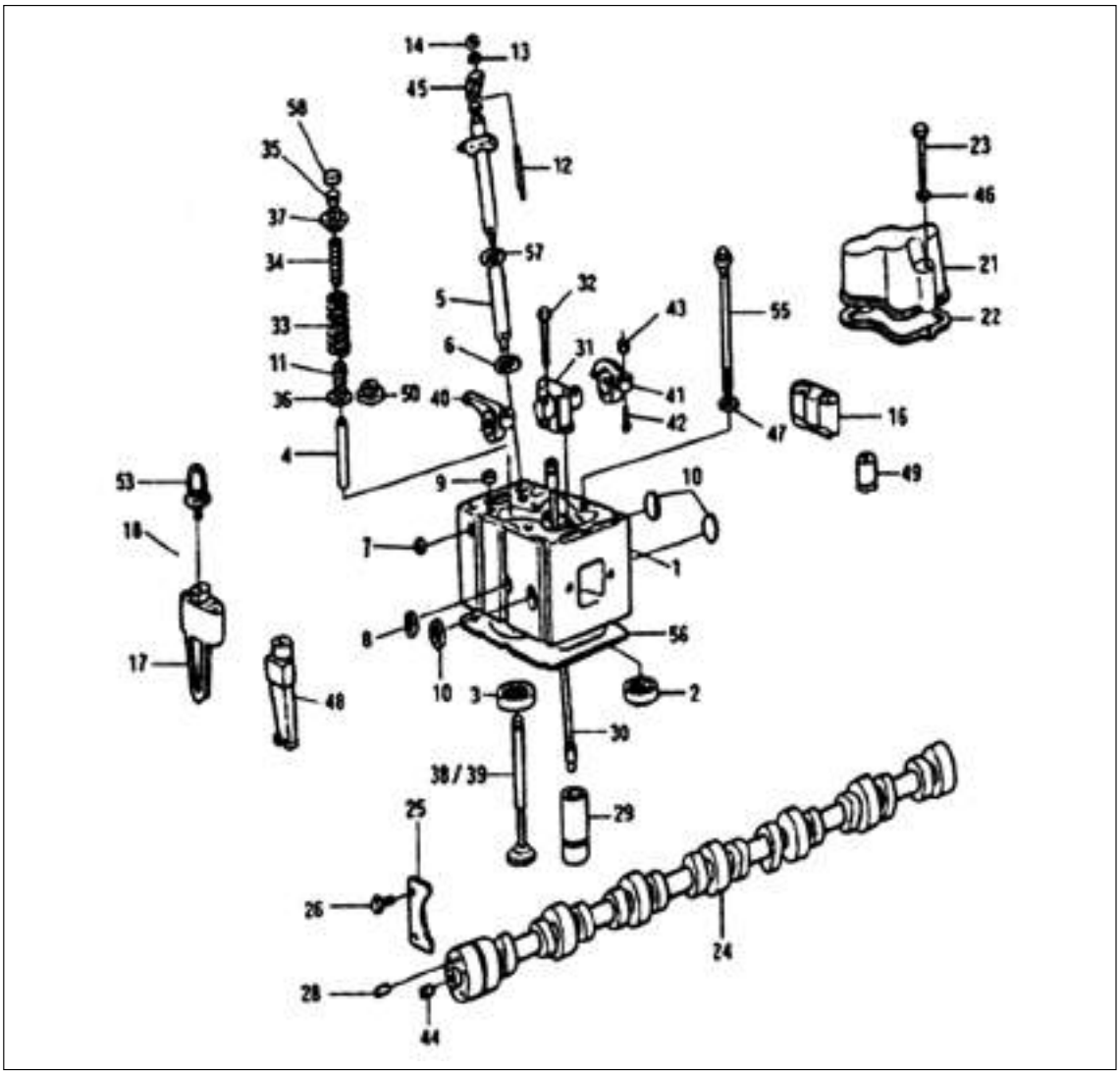


Fig. 7-7 Cylinder Head and Valve Train

Main parts:

1.Clinder Head	2. Exhaust Valve Seat	3. Intake Valve Seat 4.Valve Guide
5. Bronze Bush of Injector	6. Sealing Ring	7、8、9、10.Cup Plug
11. Seal Ring-Valve Stem	12. Stub Bolt	13、14.Washer, Nut
16.Press Pulley	17.Lift Ring Clamp Block	18. Washer
21、22.Cylinder Head Cover and Gasket		23、46.Bolt and Washer
24.Camshaft	25. Camshaft Thrust Washer	26.Bolt
28. Cylindrical Pin	29. Valve Lifter	30.Valve Push Rod
31.Rocker Arm Seat	32.Bolt	33. Outer Valve Spring
34.Inner Valve Spring	35.Valve Collet	36. Lower Spring Seat of Intake Valve
50. Lower Spring Seat of Exhaust Valve		37.Upper Valve Spring Seat
38、39.Intake/Exhaust Valve	40、41. Intake/Exhaust Valve Rocker	49. Clamp Block
53. Lift Ring Bolt	56.Cylinder Block Gasket	57. Injector Body Sealing Ring

WD615 Diesel Valve Clearance: Intake Valve (Cold State) 0.3mm
Exhaust Valve (Cold State) 0.4mm
Valve Clearance Adjustment is shown in Figs. 7-8 and 7-9.

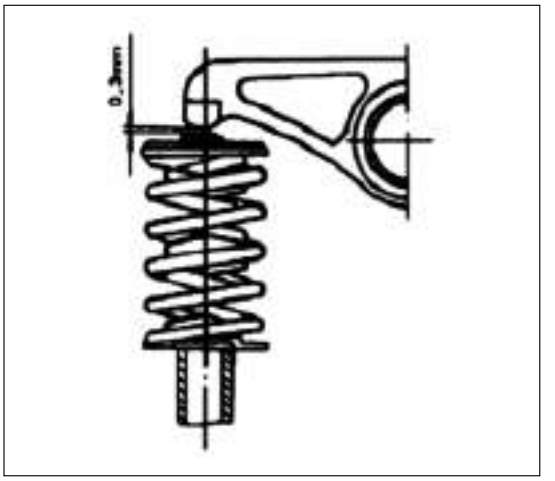


Fig. 7-8 Intake Valve(Cold State)0.3mm

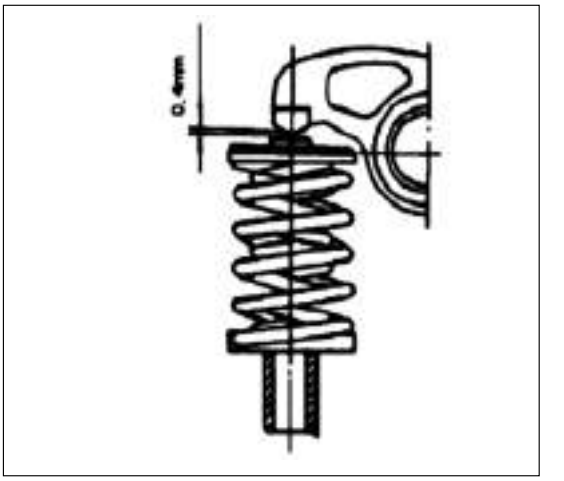


Fig.7-9 Exhaust Valve(Cold State)0.4mm

Valve Phase (Valve Clearance: Intake 0.3mm / Exhaust 0.4mm)

Intake Valve ON:Advance TDC Crankshaft Turning Angle: 34~390
Intake Valve OFF:Advance BDC Crankshaft Turning Angle: 61~670
Exhaust Valve ON:BDC Advance Crankshaft Turning Angle: 76~810
Exhaust Valve OFF:TDC Advance Crankshaft Turning Angle: 26~340

Measure valve clearance at the clearance between surface R on valve rocker and valve stem end or valve stem cap through adjusting adjustment bolt of rocker arm.

Check valve clearance after disassembling or up the second-grade maintenance. The valve should be off completely when checking. There are two ways to check the valve clearance: one is to rotate crankshaft following the engine ignition order (1-5-3-6-2-4) to locate this cylinder block at the TDC. The intake and exhaust valves are all closed. Adjust valves clearances and then rotate crankshaft by 7200; the other is to rotate crankshaft by 3600 and the first piston being at TDC, adjust the intake and exhaust valves clearances and adjust the second intake, the third exhaust, the fourth intake and the fifth exhaust clearances at the same time, and then rotate the crankshaft to the TDC of the sixth cylinder. Adjust the intake/exhaust valves clearances, the second exhaust, the third exhaust, the fourth exhaust and the fifth intake valves clearances.

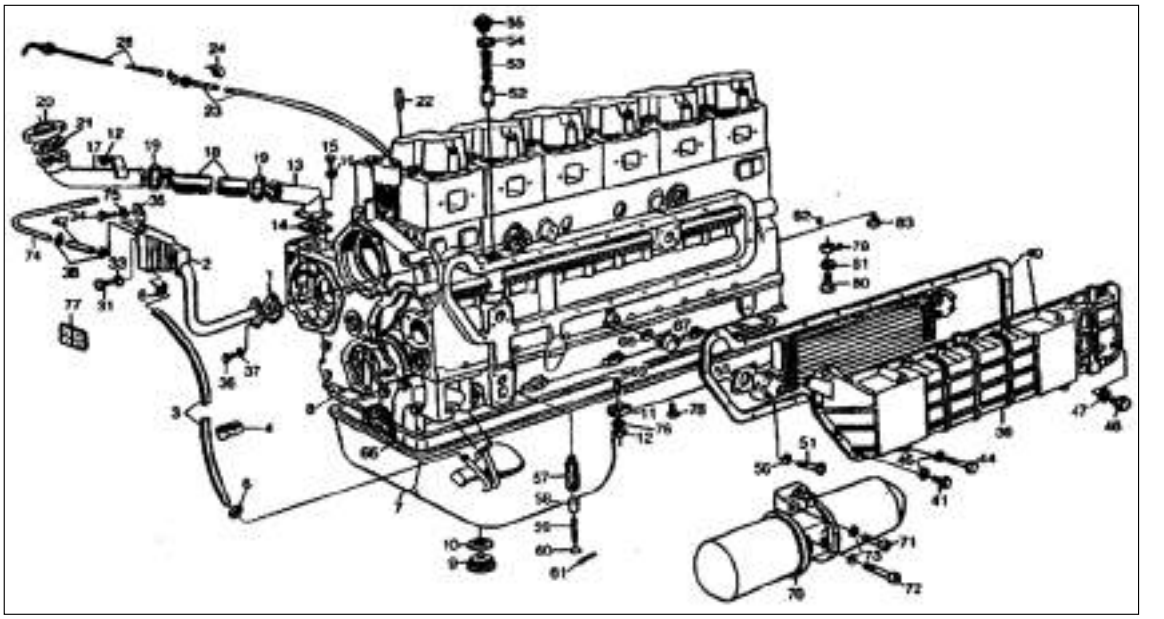


Fig.7-10a Lubrication System and Parts

Main Parts:

1、2.Oil-vapor separator	3. Rubber Pipe	7. Sump
8.Oil Sump Gasket	9.Magnetic Threaded Plug	11. Oil Sump Block
13、14. Fill Pipe, Washer	23.Dipsitck Tube	28. Dipstick
39、40. Oil Cooler Cover, Washer	48、49.Oil Cooler , Washer	
52、53、54、55.Safe Valve of Oil Cooler		
57、58、59、60、61. Pressure Limit Valve of Main Oil Passage		
66. Oil Pump	67. Pressure Sensor	70.Oil Filter
79、80、81. Oil Injector Nozzle, Washer and Hollow Bolt		

►Lubrication System

The lubrication system is used for wear reduction, cleaning, cooling and anti-rusting. Oil selection should follow company instruction. Multi-grade oil is preferential to use because it is good for cold starting performance. General multi-grade oil such as 5W30, 10W40 and 15W40 can only be used at the given temperature range. Preheat oil at the temporary cold condition or replace appropriate grade fitting for the environment temperature.

Oil replacement period depends on maintenance requirements.

Caution ⚠

Replace oil filter once replace oil.

Pressure Lubrication:

Oil is sucked by oil pump from the sump through the strainer and pressed into oil filter and oil cooler to lubricated position through oil passage system. Majority of oil volume flows to main bearing and consequently into the oil hole on the crankshaft and finally to connecting rod bearing. Cylinder liner

surface and piston pin are pressure lubricated through the nozzle. Valve control system, charger, high-pressure oil pump, air compressor and intermediate gear bearing are pressure lubricated through oil pipe and oil groove. Piston bottom is cooled through nozzle injection. Oil is lubricated by cool water through oil cooler. Oil pressure of oil circulation system is adjusted by pressure limit valve (refer to fig. 7-10a and b).

Oil pressure will increase suddenly due to low oil temperature and high viscosity while diesel engine starting. With water and oil temperatures increasing, oil pressure decreases gradually. Normal oil pressure is 350~550kPa when engine is fully loaded and water temperature is 80-950C.

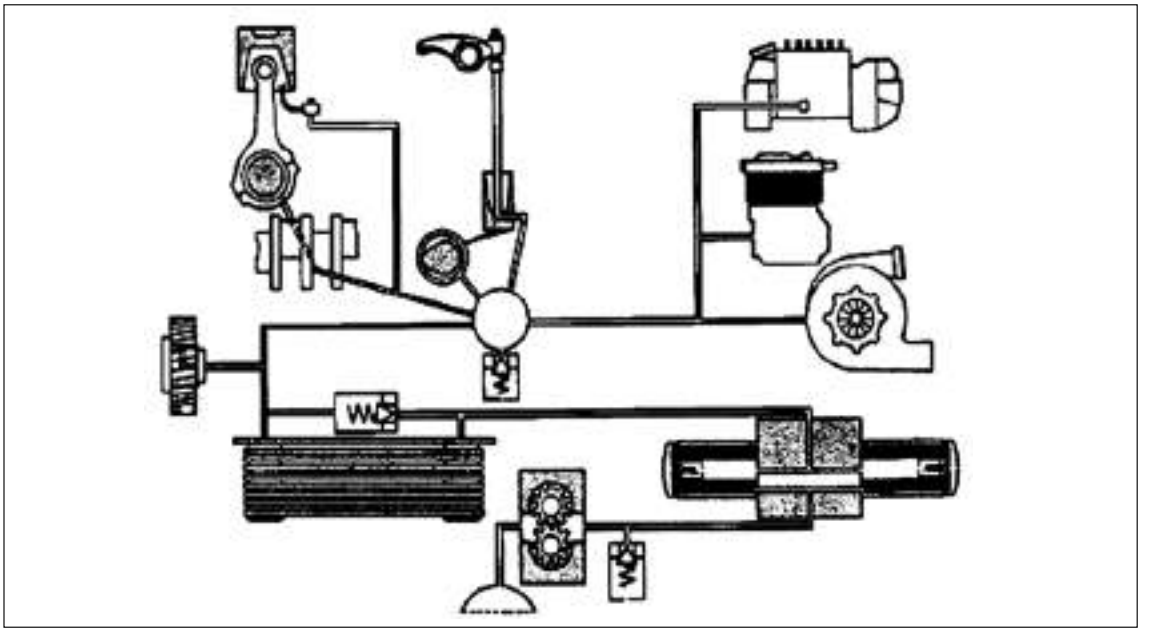


Fig. 7-10b Oil Circulation Diagram of Lubrication System

Sump:

It is formed with thin steel plat. The joint part is of a deep flanging with high rigidity. Concaved sump gasket is used. The mating face is pressed by 12 sump hold blocks and M8 bolts to prevent from fuel leakage.

Oil Cooler:

A safe valve (bypass valve) is put in the circuit of oil cooler to prevent from cooler blockage or engine damage due to high viscosity and cooler drag when engine starts in winter and resulting in fuel shortage. The opening pressure is 600±36kPa.

Pressure Limit Valve of Main Oil Passage:

It is located at the lower right of crankcase and the inner channel of the sump. The opening pressure is 500±50kPa. It is adjusted before assembling and need not to adjust by the user.

Oil Filter:

Two random spiral elements are adopted for easy maintenance and replacement.

Oil Pump:

Oil pump is of gear pump with 10 teeth and thickness 45mm or 48mm. The double-stage pump is used in high road 4-wheel drive vehicle and other vehicle is using the single pump.

►Fuel Supply System

Fuel supply system is shown in fig.7-11.

Fuel is sucked by fuel supply pump through pre-strainer from fuel tank and flows to high-pressure fuel pump and then to nozzle through high-pressure pipe.

Extra fuel returns to fuel tank through returning tank and overflow pipe.

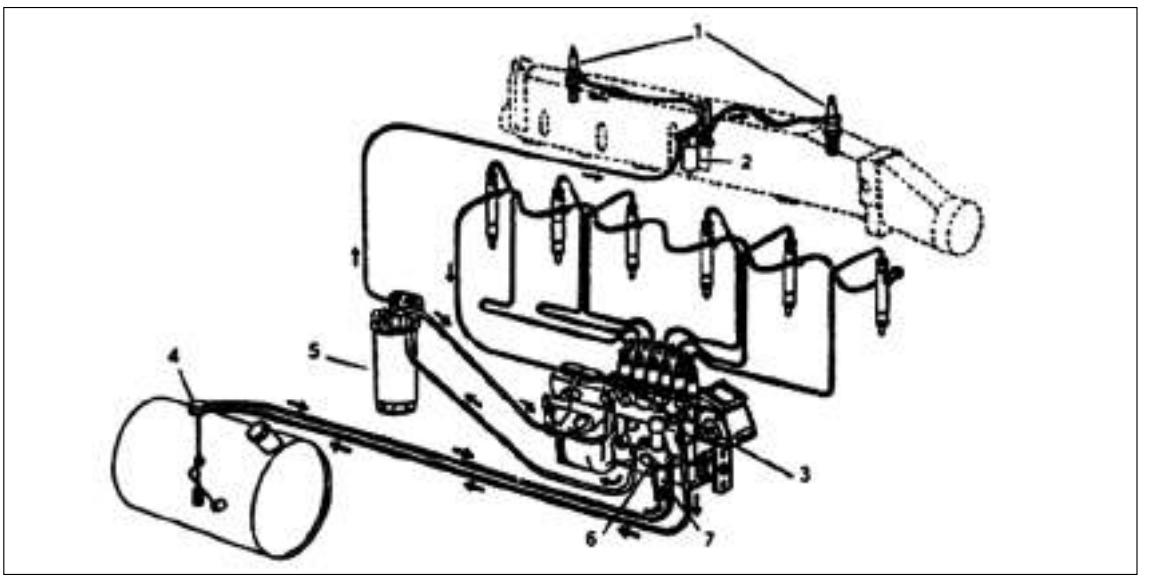


Fig.7-11 Fuel Circulation Diagram of Supply System

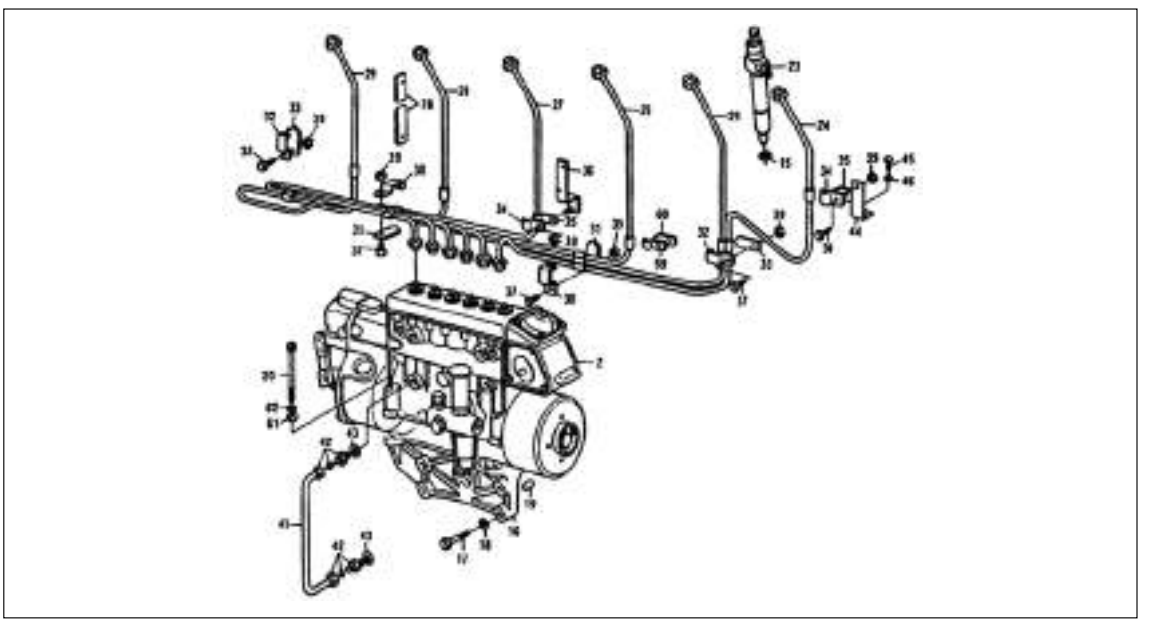


Fig. 7-12 Injection Pump, Injector Assembly and High-pressure Oil Pipe

Main Parts:

2. Injection Pump	16. Oil Pump Bracket	23.Injector Assembly
24、25、26、27、28、29.High-pressure Oil Pipe	41.Returning Oil Pipe	

►Injection pump

Among WD615 EURO II series diesel engines, all select inline P fuel injection pump. Governor is BQV-K full speed governor.

With regard to model of fuel injection pump, please see table 2 of the manual.

On fuel injection pump of supercharged engine, there equipped smoke limiter. The smoke limiter is used to improve low speed of exhaust turbo at low speed, low outlet pressure of compressor. The smoke limiter is also used to reduce smoke that is caused by reducing intake and resulting bad burn. Boost compensator induces pressure in intake pipe through air pipe. Accordingly, oil feed volume is limited. Hence, smoke of diesel engine is not too large at low speed. When diesel engine left the company, adjust is finished. Please do not adjust or change it.

Adjust of advance angle for diesel engine that is equipped with P7100 oil pump.

Oil cut-off method:

1. Adjust of advance angle

Turing first, with first cylinder of the engine be on top dead center. Then, rotate crankshaft anticlockwise (facing free end) about 400CA. Undo high-pressure oil pipe that is on fuel injector of first cylinder, then push throttle handle to maximum oil position. Use your hand to press hand oil pump, at the same time, turning clockwise (facing free end) slowly, until diesel oil at high-pressure pipe drops one time per second. Loosen the bolt of angle adjusting plate. Turning again, with scale value of flywheel (needed to adjust) align to match mark of flywheel housing. Then, tighten the bolt of angle adjusting plate.

2. Feature of advance angle:

Use said method to adjust until diesel oil at high-pressure pipe drops one time per second. At this time, observe that if scale value of flywheel is required value. If not, continue to adjust according to step 1, until it is required value. Then tighten high-pressure oil pipe of first cylinder.

Fuel injector assembly:

Adopts P porous fuel injector assembly, opening pressure is 30Mpa.

►Cooling system

The function of cooling system is to ensure that the engine can continue to work under suitable temperature. Forced circulation cooling provided best guarantee for arriving operating temperature quickly. Cooling system of WD615 diesel engine is as figure 7-13.

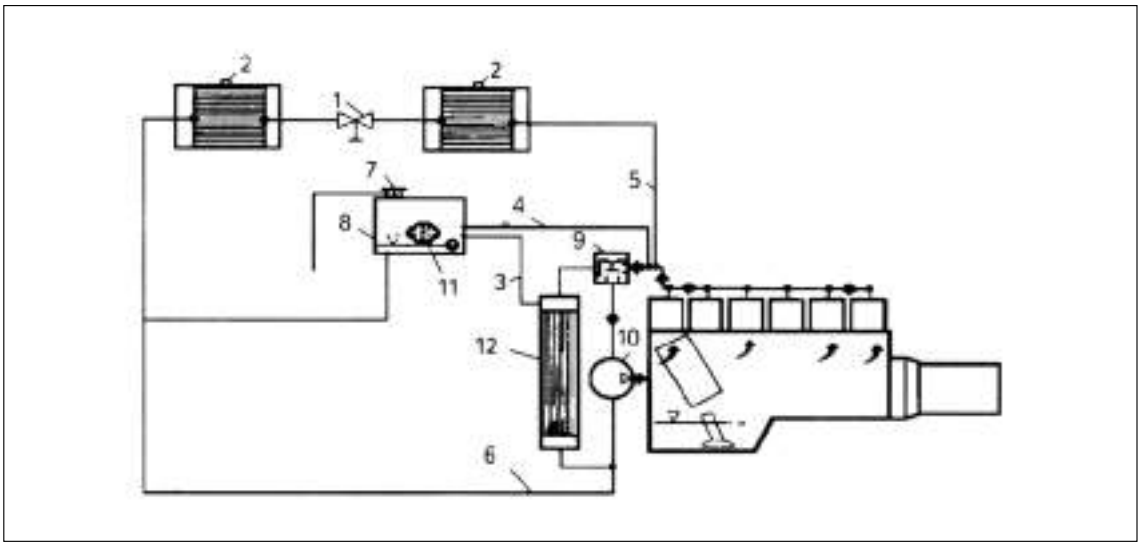


Figure 7-13 coolant circle diagram of cooling system

Main Parts:

1. Switch	2. Air heater	3. Outlet pipe of water tank
4. Intake pipe of expansion water tank	5.Intake pipe of air heater	
7. Pressure limiting valve cover	8. Expansion water tank	9. Thermostat
10. Water pump	11. Water filler cover	12. Water tank

Water pump:

On WD615 series diesel engine, water pump is installed on front end of diesel engine. Spiral casing of water pump is on upper side of timing gear case, and is integral with it. Outlet of spiral casing comes into water chamber at right side directly. Coolant flows from right lower passage hole of engine body into water layer of cylinder barrel across oil cooler. After cooling cylinder barrel, coolant comes into water cavity of cylinder head through upper water hole. After cooling cylinder head, coolant comes into outlet pipe through outlet of cylinder. At the end of outlet pipe, there is thermostat. Thermostat has two exits: one leads to water tank; the other leads to inlet of water pump, viz. small cycle. When coolant temperature is 80±20C, thermostat begins to turn on; When temperature is 950C, thermostat turns on fully. At this time, after cooled by radiator, all coolant will go into engine body from water pump. When coolant temperature is below 80±20C, thermostat will cut off said passage. Coolant comes into inlet of water pump directly, to make diesel engine warm up quickly, thus to arrive required hot condition, avoid low temperature wear, prolong lifetime of diesel engine.

In oil cavity of water pump, there is about 120em3 universal Lithium base grease. You should fill the grease periodically.

Expansion water tank:

This part is equipped by automobile manufacture. Diesel engine will not be equipped this part when leaving the company. The function of expansion water tank is to get rid of low-pressure vapor of cooling system and avoid vapor lock. In addition, by use of expansion water tank, it is unnecessary add coolant.

Pressure in expansion water tank should be kept at 50 kPa. Position of expansion water tank should be 400 mm higher than diesel engine and radiator. (When cooling water tank leaves company, it is not equipped this part.)

All water tank covers in cooling system should be in good condition. Do not open the covers. Keeping inner pressure of cooling system at 50 kPa will increase cooling efficiency of cooling system. Hence, it is not easy to open the boiler. For cooling system and its parts, please see figure 7-13 and 7-14.

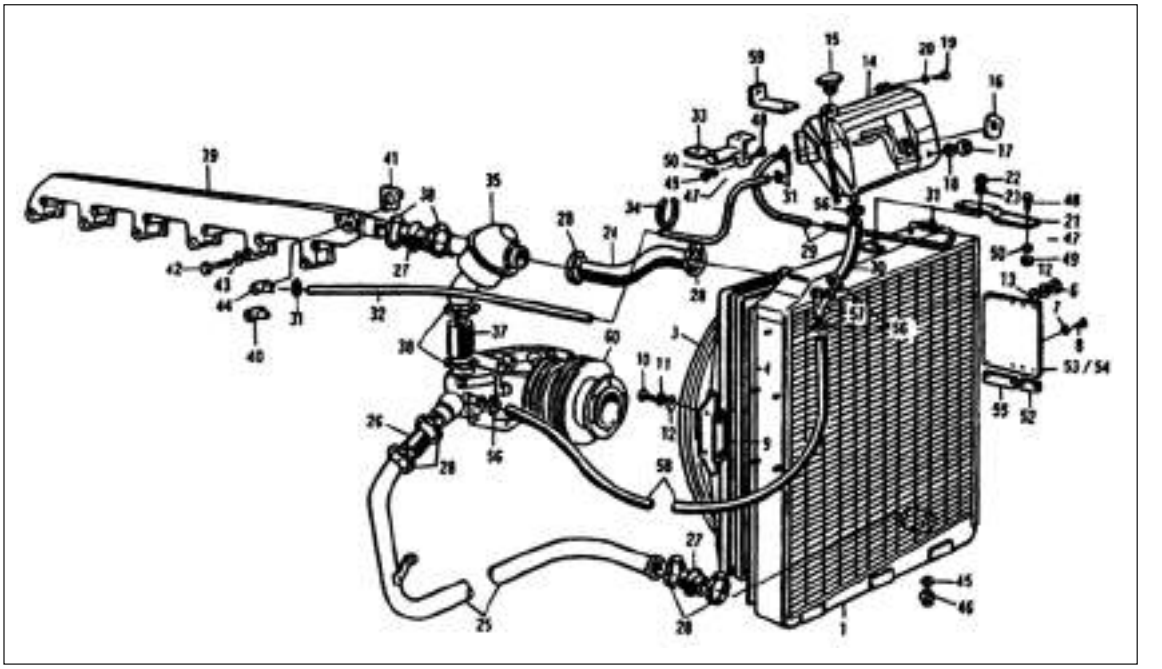


Figure 7-14 cooling system and its parts

Main parts:

1. Radiator
3. Guard ring
4. Rubber sealing tape
6、7、8、10、11、12、13. Bolt, washer, etc
14. Expansion water tank
15 Relief valve cover
16 Adding cover of water tank
17. Water level indicator
18. Gasket
19、20. Fixing bolt
25. Intake pipe
26. Rubber pipe
35. Thermostat
39. Outlet pipe
60. Water pump

Fan:

Plastic fan is died by glass fiber reinforcing PA6. It has two kinds of diameter, Φ570 and Φ620. With regard to fan transmission, there are two forms, that is, rigid transmission and silicone oil clutch transmission (viscous transmission).

Viscous fan is such a fan that adopts bimetallic temperature sensing unit to realize temperature control. Hence, it is not only can save energy, but also can ensure the diesel engine has good hot condition. It has obvious advantage on diesel engine's operation and lifetime. Main principle of this fan is that diesel engine drives driving wheel in clutch hub, and fan vane is hub rotating. When this space looses silicone

oil, driving wheel is at idle (In fact, it can drive fan to rotate at low speed). Bimetallic feeler lever is the valve that controls silicone oil to get into working space. Hence, the work of the fan is controlled by temperature. When temperature in front of the fan is below 400, bimetallic feeler lever closes valve of silicone oil compartment. At this time, driving wheel hardly transfers power, and the fan rotates as speed of 25% of driving wheel's speed. When temperature is beyond 600C, valve of silicone oil compartment opens fully, and silicone oil fills the working space. At this time, fan speed is 95% of driving wheel's speed.

When using viscous fan, you should note that after disassembled the fan, do not put it lying plainly; otherwise, silicone oil will leak out from clearance of sensor shaft.

►Intake and exhaust system

Intake pipe:

It adopts cast aluminum to manufacture. It is installed at the side of high-pressure oil pump. Inner cavity of intake pipe has huge vault. Supercharged and inter cooling intake port must be frontward.

Exhaust pipe:

It adopts spherical cast iron to manufacture. Exhaust pipe is classified two sections, front exhaust manifold and rear exhaust manifold. Two manifolds couple each other, and equip with steel sealing ring that can seal efficiently. Rear exhaust manifold use double-outlet exhaust pipe having layer to make front three cylinders and rear three cylinders supply waste gas to supercharger respectively, which will not produce interference.

Air filter:

It is double-stage air filter, first stage is swirl duster, and second stage is paper core of air filer and safety filter element. Maximum resistance of air filter should be less than 5 kPa. When maintenance indicating lamp illuminates, air filter should be maintained or replaced in time. Otherwise, it will affect diesel engine's power and lifetime.

When select and install air filter and connecting pipes, users should pay more attention to their sealing performance and reliability. Otherwise, because filtration failed, the engine will wear at early time and the use of engine has no specified lifetime. Then, some abnormal phenomenon will come forth, such as oil consumption increased, crank case blew by, the power of engine descended, emitted black smoke, etc. If serious, it will produce some malfunctions, such as piston ring of cylinder liner wore seriously, piston ring break off and cylinder scoring, etc.

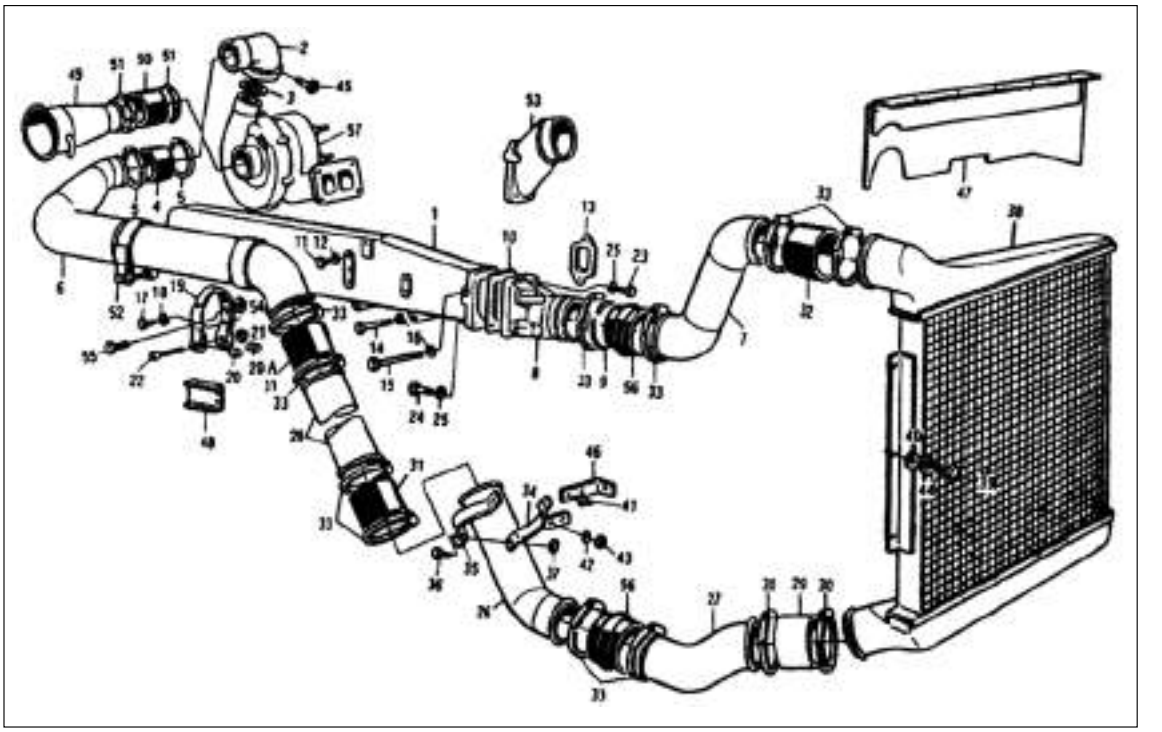


Figure 7-15 components of intake system for supercharged engine

Main parts:

1. Intake pipe	2. Connecting elbow	6、7、26、27、28. Pipe	8. Intake pipe
38. Intercooler	49. Pressure protecting pipe	57. Supercharger	

Maintain filter element of air filter as stipulation in time. After filter element is disassembled from air filter, tap end face slightly to make dust fall down. You can also make main filter element lie horizontally on clean concrete floor, then roll the element to make dust fall. Do not knock it at full tilt. If feasible, it is better to use compressed air to blow reversely (from inside to outside).

Generally, when diesel engine left the company, it is not equipped with air filter.

Caution ⚠

① If filter element is disrepair, must replace it.

② When maintain, do not pollute the inside of filter element.

③ After maintained, even using period is short than maintenance period, should also replace filter element.

►Supercharging and inter cooling system

For supercharged engine and supercharged & inter cooling engine of WD615 series diesel engine, their superchargers are exhaust turbo-supercharger. For the model of supercharger, please see table 3.

Superchargers used by supercharged engine of WD615 series diesel engine are all run-off exhaust turbo-

supercharger. The oil that lubricates and cools supercharger derives from rear end of main oil passage, and returns to lower part of crankcase.

Supercharger works at high speed (about 70000-10(0K)0r/min). Hence, after started, do not load diesel engine until it rotated at idle speed (About 5 min. If stop for a short time, you can shorten this time properly.). When diesel engine rotates at high speed and huge load, do not stop it immediately. Should lower load and speed gradually, and rotate at idle speed for 3-5 min. Otherwise, it will cause supercharger bearing to damage and out of function. After disassembled, when install, should add clean oil in oil inlet.

Supercharged intercooler:

It is air-air cooling form. Resistance of intercooler should be less than 5kPa (at rated work condition). Inlet of intercooler is on bottom, outlet is on top. Generally, when diesel engine left the company, it is not equipped with intercooler.

Caution ⚠

Ensure sealing performance of supercharged pipeline and its parts, and radiating performance of intercooler.

►Electric system

Electric system includes generator, starter, water temperature sensor, induction plug of oil pressure, and flame preheating unit, etc.

Alternator:

The rated voltage of alternator is 28V. The alternator has transistor adjuster. On vehicle, alternator and battery are parallel connection. When works, alternator is self energizing.

Circuit diagram of alternator is figure 7-16, outline drawing of alternator is figure 7-20.

Detect tension of alternator belt: apply a load that is vertical to the belt to center of two points of tangency between belt and pulley, flexibility is 3 mm. Load of ribbed belt for 612600090201 is: new belt, 43N; after used normally, it is 36N. Load of triangle belt for 61500060065 is: new belt, 6N; after used normally, it is 5N.

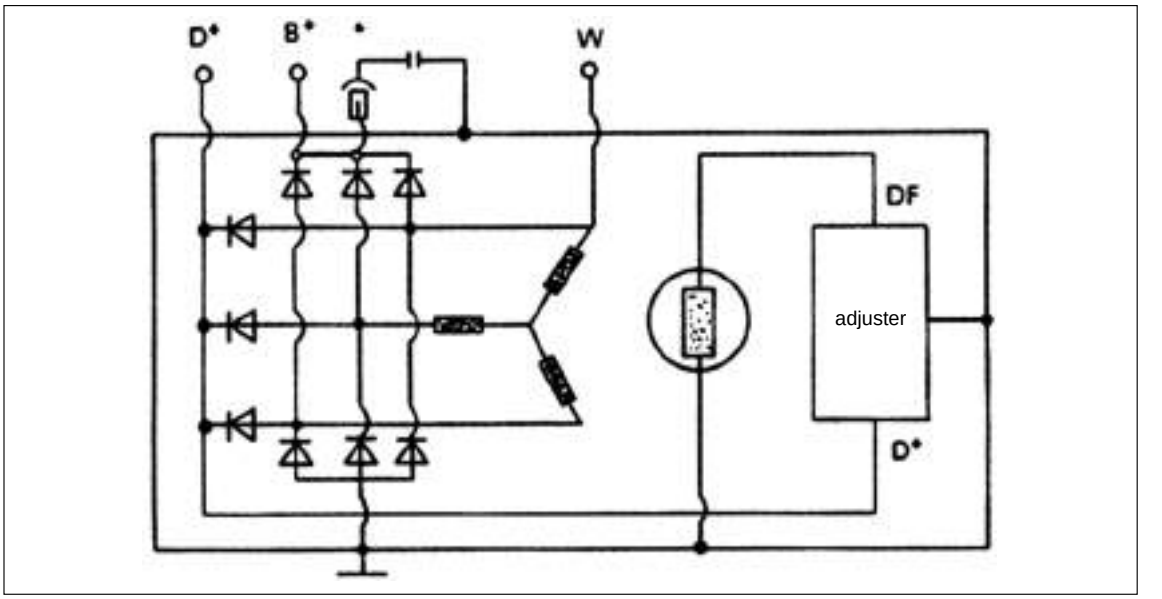


Figure 7-16 circuit diagram of alternator

Starter

This starter is a DC starter that controlled by electromagnetism. Its movement belongs to gear. It adopts friction disc isolator to transfer torque. Rated power of this starter is 5.4 kW.

Circuit diagram of starter is figure 7-17, outline drawing of starter is figure 7-18.

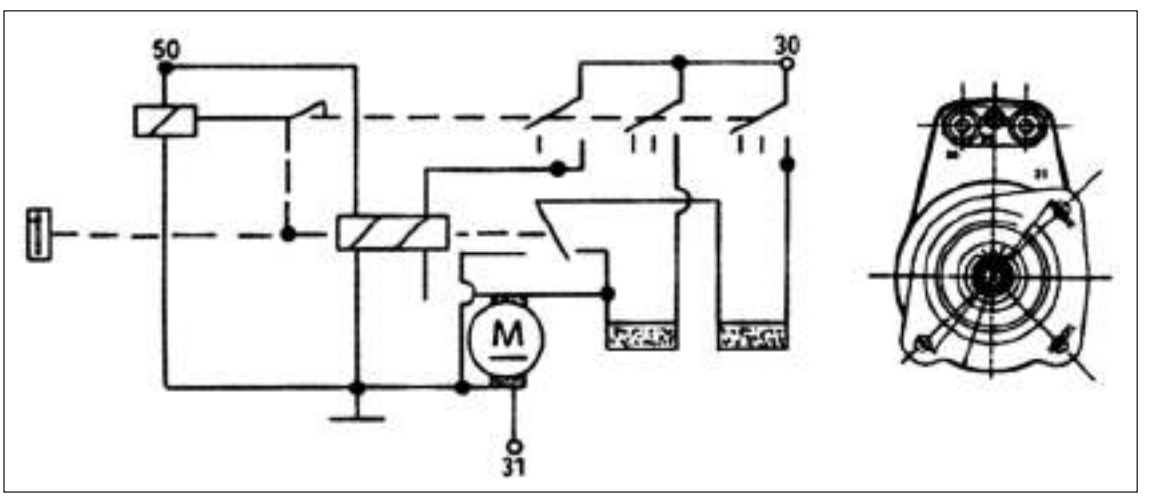


Figure 7-17 circuit diagram of starter Figure 7-18 outline drawing of starter

►Flame preheating unit

According to different environmental temperature, it can control fervor time of preheating plug that is on intake pipe of engine and flame preheating time. The driver can start the engine according to flash signal sent by preheating indicator.

Its schematic diagram is as following:

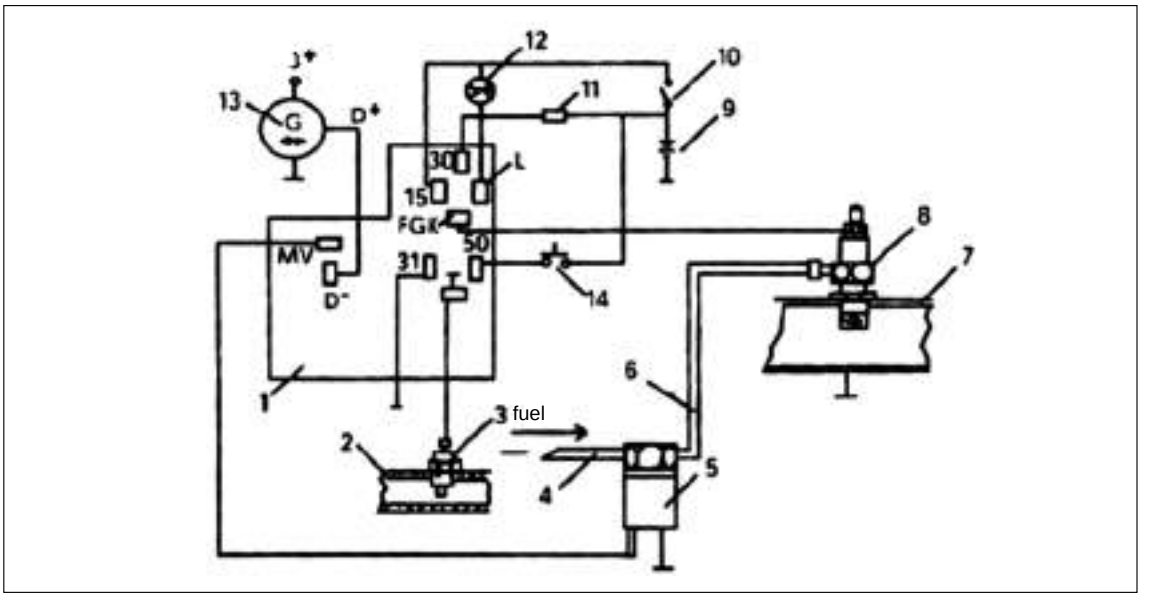


Figure 7-19 Schematic diagram of flame preheating unit

Main parts:

1. ECU A24	2 Cooling pipe of the engine	3. Temperature sensor R
4. Oil supply pipe that is connected to high-pressure oil pump		5. Solenoid valve Y2
6. Oil pipe	7 Intake pipe of the engine	8. Preheating plug R3
9. 24V battery	10 Key switch	11. Fuse box 25A
12. Preheating indicator 112/29	13. Generator	14. Start button

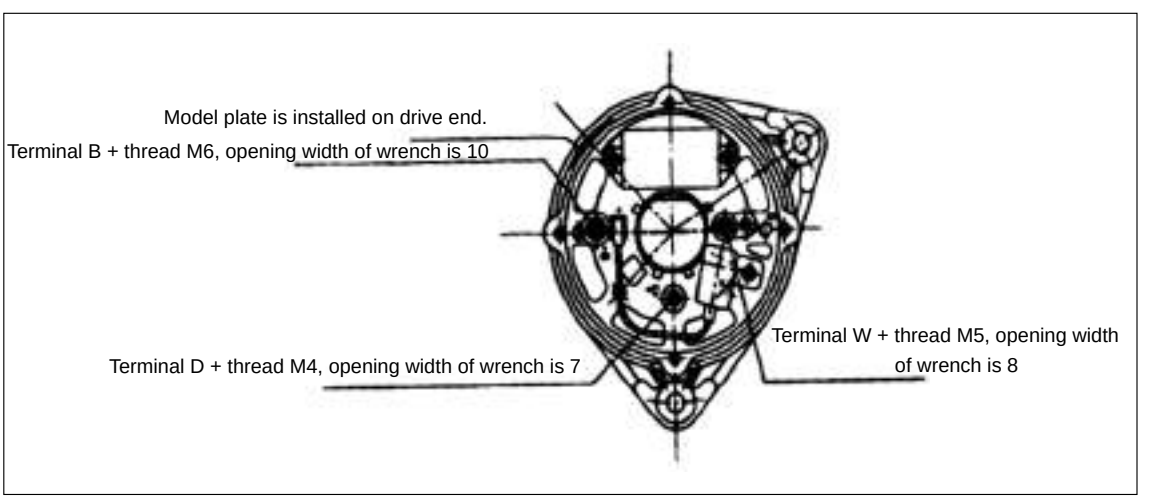


Figure 7-20 outline drawing of generator

►Air compressor

Generally, air compressor is reciprocating crack-connecting rod mechanism for single cylinder. It is on upper right of fuel injection pump tilting and driven by the gear of injection pump. Gear ratio of air compressor and engine is 1.25. Lubricating is as following: lubricant is from main oil passage to

compressor via an oil pipe fixed on cylinder block, to lubricate the bearing; then, the lubricant is from timing gear case to oil sump.

At the entrance of air compressor, air is filtered by air filter. Before filtered air comes into supercharger, there is a manifold leading to air compressor.

Cooling of air compressor is as following: connect a pipe from cylinder block to cylinder head of air compressor, then to inlet at the side of water pump.

WD615 Series Engine Operation and Maintenance

►Running Maintenance Notice

Before start diesel engine, should check if coolant level, fuel level, oil level and diesel oil level accord with requirement.

When diesel engine starts, if it doesn't have response during 15 s, the engine should start again 2 min later.

After diesel engine starts, it should run at idle speed 2-3 minutes at first, and oil pressure should be higher than 100 kPa. If coolant temperature is not beyond 600C, do not run at high speed and huge load suddenly. Because that will affect wear resistance and reliability of the engine.

For diesel engine equipped with Bosch fuel injection pump, start the engine, at the same time, start fuel enriching device. After diesel engine starts, handle of enriching device should be made to original position. Generally, when engine starts at hot condition, it is not necessary to use fuel enriching device. Within break in period (3000 km), diesel engine can only work below mid load.

Check oil level of diesel engine: you cannot check it until stop for 5 minutes. For loaded diesel engine, before stop, the load must be reduced and the speed must be lowered first. Its idle speed must last not less than 5 minutes.

►Maintenance Regulations

Table 11 Three working conditions for automobile

(WGI type)	(WG II type)	(WG III type)
Working conditions are abominable (climate is frosty or broiling, dust content is very high, transport at short distance, used on building site, or used on bus, municipal engineering vehicle, snow sweeper and fire-engine), or mileage per year is less than 2×104km, or work time per year is less than 600h.	Mileage per year is less than 6×104km, transport at short and mid distance (use for delivery goods)	Mileage per year is less than 6×104km, transport at short and mid distance (use for delivery goods)

Table 12 Period for first inspection, routine inspection and maintenance

Working condition / Item	(WG I type)	(WG II type)	(WG III type)
First inspection	When run 1000~1500km, When run 30~50h	When run 1500~2000km	When run 1500~2000km
Routine inspection	Every 5000 km, Every 30~50h	Every 1×10^4 km	Every 1.5×10^4 km
First class maintenance	Every 1×10^4 km, Every 300 h	Every 2×10^4 km	Every 3×10^4 km
Second class maintenance	Every 2×10^4 km, Every 600h	Every 4×10^4 km	Every 6×10^4 km
Third class maintenance	Every 4×10^4 km, Every 1200 h	Every 8×10^4 km	Every 12×10^4 km
Fourth class maintenance	Every 8×10^4 km,Every 2400h	Every 16×10^4 km	Every 24×10^4 km

Table 13 Oil replacing period for maintaining rule of STEYR automobile

Working condition / Item	(WG I type)	(WG II type)	(WG III type)
	Mileage per year is less than 2×104 km	**Mileage per year is less than 6×104 km**	**Mileage per year is less than 6×104 km**
First inspection	When run 1000~1500km	When run 1500~2000km	When run 1500~2000km
P	Every 500 km	Every 1×10^4 km	Every 1.5×10^4 km
WD1	Every 1×10^4 km	Every 2×10^4 km	Every 3×10^4 km
WD2	Every 2×10^4 km	Every 4×10^4 km	Every 6×10^4 km
WD3	Every 4×10^4 km	Every 8×10^4 km	Every 12×10^4 km
WD4	Every 8×10^4 km	Every 16×10^4 km	Every 24×10^4 km

Table 14 Oil replacing period got from conditions at which oil is used (depends on oil consumption)

Conditions at which oil is used is normal (oil consumption is normal)		**Conditions at which oil is used is bad (oil consumption is high)**	
Environment temperature use fuel whose content is below 0.5 % (based on quality)		A	Torrid zone or frigid zone (usually, temperature is beyond +30 ℃ or below -10℃)
		B	Use fuel whose sulfur content is 0.5%~1.0%
		C	Use fuel whose sulfur content is 1.0%~1.5%
Conditions at which oil is used	Working conditions		
Conditions at which oil is used is normal	WG I WG II WG III	5000 Every 10000 km 15000	
Conditions at which oil is used is bad, A	WG I WG II WG III	5000 Every 5000 km 5000	

Conditions at which oil is used is normal (oil consumption is normal)		Conditions at which oil is used is bad (oil consumption is high)
Conditions at which oil is used is bad, B	WG I WG II WG III	5000 Every 5000 km 10000
Conditions at which oil is used is bad, C	WG I WG II WG III	5000 Every 5000 km 5000
Conditions at which oil is used is bad, A+B	WG I WG II WG III	5000 Every 5000 km 5000
Conditions at which oil is used is bad, A+C	WG I WG II WG III	2500 Every 2500 km 2500

Table 15 Maintaining Specification of Diesel Engine

Maintaining item	First inspection	Routine inspection	First class maintenance	Second class maintenance	Third class maintenance	Fourth class maintenance
Replace diesel oil (each place for one time at least)	O	O	O	O	O	O
Replace oil filter or filter element	O	When replace diesel oil				
Check and adjust valve clearance	O		O	O	O	O
Check and adjust opening pressure of nozzle					O	O
Replace filter element of fuel filter			O	O	O	O
Clean coarse fuel filter or replace filter element			O	O	O	O
Check coolant level and fill	O	O	O	O	O	O
Replace coolant	According to table 4-5					
Tighten cooling pipe clip	O					
Tighten intake pipeline, hose and flange connection	O		O	O	O	O
Check maintenance indicating lamp or indicator of air filter			O	O	O	O
Clean dust cup of air filter (excluding air filter that remove dust automatically)		O	O	O	O	O
Clean main filter element of air filter	When indicating lamp illuminates					
Replace main filter element of air filter	Refer to related stipulation of the manual					
Replace safety filter element of air filter	After clean main filter element five times					
Check and tighten triangle belt	O	O	O	O	O	O
Check clearance of supercharger bearing						O
On test-bed, check and adjust fuel injection pump					O	O

Maintaining item	First inspection	Routine inspection	First class maintenance	Second class maintenance	Third class maintenance	Fourth class maintenance
Check and adjust clutch stroke and steel wire	O	O	O	O	O	O
Adjust idle speed	O					

Note: It needs maintaining mark.

Table 16 Correction Coefficient of Power

Temperature ℃ / a b / Air pressure kPs	10	12	14	16	18	20	22	24
110	0.97322	0.97487	0.97650	0.97813	0.97975	0.98136	0.98297	0.98456
108	0.97572	0.97737	0.97902	0.98065	0.98227	0.98389	0.98550	0.98710
106	0.97828	0.97993	0.98158	0.98322	0.98485	0.98647	0.98808	0.98968
104	0.98089	0.98255	0.98420	0.98584	0.98748	0.98910	0.99072	0.99232
102	0.98356	0.98523	0.98688	0.98853	0.99016	0.99197	0.99341	0.99503
100	0.98629	0.98796	0.98962	0.99127	0.99291	0.99455	0.99617	0.99779
98	0.98909	0.99076	0.99242	0.99408	0.99573	0.99736	0.99899	1.00061
96	0.99195	0.99362	0.99529	0.99695	0.99860	1.00025	1.00188	1.00351
94	0.99487	0.99656	0.99823	0.99990	1.00155	1.00320	1.00484	1.00647
96	0.99787	0.99956	1.00124	1.00291	1.00457	1.00622	1.00787	1.00950
90	1.00095	1.00264	1.00433	1.00600	1.00767	1.00933	1.01097	1.01262
88	1.00410	1.00580	1.00749	1.00917	1.01084	1.01251	1.01416	1.01581
86	1.00734	1.00904	1.01074	1.01242	1.01410	1.02577	1.01743	1.01908
84	1.001066	1.01237	1.01407	1.01577	1.01745	1.01715	1.02079	1.02244
82	1.001408	1.01579	1.01750	1.01920	1.02089	1.02257	1.02424	1.02590
80	1.01759	1.01931	1.02102	1.02273	1.02442	1.02611	1.02778	1.02945

Temperature ℃ / a b / Air pressure kPs	26	28	30	32	34	36	38	40
110	0.98615	0.98773	0.98930	0.99086	0.99242	0.99397	0.99551	0.99704
108	0.98869	0.99027	0.99185	0.99341	0.99497	0.99652	0.99807	0.99960
106	0.98128	0.99286	0.99444	0.99602	0.99758	0.99914	1.00068	1.00222
104	0.99392	0.99552	0.99710	0.99868	1.00024	1.00180	1.00336	1.00490
102	0.99663	0.99823	0.99981	1.00139	1.00297	1.00453	1.00609	1.00794
100	0.99940	1.00100	1.00259	1.00417	1.00575	1.00732	1.00888	1.01043
98	1.00223	1.00383	1.00543	1.00702	1.00860	1.01017	1.01174	1.01330

Temperature ℃ / a b / Air pressure kPs	26	28	30	32	34	36	38	40
96	1.00513	1.00673	1.00834	1.00993	1.01151	1.01309	1.01466	1.01622
94	1.00809	1.00971	1.01131	1.01291	1.01450	1.01608	1.01766	1.01922
96	1.01113	1.01275	1.01436	1.01596	1.01756	1.01915	1.02073	1.02230
90	1.01425	1.01587	1.01749	1.01910	1.02070	1.02229	1.02387	1.02545
88	1.01744	1.01907	1.02069	1.02231	1.02391	1.02051	1.02710	1.02868
86	1.02072	1.02236	1.02398	1.02560	1.02721	1.02881	1.03041	1.03200
84	1.02409	1.02573	1.02736	1.02899	1.03060	1.03221	1.03381	1.03540
82	1.02755	1.02920	1.03084	1.03246	1.03409	1.03570	1.03730	1.03890
80	1.03111	1.03276	1.03411	1.03604	1.03767	1.03928	1.04089	1.04250

Note:

Temperature in this table is intake temperature. Air pressure in this table is dry air pressure of intake (it is different from atmospheric pressure);

Temperature applied in this table is 10~400C, air pressure applied in this table is 80~110 kPa. During test, should take measures or select appropriate time to make real intake condition of the engine is among the range above.

Correcting power Pe0 = ad•Pe (Pe0 ---- correcting power Pe---- measured power ad--- correction coefficient)

►General Troubleshooting

8.3.1 Diesel engine cannot be started

Causes	Correction
Filter screen, hose or other oil way of oil supply pump is blocked.	Check and get rid of pollutant. Check fuel's clearance.
There is air in fuel system.	Eliminate air, check sealing performance of the joint, and renovate.
Fuel injection pump is failed.	Check plunger, delivery valve. Repair or replace damaged parts.
Fuel injector is failed.	Check atomization condition of injector and renovate.
Valve timing or initial oil supply angle is not correct.	Check and adjust it.
High-pressure oil pipe is damaged or leaks oil.	Renovate and replace.
Compacting pressure of the cylinder is not sufficient.	Check sealing performance of the valve and gasket, check wear condition of piston ring. Repair or replace.
Air temperature is too low.	Add accessory equipment for starting.

8.3.2 The engine stops after started for a short time.

Fuel filter is blocked.	Disassemble filter, clean out pollutant and water in it. If necessary, replace filter element.

There is air in fuel system.	Check sealing performance of oil pipe and the joint. Check if snifting screw is tightened. Eliminate air.
Oil supply pump does not work.	Check piston and valve of oil supply pump. Clean up and renovate.
Fuel quality is too bad. It has too much water.	Clean filter and replace fuel.
Idle speed is too low.	Adjust again.

8.3.3 Power is not sufficient

Intake air is blocked (air filter is blocked).	Check air filter and intake pipe. Clean up or replace filter element.
Exhaust backpressure is too high.	Check valve timing. Check if exhaust pipe is blocked. Adjust and repair.
Pressure of supercharging system is not sufficient.	Check and eliminate leakage at pipeline connection.
Supercharger is out of gear.	Replace the assembly.
Passage between II compressor and turbo is polluted or blocked.	Clean or replace.
Floating bearing is out of function.	Replace.
Back clearance between turbo and compressor deposited carbon and grease.	Clean.
Intercooler is damaged or leaks oil.	Replace or repair.
Fuel pipe leaks oil or is blocked.	Check sealing performance of oil pipe and joint, check pollution of air filter and check fuel pipe. Renovate or clean dirt plug, and replace filter element.
Fuel quality is poor.	Clean fuel tank, filtering parts and oil pipe. Replace fuel.
Fuel injection pump or governor is worn excessively.	Repair or replace.
Diaphragm of smoke limiter for fuel injection pump is damaged.	Replace or repair.
Air pipe of smoke limiter is damaged or leaks air.	Replace.
Atomization of nozzle is bad.	Check injecting pressure, check deposited carbon of nozzle. Adjust and repair.
Valve timing or oil supply angle is not correct.	Check and adjust.
High speed of governor is too low.	Check governing feature and adjust it.
Oil level of oil sump is too high.	Check dipstick, and discharge redundant oil.
Cylinder gasket leaks air.	When the vehicle is hot, check compacting pressure. Replace damaged cylinder gasket.
Piston ring is worn and rupture, clearance of bearing shell is too huge.	Replace worn parts or overhaul the engine.
Cylinder liner or piston is worn, or cylinder scoring.	Overhaul the engine.

8.3.4 Fuel consumption is over abundant.

Intake pipe is blocked (air filter is blocked).	Check air filter and intake pipe. Clean up them.
Exhaust backpressure is too high.	Check exhaust pipe and brake valve. Clean up them.
Fuel quality is poor.	Replace fuel as stipulation.
Fuel pipe is blocked.	Check and renovate.

Fuel pipe leaks oil.	Check and renovate.
Atomization of nozzle is bad.	Check, adjust and renovate.
Valve timing or oil supply angle is not correct.	According to stipulation, adjust valve clearance and oil supply advance angle.
Cylinder gasket leaks air.	Check compacting pressure.
Clearance of bearing shell is too huge, the engine needs overhaul.	Check and overhaul.
Piston makes cylinder expanded.	Replace cylinder liner, piston and piston ring.
Pressure of supercharging system is not sufficient.	Check and eliminate leakage at pipeline connection.
Supercharger is out of gear.	Check and replace the assembly.
Intercooler is damaged or leaks oil.	Replace or repair.

8.3.5 There is black smoke when exhaust.

Intake is blocked or exhaust backpressure is too high.	Clean up.
Quality is poor.	Cleanout and replace.
Valve timing or oil supply angle is not correct.	Adjust according to stipulation.
Atomization of nozzle is bad	Check, renovate or replace.
Fuel injection pump injects too much fuel.	Check and adjust (should be done by special plant)
Pressure of supercharging system is not sufficient.	Check and eliminate leakage at pipeline connection.
Supercharger is out of order.	Check and replace the assembly.
Intercooler is damaged or leaks oil.	Replace or repair.
Active point of smoke limiter is not correct.	Adjust again (should be done by special plant).

8.3.6 There is white smoke and blue smoke when exhaust

Fuel quality is too bad. It has too much water.	Replace fuel.
Coolant temperature is too low.	Check work temperature of thermostat. If necessary, replace it.
Valve timing or oil supply timing is not correct.	Check and adjust.
Atomization of nozzle is bad.	Check and renovate.
Compacting pressure is too low, burning is not complete, and piston makes cylinder expanded.	Check piston ring, cylinder liner, cylinder gasket and renovate.
Piston ring and cylinder liner do not break in well.	Continue to break in.
Opening of piston ring does not stagger.	Adjust or assemble again.
Oil ring of piston is out of function.	Replace.
Fit clearance between piston and cylinder liner is too big.	Repair or replace.
Sealing ring of supercharger is worn.	Repair or replace.
Thrust bearing of supercharger is worn.	Repair or replace.
Oil return pipe of supercharger is blocked.	Clean out or repair.

8.3.7 Intake port and intake pipe of supercharger deposited oil.

Supercharger can not seal.	Repair or replace supercharger.

Oil-gas separator is out of function.	Replace.
Oil level of oil sump is too high. Add too much oil.	Check and discharge some oil, making it accord with stipulation.

8.3.8 Speed is not stable.

Fuel quality is poor, it has water or wax.	Clean-up fuel system, replace fuel.
Air comes into fuel suction pipe.	Check sealing performance of fuel pipe and joint, discharge air.
Governor weight assembly and governor spring do not work normally.	Check and renovate (should be done by special plant)
Oil supply is not even.	Check and adjust (should be done by special plant).
Atomization of nozzle is not stable.	Check and renovate.
Supercharger is surging.	Check, clean passage of compressor, get rid of dirt plug, and eliminate deposited carbon that is in waste gas passage.
Supercharger bearing is damaged.	Replace it.

8.3.9 Oil pressure is too low.

Oil level of oil sump is too low, or it lacks oil.	Check oil level. Check if there is oil leakage. Add oil.
Pressure adjust valve of main oil passage is failed.	Check valve, clean-up and renovate.
Check if pick-up screen, oil pipeline, joint shim is blocked or fractured.	Check if there is loosen casting in strainer, pipeline joint and oil passage, and renovate.
Oil brand does not accord with stipulation.	According to stipulation, replace oil. Select the oil having appropriate brand.
Oil intake pipe of oil pump leaks oil.	Check oil pipe and joint. Renovate or replace.
Coolant temperature is too high, oil temperature is too high.	Check cooling system and correct it.
Resistance of oil filter is too huge.	Replace filter element.
Oil cooler is blocked.	Check and clean up.
Main oil passage is blocked.	Check and clean up.
Clearance of bearing shell is too big, or bearing shell is damaged.	Check and replace.
Parts is worn excessively. It needs overhaul.	Check working hours of the engine. Overhaul.

8.3.10 Coolant temperature is too high.

Water level of water tank is too low.	Check if there is water leakage. Add water.
Water tank is blocked.	Check water tank. Clean up or renovate.
Water pump belt is loose.	According to stipulation, adjust tension.
Gasket of water pump is damaged; impeller of water pump is worn.	Check, renovate or replace.
Thermostat is failed.	Replace it.
Water pipe is damaged, bleed into air.	Check water pipe, joint and gasket, etc. Replace damaged parts.
Oil level of oil sump is too low, or it lacks oil.	Check oil level. Check if there is oil leakage. Add oil.

8.3.11 Parts wear too quickly.

Filter element of air filter is unqualified or damaged.	Check, replace with qualified filter element.
Intake system is short.	Check intake pipe, gasket and connecting sleeve. Renovate or replace.
Oil level of oil sump is too low, or it lacks oil.	Check oil level. Check if there is oil leakage. Add oil.
Oil passage is blocked.	Clean up oil passage.
Oil brand does not accord with stipulation.	According to stipulation, replace oil.
Piston ring is fractured or worn.	Replace damaged parts.
Cylinder liner or piston is worn, or cylinder scoring.	Disassemble and inspect piston & cylinder liner. Renovate or replace.
Filter element of oil filter is not replaced in time.	Replace it.
Parts are worn excessively. It needs overhaul.	Check mileage. Confirm if it needs overhaul.
Crankshaft and follower spindle are not homocentric.	Check mounting bracket. Renovate.
Oil quality does not accord with requirement.	Use the oil that accords with standard brand.

8.3.12 Noise is too huge.

Fuel quality is poor.	Replace fuel.
Coolant temperature is too low.	Check thermostat, if necessary, replace it.
Valve timing or oil supply timing is not correct.	Check, renovate and adjust.
Atomization of nozzle is bad.	Check, renovate and adjust.
Fuel injection pump injects too much fuel.	Check and adjust (should be done by special plant).
Damper is damaged.	Check if there is damage. Check condition of connecting bolt. Replace damaged parts.
Valve leaks, or adjust wrongly.	Disassemble and inspect valve, adjust again.
Gear clearance is too big, or gear is fractured.	Check and replace damaged parts.
Cylinder liner or piston is worn, or cylinder scoring.	Check, renovate or replace.
Push rod is bent or fractured.	Replace it.
Piston ring is worn or ruptured.	Check or replace damaged parts.
Bearing shell wears excessively.	Check and replace bearing shell.
Thrust clearance of crankshaft is too big.	Replace thrust washer.
Main bearings are not homocentric.	Check and renovate.
Crankshaft and follower spindle are not homocentric.	Check the bolt of mounting bracket and renovate.
Part is worn excessively. It needs overhaul.	Check mileage. Confirm if it needs overhaul.
Supercharger is surging.	Eliminate dirt plug of air passage for compressor, and eliminate deposited carbon in exhaust air passage.
Sealing ring of supercharger sinters.	Replace assembly.

Bearing of supercharger is damaged. Rotating parts hit fixing parts.	Replace assembly.
Foreign matters come into supercharger turbo or impeller.	Replace assembly.

8.3.13 Starting motor does not work.

Battery charges insufficiently.	Check, charge or replace battery.
Connecting wire does not contact well.	Clean up the line, tighten the lug.
Fuse is blown.	Replace fuse.
Brush does not contact well.	Clean brush surface or replace brush.
Staring motor is short circuit.	Inspect, repair or replace the assembly.

8.3.14 The force of starting motor is not sufficient.

Battery pressure is not sufficient.	Charge or replace battery.
Bearing sleeve is worn.	Replace the assembly.
Brush does not contact well.	Clean brush surface or replace brush.
Reverser is not clean or singeing.	Get rid of oil stain, use sand paper to grind, or replace the assembly.
Terminal end is sealing off.	Weld again.
Switch does not contact well.	Check the switch and renovate.
Wore clutch slides.	Adjust working torque of clutch or replace the assembly.

8.3.15 Generator does not generate electricity in no respects.

Connecting line is open circuit, short circuit. Joint is loose.	Check generator. Check connecting line of current meter. Renovate.
Rotor coil or stator coil is open circuit, short circuit or ground.	Renovate or replace the assembly.
Rectifying tube is damaged.	Replace the assembly.
Insulation of pile head is damaged.	Renovate.
Adjusting pressure of adjuster is too slow.	Renovate.
Contact of adjuster is sintered.	Renovate or replace the assembly.

8.3.16 Generator charges insufficiently.

Connecting line is open circuit, short circuit. Joint is loose.	Renovate.
Rotor coil or stator coil is local short circuit, or disconnects.	Renovate or replace the assembly.
Generator belt is loose.	Check, adjust tension of the belt.
Rectifying tube of generator is damaged. Brush does not contact well.	Renovate.
Adjusting pressure of adjuster is too slow.	Adjust

Magnetic coil of adjuster or connecting line of resistance disconnects.	Renovate or replace the assembly.
Electrolyte of battery is little, or battery is old.	Add electrolyte or replace battery.

8.3.17 Charging current is not stable.

Rotor coil or stator coil will be open or short circuit.	Renovate or replace.
Brush does not contact well.	Renovate
Pile head of connecting line is loose or contacts badly.	Renovate
Pressure adjuster is damaged.	Renovate
Adjust of pressure is not correct.	Check and adjust.

8.3.18 Generator charges too much.

Internal battery is short circuit.	Renovate or replace
Adjuster pressure is too high.	Check and adjust.
Ground of adjuster is not correct.	Renovate
Contactor of adjuster is out of control and polluted. Pressure coil or connecting line of resistance disconnects.	Renovate or replace

8.3.19 Generator sends out abnormal noise.

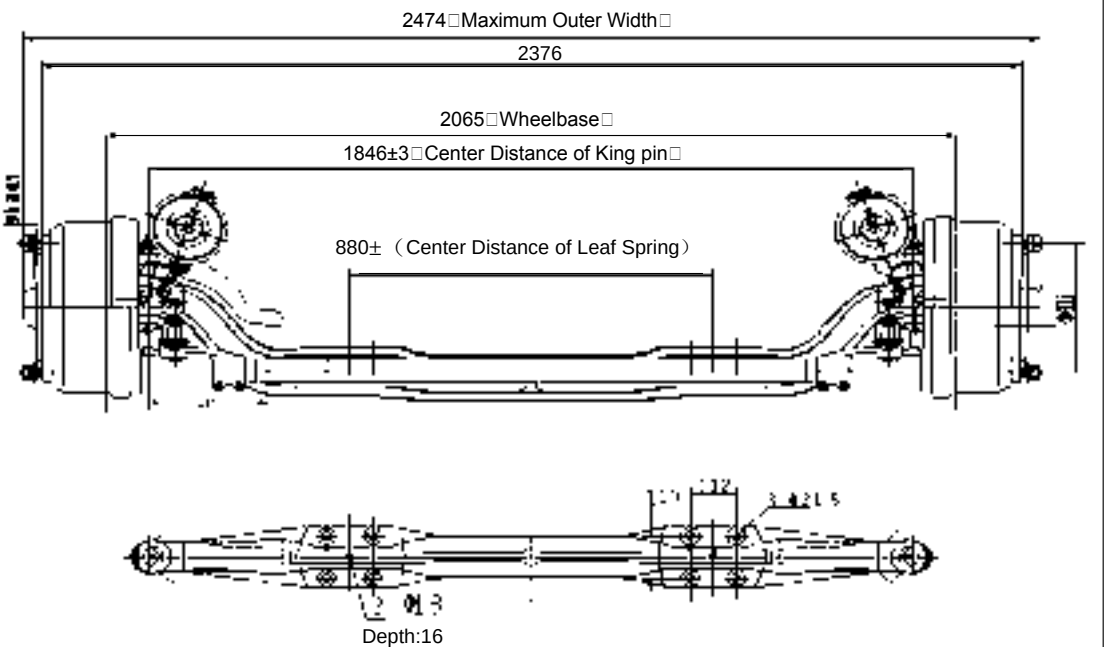
Installation of generator is not correct.	Renovate
Bearing is damaged.	Replace bearing.
Rotating part contacts fixing part.	Renovate or replace
Rectifier is short.	Replace.
Stator coil is short.	Renovate or replace

4 Front Axle and Steering System

Main Technical Data

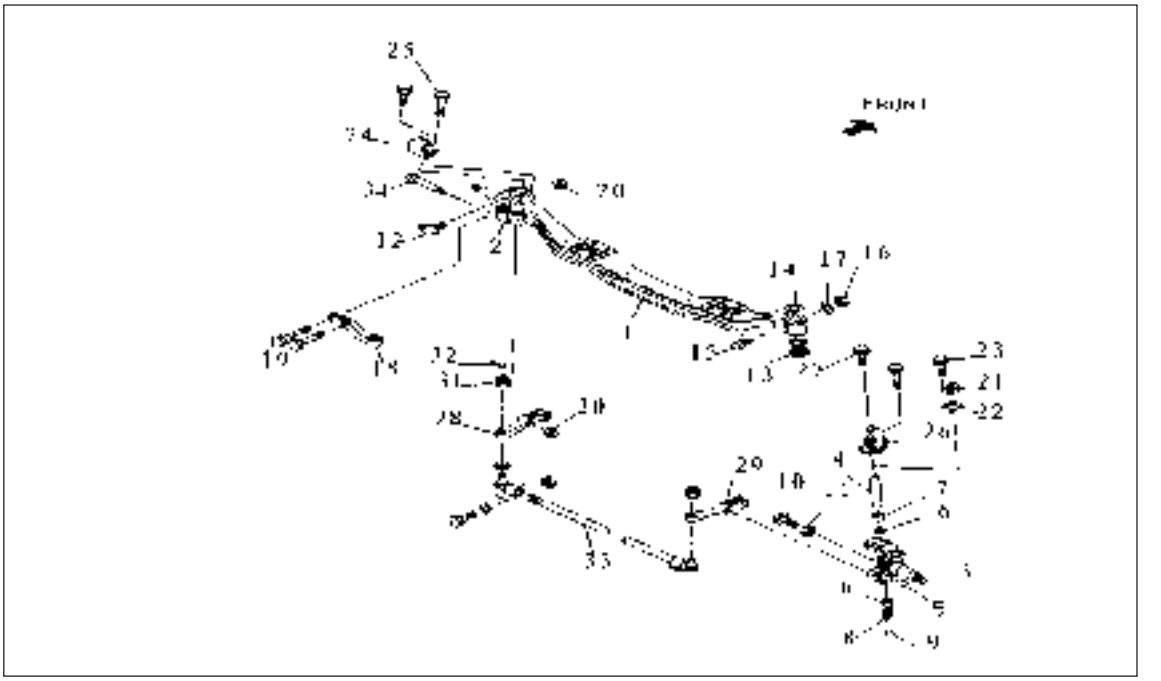
Rated Axle Load	75000kg
Wheelbase	2065mm
Central Distance of Leaf Spring	880mm
Maximum Steering Angle	Inner Wheel 470;Outer Wheel 350
Fall Difference between King pin Hole Basis and Leaf Spring Seat Face	105mm
Camber of Front Wheel	0.50
Camber of King pin	7.50
Toe-in of Front Wheel	0-2mm
Specification of Brake	Φ410×160mm

Outline Drawing and Connection Dimension



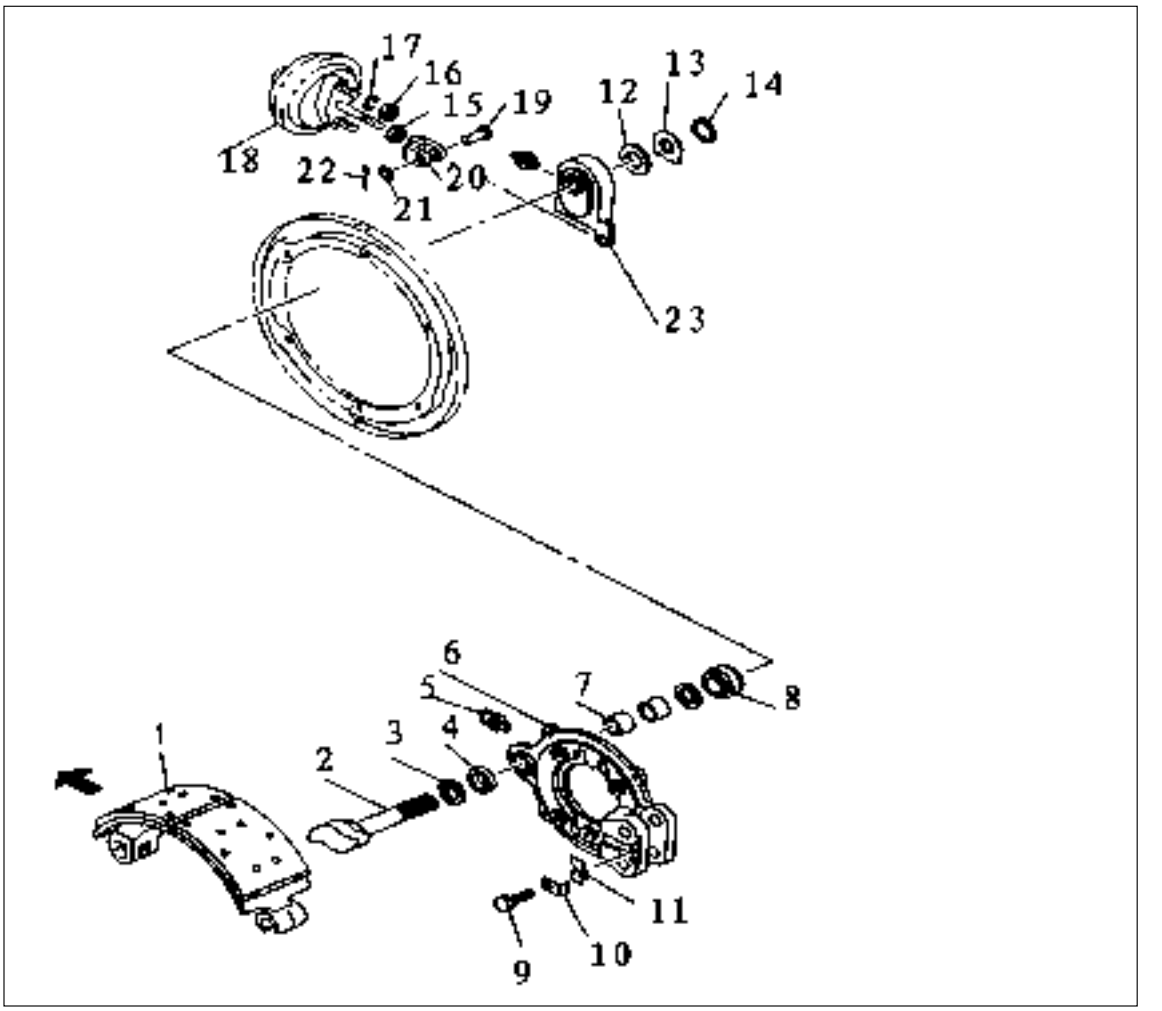
Structure

►Structure of Front Axle



No.	Name of Spare Part	No.	Name of Spare Part	No.	Name of Spare Part
1	Front axle	15	Lock bolt of king pin for steering knuckle	29	Right tie rod arm
2	Left steering knuckle assembly	16	Lock nut of king pin for steering knuckle	30	Nut- tie rod arm
3	Right steering knuckle assembly	17	Spring shim	31	Hexagon slotted thin nut
4	King pin	18	Steering knuckle arm	32	Split pin
5	Positioning pin	19	Long bolt	33	Tie rod assembly
6	Bushing	20	Nut	34	Long bolt
7	(Upper) Needle bearing	21	Plug cap		
8	(Lower) Needle bearing	22	Shim for king pin cap		
9	Elastic rings for holes	23	Bolt for king pin cap		
10	Stop bolts for steering knuckle	24	Left support-front brake chamber		
11	Stop nuts for steering knuckle	25	Long bolt-support		
12	Bent lubrication nozzle	26	Right support-front brake chamber		
13	Thrust bearing	27	Short bolt-support		
14	Adjustment shim	28	Left tie rod arm		

►Structure of Brake



No.	Name of Spare Part	No.	Name of Spare Part	No.	Name of Spare Part
1	Brake shoe	10	Shim	19	Pin
2	Left/right brake camshaft	11	Lock plate	20	Push fork
3	Oil seal for camshaft	12	Shim	21	Shim
4	Adjustment shim	13	Guard plate of camshaft	22	Split pin
5	Grease nozzle	14	Clip spring	23	Brake adjustment arm
6	Foundation support of brake drum	15	Nut		
7	Bushing	16	Nut		
8	Guard ring of camshaft	17	Spring washer		
9	Bolt	18	Left/right brake chamber		

Operation and Maintenance

►Prior to operation of new axle

Fill sufficient 2# lithium base grease into each grease fitting nipple.

►Operation of new axle

1500km running-in shall be conducted before the new axle is assembled into the vehicle. The new axle can be put into operation, only when the brake clearance is readjusted and each fastener part is checked.

►Maintenance of Axle

1. Fill 2# lithium base grease into each grease fitting nipple every 2000km;
2. Check brake clearance every 5000km;
3. Check the fastening conditions for the brake support, check the loosening conditions for the hub bearings, and check the wear conditions for brake discs every 8000-10000km, if the wear of brake disc exceeds the limit pit, the brake discs shall be duly changed.

►Repair Standards for Main Parts

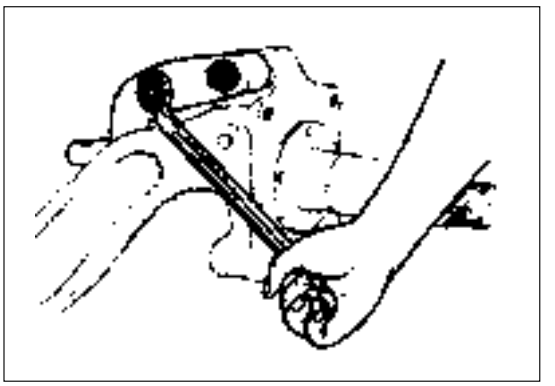
1. Tightening torque for bolts and nuts（Nm）

Nut, steering knuckle arm	280-350
Nut, tie rod arm	350-450
Bolt, front brake support plate	160-210
Internal nut for tire bolt	420-490
Lock nut	25-40
Lock nut for stop bolt	80-100
Nut, steering ball pin	250-310
Nut, tie rod joint	38-42
Front adjustment nut	200
Plug cap bolt for king pin	60-80
Bolt, brake chamber support	68-80
Retaining nut, brake chamber	40-60

2. Maintenance Standard

Items	Maintenance Standard	Maintenance Limit	Wear Limit	Remark
Clearance of king pin and bushing of steering knuckle	0.01-0.1mm	0.2mm		
Clearance of front shaft and main lock hole	0-0.04mm		0.15mm	
Starting torque of front wheel hub	25-55N			Measured at the hub bolts
Starting force of steering knuckle	< 10N			Measured at split pin of axle journal
Axial clearance of steering knuckle and front shaft	< 0.1mm			Shim adjustment
Starting force of transverse tie rod	< 50N			Measured at split pin hole
Ball pin, tie rod			37.5mm	
Inner diameter of brake drum		412mm	414mm	
Radial run-out of brake drum	0-0.1mm	0.2mm		
Clearance of brake drum and brake shoe	0.5mm			
Clearance of brake shoe shaft and bushing	0.16-0.26mm	0.35mm		
Thickness of friction plate		7-9mm	6mm	

Dismantling

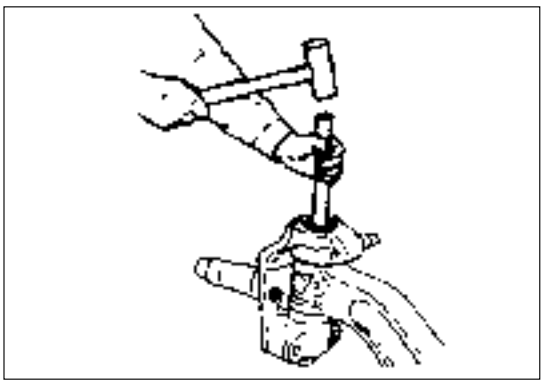


►Dismantle front hub and brake drum assembly

(1) Dismantle the bearing end cap of hub.
(2) Take off split pin, adjustment nut and retaining plate.
(3) Slightly rotate the hub and brake drum, draw them outward, meanwhile, slightly knock the brake drum to loosen the inner ring of outer bearing. Take off the hub and brake drum after the inner ring is loosened.

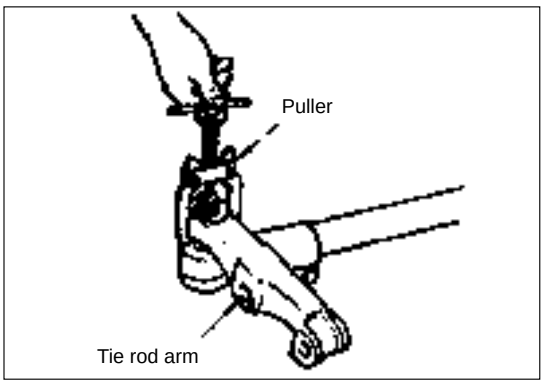
Caution ⚠

The hub and brake drum assembly is heavy. Do not cause any damages or person injuries.



►Disassemble steering knuckle and king pin

(1) Dismantle steering knuckle arm.
(2) Dismantle the plug cap and related parts from the upper and lower end of king pin.
(3) Loose wedge lock pin nut from king pin, until the outer surface of nut is mounted flush to the end of lock pin.
(4) Pound the nut by the copper hammer to loosen the connection between lock pin and king pin.
(5) Dismantle lock-pin nut and lock pin.
(6) Use copper hammer and copper rod to hammer out the king pin from the top to the bottom.
(7) Dismantle the steering knuckle, thrust bearing and adjustment shim.



►Dismantle tie rod

(1) Dismantle the slotted nuts between the tie rod arm and the tie rod joints.
(2) Separate the tie rod arm from the tie rod by the Puller.
(3) Dismantle the tie rod clamp bolt from the joints.
(4) Dismantle the tie rod joints from the tie rod.
(5) Pull out the split pin from the tie rod joint, dismantle the slotted nuts, decomposing each part.

Cleaning and Inspection

►Cleaning

The dirty oils and sludge are possibly stained on the parts, so cleaning parts is absolutely necessary process. The commonly applied methods are steam cleaning, gasoline washing, acid or alkaline solution washing, neutral agent washing, trichloroethylene cleaning and magnetic cleaning. Some parts can be possible damaged during cleaning process, therefore, careful inspection shall be performed during cleaning process.

1. Metal parts

(1) Gasoline

Different from other methods, gasoline cannot penetrate or dissolve mud. Unless the surface of parts is of finish machining, it's mandatory to clean off the mud with wire brush or other tools. Clean twice.

(2) Alkaline treatment

The effect of cleaning steel part and cast iron part by alkaline treatment method is good. If the part is made by alloy, it can not be cleaned by alkaline.

2. Rubber part

Do not use mineral oil, however, alcohol cleaning can be applied. Only one clean rag can be applied to wipe off the dirt.

3. Anti-rust

Apply one layer of clean oil on the surface to prevent from rusts after cleaning all waste oils and greases on the surface of the parts.

►Inspection

Apply the previously prepared measuring instrument or tool to perform inspection prior to cleaning parts. Determine whether the parts are suitable to be reused according to the appointed maintenance standard. The damaged parts shall be repaired or changed according to the requirements. If one of the matched parts is seriously worn, and its fitting clearance exceeds the specification, this part or the matched part can be changed according to the requirements.

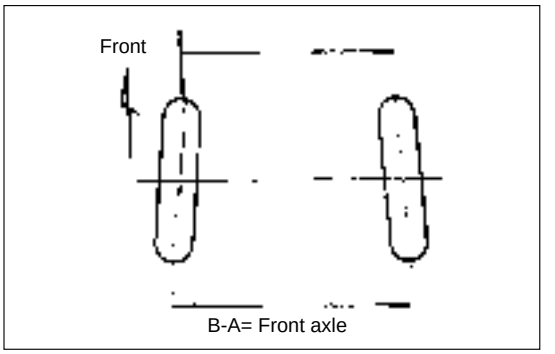
Seen from the view of predictive maintenance, some parts within the limit of repair or wear shall be changed before they exceed the limit.

All parts shall be carefully inspected by observing appearance or using infrared ray flaw detection. If any below abnormal phenomenon is found in the process of observing appearance, this part shall be repaired or changed as required.

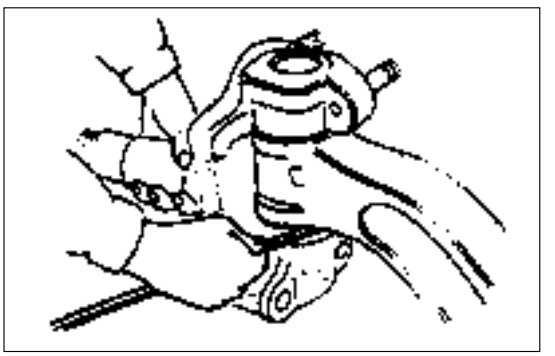
All rubber parts, such as: O rings, oil seals, sealing gasket and etc, shall be determined for their rejection after they are dismantled.

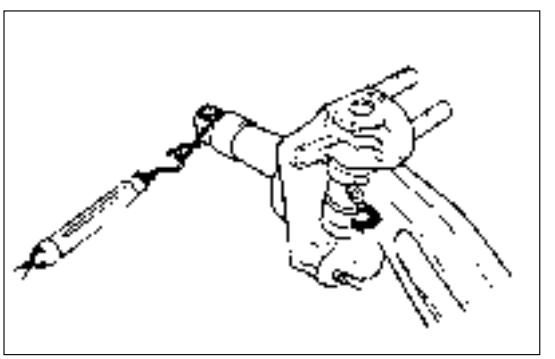
Abnormal Phenomenon

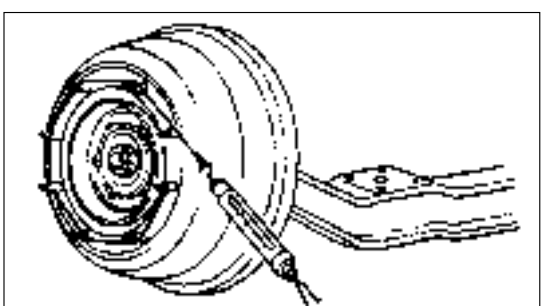
Uneven wear	Deformation	Abnormal noises (bearing and etc.)
Iron rusts	Failure or become weak (spring)	Color change
Bend	Partial Wear	
Scratch	Deterioration (brake friction disc)	
Crack	Not tightly fitting	



B-A= Front axle






Pull the spring balance along the horizontal direction

Assembly and Adjustment

►Assembling of assembly

The installation process of each part is opposite to the above process. However, pay more attention to the tightening torque of the screw connection parts and the adjustment of bearing pre-tightening force.

►Adjustment of axle

1. Adjustment of toe-in

(1) Firstly, loosen the tightening bolts of the tie rod.

(2) Rotate the tie rod to make the toe-in value of 0-2mm(bias tire)or 2-0mm(radial tire)at the outer diameter of tire.

(3) Tighten the fastening nut of tie rod. The mutually included angle is not greater than 40 for left and right joints. The swinging angle shall reserve the allowance at the maximum rotation angle.

2. Adjustment of brake clearance

Too big or too small brake clearance can influence the whole brake property. Adjust the hexagonal head of worm shaft of adjustment arm by wrench. Firstly rotate it in clockwise direction to make the clearance zero, then rotate it reversely until two or three steel ball slippage noises are heard, the clearance is 0.3-0.4mm at this time.

3. Adjusting the axial clearance of front axle and steering knuckle

(1) Install the steering knuckle and thrust bearing to the front axle, select the proper adjustment washer to adjust the clearance, ensure the clearance of below 0.1mm.

Caution ⚠

(1) ①The face of thrust bearing with O ring (small dimension) is installed toward the front axle. ②Only one adjustment washer is allowable. Specification of adjustment washer:2.1-2.8mm(8 types, progressively increasing at 0.1mm).

(2) Apply one thin layer of grease on the surface of king pin.
(3) The lock-pin groove of the king pin is mounted flush to the lock pin hole of front axle, insert the king pin and tighten the lock pin.
(4) Measure the starting force of steering knuckle. The starting force shall be less than 10N.

Caution ⚠

Measure the left and right side separately prior to applying grease.

4. Adjusting the pre-tightening force of front hub bearing

(1) Apply 2# lithium base grease into the steering knuckle end screw and retaining piece of wear reducing.
(2) Tighten the lock nut at the specified torque of 200Nm.
(3) Rotate hub for 2-3 cycles, ensure proper positioning of the bearing.
(4) Tighten the lock nut at the specified torque of 200Nm.
(5) Rotate the lock nut at 600.
(6) Then rotate hub for 2 to 3 cycles, confirming whether the pre-tightening force of hub bearing is correct. The pre-tightening force of hub bearing shall be 20-55N.

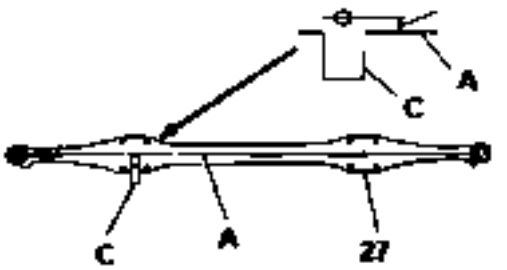
5. Measurement of horizontal curvature and vertical curvature for front axle 27

(1) Pass rope A through the king pin hole of front axle 27 and hang one weight block B at each end.
(2) Measure the horizontal curvature D and vertical curvature E by straight ruler C.
(3) If the reading is above the limit value of 7, below the standard value of 3, the front axle 27 shall be replaced.

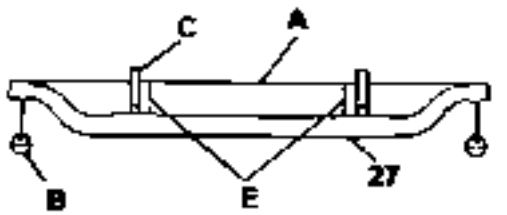
6. Measurement of king pin caster

Place the king pin 19 of front axle 27 to the illustrated location and measure its camber.
If the reading is above the limit value of 7, the front axle shall be changed.

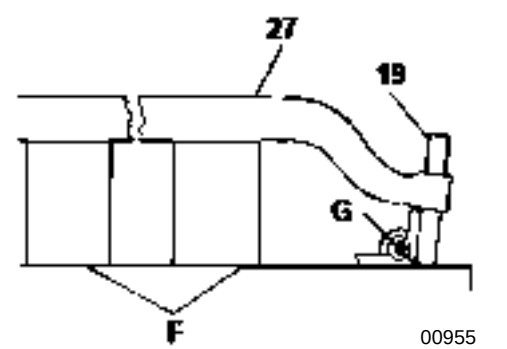
<Horizontal curvature>



<Vertical curvature>



00954



00955

Common Failures and Troubleshooting

Troubles	Causes analysis	Treatment method
Unsmooth Hub bearing	1.Over-big pre-tightening force for hub bearing	Adjust pre-tightening force
	2.Insufficient lubrication or improper grease for bearing	Apply grease or change grease
	3.Dusts adhered on the bearing	Clean and apply grease
Insufficient brake force	1.Ineffective rotation for camshaft	Check the operation conditions for camshaft
	2.Improper adjustment of push rod stroke for brake chamber	Adjust the stroke
	3.Overheat or deterioration for brake friction disc	Change friction disc
	4.Improper application of brake friction disc	Correct the application location of the friction disc
	5.Water intake into the brake drum	Slightly step on the pedal; fully discharge the waters during running process.
	6. Greases on the friction disc and brake drum.	Clean out the grease or change friction disc.
Abnormal brake noises	1. Protruded bolts caused by friction disc wear	Change friction disc.
	2. Hardening or deteriorating of surface of friction disc.	Change friction disc.
	3. Uneven brake drum or not firm installation.	Correct the brake drum or tightening bolts.
	4. Not tight contact for brake shoes and friction disc.	Change rivet.
	5. Loosen fixed pin of brake shoes.	Tighten the lock screw of fixed pin.
	6. Hub bearing wear	Change hub bearing
	7. Deformation of brake drum	Change brake drum
Unsmooth wheel	1.Improper lubrication of camshaft or not returned adjustment arm	Correct the failed parts
	2.Broken return spring or fatigue for brake shoe or chamber	Change the failed parts
Heavy operation of steering wheel, possible troubles and its elimination for front axle	1.Improper wheel positioning (excessive caster)	Check and adjust the positioning.
	2. Excessive clearance of king pin or bushing.	Check and adjust the clearance
	3. Inverse installation of thrust bearing.	Correct the assembly
	4. Insufficient lubrication of front axle parts.	Apply grease into the front axle
	5. Too tight or over loose ball joint connection.	Check and lubricate ball joint pin.
Steering wheel shimmy	1.Front axle bearing wear	Change bearings
	2.Excessive wear for king pin or bushing	Correct or change the troubled parts
	3.Deformation of steering knuckle	Change the steering knuckles.
	4. Improper positioning adjustment for wheels.	Check and adjust the positioning.
Deflection of steering wheel	1. Improper positioning adjustment for front wheels.	Check and adjust the positioning.
	2. Front axle bending.	Correct or change the front axle.
	3. Unsmooth braking.	See the related brake items.
	4. Loosen front hub bearing nut.	Tighten the nut according to the specified torque.
Uneven or early tire wear	1. Improper adjustment of front wheel positioning.	Check and adjust the positioning.
	2. Worn or torn hub bearing, loosen bearing nuts.	Change bearings or tighten the nut according to the specified torque.
	3. Too tight or too loosen ball joint pin, king pin and bushing.	Correct, if necessary, change the troubled parts

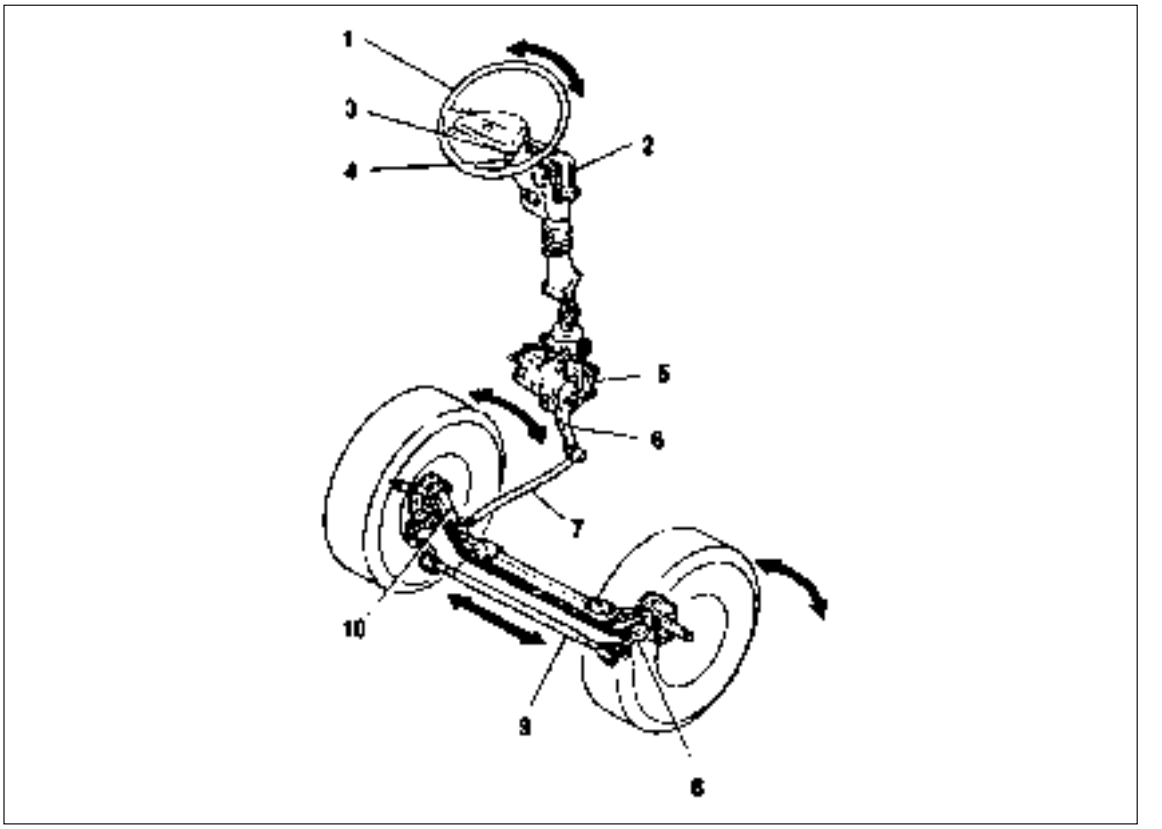
High–mortality Parts

No.	Name	Quantity
1	Front brake discs	8
2	Rivet- tightening front friction disc	48
3	Inner bearing – front hub	2
4	Outer bearing – front hub	2
5	Thrust bearing	2
6	Oil seal assembly- front hub	2
7	Sealing gasket – front hub cover	2

Steering System

►Introduction to steering system:

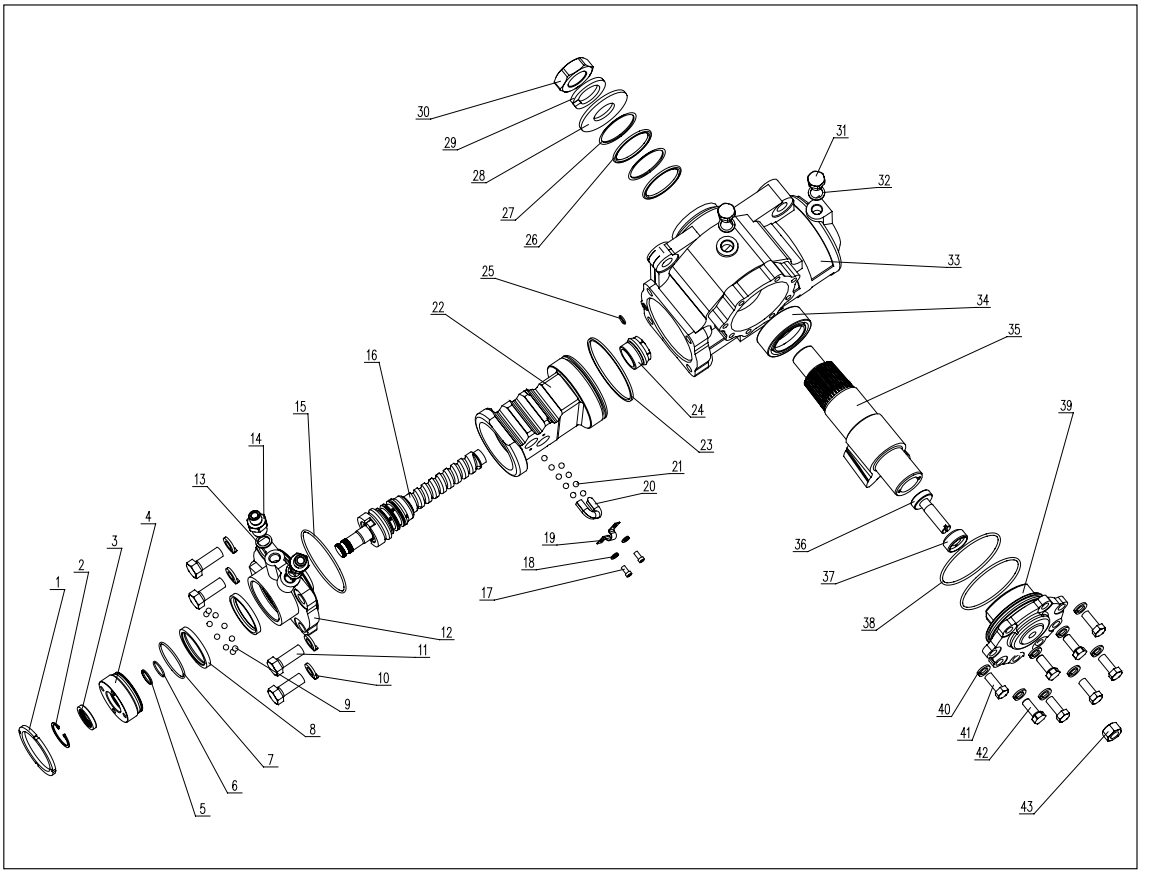
The power steering system of automobile is composed of power steering gear, steering oil pump, steering oil tank, steering oil pipes and steering transmission system. Of which, the power steering gear is the executive element of hydraulic assistance; the steering oil pump connected to the engine is the hydraulic power source of system; the steering oil tank has the function of storage, cooling, filtration and supplementing oil fluids; the steering transmission system is the transmission mechanism of realizing the automobile steering function.



Steering transmission system

No.	Name of spare parts	No.	Name of spare parts
1	Steering wheel	6	Steering pitman arm
2	Steering column assembly	7	Steering drag link
3	Horn contact	8	Steering tie rod arm
4	Combination switch	9	Steering tie rod
5	Power steering gear	10	Steering knuckle arm

Power steering gear:



No.	Name	No.	Name
1	Lock nut	1	
2	Retaining ring for holes	1	Q43040
3	Oil seal assembly-upper cover	1	Φ25×Φ40×7
4	Screw plug	1	
5	Sealing ring of valve body	1	Φ25×Φ22.2×2
6	O-Ring	1	Φ26.5×1.8G
7	O-Ring		Φ63×2.65G
8	Bearing outer ring	2	
9	Steel ball Φ8 GB308-84	20	
10	Spring washer 16 Q40316	4	
11	Hexagonal head bolt M16×1.5×42	4	Q151B1642TF3
12	Front cover	1	
13	Sealing washer	2	Q72318
14	Coupling head of oil inlet and outlet	2	
15	O-ring	1	Φ103.8×3.1
16	Valve body assembly	1	
17	Inner hexagonal screw M6×8	2	Q218B0608
18	Spring washer 6		Q403062
19	Duct clip	1	
20	Steel ball duct	2	
21	Steel ball Φ8 GB308-84	27	
22	Rack piston	1	
23	Sealing ring of rack piston	1	
24	Plug	1	
25	O ring	1	Φ9.5×1.8G
26	Sealing ring, output end of rocker arm (II)	2	
27	Sealing ring, output end of rocker arm (I)	2	
28	Flat washer 36 Q40136	1	
29	Spring washer36 GB93-87	1	
30	Hexagonal lock nut M36×1.5	1	
31	Magnetic screw plug	2	
32	Sealing washer	2	Q72318
33	Housing	1	
34	Needle bearing without inner ring	1	NK 60/28
35	Rocker shaft	1	
36	Adjustment screw	1	
37	Arm shaft screw plug	1	
38	O ring	2	Φ97.5×3.55G
39	Side cover assembly	1	
40	Spring washer 12 Q40312	8	
41	Hexagonal bolt M12×1.25×30	5	Q151B1230TF3
42	Double end stud	3	
43	Hexagonal nut M16×1.5	1	Q341B16

►Working principle

1. Neutral position

When the automobile runs in straight direction (the steering wheel does not rotate), the hydraulic oil feeding the oil pump is provided from the oil inlet, after passing through the pre-opened clearance, the hydraulic oil is returned to the oil tank from the return-oil inlet because the rotating valve does not rotate at this time, the oil pressure at two operation chambers are the same, not producing the power.

2. Steering process

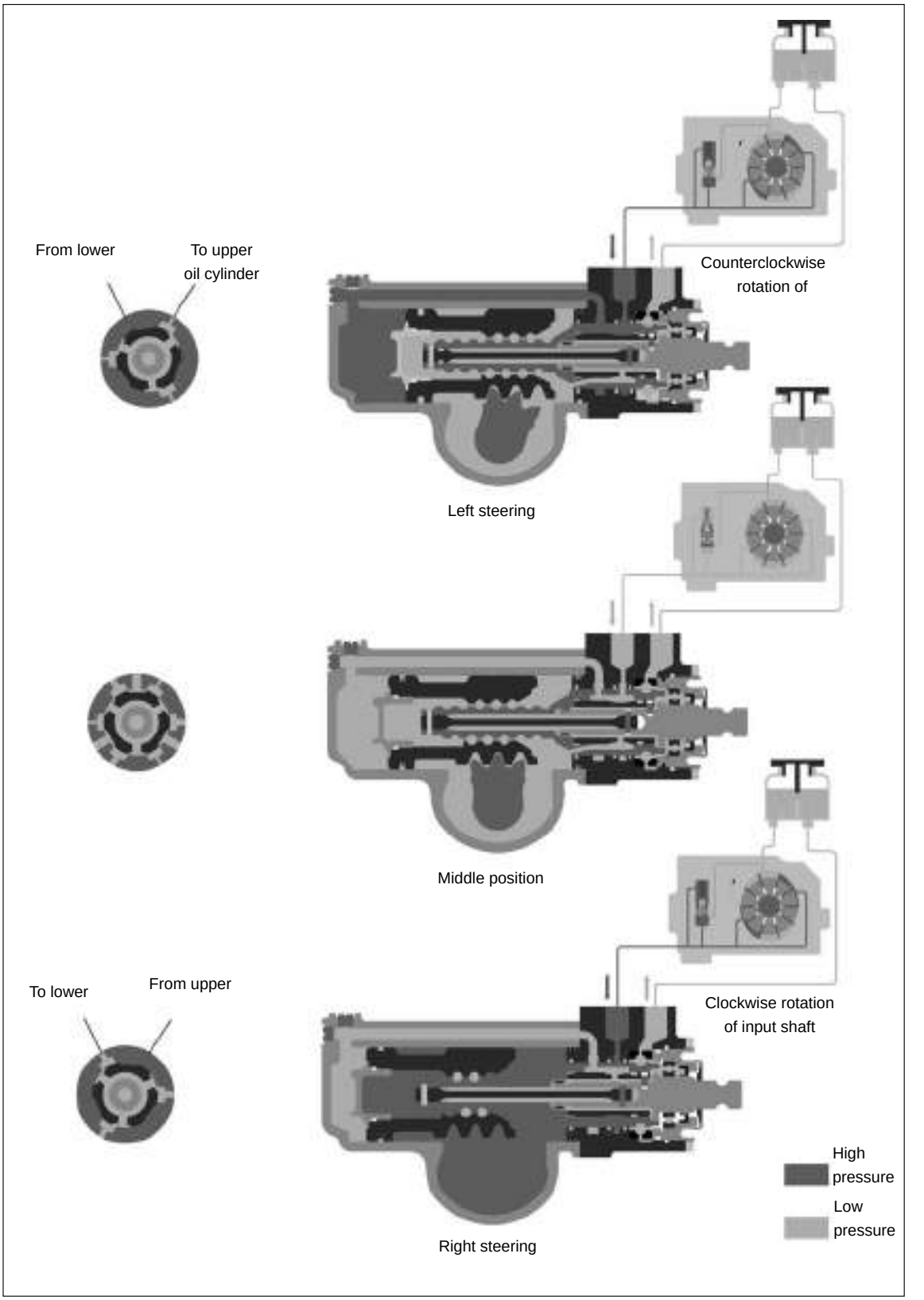
When the steering wheel is rotated, the pre-opened clearance is changed between the valve sleeve and the steering screw, so as to produce the oil pressure difference corresponding to the steering resistance for the hydraulic oils flowing into two operation chambers, this oil pressure difference is applied on the steering nut (piston) to rotate the steering nut (piston) to overcome the steering resistance, producing placement, so as to drive the rotation of the arm shaft, realizing the power steering.

3. Return process

When the power steering is completed, the force applied on the steering wheel is disappeared, under the function of the internal torsion bar of the power steering gear and the automatic aligning torque of the front wheel of automobile, the oil pressure difference is disappeared for two operation oil chambers of the power steering gear, the automobile wheels will move toward the linear running direction until completely returning to the linear running direction of automobile.

4. Road feel effect

Road feel effect means the ability of producing steering feel. When the driver applies the force on the steering wheel, at the same time, this force applies on the torsion bar of the power steering gear too, causing the torque deformation; however, this deformation amount depends on the steering resistance of wheels, when the steering resistance is big, the deformation amount is increased accordingly, therefore, the driver can judge the variation of the steering resistance according to the forces applied on the steering wheel, so as to achieve the “road feel” effect.


From lower
To upper
oil cylinder
Counterclockwise
rotation of
Left steering
Middle position
To lower
From upper
Clockwise rotation
of input shaft
High
pressure
Low
pressure
Right steering

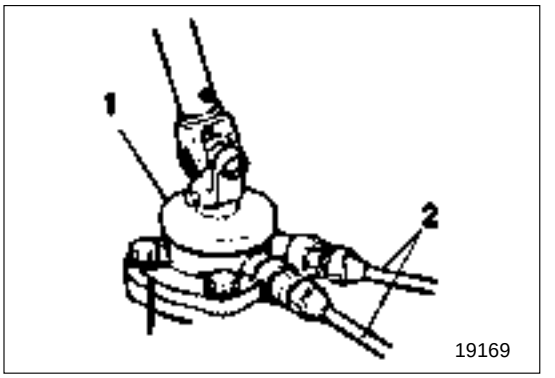
►Operation instructions and maintenance of power steering gear:

To make the power steering gear work safely and reliably, the driver shall fully understand the structural principle, operation methods and maintenance regulations of the steering gear.

- This integral power steering gear belongs to the constant flow structure, which drives the oil pump by the automobile engine. Therefore, the automobile shall not slide with power off to prevent from the driver not accommodating the heavy steering caused by the engine power off, resulting in accidents.
- The power steering gear can work as the mechanical steering gear, if the failures of the oil pumps or the oil circuits appear in the steering system, forcing the steering to drive the automobile to reach the repair point, however, it is not allowable to perform the long time forced steering. Prohibit the over-load of the vehicle so as to ensure the safe driving.
- The inside of the power steering system shall be kept clean. It is not allowable to apply the unclean container to receive the oils during oil filling process. The parts shall not be randomly placed during disassembly process. No any sundries shall be entered into the system during assembly process. The operation oil level shall not be less than the specified standard.
- The users shall not randomly disassemble the control valve of the steering gear.
- When the steering pitman arm is assembled, the alignment shall be ensured for the wheel, the mark line on the pitman arm shall be aligned to the mark line of the output end surface of the rocker shaft. When the automobile runs in the straight direction, if any too big or too small free clearances are found in the steering wheel, the steering universal joints and tie rod system shall be checked.
- During the steering process, it is allowable to rotate the steering wheel to the limit position. However, the time shall not be too long, preventing from influencing the service life of the oil pump.
- The oil inlet and outlet shall not be connected oppositely in the power steering gear. The oil inlet and outlet shall be connected according to the arrow direction of the front cover for the power steering gear, the inlet oil is the high pressure oil of the oil pump, and the outlet oil is low pressure oil of the oil return tank.
- The oils shall be duly changed after 3000km of running-in for the new steering gear and subsequent running every 5000km, meanwhile, the filter element shall be changed in the oil tank. The filtering accuracy shall not be less than 30um for the filter element. Frequently check whether the oil amounts in the oil tank are lacked, whether the oils are deteriorated, whether the impurities are excessive, duly add or change oils in case of any bad states are found.

Warning ⚠

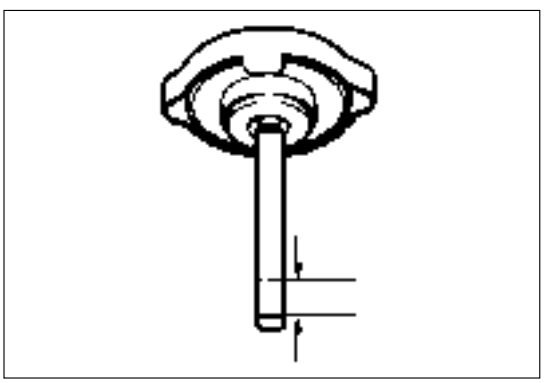
To prevent from any damages of the power steering gear and steering oil pump, strictly prohibit the pivot steering of the vehicles, whatever with double front axle or single front axle, with idle load or full load. The holding time shall not exceed 10 seconds when the wheels turn to the left and right limit position during running process.



► Change power steering oils:

Oil discharges：

- Erect the front axle or uncouple the steering drag link from the pitman arm.
- Loosen the connection and the oil tube 2 of the power steering gear 1.
- Open the oil tank cover, repetitively rotate the steering wheel to the limit position of two ends to discharge the residual oils from the oil pump and oil tank. If necessary, idling running the engine and operating the steering wheel to the left and right limit location for several times, until no any oils discharging from the oil ports.
- Tighten the oil tube 2 after the oil fluids are discharged.
- When the ambient environment is above 00C, the power steering gear applies common hydraulic oil No. 46, when the ambient environment is below 00C, it applies common hydraulic oil No. 32, the oils shall be clean.



Oil filling:

Warning ⚠

- Do not rotate the steering wheel to the left and right limit position for above 10 seconds during engine rotating process. Otherwise the power steering oil pump will be blocked.

- Fill the oils from the power steering oil tank port.
- In case of the flameout of the engine, erect the front axle and repetitively rotate the steering wheel to the left and right limit position, fill the oils after the oil level is fallen.
- Start the engine, repetitively rotate the steering wheel to the left and right limit position at the idle speed running state. Refill the oils after the oil level is fallen. Keep the oil level within the scale scope of the oil gauge. Repeat the above procedures, until the oil level does not fall any more.
- The abnormal noises indicate that airs are

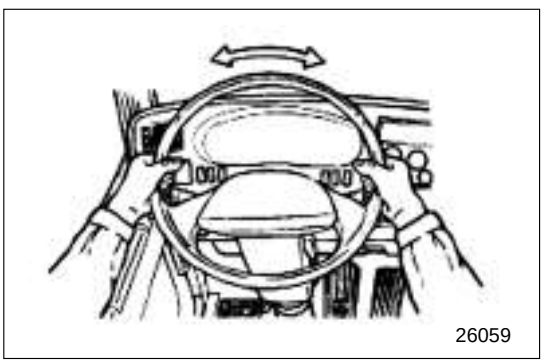
available in the system. Rotate the steering wheel for several times to increase the oil temperature under this condition. Stop the engine, keeping this state for 5 minutes.

- Lay down the front wheel and rotate the steering wheel for several times, if no any abnormal noises are heard, this indicates that the air discharges are completed.
- Shall check the oil level in the oil tank, check whether any oil leakages are existed in the pipes and joints after the airs are eliminated.

Clearance of steering wheel:

Maintenance standard

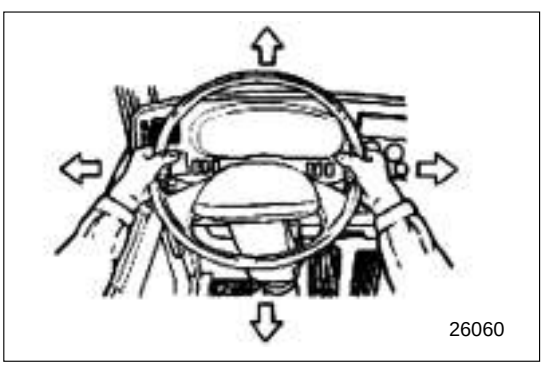
Location	Maintenance Items	Standard Value	Limit Value	Correction Method
-	Clearance of steering wheel (measuring from the external circle of the steering wheel)	15-35	-	Correct



Locate the automobile in the straight forward position, start the engine. Slightly rotate the steering wheel to the left and right direction, measure the clearance of the steering wheel from the external circle of the steering wheel, if the measured clearance does not conform to the standard value, the side clearance of the tightening point and the power steering booster shall be adjusted.

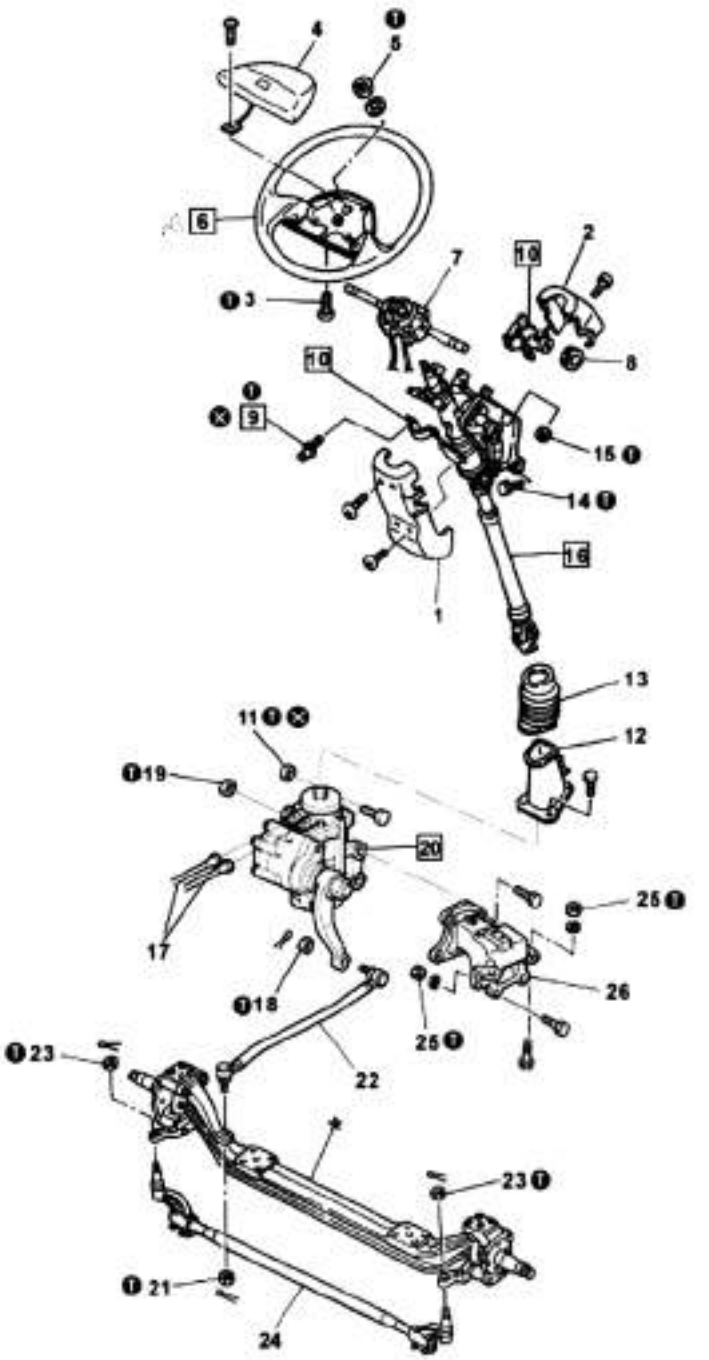
Steering wheel loosening, offset and drawing to one side

Steering wheel loosening, offset and drawing to one side



- Move the steering wheel up and down, forward and backward, left and right to check whether any loosened parts are existed.
- Drive the automobile at low speed, at the same time, check whether any vibrations, drawing to one side, excessive heavy operation and worse self-returning problems are existed.

► Dismantling sequence:



● Dismantling sequence

1 Rear cover of shaft	11 Nut	21 Nut
2 Front cover of shaft	12 Support	22 Steering drag link
3 Screw	13 Dust protection cover	23 Nut
4 Gasket of steering wheel	14 Bolt	24 Steering tie rod assembly
5 Nut	15 Nut	25 Nut
6 Steering wheel assembly	16 Steering column assembly	26 Power steering booster support
7 Combination switch	17 Oil tube	
8 Oil ring of metal seal	18 Nut	
9 End cutting bolts	19 Nut	Parts not be used repeatedly
10 Start switch	20 Power steering booster	

Remarks:

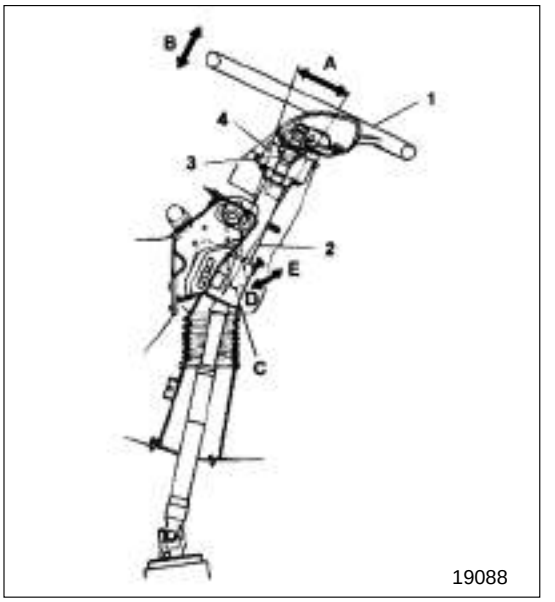
- Pay attention to handle the steering wheel assembly 6, do not drop it or make any collision to the hard materials.
- Firstly clean the oil hole areas, preventing from any intruded dust before disassembling the oil tube 17.

● Dismantling sequence

According to the opposite sequence of disassembling

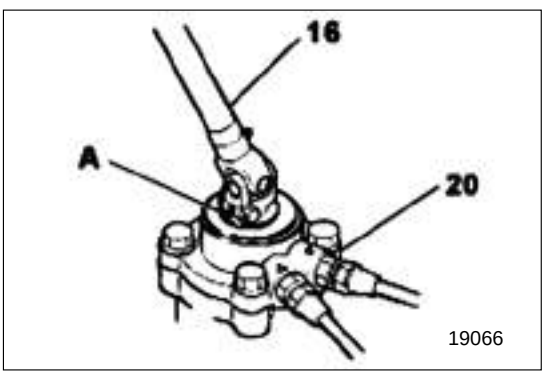
Tightening torque

Position	Parts tightened	Tightening torque	Remark
3	Screw (for installing the gasket of the steering wheel)	3.92(0.4)	
5	Nut (for installing the steering wheel assembly)	68-78(6.9-7.9)	
9	End cutting bolts(for installing starting switch)	13-15(1.3-1.5)	
11	Nut (for installing steering column assembly and power steering booster)	51.45±2.45(5.25±0.25)	
14	Bolt (for installing steering column assembly)	17.26(1.7-2.6)	
15	Nut (for installing steering column assembly)	9-14(0.9-1.4)	
18	Nut (for installing power steering booster and steering drag link)	353±88.3(36±9)	
19	Nut (for installing power steering booster)	270±34(27.5±3.5)	
21	Nut (for installing steering drag link and front axle assembly)	353±88.3(36±9)	
23	Nut (for installing steering tie rod and front axle assembly)	353±88.3(36±9)	
25	Nut (for installing power steering booster support)	255-343(26-35)	



►Steering column assembly

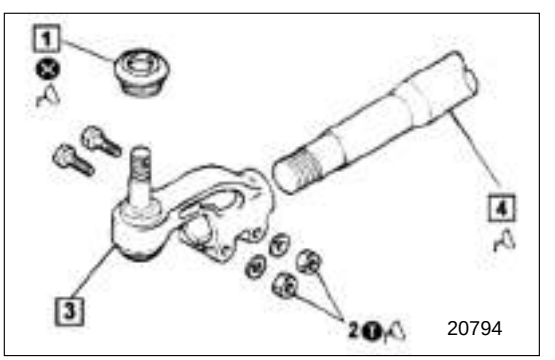
- The steering wheel 1 is a kind of vibration absorption steering wheel. Its shape can be improved to absorb the impact when the strong force is applied on it during the accidents, so as to release the harm to the driver's abdomen.
- The steering column assembly 2 can be adjusted at two directions. Its structural design is: when the lock rod C is moved from the lock location D to the free location E, either the inclined movement A or the telescopic movement B can be performed so as to adjust it to the optimal driving position.



Disassembly and installation of steering column assembly and power steering booster 16 and 20
Firstly make the fitting mark A, then disassemble the steering column assembly from the power steering gear 20.

Caution ⚠

- The bolts and nuts connecting the steering column assembly and power steering gear shall be the standard part of automobile with self locking function.



►Steering tie rod assembly

Disassembling sequence

1 Dust protection cover
2 Nut
3 Steering tie rod end joint assembly
4 Steering tie rod
⊗: Parts not to be used repeatedly

Remark

- Do not disassemble the dust protection cover 1, unless if it has defects.
- Do not try to dismantle the steering tie rod end joint assembly 3, because it is an integral structure.

Assembling sequence

According to the opposite sequence of dismantling.

Maintenance Standard **Unit:mm**

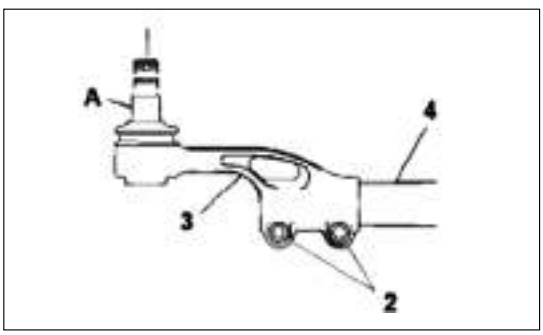
Location	Maintenance Items	Standard Value	Limit Value	Correction Method
4	Curvature for steering tie rod	Below 2.7	2.7	Change

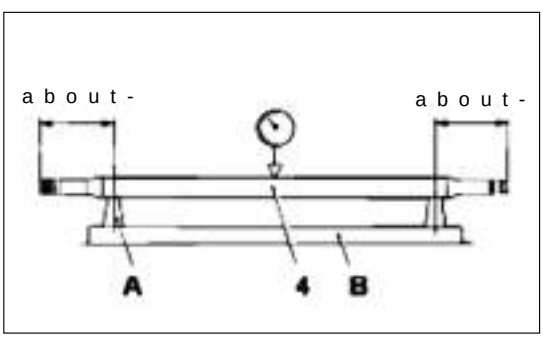
Tightening torque **Unit:N.m{kgf.m}**

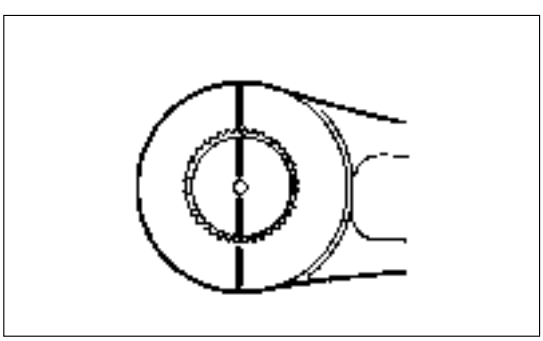
Position	Parts tightened	Tightening torque	Remarks
2	Nut (for fastening the steering tie rod end joint assembly)	78+12(8.0±1.2)	Wet

Lubricants

Position	Application location	Specified lubricants	Quantity
3	Whole external area of O-ring	Lubrication oil applied in the freezer S-PAG56	As required
4	External area of pipes	Lubrication oil applied in the freezer S-PAG56	As required







Installation

Install the steering tie rod end joint assembly 3 to the steering tie rod 4, make the central distance C of ball pin A between the left and right steering tie rod end joint assembly 3 to the indicated value, then tighten the nut 2 to the specified torque.

4 Curvature of steering tie rod

Measure the curvature at the central point of steering tie rod 4, if the measurement value exceeds the limit value, the steering tie rod shall be corrected or changed.

A: V Block

B: Flat plate

Remarks

When the measurement value of the steering tie rod 4 has any offsets, rotate it for one whole cycle, then read the indicating value of the micrometer gauge, the curvature is 1/2 of the indicating value.

►Installation of the steering pitman arm:

Installing the steering pitman arm

- Install the steering pitman arm to the output shaft of the steering gear, and install the flat washer and spring washer to the shaft.
- Tighten the nut to about 450N•M.

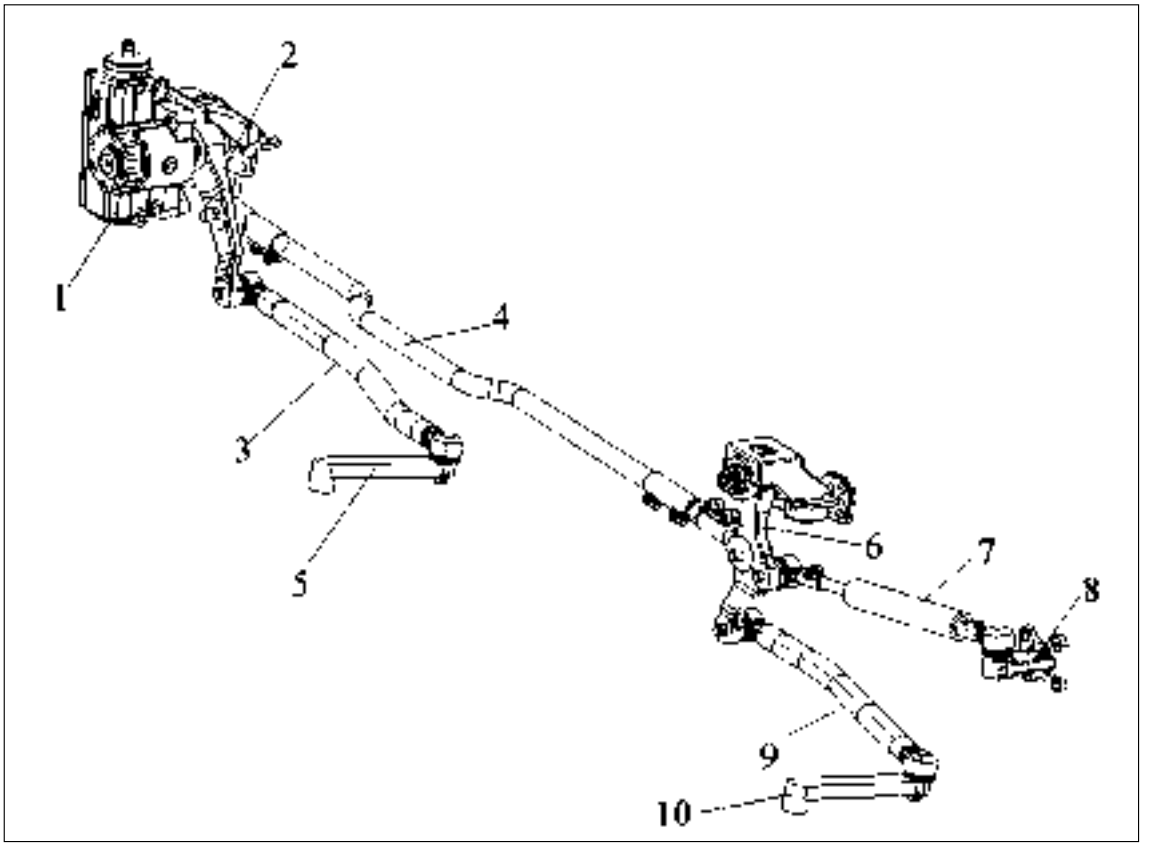
Troubleshooting:

Possible reasons \ Symptom		Operation troubles of the steering wheel	Too big or not constant clearance of steering wheel	Drawing to one side of steering wheel	Vibration of steering wheel	Worse self-returning property	No movement of steering wheel	Insufficient steering angle or different steering angle of left and right steering wheel	Oil leakage	Abnormal hydraulic pressure	Coo noises are sent from the oil pumps	Screaming noises are sent from the oil pumps	Rumbling noises are sent from the oil pumps	Remarks
Failure of power steering mechanism	Damage or wear of thrust bearing	O			O	O								
	Wear of circulating ball groove and steel ball	O	O		O									
	Insufficient discharged airs	O												
	Improper oil viscosity	O												
	Failure of power steering booster	O												
	Failure of oil pump valve	O												
	Wear of rack and gear for circulating ball component		O											
	Bearing wear of sector gear shaft		O		O									
	Loosen installation bolts or nuts for power steering booster		O											
	Improper backlash between the circulating ball and the sector gear shaft				O									
	Valve control edge damage or control seal ring and O ring wear				O									
	Improper oils of power steering system				O									
	Improper adjustment for starting torque of rack meshing	O				O								
	Blocked hydraulic circuit	O				O								
	Gear wear of sector gear shaft		O											
	Damage or wear of short shaft fine gear surface		O											
	Failure of power steering booster	O		O	O									
	Damage of O ring and oil seal								O					
	Improper sealing glue application								O					
	Low level of oil tank	O												
Failure of steering column and linkage mechanism	Abnormal wear, damage or improper lubrication of universal joints	O	O											
	Deformation of continuous rod	O												
	Loosened ball pin of steering drag link		O		O									
	Loosened ball pin of steering tie rod end joints		O		O									
	Bent steering tie rod						O							
	Improper installation location of steering arm							O						
	Rotation center offset of steering wheel			O										

Possible reasons \ Symptom		Heavy Operation of the steering wheel	Too big or not constant clearance of steering wheel	Drawing to one side of steering wheel	Vibration of steering wheel	Worse self-returning property	No movement of steering wheel	Insufficient steering angle or different steering angle of left and right steering wheel	Oil leakage	Abnormal hydraulic pressure	Coo noises are sent from the oil pumps	Screaming noises are sent from the oil pumps	Rumbling noises are sent from the oil pumps	Remarks
Failure of front axle and etc.	Improper lubrication of king pin	O		O		O								
	Improper front wheel positioning (toe-in, camber , king pin caster)	O		O	O	O								
	Thrust bearing wear	O												
	Wear or damage of wheel hub bearing		O	O	O									
	Wear or damage of king pin or bushing		O	O	O									
	Deformation of front axle			O										
	Improper tightening of steering knuckle arm, steering tie rod arm, or steering knuckle				O									
	Loosened U bolt or nut for front spring				O									
	Too tight front axle parts					O								
	Improper adjustment of steering angle						O	O						
	Loosened fastening parts and connection points		O											
	Improper adjustment of steering knuckle limit bolt							O						
Failure of oil pumps	Failure of oil pump body								O					
	Damage of O ring and oil seals								O					
	Improper tightening of bolt								O					
	Insufficient yielded maximum hydraulic pressure									O				
	Damage or blocking of hydraulic pipes									O				
	Air entering into the oil pumps										O			
	Internal blocking of oil pump									O	O	O		
	Loosened installation of bolts or nuts												O	
	Pump body damage	O											O	
	Failure of valve									O				
Failure of oil tank	Oil leakage caused by excessive oils in the oil tank								O					
	Oil leakage of the oil tank, caused by air resistance function								O					

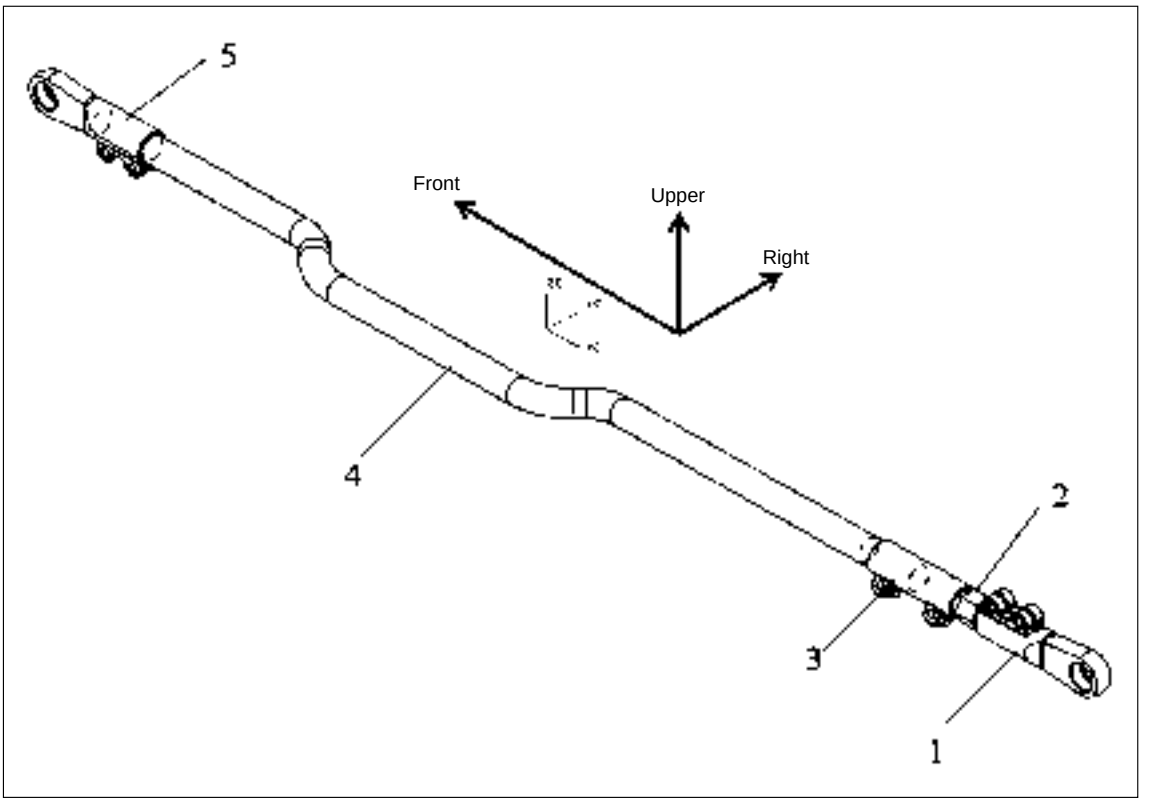
Possible reasons \ Symptom		Heavy Operation of the steering wheel	Too big or not constant clearance of steering wheel	Drawing to one side of steering wheel	Vibration of steering wheel	Worse self-returning property	No movement of steering wheel	Insufficient steering angle or different steering angle of left and right steering wheel	Oil leakage	Abnormal hydraulic pressure	Coo noises are sent from the oil pumps	Screaming noises are sent from the oil pumps	Rumbling noises are sent from the oil pumps	Remarks
Other failures	The load is too near to the front side of the load carrying stand	O												
	The load is too near to the rear side of the load carrying stand		O											
	The load is too much deviated to one side of the load carrying stand			O										
	Big difference of the left and right wheelbase			O										
	Radial run-out of transaxle				O									
	Bended front axle				O									
	Bended rear axle housing			O										
	Damage or improper meshing of reducing gear and small gear				O									
	Insufficient tire pressure	O												
	Too big tire pressure		O											
	Not identical left and right tire pressure			O	O									
	Too big wear difference of left and right tire			O										
	Different outer diameter of left and right tire			O										
fuel tank malfunction	Radial and transversal run out of front tire, improper static and dynamic balance				O									
	One side braking			O										

►Double front axle steering mechanism:



No.	Name of spare parts	No.	Name of spare parts	No.	Name of spare parts
1	Power steering gear	5	The first axle steering knuckle arm	9	The second steering drag link
2	Steering pitman arm	6	Middle arm	10	The second axle steering knuckle arm
3	The first steering drag link	7	Power steering oil cylinder		
4	Steering linkage	8	Oil cylinder support		

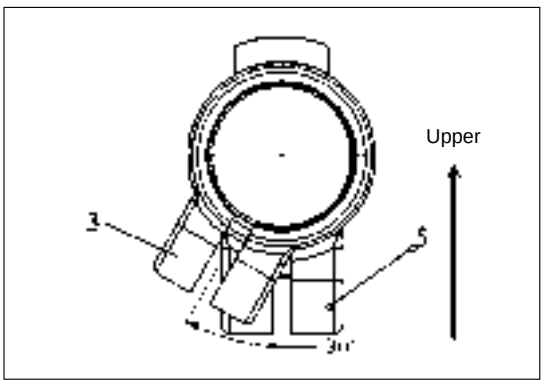
►Assembling the steering linkage assembly:



No.	Name of spare parts	No.	Name of spare parts
1、5	Bearing support	3	Linkage cutting sleeve
2	Adjustment rod	4	Steering linkage

● Do not dismantle the steering linkage unless any components are damaged in the steering linkage assembly.

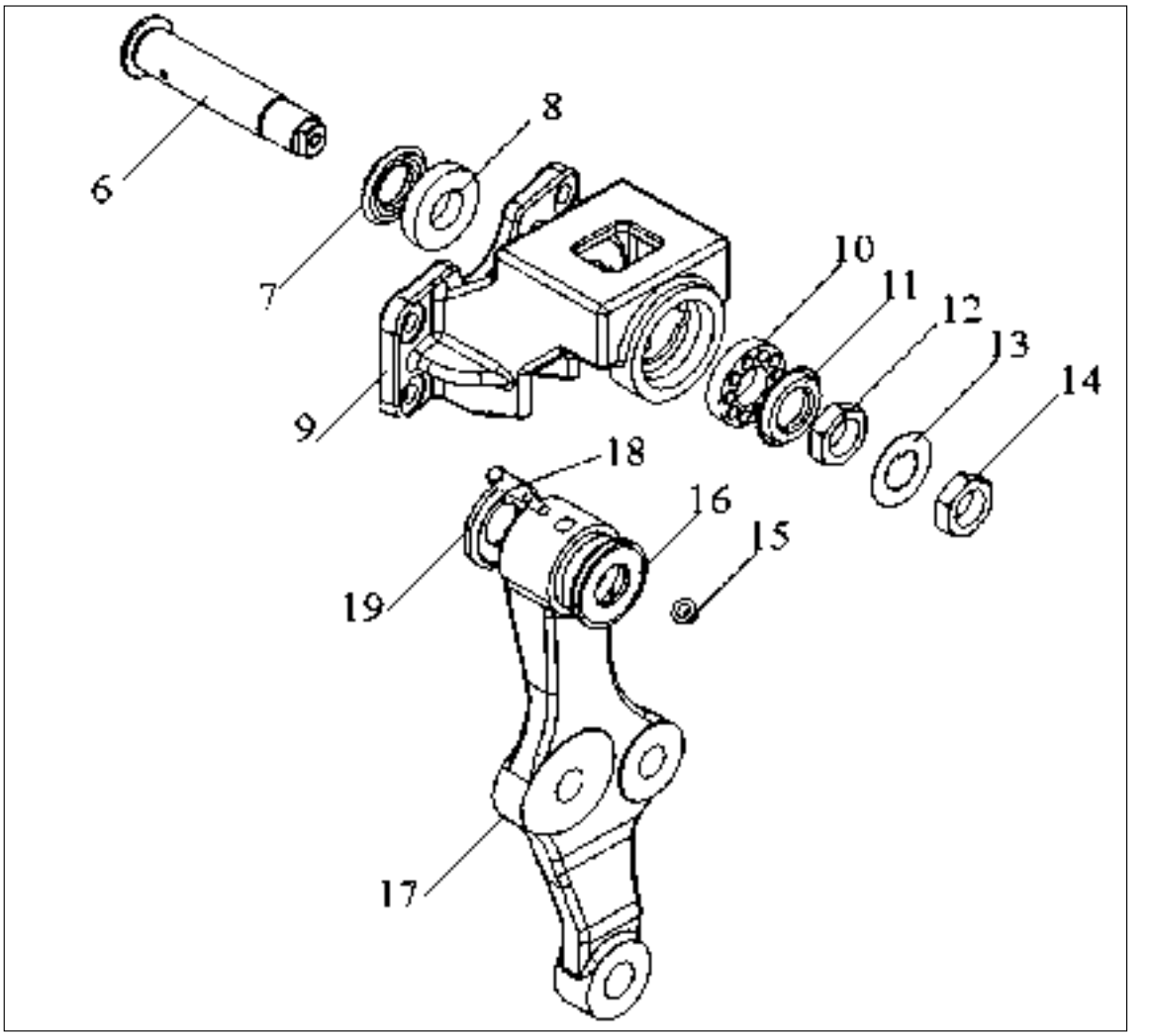
The assembly sequence of the steering linkage is 1----2----3----4----5



Caution ⚠

1. Comply Strictly with the assembly sequence for assembling.
2. The screw connection shall be rotated to the end for each step of assembly.
3. The lug of bearing support 1 is placed upward; the lug of bearing support 5 is placed downward; the lug of linkage cutting sleeve 3 is inclined at 30 degrees (see attached drawing).

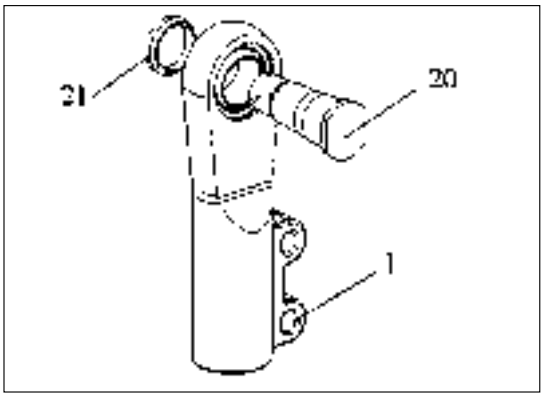
►Assembling the middle arm:



No.	Name of spare parts	No.	Name of spare parts
6	Pin shaft	13	Lock plate
7、11	Seal ring	15	Hexagonal flange face nut
8、10	Bearing	16、19	Sealing ring II
9	Middle arm support	17	Middle arm
12、14	Hexagonal thin nut	18	Lock pin

Caution ⚠

1. Apply the grease to the bearing during the installation of the bearing.
2. The bearing shall be installed in place, which is stopped by the boss of the middle arm support.

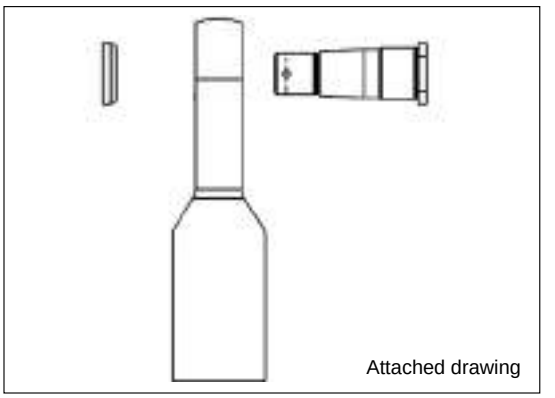


►Assembly of the pin

1. Bearing support

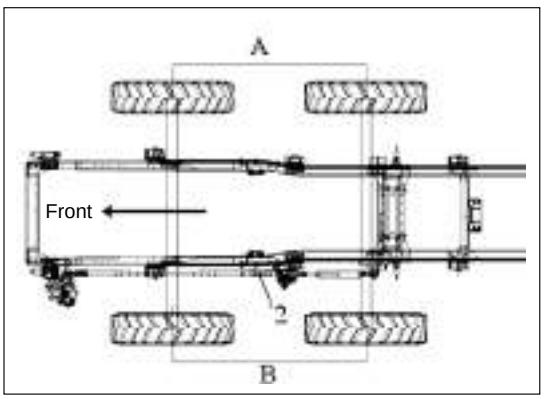
20. Pin

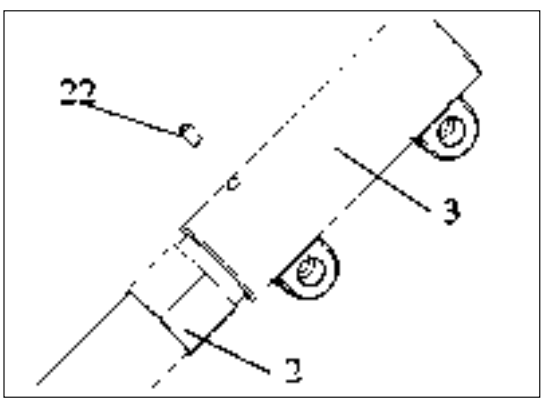
21. Washer



Caution

The washer shall not be oppositely installed. (See attached drawing).





►Commissioning of the double front axle steering mechanism

Main points:

1. Check whether the toe-in of two front axles is correct. The front axle toe-in of 0-2 is qualified for radial tire application. The front axle toe-in of 1-4 is qualified for other tire application.
2. When the first front axle is vertically forward, adjust the regulating rod 2, making the track B between double wheels on left side is equal to track A between double wheels on the right side. This theoretical value is 1850mm. The error of this actual value is possibly existed due to the different load and etc., which shall be controlled within 8 mm.
3. After the adjustment is completed, lock the inner hexagonal lock bolt 22 to the small hole of linkage cutting sleeve 3.
4. Finally, lock all bolts on the steering linkage assembly.

5 457 Single Rear Axle

Operation and Maintenance

►Before the use of new vehicle

You should apply sufficient 2# lithium base grease to grease nipple.
Should apply sulfur-phosphor type, heavy-load and 90# gear oil to lubrication hole, until the oil-level hole in rear cover is even (about 12 liters)

►Use of new axle

After installed new axle in the vehicle and run-in 1500 km, should drain gear oil, clean decelerator and inner cavity of axle housing. Refill new gear oil, check and tighten all fastenings as specified torque. Adjust brake clearance again and replace grease in the hub. Then it can be put into use formally.

►Maintenance of axle

A. Clean dirt and dust on vent plug of rear axle housing often.

B. Check screw-plug of lubrication hole and screw-plug of oil drain hole usually. If there is leakage, tighten or replace sealing gasket timely.

C. When do elementary maintenance, check tightness conditions of half shaft bolts. If loosen, the half shaft bolts will rupture. Thus, you should retighten half shaft bolts as requirement.

D. When do complete maintenance, you should disassemble hub, clean inner cavity of hub and hub bearing, then fill new grease to cavity among inner ring of bearing, roller and holder. Finally, assemble again as requirement and adjust the tightness degree of hub bearing. When assemble, check the thread of tightening nut of half shaft sleeve and hub bearing. If there is slip and serious damage that will affect the tightness of nut, repair or replace it.

E. When do complete maintenance, check and replenish grease in rear axle housing. Clean vent plug.

F. Every 1500 km or when do complete maintenance, remove main decelerator and tighten nut of differential bearing cover and differential housing. Dismantle propeller shaft, tighten flange nut of driving bevel gear, and replace lubricant.

G. When do No.3 maintenance level, you should break down the components, check and maintain. After reinstall rear axle assembly, should apply new lubricant and grease, and run-in. Rear axle should use 2# lithium base grease.

H. After every 2000km, should add 2# lithium base grease to all grease nipples and clean vent plug; check tightening conditions of half shaft bolt, check brake clearance and replenish gear oil.

I. After every 6000~8000km, should check tightening conditions of brake plate, check tightness degree of hub bearing, and check wear conditions of friction disc in brake. If wear of friction disc exceeds locating depression in friction disc, you must replace friction disc at once. Check if the grease in hub

bearing is degenerative or unfreezing, if that, replace it.

Dismantling and Disassembly of Rear Axle

Dismantling and deassembly of rear axle should be done according to fault features and repair contents of rear axle.

►Dismantling of rear axle can be done as the following sequence:

1. Screw out oil drain cock that is in the bottom side of axle housing, and drain out lubricant in axle housing;

2. Dismantle connecting bolt between driving bevel gear flange and propeller shaft;

3. Disassembly of half shaft: Before disassemble, cover front wheel with wood, and undo parking brake. During disassemble, undo and screw out all tightening nuts of half shaft and gaskets; use copper hammer to tap center of half shaft tail 2~3 times slightly, to make flange face of half shaft separate from connecting face of hub, then pull half shaft flange with hand, and it will be pulled out. Please note that, when spline of half shaft is about to pass though oil seal, hold half shaft rod with hand, and rotate half shaft slowly to move out the half shaft in parallel. So that the oil seal of half shaft cannot be damage, and can prevent half shaft falling down to injure persons.

4. Dismantling of main decelerator assembly:

A: Dismantle rear brake hose and three-way union.

B:Support decelerator housing with dolly, remove 12 bolts connecting decelerator housing and rear axle, and take down decelerator assembly from axle housing.

5. Disconnect brake chamber hose and connection between pipelines. Dismantle brake chamber and dismantle adjusting arm assembly.

6. Dismantle tightening screw of lock slice of adjusting nut for hub, take out lock slice, and remove adjusting nut of hub with special socket. Rotate hub and brake drum slightly, pull hub outside with gear puller; at the same time, tap brake drum slightly, to loosen inner ring of outer bearing; after inner ring of outer bearing is loose, take down hub and brake drum assembly. Please note that, the assembly is heavy, do not fall down or injure persons. Prevent inner ring of outer bearing from falling down.

7. Dismantle inner ring assembly of inner bearing and seat ring assembly of oil seal with gear puller.

8. Dismantle return spring of brake with removal tool, and take down camshaft; dismantle tightening bolt of brake plate with wrench, and take down brake plate, including brake shoe and dust cover assembly.

9. Dismantle brake chamber bracket and axle housing assembly.

►Disassmebly main decelerator assembly:

1. Before break down main decelerator assembly, make marks on left and right bearing cap of differential, to avoid confusion when reinstall. Use dial indicator to measure tooth-side clearance of driving gear and driven gear.

2. Take apart bolt of lock slice of differential bearing cap, take down lock slice, and slacken fixing bolt of bearing cap. Use differential wrench to dismantle nut of bearing cap.

3. Dismantle bearing cap and bolt of differential. Take out differential assembly as indicated.

4. Dismantle bolt connecting bearing seat of driving bevel gear and differential housing, and take down driving bevel gear assembly. Do not damage or lose adjusting gasket of bearing seat of driving bevel gear.

5. Dismantle driving bevel gear. First, separate nut that fixes flange of driving bevel gear from jointed part of driving bevel gear head, screw out nut with special tool, and take down flange assembly; then, extrude driving bevel gear and inner ring of rear bearing. If bearing is not damage, do not dismantle inner & outer ring; if replace, dismantle it. Do not lose adjusting gasket.

►Disassembly of differential assembly:

1. Make marks on composition plane of left & right housing of differential, disassemble bolt that fixes differential housing. Then knock outer flange of driven bevel gear with copper rod slightly, to break down differential.

2. Take down thrust washer and half shaft gear, and measure tooth-side clearance of planet gear.

3. Dismantle planet gear and spider assembly, and then dismantle thrust washer and planet gear from spider.

4. Take down half shaft gear and thrust washer.

5. Dismantle the bolt that fixes left housing of differential and driven bevel gear, dismantle driven bevel gear.

6. Check if bearing on both sides of differential is damage, if no, do not dismantle bearing; if yes, replace inner & outer ring of bearing together.

Inspection and Cleaning

►Cleaning

There may be dirt oil and silt on the components. Cleaning components is the necessary process. Typical method is as the following: steam cleaning, gasoline cleaning, acidic or alkaline solution cleaning, neutral

solvent cleaning, trichloroethylene cleaning and magnetic force cleaning. During cleaning, you may find that some components are damaged. So, during cleaning process, you should check carefully.

1.1 Metal parts

1. Gasoline

Different from other methods, gasoline hardly has penetration or dissolution ability on sludge. Unless the part surface is finished, you should use metal brush or other tool to eliminate sludge, and brush twice.

1.2 Alkalization treatment

1. It is effective to use alkalization treatment method to clean steel parts or cast iron parts. If the component made up of alloy, do not use alkalization treatment method.

2. Rubber parts

Do not use mineral oil. Can use alcohol to clean, or use clean dishcloth to scrub sludge.

1.3 Anticorrosion

After clean all waste oil and grease on the surface of components, you should apply a layer of clean oil on the surface to avoid corrosion.

►Inspection

Before clean the parts, use prepared meter or tool to check. Based on specified repair standard, judge that if the part is suitable for reuse. Repair or replace damaged parts as required. For matched parts, if one of the parts is worn badly and the installing clearance is beyond regulation, can replace this part or the matched parts as required. In principle, should replace the matched parts.

In view of preventative maintenance, some parts that are in the repair or wear limit, should replace them before they are beyond the limit.

According to requirement, check all the parts carefully by appearance or nondestructive examination that includes infrared ray, ultrasonic and X ray. If there is abnormal phenomenon, such as uneven wear, rust, bend, deformation, scratch, crack, changing color, incompact fit, friction disc worn excessively, friction disc deteroprated, return spring disabled or weakened, and bearing or gear has abnormal noise, then should repair or replace this part as required.

For all rubber parts, such as O-ring, oil seal and gasket, after being dismantled, determine that if they should be scraped and replaced by new one. Half shaft oil seal and driving bevel gear oil seal must be replaced after being dismantled.

Clean decelerator and the parts of differential assembly, place as installing order.

Check dismantled bearing, gear and other parts for ablation, flaking, spot or excessive wear, if that, replace it.

Assembly and Adjustment

The assembly sequence of rear axle system is contrary with disassembling sequence. You should pay attention to the tightening torque of bolt and pretension force adjustment of bearing. When install pipeline of brake chamber, should pay more attention to the mark on the brake chamber. The air hatch that has the DRIVING or driving mark should connect with running brake valve (that is foot brake), and the air hatch that has PARKING or parking mark should connect with parking brake valve (that is hand brake). It is not allowed to make wrong matches. Otherwise, brake is invalid.

►Tightening torque of bolt

Part name	Tightening torque（N.m）	Part name	Tightening torque（N.m）	Part name	Tightening torque（N.m）
Oil drain cock	130~150	Fixing bolt of rear brake plate	200~250	Fixing bolt of bearing cap for differential	680~720
Screw-plug of oil level hole	130~150	Fixing bolt of brake chamber bracket	120~130	Bolt of stop piece for differential bearing cap	20~25
Half shaft bolt	140~180	King nut of driving gear	500~600	Fixing bolt of bearing seat for driving bevel gear	140~170
Connecting bolt between decelerator housing and axle housing	140~170	Fixing bolt of driven gear	530~570		
Fixing nut of rear brake chamber	167~186	Fixing bolt of left & right housing of differential	410~450		

►Adjustment of axle

A. Adjustment of brake clearance of the brake

The clearance between brake friction disc and brake drum is too big or too small, which will affect the brake performance of the vehicle. At this time, use wrench to adjust worm on the adjust arm. At first, rotate anticlockwise to make the clearance be zero (that is, retract push rod of brake chamber completely. Do not adjust contrarily, because that will weaken brake torque and affect brake effect); then, rotate the worm reversely about 1/2 run. At this time, the clearance is about 0.5~0.8 mm.

B. Adjustment of pre-tension force of hub bearing

Use special wrench to tighten adjust nut with torque more than 500 Nm, and rotate brake drum 2~3 turns to make bearing be in position; then tighten adjust nut with torque more than 500 Nm, rotate adjust nut 1/4~1/6 run reversely, and rotate brake drum 2~3 turns. Use spring balance to measure start force on the hub bolt, the force should be 30~65N. If the force is not in this range, dismount the nut, rotate brake drum 2~3 turns, and reinstall.

►Maintenance standard

Item	Maintenance standard	Maintenance limit	Wear limit
Clearance between differential planet gear and spider	0.1~0.14 mm		0.3mm
Clearance between projection of half shaft gear and differential housing	0.21~0.31mm		0.60mm
Tooth-side clearance of driving gear	0.15~0.40mm	0.60mm	
Clearance between half shaft gear and planet gear	0.25~0.35mm	0.5mm	
Iinside diameter of brake drum	400mm	402mm	404mm
Run-out of brake drum	0~0.1mm	0.2mm	
Thickness of friction disc		12~13mm	8.5mm
Clearance between brake drum and brake shoe	0.5~0.8		
Stroke of push rod of brake chamber	24mm	45mm	
Clearance between camshaft and sleeve	0.40~0.46mm	0.7mm	
Clearance between shoe shaft and sleeve	0.16~0.26mm	0.56mm	
Pre-tension force of bearing for driving bevel gear	45~75N		
Pre-tension force of supporting bearing for differential	80~120N		

Common Failures and Troubleshooting

In rear axle, if bearing is loose or damage and does not mesh well with gear; if tooth face is damage or decelerator housing is deformed, different fault will come forth when the automobile starts, accelerates, swerves or drives normally.

►Abnormal noise of rear axle

1. There is abnormal noise when driving normally; when raise the speed, the noise increases; when you select gear, the noise weakens obviously or disappears. That indicates when transmit torque, there will be noise; when does not transmit torque, noise weakens. This fault is relative to mesh conditions of each gear set. The following table is abnormal noise analysis when drive member of rear axle has load:

Abnormal noise analysis when drive member of rear axle has load

Mesh condition of gear	Feature of abnormal noise	Examining method
Clearance between driving bevel gear and driven bevel gear is too big	There is knock noise of metal in a short time after start and during shifting. After speed stabilizes, it becomes clang.	Prizing driving gear with long stick and supporting a rear wheel with jack, check free rotation of rear wheel; measure at the edge of rim, it should be 18~25mm, max. is 45 mm.
Clearance between driving bevel gear and driven bevel gear is uneven	There is "geng geng" sound when drives at the same speed. When drives at high speed, the sound increases, the rhythm is obvious, and accompanies vibration of rear axle.	Set up rear axle, shift gearbox to neutral. Score an aligning line at the position where front bearing cap of driving bevel gear approaches to flange. Then, measure clearance of driving bevel gear after rotate one turn or two turns. If difference of measured value is huge, then check driven bevel gear for deflection.
Driving bevel gear and driven bevel gear do not mesh well	It is not obvious at low speed, but at high speed, there is "hiss" sound.	Use the said method to check and adjust.
Gear tooth broken or tooth face damaged	During driving, there is knock noise, or there is strong and rhythmed knock noise of metal suddenly. At high speed, gearbox makes a sound, like the knock sound at resonance. After you select gear, this sound disappears or weakens.	Park and check driving bevel gear and driven bevel gear for tooth broken or tooth face damage.

2. There is abnormal noise during driving and this noise does not disappear during sliding. Possible reason and feature is as following:

Reasons and features of abnormal noise of rear axle

Reason	Feature of abnormal noise
Roller bearing of driving bevel gear is loose	During drives, propeller shaft makes irregular knock noise of metal (or similar phenomenon). When change speed, this sound will weaken. When shake steering knuckle, flange of driving bevel gear will shake, too.
Tapered roller bearing of differential is loose	At low speed, especially when you select gear to slide and approach to parking, there is continuous and deep "geng geng"sound in rear axle, and vehicle body trembles slightly. At high speed, it is not obvious. It is difficult to dismantle and reinstall shaft.
In some area, bearing clearance is too small and pretension force is too big.	After raise speed, there is strident noise, and decelerator housing is too hot. When slide at low speed, there is knock noise in propeller shaft. The lubricant is sufficient. By rear axle supported, it is difficult to rotate flange of driving bevel gear.
Mesh clearance between driving bevel gear and driven bevel gear is too small	At low speed, there is continuous "ao ao" sound; raising speed, the sound will increase; when you select gear to slide, the sound will weaken.

3. When drives along beeline, it is good; when swerves, there is abnormal noise. Mostly, fault is inside differential. Reason and feature is as following table.

When drives along beeline, it is good; When swerves, there is abnormal noise.

Reason	Feature of abnormal noise
Differential planet gear and half shaft gear do not match, thus causing mesh badly.	Supporting gearbox of rear axle and shifting to neutral, rotate one of the rear side wheel, rotating direction of two wheels is different and there is no abnormal noise, but when swerves, there is abnormal noise.
Surface of planet gear is damaged or broken.	When do the said experiment, if rotating direction of two wheels is different and there is abnormal noise, well then, surface of planet gear is damaged or broken.
Planet gear sizes with spider or install badly, so planet gear is difficult to rotate.	When do the said experiment, if rotating direction of the two wheels, it is the clamping stagnation between planet gear and spider or the overthickness of thrust washer of the planet gear that makes the difficult rotation.

►Local overheating

Sometimes, local overheating and abnormal noise of rear axle coexist. The reason is the same as abnormal noise. In addition, it has the following factors.

Failed position	Reason
Bearing of driving bevel gear heated	Pretension force of bearing is excessive. Lubricating oil is not sufficient, dirty or used for a long time.
Bearing seat of driving bevel gear and driven bevel gear heated, or whose temperature is too high.	Outer ring of bearing is loose, thus to cause slide; mesh clearance of driven bevel gear is too small.
Spider and planet gear sintered, half shaft gear seized with planet gear.	Install wrongly. Mesh clearance is too small. Lubricate badly.

►Oil leakage

Failed position	Reason and treatment
Connection of decelerator and axle housing	Apply sealant at both sides of sealing gasket, and tighten connecting bolt with force of 80~90 N•m.
Bearing cap of both sides of decelerator housing	There is defect, dirt on installing surface; adjust gasket is folded, damaged; there is dirt between gaskets. Clean, apply sealant and reinstall; Tighten connecting bolt with force of 80~90 N•m; Apply sealant to thread of connecting bolt.
Bearing seat of driving bevel gear	same as the said
Oil seal of main decelerator leaked.	Oil seal damaged or installed wrongly; force of oil seal spring is too small. Replace oil seal or reinstall.

►Common faults and troubleshooting of brake.

Fault	Reason	Eliminating method
Brake seized, brake drum heated	Clearance between friction disc of brake shoe and brake drum is too small.	Adjust the clearance to 0.5~0.8mm.
	Roundness deflection of brake drum is too big.	Machine brake drum again, to make roundness deflection be not more than 0.3 mm.
	Brake shoe shaft or camshaft seized.	Clean, lubricate shoe shaft or camshaft. If necessary, replace sleeve or camshaft.
	Tension of return spring of shoe is too small.	Replace.
	Friction disc is broken or rivet is loose.	Replace or tighten.
Brake force is not sufficient, and brake is sluggish.	Rotation of camshaft is not flexible.	Check work condition of camshaft.
	Stroke of push rod for brake chamber is not correct.	Adjust stroke.
	Friction disc is overheating or degenerative.	Replace friction disc.
	Joint of friction disc is not correct.	Correct joint position of friction disc.
	Water comes into brake drum.	During driving, step pedal slightly to discharge water.
	There is lubricating oil on friction disc and brake drum.	Cleanout grease or replace friction disc.
	Brake pressure or air volume is not sufficient.	Check air pipe or air valve.
	Clearance between friction disc and brake drum is too big.	Adjust the clearance to 0.5~0.8 mm.
	Air pressure of air reservoir is too low.	Adjust air pressure adjuster, to make the air pressure of air reservoir be 637~833Kpa.
	Stroke of push rod for brake chamber is too long. Push rod tilted or seized.	Check and adjust. Clean rust.
There is abnormal noise when braking.	Friction disc worn, so rivet extruded.	Replace friction disc.
	Surface of friction disc is hardened or degenerative.	Replace friction disc.
	Brake drum wears unevenly, or installation of brake drum is not firm.	Correct brake drum or tighten bolt.
	Brake shoe and friction disc do not contact tightly.	Tighten connecting bolt.
	Fixed pin of brake shoe is loose.	Tighten fixing bolt of the fixed pin.
	Hub bearing wore.	Replace hub bearing.
	Brake drum is deformed.	Correct or replace brake drum.
Brake is ineffective	Stroke of push rod for brake chamber is too big.	Adjust again.
	Camshaft and bracket are not homocentric.	Adjust again.
	Camshaft on the bracket rusted.	Clean and lubricate.
	Friction disc wore excessively.	Replace new part.
	There is crack on diaphragm of brake chamber.	Replace new diaphragm.

6 STEYR Single Rear Axle

STEYR Drive Rear Axle

Basic data of STEYR drive rear axle are as shown in Table 2-1.

Table 2-1 Basic performance parameters of STEYR drive rear axle

Description	Parameters
Rated axle load (kg)	13000
Maximum input speed (rpm)	3500
Maximum input torque (N•m)	
Gear ratio i=4.8	16680
Gear ratio i=5.73	13730
Gear ratio i=6.72	11770
Brake drum diameter × width (mm)	Φ420×185/Φ410×220
Brake type	"S"cam type air controlled brake
Brake air pressure (bar)	29810
Brake lining and brake drum friction coefficient	6
Brake efficiency	0.39
Parking brake type	0.89
Axle total weight (tyre and lube oil not included) (kg)	Spring accumulated energy air controlled brake
Lube oil (liter)	Approx. 780kg
Final gear (liter)	6
Each wheel reductor (liter)	2

Basic dimensions of STEYR drive rear axle are shown in Fig. 2-1

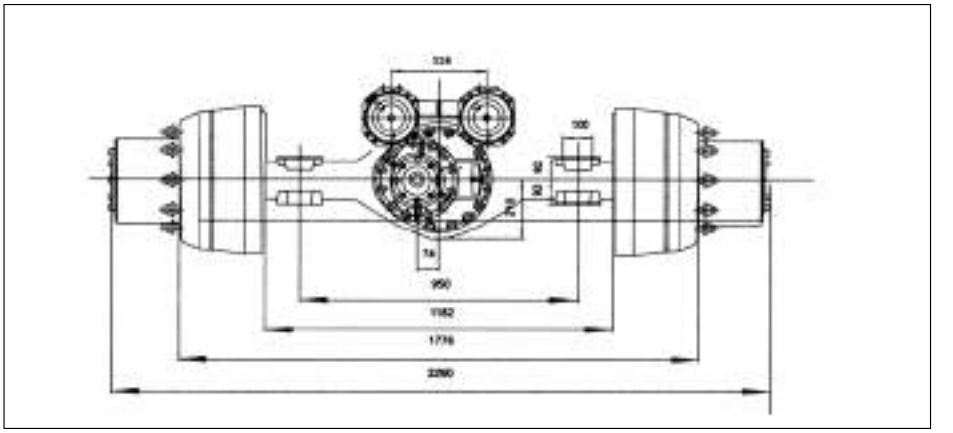


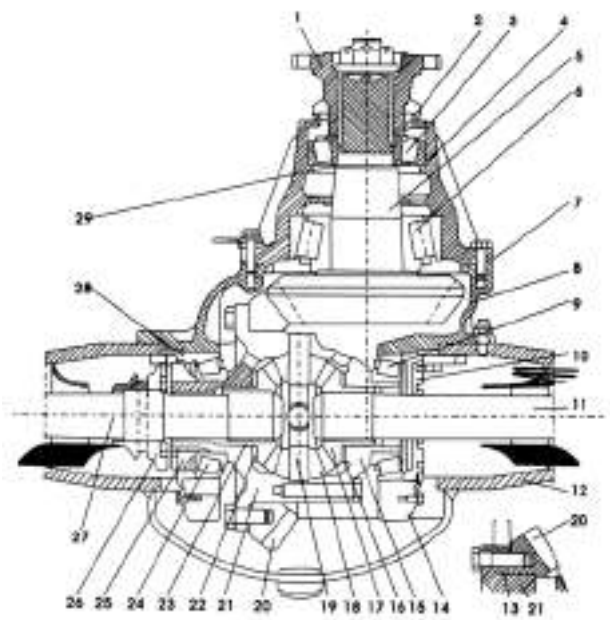
Fig. 2-1 Basic dimensions of STEYR drive rear axle

STEYR 91 series heavy truck drive rear axle has multiple gear ratios for selection, at present, three kinds of gear ratio are commonly used in China-made Sida – STEYR vehicle, i.e., i=4.8, 5.73 and 6.72.

►Structure and working principle of STEYR drive rear axle

Fig. 2-2 is the structure of STEYR drive rear axle central reductor, Fig. 2-3 is exploded view of the central reductor, Fig. 2-6 is the structure of wheel reductor of STEYR drive rear axle, and Fig. 2-7 is exploded view of the wheel reductor.

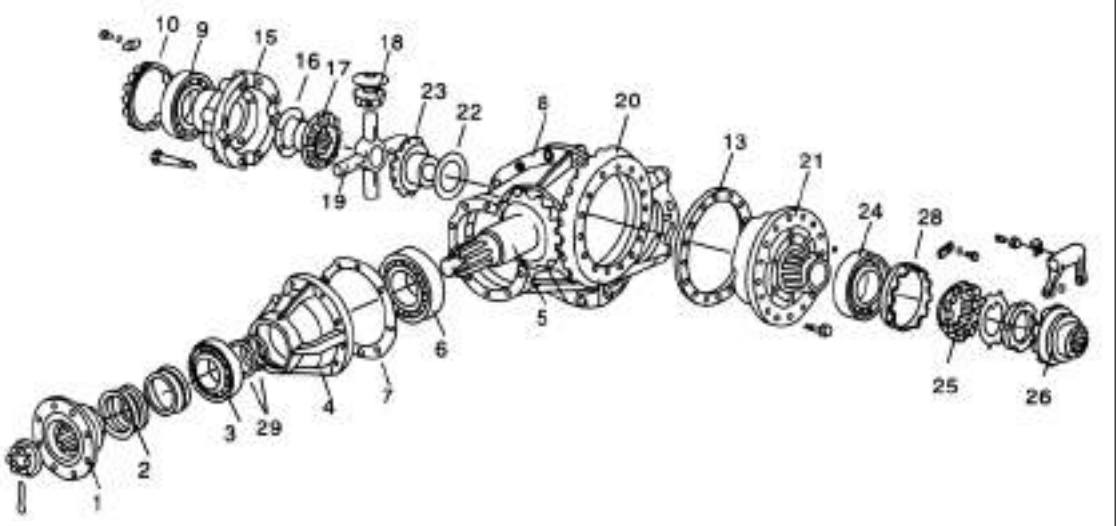
As shown in Figs. 2-2 and 2-3, power transferred by propeller shaft is transferred to drive conic gear 5 through flange assembly 1, and then is transferred to differential through driven conic gear 20. Coupling bolt connects the two differential half housings 15 and 21 into one, therefore, when the differential housing is rotating, the cross shaft rotates as well, the planetary gears produce revolution, and drive the left, right side gear 17 and 23 to rotate, as a result, torque is transferred to the left, right side gear by the left, right half axles. When vehicle is turning, the steering inner wheels must have less rotating turns than the outer wheels; because of the equilibrium relationship of the torque, the planetary gears not only revolve, but also turn around the cross shaft, thus, make the two side gears rotate differentially, i.e., the number of fewer rotation of the steering inner wheel is just the number of more rotation of the steering outer wheel synchronically; in this way, the differential function obtained, and stability of the vehicle during turning is ensured.



1. Flange assembly
2. Shaft seal ring
3. Tapered roller bearing 30312
4. Bearing pedestal
5. Driving conic gear
6. Tapered roller bearing 32315
7. Adjusting shim
8. Final drive casing
9. Tapered roller bearing
10. Differential adjusting nut
11. Half-axle (right)
12. Axle casing
13. Differential housing washer
14. Differential bearing cover
15. Differential housing (right)
16. Adjusting shim 17. Half-axle gear
18. Planetary gear and gasket
19. Differential cross shaft
20. Driven conic gear
21. Differential housing (left)
22. Adjusting shim
23. Half-axle gear
24. Tapered roller bearing
25. Fixed engagement sleeve
26. Sliding engagement sleeve
27. Half axle (left)
28. Differential bearing adjusting nut
29. Adjusting shim

Fig. 2-2 Structure of STEYR drive axle central reductor

Driving conic gear 5 is installed in bearing pedestal 4, supported by two inner, outer tapered roller bearings 3 and 6, in order to ensure pretensioning of the bearings, adjusting shim 29 is provided on inner race of outer bearing 3 and shaft shoulder of shaft 5. (Fig. 2-4D) when assembling, choose the shim with proper thickness, so that the rotating resistance torque of the bearing pedestal 4 is within 1.0~2.0 Nm after assembling of the drive gear shaft and the case (after the two tapered roller bearings are pressed completely). This can be certified by pulling the fine rope spring balance winded on the drive gear case, with the bearings pressed tightly by press (or other facilities), the spring balance pulling force must be within 8 ~ 16N when it pulls the shaft case to rotate, then the bearing tensioning is proper (for details, see section Assembling). If the rotating drag torque is too big, the shim thickness has to be increased accordingly, and have the shim thickness reduced, vice versa (8 - 16N value is obtained by conversion).



(The notes are identical to those on Fig.2-2)

Fig. 2-3 Structure of STEYR drive axle central reductor

On spherical rear of the differential planetary gears are all installed with standard spherical washers, on rear of each side gear, there is an adjusting shim 16 and 22 with different standard thickness for selection. When assembling, shim with proper thickness shall be selected, so as to get the flank backlash between the planetary gears and the two side gears to be at 0.18~0.22mm (for details, see the section Assembling).

Two tapered roller bearings 9 and 24 support the differential onto the bearing pedestal and bearing cover of the final drive casing. To ensure pretensioning of the support, differential bearing adjusting nut (also called circular nut) 10 and 28 is provided respectively on the bearing pedestal, bearing cover. When assembling, the nut tightening torque must be adjusted, so as to get the rotating drag torque of the differential assembly in final reduction gear seat hole to be at 1.5~4.0Nm. This can also be certified by pulling the fine rope wound on the differential housing, the rotating pulling force measured by the spring balance must be at 13 ~ 36N. If the rotating drag torque is too big, loosen the adjusting circular nut, or

tighten it, vice versa.

When disassembling and assembling the differential, pay attention to L, as the differential bearing cover and the bearing pedestal are machined in pairs, therefore, if there is no matching mark on the bearing cover and bearing pedestal, stamp the matching mark before disassembling, so as to avoid mistake when reassembling, (although there is installation pin on the bearing pedestal and the bearing cover, the assembling mark is still required). In order to ensure the fit clearance of the run-in bearing, it is better to make assembling marks also on the planetary gear and cross shaft when disassembling the planetary gear cross shaft, so as to keep the original run-in fitting when reassembling.

The drive, driven gear of central reductor are also ground in pairs when machining, therefore, they must be assembled in pairs when assembling, and must be replaced in pairs when replacing. In order to ensure the backlash of the gear and the rational engagement of the tooth face, the thickness of shim T of the drive gear case and the differential housing must be calculated and adjusted when assembling, shim with proper thickness shall be selected, as shown in Fig. 2-4.

Thickness of adjusting shim T shall be calculated according to the formula below:

$X=(A\pm Z)+B-(L\pm Y)$

Where: A- theoretical value of crest end of the drive gear to axis distance of the driven gear (mm)

B- measured value from crest end face of the drive gear to coupling face distance of the drive gear case (measure when the adjusting shim is not installed) (mm)

L- theoretical value from coupling face of the final drive casing to axis distance of the driven gear (mm)

Z- actual deviation of value A (stamped on the crest end face of the drive gear (mm)

Y- actual deviation of value L (stamped on the final drive casing coupling face) (mm)

For the drive axle of three drive ratios (i=4.8, i=5.73, i=6.72) of the China-made STEYR vehicles at present, A=102mm, L=170mm.

For example: observe the crest end face of the drive gear stamped Z=-0.3mm, the final drive casing coupling face printed Y=0.07mm. After the drive gear and the casing is assembled, measure with depth gauge B=70.2mm, then

$X=(A\pm Z)+B-(L\pm Y)$

$=102-0.3+70.2-(170-0.07)$

$=1.97mm$

The standard thickness of the adjusting shims is 0.1, 0.15, 0.4 and 1.0mm, at this time, select 1 shim of 1.0mm, 2 shims of 0.4mm and 1 shim of 0.15mm for combination. When disassembling the old final gear, take care to keep the original adjusting shims for later use when reassembling.

After assembling the drive gear shaft assembly into the final drive casing, check the engaging flank backlash of the driven gear and the drive gear, this backlash must be measured at the large conical surface crest

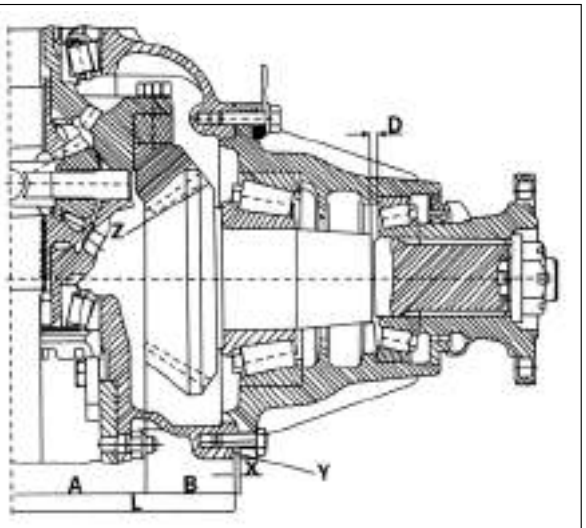


Fig. 2-4 Adjustment of adjusting shims D and X

position. Press the dial gauge probe directly on the large conical surface crest, move back and forth the gear, observe the backlash value, which must be within 0.2~0.48mm.if it does not comply with standard, adjust it. This backlash can be realized by moving the axial position of the driven gear with differential bearing adjusting nut 10 and 28. If the backlash value is too big, move the differential assembly (i.e. driven gear) to right, if the backlash is small, move the differential assembly to left. In order to ensure the differential bearing pretensioning unchanged, note that the loosening and tightening operation of the left, right circular nut must be carried out at the same step when adjusting, i.e. the angle the left circular nut loosened, the same angle the right circular nut must be tightened. Therefore, it is better to make nick on the cap in operation.

After the backlash is checked and adjusted, the face contact trace must be checked finally, apply red lead or other pigment to the driven gear tooth face, move the gear back and forth to observe the tooth face contact trace. If the tooth face contact trace is not in middle of the tooth face, it indicates the thickness of the shim X still is not proper, and then readjustment must be made. Generally speaking, if the trace is near the crest, it is necessary to reduce the shim T thickness; if the trace is near tooth root, it is necessary to increase the shim T thickness (for details, see section Assembling).

Parts and components for different gear ratio are some what different; for drive gear bearing pedestal of axle of i=4.8, the special part is –99012320131, for differential housing, the special part is –99012320503, bearing is 32316; for drive gear bearing pedestal of axle of i=5.73 and 6.72, the special part is –99012320103, for differential housing, the special part is –99012320198, bearing is 32315.

Note:

Parts in No. 13 in Figs 2-2 and 2-3 will be used only for big gear ratio, for instance: above 7.49.

Number of teeth is different for drive, driven gear of different overall gear ratio. For the number of teeth, see Figs 2-5 and 2-2.

Table 2-2 Number of teeth of drive, driven gear of different gear ratio

Gear ratio 1	4.8	5.73	6.72
Gear ratio Z1	21	17	15
Gear ratio Z2	29	28	29

Differential lock is installed on the left half axle of drive rear axle and differential housing. Fixed engagement sleeve 25 is fixed onto the differential by fixing circular nut. Sliding engagement sleeve 26 is supported on the spline shaft of the left half axle. When the vehicle is running on dirt road while a single side is slipping and idling, operate the differential lock switch, use solenoid valve to make the compressed air go to the differential lock working cylinder, the working cylinder piston push rod will make the sliding engagement sleeve 26 engage with the fixed engagement sleeve 25 through fork, so as to make the half axle and the differential housing become one, in other words, make the left/right half axle become one, so that the vehicle can run stably on the dirt road.

Drive rear axle adopts wheel planet reduction mechanism so as to increase the gear ratio, reduce the

central reductor dimension, thus the clearance of the chassis from the ground increased, and the vehicle trafficability improved.

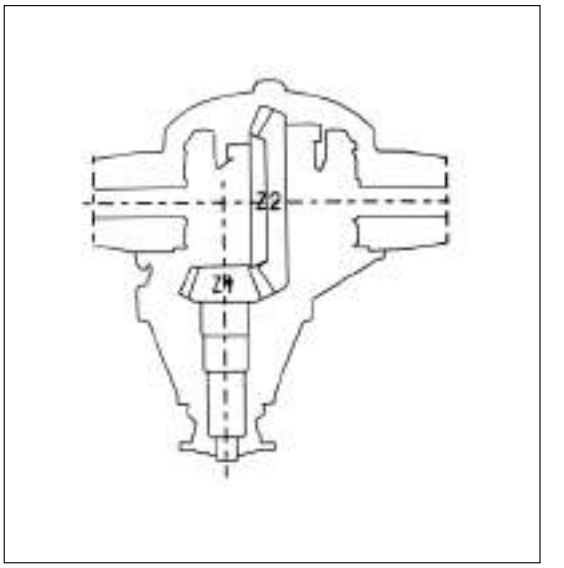
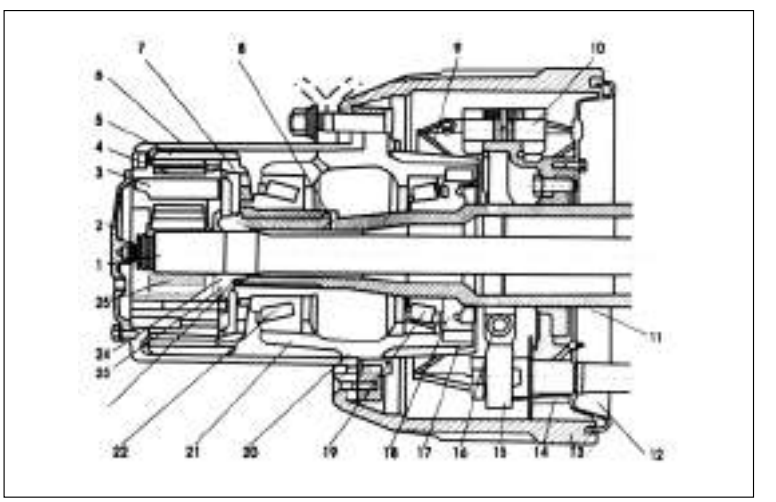


Fig. 2-5 Number of teeth of drive, driven gears

As shown in Figs. 2-6 and 2-7, half axle 1 is integrated with sun gear 25 through spline, and around the sun gear 25, there are 5 planetary gears 4. Outside the planetary gears 4, there are inner gear rings 5 to engage with them, and the inner gear rings are joined with the gear ring sleeve 7 that is fixed on the axle neck. When the half axle is rotating, the sun gear 25 rotates as well, and drives the planetary gears 4 rotating. However, the gear ring 5 engaged with the planetary gears 4 is stationary, as a result, force the planetary gears 4 not only rotate themselves, but also make revolution around the axis, consequently, push the wheel reductor housing 6 to rotate through planetary gear shaft 3, and drive the wheel housing 21, brake drum 13 to rotate jointly. Gear ratio of wheel reductor is only related with the sun gear tooth number Z1 and the gear ring tooth number Z2, as the number of tooth of the gear ring has big difference with the number of tooth of the sun gear, the gear ratio of the formed planetary gear train is quite big, i=3.478.

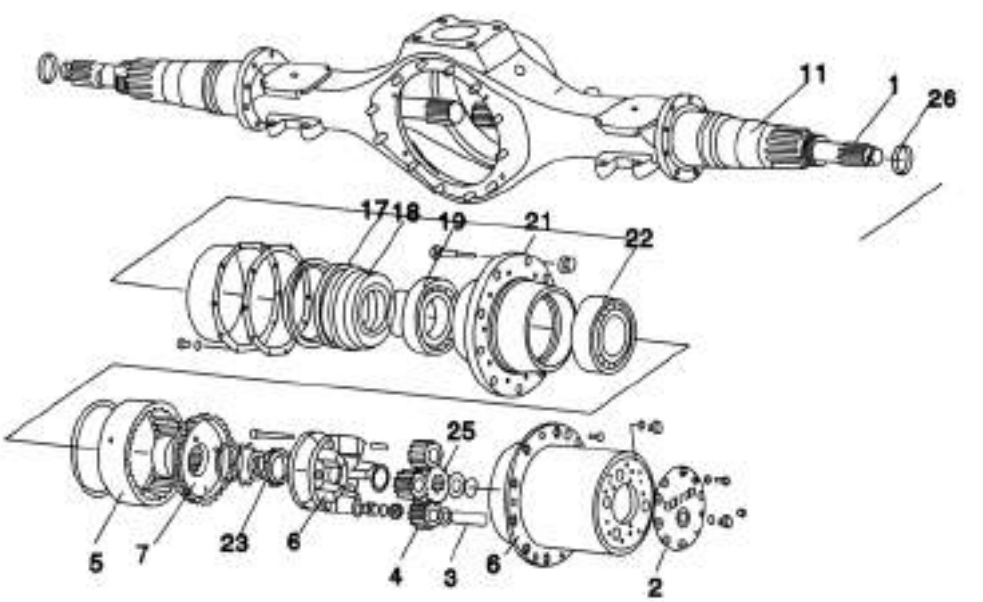


1. Half axle	2. End cover	3.Planetary gear shaft	4. Planetary gear
5. Inner gear ring	6. Wheel reductor housing	7. Gear ring support	8. Breather
9. Brake shoe	10. Pin shaft	11. Axle neck	12. Brake lightproof hood
13. Brake drum	14. Brake back plate	15. Brake camshaft	16. Return spring
17. Shaft seal ring	18. Shaft sleeve	19.Tappered roller bearing	20. Seal ring
21. Wheel housing	22. Tapered roller bearing	23. Circular nut	24. Adjusting shim
25. Sun gear	26. Shaft seal ring		

Fig. 2-6 Structure of wheel reductor

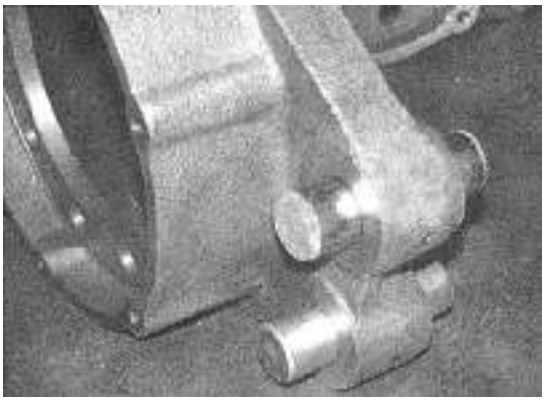
Pretensioning of the wheel housing bearing is guaranteed by circular nut 23 (also called spline cap), in order to ensure stability of the axle neck circular nut, there is a adjusting shim 24 on the shaft shoulder and axle neck face in the axle neck circular nut. When assembling, tighten the axle neck nut with torque of 300 ~ 400Nm, then measure the clearance from the shoulder to axle casing axle tube face in the nut with feeler gauge, reassemble by selecting washer with proper thickness. The pretensioning torque of the wheel casing bearing is 7 ~ 9Nm, to ensure qualified pretensioning torque, tighten the circular nut with 300 ~ 400Nm torque first, and at the same time, use copper bar to shock the wheel casing in axial direction to clear the clearance, then use fine rope to wind the 10 tyre bolts by three turns, pull the rope with spring balance, the number of turns should be between 70 ~ 90N.

Inner diameter of the newly replaced brake drum is 420±0.1, outer diameter of the brake drum after turning is 419.7.



(The notes are identical to those on Fig.2-6)

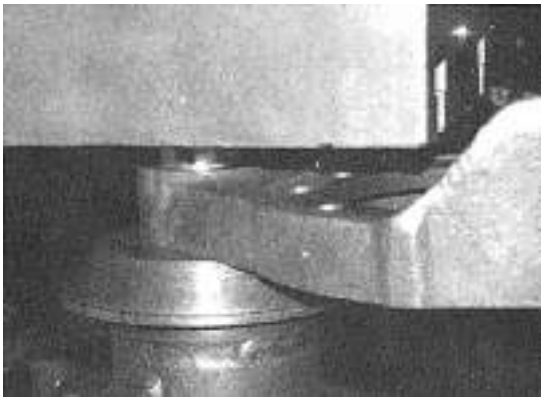
Fig. 2-7 Exploded view of wheel reductor



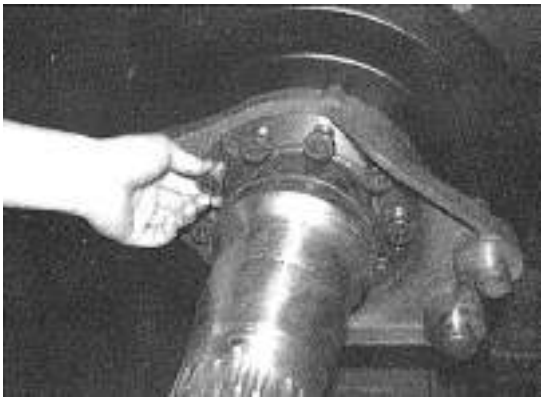
Assembling of drive rear axle

►Assembling of wheel-hub

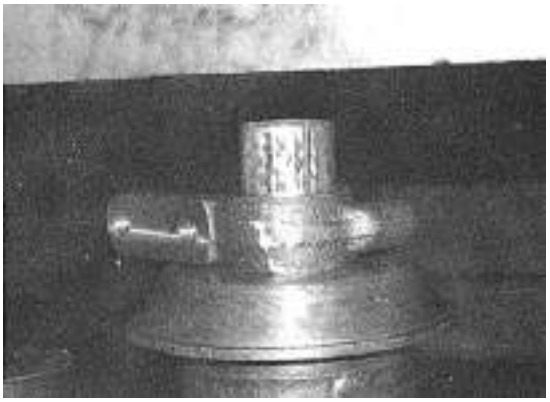
1. Press the two brake shoe bearing shafts into brake back plate hole seat.



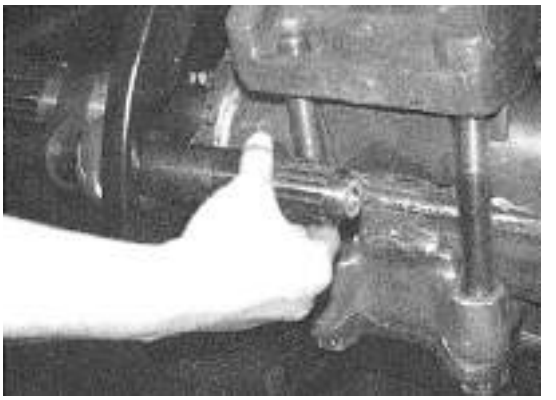
2. Press the sleeve into camshaft seat hole of brake back plate.



3. Place the dust cover and brake back plate onto the axle casing axle tube, tighten the brake back plate and axle tube flange coupling bolt with torque of 300Nm, and apply Tianshan 1243 fixing agent to the bolt.



4. Press the brake camshaft sleeve into camshaft support.



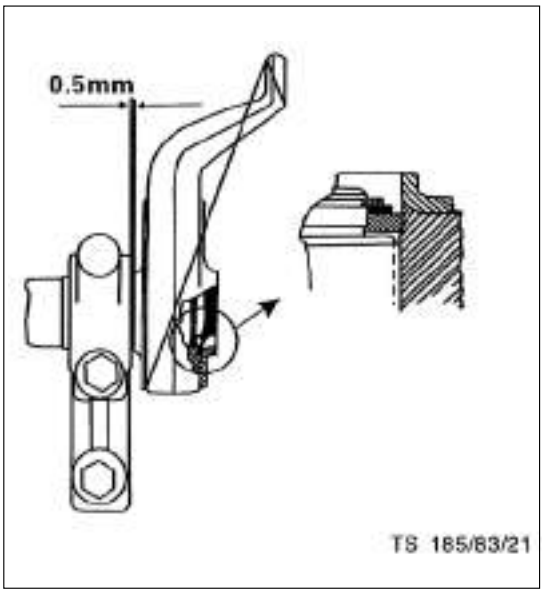
5. Insert the washer and seal ring and the brake camshaft into brake back plate and dust cover seat hole.

6. Assemble the washer and circlip onto the camshaft.

7. Spray lube oil on the support bush and slide the camshaft onto the axle support.

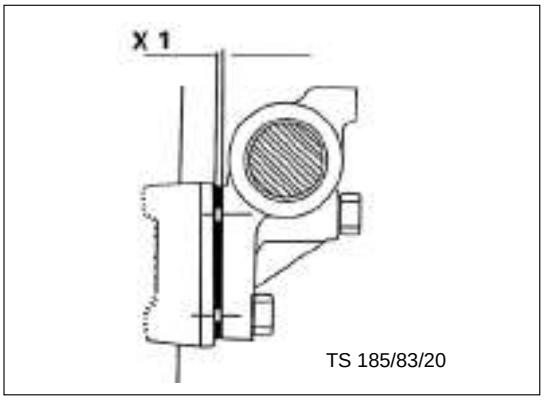
8. Install the brake adjusting arm onto the camshaft.

9. Assemble the brake camshaft to its position, use washer and circlip to position the brake camshaft onto the brake back plate.

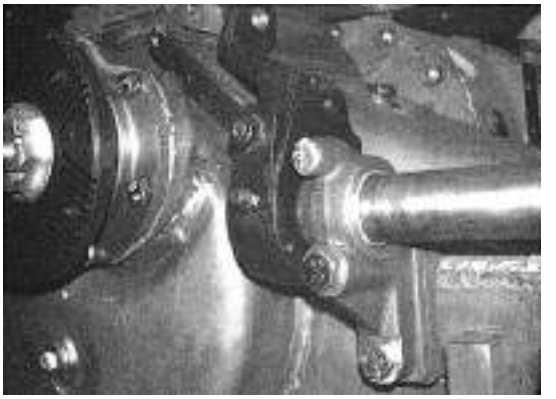


10. Select the washer thickness to make the brake adjusting arm have a clearance of 0.5mm in axial direction.

11. Use circlip to fix the brake adjusting arm.



12. Select the adjusting shim with thickness of 1.5mm. Pre-fix the support, and check the camshaft for free rotation.



13. Place the selected shim in between the support and the casing base, tighten the fixing bolt.

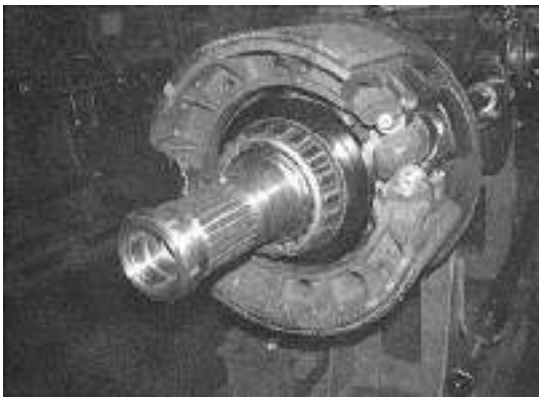
14. Install the top brake shoe into the supporting axle.

15. Close the bottom brake shoe onto the spring of the two shoes.

16. Close one end of the return spring with the top shoe, use gib head lever to gib another end of the spring, and insert the spring pin of this end.

17. Spray the top and bottom roller shaft shoulder with anti-seize agent Letai 767, install the brake shoe.

18. Assemble the “O” ring into inner hole groove of the hub oil seal spacer, and drop a little lube oil.



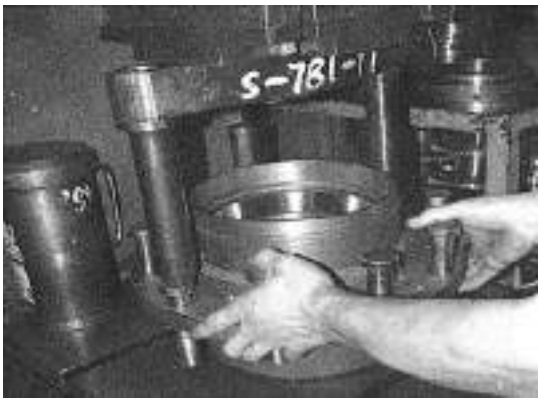
19. Heat the hub inner bearing race to 80°C,assemble it onto the axle tubular axis, and confirm it is closely against the oil seal shaft sleeve without axial clearance.

20. Install the half axle oil seal into the axle tubular axis end, and let the oil seal edge face outward.

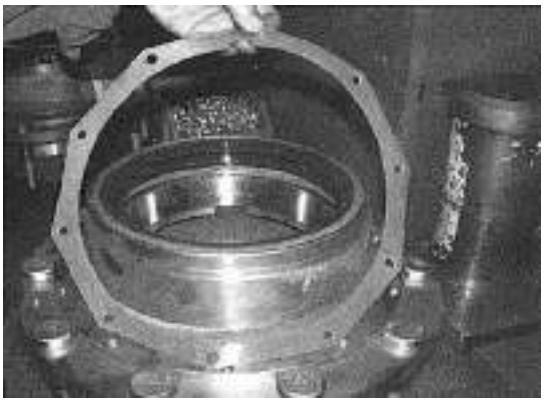
21. Use press to press in the hub inner, outer bearing outer race, and confirm they are closely against the shaft shoulder.

22. Then press the hub outer oil seal into the hub, note that the oil seal edge must face inward.

23. Then press the hub outer oil seal into the hub, note that the oil seal edge must face inward.

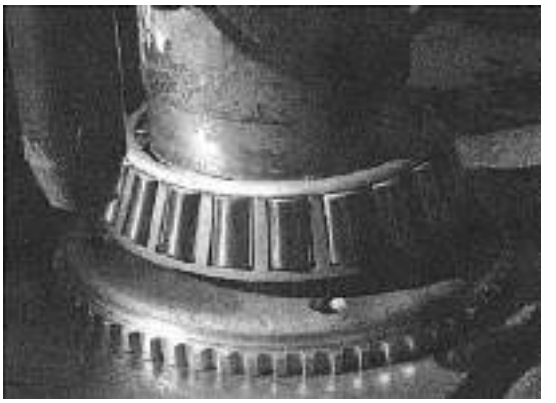


24. Install the tyre bolts onto the hub.

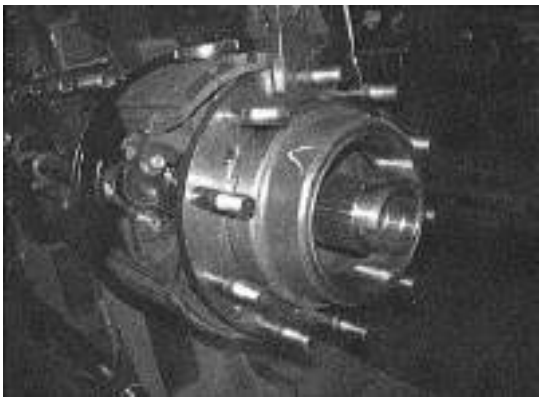


25. Place the tyre shim into the hub.

26. Fix the hub cover onto the hub, and pack fully the oil seal cavity with grease.



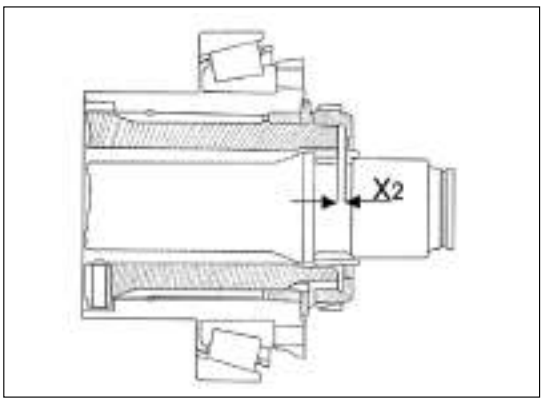
27. Heat the hub outer bearing inner race to 80 ℃ and assemble it onto the gear ring support shaft sleeve without axial clearance.



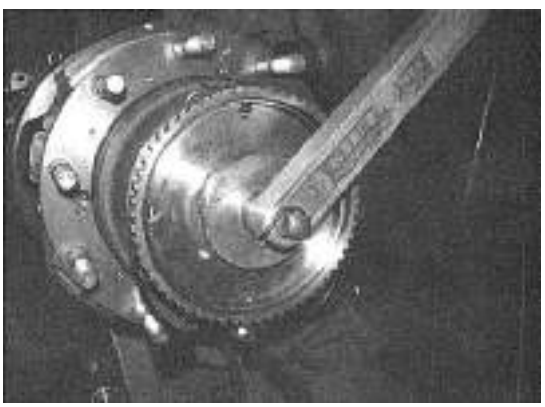
28. Push the hub into the axle tube.

29. Push the gear ring shaft support bush into the axle tube. When pushing in the gear ring support, special attention must be paid to the breather on the axle tube, then install the bush, washer, locking plate and slotted nut into the axle tube.

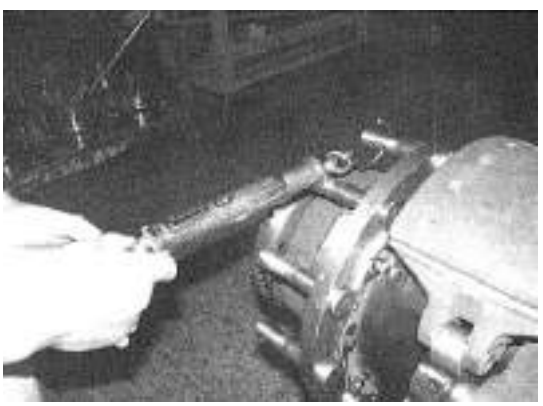
30. Use axle neck circular nut wrench to pretension to 300 - 400Nm.



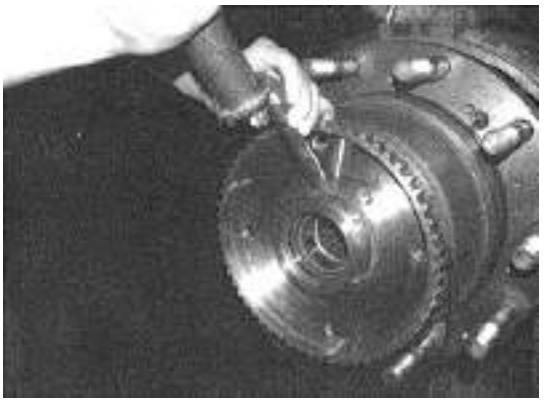
31. Use feeler gauge to measure the clearance X2 of the inner groove face of the slotted nut and the face of the axle tube.



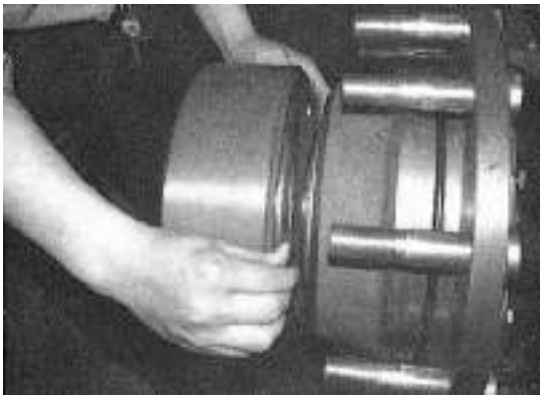
32. Select shim satisfying thickness X and insert it into the slotted nut, screw in the axle casing axle tube, use axle neck slotted nut wrench to tighten the slotted nut with torque of 300 - 400Nm.



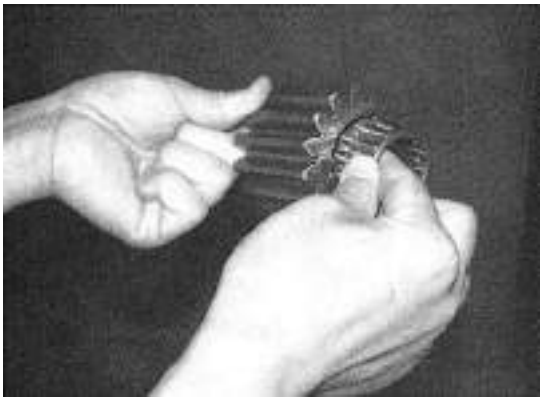
33. Use spring balance fine rope to wind the hub by one turn, rotate the hub, the pulling force of the spring balance must be 70 - 90N, otherwise, replace the adjusting shim thickness.



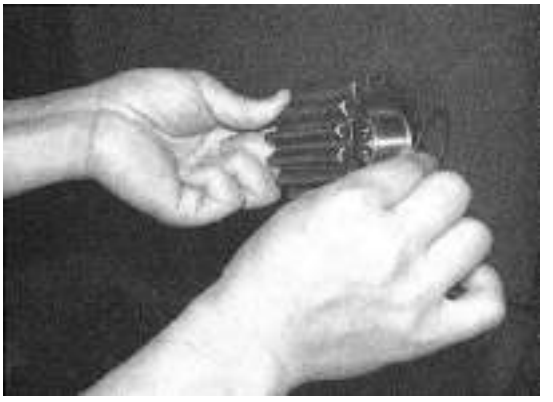
34. Use locking plate to lock securely the slotted nut.



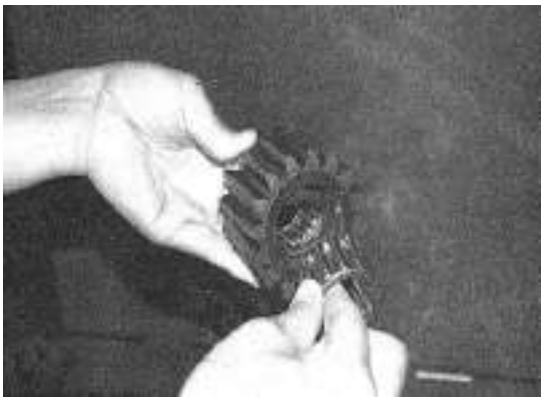
35. Join the gear ring and the gear ring support and use circlip to fix.



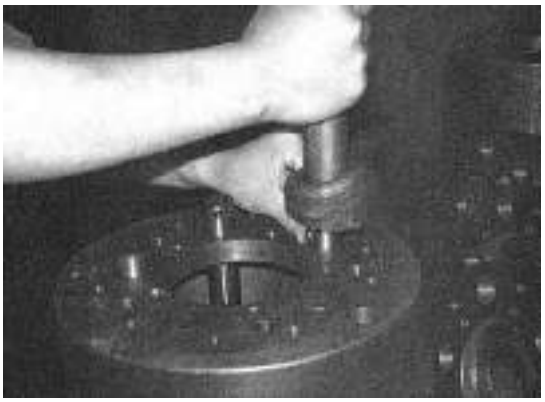
36. Install the needle roller bearing into planetary gear shaft hole.



37. Place the spacer into the planetary gear shaft hole.

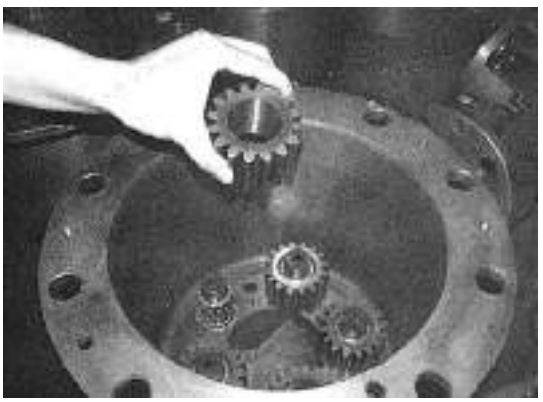


38. Install another needle roller bearing into the shaft hole. Note: in every planetary gear shaft hole, the two needle roller bearings must be the same class and assembled in pairs.

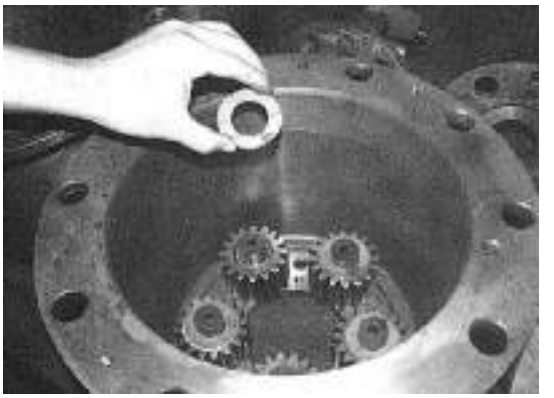


39. Install the steel ball into the planetary gear shaft, then install the shaft into the wheel reductor housing.

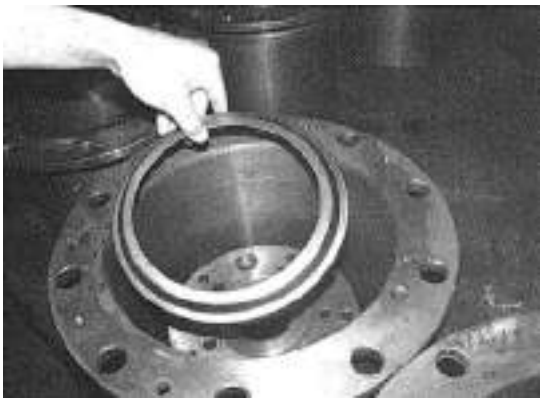
40. Install thrust plate into the planetary gear shaft. Note that the thrust plate face with through groove must face the housing face. The face with short groove must face the planetary gear face.



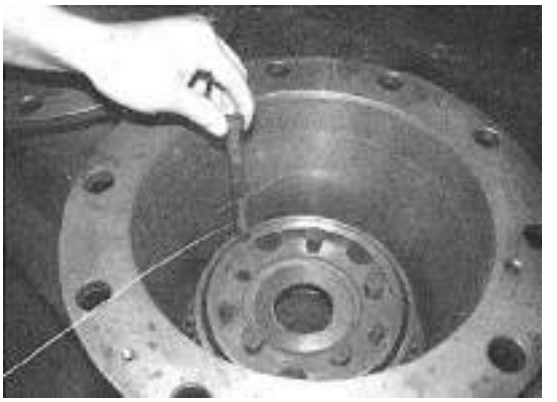
41. Install the planetary gear into planetary gear shaft.



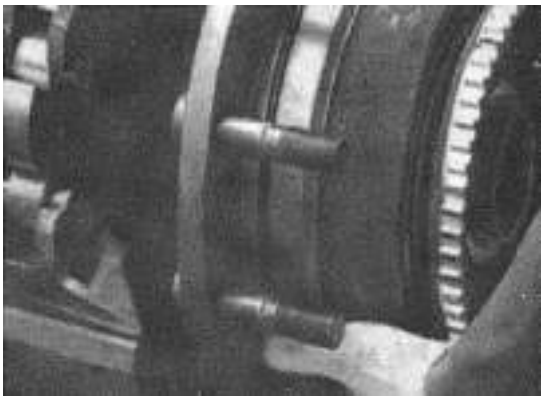
42. Then install another thrust plate into the planetary gear shaft. And also the thrust plate face with through groove must face upward.



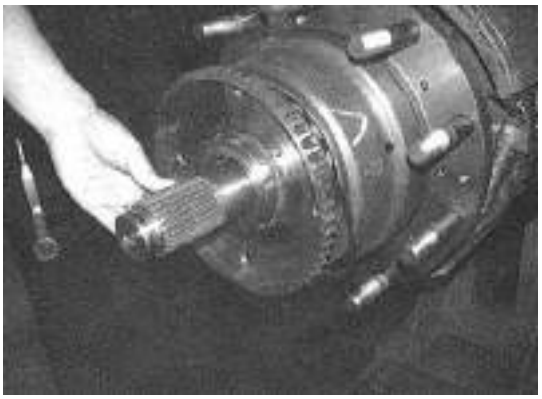
43. Assemble the planetary gear carrier end cover into the axle neck planetary gear carrier. Note that the assembling marks on the end cover and the axle neck must be matched when assembling.



44. Tighten the fixing bolt of the planetary gear carrier end cover with torque of 125Nm.



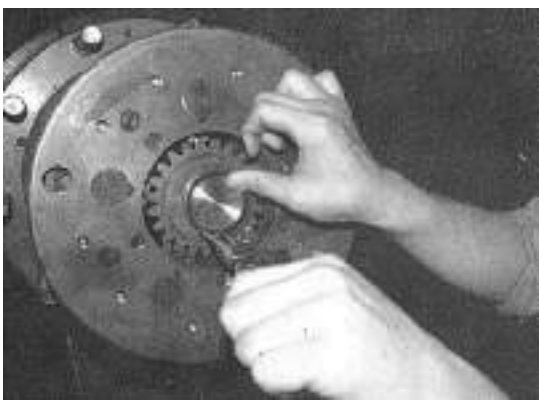
45. Reassemble the planetary gear carrier and the wheel reductor housing according to the corresponding marks, and assemble the oil shield onto the planetary gear carrier.



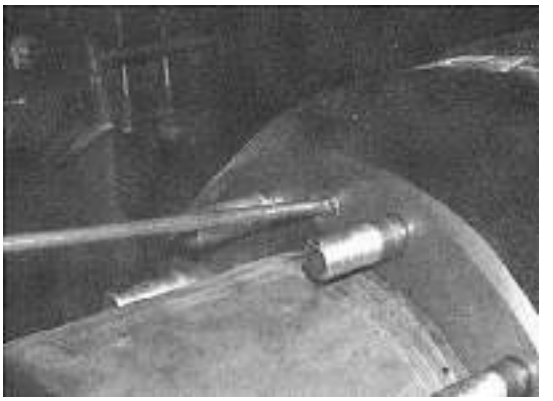
46. Spray lube oil to the half axle oil seal in the axle tube, assemble carefully the half axle into the axle casing, take care not damage the half axle oil seal.

47. Push flat the wheel reductor assembly into hub; take care not damage the “O” ring.

48. Use two fixing screws to fix the wheel reductor assembly and the hub.



49. Place the washer into the half axle. Note that let the face with groove face outward. Assemble the sun gear to the half axle end. Note, the sun gear must be engaged simultaneously with the 4 planetary gears. Then place the outer washer to the half axle end, and use circlip to fix the sun gear.



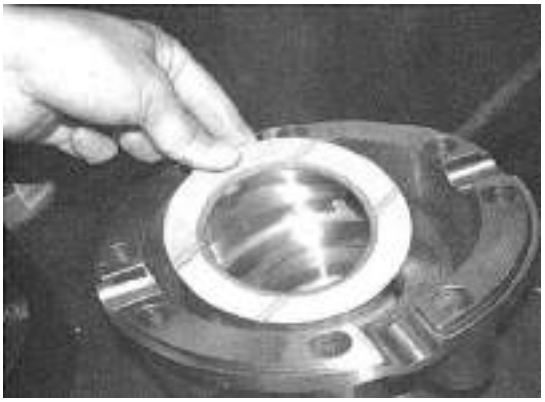
50. Wipe clean the brake drum inner surface, and use fixing bolt to fix the brake drum onto the wheel hub assembly.

51. Apply Letai 587 plane sealing strip continuously along the end cover fixing bolt hole at the planetary gear carrier axle neck face, assemble the end cover, and tighten the fixing bolt.

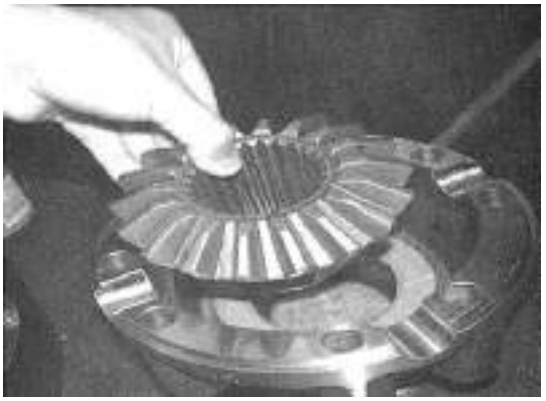
52. Install the oil drain and oil filling plug and tighten securely.

►Assembling of final gear

1. Press the driven gear into differential housing.



2. Insert the half axle gear thrust plate shim into differential housing, note that make the face with chamfered hole face the side gear.

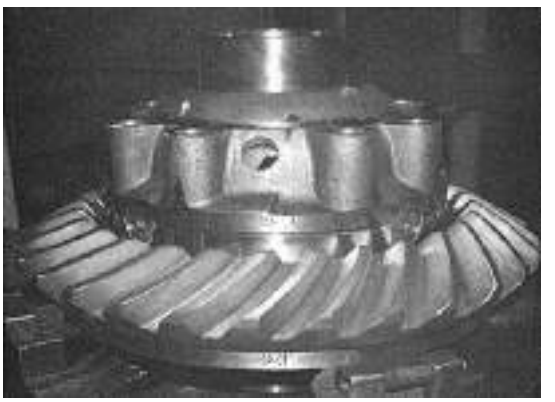


3. Place the side gear into differential half housing respectively.

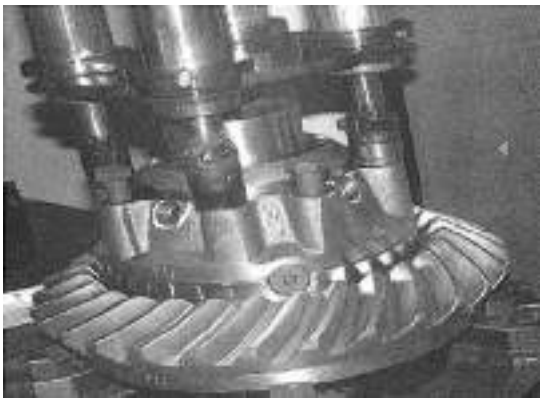
4. Assemble the planetary gear and planetary gear spherical washer into the cross shaft. Note the original assembling marks of the gear and the cross shaft when assembling.

5. Assemble the assembled planetary gear set into differential half housing.

6. Measure the backlash of the side gear and the planetary gear.
   Adjust the side gear thrust plate to get the tooth space to be 0.20-0.45mm.
   The standard thickness of the side gear thrust plate is 4.9, 5.0, 5.1, 5.2, and 5.3mm for selection.

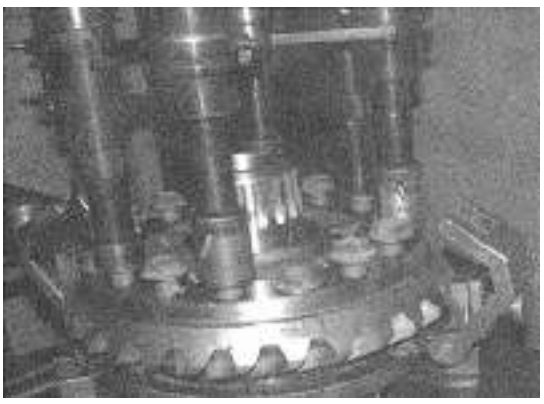


7. Insert the side gear and shim into differential housing, close the assembling marks of the two differential half housings marked prior to disassembling.

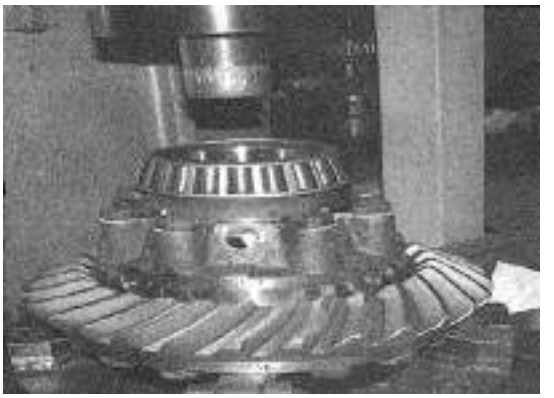


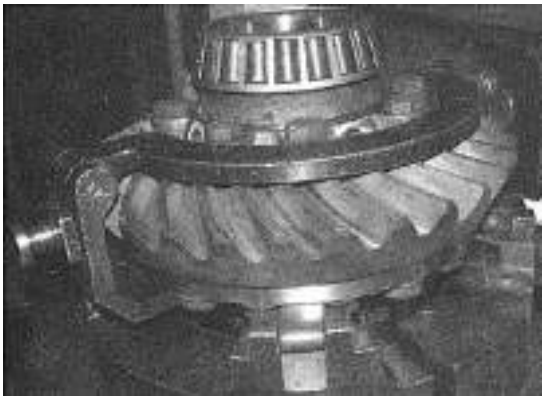
8. Apply Letai 242 thread gum to the thread of the differential coupling bolt and tighten it with torque of 210Nm.

9. Apply Tianshan 1262 thread compound to fixing bolt of the driven gear.



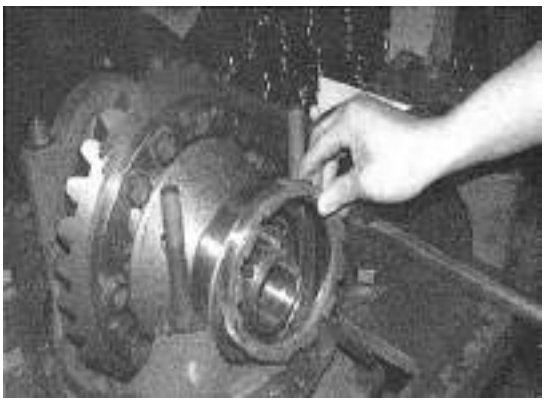
10. Tighten the coupling bolt with torque of 325Nm.



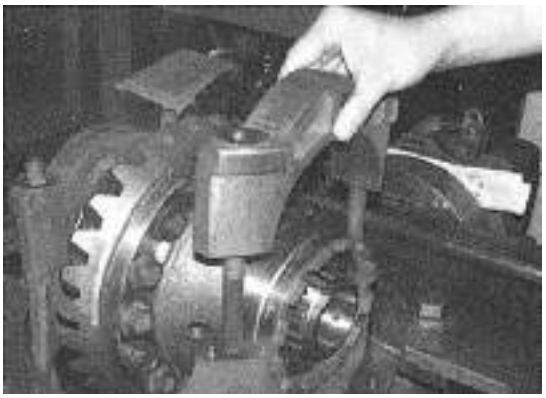


11. Assemble the differential bearing inner race to the two half casings of the differential, be sure it is closely against the shaft shoulder without axial clearance.

12. Place the differential assembly to the final drive casing, and close the bearing outer race and the bearing race.



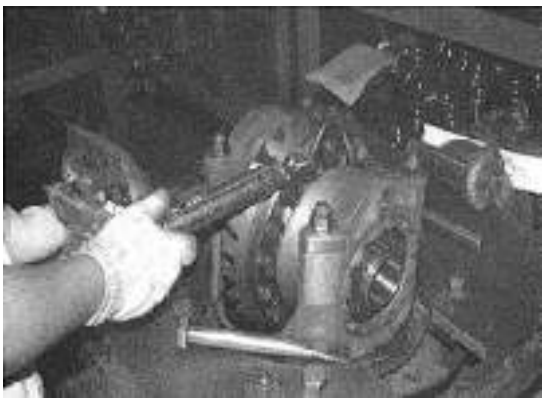
13. Assemble the differential nut into the final drive casing half circular hole.



14. Assemble the bearing differential according to the matching marks.

15. Adjust the differential adjusting nut to its position.

16. Knock gently the bearing pedestal and tighten the fixing nut.

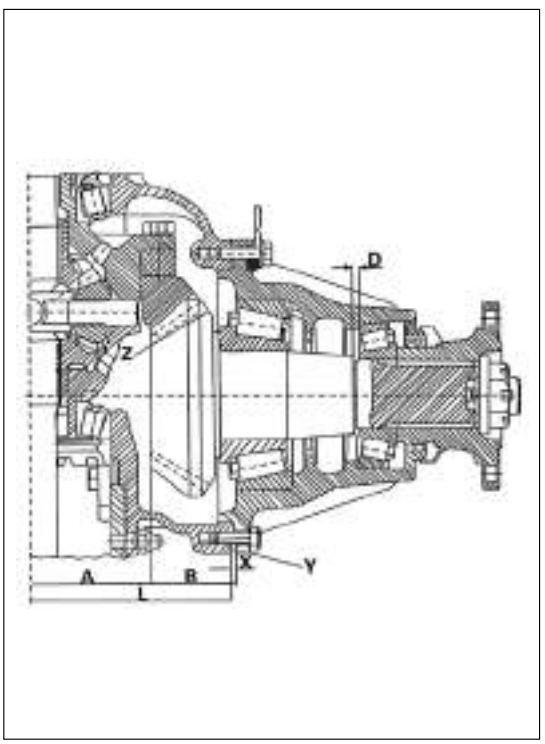


17. Apply lube oil to the left, right bearing, use spring balance and fine rope to wind the differential by one turn, the measured spring balance pull force must be 13 - 36N. If not complying with this standard, adjust it by tightening or loosening the adjusting nut.

18. Press the inner, outer bearing outer race steel bowl of drive gear into bearing pedestal, and confirm it is closely against the hole shoulder.

19. Assemble onto the gear shaft, and confirm it is closely against the shaft shoulder.

20. Assemble the bearing pedestal of drive gear onto the gear shaft.



Thickness of adjusting shim X between drive gear case and final gear:

X=(A±Z)+(L±Y)

Where: A- theoretical value from crest face of the drive gear to axis of the driven gear.

B- measured value from crest end face of the drive gear to coupling face distance of the drive gear case (measure with depth gauge when the adjusting shim is not installed).

L- theoretical value from coupling face of the final drive casing to central distance of the driven gear.

Z- actual deviation of value A (stamped on the drive gear face).

Y- actual deviation of value L (stamped on the final drive casing coupling face).

The three gear ratios used by STEYR 91 series heavy truck at present are i=4.8, 5.73 and 6.72

Of which, A=102mm

L=170mm

21. Select washer with proper thickness and place them into gear shaft.
The standard washer thickness: 2.0, 2.05, 2.1, 2.15, 2.3, 2.35, 2.45, 2.5, 2.55, 3.0, 3.1, 3.3 and 3.4mm.

22. Heat the gear shaft outer bearing to 80℃, assemble it to the gear, and apply lube oil to the two bearings.

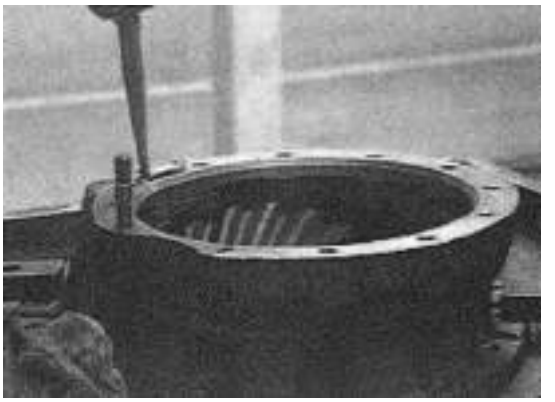
23. Press the bearing with press to its right position, measure the rotating drag torque of the shaft casing, which must be 1.0 - 2.0Nm, or measure with spring balance fine rope, its pulling force must be 8 ~ 16N, if not comply with the requirement, adjust the thickness of washer D.

24. Press the two oil seals into the oil seal ring and pack grease in the oil seal cavity.

25. Apply Letai 587 sealant to outer ring of the oil seal, and use press to press bearing pedestal.

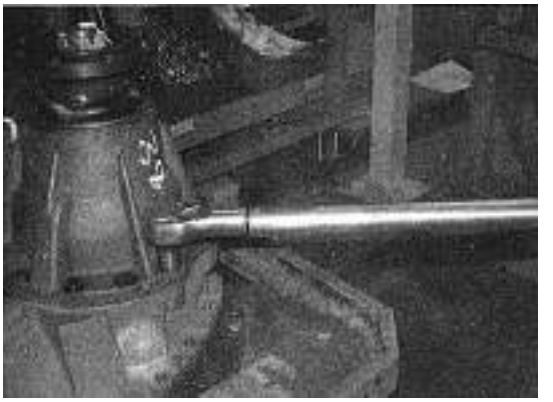
26. Assemble the input drive flange into drive gear shaft.

27. Place the “O” ring onto the drive gear shaft casing.



28. Apply Letai 587 plane sealant continuously to the casing joining surface.

29. Close the two casings.



30. Tighten the coupling bolt with torque of 120Nm.

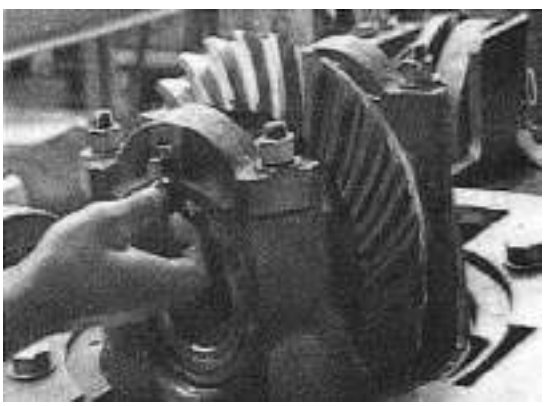
31. Check gear backlash with dial gauge, place vertically the dial gauge needle to the driven gear end tooth top, swing the gear back and forth, the measured backlash must be at 0.2 ~ 0.48mm.

If the measured backlash does not comply with the standard, adjust the bearing adjusting nut; if the backlash value is greater than the standard, tighten the adjusting nut at back of the driven gear, and loosen the adjusting nut opposite to

the driven gear as well, vice versa.

To ensure the rotating drag torque of the differential unchanged, make marks on the adjusting nut when adjusting, so as to ensure the angle degree of the left adjusting nut tightened, the same angle degree of the right adjusting nut must be loosened.

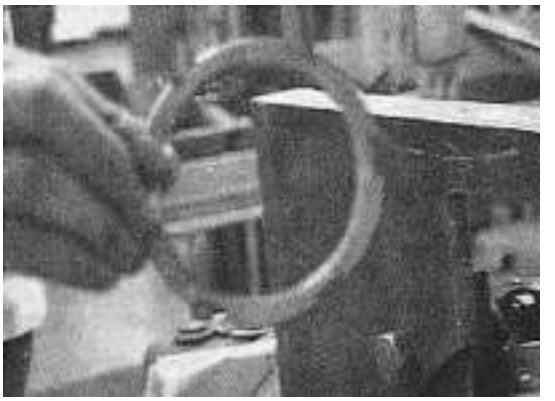
At the end of the adjustment, check the backlash again.



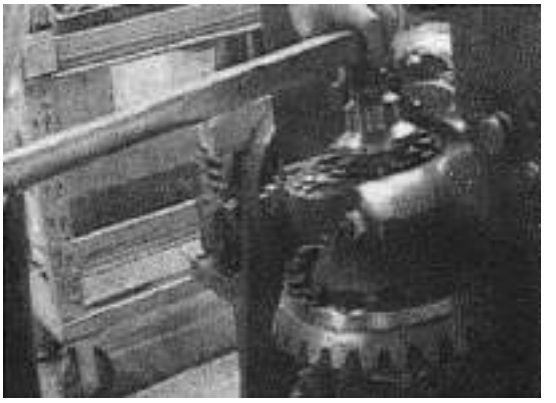
32. Lock the left, right adjusting nut respectively with locking plate.

33. Assemble the differential engagement sleeve into the differential housing splined shaft.

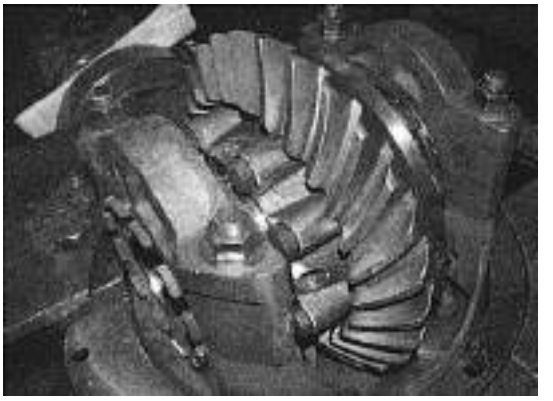
34. Assemble the locking plate into the engagement sleeve.



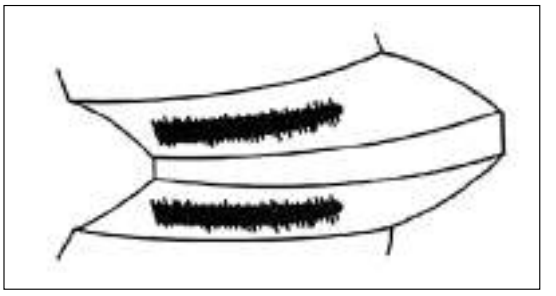
35. Use differential lock cap wrench to screw the circular nut into the differential shaft sleeve.



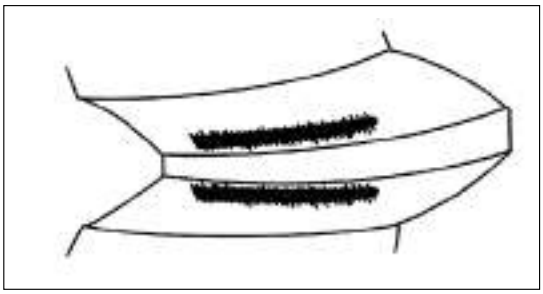
36. Tighten the locking nut with torque of 200NM.



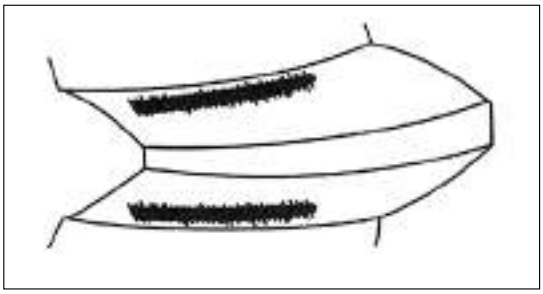
37. Apply red lead or other pigment to the tooth face, rotate the drive, driven gear back and forth, observe the engagement face of the tooth face of the two gears.



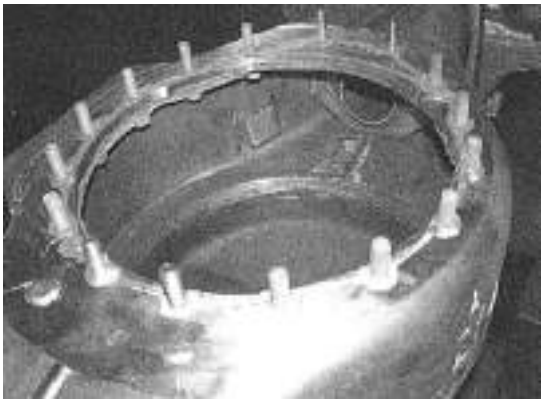
Correct engaged trace.



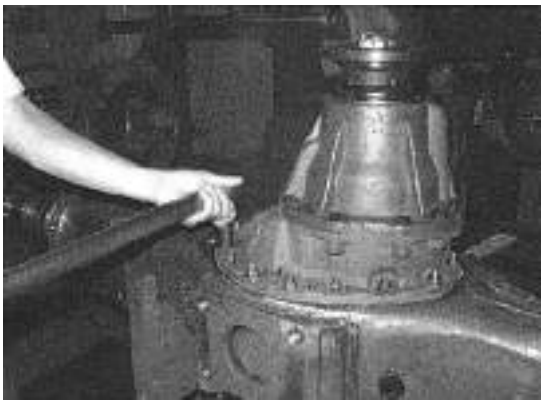
If the engaged trace is near the crest, it is necessary to reduce the thickness of shim X of the drive gear bearing pedestal and the final drive casing.



If the engaged trace is near tooth root, it is necessary to increase the thickness of the shim X of the drive gear bearing pedestal and the final drive casing.



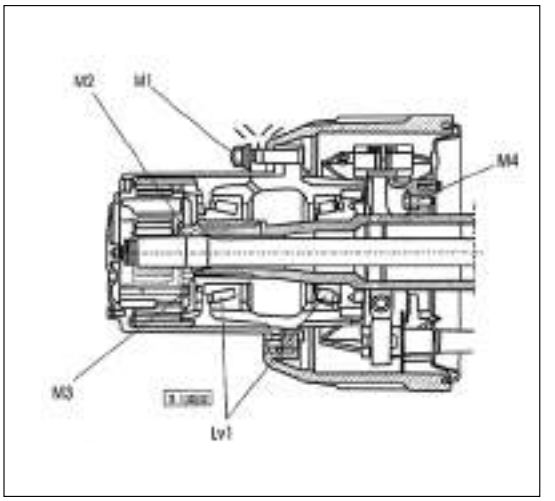
38. Apply Letai 587 plane joint strip continuously on the axle casing joining surface.



39. After the differential lock mechanism is installed, lift vertically the intermediate, rear axle final gear assembly into the axle casing, and tighten the connecting nut.

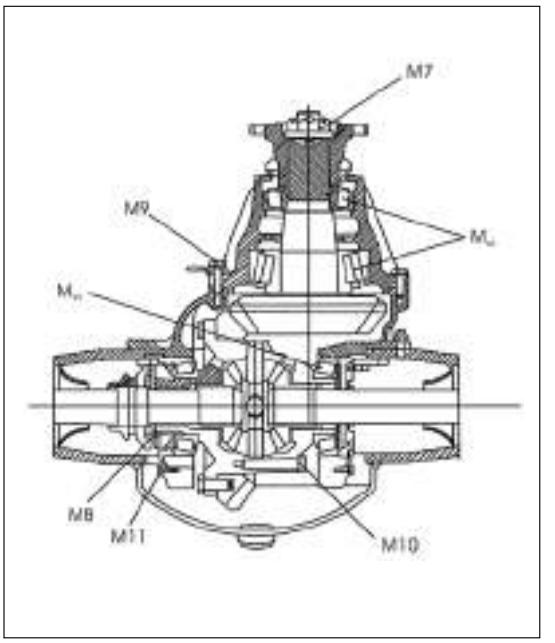
Note:

for the following steps, see illustration related to double axle.



Torque for main positions of the rear axle wheel reductor

Positions	Torque
M1	550~600
M2	500~400
M3	125
M4	300
M5	6.8



Tightening torque for main positions of rear drive axle

Positions	Torque
M7	750~800
M8	200
M9	110
M10	210
M11	325
M12	1.5~4.0
M13	1.0~2.0

Trouble–shooting of common faults of STEYR drive rear axle

►The following faults are the common faults of STEYR drive rear axle:

1. Oil leaking

Oil leaking of drive rear axle often happens on some obvious positions; the oil leaking position of central reductor often happens at input shaft, this is normally due to damage or worn of the input shaft (drive gear shaft), or loosening of the oil seal spring. Care must be taken when repairing, if oil is leaking from outer ring of the oil seal, it indicates fitting of the outer ring of the oil seal and the casing is loosened. When reassembling, clean the outer ring of the oil seal and the oil seal seat hole of the casing, apply Letai 603 fixing gum to the outer ring of oil seal, and push the oil seal into the oil seal seat hole; if the oil seal is intact, but oil is still leaking seriously, check the breather of the axle casing (which must be checked from time to time). If the breather is blocked by oil strain, heat produced by the axle casing makes the air pressure increased, and then consequently, force the lube oil to drain outwards, this issue is often neglected by people.

Three positions have to be checked for gear casing splashing of oil, "O" ring of the gear case and the planet carrier axle neck, "O" ring of the gear case oil seal seat and the axle casing axle tube, generally speaking, there is more possibility of gear case oil seal leaking. When reassembling the gear case oil seal, note that, the gear case has two oil seals that are entirely the same in size, but different in material, normally place the one marked with yellow mark or stamp at inner side, and the other at outer side, if fitting of the outer ring of the oil seal and the gear case oil seal seat hole is loosened, you may apply Letai 603 fixing gum to the outer ring of the oil seal.

If the axle neck end cover is leaking, it indicates the contact surface of the end cover and the planet carrier not tight; joining of the end cover and the axle neck is gasketless, you may disassemble the end cover and the planet carrier face and clean them, then apply Letai 587 sealant to them and reassemble them. When applying sealant, apply continuous strip on the joining surface.

If oil drain from ventilation hole of the axle casing is often found, while the wheel reductor is always out of oil, normally it is because the half axle oil seal is assembled in reverse direction or damaged.
The result of splashing of oil of the axle neck always makes the brake shoe and the brake drum be stained with oil, leading to brake failure.

2. Gear case overheat

Overheat of gear case is normally due to too big of pretensioning of the gear case bearing, normally it occurs after maintenance. The axle neck circular nut is not tightened according to the specified torque during the maintenance so that too big tightening torque for the neck circular nut makes too big pretension force for the bearing. The gear case must be reassembled according to the requirement. Deformation, damage of the gear case definitely will cause gear case overheat.

3. Brake drum overheat

There are many factors to cause brake drum overheat, there may be the brake mechanical problem, or the brake control air loop system problem.

Check first whether the brake cylinder can return rapidly after braking. If the brake cylinder fails to return or returns slowly, you may disconnect the cylinder push rod and the brake adjusting arm, and then check whether the brake cylinder can return rapidly, if it still returns slowly, the fault lies obviously in the brake cylinder and the brake control air loop. If it returns freely after the cylinder and the adjusting arm disconnected, then check whether the brake camshaft rotates freely. Bent and deformation of the brake camshaft, out of oil in shaft bush or deformation and dislocation of the brake camshaft support, would cause brake return unsmooth, consequently, the brake drum get overheated.

Broken or loosening of the brake shoe return spring will not only make the brake drum overheat, but also produce friction noise.

During normal running, there must be certain clearance between the brake lining and the brake drum (normally 0.2mm), too big clearance will affect the braking result and too small clearance will produce overheating.

Clearance between the brake drum and tyre steel ring of STEYR vehicle is too small, therefore, the radiation condition of the brake drum itself is not good, frequent braking will quickly make the brake drum overheat, or even the tyre valve get burnt, leading to tyre leaking when the case is serious, therefore, when vehicle running on long distance downhill in mountain area, to use engine exhaust for braking and deceleration is encouraged, avoiding frequent use of running brake.

4. Main gear abnormal sound

During running, if the rear axle middle part has sudden abnormal sound, stop running immediately for check, because such abnormal sound is always the indication of a part get damaged.

Such cases as differential supporting axle falling apart, serious pitting corrosion or wearing of the bearing, fixing bolt of driven gear loosened or come off, differential lock engagement sleeve loosened and tooth hit of the drive gear or differential gear will all result in serious abnormal sound.

If continuous sound of wheel worn is found, and the sound becomes louder as the vehicle speed increases, this is normally produced by pitting corrosion of bearing, worn of drive gear or scratching, pitting of tooth face, if no obvious noise in normal running, but the noise becomes obvious when decelerating and cutting off oil, this is normally caused by injury, or pitting corrosion of back of the drive gear.

There is no obvious noise when the vehicle is running on straight line, but there produces abnormal sound when turning, obviously, it is produced by differential gear damage or burnt, or the differential lock engagement sleeve loosened and run-out.

If continuous noise is produced after replacing with new drive, driven gear, and the noise increases as the speed increases, then you have to check whether the drive, driven gear engagement clearance and the

tooth face contact trace are qualified, especially, pay attention to whether the assembling of the drive gear, driven gear is matched.

Axle casing deformation will also produce rear axle abnormal sound, attention must be paid to it when inspecting.

When abnormal sound is found at the rear axle, never run the vehicle by force, but stop for disassembling and inspection, because falling apart of the bearing, loosening of fixing bolt, damage of gear will cause serious consequences if they are not repaired timely.

5. Differential lock unable to couple

When it is necessary to couple the differential lock, the indicator for coupling not lit when the differential lock switch is pressed. In this case, check first whether the piston push rod of the differential lock working cylinder operates when pressing the switch. When the push rod of the working cylinder is out, but the differential lock still cannot be coupled to its position, it indicates the engagement sleeve crest and the crest face are not engaged to the right position, you may move the vehicle forward and backward, it will be coupled to the position by itself; if the working cylinder no any response, it is obviously the problem of electrical, air control system of the solenoid valve itself. You may unscrew the solenoid valve output air connector and observe whether there is any compressed air output, if there is no output of compressed air, it is obviously the problem of circuit control or the solenoid valve itself. If there is output of compressed air, it is obviously the problem of the working cylinder itself.

If after pressing the differential lock switch, and the working cylinder push rod has really pushed the differential lock to its position, but the indicator of the switch not lit, the problem lies obviously in the differential lock indicator switch or the bulb, it is easy to locate by test.

6. Rear wheel rubbing tyre

Rear wheel rubbing tyre

There are several possibilities to have rear wheel rubbing with tyre: tyre steel rim deformed, gear case bearing loosened and rear axle dislocated. And the rear axle dislocation is normally caused by broken of steel plate central screw.

Service and maintenance of STEYR drive rear axle

►The following points have to be paid attention to in service and maintenance of STEYR drive rear axle:

1. Maintain the lube oil quantity, check from time to time the oil quantity of the wheel reductor and the final gear, short of oil would cause earlier wearing of moving parts, or result in ablation when the case is serious; however, it is not to say the more the lube oil the better, as too much lube oil will cause high temperature, and even result in oil leaking.

There are two plugs on the wheel reductor: the plug provided on the very edge of the neck is an oil drain plug, and the plug on the near center of the end cover is an oil filler plug. Normal position of the wheel reductor oil quantity is checked in this way: with the oil drain plug at the highest position, oil filler plug horizontal, at this time, open the oil filler plug and put your finger flat to the hole, it is proper if your finger can touch the oil level.

When replacing lube oil for wheel reductor of new vehicle initial maintenance, turn the wheel to the position with the drain plug at the lowest position when filling fresh oil according to the requirement, while the oil filler plug is at the most half top position, open the drain plug to drain the old oil, then replace the drain plug, and open the oil filler plug to fill oil to the high level position, then screw in the oil filler plug. Rotate the wheel repeatedly for several times, then place the wheel oil drain plug to the highest position, while the oil filler plug is at the less half position, open the oil filler plug, let the excessive lube oil flow out until the level maintaining at the oil filler plug position, replace the oil filler plug.

There are two plugs on the rear axle middle part case, one oil drain plug at bottom of the middle part, and another oil filler plug at near half edge height of the middle part, normal level must be always kept at the oil filler plug height.

Rear axle final gear and wheel reductor use gear oil of brand GL-5, 85W/90. When the ambient temperature is lower than -100C, 75W/90 can be used for substitution. Oil capacity of the middle part is normally 6L and oil capacity of each wheel reductor is 2L.

Gear oil change time of the drive rear axle is 50000km or 1 year, compulsory maintenance of every 2000-2500km must change the gear oil.

2. Correct use of differential lock

Differential lock of the drive rear axle makes the left, right wheel be differential automatically when turning, so as not to wear the tyre and cause mechanical damage, when single side wheel of the vehicle run on slideway or dirt road and is impossible to run out, couple the differential lock (normally called lockout position), at this time, the left, right half axle become a rigid coupling, the vehicle can run out of the fault road by itself. After the vehicle runs out of the fault road, remove the differential lock immediately, otherwise such heavy accident as severe wearing of tyre and differential damage would occur.

3. Avoiding severe overloading

The design carrying capacity of STEYR drive rear axle is 13t, normally the axle casing wall thickness of China-made vehicle is 16mm, in some vehicles with load relatively concentrated and road condition relatively poor, (e.g., K35 and N56 model), reinforced axle casing with wall thickness of 20mm (China-made axle casing) is used in such vehicles, severe overloading and concentrated load will all cause deformation and broken of axle casing. Do remember to load the vehicle according to the load specified by the running condition.

4. During repairing, if such coupling parts for differential, driven gear have to be reassembled, apply Letai 262 thread fixing compound to the thread and tighten it with specified torque, so as to ensure fixing of the coupling bolt.

7 457 Middle Axle

Main Technical Data

Rated axle load:	13000Kg	Dead load:	900Kg
Applicable tyre type:	11.0-20	Brake size:	Φ4000×200mm
Applicable wheel track:	1847mm	Broadened brake size:	Φ410×220mm
Applicable rim type:	8.0-20	Min. ground clearance:	241mm
Available gear ratio:	4.444 4.875 5.286 5.833	Max. output torque:	40000Nm

Outline Drawing and Connection Dimensions

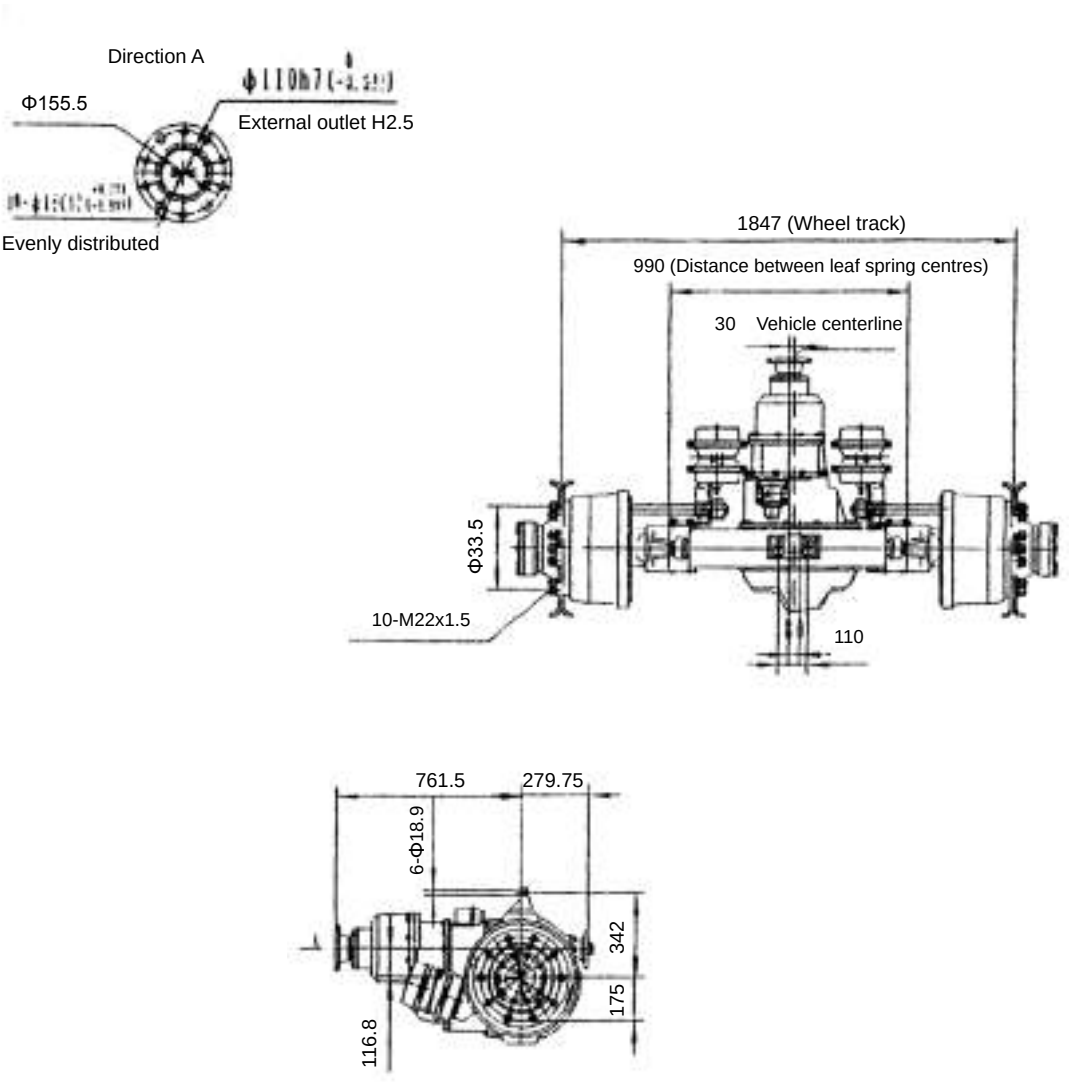


Fig.1

Structure

►Structure of rear axle assembly

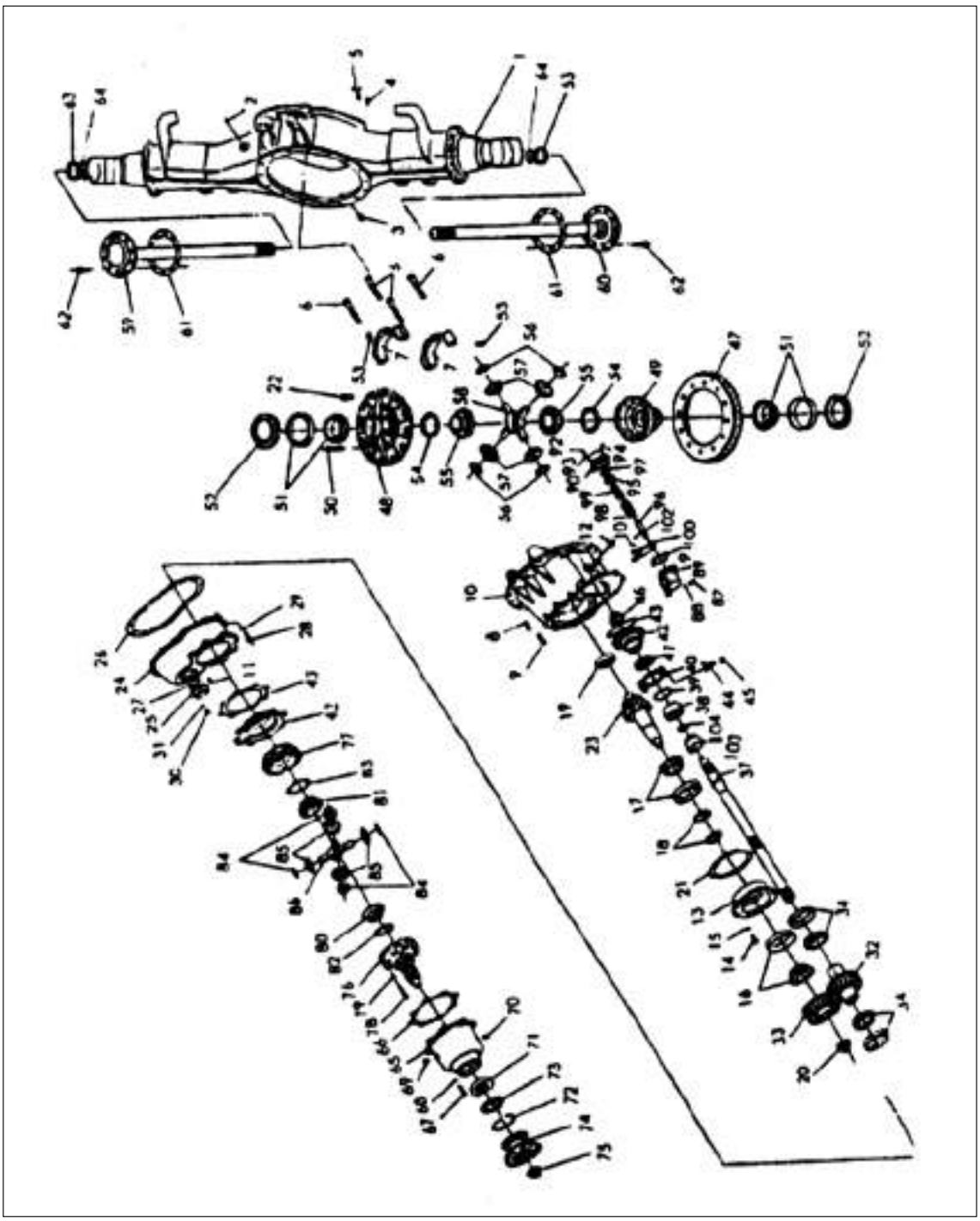


Fig.2

►Assembly drawing of middle axle final drive assembly

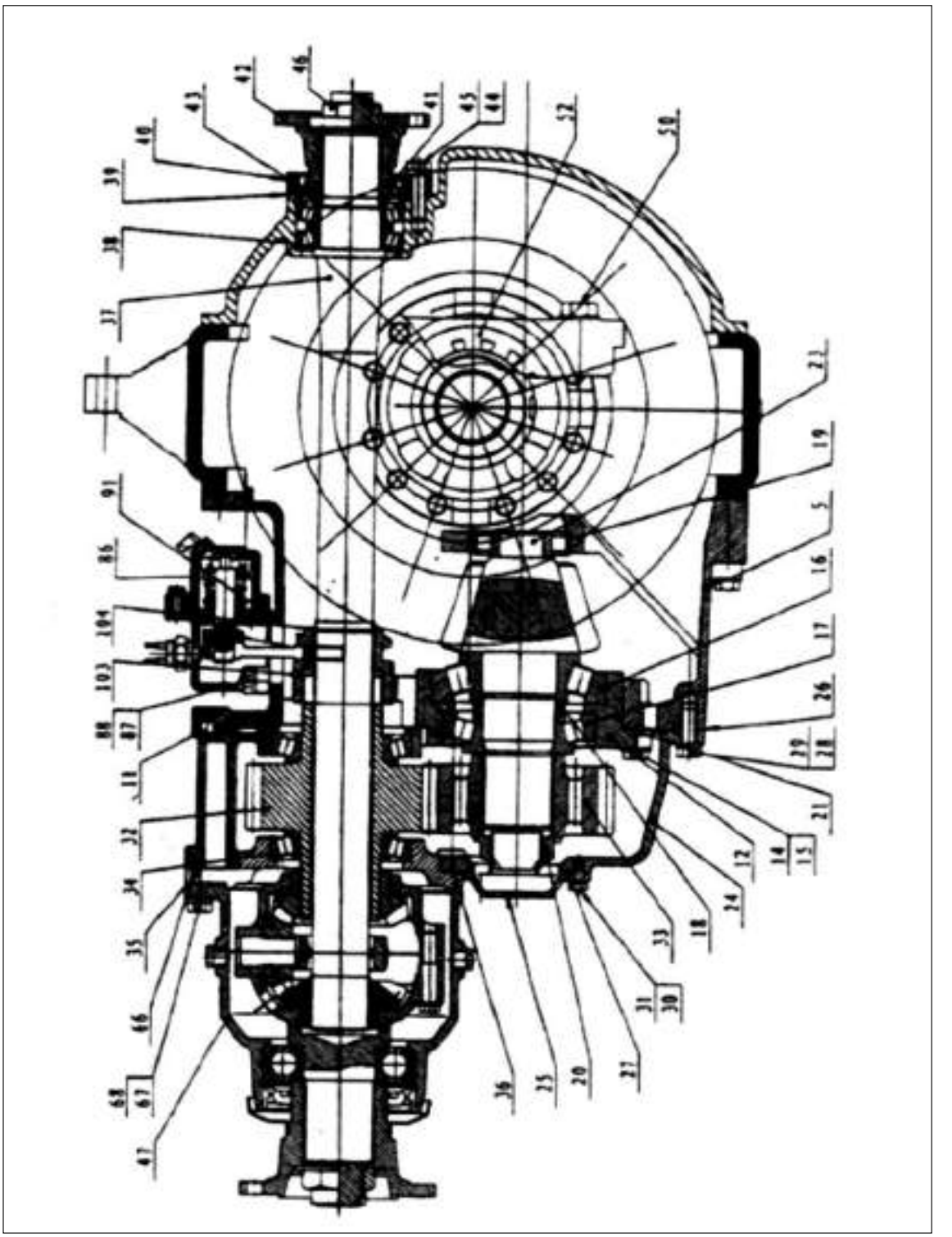


Fig.3

Serial no.	Drawing No.	Description	Qty
1	S2501010PSH	Middle axle housing assembly	1
2	SQ2401068-A01	Rubber breather plug assembly	1
3	CQ61804	Plug screw	1
4	Q61304	Oil drain plug screw	1
5	S2502015K5H	Reducer housing and differential shaft cup assembly	1
6	SQ2402119-A01	Bolt – for tightening of differential bearing cap	2
7	SQ2402019D1H	Reducer bearing cap	2
8	2402016D1H	Bolt for tightening of reducer	8
9	2402017D1H	Bolt for tightening of reducer	4
10	S2502018K5H	Reducer housing	1
11	CQ5241226	Cylindrical pin – reducer housing	2
12	S2502045K5H	Square head taper oil filling plug	1
	S2502045K5H	Axle drive bevel pinion bearing block assembly	1
13	S2502049K5H	Bearing block - axle drive bevel pinion	1
14	CQ1501440	Bolt – for tightening of axle drive bevel pinion bearing	8
15	2403038-A31	Plain washer	8
16	9278/9220	Taper roller bearing	1
	9220	Outer race, bearing	1
	9278	Bearing inner race and roller assembly	1
17	30613B	Taper roller bearing	1
	30613B-1	Outer race, bearing	1
	30613B-2	Bearing inner race and roller assembly	1
18	2402081D1HB1	Adjusting washer-axle drive bevel pinion bearing（3.07-3.09）	1
	2402082D1HB1	Adjusting washer- axle drive bevel pinion bearing（3.17-3.19）	1
	2402083D1HB1	Adjusting washer- axle drive bevel pinion bearing（3.27-3.29）	1
	2402084D1HB1	Adjusting washer- axle drive bevel pinion bearing（3.37-3.39）	1
	2402086D1HB1	Adjusting washer- axle drive bevel pinion bearing（3.47-3.49）	1
	2402087D1HB1	Adjusting washer- axle drive bevel pinion bearing（3.57-3.59）	1
	2402088D1HB1	Adjusting washer- axle drive bevel pinion bearing（3.67-3.69）	1
	2402089D1HB1	Adjusting washer- axle drive bevel pinion bearing（3.77-3.79）	1
	2402091D1H	Adjusting washer- axle drive bevel pinion bearing（10）	1
	2402092D1H	Adjusting washer- axle drive bevel pinion bearing（0.05）	1
19	42708K	Axle drive bevel pinion cylindrical roller bearing assembly	1
	42708K-01	Bearing outer race and roller assembly	1
	42708K-02	Bearing inner race	1

Serial no.	Drawing No.	Description	Qty
20	2402071D1H	Nut for tightening of driven cylindrical gear	1
21	S2502097K5H	Adjusting shim – axle drive bevel pinion bearing bearing block（i = 0.5）	3
	S2502098K5H	Adjusting shim – axle drive bevel pinion bearing block（i = 0.2）	3
	S2502099K5H	Adjusting shim – axle drive bevel pinion bearing block（i = 0.1）	3
22	2402063D1H	Bolt – for tightening of driven bevel pinion and differential left case	12
23	S2502036K5H	Axle drive bevel pinion	1
24	S2502121K5H	Housing – cylindrical gear	1
25	S2502122K5H	Blind cover – cylindrical gear housing	1
26	S2502123K5H	Shims, cylindrical gear housing	1
27	SQ2502124K5H	O-ring	1
28	CQ1501440	Bolt – for tightening of cylindrical gear housing	13
29	Q40314	Spring washer	13
30	CQ1501020	Bolt – for tightening of cylindrical gear housing cover blocked	2
31	Q40310	Spring washer	2
32	S2502107K5H	Drive cylindrical gear	1
33	S2502108K5H	Driven cylindrical gear	1
34	30215	Drive cylindrical gear bearing assembly	2
	30215-1	Outer race, bearing	2
	30215-2	Bearing inner race and roller assembly	2
35	S2502126K5H	Bearing block, drive cylindrical gear	1
36	S2502131K5H	Adjusting shim - drive cylindrical gear bearing block（i = 0.5）	2
	S2502132K5H	Adjusting shim - drive cylindrical gear bearing block（i=0.2）	3
	S2502133K5H	Adjusting shim - drive cylindrical gear bearing block（i=0.1）	4
	S2502134K5H	Adjusting shim - drive cylindrical gear bearing block（i=0.05）	4
37	S2502161K5H	Thru shaft	1
38	30211	Thru shaft bearing assembly	2
	30211-1	Outer race, bearing	2
	30211-2	Bearing inner race and roller assembly	2
39	S2502171K5H	Adjusting shim-thru shaft bearing cap（i=0.5）	2
	S2502172K5H	Adjusting shim-thru shaft bearing cap（i=0.2）	2
	S2502173K5H	Adjusting shim-thru shaft bearing cap（i=0.1）	1
40	S2502168K5H	Bearing cap –thru shaft	1
41	S2502170K5H	Thru shaft oil seal assembly	1
42	S2502166K5H	Flange –thru shaft	1
43	S2502169K5H	Washer –thru shaft flange	1

Serial no.	Drawing No.	Description	Qty
44	CQ1501445	Bolt – for tightening of thru shaft bearing cap	1
45	Q40314	Spring washer	3
46	S2402071K5H	Nut – for ightening of thru shaft flange	1
47	A2502037K5H	Driven bevel pinion	1
	A2503010K5H	Differential assembly	1
	2403015DH1	Differential housing assembly	1
48	2403017D1H	Left case, differential	1
49	2403018D1H	Right case, differential	1
50	2403023D1H	Bolt – for tightening of differential housing	12
51	7518E	Differential bearing assembly	2
52	2403071D1H	Adjustable ring	2
53	SQ2403072B01D	Lock plate – adjustable ring	2
54	240053D1H	Gasket - half axle gear	2
55	2403051D1HB1	Half axle gear	2
56	2403058D1H	Shim - planetary gear	4
57	2403056D1H	Planetary gear	4
58	2403061D1H	Differential spider	1
59	S2403081K5HB1	Left half axle	1
60	S2403082K5HB1	Right half axle	1
61	2403086-4E	Shim – half axle	2
62	2403083-4E	Bolt – half axle	20
63	2403090D1H	Half axle oil seal assembly	2
	S2507010K5H	Interaxle differential and housing assembly	1
64	2401058-4E	Lock plate	2
65	S2507011K5H	Housing – interaxle differential	1
66	S2507013K5H	Shim - interaxle differential housing	1
67	CQ1501455	Bolt – for tightening of interaxle differential housing	8
68	Q40314	Spring washer	8
69	CQ61803	Oil filling plug	1
70	CQ61803	Oil draining plug	1
71	6313K	Bearing of interaxle differential	1
72	Q430140	Retaining ring - bearing of interaxle differential	1
73	2402055D1H	Interaxle differential oil seal assembly	1
	2402067D1H	Dust arrester - interaxle differential oil seal	1
74	2402065D1H	Interaxle differential flange assembly	1

Serial no.	Drawing No.	Description	Qty
74	2402066D1H	Flange	1
75	2402071K5H	Nut – for tightening of interaxle differential flange	1
	S2507050K5H	Interaxle differential assembly	1
	S2507055K5H	Interaxle differential housing assembly	1
76	S2507057K5H	Front case - interaxle differential	1
77	S2507058K5H	Rear case - interaxle differential	1
78	CQ1601475	Bolt – for tightening of interaxle differential housing	8
79	2403038A31	Plain washer	8
80	2403051A31	Front half axle gear – interaxle differential	1
81	S2507068K5H	Rear half axle gear – interaxle differential	1
82	2403053A31	Shim – front half axle gear	1
83	S2507072K5H	Shim – rear half axle gear	1
84	S2403058A31	Shim - planetary gear	4
85	2403056A31	Planetary gear – interaxle differential	4
86	2403061A31A1	Spider – interaxle differential	1
	SQ2508010K5H	Interaxle differential lock assembly	1
87	CQ1501030	Bolt – for tightening of housing	4
88	Q40310	Spring washer	4
89	SQ2508011-52	Housing - differential lock	1
90	2508021-52	Air cylinder - differential lock	1
91	2508023-52	Shim – air cylinder	1
92	CQ1500825	Bolt – for tightening of air cylinder	1
93	Q40308	Spring washer	4
94	CQ63505	Joint – air cylinder	1
	2508025-52	Piston and shifting yoke assembly	1
95	2508026-52	Piston	1
96	2508027-52	Shifter shaft	1
97	Q7343150	Rubber O-ring	1
98	2508031-52	Return spring, piston	1
99	2508032-52	Return spring, piston	1
100	S2508041K5H	Shifting yoke	1
101	Q5280416	Spring washer cylindrical pin	1
102	Q5280416	Spring washer cylindrical pin	1
103	S2508052K5H	Gear sleeve – (differential between azles) intermediate axle differential lock	1
104	S2508054K5H	Steel wire retaining ring	1

►Structure of brake

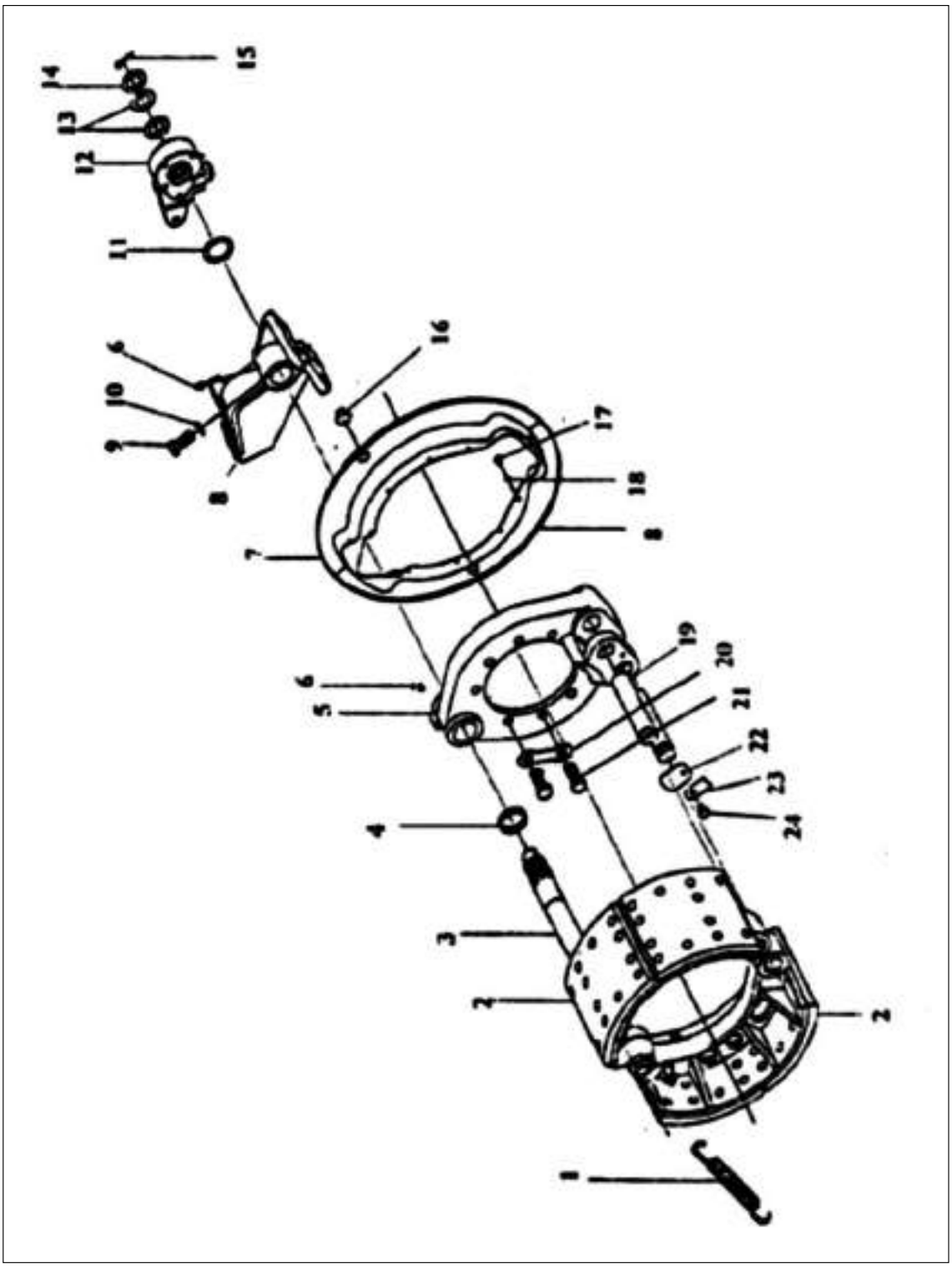


Fig.4

Serial no.	Drawing no.	Description	Qty
1	3502436-4E	Retracting spring	2
2	3502380-1H	Rear lower left (upper right) brake shoe band	
		Roller assembly	2
	3502375-1H	Rear upper left (lower right) brake shoe band	
		Roller assembly	2
3	3502151-5H	Right middle brake cam	1
	3502152-5H	Left middle brake cam	1
4	3501134-4E	Cam washer	2
5	3502025-4E	Rear brake support assembly	2
	3502026-4E	Rear brake support	2
	3502029-4E	Bushing	4
6	CQ70001	Grease	2
7	3502031-1H	Rear brake upper left (lower right) dust arrester	2
8	3502032-1H	Rear brake lower left (upper right) dust arrester	2
	3502125-1H	Left support assembly – middle brake cam	1
	3502130-1H	Right support assembly – mmiddle brake cam	1
9	CQ1501435	Bolt – for tightening of rear brake cam support	8
10	Q40314	Spring washer	8
11	3501156-01	Adjusting washer	4
12	3502205 – 1H	Left rear brake adjusting arm assembly	1
	3502210 - 1H	Left rear brake adjusting are assembly	1
13	3501157-01	Adjusting shim – brake cam	4
14	3501158-01	Washer – brake cam	2
15	Q5006035	Split pin	2
16	3501034	Plug	4
17	CQ1500610	Bolt – for dust arrester	16
18	Q40306	Spring washer	16
19	3502082-4E	Rear brake shoe shaft	4
20	3502039-4E	Lock plate	8
21	CQ1501635T	Bolt – for tightening of rear brake support	16
22	3501086-4E	Brake shoe shaft baffle	2
23	3501087-4E	Lock plate – brake shoe shaft	2
24	CQ1501016	Bolt – for baffle	2

Precautions of Maintenance and Operation

►Before operation:

(1) Fill up with sulfur-sulfur type high-duty gear oil #90 (GL-5). For rear axle, fill up the reducer with gear oil (approx. 16 liters) through the oil-filling aperture on the axle housing up to the oil hole; for middle axle, fill up the reducer with gear oil (approx. 20 liters) through the oil-filling aperture on the reducer housing up to the oil hole; fill up the interaxle differential with gear oil (approx. 2 liters) through the oil-filling aperture on the differential housing. (Note: this applies to area with an air temperature no lower than -10℃.)

(2) Fill up each grease nipple with sufficient quantity of lithium base grease #2.

►After operation:

(1) After run-in of 1500Km, replace the gear oil of middle and rear axles.

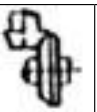
(2) Due to the large torque transferred by the half axle flange as well as the impact of shock loading, it is necessary to check the tighteness of half axle bolt frequently to prevent it from loosening and breaking.

(3) Inspect and make up oil and clean breather plug regularly. Unscrew the oil level plug and inspect the gear oil level inside the axle housing. Check the quality of the gear oil inside the axle housing and replace it with fresh oil in case of thinning and deterioration. The initial oil change mileage is 1500km; and after that the gear oil and hub grease shall be changed for every 24000km running.

(4) Check brake clearance for every 5000km running for axle without brake clearance automatic adjusting arm.

(5) Check the tightness of brake plate, tighteness of hub bearing and abrasion of braking plate for every 8000-10000km running. Replace immediately the brake shoe in case that the abrasion wears of the brake plate exceed the dent on limiting stopper.

(6) Fill up each grease nipple with sufficient quantity of lithium base grease #2 for every 2000km running

Forward running 	Backward running 	Corrections	
		Move driven bevel pinion close to axle drive bevel pinion, and in case that the backlash acquired at this moment is too small, move apart the axle drive bevel pinion.	
		Move driven bevel pinion apart from axle drive bevel pinion, and in case that the backlash acquired at this moment is too large, move close axle drive bevel pinion.	
		Move axle drive bevel pinion close to driven bevel pinion, and in case that the backlash acquired at this moment is too small, move apart the driven bevel pinion.	
		Move axle drive bevel pinion apart from driven bevel pinion, and in case that the backlash acquired at this moment is too large, move close the driven bevel pinion.	

►Adjustment of engagement marking and running clearance of axle drive and driven bevel pinions

★ The proper engagement and running clearance of bevel pinion is adjusted by the axial displacement of axle drive and driven bevel pinions.

- The axial displacement of axle drive bevel pinion is adjusted by changing the thickness of the adjusting gaskets installed between axle drive bevel pinion bearing block and reducer housing ends.
- The axial displacement of driven bevel pinion is controlled by equally adjusting the adjusting rings at both ends of differential bearing without changing the pretightening load of differential bearing .

►Check-up of the engagement of bevel pinions:

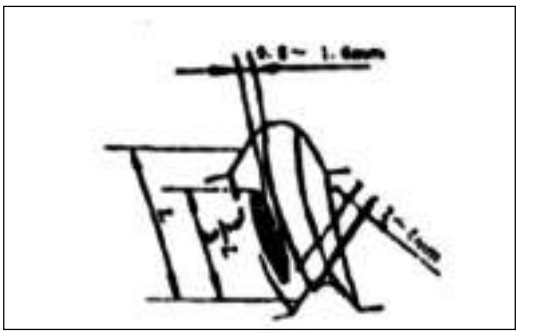
- After the pretightening load of the driven bevel pinion beariing is adjusted, check the engagement of the bevel pinion with axle drive bevel pinion adjusting gasket of proper thickness under no load condition by color coating.

When the axle drive and driven bevel pinions are properly engaged:

○ The engegement marking on tooth crown of driven bevel pinion shall comply with the drawing, which shall be at the smaller end of the middle part in the direction of tooth length and the middle part in the direction of tooth depth.

○ The engagement marking on axle drive bevel pinion can reach the upper edge of tooth.

○ The engagement marking and running clearance of bevel pinions shall be checked at three teeth equally-



spaced along the circumference of driven bevel pinion in the direction perpendicular to the larger end crown.

★ If the engagement and running clearance of bevel pinions can not meet the above requirements, readjust according to the drawing on the previous page until the requirements are satisfied.

►Engagement of drive and driven cylindrical gears:

- The engagement and running clearance of drive and driven cylindrical gears can not be adjusted. When assembling, as long as the pretightening load of the drive cylindrical gear bearing is satisfied, the axial position of drive and driven cylindrical gears can be guaranteed.
- The four planetary gears and two half axle gears inside the interaxle differential and the differential do not need adjustment. When each differential assembly is assemblied, the half axle gears can be rotated easily and no sticking or jamming at a certain position is allowed during rotation. Only when replacing seriously abraded or damaged parts, the differential assembly shall be dismounted.

Caution ⚠

Normally, the differential assembly shall not be dismounted and only when replacing seriously abraded or damaged parts, it shall be dismounted.

Do not operate interaxle differential during normal running.

►Maintenance of axle

1 Dismounting

1. Middle axle system consistes of three parts, namely the axle housing assembly, final drive assembly and brake assembly. The dismounting of drive axle shall be proceeded as follows in principle:

(1)Drain the gear oil;

(2)Dismount the properller shaft connecting middle axle and rear axle;

(3)Unscrew the oil seal retainer bolt and remove thru shaft assembly;

(4)Disconnect the middle axle input end properller shaft and middle axle;

(5) Remove air pipe from differential lock control assembly;

(6) Dismount half axle;

(7) Remove final drive assembly;

(8)Disconnect hose and piping of brake air chamber;

(9) Dismount hub brake drum assembly;

(10) Dismount brake assembly;

(11) Dismount axle housing.

Caution ⚠

①Measure the running clearance of each gear before dismounting.

②Before dismounting differential assembly, bearing caps shall be marked with pairing number to avoid mistakes during reassemblying.

2. Dismount final drive assembly

(1) Dismount interaxle differential lock assembly;
(2)Dismount differential lock control assembly and geared sleeve;
(3) Dismount differential reducer assembly;
● Clean throughly sealing compound from attachment face.
● Degrease, clean and throughly remove the oil, water and other dirties from attachment face.

Note:

Use a proper tool, such as scraper to clean sealing compound from attachment face to prevent the damage of attachment face.

(4) Inspect and take note of running clearances of axle drive and driven bevel pinions:
(5) Dismount lock plate;
(6) Mark properly on bearing cap and reducer housing proper with pairing number;
(7) Gently unscrew bearing cap set bolt and use a special spanner to dismount adjusting nut;
(8) Remove bolt and bearing cap;
(9) Dismount differential assembly;
(10) Remove axle drive bevel pinion bearing block bolt;
(11) Dismount axle drive bevel pinion assembly and adjusting gasket via the back space bolt hole on bearing block;

3. Dismount interaxle differential assembly

(1) Dismount flange lock nut and remove flange assembly;
(2) Remove oil seal retainer;
(3) Use a soft wood bar to gently hit interaxle differential housing and remove housing;
(4) Dismount ball bearing from interaxle differential housing;
(5) Dismount interaxle differential assembly and measure half axle gear and planetary gear clearance;

Note:

Put spider in proper place and measure the clearance.

(6) Dismount spider assembly, half gear and thrust washer;
(7) Remove thrust washer and planetary gear from spider.

4. Dismount differential lock control assembly

(1) Dismount air cylinder and separate O-ring with return spring;
(2) Dismount nut, washer and piston;
(3) Remove felt oil seal and O-ring;
(4) Remove washer and pin from plug socket;
(5) Move out forward shifter shaft and then remove O-ring, plug and shifting yoke.

5. Dismount cylindrical gear housing assembly

(1) Dismount reducer housing and cylindrical gear housing;
(2) Remove taper roller bearing, sleeve and adjusting washer;
(3) Remove drive cylindrical gear bearing block and adjusting washer from cylindrical gear housing via back space bolt hole;
(4) Use bearing puller to remove taper roller bearing 30215 inner race (only when it is necessary to replace bearing);

(5) Use bearing puller to remove bearing outer race (only when it is necessary to replace bearing).

6. Dismount brake assembly

(1) Support and secure axle assembly;

(2) Use spanner to dismount half axle bolt;

(3) Draw out half axle gently and rotate it slowly when its spline passes oil seal to avoid damage of oil seal. In case that it is difficult to draw half axle, use an outbroad type copper hammer to hit gently the central part of half axle tail part untill half axle is loosen;

Note:

The above items (1) – (3) can be followed as the dismounting process of half axle.

(4) Use socket spanner to dismount two bolts on lock plate and remove the lock plate;

(5) Use special spanner to dismount adjusting nut;

Caution ⚠

The dismounted adjusting nuts shall be marked properly on the mating surface to avoid mistakes during reassemblying.

(6) Rotate hub brake drum slightly and pull it out with puller and meanwhile hit gently on brake drum to loosen outer bearing inner race, remove hub brake drum when outer bearing inner race is loosen. However, attention shall be paid not to hurt the assembly or people because the assembly is very heavy, in addition, pay attention not to let the outer bearing inner race fall down.

Caution: The above items (1) – (6) can be followed as the dismounting process of hub brake drum.

(7) Use special tool to dismount return spring;

Note:

Use a ring or steel wire to tire the brake shoe before dismounting return spring;

(8) Dismount brake shoe;

1* Remove steel lock wire and lock screw;

2* Remove brake shoe shaft and brake shoe;

(9) Dismount roller shaft and roller;

(10) Dismount split pin, adjusting gasket and washer;

(11) Dismount nut and air pipe and remove brake air chamber from air chamber support;

(12) Dismount brake adjusting arm;

(13) Dismount camshaft;

Caution:

Left and right camshafts shall be properly marked to avoid mistakes during reassemblying. 。

(14) Dismount brake air chamber support;

(15) Dismount brake plate and dust arrester.

7. Dismount axle housing

(1) Dismount half axle;

Refer to items(1) – (3) of 6;

(2) Dismount slide. (Note: Take note of the deflection direction of slide releative to axle housing to avoid reverse assembling of slide during reassemblying.)

►Cleaning and inspection

1. Cleaning

Parts may be contaminated with dirty oil and sludge, so it is necessary to clean them. Common cleaning methods include steam cleaning, gasoline cleaning, acid or alkali solution cleaning, neutral detergent cleaning, trichlorethylene cleaning and magnetic cleaning. Some parts may have been damaged; therefore, they must be inspected carefully during cleaning.

(1) Metal parts

1) Gasoline

Different from other methods, gasoline has hardly any penetrability or dissolving power on sludge. Use metal wire brush or other tools to remove sludge unless the surface of parts are precisely machined, repeat the cleaning process.

(2) Rubber parts

Mineral oil can not be used for cleaning. Use spirit or a clean rag to remove dirts.

(3) Anti-rusting

When all waste oil and grease are removed from the surface of parts, paint the surface with a coating of clean oil to prevent rusting.

2. Inspection

After the parts are cleaned, inspect them with measuring devices or tools which are got ready beforehand. Make judgement whether the parts are suitable for reuse according to specified maintenance standard and the damaged parts shall be repaired or replaced according to the requirements. In case that one of the paired parts is seriously damaged and fit-up gap exceeds the specification, it may be necessary to replace the part or the paired parts.

From the preventive maintenance point of view, the parts within repair or abrasion limits shall be replaced routinely before they exceed the limits.

All parts shall be inspected carefully by visual check or infra-red detection. When the following abnormalities are found during visual check, the part shall be repaired or replaced as necessary.

All rubber parts, such as O-ring, oil seal and seal washer shall be determined for discarding when dismounted.

3. Abnormalities

- Uneven abrasion
- Eccentric wear
- Scrape
- Abnormal noise bearing ,etc.)
- Failure or weakening (spring)
- Loose fit
- Bending
- Deformation
- Rust
- Deterioration (brake bush)
- Cracks
- Off-coloring

►Assembling and adjustment

The assembling of middle axle is in the reverse order of dismounting; however, attention shall be paid to the adjustment of bolt tightening torque and bearing pretightening torque as well as the adjustment of gear clearance.

1) Installation of slide

(1) Put the slide on the top of axle housing with the bottom in contact with the housing top;
(2) The gap between the slide and axle spring guide is 3mm;
(3) Fit bolts, spring washers and nuts. Tighten nuts diagonally with a tightening torque of 140-190Nm.

2) Tightening torque for bolt assembling (Nm)

Item	Tightening torque (Nm)	Item	Tightening torque (Nm)
Fastening bolts of left and right bevel gear differential housings	340±20	Locknut of interaxle differential flange	650-700
Fastenting bolt of driven			
gear	650±20	Oil filling plug and drain plug	80-120
Fastening bolt of bearing			
cap	650±20	Bolt for tightening of reducer	320-360
Upper hexagon lock nut			
of axle drive bevel pinion	650-700	Brake mounting bolt	260-320
Fastening bolt of axle drive upper bearing block	140-190	Fastening bolt of lock plate	36-63
Fastening bolt of cylindrical gear housing	140-190	Fastening bolt of half axle	260-320
Fastening bolt of drive cylindrical gear bearing block	140-190	Fastening bolt of through-going shaft assembly	140-190
Tightening nuts of front and rear differential housings	140-190	Lock nut of through-going shaft end	650-700
Bolt of drive shaft	130-160		

3) Bearing pretightening torque and gear clearance

Item	Tightening torque (Nm)	Item	Tightening torque (Nm)
Hub bearing pretightening torque	30-65N	Clearance between axle shaft gear and planetary gear	Nominal clearance 0.30-0.4mm Repair limit 0.5mm
Clearance between brake shoe and brake drum	0.2-0.5mm	Clearance between planetary gear and spider	Nominal clearance 0.10-0.14mm Worn-out limit 0.3mm
Pretightening torque of axle drive bevel pinion bearing block	2.5-4.5Nm	Planetary gear clearance of differential	Nominal clearance 0.20-0.30mm repair clearance 0.45mm
Clearance between axle drive bevel pinion and driven bevel gear	Nominal gear clearance 0.25-0.40mm	Pretightening torque of drive cylindrical gear bearing block	1.5-3.5Nm
Pretightening torque of differential bearing	20.-4.0Nm		

4) Importants for assembling

(1) Assemblling of differential housing

After the assembling marks are matched, put the right housing onto the left one.

(2) Assembling of bearing cap

When refitting bearing cap, follow the marks made before disassembling to avoid mistakes.

5) Adjustment of axle

(1) Adjustmeng of brake clearance

When the clearance between brake rubber and brake drum is too large or small, the brake performance of the whole vehicle will be impacted. Under this condition, use spanner to adjust the worm hexgonal head on the adjusting arm. Rotate in CCW direction until the clearance is zero; and then rotate reversely to hear two slippings of steel ball and now the clearance is 0.3-0.4mm.

(2) Adjustment of hub bearing pretightening torque

① Dismount the keeper, use special spanner to tighten adjusting nut with a tightening torque greater than 500Nm.

② When brake drum is rotated for 2-3 turns, the bearing is placed in position properly, and then tighten with a torque ≥ 500Nm.

③ Rotate reversely the adjusting nut 1/4-1/6 turn, rotate brake drum 2-3 turns.Measure the starter force on hub bolt with spring scale, the value shall be 300-65N.

④ Install the keeper and tighten fastening bolt of keeper.

Common Faults and Troubleshooting

Fault	Possible Cause	Remedy
Abnormal noise of drive gear	1. Improper differential gear clearance.	Replace thrust washer or gear.
	2. Excessive clearance between axle drive and driven gears.	Replace thrust washer or gear.
	3. Too small the axle drive bevel pinion bearing pretightening torque.	Adjust pretightening torque.
	4. Worn-out or damaged axle shaft gear, planetary gear, spider thrust washer.	Correct or replace damaged parts.
	5. Too low oil level.	Top up the oil
Oil leakage	1. Oil seal is worn out, loosen or damaged.	Replace oil seal
	2. Reducer fastening bolt is loosen.	Tighten with pretightening torque.
	3. Sealing compound is damaged.	Reapply sealing compound.
	4. Bearing block fastening bolt is loosening.	Tighten according to specified torque.
	5. Oil drain screw plug is loose or liner damaged.	Tighten screw plug according to specified torque or replace liner.
	6. Axle housing is deformed due to overload.	Align or replace axle housing.
	7. Breather plug is blocked or damaged.	Clean or replace breather plug.
Hub bearing stuck	1. Excessive pretightening torque of hub bearing.	Adjust pretightening torque.
	2. Bearing is lack of lubrication or grease is not appropriate.	Fill up grease or replace grease.
	3. Bearing is contaminated with dust.	Clean and replace grease.
	4. Bearing is damaged.	

Fault	Possible Cause	Remedy
Insufficient braking torque	1. Unsmooth rotation of camshaft.	Check the operation of camshaft.
	2. Improper adjustment of tappet travel of brake chamber.	Adjust travel.
	3. Abrasion or deterioration of brake lining.	Replace brake lining
Insufficient braking torque	4. Improper binding of brake lining.	Correct the binding position of brake lining.
	5. Water induction of brake drum.	During running, step down pedal gently and drain water.
	6. Grease on brake lining and brake drum.	Degrease or replace brake lining.
	7. Insufficient brake air pressure or volume.	Check pneumatic piping and each pneumatic valve.
Abnormal noise of brake	1. Brake lining is abraded resulting in bolt extruding.	Replace brake lining.
	2. Surface hardening or deterioration of brake lining.	Replace brake lining.
	3. The abrasion of brake drum is not even or its installation is not secured.	Correct or replace brake drum or tighten bolt.
	4. Loose contact between brake shoe and lining.	Tighten connecting bolt
	5. Loose brake shoe fixed pin.	Tighten fixed pin set screw.
		Replace hub bearing.
		Correct or replace brake drum.
Instable braking	1. Brake shoe is not properly installed.	Tighten fixed pin set screw
	2. Retracting spring is damaged.	Replace retracting spring
	3. Oily or deteriorated brake lining.	Clean or replace brake lining.
	4. Damaged brake plate.	Replace brake plate.
	5. The brake shoe clearance is not properly adjusted, which must be readjusted.	
Wheel stuck	1. Poor lubrication of camshaft or no retracting of adjusting arm	Correct the failures.
	2. Broken or fatigue of brake shoe or retracting spring.	Replace the failed parts

Wear Parts

Serial no.	Drawing no.	Description	Qty
1	30613B/（9278/9220）	Axle drive bevel pinion bearing assembly	1
2	42708K	Axle drive bevel pinion cylindrical roller bearing assembly	1
3	30215	Driven cylindrical gear front bearing assembly	1
4	30215	Driven cylindrical gear rear bearing assembly	1
5	30211	Through-going shaft bearing assembly	1
6	S2502170K5H	Through-going shaft oil seal assembly	1
7	594A/592A	Differential taper roller bearing assembly	2
8	2403084-4E	Shim – half axle	2

Serial no.	Drawing no.	Description	Qty
9	2403090D1H	Half axle oil seal assembly	1
10	6313K	Interaxle differential bearing assembly	1
11	2402055D1H	Interaxle differential oil seal assembly	1
12	Q7343150	O-ring	1

8 457 Tandem Rear Axle

Main Technical Data

Rated axle load:	13000Kg	Dead load:	820Kg
Applicable tyre type:	11.0-20	Brake size:	Φ4000×200mm
Applicable wheel track:	1847mm	Broadened brake size:	Φ410×200mm
Applicable rim type:	8.0-20	Min. ground clearance:	241mm
Available gear ratio:	4.444 4.875 5.286 5.833	Max. output torque:	40000Nm

Outline Drawings and Connection Dimensions

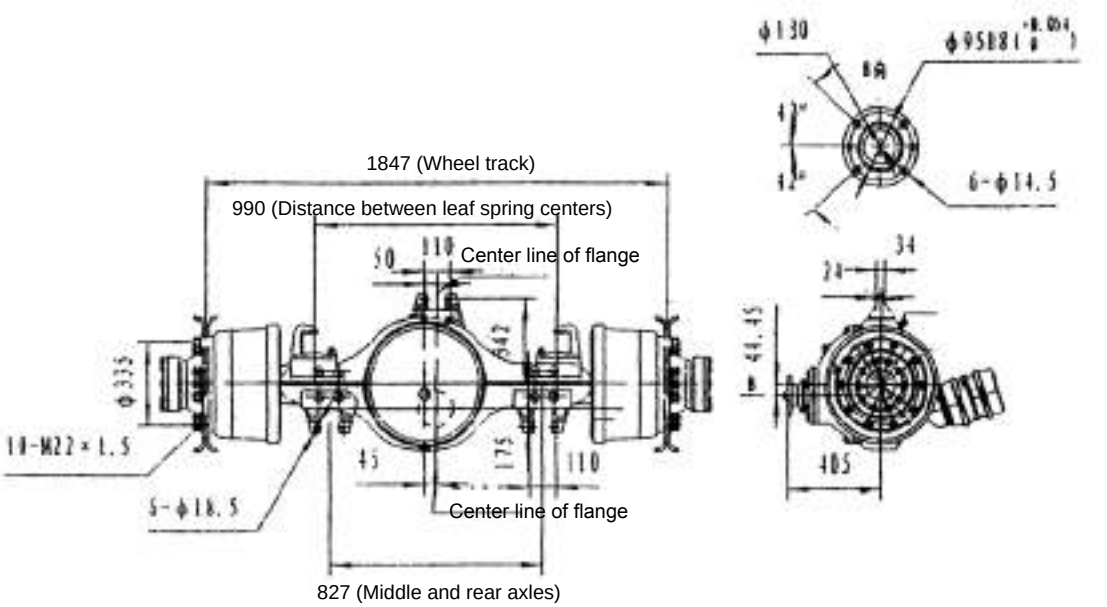


Fig.5

Structure

►Structure of rear axle assembly (Refer to middle axle for Maker)

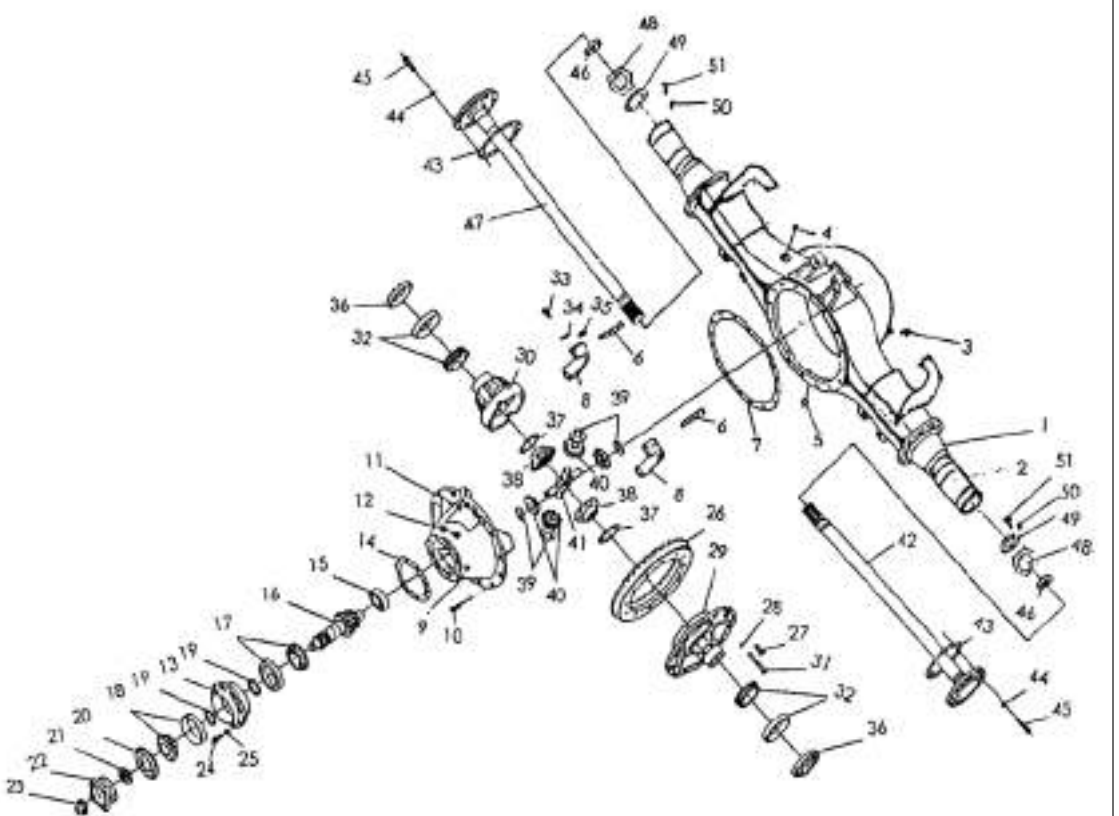


Fig.6

►Assembly drawing of rear axle final drive assembly

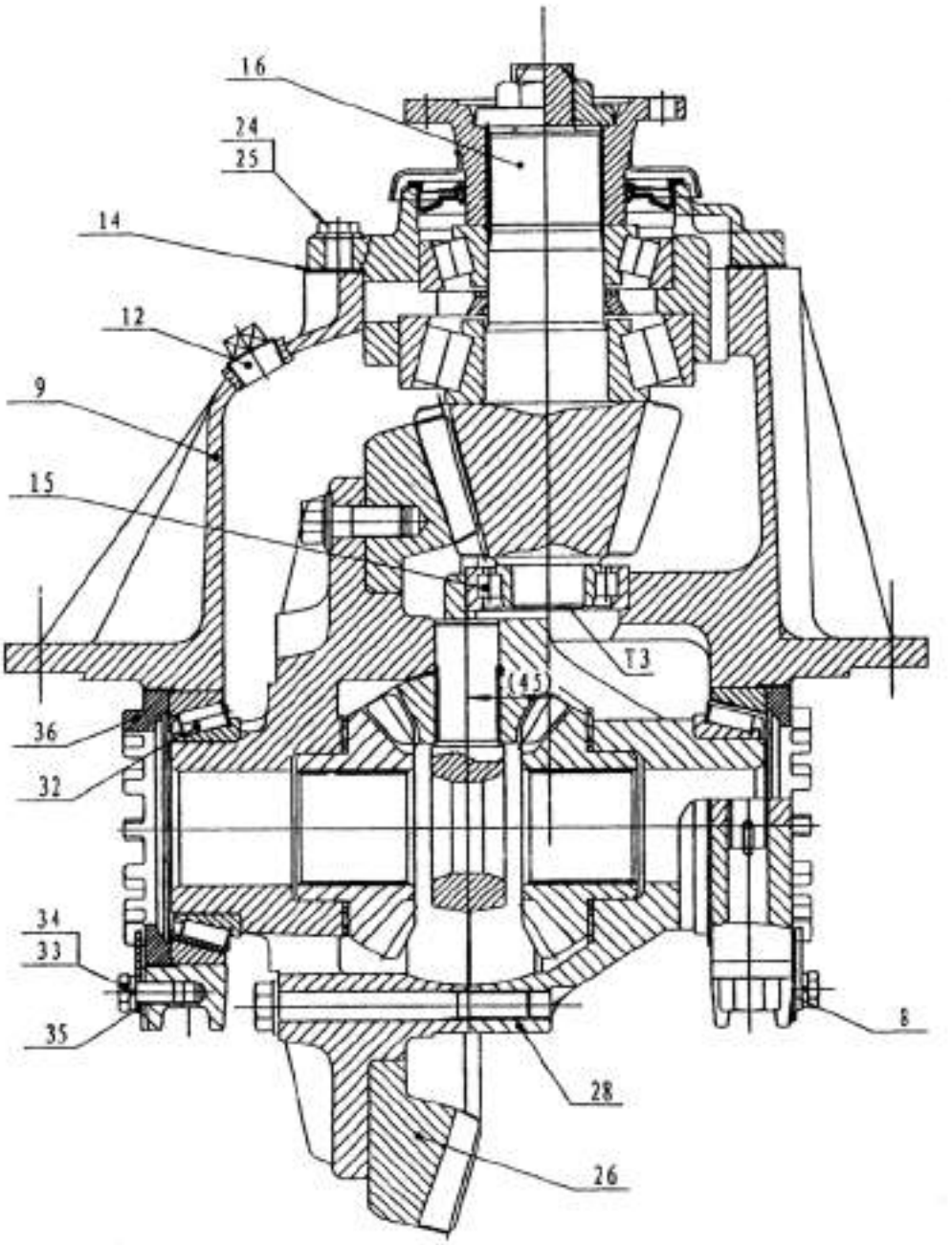


Fig.7

Serial no.	Drawing No.	Description	Qty
1	S2401010PSH	Rear axle housing assembly	1
2	S2401021K1H	Axle head	1
4	Q61304	Oil drain plug	1
3	SQ2401086	Rubber vent plug assembly	1
5	CQ61804	Plug screw	1
6	SQ2402119-A01	Bolts for fastening bearing cap of differential	2
7	HZ-1 Oil-resistant RTV Sealant	Positions for applying sealant on the seal gasket	1
8	SQ2402019D1H	Bearing Cap of differential	2
9	2402018D1H	Reducer housing	1
10	2402016D1H	Bolts for fastening of the reducer	8
11	2402017D1H	Bolts for fastening of the reducer	4
12	Q62510	Oil filling plug screw	1
	2402045D1HA1	Bearing block assembly of axle drive bevel pinion	1
13	2402049D1HA1	Bearing block	1
14	2402099D1H	Adjustment washer-- bearing block of axle drive bevel pinion(i=0.5)	3
	2402098D1H	Adjustment washer-- bearing block of drive bevel pinion(i=0.2)	3
	2040299D1H	Adjustment washer- bearing block of axle drive bevel pinion(i=0.1)	3
15	42708K	Cylindrical roller bearing without retainer	1
	42708K-1	Bearing outer race & roller assembly	1
	42708K-2	Bearing inner race	1
16	S2402036K5H	Axle drive bevel pinion	1
17	9278/9220	Cylindrical roller bearing of axle drive bevel pinion	1
	9220	Bearing outer race	1
	9278	Bearing inner race & roller assembly	1
18	30613B	Cylindrical roller bearing of drive bevel pinion	1
	30613B-1	Bearing outer race	1
	30613B-2	Bearing inner race & roller assembly	1
19	2402091D1H	Adjustment washer- bearing of axle drive bevel pinion(10)	1
	2401081D1HB1	Adjustment washer- bearing of axle drive bevel pinion(3.07-3.09)	1
	2401083D1HB1	Adjustment washer- bearing of axle drive bevel pinion(3.07-3.19)	1
	2401083D1HB1	Adjustment washer- bearing of axle drive bevel pinion(3.07-3.29)	1
	2401084D1HB1	Adjustment washer- bearing of axle drive bevel pinion(3.07-3.39)	1
	2401086D1HB1	Adjustment washer- bearing of axle drive bevel pinion(3.07-3.49)	1
	2401087D1HB1	Adjustment washer – bearing of axle drive bevel pinion(3.07-3.59)	1

Serial no.	Drawing No.	Description	Qty
	2401088D1HB1	Adjustment washer- bearing of axle drive bevel pinion(3.07-3.69)	1
	2401089D1HB1	Adjustment washer- bearing of axle drive bevel pinion(3.07-3.79)	1
	2402092D1H	Adjustment washer- bearing of axle drive bevel pinion (0.05)	1
20	2402055D1H	Oil seal assembly- bearing of axle drive bevel pinion	1
21	S2402067K5H	Dust cover- oil seal of axle drive bevel pinion	1
22	S240265K5H	Flange assembly of axle drive bevel pinion	1
23	S2402071K5H	Nut- flange of axle drive bevel pinion	1
24	CQ1501440	Bolt- for fastening of the bearing cap of axle drive bevel pinion	8
25	2403038A31	Plain washer	8
26	2402037D1H	Driven bevel pinion	1
27	2402063D1H	Bolt- for fastening driven bevel pinion & left housing of differential	12
28	2403010D1H	Differential assembly	1
	2403015D1H	Housing assembly of differential	1
29	2403017D1H	Left case of differential	1
30	2403018D1H	Right case of differential	1
31	2403023D1H	Bolt for fastening the housing of differential	12
32	594A/592A	Bearing assembly	2
33	CQ1501020	Bolt- bearing cap of differential	2
34	Q40310	Spring washer	2
35	SQ2403072B01D	Stopper- adjustment ring	2
36	2403071D1H	Adjustment ring	2
37	2403053D1H	Gasket of half axle gear	2
38	2403051D1HB1	Half axle gear	2
39	2403058D1H	Gasket of planetary gear	4
40	2403056D1H	Planetary gear	4
41	2403061D1H	Differential spider	1
42	S2403081K5HB1	Left half axle	1
43	2403084-4E	Gasket of half axle	2
44	Q40316	Spring washer	20
45	2403083-4E	Bolt of half axle	20
46	2403090D1H	Oil seal assembly of half axle	2
47	S2403082K5HB1	Right half axle	1
48	2401053-4E	Adjustment nut	2
49	2401058-4E	Lock plate	2
50	Q40308	Spring washer	6
51	CQ1500816	Bolt	6

Precautions of Maintenance and Operation

Axle Maintenance

►Dismounting

1. The rear axle consists of axle housing assembly, general reducer assembly as well as brake. In principle, dismount rear axle according to the following procedures:

(1) Drain off the gear oil;
(2) Remove the driving shaft connecting rear axle and the gear box;
(3) Remove half axle;
(4) Take off final drive assembly;
(5) Break the connection between the hose and piping of the brake chamber;
(6) Remove the brake drum assembly of wheel hub;
(7) Remove the brake assembly;
(8) Remove the axle housing.

Cautions:⚠

(1) Measure the gap at teeth side of each gear before dismounting.
(2) While dismounting the differential assembly, make match mark on the bearing before removing the cap so as to avoid mismatching during reassembly.

2. Remove the differential assembly

The procedures are the same as that of middle axle. Refer to item (1)- (3) for removing the half axle; Refer to item (1) - (6) for removing the brake drum assembly of the wheel hub.

3. Remove main reducer assembly

(1) Measure and record the gap at teeth side of driving and driven gears before dismounting;
(2) Remove the lock plate;
(3) Make mounting mark on the bearing cap and the housing;
(4) Loosen the fastening bolts of the bearing cap, remove the adjustment nut by the differential spanner;
(5) Remove the differential assembly;
(6) Remove the driving gear assembly with the puller，and remove the adjustment shim.

4. Remove the differential assembly

(1) Remove right housing of the differential.
(2) Remove the thrust shim and half axle gear.
(3) Measure and record the gap at teeth side of planetary gear.
(4) Remove the planetary gear and cross-axle assembly, then remove the thrust shim and planetary gear from the cross-axle.
(5) Take off half axle gear and the thrust shim.
(6) Remove the driven gear from left housing of the differential.
(7) Remove the bearing from the differential..

►Cleaning and Inspection

Refer to the section cleaning and inspection of middle axle.

►Mounting and Adjustment

Mount rear axle in the reverse order of dismounting, paying attention to the tightening torque of bolts and pretension adjustment of bearing.

1. Tightening torque of the bolts (N.m)

Oil drain plug screw	80-120
Fastening bolt of rear brake back plate	260-320
Fastening nut of rear brake chamber	140-190
Big nut of driving gear	650-700
Bolt of bearing block	140-190
Bolt of driven gear	600±
Bolt of differential housing	340±20
Bolt of differential	650±20
Bolt of half axle	260-320
Bolt connecting reducer housing and axle housing	320-360

2. Parts & positions to be applied sealant

Bolt of driven wheel / Bolt of differential housing / Bolt connecting reducer housing and axle housing / Flanged end of axle housing

3. Axle Adjustment

Refer to section “mounting & adjustment” of middle axle

4. Gears gap

Gap between the cross shaft and the planetary gear of the differential	Standard gap 0.1- 0.40mm Repair limit 0.30mm
Gap between the half axle gear boss and the differential housing	Standard gap 0.20- 0.30mm Repair limit 0.50mm
Backlash between driving and driven gears	Standard gap 0.25- 0.40mm Repair limit 0.60mm
Backlash between the planetary gear and the half axle gear	Standard backlash 0.20- 0.30mm Repair limit 0.50mm

5. High-mortality Parts

No.	Drawing No.	Description	Quantity
1	3063B	Cylindrical roller bearing assembly of axle drive bevel pinion	1
2	42708K	Cylindrical roller bearing without retainer	1
4	9278/9220	Cylindrical roller bearing of drive bevel pinion	1
5	594A-592A	Conical roller bearing assembly of differential	2
6	2403090D1H	Oil seal assembly of half axle	2
7	2403084-4E	Gasket of half axle	2

9 STEYR Series Axle

STEYR Double Drive Axle

On 6×4.6×6 driven STEYR automobile, the rear drive adopts double drive axle. Figure 3-1 is the outline of double drive axle.

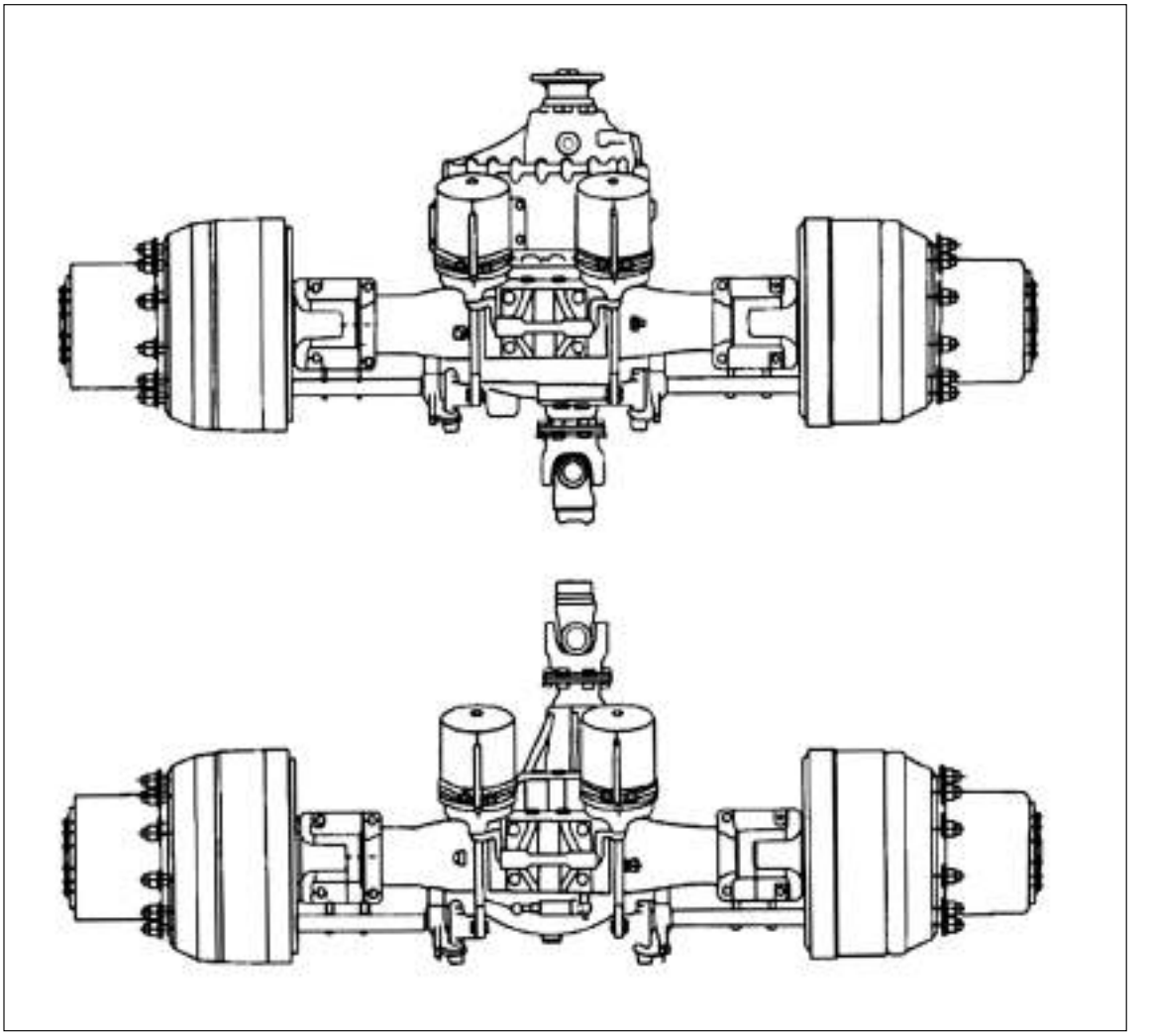


Figure 3-1 Outline drawing of double drive axle

Double drive axle is made up of middle axle and rear axle. Propeller shaft inputs power to middle axle. There is inter-axle (or inter-axial) differential in the middle axle. Inter-axle differential transfers power to middle axle and rear axle respectively. Basic performance parameter of double drive axle is as table 3-1.

Double drive axle has many speed ratios to select. At present, homemade SIDA-STEYR automobile only uses three speed ratios, that is i=4.8、5.73 and 6.72. At present, wall thickness of homemade double drive axle housing is 16 mm.

Table 3-1 Basic performance parameter of double drive axle

Item	Parameter
Rated shaft load (kg)	2×13000
Max. input speed (r/min)	3500
Max. input torque (N.m)	
I=4.8	23540
I=5.73	19620
I=6.72	17170
Brake drum :diameter × width (mm)	Φ420×185
brake mode	Air-separated brake cam
Brake pressure (bar)	6
Friction coefficient of brake friction disc and brake drum	0.39
Speed ratio of wheel-side decelerator	3.479
Brake efficiency	0.89
Park braking mode	Energy storage spring brake chamber
Gross weight of axle (excluding tyre and lubricating oil)(kg)	Middle axle about 870, rear axle about 780
Injecting volume of lubricating oil (liter)	Main decelerator of middle axle : 8.3, main decelerator of rear axle: 6, wheel-side: 2/each

Structure and Working Principle of STEYR Double Drive Axle

Double drive axle is made up of middle axle and rear axle. Rear axle of double drive axle is the same as drive rear axle mentioned in the said chapter, which is also made up of first-class center decelerator and planetary gear wheel-side decelerator. Speed ratio of planetary gear wheel-side decelerator is 3.478. Planetary gear wheel-side decelerator equipped with center driving bevel gear and driven bevel gear that have different teeth, so it has several speed ratios to select. Typical speed ratios used by homemade STEYR automobile is i=4.8, 5.73 and 6.72.

Structure of middle axle is very complex. Figure 3-2 (A) shows structure diagram of drive middle axle, figure 3-2 (B) shows its resolution graph.

As figure 3-2 (A) shown, power is transferred to flange assembly 1 by propeller shaft, then drive differential housing (front) 38 to rotate through castellated shaft. In fact, differential housing (front) 38 is front half housing of inter-axle differential, and links with rear half housing of differential 35 by hexagon stud. In inter-axle differential, the same spider planetary gear meshed with two half- shaft gears, so to drive half shaft gear 3 & 8 to rotate together. Front half shaft gear 3 links with thru shaft 11 of drive rear axle through spline, thus to transfer power to rear drive axle. Rear half shaft gear 8 links with hollow shaft 9 through spline. Hollow shaft 9 links with driving cylindrical gear 10 through spline, thus transfer power to driving bevel gear shaft 29 via driven cylindrical gear 30, and then transfer power to left & right shaft

of middle axle through driving bevel gear and driven bevel gear via inter-wheel differential 17.
There are two differentials in drive middle axle. One is inter-wheel differential, which is used to finish automatic differential of left & right wheel when automobile swerves. Another is inter-axle differential, which is used to finish automatic differential between middle axle and rear axle when automobile drives on rugged road. When automobile drives on rugged road, instant speed of middle axle should be different from rear axle (at some instant, middle axle rotates more than rear axle; at another instant, middle axle rotates less than rear axle), to suit the requirement of road. If middle axle and rear axle link stiffly completely, then at any instant, the speed of middle axle and rear axle is the same. It will produce bad phenomenon. Not only consume power, but also wear the tyre, even damage the gadget. Inter-axle differential can regulate the speed of middle axle and rear axle automatically, thus to suit the requirement of road.

Same as drive rear axle, there is differential lock on inter-wheel differential. When left & right wheel cannot drive because of unilateral skid, you can engage inter-wheel differential lock. At this time, slip shift sleeve 14 that links with right half shaft will mesh with fixing shift sleeve on differential (left) 17 so that differential housing and right half shaft are integrated. Differential do not act any more. Left & right shaft will be a rigid drive shaft. Automobile will drive off faulted road successfully.

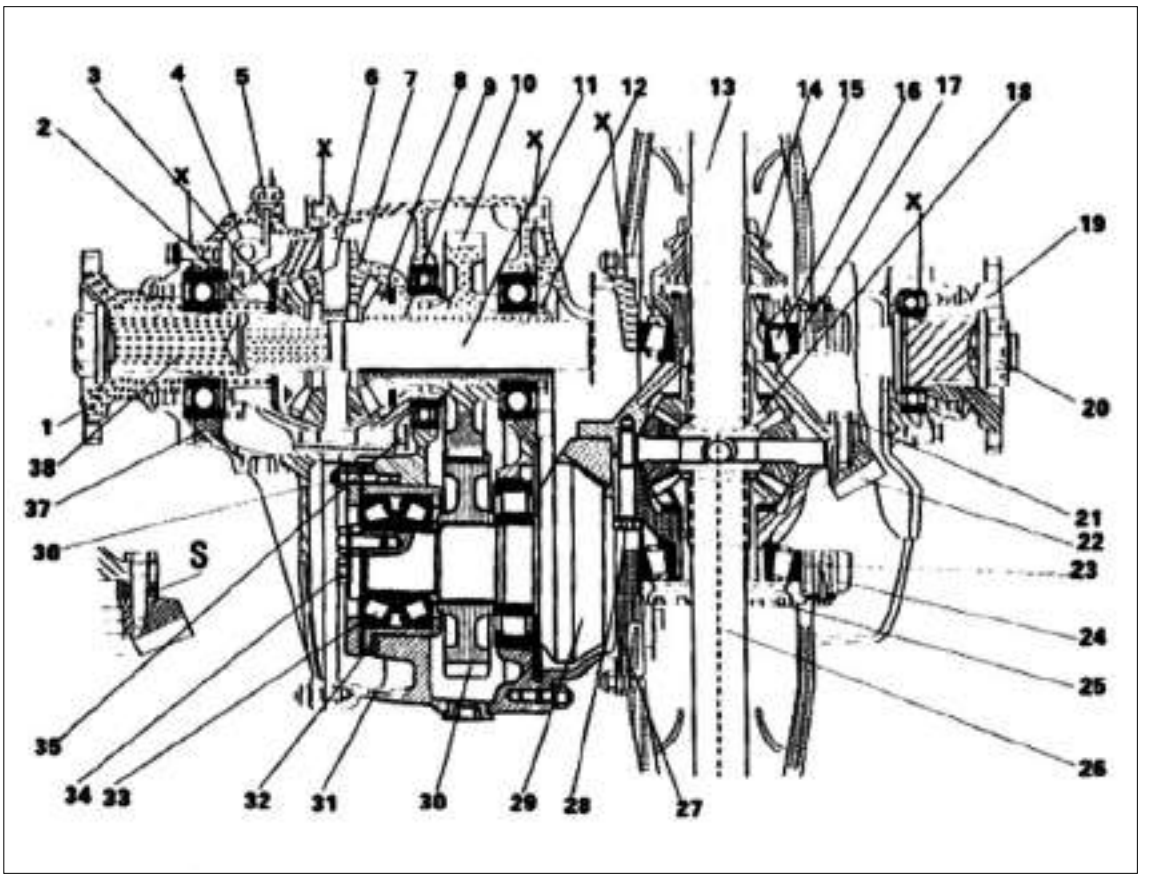


Figure 3-2 (A) Structure diagram of drive middle axle

1. flange assembly
2. differential lock pin
3. half shaft gear (front)
4. fork
5. pressure switch of indicator for differential lock
6. differential spider
7. planetary gear
8. half shaft gear (rear)
9. hollow shaft
10. driving cylindrical gear
11. thru shaft
12. slotted round nut
13. half shaft (right)
14. slip shift sleeve
15. axle housing
16. tapered roller bearing
17. differential (left)
18. half shaft gear
19. flange assembly
20. flange nut
21. hexagon stud
22. driven bevel gear
23. tapered roller bearing
24. bearing cap of differential
25. adjust nut of bearing
26. half shaft (left)
27. main decelerator housing
28. hexagon stud
29. driving bevel gear
30. driven cylindrical gear
31. intermediate gear case
32. bearing seat
33. tapered roller bearing
34. hexagon bolt
35. hexagon stud
36. stud
37.bearing seat
38. differential housing (front)
39. gasket of differential housing

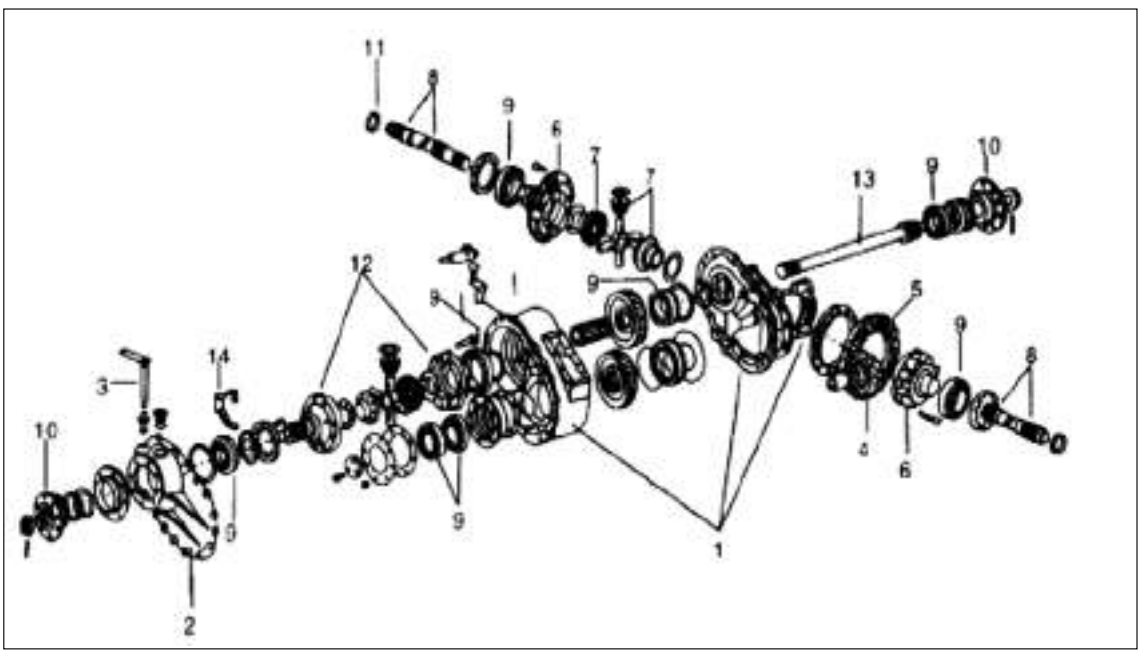


Figure 3-2 (B) Resolution graph of drive middle axle

1. intermediate gear case, main decelerator and differential bearing cap
2. bearing seat
3. shifting yoke shaft
4. driving bevel gear
5. driven bevel gear
6. differential housing (left)
7. planetary gear and half shaft gear
8. half shaft
9. tapered roller bearing
10. flange assembly
11. ciclip for shaft
12. differential housing
13. thru shaft
14. shifting yoke

After engaged inter-wheel differential lock, if left & right wheel of middle axle skids, but rear wheel axle does not move; or rear wheels skids, but middle axle wheel do not move (that indicates inter-axle differential acted), automobile cannot move, then should engage inter-axle differential lock. After pressing down switch of inter-axle differential lock, solenoid valve opens compressed air to make it into work cylinder of inter-axle differential lock, thus to push piston rod to make differential lock shifting yoke 4 push differential lock pin 2 into pin bore of front half shaft gear. Then lock the differential housing and half shaft gear, differential do not act any more. Thru shaft 11 and hollow shaft 9 link rigidly completely, at this time, middle axle, rear axle, left half shaft and right half shaft integrate rigidly. Automobile will drive off faulted road successfully. After left faulted road, inter-axle differential lock and inter-wheel differential lock should be disconnected and removed.

When install again, should check and adjust pretension degree for driving gear bearing, adjusting gasket of bearing shell for driving gear, clearance of differential gear, clearance of driving gear and driven gear, and pretension degree for inter-wheel differential bearing.

Tooth-side clearance between planetary gear of inter-axle differential and half shaft gear should be 0.18~0.22 mm. Tooth-side clearance between planetary gear of inter-wheel differential and half shaft gear should be 0.18~0.22 mm. By measuring left & right movement of top tooth of big conical face for planetary gear with dial gauge, can get this clearance. This clearance is measured on each half of differential housing during assembling differential. This clearance is realized by adjusting thickness of thrust washer of half shaft gear.

When install inter-wheel differential bearing into housing, pretension of which is realized by torque of adjust nut (it can be named cap) 25. Moderate pretension force should make resisting moment of rotation for inter-wheel differential be among 13-36 N. By pulling the spring through thin rope twisted on differential, can measure that resisting moment.

As shown in figure 3-3, pretension degree of driving gear bearing is realized by adjusting adjust gasket D on pressure plate of outer ring for bearing, mounting distance for driving gear and driven gear is realized by adjusting adjust gasket X on linking face between bearing cap and intermediate gear case. When install two tapered roller bearings of driving shaft, select gasket D with appropriate thickness. After turn pressure cover tightly, rotating resistance of driving shaft is 0.5~2.5 Nm. Pulling the thin rope twisted on bearing cap and measuring with spring balance, can measure this rotating resistance. In normal condition, tensile force reading on the spring balance should be among 6.6~33 N. If tensile force is too huge, add thickness of gasket; if tensile force is too small, reduce thickness of gasket (for detailed information, please see assembly section).

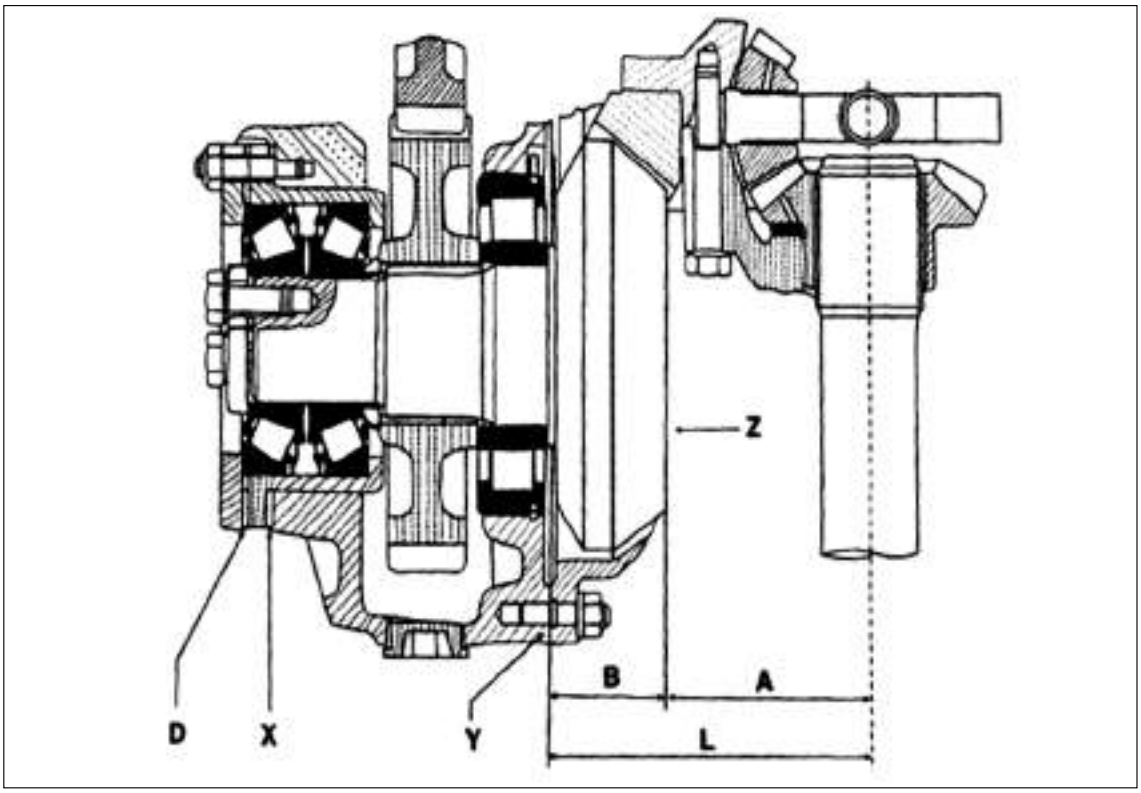


Figure 3-3 Adjustment of pre-tension degree and mounting distance of driving gear bearing

Thickness of adjust gasket X for mounting distance of driving gear can be calculated as the following formula:

$$X=（A\pm Z）+B—（L\pm Y）$$

Where,

A——theoretical value of distance between end face of driving gear and axes of driven gear (theoretical mounting distance, millimeter)

B——measured value of distance between end face of driving gear and linking face of intermediate gear case (millimeter) (before install adjust gasket)

L——theoretical value of distance between linking face of main decelerator housing and axes of driven gear (millimeter)

Z——actual deflection of A (millimeter) (printed on end face of driving gear)

Y——deflection of L (millimeter) (printed on linking face of main decelerator housing)

For middle axle with speed ratio i=4.8, 5.73, 6.72, A=102 mm, L=160 mm.

For example, before install adjust gasket X, measured B=60 mm, observed Z (printed on end face of driving gear) = +0.2 mm, Y (printed on end face of linking face of main decelerator) =-0.07 mm, then the thickness of gasket is:

$$X=（A\pm Z）+B—（L\pm Y）$$
$$=102+0.2+60—（160—0.07）$$
$$=2.27 \text{ mm}$$

Standard thickness of adjust gasket is 0.1 mm, 0.15 mm, 0.4 mm and 1.0 mm. In this place, two gaskets

with 1.0 mm, one gasket with 0.1 mm and one gasket with 0.15 mm can be used.
When disassemble old intermediate gear case of middle axle, store gasket D and X well, so that they can be used when reinstall. During disassemble, do not mix gasket D and X, because these gaskets are the same.

Putting dial gauge on top of big tapered face of driven gear can measure clearance of driving gear and driven gear. Standard clearance should be 0.3~0.4 mm. Adjusting adjust nut to make differential move left and right, then this clearance can be realized. During adjusting, to ensure adjusted pretension degree of bearing, the left & right nut should be adjusted synchronistically and equally. That is, unscrewing degree (turns) of left nut should be the same as that of right nut. So, before adjust, apply marks on left & right adjust nut. (For detailed information, please refer to assembly section).

At last, check contact trace of tooth face. Apply red lead oil or paint on tooth face, rotate driving & driven gear repeatedly, observe trace of tooth face. Contact trace should be in the middle position of tooth face. If contact trace is on top of tooth, reduce thickness of adjust gasket X properly. If contact race is on tooth root, raise thickness of adjust gasket X, until meet requirement.

For double drive axle of homemade STEYR automobile with speed ratio i=4.8, 5.73 and 6.72, tooth number of driving bevel gear, driven bevel gear, driving cylindrical gear and driven cylindrical gear for middle axle, tooth number of driving bevel gear & driven bevel gear for rear axle is as figure 3-4 and table 3-2.

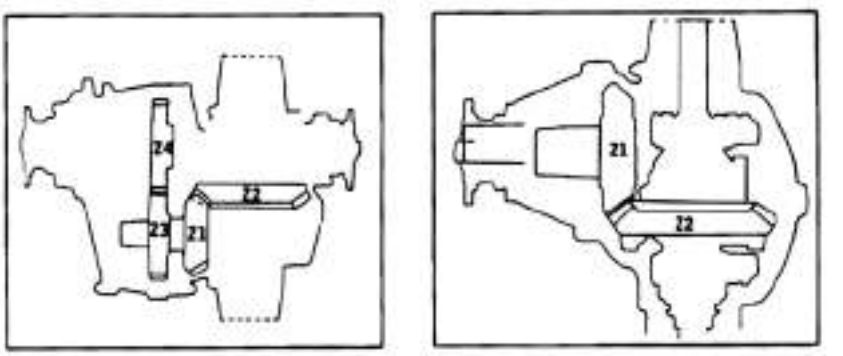


Figure 3-4 Tooth number of central transmission gear for middle axle and rear axle

Table 3-2 Tooth number of central transmission gear for middle axle and rear axle

1 Total speed ratio 1		4.8	5.73	6.72
Rear axle	Driving bevel gear Z2	21	17	15
	Driven bevel gear Z2	29	28	29
Middle axle	Driving bevel gear Z1	17	17	15
	Driven bevel gear Z2	28	28	29
	Driven cylindrical gear Z3	26	35	35
	Driving cylindrical gear Z4	31	35	35

General road vehicle of STEYR automobile, such as 1491.280/043.6×4 truck, 1491.280/S29.6×4 tractor, usually selects i=5.73. General non-road vehicle and engineering vehicle, such 1491.280/043.6× 1491.280/038.6×6 truck, 1491.280/K29.6×4 dumper, usually selects i=6.72. At present, only one kind of vehicle , that is 1491.310/S29×4 tractor, selects double drive axle with i=4.8.

From table 6-6, we can see that, with regard to double drive axle with i=6.72, middle axle and rear axle of driving bevel gear & driven bevel gear are the same; with regard to double drive axle with i= i=5.73, middle axle and rear axle of driving & driven bevel gear are the same, too. Driving cylindrical gear & driven cylindrical gear in intermediate gear case of intermediate with i= 5.73 and 6.72 are the same, too. In other words, for double drive axle with i=5.73 and 6.72, except that tooth number of driving bevel gear and driven bevel gear is different, the other parts are basically the same. So when replace driving bevel gear and driven bevel gear, should pay more attention to original speed ratio. If replace with wrong gear, speed ratio of middle axle and rear axle will be different, thus to burn out inter-axle differential.

With regard to 1491.280/S29.6×4 and 1491.310/S29.6×4 tractor, besides engine power is different, total speed ratio of their double drive axle is also different. For S29 tractor equipped with engine of 280 horsepower, its total speed ratio i=5.73; for S29 tractor equipped with engine of 310 horsepower, its total speed ratio i=4.8. While, driving bevel gear and driven bevel gear for middle axle of i=4.8 are the same as that of i=5.73, only tooth number of driving bevel gear and driven bevel gear in intermediate gear case of middle axle for i=4.8 is different from that of i=5.73 and 6.72.

It is noteworthy that, because driving bevel gear and driven bevel gear of said two vehicles are the same, the profile of transmission mechanism (often called mid section of middle axle) of middle axle is the same, too. When installed with axle housing, they can be interchanged completely. So, when replace mid section assembly of middle axle, note that if the speed ratio of replaced mid section assembly is the same as that of original vehicle. If ratio of replaced mid section assembly is different from original one, speed ratio of middle axle and rear axle will be different, and will make inter-axle differential to burn out.

Intermediate gear case and main decelerator of middle axle adopts splash lubrication. On top of inter-axle differential in intermediate gear case, there is an oil filler plug; on bottom of intermediate gear case, there is an oil drain plug. On tooth position of middle axle, there is an oil filler plug and an oil drain plug, too.

There is a baffle plate above intermediate gear case of middle axle. This baffle plate makes splashed lubricant flow into inter-axle differential to lubricate differential. Position of inter-axle differential is very high, and lubricating condition is very bad, so should pay special attention to lubricant volume in middle axle.

Assembly of Intermediate Axle

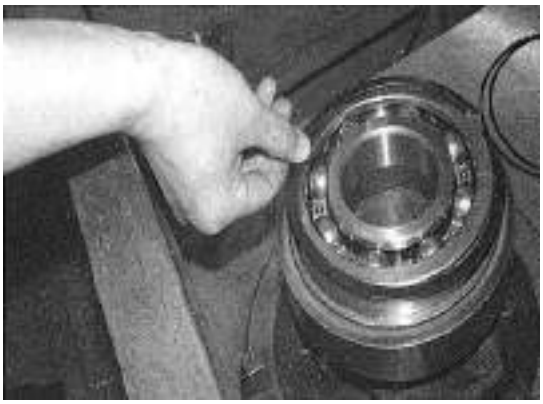
►Assembly of intermediate gear case of middle axle

1. Press bearing into bearing seat of driving bevel gear.

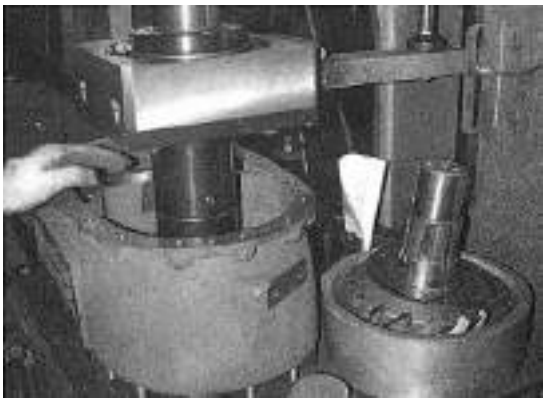
2. Put selected adjust gasket on upper flange of bearing seat, press into pressure plate and tighten with bolts.

3. Cover combined parts finished in figure 2 onto driving bevel gear, to detect pretension force of bearing.

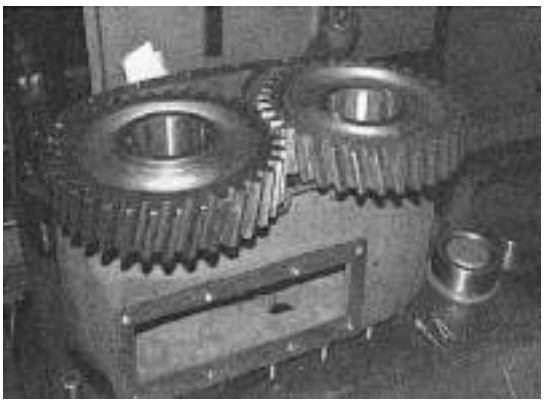
4. Use spring balance to measure resisting moment of rotation. Reading of spring balance should be among 6.6~33 N. If it is not in this range, adjust gasket thickness again. If resisting moment is too huge, reduce gasket thickness; if resisting moment is too small, raise gasket thickness.



5. Put snap ring of bearing into bearing groove.



6. Clipping snap ring tightly with hand vice, put driving bearing into intermediate gear case slightly.



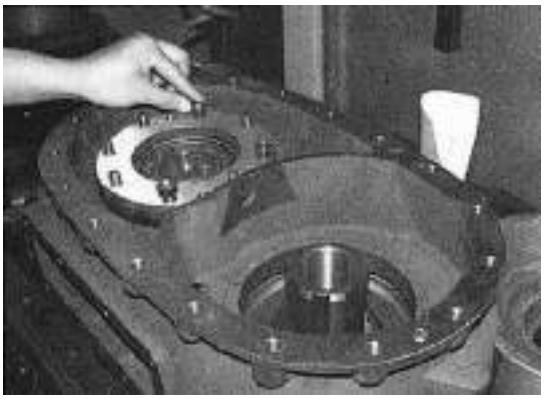
7. Install two driven cylindrical gears in intermediate gear case.

8. Press into hollow shaft.

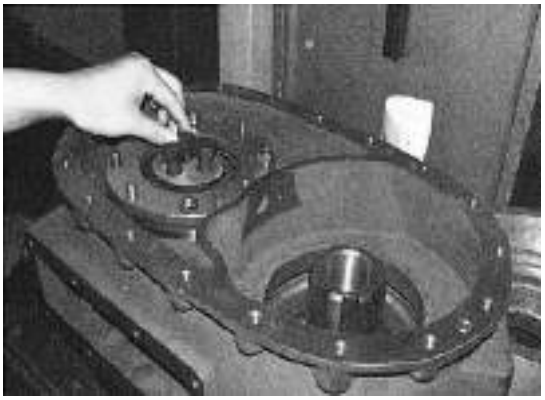
9. Tighten round nut with force of 300 N•m.

10. Put oil strainer on driving bevel gear.

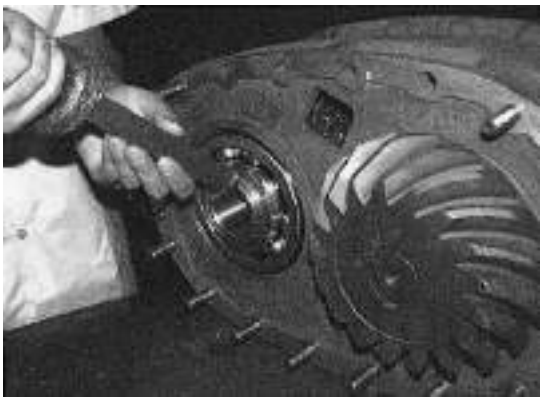
11. Place a set collar. Reinstall bearing seat into driving gear shaft. Note mounting position of oil hole of bearing seat. Press the bearing seat into driving gear shaft.



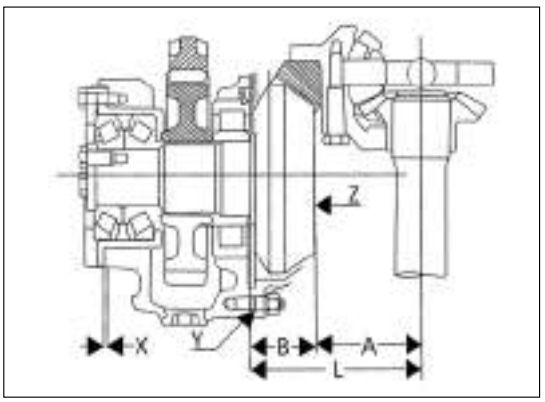
12. Reinstall adjust gasket and cover plate into bearing shell, and tighten fixing bolt of bearing shell.



13. Install baffle plate into gear shaft. Tighten fixing bolt of baffle plate of driving shaft with 180 N•m.



14. Use drift to lock nut.



Thickness of adjust gasket X for driving gear bearing seat and intermediate gear case is as:
X=(A±Z)+B—(L±Y)
where
A—theoretical value of distance between end face of driving gear and axes of driven gear
B—measured value of distance between end face of driving gear and linking face of intermediate gear case (before install adjust gasket)
L—theoretical value of distance between linking face of main decelerator housing and axes of

driven gear

Z—actual deflection of A (printed on end face of driving gear)

Y—deflection of L (printed on linking face of main decelerator housing)

For STEYR series heavy-duty vehicle with speed ratio i=4.8, 5.73, 6.72,

A—102 mm

L=160 mm

►Assembly of inter-wheel differential of middle axle

Assembly of inter-wheel differential for middle axle is the same as single rear axle (omit).

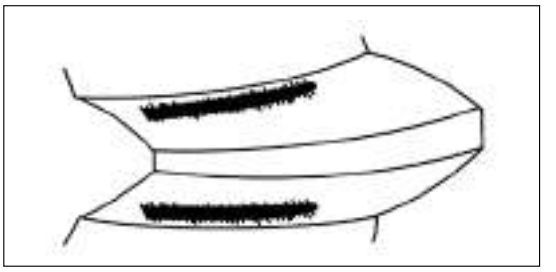
►Assembly of main decelerator of middle axle

Adjusting for pretension force of differential is same as single rear axle (omit). Mounting intermediate gear case is the first step.

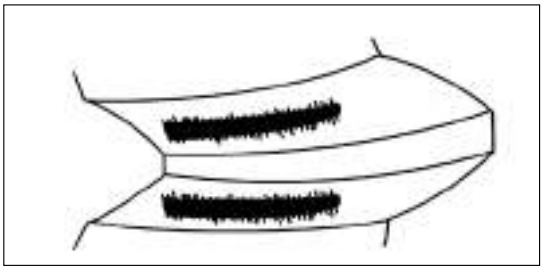
1. Apply Loctite 587 on linking surface between main decelerator housing and intermediate gear case.

2. Lift and install intermediate gear case into main decelerator housing, and tighten the connecting bolt.

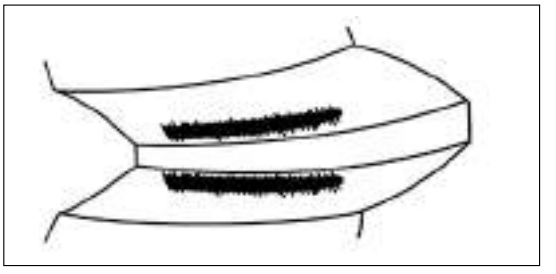
3. Check if the clearance of driving bevel gear and driven bevel gear is among 0.20~0.48 mm. If the clearance is not in that range, left & right adjust nut of driven gear should be adjusted. Rotating angle should be consistent.
   After adjust, the lock slice of adjust nut should be locked.



Apply red lead paint on tooth face. Rotate the gear frontward and backward to check contact trace of tooth face.
Contact trace of tooth face is correct.



If contact race is on top of tooth, reduce thickness of adjust gasket X.



If contact race is on tooth top, the thickness of adjust gasket X should be raised.

►Assembly of inter-axle (shaft) differential of middle axle

1. Put gasket of half shaft gear in differential housing.

2. Put half shaft gear in differential housing.

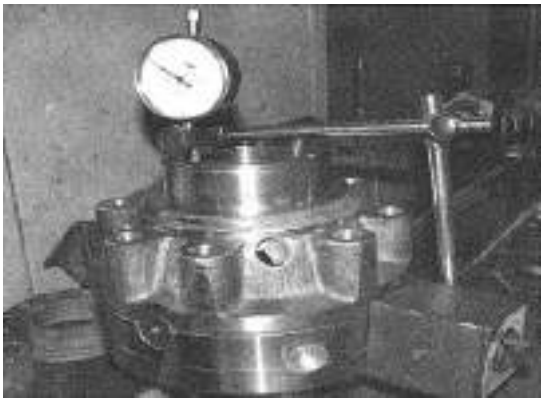
3. Put planetary gear and spider parts in differential housing.

4. Install selected gasket of half shaft gear that is on the other end.

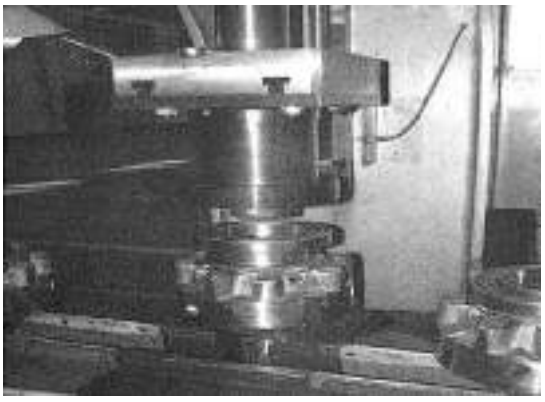
5. Install half shaft gear that is on the other end.

6. According to mounting mark, install the other part of differential housing.

7. Apply Tiansan 1262 thread sealant to connecting bolt, and tighten it with torque of 210 N•m (21 kg•m).



8. Measure combined tooth- side clearance. By adjusting thickness of half shaft gear, make tooth -side clearance be 0.25~0.45 mm.



9. Heat differential bearing to 80° , mount it on shaft shoulder of differential and fix with snap ring.

10. Mount differential ring on differential, and mount baffle plate.

11. Put seal ring and sleeve into shifting yoke shaft, fix with snap ring.

12. Install crosshead in shifting yoke hole.

13. Fix lock cap of locating pin. Install differential lock.

14. Install snap ring into bearing, and press bearing into cover of intermediate gear case. Indicator opened or closed.

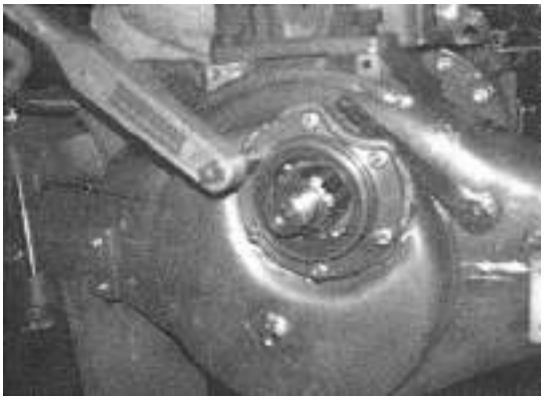
15. Press oil seal into bearing cap, and apply lubricant. Apply Loctite 587 to end face of bearing cap. Install bearing cap on intermediate gear case cover, and tighten connecting bolt.

16. Press drive flange into input shaft, tighten the nut, and tightening torque is 750~800 N•m. Aligning the pin bore, insert split pin.

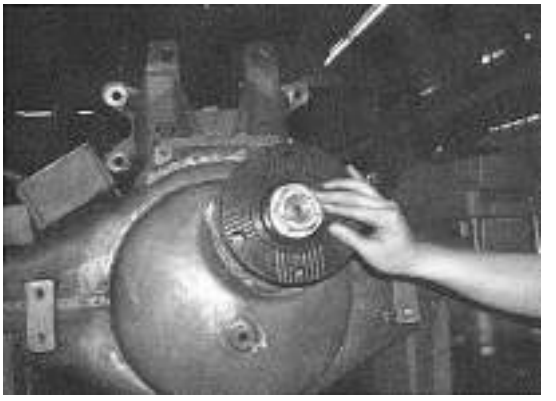
17. Apply Loctite 587 to linking face of intermediate gear case, install intermediate gear case cover on intermediate gear case, and tighten connecting nut.

►Assembly of tandem axle of middle axle

1. Install tandem bearing into thru shaft, press thru shaft and bearing into middle axle housing.



2. Press bearing into bearing cap. Apply Loctite 587 on linking face of bearing cap, install bearing cap, tighten connecting bolt.

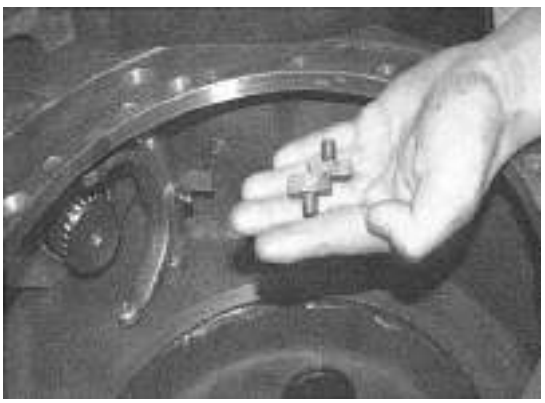


3. Mount drive flange on castellated shaft of tandem axle. Install fixed screw cap of flange, and tighten it with torque of 750~800 N•m. Lock screw cap with split pin.

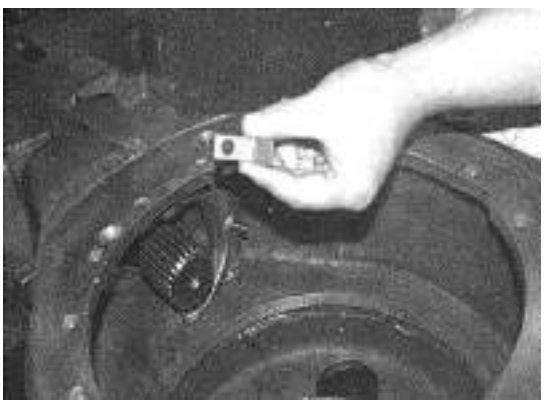
► Assembly of inter-wheel differential lock

1. Install seal ring on shifting yoke shaft of differential lock.

2. Install shifting yoke shaft of differential lock in axle housing. At the same time, aligning spline, connect shifting yoke with shifting yoke shaft.

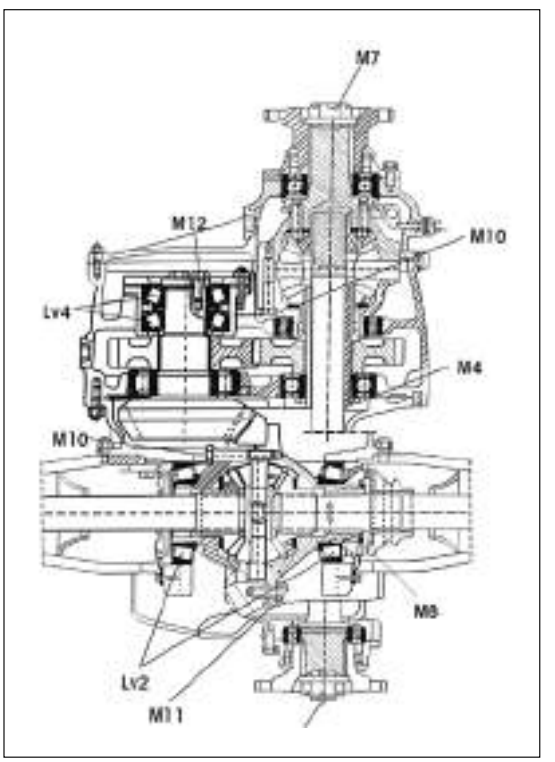


3. Mount crosshead of shifting yoke on shifting yoke, and tighten shifting yoke.



4. Install plate of differential lock indicator on shifting yoke, and tighten with nut.

5. Install most meshed part onto the shifting yoke and make half shaft be through shaft hole of shift sleeve.



Apply Loctite 587 on linking face of axle housing and main decelerator housing. Install intermediate gear case assembly (normally called mid section of middle axle) of middle axle in axle housing, and tighten connecting bolt.

During assemble, rotate thru shaft constantly to make it insert spline hole of haft shaft gear of inter-axle differential successfully. Assembly of wheel-side decelerator is the same as that of rear drive axle. For more details, please see “assembly of wheel-side differential” section.

Insert left & right half shaft into spline hole of left & right half shaft gear. Install end cover of shaft on wheel-side differential.

Assembly of middle axle is finished.
Tooth-side clearance of driving bevel gear and

driven bevel gear is 0.20~0.48 (be adjustable); tooth-side clearance of half shaft gear and planetary gear is 0.18~0.22 (be adjustable);

Tooth-side clearance of driving cylindrical gear is 0.16~0.37 (can not be adjustable).
For tightening torque of wheel-side decelerator of middle axle, please see “wheel-side decelerator of rear axle” section.

Tightening torque of central transmission for middle axle

(N.m)

Position	Torque
M4	295
M7	750-800
M8	200
M10	195
M11	325
M12	180
M13	1.5~4.0
M14	0.5~2.5

Troubleshooting of STEYR Double Drive Axle

Double drive axle is complex part of drive system, so probability of fault may be higher. Common fault is as following:

►Inter-axle differential burns out

During service, we find that some inter-axle differentials burned out, after replaced with new ones, they would burn out, too; even sintered planetary gear and spider together. Two main reasons are as following: one reason is lack of oil; the other reason is that speed ratio of middle axle and rear axle is different.

Main decelerator and intermediate gear case of middle axle adopt splash lubrication, and position of inter-axle differential is very high, so lubricating condition of inter-axle differential is very bad. Lack of oil will threaten inter-axle differential. When new vehicle fill oil or replace gear oil, must fill new oil from filler cap on inter-axle differential housing, until oil level reach to check port of intermediate gear case of middle axle.

During service, we also find that some users do not notice original speed ratio when replace driving bevel gear & driven bevel gear of middle axle or rear axle, so speed ratio of driving bevel gear & driven bevel gear is different from original one(mounting dimension of driving bevel gear & driven bevel gear with different speed ratio is the same). So speed ratio of middle axle and rear axle is different, inter-axle differential will rotate at high differential speed during driving. In addition, lubricating condition of differential is very bad, so, differential will burn out quickly.

So, when replace driving bevel gear and driven bevel gear, note that its tooth number must be the same as that of old one.

When repair mid section of middle axle for 1481.310/S29.6X4 S29 tractor (equipped with engine of 310 horsepower), especially when replace mid section assembly of middle axle, should pay attention to speed ratio. Because with regard to S29 tractor (280 horsepower) and S29 tractor (310 horsepower), their mid section profile, mounting dimension, even driving bevel gear and driven bevel gear are the same; only difference is the two driving cylindrical gears in intermediate gear case. For S29 tractor (280 horsepower), tooth number of two driving cylindrical gears is 35; for S29 tractor (310 horsepower), tooth number of two driving cylindrical gears is 31 and 26 respectively. So total speed ratio of middle axle for S29 tractor (280 horsepower) is i=5.73; total speed ratio of middle axle for S29 tractor (310 horsepower) is i=4.8. If install mid section of middle axle whose speed ratio is i=5.73 to S29 tractor (310 horsepower) whose speed ratio i=4.8, speed ratio of middle axle and rear axle will be different hugely, inter-axle differential will burn out during running.

In 1993 and 1998, HEAVY DUTY COMPANY used 043- truck to refit a batch of K29 dumpers. During repair, users who own this kind of dumpers should note that, total speed ratio of double drive axle for these vehicles is i=5.73, but not i=6.72. When replace driving bevel gear and driven bevel gear, should pay more attention to that.

►Abnormal noise of axle

When find abnormal noise of axle, should judge that this noise belongs to middle axle or rear axle first, then judge the basic position of abnormal noise. Pay more attention to obvious and sudden abnormal noise, and examine immediately. When examining position of abnormal noise, use lifting jack to support middle axle (or rear axle) completely, start the engine and keep it at low speed. Rotate supported axle slowly, and observe position of abnormal noise. When operate like that, must note your safety and adopt safeguard.

With regard to abnormal noise of rear axle, we have introduced in "rear axle" section. We will not introduce it here.

Main reasons of abnormal noise for middle axle:

1. Fixing bolt of driven bevel gear is lost or loosened.

Because when installed driven bevel gear, forgot to apply sealant to connecting bolt, and torque was not sufficient; after drive for some time, bolt is loose even lost. This kind of noise is sudden, ruleless and huge. At this time, do not drive forcedly, must do overhaul inspection.

When repair or replace driven bevel gear, must apply Loctite 262 to thread of connecting bolt, and tighten as specified torque.

2. Gear is damage.

During running, gear is damage because of many reasons. This kind of abnormal noise is sudden and obvious, too. Should do overhaul inspection, immediately.

3. Bearing fall to pieces.

Middle axle has seven bearings. Abnormal noise caused by falling bearing is obvious, too. Should judge position of abnormal noise first, then do overhaul inspection. Pay special attention that two tapered roller bearings of inter-axle differential are easy to make a mistake. Mounting direction of cover plate of driving wheel must be correct.

4. Shift sleeve of differential lock loosened.

Adjust nut of shift sleeve for inter-wheel differential lock is loose and shift sleeve loosened, which will produce impact noise of two shift sleeves. Loosen of inter-axle differential lock pin will produce knock sound, too. This kind of abnormal noise is ruleness, mechanical impacting noise.

5. Differential gear burned out.

Whether planetary gear and half shaft gear for inter-wheel differential and inter-axle differential burned out, or tooth damaged, which will produce obvious noise.

Because noise produced by said gadget is sudden and obvious. When encountering this kind of abnormal noise, should dismantle immediately. Do not run continually, otherwise, it will cause much serious result.

6. There is continuous noise, and this noise will increase with increase of load and speed. This abnormal noise usually caused by the following reasons: pitting of bearing, wear of gear, too big or too small gear clearance, deflection of contact position for tapered gear and tooth face. Though this kind of noise is not terrible, but if it is serious, you should dismantle and repair, otherwise, the fault will enlarge.

If this kind of noise exists after replace driving bevel gear and driven bevel gear, which indicates gear clearance or thickness of adjust gasket for mounting distance is not correct, so contact of two tooth faces are not in correct position. Driving bevel gear and driven bevel gear are ground in pair. If replaced ones are not in pair, will produce this kind of noise, and that noise can not be eliminated.
When repair and disassemble driving bevel gear and driven bevel gear, keep adjust gasket of mounting distance well. When reinstall, should mount the original gasket. Otherwise, when driving bevel gear meshes driven bevel gear, deflection of adjust gasket will also cause noise.

7. There is abnormal noise when automobile drives normally. After decelerates, there is buzz. Generally, that is because back face of gear damage or pitting. Slight noise is not terrible, but if it is serious, should disassemble and examine.

8. Gear clearance is too big, castellated shaft and hole is loose, so abnormal sound can be heard when accelerating fast and starting and the sound of slacking parts can be heard obviously.

► Axle is overheating

There maybe three reasons: lubricant is redundant, lubricant is deficient, or pretension force of bearing is too huge.

If lubricant is deficient, gadget will get hot because it can not be lubricated. Excessive lubricant will cause overheating, too. For support bearing of differential & driving gear shaft, too big pretension force will cause overheating, too. For the latter phenomenon, adjust gasket thickness to solve it.

►Oil leakage

With regard to leaking oil, there is other reason besides oil seal. For example, some clients reflect that after replace new oil seal, there is still leakage. That indicates the reason is not belong to oil seal. Firstly, check if the air hole of axle housing or intermediate gear case is expedite. If air hole is blocked, heat caused by gadget's rotation will make air expand to produce pressure, then force lubricant to pull out from oil seal. Oil leakage caused by loose outer ring of oil seal and loose seat hole will not be noticed. Solving method is to clean outer ring of oil seal and seat hole before install oil seal, apply Locite 603, then push into oil seal.

►Tyre is worn

With regard to worn tyre, there are many factors, such as steel ring is deformed, bearing is loose, differential pressure of two rank tyre is too huge. For double drive axle, another important reason of worn tyre is disturbed axle.
Many reasons will cause axle to disturb, such as sleeve of balance shaft for double drive axle is loose, rubber support of push rod for balance suspension is damaged, welding between bearer of push rod and axle housing is open. (Troubleshooting of wheel-side decelerator for double-drive axle can refer to "rear axle" section.)

Operation and Maintenance of STEYR Double Drive Axle

During operation and maintenance of STEYR double drive axle, attention must be paid to:

►Operation of differential lock

When the vehicle is in stop condition or at the speed similar to walk, should use differential lock. When the vehicle swerves, drive wheel-side differential of rear axle to make left & right wheel differential automatically, so as not to wear tyre or damage mechanism. When the vehicle drives onto smooth or sludgy road with single-side wheel, and can not leave that road because of slide, should engage differential lock. At that time, left & right half shaft become a rigid linking shaft, then the vehicle will drive out faulted road. After the vehicle drive out faulted road, pick off differential lock immediately. Otherwise, will cause serious accident, such as serious wear of tyre and damaged differential.

Principle of differential lock:

Operate differential lock switch, make compressed air flow into working cylinder of differential lock through solenoid valve. By fork, push rod of piston in working cylinder make shift sleeve in axle housing mesh. Half shaft and differential housing become a unity. In other words, left & right half shaft become a unity. Then the vehicle can drive out faulted road stably.

Common failures and troubleshooting of differential lock:

When engage differential lock, if press down differential lock switch, indicator light does not illuminate. Check if piston rod of working cylinder for differential lock works when press down differential lock switch. If push rod of working cylinder protrudes, but does not engage, which indicates tooth top of shift sleeve does not mesh well. Moving the vehicle forward and backward can mesh well. If working cylinder does not react, it is the problem of electric control system of solenoid valve. Loosen outlet joint of solenoid valve, and observe if there is compressed air. If there is no compressed air, it is the problem of circuit control of solenoid valve or the problem of solenoid valve itself; if there is compressed air, it is the problem of working cylinder. After press down switch, if piston rod of working cylinder for differential lock can engage well, but indicator light in switch does not illuminate, it is the problem of indicator light switch or bulb. You can examine with test lamp.

During repair and maintenance, when pull out half shaft, attention must be paid to:

On the side without installing differential lock, can pull out half shaft arbitrarily; on the side with installing differential lock, before pull out half shaft, should engage differential lock at first. To ensure shift sleeve of differential lock doest not fall off, use iron wire to fix push rod of working cylinder for differential lock.

►Adjustment of brake clearance of driven axle

Rotate hexangular bolt on shaft end of worm until lock wheel. Then rotate reversely until hear three voices. Before adjust, loosen hand brake and support wheel. After adjust, drive and check if brake deflects.

（2）simple adjust of automatic clearance adjust arm

a. Release hand brake (If the structure is not spring brake chamber, do not use this).

b. Arrow direction of adjust arm is the same as brake direction.

c. Rotate hexangular bolt on adjust arm clockwise, to make brake arm insert into U fork of push rod of brake chamber. Aligning hole, connect with flat pin, flat gasket and split pin.

d. Push adjust arm with hand, until can not push any more. Then fix locating support, use bolt, nut and gasket to connect locating support with adjust arm tightly.

e. Rotate hexangular nut on adjust arm clockwise, to make camshaft rotate. Splay brake arm until friction disc of brake shoe contact with brake drum. Then rotate hexangular 3/4 turns adversely.

f. Apply several brakes. Brake clearance will be adjusted to normal range automatically.

►During repair and maintenance, when pull out half shaft, attention must be paid to:

On the side without installing differential lock, can pull out half shaft arbitrarily; on the side with installing differential lock, before pull out half shaft, should engage differential lock at first. To ensure shift sleeve of differential lock doest not fall off, use iron wire to fix push rod of working cylinder for differential lock.

►When new vehicle drives for 2000~2500 km, should maintain forcedly.

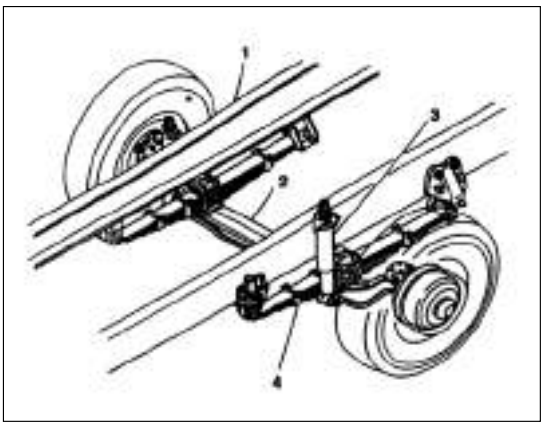
When maintain forcedly, should replace gear oil for central transmission and wheel-side decelerator. For inter section of middle axle, when add lubricate, should add from oil filler plug on inter-axle differential housing. For central transmission and wheel-side decelerator of double drive axle, should add gear oil of APIGL-4 grade, SAE85W/90 viscosity. Homemade 18# hyperbolic gear oil can replace that gear oil completely.

List of High–mortality Parts

Serial number	Component number	Component name	Quantity
1	90003078956	Oil seal assembly of hub	2
2	90003078957	Oil seal assembly of hub	2
3	99000340068	Brake friction disc	2
4	90003070026	Oil seal of driving bevel gear	1
5	99012340027	O ring	2
6	90003326067	Inner bearing of hub	2
7	90003326167	Outer bearing of hub	2
8	90003074340	Oil seal of half shaft	2

10 Front Suspension

Structure

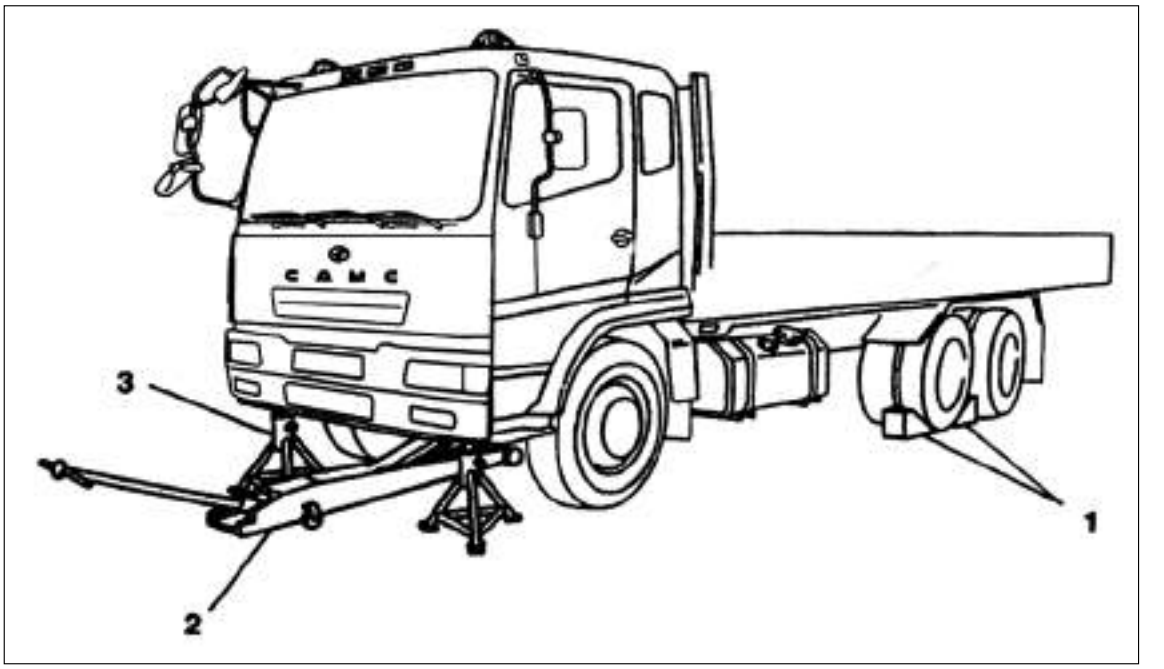


1 Front axle
2 Frame
3 Shock absorber
4 Leaf spring assembly

Leaf spring assembly (4) and shock absorber (3) are fitted between frame (2) and front axle (1) to support the body weight, absorb vibration and shock from road and prevent vibration and shock being directly transmitted to the vehicle body for protection of vehicle body, people and goods on it. This structure can also suppress the irregular vibration to ensure smooth running.

Common Failures and Causes

Possible causes \ Failures		Ethereal driving and weak shaking when running	Noise generated when in no-load running	Direct shock from uneven road surface	Noise generated when in on-load running	Periodic vibration from road surface	Remark
Leaf spring	Cracked or damaged			○			
	Breakage		○				
	Spring carrier arm is damaged.				○		
	U-bolts are loosened.				○		
	Spring bushing is worn out.		○				
Shackle pin moves in the thrust direction		○					
Suspension compression travel limiting stopper is damaged or broken.				○			
Shock absorber	Obvious leakage occurs or damping force subsidizes	○					
	Rubber bushing is worn out		○				
	Installation becomes loose		○				
Tyre	Unevenly-worn tyre					○	
	Unbalance of the tyre and wheel					○	
	Too much inflation pressure			○			



Dismantling

►Operations before dismantling

1 Place wheel chocks.

2 Push up the front axle center with garage jack.

3 Support front frame on a solid tripod.

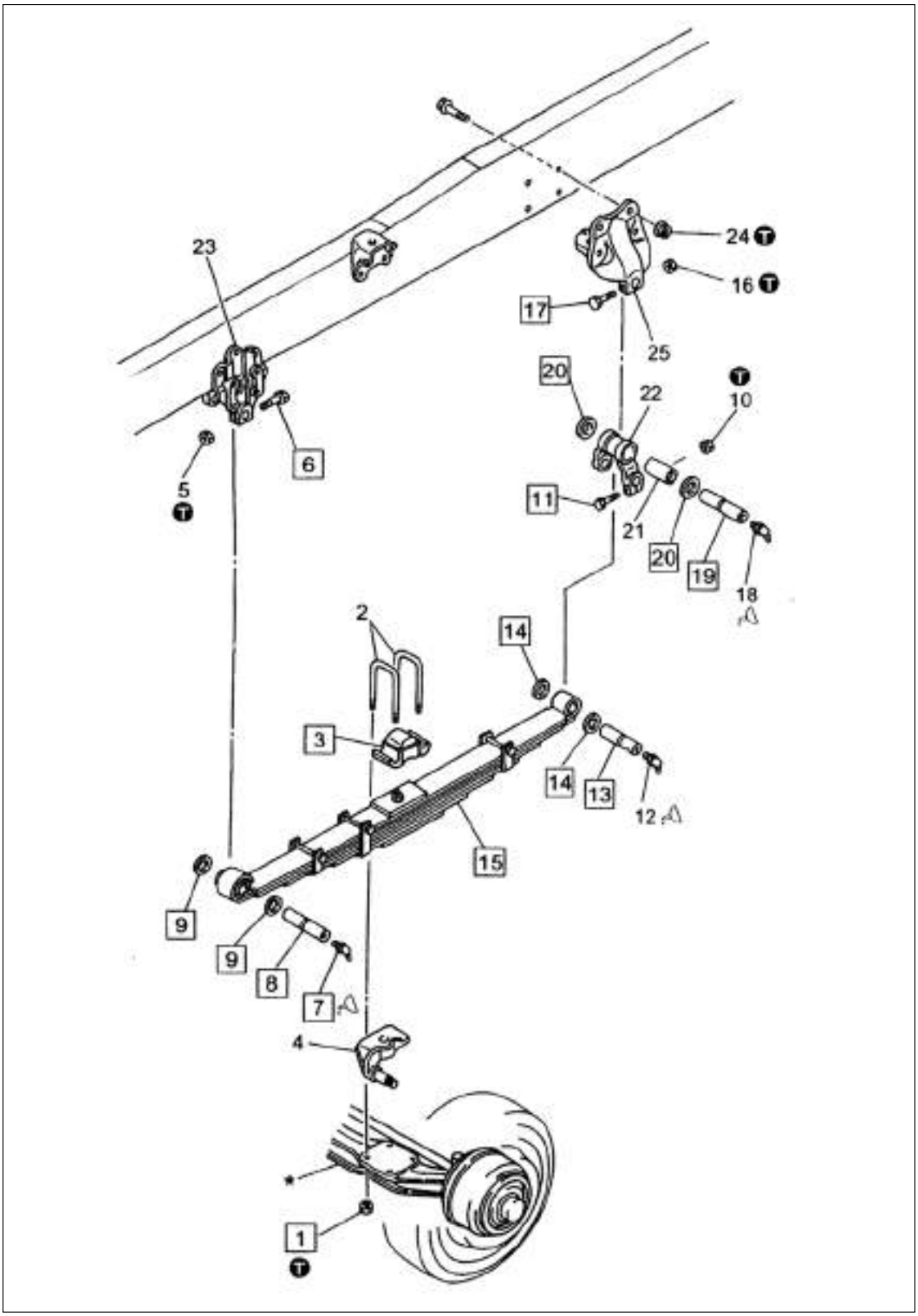
Warning ⚠

- Tuck the wheel chocks firmly to prevent moving of the car.
- Removal of wheel chocks is not allowed before completion of all operations.
- It's very dangerous only to have the garage jack push up the car. Always prop up the frame with a solid tripod.
- Keep the garage jack and tripod in right place before the completion of all operations and don't take them away during working.

►Operations after installation

Proceed in the reverse sequence of dismantling.

Memo


23
24 T
16 T
17
25
20
22
10 T
5 T
6
11
21
20
19
18
2
14
3
14
13
12
15
9
9
8
7
4
1 T

►Dismantling Sequence

1 U-bolt and nut 2 U-bolt 3 Suspension compression travel limiting stopper
4 Lower bracket 5 Nut 6 Bolt
7 Grease nipple 8 Shackle pin 9 Side washer
10 Nut 11 Bolt 12 Grease nipple
13 Shackle pin 14 Side washer 15 Leaf spring assembly
16 Nut 17 Bolt 18 Grease nipple 19 Shackle
20 Side washer 21 Spring bushing 22 Shackle
23 Front spring front bracket 24 Nut 25 Front spring rear bracket

Remark

Dismantle shackle pin 8, 13, 19 with shackle pin drawing dies following the maintenance method. If there is not enough space for dismantling, use a rod with a diameter of 16mm and a length of 400mm.
Don't dismantle front spring front bracket 23 and rear bracket 25 unless they are damaged.

►Assembling sequence

Proceed in the reverse sequence of dismantling.

Maintenance standard

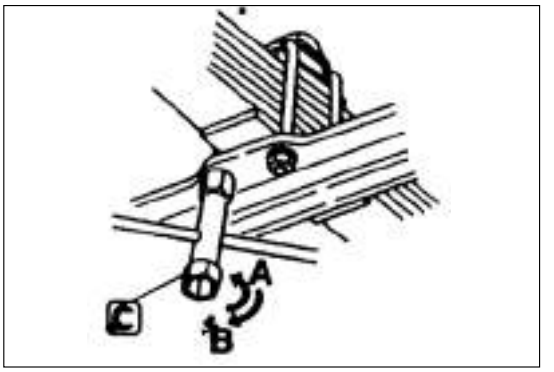
Item	Maintenance items	Standard value	Limit value	Correction method
8，13，15	Clearance between shackle pin and spring assembly spring bushing	[32] 0.03-0.15	0.5	Replace
8，23	Clearance between shackle pin and front spring bracket	[32] 0-0.05	0.3	Replace
9，23	Clearance between side washer and front spring front bracket	0-1.3	1.5	Replace side washer
13，22	Clearance between shackle pin and shackle	[32] 0-0.05	0.3	Replace
14，22	Clearance between side washer and shackle	0-1.3	1.5	Replace side washer
19，22	Clearance between shackle pin and spring bushing	[32] 0.03-0.15	0.5	Replace
19，25	Clearance between shackle pin and front spring rear bracket	[32] 0-0.05	0.3	Replace
20，25	Clearance between shackle pin and front spring rear bracket	0-1.0	1.3	Replace side washer

►Tightening torque

Item	Maintenance items	Standard value	Limit value
1	U-bolt nuts (for securing U-bolt)	440-549[45-55]	Wet
5，10，16	Nuts (for securing shackle pin)	80-110[8.2-1.2]	—
24	Nut (for securing front spring rear bracket)	200-270[20.4-27.5]	—

►Lubricant

Parts	Coating position	Time specified	Quantity
7，12，18	Coating grease nipple	Lubricant for wheel bearing [NLGINo.2 (Lithium base)	



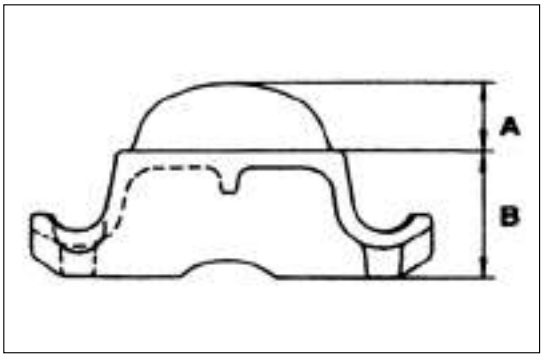
Maintenance method

►Dismantling and assembling of U-bolts and nuts

:Socket wrench

A: Dismantling

B: Assembling



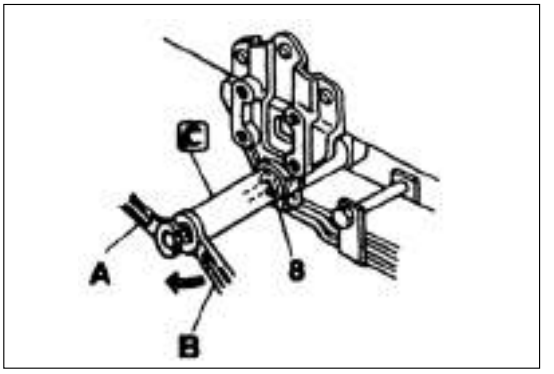
►Suspension compression travel limiting stopper

Remarks

Height A and height B of suspension compression travel limiting stopper 3 vary with the vehicle type and leaf spring assembly 15. Identify it carefully so as not put a wrong one

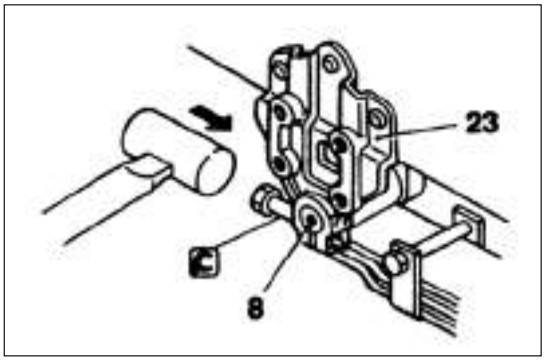
A:20、26mm

B:47、62mm



►Dismantling of bolts

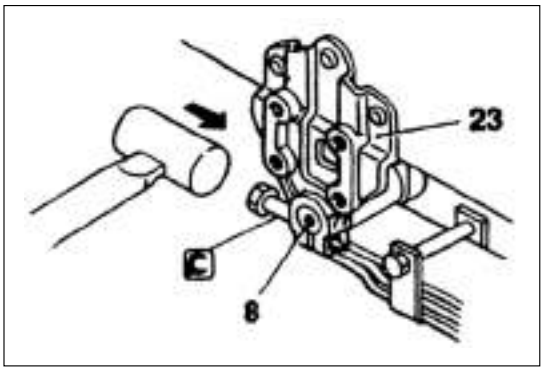
: Shackle pin stop rod



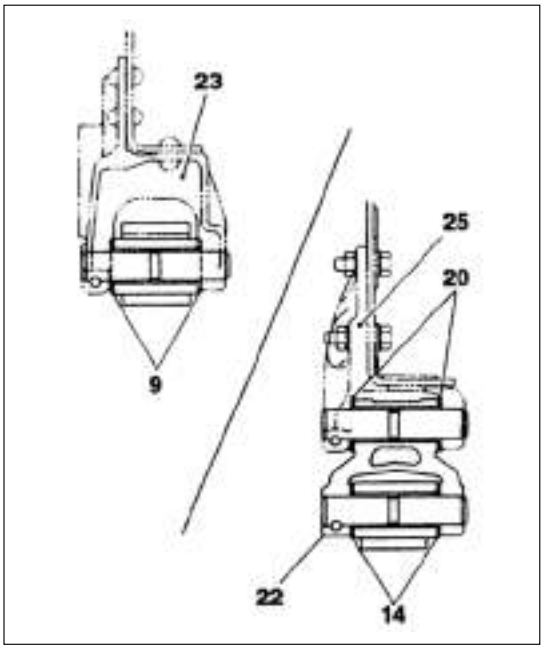
► Shackle pin

[Dismantling]

Connect shackle pin drawing dies to the installing thread of grease nipple of shackle pin 8, hold drawing dies bolt with Wrench A and turning the nut with Wrench B to remove the shackle pin.



Align C the bolthole on front spring front bracket 23 with bolt groove on shackle pin 8 with shackle pin stop rod.

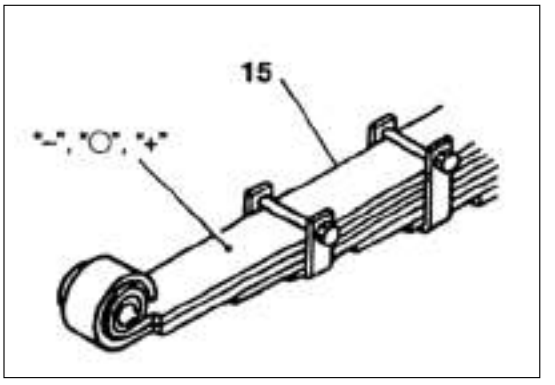


►Side washer (for adjustment)

- Adjust with washer to keep the clearance between side washer 9 and front spring front bracket 23 in accordance with standard value.
- Adjust with washer to keep the clearance between side washer 14 and shackle 22 in accordance with standard value.
- Adjust with washer to keep the clearance between side washer 20 and front spring rear bracket 25 in accordance with standard value.
- Side washers 9, 14, 20 have three thicknesses: 3.0, 3.5, 4.0mm.

[Assembling]

Align C the bolthole on shackle 22 with bolt groove on shackle pin 13 with shackle pin stop rod.



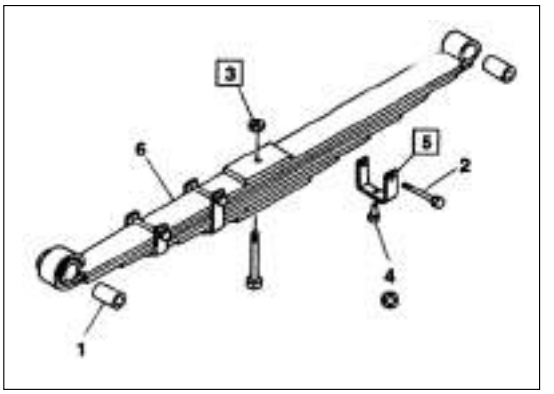
►Leaf spring assembly left and right height combination

When replacing leaf spring assembly 15, parts that we choose should make the combination of right height marks "-", "○", "+" as shown.

Item	Combination						
	1	2	3	4	5	6	7
Assist seat side leaf spring assembly	-	-	○	○	+	○	+
Driver seat side leaf spring assembly	-	○	○	+	+	-	○

Note ⚠

The camber of assist seat side leaf spring assembly differs from that of driver side leaf spring assembly. Don't mix them, or it will lead to the vehicle titling.



Leaf spring

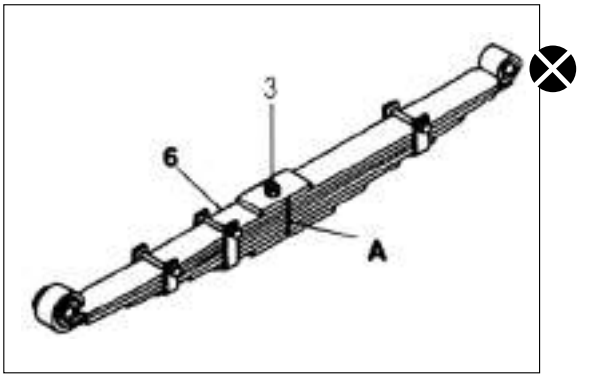
►Leaf spring

Dismantling sequence
1 Spring bushing
2 Snap bolt
3 Center bolt
4 Rivet
5 Snap
6 Leaf spring

⊗:Parts not to be repeatedly used

● Assembling sequence

Proceed in the reverse sequence of dismantling.

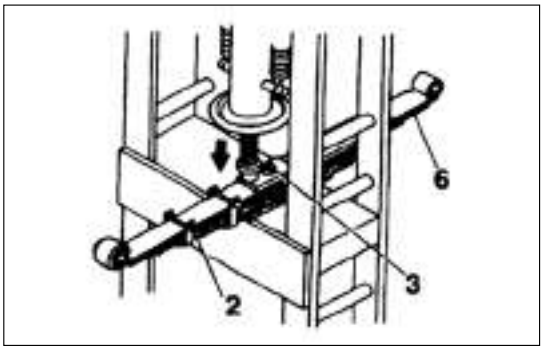


►Leaf spring

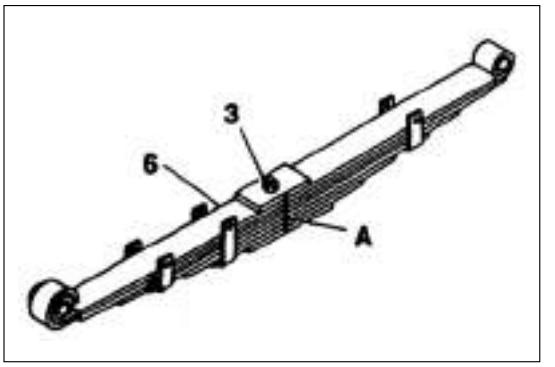
Center nut

[Dismantling]

- Make matching mark A on the side of leaf spring 6.

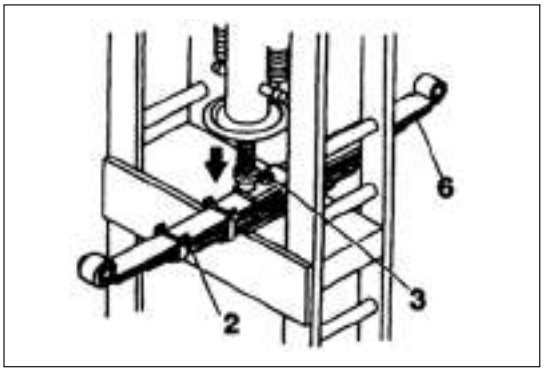


- Press leaf spring 6 with press machine and remove snap bolt 2 and center nut 3.

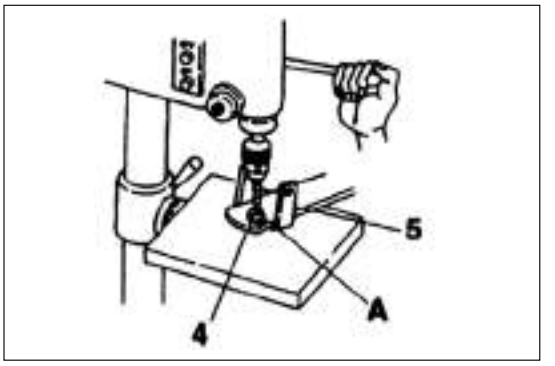


[Assembling]

- Before assembling, align with the matching mark A on the side of leaf spring 6.
- Tighten the center nut temporarily.



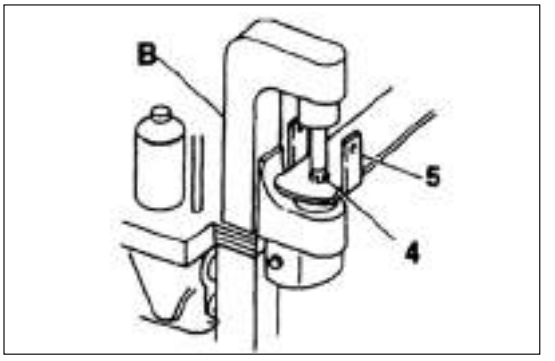
- Press leaf spring 6 with press machine, fully tighten center nut 3.
- After tightening of center nut 3, make it tight at three positions with a punch.
- Assembling snap bolt 2.



Snap

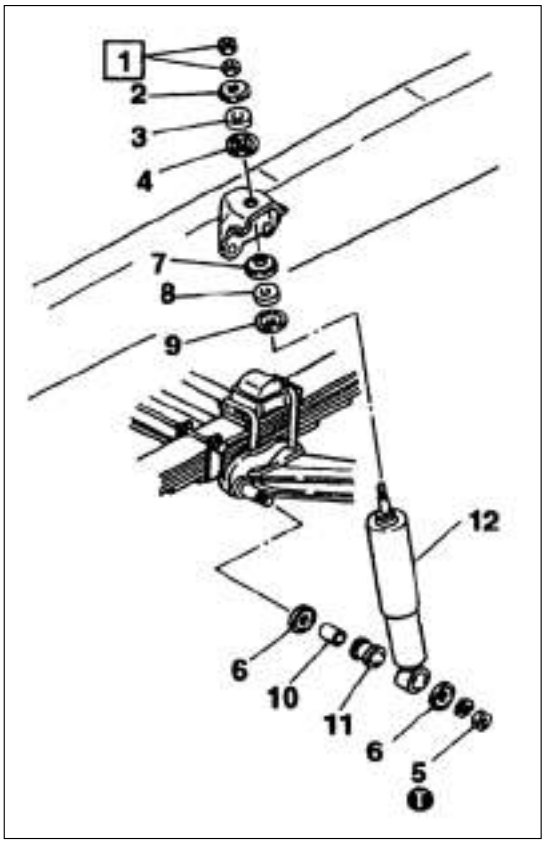
[Dismantling]

Drill through riveting end A of rivet 4with drill machine's driller and remove snap 5.



[Assembly]

Fix rivet 4 with riveting machine B and assembly snap 5.



● Disassembling sequence

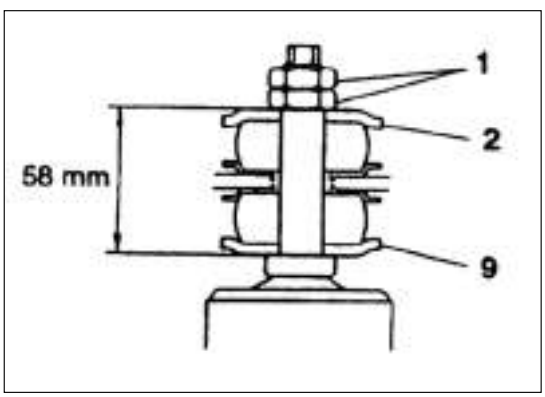
1. Nut
2. Washer
3. Rubber bush
4. Centering washer
5. Nut
6. Washer
7. Centering washer
8. Rubber bush
9. Washer
10. Bush
11. Rubber bush
12. Damper

● Assembling sequence

It is opposite to that of disassembling.

Tightening torque

Position	Parts tightened	Tightening torque	Remark
5	Nut (used for installation of damper)	250—330 [25—34]	—



◆ Maintenance method

Tighten nut 1 to make clearance between washer 2 and washer 9 accord with specified dimension.

Tighten nut (double nut) 1.

11 Rear Suspension

Main Technical Data

Wheelbase between intermediate axle and rear axle	1350mm
Center distance of leaf spring	1040mm
Frame span	860mm
Camber of leaf spring (no load)	40mm
Rated load of leaf spring	83000N

Outline Drawing and Connection Dimensions

Refer to page7-5

Structure

No.	Drawing No.	Name	No.	Drawing No.	Name
1	55503 72063	Gudgeon bracket	12	11-11 08174	Bolt
2	81-04645-1A	Bolt		89-12948-1A	Nut
	89-12946-1A	Nut		89-15248	Spring washer
	89-15246	Spring washer	13	43093 Z2012	Block
3	81-04655-1A	Bolt	14	55241 Z2000	Rubber cushion
	89-12946-1A	Nut	15	14-12 00044	Bolt
	89-15246	Spring washer		14-12 00014	Bolt
4	81-0460-1A	Bolt		89-11642-1A	Nut
	89-12946-1A	Nut		89-15142-1A	Spring washer
	89-15246	Spring washer	16	11-11 08314	Bolt
5	11-11 09104	Bolt	17	54249 00Z00	U-bolt
6	55020 Z2302	Leaf spring assembly	18	9-32101	Straight grease nipple
7	43093 Z2104	Rib	19	55507 Z2009	Cover
8	81-94450-1A	Bolt	20	55289 Z2005	Side plate
	89-12944-1A	Nut	21	55565 Z2102	Seat assembly
	89-15144-1A	Spring washer	22	55246 22313	U-bolt
9	55502 Z2176	Thrust bar and bushing assembly	23	55524 Z2015	Spring cushion
10	81-24885-1A	Bolt	24	55515 00Z00	Oil seal
	89-12948-1A	Nut	25	55518 00Z00	Safety valve
	89-15148-1A	Spring washer	26	55504 00Z00	Screw
11	55547Z0000	Thrust bar bracket		89-11254-1A	Nut
			27	55501 Z2064	Rotating shaft

Operation and Maintenance

►Before the operation of rear suspension

1. Before assembling leaf spring assembly, spread chassis-specific grease on four places between leaf spring and sliding plate.
2. Fill 2# lithium base grease into grease nipple on the end cover of rotating shaft until grease overflows.
3. After installation of vehicle chassis, check whether the assembling of rear suspension system is correct.

(1) Under no-load condition, ensure the wheel base between forward-rear axle and rear axle is 1300± 3mm.

(2) Install the hold-down bolt of thrust bar assembly in strict accordance with drawing. It's not allowed to install it in wrong direction.

(3) Check U-bolts for tightening leaf spring, and ensure that tightening torque for its nut is 716-843Nm.

►After the use of rear suspension

1. Fill 2# lithium base grease into grease nipple for every 10000km travel.
2. Re-tighten U-bolts and hold-down bolts of thrust bar assembly with installing torque for every 8000-10000km.

Dismantling, assembling and adjusting

►Dismantling of thrust bar and rubber bushing

1. When assembling thrust bar and rubber bush, the rubber bush is installed as a whole part assembly. Theoretically, it's not allowed to dismantle rubber bushing. If there is some problem, replace the assembly.
2. Dismantling load for rubber bushing assembly is above 5×10N.
3. When assembling rubber bushing assembly, first fix the thrust bar flat on the press machine platform. Align the rubber bushing assembly with ferrule hole on the thrust bar assembly, start press machine to press the rubber bushing assembly in with a force not smaller than 5×10N.

Caution ⚠

(1) Rubber bushing assembly or thrust bar assembly cannot be installed with heating.

(2) Rubber bushing assembly and thrust bar assembly belong to interference fit, with interference of 0.4-0.7mm.

►Tightening torque for assembling bolt (N•m)

Hold-down bolts of thrust bar and rubber bushing assembly 197-264

Tightening nut of U-bolt 716-843

Locking bolt of the leaf spring on the rear spring seat 157-245

Hold-down bolt of rotating shaft side ring 216-235

Tightening bolt of rotating shaft end cover 17-22

Common Faults and Troubleshooting

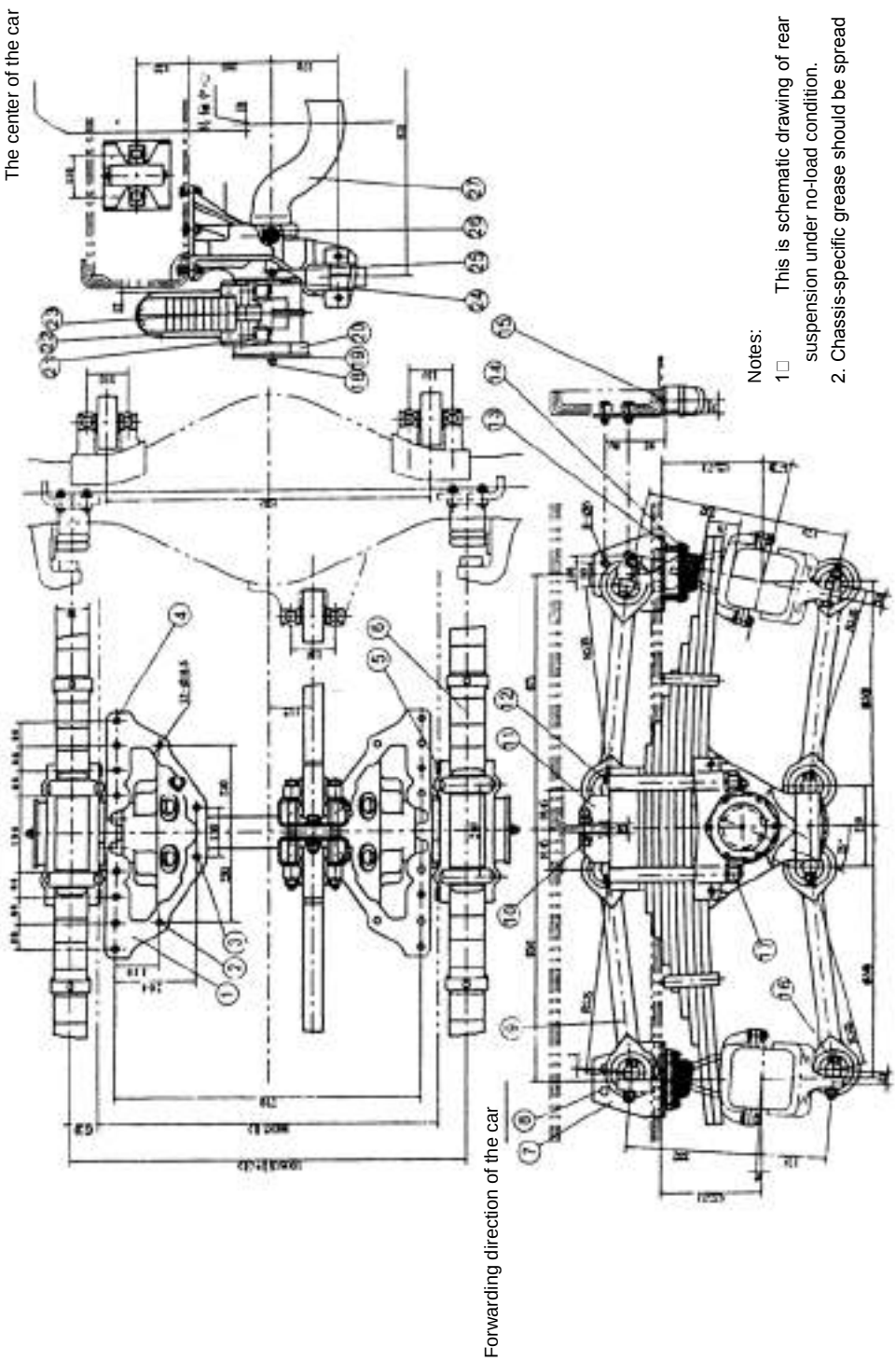
Failures rarely occur to rear suspension system.

During the running of the vehicle, cracking of U-bolt for tightening the leaf spring assembly is one possibility. On one hand, the user didn't tighten the U-bolt with specified torque when installing; on the other hand, the user didn't operate in accordance with 4 "use and maintenance" during use. If such problems arise, stop driving, get it repaired and replace U-bolts.

High–mortality Parts

No.	Drawing No.	Name	Quantity
1	55515 00Z00	Oil seal-rear spring seat	
2	555246 Z2313	U-bolt-standard	4
3	55246 XJ2313	U-bolt-extension	4
4	55542 90002	Rubber bushing assembly (rear)	6
5	55542 Z2005	Rubber bushing assembly (front)	6
6	55513 90003	Rear spring seat bearing pad (inner)	2
7	55512 Z0000	Rear spring seat bearing pad	4

Outline drawing and connection dimensions of rear suspension



Notes:

1□ This is schematic drawing of rear suspension under no-load condition.

2. Chassis-specific grease should be spread

12 Balance Shaft Assembly

Structure and Working Principle

Balanced suspension consists of two longitudinal inversed arc leaf springs. Through balance shaft, balance shaft assembly integrates two balance shaft brackets with balance bearing hub. Balance shaft brackets make rigid connection with frame and are connected to forward-rear and rear axles through two groups of torque arms on the balance shaft brackets (supports on both ends). The forward-rear and rear axles are connected to frame with a group of upper torque arms. The thrust and reaction torques from drive axle are transmitted to vehicle frame through upper and lower torque arms.

Leaf springs are fastened together with center bolt. At the time of assembling, the head of center bolt should be on the side of short leaf for positioning leaf spring. Head of center bolt of leaf spring should fall into the positioning hole of balance shaft hub. Install cover plate on the leaf spring surface. At last the middle part of leaf spring assembly makes a rigid connection of leaf spring assembly and balance bearing hub through two U-bolts. Balance bearing hub is installed on the balance shaft and forms a rotary support. Two ends of leaf spring are fitted on the sliding plate of leaf spring guide seat on the axle case, to make jumping spring move between sliding plate and guide seat. In order to limit the deformation of leaf spring and jumping of drive axle, a rubber limiting block is fitted on the frame side member lower wing which is facing the axle case.

Outline Drawing and Connection Dimensions (refer to Fig1, Fig2, Table1)

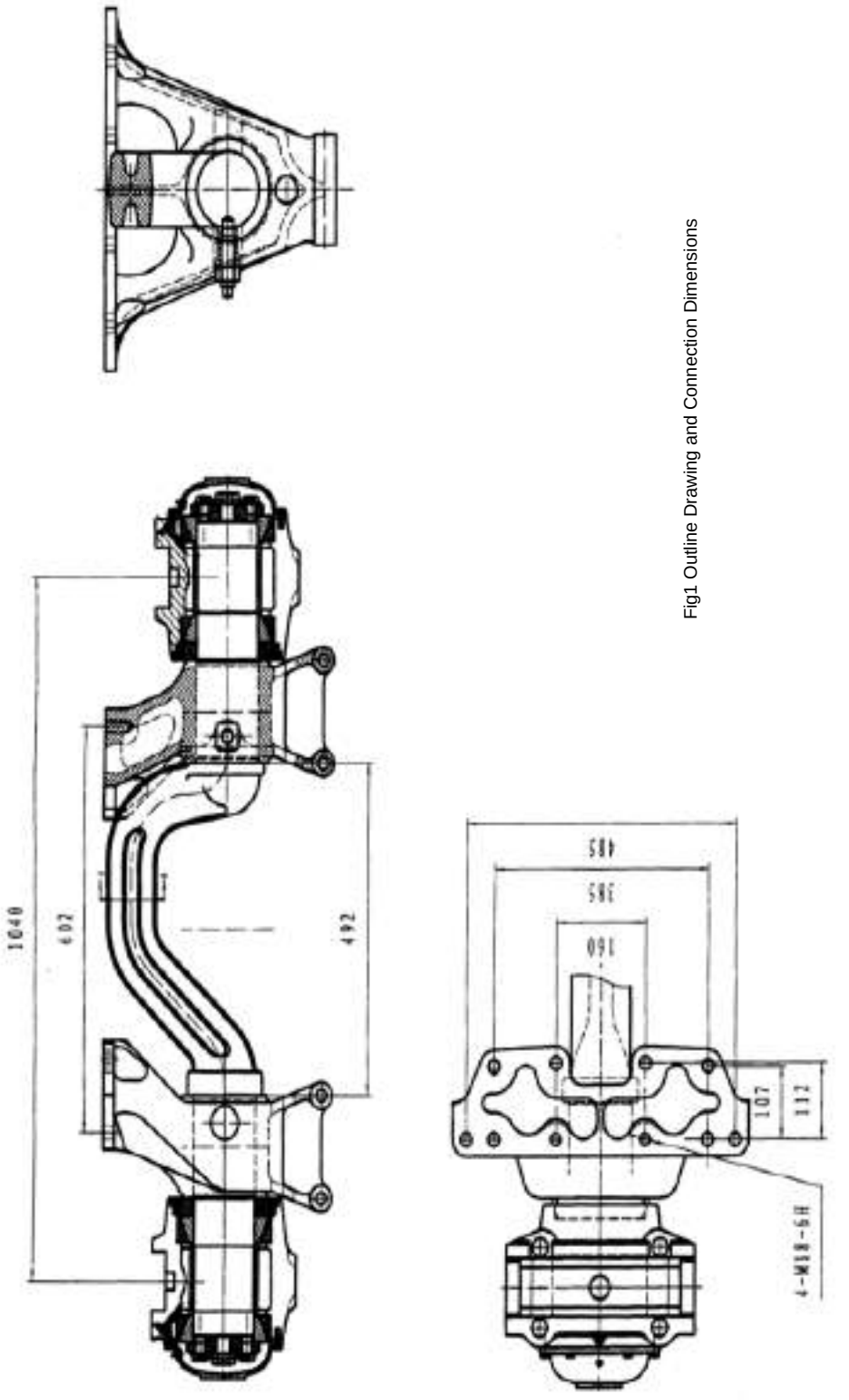


Fig1 Outline Drawing and Connection Dimensions

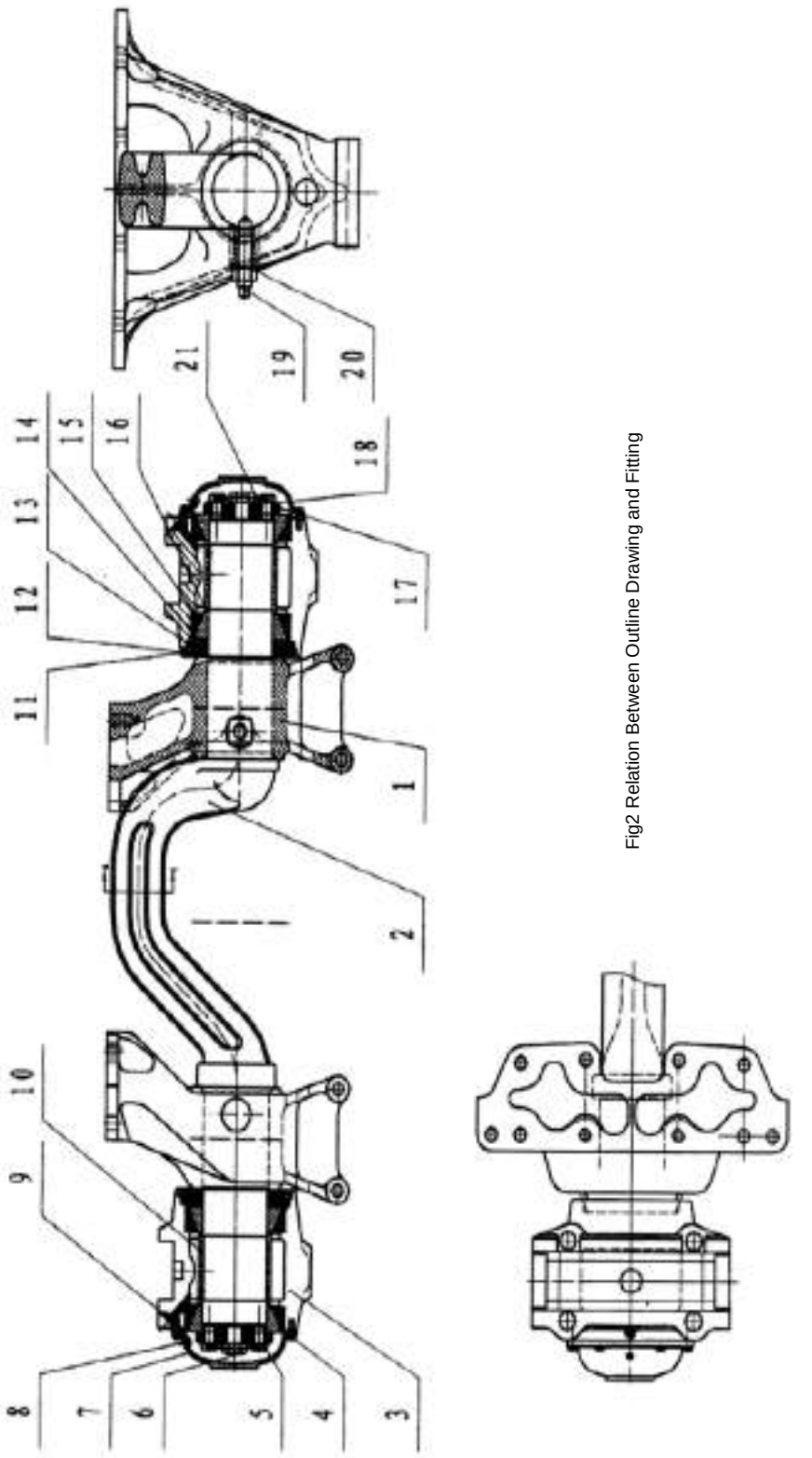


Fig2 Relation Between Outline Drawing and Fitting

List of Parts

No.	Drawing No.	Name of parts	Quantity	Remark
1	29AHD-18521	Balance shaft support	2	
2	SLH99014520185	Balance shaft	1	
3	29AHD-18531	Bearing hub	2	
4	Q150B0816/Q40308	Bolt/spring washer	16	
5	Q171B1655TF2	Hex bolt	8	
6	AZ9114520041	Hex bolt	2	
7	SL99014520311	Cover of balance shaft case	2	
8	Q150B410	Filling test plug	2	
9	Q150B0810/Q72308	Hexagon-head bolt/copper washer	2/2	
10	99014520191	Distance bush	2	
11	99114520222	Ring	2	
12	614130062	O ring	2	
13	99114520223	Bearing seal ring	2	
14	99114520136	Bearing oil seal cover	2	
15	99014520042/B	Bearing inner (outer) ring/rocker bearing	4/4	
16	99114520192	Space washer	Adjustable	
17	99014520188	Bearing ballast	2	
18	99014520265	Stop washer	2	
19	29AHD-18541	Set bolt	2	
20	29AHD-18551	Nut	2	
21	29AHD-18561	Galvanized wire		

Assembling and Adjustment

►Assembly of balance shaft assembly (refer to the above figs)

1. Set bolt and nut on the balance shaft support should be tightened during assembling of balance shaft support with a tightening torque of 467-569Nm.
2. Bolts on the bearing ballast should be tightened during assembling of balance shaft hub, a tightening torque of 200-260Nm for M16×1.5 bolt and a tightening torque of 390-490Nm for M24×2 bolt.
3. Balance bearing hub should be filled with 1.4Kg GL-5 80W-90 heavy-duty gear oil.

Daily Maintenance of Balance Shaft Assembly

1. Check connecting and fastening of all parts of the balance shaft assembly before putting a new vehicle into service.

2. Running-in period of a new vehicle

(1) When the car has traveled 200Km, check and tighten the set bolt and nut which are used for the connection of balance shaft support and balance shaft once and U-bolt and nut of the leaf spring once as per specified torque under full-load condition.

(2) When the car has traveled 500Km, check and tighten again under above-mentioned condition.

3. Running-in of a new vehicle

(1) It's necessary to check and tighten bolts and nuts above once again under full-load condition before putting into service after the car has finished the running-in and after replacing or re-assembling leaf spring assembly.

(2) When the car is in use, check and tighten bolts and nuts with specified torque under full-load condition for every 200-300Km travel. One time for each bolt and nut, totally 3 times.

4. Check and tighten bolts and nuts of the exposed parts of balance shaft assembly with specified torque for every 1500-2000Km travel. Fill GL-5 80W-90 heavy-duty gear oil according to lubrication list. Caution: check and tighten all bolts and nuts under full-load condition.

5. Fill GL-5 80W-90 heavy-duty gear oil into balance bearing hub for every 2500-3500Km travel.

6. Besides the above items, also check the working condition of shock absorber to see if more shock absorber oil is needed or if it's necessary to dismantle and lubricate the leaf spring for every 6000-8000Km travel.

7. Check the tightening between balance shaft support and frame and other tightening bolts and nuts periodically during the use of the car.

Tightening Force of Major Bolts and Nuts

Name	Tightening torque		Quantity/vehicle
	N.m	Kgf.m	
Set bolts and nuts for the connection of balance shaft support and balance shaft	467~569	4.67~5.69	2
Connecting bolt of bearing ballast of balance shaft bearing hub	200~260	2.0~2.6	8
	390~490	3.9~4.9	2

Matching Clearance List of Major Parts

Name	Adjusting space	Remarks
Spherical plain bearings	0.1~0.3	Balance bearing hub can be turned manually

Lubrication List

Mileage interval	Lubrication parts	Amount of filling	Number of lubrication points	Lubricant	Remarks
2500~3500	Balance bearing hub	Proper	2	GL-5.80W-90 heavy-duty gear oil	Add

13 Clutch

Precautions of Operation

1. Driven plate assembly should be clean, and friction plate should be protected against dust, dirt and grease. Surfaces of pressure plate and flywheel should be scrubbed clean and degreased before the assembly of engine so as to prevent clutch slipping.
2. Clutch has been adjusted before it leaves the factory and usually doesn't need adjusting when using. If clutch does need adjusting, it must be adjusted by adjusting nuts on special apparatus. Pressure plate must be prevented from tilting and the six release lever top cambered surfaces must contact retractor collar.
3. In order to ensure the working stability of clutch, clutch pressure plate and driven plate assembly have been balanced before leaving the factory. Don't remove parts randomly when using. If it must be disconnected to repair clutch, please make marks first. Assemble and re-balance as per these marks after repair.
4. Screw or unscrew bolts or nuts in turn diagonally that secure clutch on flywheel when assembling or disassembling clutch.
5. When mounting clutch, use temperature and pressure resistant lubrication grease to lubricate driven plate spline and transmission imput shaft spline so as to ensure that driven plate can move freely on imput shaft. Excessive lubrication can cause friction plate stained with grease and clutch slipping, so it must be avoided.
6. Be careful not to damage driven plate spline when mounting clutch. Prevent the movement of driven plate around the shaft from being blocked and not being able to be released.
7. The clutch release stroke must accord with the requirement. If the stroke is too long, there is a danger of release lever touching driven plate; if too short, clutch will not be released completely.
8. When clutch is in a state of engagement, there should be a clearance of 2-3mm between release bearing and retractor collar so as not to prevent pressure plate from forcing against friction plate if friction plate wears out, ensuring safe transfer of engine torque.
9. Release bearing must be able to move freely on transmission imput shaft sleeve.
10. Change driven plate assembly immediately if the wear of friction plate extends to clutch wearing stroke.
11. GF series clutch is of grey U cast iron body. Handle with care. Do not bump. Never lift the retractor collar with the clutch hanging in the air when carrying, or else torsion spring can deform.
12. Operate clutch correctly. Avoid clutch slipping caused by incorrect operation, such as, putting into high-gear and increasing accelerator without speed reaching high enough when shifting from slow to fast after starting at full throttle, continuous starting for many times on steep road, rushing by force through accelerating or clutch released not completely when wheels are slipping or sinking on muddy road. These can bring high temperature for clutch because of continuous acute rub, causing elasticity of pressure spring declines because of heat. As a result, clutch is slipping or friction plate is burnout in serious cases.

Faults and Troubleshooting of the Clutch

Faults	Causes	Troubleshooting
Slipping	1. Overloading	Normal.
	2. Excessive wear of friction plate because operator frequently places clutch in semi-coupling condition.	Operate correctly.
	3. Oil stain on friction surface.	Degrease or change driven plate.
	4. No clearance between release bearing and clutch ring.	Adjust the clearance to 2-3mm.
	5. Frequent operation of clutch at over-speed and overloading.	Operate clutch correctly.
	6. Driven plate or pressure plate warps or deforms.	Change driven plate or pressure plate.
	7. Pressure spring is too flexible or deforms because of heat, and its elasticity declines.	Change pressure plate assembly.
	8. Pedal of hydraulic-operated clutch becomes higher and higher after being treaded.	Check and adjust master cylinder and sub-cylinder, unblock the oil circuit.
Incomplete releasing	1. Release bearing is tilting and cannot return to correct operating position.	Change release bearing.
	2. Transmission first/imput shaft is not in line with crankshaft.	Check whether assembly conforms to requirement.
	3. Excessive free stroke and insufficient release stroke of pedal.	Adjust free stroke and release stroke.
	4. Driven plate spline is not able to move freely on transmission first/imput shaft.	Check the conjugation of spline pair.
	5. Top of release lever not parallel with flywheel face. Pressure plate tilting.	Adjust as required.
	6. Driven plate warps or deforms.	Change driven plate.
	7. There is lack of oil, insufficient oil pressure or air in oil circuit of hydraulic-operated clutch.	Check oil circuit.
Chattering	1. Abnormal contact of release bearing.	Examine release bearing.
	2. Excessive difference in the thickness of driven plate, or rough friction plate.	Change driven plate.
	3. Top of release lever not parallel with flywheel face. Pressure plate tilting.	Adjust as required.
	4. Bolts that secure pressure plate and flywheel as well as flywheel housing and transmission are not tight, or oil seal of drive shaft is too tight. There is a delay when braking with foot or hand.	Find out the cause and troubleshoot.

14 Transmission

Main Property Parameters and Data Table Graph for Shanxi FAST Twin Countershaft 9–Speed Transmission

►Main Property Parameters for Shanxi FAST Twin Countershaft 9-Speed Transmission RT-11509C

Maximum input power: 265kW (360hp)
Maximum input torque:1490Nm (152kgm)
Maximum output torque:169360Nm (1728kgm)
Maximum input speed of rotation:2600rpm

►Main cross-section drawing for transmission assembly

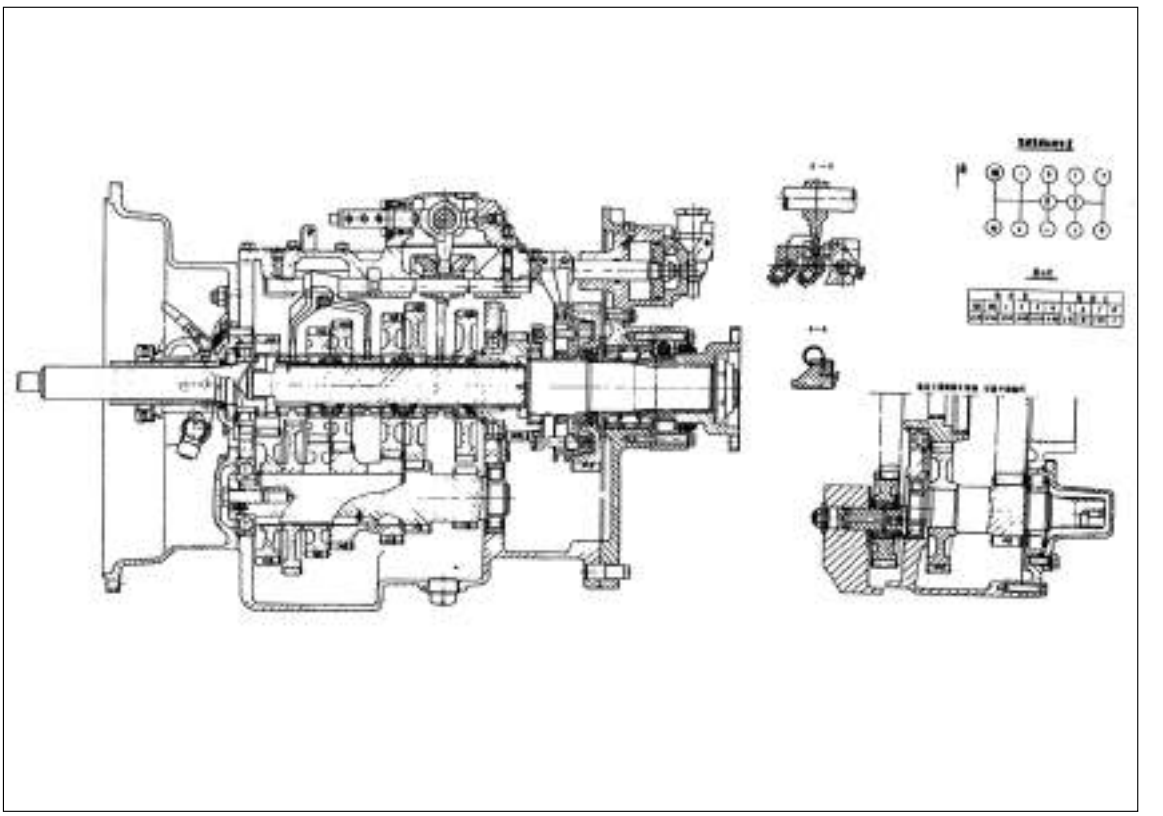
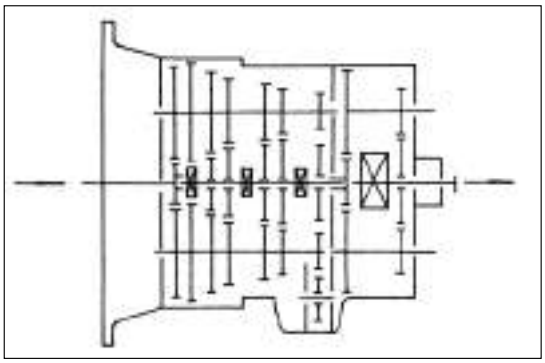


Fig. 1-1: Main Cross-section Drawing for Shanxi FAST Twin Countershaft 9-Speed Transmission Assembly



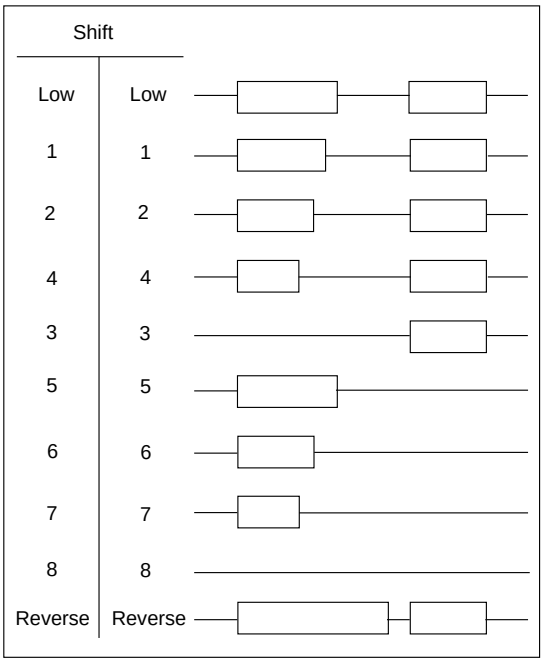


Fig. 1-2: Power Transferring Route for Shanxi FAST Twin Countershaft 9-Speed Transmission

►Powe rtransferring of transmission

Refer to Fig. 1-2 “Power Transferring Route for Shanxi FAST Twin Countershaft 9-Speed Transmission”

Shanxi FAST Twin Countershaft 9-speed transmission is composed of one front 5-speed transmission and one 2-speed auxiliary transmission (refer to Fig. 1-1). The input shaft (shaft 1) and gear of shaft 1 are connected by spline. Except that the reverse gear and low speed gear are integrated to the countershaft, the gears of countershaft (layshaft) are matched to the countershaft by a certain amount of interference and connected by whitney key or long key. The main shaft gear is supported by the spline shim, showing radial floating state on the main shaft, performing the axial positioning by the stop collar installed in the inner hole, long hexagonal key, spline shim and adjustment shim on the main shaft. The clearance of two adjacent shift gears can be adjusted by selecting the thickness of adjustment shim. Each shift gear in the main and auxiliary transmission is constantly meshed. The power of the engine is transferred to the gears of input shaft and shaft 1 by clutch. Gear of shaft 1 is constantly meshed to the transmission gear of the countershaft to drive the transmission of countershaft. The gear of the countershaft is constantly meshed to the gear of main shaft. Because the gear of main shaft is supported on the outer circle of the spline shim unstably, the gear of main shaft runs idle on the main shaft. The slide sleeve of shaft 2 is connected to the main shaft by spline, when the slide sleeve is moved to connect the coupling gear（outer spline）of slide sleeve to the internal gear of main shaft , the main shaft is coupled to the gear of main shaft and rotate at a certain ratio for power output.

When the auxiliary transmission is located in the high shift zone, the power from the main shaft of main transmission is directly outputted to the output shaft by the driving gear and synchronizer gear sleeve of auxiliary transmission; when the

auxiliary transmission is located in the low shift zone, the power from the main shaft of main transmission is transferred to the countershaft of auxiliary transmission by the driving gear of the auxiliary transmission to drive the reduction gear and synchronizer gear sleeve of auxiliary transmission to transfer the power to the output shaft.

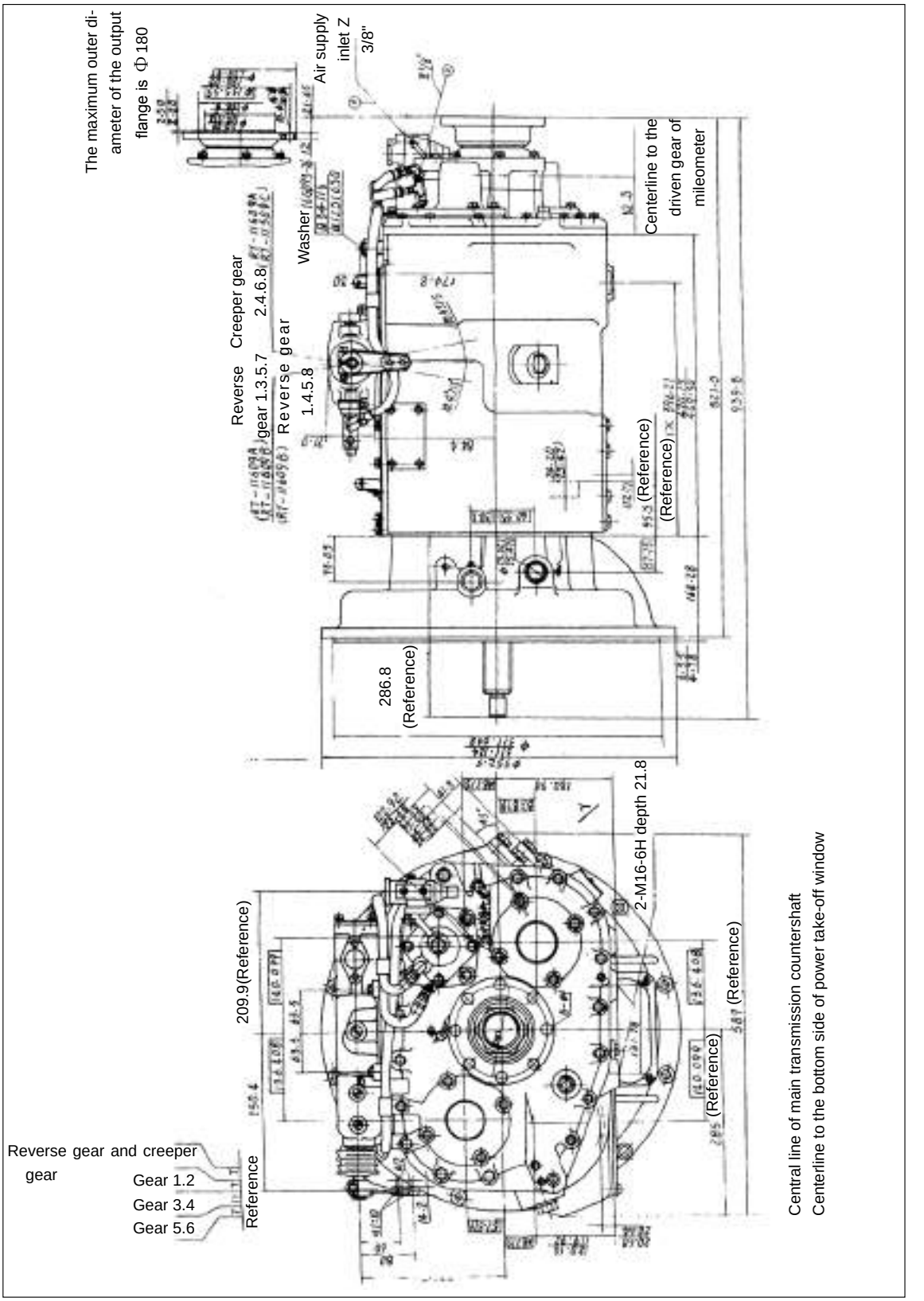
The power of the engine is directly transferred to the main shaft from gear of shaft 1, and then transferred to the output shaft by the driving gear (main shaft) of the auxiliary transmission, which is called as the direct shift; when the speed of rotation of the output shaft is greater than the speed of rotation of input shaft, it is called the overdrive transmission; the intermediate gear of reverse shift is coupled to the countershaft of reverse shift by the needle bearing, move the slide sleeve to couple the reverse gear, so as to realize the reverse gear transmission.

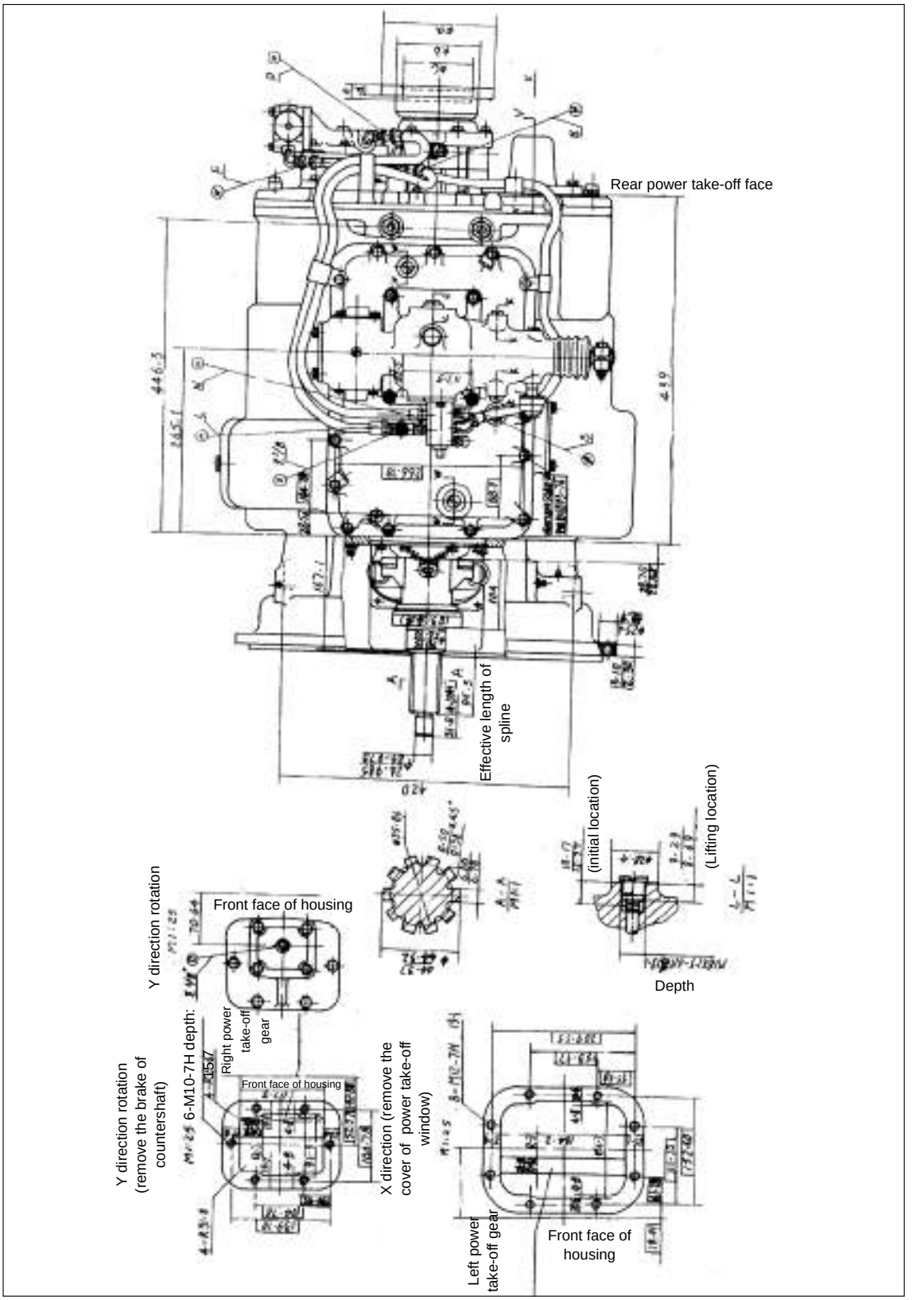
►Overall dimension and installation dimension drawing of transmission

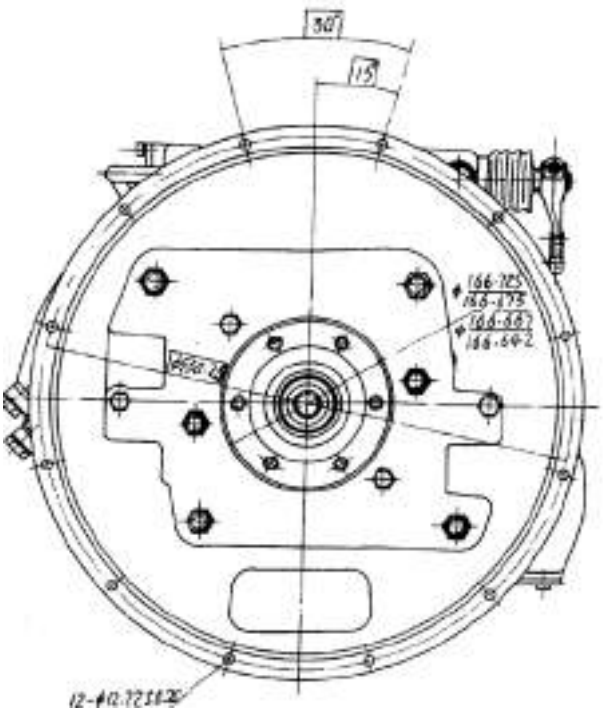
Refer to Fig. 1-3: Overall Dimension and Installation Dimension Drawing of Shanxi FAST Twin Countershaft 9-Speed Transmission (Refer to inset)

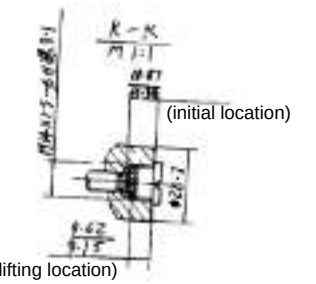
12.65-8.38-6.22-4.57-3.40-2.46-1.83-1.34-1.00

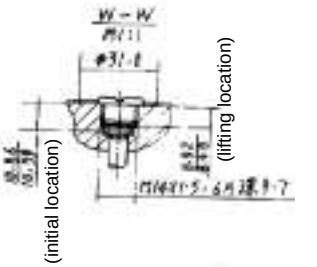
R:13.22


The maximum outer diameter of the output flange is Φ180
Air supply inlet Z 3/8"
Washer
Centerline to the driven gear of mileometer
Reverse gear 1.3.5.7
Creeper gear 2.4.6.8
Reverse gear 1.4.5.8
(Reference)
(Reference)
286.8 (Reference)
2-M16-6H depth 21.8
209.9(Reference)
(Reference)
(Reference)
Reverse gear and creeper gear
Gear 1.2
Gear 3.4
Gear 5.6
Reference
Central line of main transmission countershaft
Centerline to the bottom side of power take-off window

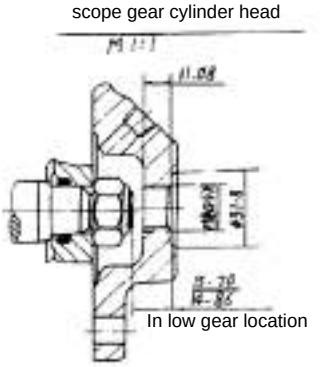

Rear power take-off face
Effective length of spline
(initial location)
(Lifting location)
Depth
Front face of housing
Y direction rotation
Right power take-off gear
Y direction rotation (remove the brake of countershaft)
6-M10-7H depth:
Front face of housing
X direction (remove the cover of power take-off window)
Left power take-off gear
Front face of housing

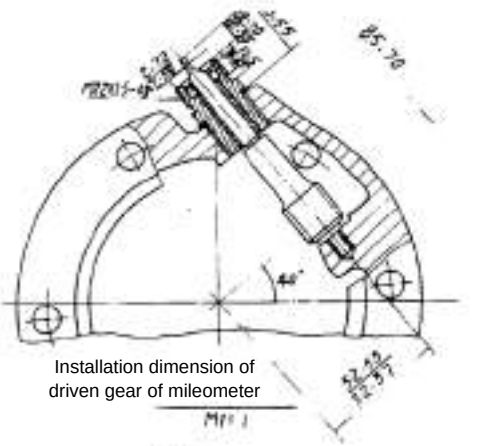




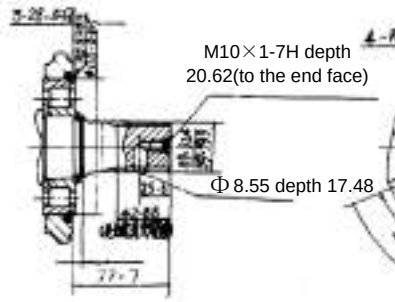


Cross-section diagram of scope gear cylinder head

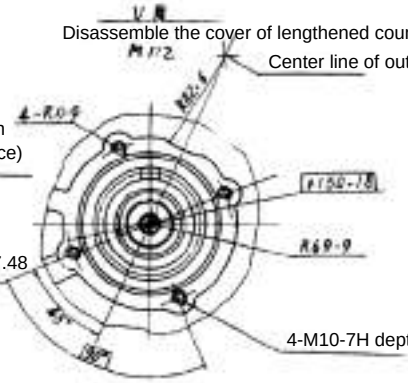




Disassemble the cover of lengthened countershaft



Disassemble the cover of lengthened countershaft



►Speed Ratio Table of Twin Countershaft 9-Speed Transmission

5-1 Speed Ratio

Type	9JS119	9JS135T	RT-11509C	9JS150T-B	9JS165T
Low	12.11	12.113	12.42	12.42	12.65
1	8.08	8.084	8.26	8.29	8.38
2	5.93	5.956	6.08	6.11	6.22
3	4.42	4.420	4.53	4.53	4.57
4	3.36	3.360	3.36	3.36	3.40
5	2.41	2.406	2.47	2.47	2.46
6	1.76	1.773	1.81	1.82	1.83
7	1.32	1.317	1.35	1.35	1.34
8	1	1.00	1	1.00	1.00
Reverse	12.66	12.66	12.99	12.99	13.22

Typical Structure of Shanxi FAST Twin Countershaft 9–Speed Transmission

►Structure of Twin Countershaft

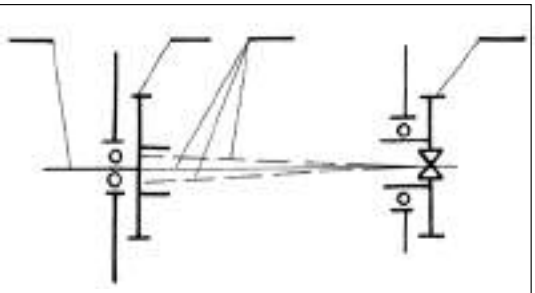
The main transmission and auxiliary transmission of Shanxi FAST Twin Countershaft 9-speed transmission apply the completely identical structure of countershaft and the included angle is 180° . The power inputted from the input shaft is distributed to two countershafts, and then collected to the main shaft for output, so is the auxiliary transmission.

Theoretically, each countershaft only transfers 1/2 torque, so applying Twin Countershaft can reduce the center distance of transmission, the width of gear is reduced, the axial dimension is shortened and the mass is reduced. After applying Twin Countershaft, each speed gear on the main shaft shall be meshed with gears of two countershafts simultaneously.

In order to ensure the proper meshing and make the loads evenly distributed as possible, the main shaft gear shows the radial floating state on the main shaft, and the main shaft applies hinge type floating structure. Refer to Fig. 2-1. The journal of main shaft is inserted into the hole of input shaft. The oily guide sleeve is pressed into the hole. There should be enough radial clearance between the journal of main shaft and the guide sleeve. The rear end of main shaft is inserted into the hole of driving gear of auxiliary transmission by involute spline. The journal of auxiliary transmission driving gear is supported in the ball bearing.

In serrated gear transmission, there are two recesses in the journal of auxiliary transmission driving gear. O rubber ring is installed in the recesses, forming the elastic support with the bearing.

Since each speed gear of main shaft is floated on the main shaft, the traditional needle bearing is cancelled, resulted in a much more simple and reasonable structure of main shaft assembly. During operation, two gears of countershaft apply the same radial force on the gear of main shaft, the direction is opposite, and mutually cancelled, causing the main shaft only to bear the torque, not to bear bending moments, improving the force application state for main shaft and bearing, and greatly improving the operation reliability and durability of transmission.



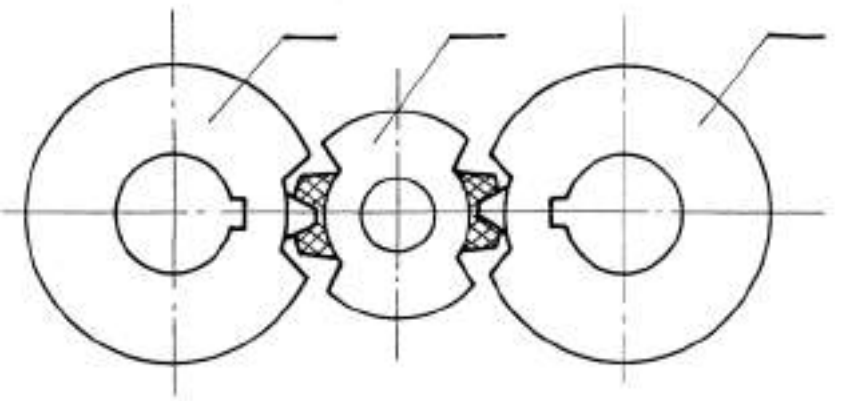
1. main shaft 2.input shaft 3.gear of input shaft 4.driving gear of auxiliary transmission

Fig. 2-1: Floating Structure Scheme of Main Shaft

►"Matching Gears" and Procedure of Matching Gears

In order to ensure the proper meshing of the gears of Twin Countershaft and main shaft gears, "matching gears" shall be performed.

"Matching Gears" means that the marked gear teeth of the transmission gear on two countershafts shall be inserted into the gullet of two sets of marked gear teeth (each set includes the adjacent two teeth) on the gears of input shaft (shaft one), refer to Fig. 2-2.



1. Transmission gear of left countershaft 2. Transmission gear of right countershaft
3. Gear of input shaft

Fig. 2-2: Layout of Matching Gear for Assembling Transmission Assembly

"Matching Gears" for auxiliary transmission shall also be performed according to the above methods. Generally, choose a rear pair of gears to perform the "Matching Gears".

In order to be convenient for "Matching Gears", generally, the whole gears of the transmission are straight teeth, and the gears of input shaft, main shaft and output shaft are even number of gears.
Procedures of "Matching Gears"

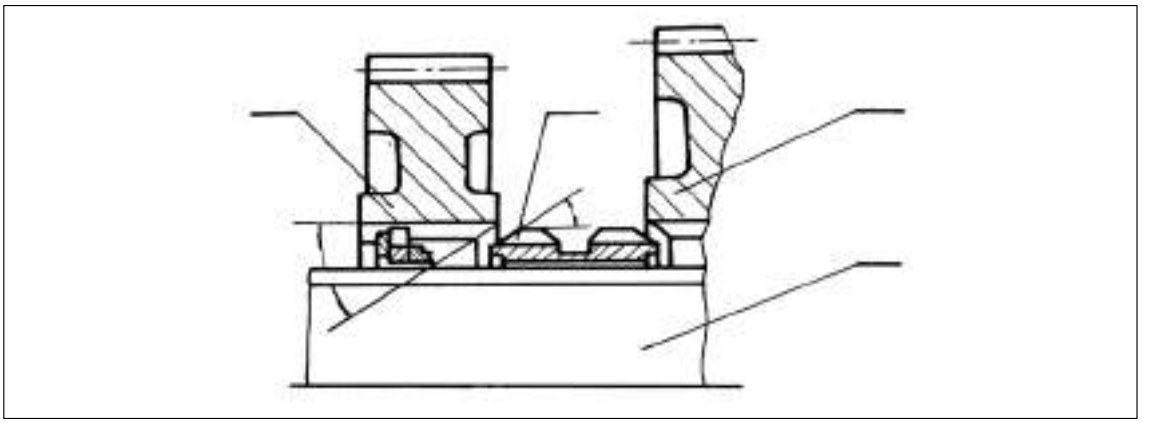
1. Stamp the marks on any two adjacent teeth of gear on shaft one, and then stamp the marks on its symmetrical two adjacent teeth oppositely. The number of teeth for two sets of marks shall be equal.
2. Mark the teeth of the transmission gear of each countershaft, which is opposite to the gear key, so as to be easily identified.
3. During assembly, the marked teeth of transmission gears on two countershafts shall be meshed to two teeth marked on left and right sides of gears of shaft one respectively.

►Shifting Mechanism

There is no synchronizer in the main Shanxi FAST Twin Countershaft 9-speed transmission. The slide sleeve of main shaft is coupled on the main shaft by involute spline, move the slide sleeve to mesh the engaging teeth of slide sleeve to the inner engaging teeth of the main shaft gears, refer to Fig. 2-3.

The slide sleeve and the inner engaging teeth end of main shaft gear have the same conical angle (a=35°). Since the main shaft and the main shaft gear are in the floating state, two conical faces can perform the automatic centering and synchronization function during shifting gear.

There are many gears in the Shanxi FAST Twin Countershaft 9-speed transmission. The extreme difference for the speed ratio of each gear is small. Therefore, the difference of rotation speed between the adjacent gears is also small during operation process, resulted in a easy transmission operation, simple



shifting mechanism, low prices and reliable operation.

1. Slide sleeve 2. Main shaft gear 3. Main shaft

Fig. 2-3

►Control Mechanism

Two types of control mechanisms are available for Shanxi FAST Twin Countershaft 9-speed transmission, i.e. direct-control (single H) type and long distance control（single H or double H）type. (CAMC serial trucks apply long distance control type)

4-1 Direct Drive/Control (single H) Type

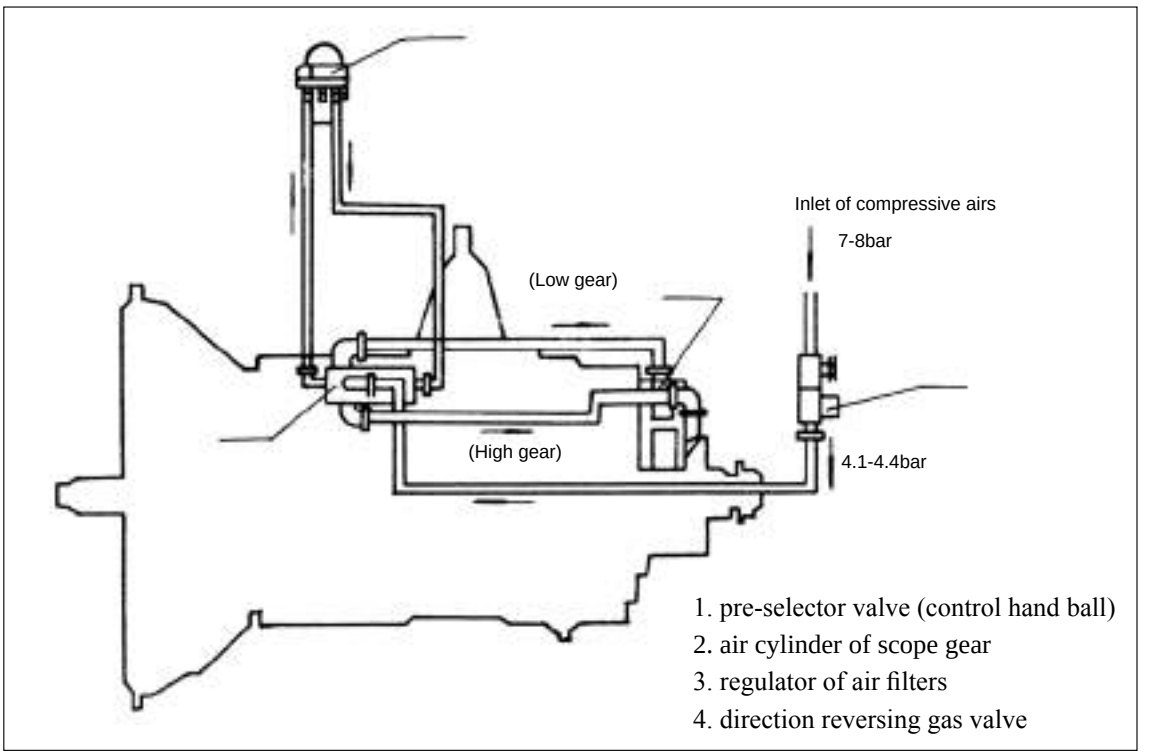
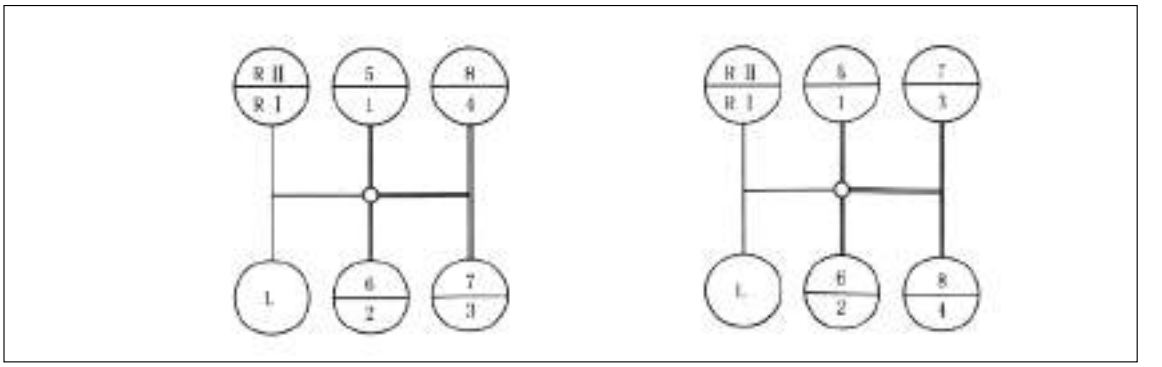


Fig. 2-4: Pneumatic Line Scheme for Single H Shifting Mechanism

Fig. 2-4: Pneumatic Line Scheme for Single H Control Mechanism. The compressed air is fed into the directional reversing air valve 4 through the regulator of air filter 3, and the high gear or low gear is respectively connected by the pre-selector valve 1 installed in the control hand ball.

Fig. 2-5: Location of Control Hand Ball in the Direct Control (Single H) Mechanism



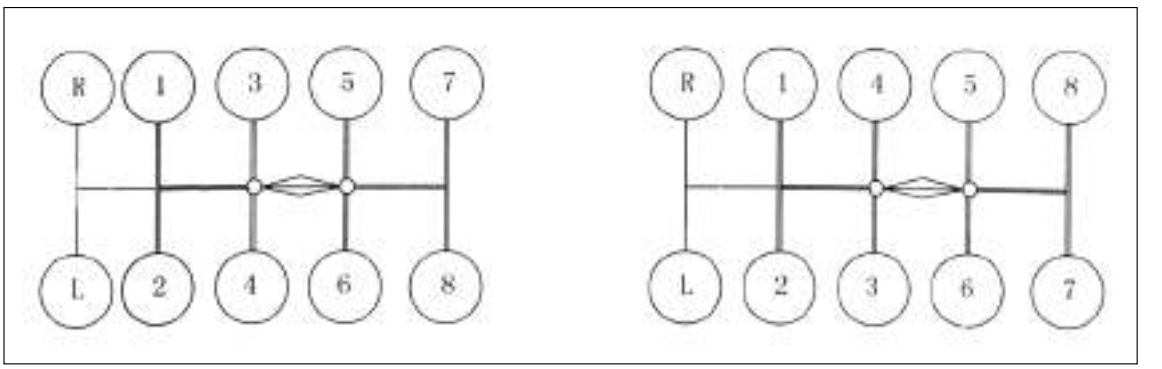
A: Location of Control Hand Ball in the RT type Single H Shifting Mechanism

B: Location of Control Hand Ball in the RTO type Single H Shifting Mechanism

Fig. 2-5

4-2 Long Distance Control Mechanism

At present, most of the domestic vehicles installing the Shanxi FAST Twin Countershaft 9-speed transmission apply long distance double H control mechanism. Refer to Fig. 2-6 for the location of its control hand ball. (CAMC serial trucks apply RT type double H shifting mechanism)



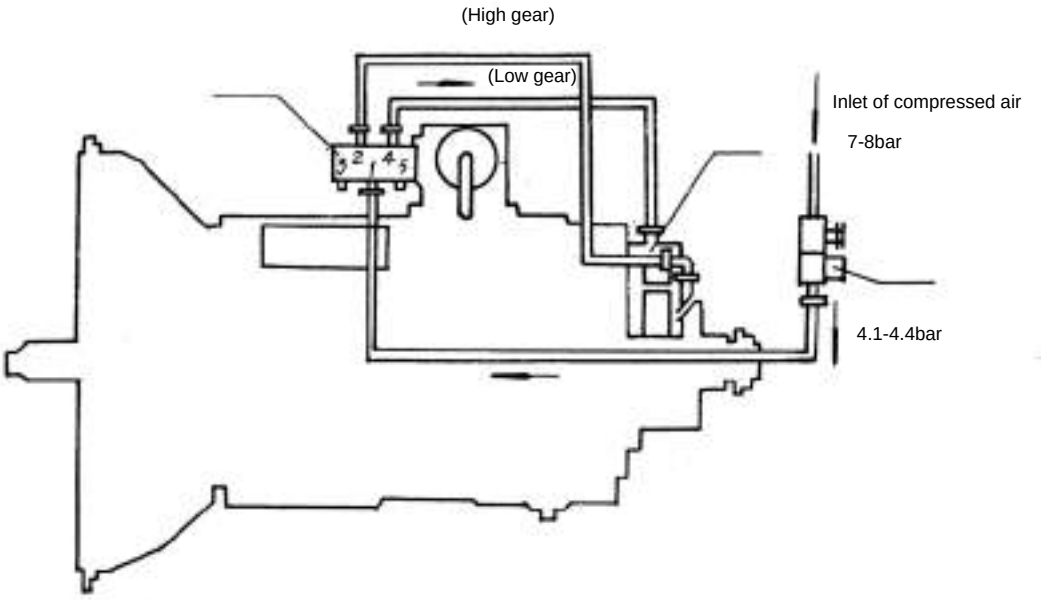
A: Location of Control Hand Ball in the RT type double H Shifting Mechanism

B: Location of Control Hand Ball in the RTO type double H Shifting Mechanism

Fig. 2-6

In the double H control mechanism, 1-2-3-4 and R-L gear are in the low speed area, 5-6-7-8 gear is in the high speed area.

Refer to Fig. 2-7 for the pneumatic line of double H shifting mechanism. Two pneumatic lines are available in its midst location, one is in the neutral position of 3-4 gear for low speed area, and the other is in the neutral position of 5-6 gear for high speed area.



1. Double H direction reversing valve; 2. Cylinder in scope shift; 3. Regulator of air filter

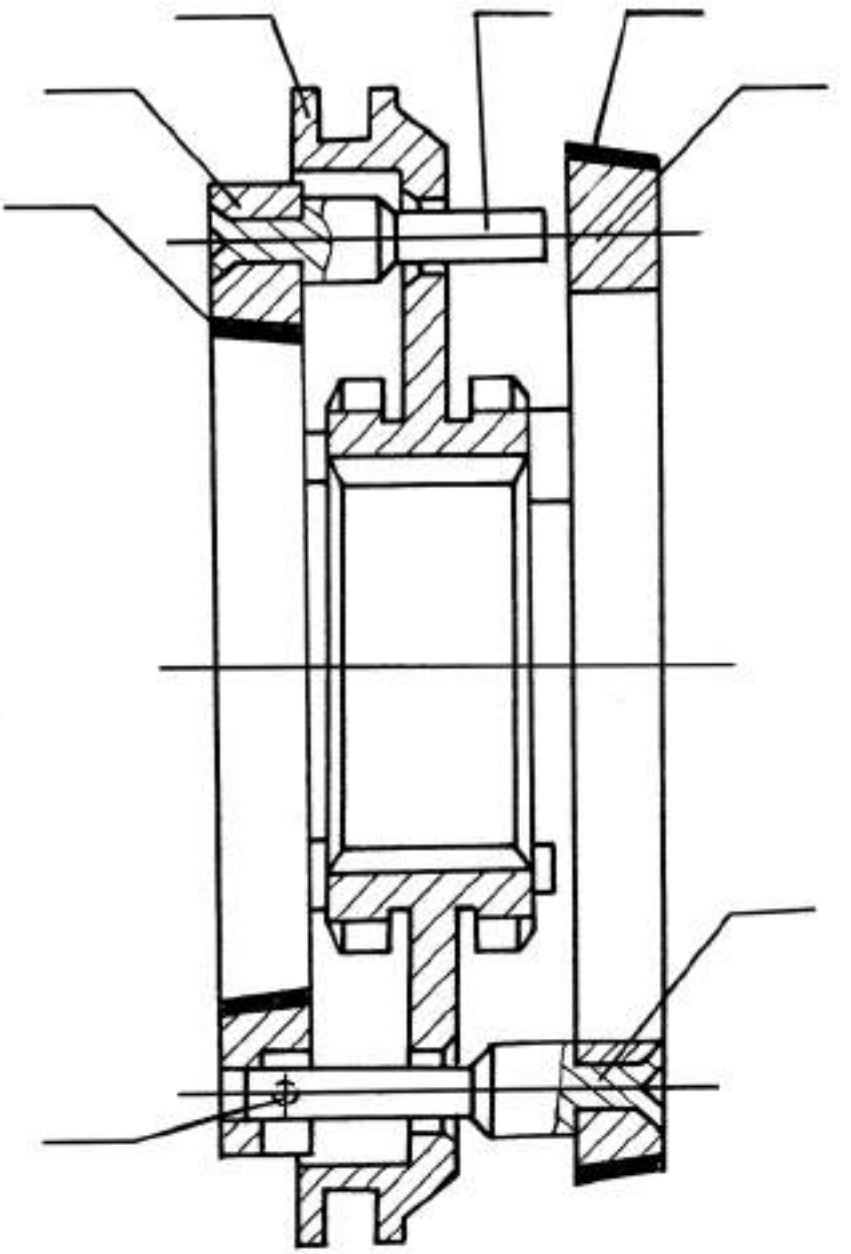
Fig. 2-7: Pneumatic Line Diagram of Double H Shifting Mechanism

The shifting head installed in the lateral pull rod of double H control device directly controls double H direction reversing valve, which connects the air pipes of high speed area and low speed area respectively, realizing the automatic shifting between the high speed area and the low speed area. The holes 2 and 4 in the double H direction reversing valve are the air outlet, the holes 3 and 5 are the exhaust openings, and the hole 1 is the air inlet.

►Structure of Synchronizer

The lock pin inertial synchronizer is installed in the auxiliary Shanxi FAST Twin Countershaft 9-speed transmission. It is controlled by the shifting cylinder of auxiliary transmission, which is only applied when the high speed and low speed are changed (i.e. it is only operated when the high speed area is shifted to the low speed area, or the high speed area is shifted to the low speed area). Its motion is controlled by the lateral pull rod and double H air valve.

Refer to Fig. 2-8 for the structure of synchronizer. Three lock pins 4 and 7 are pivoted on high gear synchronizing ring 2 and low gear conical ring 6; the sliding gear sleeve 3 is integrated with the output shaft of auxiliary transmission by spline. The matrix of high gear synchronizing ring and low gear conical ring is sintered and forged by the iron base powder. The inner conical face of the high gear synchronizing ring and the outer conical face of the low gear conical ring are adhered by non-metal materials with high friction property. The corresponding outer conical face and inner conical face are available in the driving gear and the reduction gear of the auxiliary transmission respectively.



1. High gear friction band
2. High gear synchronizing ring
3. Sliding gear sleeve
4. High gear lock pin
5. Low gear friction band
6. Low gear conical ring
7. gear lock pin; 8. Spring

Fig. 2-8: Synchronizer Assembly

►Brake of Countershaft (Auxiliary Shaft)

The brake of countershaft is also named brake of auxiliary shaft or the brake of clutch; it is installed in the right side of the main transmission housing (see from the forward direction of automobile). Refer to Fig. 2-9 for its structure.

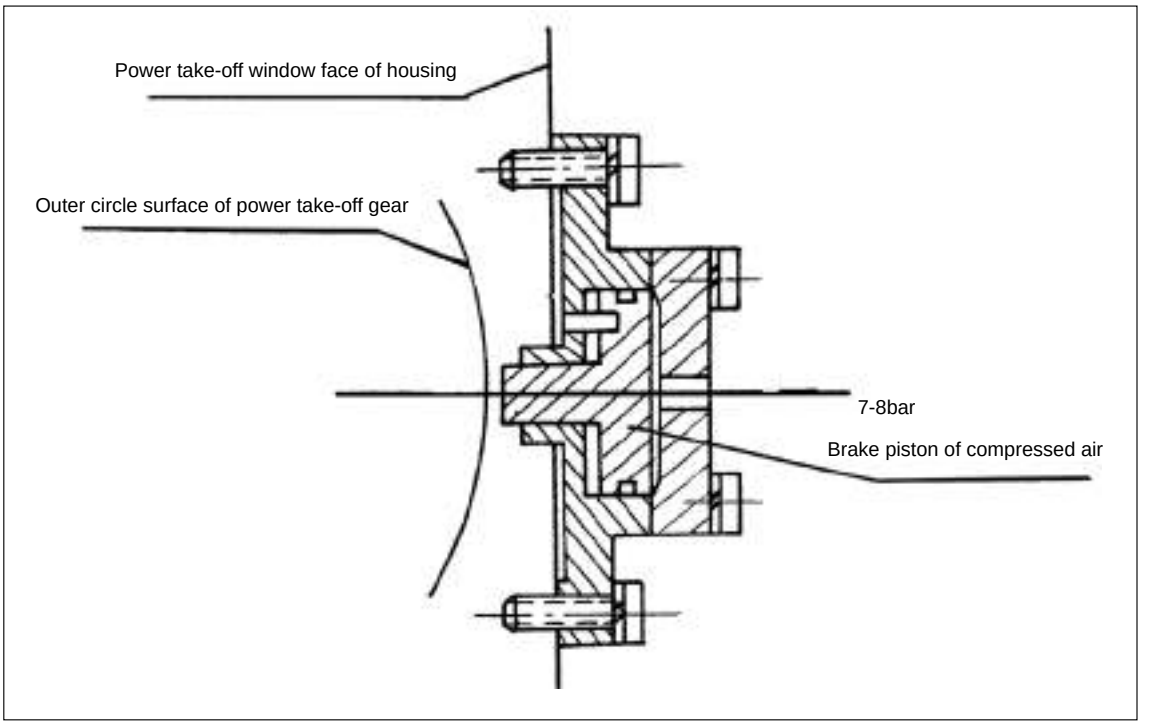


Fig. 2-9 Structure for Brake of Countershaft

The brake of countershaft is a kind of brake control device. The control air valve is installed in the control handle and controlled by hands; or it is installed at the bottom of the clutch pedal, step the pedal to the bottom to connect the pneumatic lines during driving process, the compressed air push the brake piston to the tooth top of power take-off gear of auxiliary shaft (countershaft), rapidly reducing the speed of the driven parts of countershaft, main shaft gear and clutch.

The brake of countershaft is applied in the transmission system of push clutch. When the vehicle is initially started, the transmission is in the neutral position, main shaft gear, countershaft and the transmission parts of clutch are rotated together with the engine, but the main shaft does not rotate. When the shift is engaged for starting, firstly separate the clutch, then connect the pneumatic lines of the brake of countershaft, rapidly reducing the speed of driven parts of clutch, and its connected shaft one, gear of countershaft and main shaft gear, so that the vehicles can be rapidly and stably engaged for starting. The brake of countershaft is only applied in the starting phase.

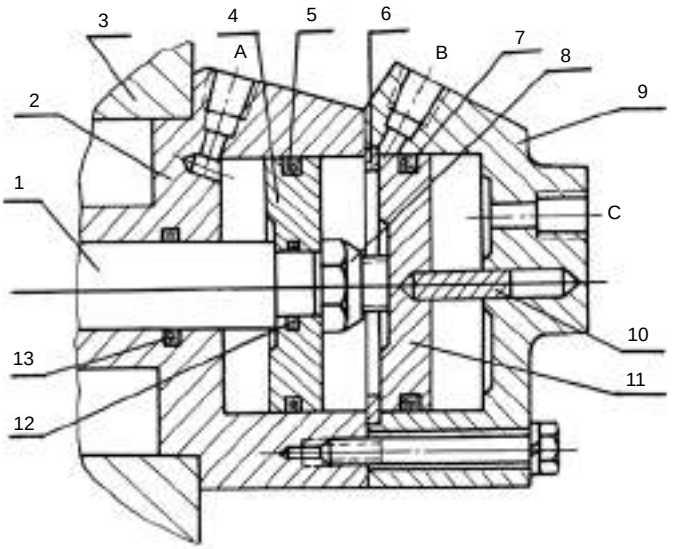
►Power Take-off Mechanism

In order to accommodate some requirements of special vehicles, the bottom power take-off can be installed in the power take off window of left bottom of main transmission housing of Shanxi FAST transmission, which takes the force from the power take-off gear located between the transmission gear

of countershaft and three speed gear. The force can also be taken from the lengthened countershaft of auxiliary transmission in the rear end of transmission, which is named “rear power take-off”. At present, this kind of power take-off is quite common.

In the application of “rear power take-off”, the power take-off is not connected to the inner chamber of the transmission, so the additional lubrication oil shall be applied. Meanwhile, in order to realize the power take-off by parking, the auxiliary transmission shall be engaged in the neutral position. To solve this problem, it is required to take off the cylinder cover of scope shift of transmission, and install one neutral position cylinder. i.e. 2-10 is the cylinder structure of neutral position, the illustrated position is in the neutral gear.

In Fig. 2-10, holes A and B are connected to the low gear and high gear air pipes of transmission respectively and connected to double H air valve of the transmission, the air pressure is 0.41~0.44bar. Hole C is the inlet of compressed air when the transmission is in the neutral (middle) position, the air pressure is 0.7~0.8bar, when the vehicle is parked for power take-off, firstly push the control handle of the transmission to the low gear area, making the cylinder piston 4 in the scope gear pressed to the positioning ring 6 tightly, then operate the cylinder control valve at idle location to introduce the compressed air with the pressure value of 0.7~0.8bar from hole C to the cylinder 9 in the neutral gear location. Since there is a pressure difference, the cylinder piston 11 at the neutral position is moved left side until it is stopped at the top positioning ring 6, so that the cylinder piston 4 of the transmission in the scope gear is located in the neutral position.



1. Shifting yoke shaft in scope gear
2. Cylinder in scope gear
3. Rear cover housing
4. Cylinder piston in scope gear
5. O type sealing ring
6. Positioning ring
7. O type sealing ring
8. Hexagonal nylon lock nut
9. Cylinder in neutral gear
10. Guide pin
11. Cylinder in neutral gear
12. O type sealing ring
13. O type sealing ring.

Fig. 2-10: Structure of Cylinder in Neutral Shift

When the power take-off of parking is not applied, it is only needed to introduce the compressed airs of the cylinder in the neutral position to the airs.

Operation Requirements and Cautions for Shanxi FAST Twin Countershaft 9–Speed Transmission

►Operation Requirements

Properly and reasonably operating the transmission and regularly performing the maintenance are very important to ensure the safe running and extend the life of transmission. Please comply with the following operating requirements:

1. Brand of Lubrication Oils

Good quality lubrication oils shall be filled in the transmission. It is recommended to use No. 18 fractional phenolic hyperbola gear oils or 85W/90 vehicle gear oils produced by Lanzhou oil refinery plant.

2. Proper Oil Level

Ensure that the oil level is flushed with the pouring orifice (the height of oil level is checked from the conical oil filler hole on the side of housing, when the overflow is appeared in the places of oil filler hole, the oil filling is completed). The oil filling amount is about 13 kg.

3. Operation Temperature

The temperature of transmission shall not exceed 120℃ during continuous working period. When the operation temperature exceeds 120℃, the lubrication oils can be decomposed and service life of transmission will be reduced.

Any of the following conditions can cause the operation temperature of the transmission above 120℃.

a. Continuously operating under the conditions of the running speed less than 32km/h.

b. High speed of engine.

c. High ambient temperature.

d. The vortex surrounds the transmission.

e. The exhaust system is too close to the transmission.

f. Rotating at over speed and big power.

It is required to frequently change oils at high operation temperature. In case of the above conditions, the cooling elements can be applied to maintain the operation temperature of the transmission below 120℃.

4. Period of Oil change

The lubrication oil shall be changed when the new transmission runs at 2000~5000 km.

The height and leakage conditions of the oil levels for the lubrication oil shall be checked while running every 10000 km, and the oils shall be duly filled.

The lubrication oil shall be changed while running every 50000 km.

5. Inclination Angle of Operation

When the operation inclination angle of transmission exceeds 12° , the lubrication is possibly not ample. The inclination angle of operation equals the installation angle plus the slope angle on the chassis of the transmission. If this angle exceeds 12° , the lubrication oil pump or cooling device shall be installed in

the transmission, so as to ensure good lubrication.

6. Towing or Sliding

It is required that the countershaft and main shaft gear continually rotate during the operation of transmission, so as to provide the ample lubrication oil for the transmission, however, when the vehicle is towed on the condition that the rear wheels touch the ground and the transmission system is connected, the above gears do not rotate, but the main shaft is driven by the rear wheels and rotates at high speed. The friction produced among the spline shims on the main shaft, the shortage of lubrication and big difference of rotation speed will cause the serious damages in the transmission.

The sliding of the transmission at the neutral gear can cause the same adverse results. To prevent from such kind of damage, the towing or sliding of the vehicle is prohibited at the conditions of neutral gear.
When the vehicle is required to be towed, the half axle can be drawn out or the transmission shaft can be disconnected, and the drive wheel can also be towed off the ground.

►Precautions

1. The shift control mechanism of the main transmission is the manual mechanical operation. The shifting mechanism of the auxiliary transmission is pneumatic operation, which is automatically completed by the mechanical control of the shifting mechanism for the main transmission, the air pressure of shifting is 4.1~4.4bar.

2. There are two neutral positions of high gear and low gear for the gear shifting lever. The neutral gear of the high speed area is between 5~6 speed, the neutral gear of the low speed area is between 3~4 speed. When the gear shift lever is moved from the low speed area to the high speed area (or from the high speed area to the low speed area), use a certain manual power to overcome the self-locking force between the internal gears of the transmission. When the vehicle is parked, the gear shift lever is located at the neutral positions of low speed area.

3. When the vehicle is at the low speed (creeping gear) or reverse gear, firstly the vehicle shall be parked, and then the gear shall be engaged, so as to prevent from damaging the internal parts of the transmission. When the reverse gear is engaged, a bigger manual force shall be applied to overcome the resistance of the reverse shift lock.

4. The clutch shall be completely separated when the lever is changed from speed 4 to speed 5 (or from speed 5 to speed 4), and when the gear shift lever is passed the neutral gear of the high speed area (or neutral gear of the low speed area), it is stopped for a moment (1~2 seconds) consciously, so that the auxiliary transmission can complete the changes from the high speed area to the low speed area.

5. When the transmission is shifted from the low gear area to the high gear area (or the opposite), do not skip the gear to operate. Otherwise, it will influence the service life of the synchronizer of auxiliary transmission.

6. It's not allowed to use the brake of countershaft while changing the gear during running process.

7. When the vehicle goes down the slope, do not change the high gear area and the low gear area, so as to prevent from the early abrasion of the friction cone of the synchronizer of auxiliary transmission.

8. Apply speed 1 or speed 2 to start the vehicle according to the road conditions.

9. Before the vehicle is started, firstly, the parking brake shall be released. After the brake valve is connected, the vehicle applying the air brake can be engaged for starting when the air pressure is lifted to the pressure value required by releasing the brake.

10. If any abnormal phenomenon, such as abnormal noises or obvious heavy operation, is found during the operation of the transmission, the vehicle shall be stopped for inspection immediately, after the troubles are eliminated, the vehicle can run continuously.

Main Property Parameters and Data Table Graph for Shanxi FAST Twin Countershaft 12–Speed Transmission

►Main Property Parameters for 12-Speed Serial Transmission

Model of Transmission	12JS160T(A)
Rated input power	285
Rated input torque N.m	1600
Maximum input rotation speed rpm	2600

Model	Low speed ratio						High speed ratio						Reverse gear	
	1	2	3	4	5	6	7	8	9	10	11	12	Reverse 1	Reverse 2
12JS160T	15.53	12.08	9.39	7.33	5.37	4046	3.48	2.71	2.10	1.64	1.28	1.00	14.86	3.33

Note:

1. The weight includes clutch housing, however, does not include lubrication oil and clutch separation device.
2. The total length means from the front flange face of the clutch housing to the rear flange face of output flange.

12JS160T (A)(weight:350kg oil filling amounts:14.5L total length:968.5mm)

Typical Structure for Shanxi FAST Twin Countershaft 12–Speed Transmission

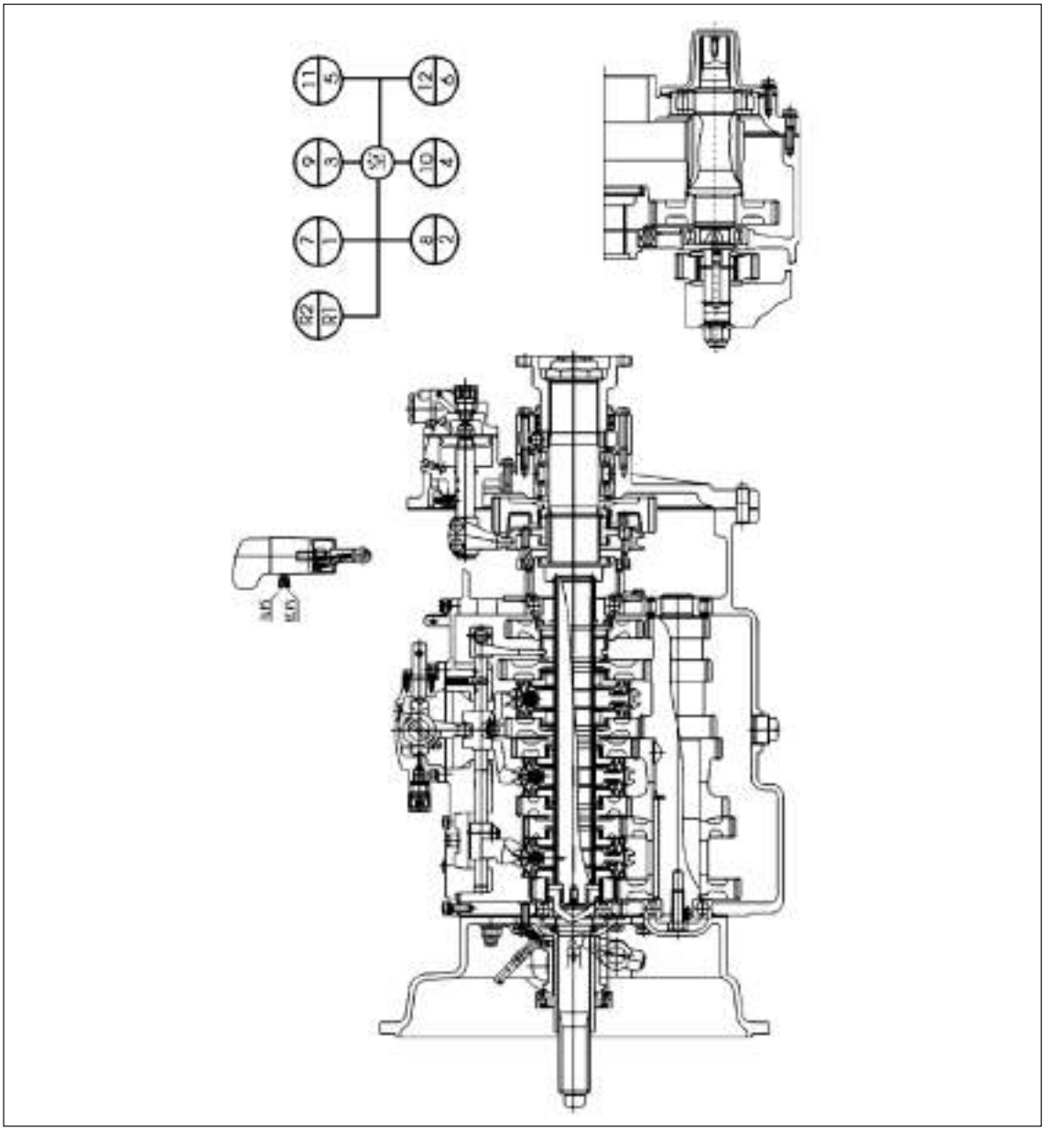


Fig. 5-1: Main Section Drawing for 12-Speed Serial Transmission Assembly

12-speed all synchromesh serial transmission is the integral structure of main transmission and auxiliary transmission housing, which applies the sectional type, i.e. scope gear type. The main transmission has 6 forward gears, and the auxiliary transmission has 2 gears, composing 12 forward gears and 2 reverse gears in total. Power transferring routes

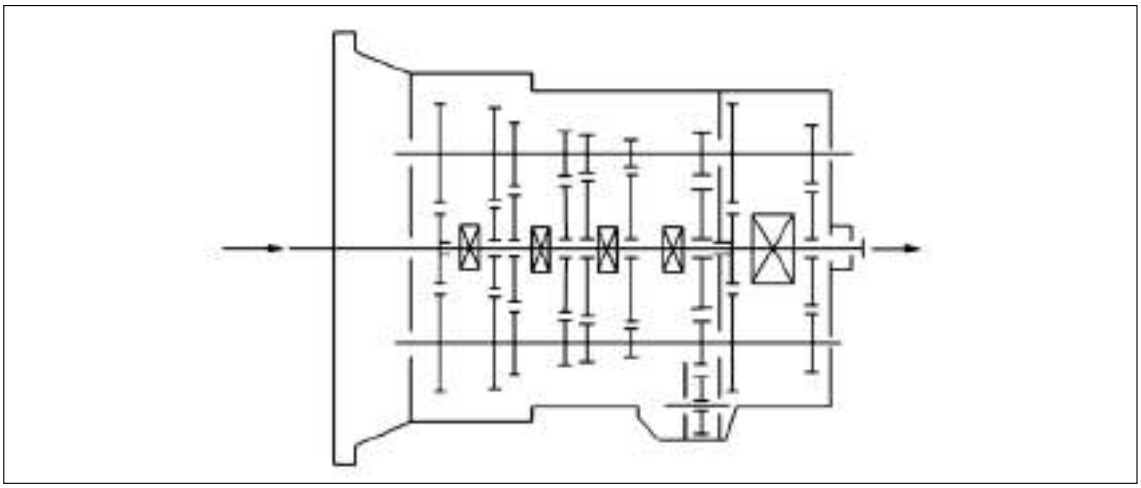


Fig. 5-2: Structure Layout

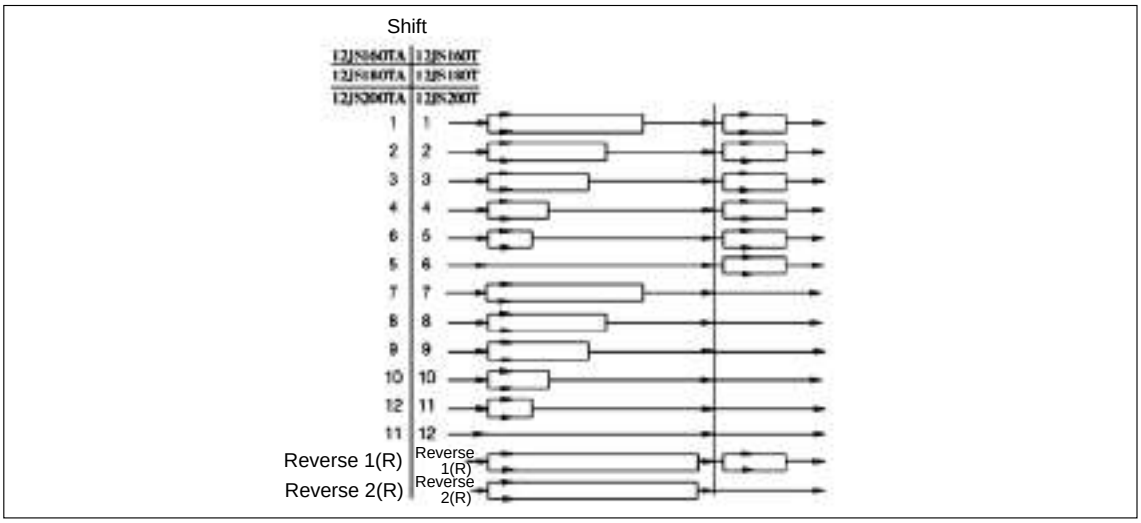


Fig. 5-3: Power Transferring Routes

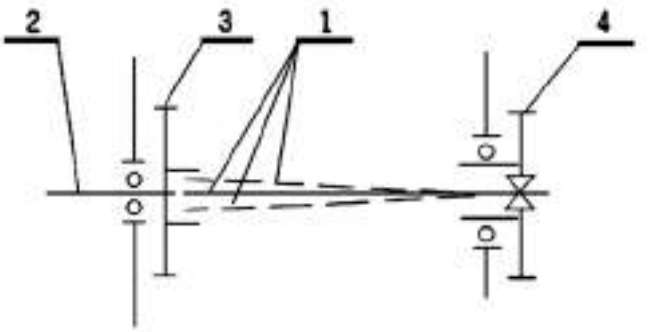
Twin Countershaft Structure

The main transmission and auxiliary transmission of 12-speed all synchromesh serial transmission apply the completely identical structure of countershaft, the included angle is 180°. The power inputted from the input shaft is distributed to two countershafts, and then collected to the main shaft for output, so is the auxiliary transmission.

Theoretically, each countershaft only transfers 1/2 torque, so applying Twin Countershaft can reduce the center distance of transmission, the width of gear, the axial dimension and the mass. After applying Twin Countershaft, each speed gear on the main shaft shall be meshed with gears of two countershafts simultaneously.

In order to ensure the proper meshing and make the loads evenly distributed as possible, the main shaft gear shows the radial floating state on the main shaft, and the main shaft applies hinge type floating structure. Refer to Fig. 5-4. The journal of main shaft is inserted into the hole of input shaft. The oily

guide bushing is pressed into the hole. There is enough radial clearance between the journal of main shaft and the guide bushing. The rear end of main shaft is inserted into the hole of driving gear of auxiliary transmission by involute spline. The journal of auxiliary transmission driving gear is supported in the ball bearing.



1. main shaft 2.input shaft 3.gear of input shaft 4. driving gear of auxiliary transmission

Fig. 5-4: Floating Structure Scheme of Main Shaft

Since each speed gear of main shaft is floated on the main shaft, the traditional needle bearing is cancelled, resulted in a much more simple and reasonable structure of main shaft assembly. During operation, two gears of countershaft apply the same radial force on the gear of main shaft, their direction is opposite, and mutually cancelled, causing the main shaft only bearing the torque, not bending moments, improving the force application state for main shaft and bearing, and greatly improving the operation reliability and durability of transmission.

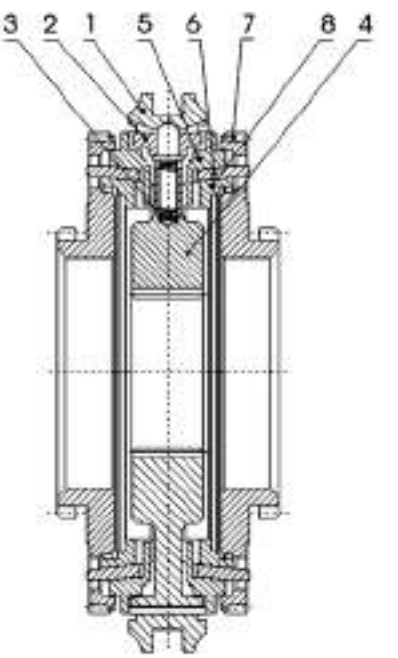


Fig. 5-5 Assembly of Double Conical Surface Synchronizer of Main Transmission

Double conical surface lock ring synchronizer is installed in the main transmission. The attached drawing 5-5 is the axial main sectional structure.
Since the lock ring synchronizer has the compact structure, good property, reliable application and low costs, it has been widely applied presently. Its disadvantage is the small friction torque of synchronizer. Double conical surface lock ring synchronizer is a newly developed and designed synchronizer based on the basically similar operation principle and structural arrangement to that of the lock ring synchronizer, it applies the advantages of the lock ring synchronizer and compensates its disadvantages in improving the friction torque of synchronizer.

Fig. 5-5 is 5-6 speed synchronizer, 5 speed and 6 speed are both double conical surface, its gear sleeve, gear hub, slide block, spring of the synchronizer are commonly applied by both 5 speed and 6 speed, and both gears have three（5、6、8）conical parts, 6 single key in the outer cone of the synchronizer（5）are connected with 6 key groove in the inner cone of the synchronizer（8）, therefore, outer cone（5）and inner cone（8）are rotated together with the shaft 2 of synchronizer, however, 6 stings on the synchronized cone（6）are integrated to 6 holes in the binding ring（7）, therefore, cone（6）is rotated together with 5speed gear, the result is that when the transmission is shifted from 4 speed to 5 speed or from 6 speed to 5 speed, 5 speed gear produces the relative angular speed difference with shaft 2, at this time, two pairs of slide friction conical surfaces starts to work in 5 speed synchronizer conical structure, therefore, based on the same general dimension, the synchronized friction torque produced on the friction cone by the axial push force applied on the gear sleeve of synchronizer equals to the sum of friction torques applied between two pairs of cone, i.e. the synchronized friction torque produced in 5 speed is about two times of single cone synchronizer, so as to reduce the shifting force by about 50%.

Operation Requirements and Precautions for Shanxi FAST Twin Countershaft 12–Speed Transmission

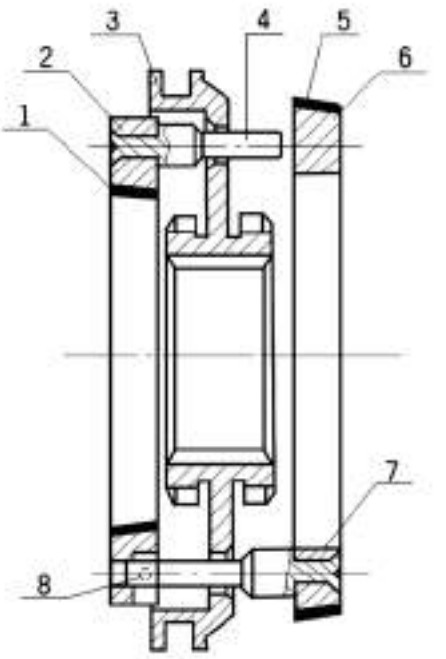
During the vehicle's running process, after the driver pushes the shifts in the neutral position, each part of the transmission is in the illustrated location of the attached drawing 5-2. At this time, the power is transferred to shaft one from engine and clutch, and then transferred to the gear of shaft one by involute spline, the gears of shaft one are meshed with the transmission gears of the countershaft, the power is transferred to the countershaft. Since each speed gear of the countershaft is connected with the countershaft, they rotate together. Each speed gear of the countershaft drives each speed gear on the shaft two to rotate together, since each synchronizer is in the neutral gear location, each speed gear of shaft two is also in the idle rotation state and no power is outputted from shaft two.

When the driver wants to engage 5 speed, operate the control lever in the driver's cab, move the shifting fork of gear five and six to the right side by the transmission mechanism of the shift lever, the shifting fork end pushes the synchronized gear sleeve shaft to move axially, at this time, two pairs of slide friction cones start to work in the synchronizer cone of gear 5, when the relative angular speed between 5 speed gear and shaft two is about zero, the inner spline in the slide sleeve of synchronizer is meshed with the outer spline of 5 speed gear lightly, thus, the whole shift engaging process is completed smoothly. After the power is inputted by shaft one through engine and clutch, it is transferred to the gear of shaft one by spline, and then transferred to the symmetrically arranged transmission gear of countershaft, transferred

to 5 speed gear of shaft two by two symmetrically arranged 5 speed gears of countershaft, and finally transferred to the synchronized gear sleeve, shaft two by the spline meshing. Subsequently, the power is transferred to the driving gears of auxiliary transmission and inputted into the auxiliary transmission. Finally, it is outputted by the output flange of the auxiliary transmission.

The lock pin inertial synchronizer is installed in the auxiliary transmission (Refer to Fig. 5-6). It is controlled by the shifting cylinder 2 of auxiliary transmission, which is only operated when the high speed area is shifted to the low speed area, or the high speed area is shifted to the low speed area. Three lock pins 4 and 7 are pivoted on high gear synchronizer 2 and low gear conical ring 6 respectively; the slide gear sleeve 3 is integrated with the main shaft (output shaft) of auxiliary transmission by spline.

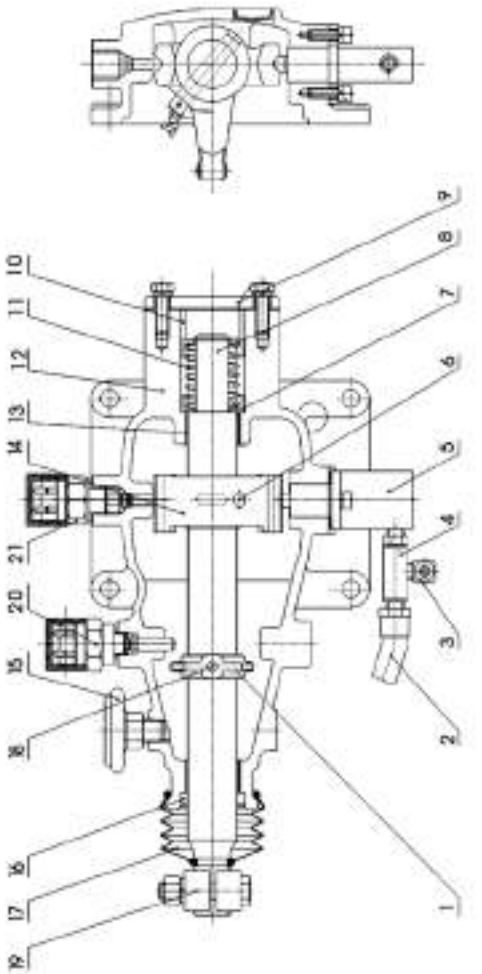
The basis of high gear synchronizing ring and low gear conical ring is sintered and forged by the iron base powder metallurgy. The inner conical face of the high gear synchronizing ring and the outer conical face of the low gear conical ring are adhered by non-metal materials with high friction property. The corresponding outer conical face and inner conical face are available in the driving gear and the reduction gear of the auxiliary transmission respectively.



1. High gear friction band
2. High gear synchronizing ring
3. Sliding gear sleeve
4. High gear lock pin
5. Low gear friction band
6. Low gear conical ring
7. Low gear lock pin
8. Spring

Fig. 5-6: Synchronizer Assembly of Auxiliary Transmission

Refer to Fig. 5-7. It is mainly composed of control device housing, outer shifting arm, lateral shifting lever, reverse gear switch control block, shifting fork head, compressed spring, air lock or the indicator switch, starting pin and etc. Its function is to complete the gear selection and gear releasing and engaging for the transmission.



1. Low reverse gear switch control block
2. Air pipes assembly
3. 90° Quick change joints
4. Three-way pipe joint
5. Air line control valve
6. Cylindrical pin
7. Spring seat
8. Lateral shifting lever
9. Side plate
10. Limit sleeve
11. Compressed spring
12. Housing of driving device
13. Bushing of lateral shifting lever
14. Fork head
15. Air plug
16. Oil seals
17. Sleeve
18. Elastic cylindrical pin
19. LRC outer shifting arm
20. Reverse switch
21. Neutral switch

Fig. 5-7 Simplified Drawing of Single H Driving Device

Outer shifting arm, reverse switch control block, shifting fork head, spring seat, spring and clip ring are assembled in the lateral shifting lever. Operate the outer shifting arm to perform the lateral movement and rotation of the lateral shifting lever for shift selection, shift releasing and shift engaging. One sector boss is available on both sides of the shifting fork head. The groove is opened on the boss to control the indicator switch of the neutral gear and the control valve of pneumatic lines. The indicator switch of the reverse gear is controlled by the movement and the rotation of the reverse gear switch control block.

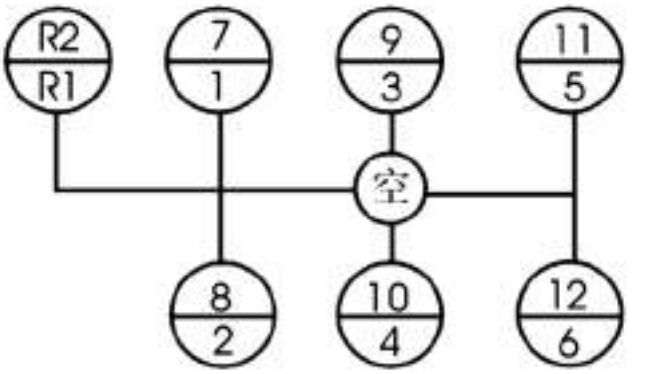
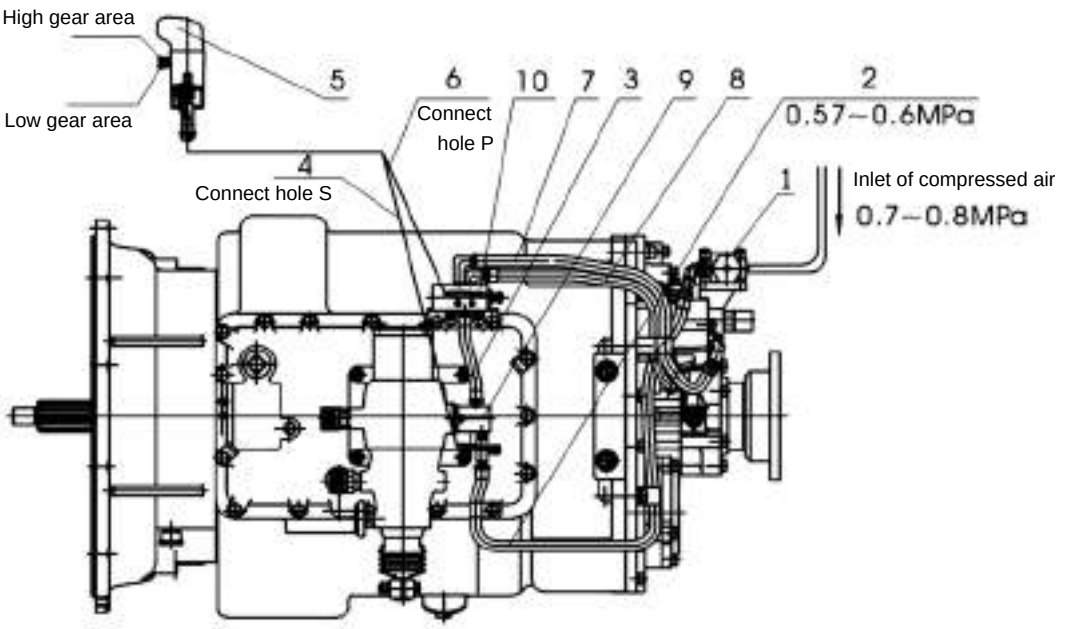


Fig. 5-8: Location chart of the control handball gear

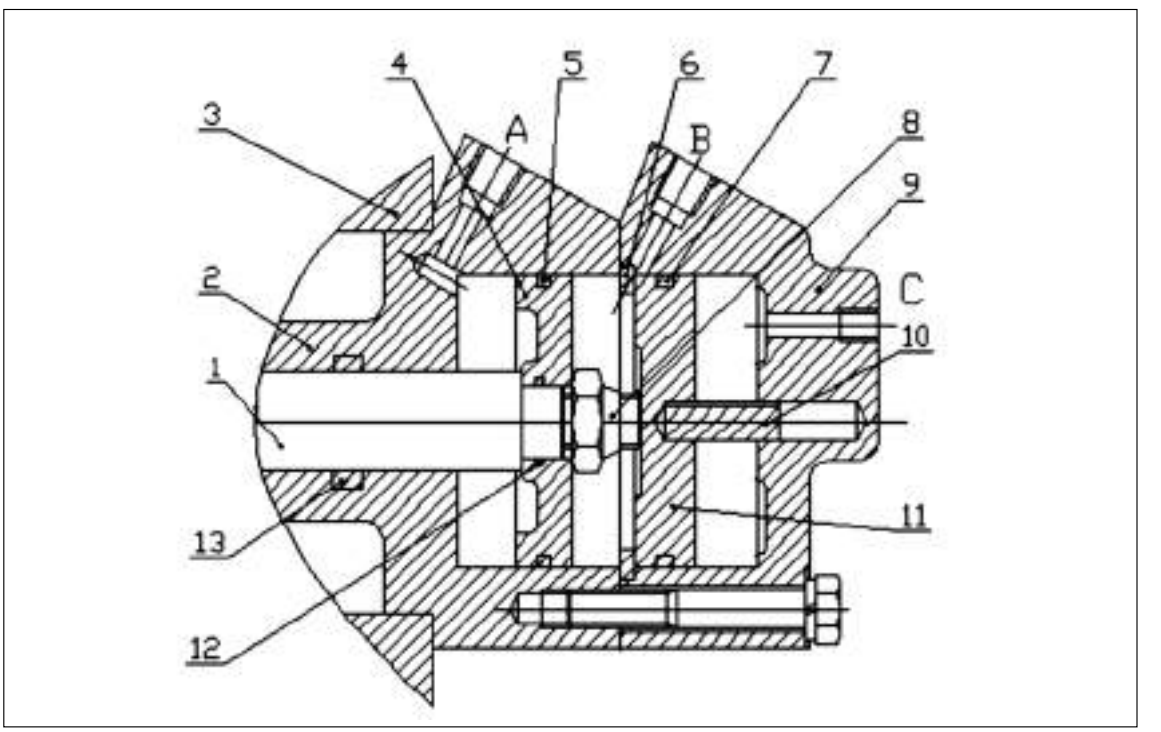
The basic control mechanism of 12-speed all synchromesh serial transmission is long distance control mechanism with compact structure, clear gear location and good shifting feels. R1, 2, 3, 4, 5 and 6 gears are in the low speed area, R2, 7, 8, 9, 10, 11, 12 gears are in the high speed area, the neutral gear location in the low gear area is in gears 3 and 4, the neutral gear location in the high gear area is in gears 9 and 10.(refer to Fig.5-8）



1. Regulator of air filter
2. Main air pipes
3. Transitional air pipes
4. Control inlet pipes
5. Shifting handle
6. Control outlet pipes
7. High gear air pipes
8. Low gear air pipes
9. Air pipe control valves
10. Single H valve

Fig. 5-9 Pneumatic pipe Diagram for Shifting Mechanism

After the compressed airs of 0.7~0.8MPa from the whole vehicle are regulated to 0.57~0.6MPa by the regulator of air filter, they are introduced into main air pipe 2 and control inlet pipe 4. When the main transmission is in the neutral position, the air pipe control valve 9 is opened, and then the compressed airs are introduced into the directional valve of air pipes 10, if there are airs in the control outlet pipes, the compressed airs introducing the single H valve can enter into the cylinder of the auxiliary transmission by the low gear air pipes, so as to realize the low gear; if there are no airs, the compressed airs can be introduced into the cylinder by the high gear air pipes, realizing high gear. Whether any airs are available in the control outlet pipe 6 is related to the location of the high gear and low gear conversion fork head in the driving handles. When the fork head is in the high position, no air in the control outlet pipes can realize the high gear. Contrarily, it is in the low gear. When the main transmission is in the shift engaging position, the air line control valve is opened, and the compressed airs can not be introduced into the directional valve of air line to realize the conversion of high gear and low gear, which means that the conversion of high gear and low gear can only be realized when the main transmission is in the neutral position (Refer to Fig. 5-10)



1. Declutch shifter fork shaft in scope gear
2. Cylinder in scope gear
3. Rear cover housing
4. Cylinder piston in scope gear
5. O type sealing ring
6. Positioning ring
7. O type sealing ring
8. Hexagonal nylon lock nut
9. Cylinder in neutral gear
10. Guide pin
11. Piston in neutral gear
12. O type sealing ring
13. O type sealing ring.

Common Failures and Troubleshooting for Shanxi FAST Twin Countershaft Transmission

►Throw-out of gear of Transmission (Gear Falling)

1. Throw-out of gear of Main Transmission

When the coupling gear seats (sliding sleeve of shaft two) are moved to mesh with the main shaft gears, the meshed gears shall be parallel. If the coupling gears have taper angel or they have been worn, the separation trend exists during rotation process, which can cause the throw-out of gear under a certain condition.

Reasons of throw-out of gear

①The transmission input shaft is not aligned to the guide bearing of the flywheel of the engine;

②The gears are greatly collided in shifting process, causing the surface of the coupling gears abrasion;

③The coupling gears are ground in cone type;

④The pressure of the positioning steel ball of the shifter fork is not enough due to the weaken or damaged of lock spring;

⑤Over-wear of positioning groove of the shift shaft.

⑥The improper adjustment of connecting rod for long distance shifting control mechanism make the coupling gear cannot be meshed with the slide sleeve along the whole length.

⑦The throw-out of gear often appears in deceleration process, when the vehicle is towed at full power or pushed with the load.

⑧When the vehicle runs on the rough road, too long and too heavy shift lever can be swirled like the clock pendulum. The swirling of the shift lever can overcome the pressure of the lock springs, resulted in gear falling.

2. Throw-out of gear of auxiliary transmission

The throw-out of gear for the auxiliary transmission can be caused by the coupling gear wear, taper or the meshing along non-full length of the driving gear of auxiliary transmission and synchronizer sliding sleeves.

These defects are caused by the normal abrasion of the shift collision and long-term usage.

The vibration caused by the improper installation of transmission shaft and the insufficient air pressures in the airline system can also cause the throw-out of gear.

►Difficult Gear Shifting

When the transmission is shifted, the required forces for shift changing are different. However, if the shifting force is too big, it is not normal.

Most of the difficult shifting appears in the long distance control device applied in the flat head vehicle; therefore, while inspecting the reasons for the difficult transmission shifting, it is required to check the connecting rod of the long distance control device first. The problems in the connecting rods are caused

by the wear, occlusion, improper adjustment of the connecting fork or the bushing, or free motion of the lever prohibited by the mechanical obstacles.

In order to determine whether the difficult shifting is caused by the transmission, it is required to remove the shift lever or the connecting rod from the transmission, and then apply the lever or the screw driver to move the shifting guide to make it mesh in each gear. If the fork shaft can be slid lightly, it indicates that the failures exist outside the transmission. Otherwise, the failures are inside the transmission.

The inside failures are generally caused by the following factors:

1. The spline of slide sleeve of shaft two is coupled on the main shaft, which is caused by twisting of main shaft, bending of shift fork or the bending of spline of main shaft.

2. Fork shaft is coupled on the upper cover housing, which is caused by the bending of the fork shaft and the surface stumbling of the fork shaft due to housing cracked and too big tightening torque of lock screw on the shifting shaft.

3. Loosened lock screw on the shifting shaft.

The outside failures are generally caused by the following factors:

1. A certain place of the shifting control mechanism is loosened. Because of the frequent operation of selecting or shifting gear, a certain place of loosened bolts may be possibly caused, resulted in the difficult shifting, the detailed failure eliminating proposals are as follows:

● Lifting the driver's cab to inspect whether the bolts on two control levers at the bottom of the driver' s cab are loosened; 2) Inspecting whether the balls on the control lever connected to the shifting relay rocker arm in the front of driver's cab are loosened; 3) Inspecting whether the bolts on the rocker arm II for selecting gear and rocker arm II for shifting assembled on the frame surface are loosened; 4) Inspecting whether the ball ends of the control levers connected to the rocker arm II for selecting gear and rocker arm II for shifting are loosened; 5) Inspecting whether the rocker arm III for selecting gear and rocker arm III for shifting in the transmission are loosened. If any loosened bolts or nuts are found, please retighten them.

2. A certain part of shifting control mechanism is worn. Because of the frequent operation of selecting or changing gear, a certain place of serious abrasion for the shifting control mechanism may be possibly caused, resulted in the difficult gear shifting, the specific failure eliminating proposals are as follows:

● Lifting the driver's cab, dismantling all shifting control levers to inspect whether the ball ends on all control levers are seriously worn, resulted in difficult rotation, which have to be changed; 2) Starting from the shifting control lever in the driver's cab, inspecting whether the relay rocker arm for the shifting selection and change, rocker arm II for shifting selection and rocker arm II for shifting are seriously worn, resulted in the difficult rotation. If the wear is serious, the corresponding parts can be changed;

3. Occurrence of the interference phenomenon. This situation rarely appears. The driver performs the shift selection and change operation orderly and slowly by sitting in the driver's cab after the engine is ignited off, a person at the bottom of vehicle starts from the shifting control lever at the bottom of the driver's cab to carefully inspect whether any interference phenomena are produced in the rotation process of the actuated rocker arm for the shifting selection and change, rocker arm II for shifting selection, rocker arm II for shifting, rocker arm III for shifting selection and rocker arm III for shifting and all control levels. If any interference phenomena are found, adjust and release them.

►Overheat of Transmission

The long-term operation temperature of the transmission shall not exceed 120℃. If such temperature is exceeded, the lubrication oils can deteriorate, the service life of the transmission can be influenced.

Due to the friction of the moving parts, the transmission will produce a certain amount of heat. The normal operation temperature is about 38℃ higher than the ambient temperature. The heat can be radiated out through transmission housing. If the heat radiation is not normal, the over heat can be caused.

Prior to looking for the causes of overheat, the oil temperature meter and oil temperature sensor shall be inspected, so as to ensure the proper readings on the oil temperature meter. Overheat is generally caused by the following factors:

1. Improper lubrication. Too low or high oil levels, incorrect oil brand, or the operation angle of the transmission exceeds 12° .
2. The running speed is generally below 32km/h.
3. Over high rotation speed of engine.
4. Since the transmission is enclosed in the frame, floor, fuel tank and installed between the big bumper assembly, resulted in the blocked air flow surrounding the transmission.
5. The exhaust system of engine is too close to the transmission.
6. Over high ambient temperature.
7. Over load and over speed running.

►Big Noises of Transmission

When the transmission is in the normal condition, a certain noises exist. However, if the noises are too big or abnormal, such as the roaring noises, screaming noises and etc., it indicates that a certain problem is there. These noises are possibly caused by the transmission itself or produced by the noises on other positions of the vehicles transferred to the transmission and enlarged by it.

● Noises of Transmission

1. Knocking noises

①It is caused by the stumbling of the gear surface of the inner gear of transmission, which can be distinguished by the bright points appeared after the gear surface are greatly pressed and ground. Generally speaking, when the gears bear the load, such noises are much more significant. Therefore, when the noises are produced by engaging one certain shift, which indicates that the gear in this gear

position has problem. Such stumbling can be ground by oilstones or manual sand wheel.

②If the bowls or rollers are damaged in the bearings, the raceway produces pitting and peeling, resulted in noises in each gear of low rotation.

③If cracks appear in the gears after the gears bear the impact loads or in the assembling process, the knocking noises will be produced at low speed, and the screaming noises will be produced at high speed.

2. Screaming noises

①Caused by the normal abrasion of gears, including pitting appeared after long-term application, the screaming noises before the damages.

②Caused by improper gear meshing, which can be distinguished by the non-uniform abrasion of gear surface.

③ After the bearings are pre-tightened, over small axial and radial clearance can also produce screaming noises.

3. Roaring noises

Caused by the errors of "matching gears". The "matching gears" is not correct when the transmission is reassembled, or the improper "matching gears" caused by the rotation of gear on auxiliary shaft can also produce roaring noises.

4. Chugging noises

The axial clearance between bearing for auxiliary shaft and the main shaft is too big. When the torque changes the direction, the chugging noises can be produced. Over big radial clearance of the bearings for auxiliary shaft can cause big center distance of shaft, making the load apply on the tooth crest, this condition can possibly cause the breakage of gears.

Noises caused by other parts of vehicle.

1. The rotation is imbalanced at the idle speed of engine;
2. Operation noises of engine;
3. The springs or rubber blocks for the driven discs of the clutch are broken due to wear, losing the vibration damping function;
4. Imbalance of transmission shaft;
5. Operation angles of universal joints are not equal;
6. Wear of cross shaft of universal joints;
7. The propeller shaft center supporting bearings are loosened or worn;
8. The gear surfaces of driving axles concave angle gear are worn or have pitting, the gears of rear axle are damaged;
9. The wheels are not balanceable;
10. The shackle bearings of leaf springs are worn;
11. Saddle clamp bolts become loose;
12. Brake hubs are wrapped or not balanced.

►Damage of Gears

1. Damage of Coupling Tooth for Gears

Damage of the coupling gears caused by the knocking of gears in the shifting process is a common failure easily produced in the transmission without synchronizers. Damage caused by the slight knocking is not big. The serious damage is due to the fierce knocking caused by the coupling gears before reaching the synchronization. Such condition can possibly cause the material peelings of the coupling gears.
The following factors can cause the damage of coupling teeth:

① Improper shifting operation. The drivers are not familiar with each gear location, or do not understand the variation scope of rotation speed for engine among each gear.
② When the vehicle starts in gear one or reverse gear, the insufficient declutching clearance or incomplete declutching of clutch may produce knocking.

2. Damage of Gears

① Normal abrasion
Since the relative sliding happens in the gear meshing process, the gears can wear down. Such normal wear is stable and slow. However, such worse operation conditions can speed up the wear of gear surface, reducing the service life of gears.

② Gear tooth breaking
Gear tooth breaking is a kind of serious damage type. The fractures of the gears usually will cause the serious damages of other parts.
The serious impact loads cause most of gear tooth breaking. The gear tooth broken after a short time operation under the heavy loads is called “impact breaking” or “brittle breaking”. The breaking happened after many operation cycles is called “fatigue breaking”.

③ Pitting and peeling
The pitting and peeling can be gradually produced after long term over load operation of gears. The incorrect brand of lubrication oils or unclean lubrication oils can also produce this kind of damage of gear tooth. If these gears can continually work, it will produce fatigue breaking.

④ Scratching and binding
Scratching and binding is caused by the direct contact between the metals of the meshed gears.
The relative sliding on the metal surface can produce high temperature, resulted in soft sided metal of gears. Such soft metal can produce binding during meshing process.
The inferior lubrication oils or temporally lacking lubrication oils mainly cause the scratching and binding.

►Twisting and Breaking of Shaft

When the torque or bending moment born on the transmission shaft is greater than the design value, the shaft will twist or break. The reasons of twisting and breaking are as follows:

1. The shifting method is not correct;
2. The starting gear of transmission is too high;
3. Fierce towing;
4. Attempt to start vehicles when the brake is not released;
5. The operation conditions of the transmission do not conform to the design stipulation;
6. The vehicle end is knocked with other things during reversing process;
7. Breaking due to fatigue or impact.

►Failures of Bearing

1. Fatigue

The characteristics of bearing fatigue is the peeling of bearing raceway or bearing rollers, the surfaces of the peeled bearing raceways or bearing rollers are coarse, resulting in noises and vibration. When the bearings reach their expected life during normal load and operation conditions, the normal fatigue damage will occur.

After the inner bearing hole in the transmission is refitted, if the dimension of the bearing hole is too small or out of round, the early fatigue damage will be produced. After the housing hole is bored in deflection, it can cause the installation errors of shaft, and also cause the early fatigue damage of bearing.

2. Poor Lubrication

The characteristics of bearing damage caused by the poor lubrication are:
Discoloration and raceway peeling of bearing parts. It can possibly cause the retainer damaged. The reasons of bearing damage are not only too low height of oil levels, but also possibly the impurities contained in the lubrication oils, the mixture of improper quality and different brand of lubrication oils.

►Failure Analysis of Pneumatic System

The auxiliary Shanxi FAST Twin Countershaft 9-speed transmission is shifted by the operation of pressure regulating pneumatic system.
The pneumatic system includes the regulator of air filter, double H air valve, the shifter cylinder of auxiliary transmission and connection pipes.
The failure of pneumatic system may possibly cause the failure of shifting, creeping or the damage of transmission parts. The problems can be found and duly eliminated by grasping the work principle of pneumatic system and performing the simple inspection.

● Working Principle

Refer to Fig. 2-7
The regulator of air filter filters and regulates the compressed air which comes from air tank of the vehicle from 7~8bar to 4.1~4.4bar, imports it into the inlet 1 of input double H air valve, and outlet 2 and 4 of double H air valve are connected to the inlet of cylinder for high speed area and low speed area respectively. When the shift lever is operated in the low speed area, the route of compressed air is:

Compressed air $\xrightarrow{7\sim8bar}$ Air filter $\xrightarrow{Filtering}$ Double H air valve $\xrightarrow{outlet\ 4}$ Inlet of low speed area for auxiliary transmission shifting cylinder. Make the piston of cylinder tightly against the right end of cylinder. When the shift lever is operated in the high speed area, the work route of the compressed air is:
Compressed air $\xrightarrow{7\sim8bar}$ Air filter $\xrightarrow{Filtering}$
Double H air valve $\xrightarrow{outlet\ 4}$ Inlet of high speed area for auxiliary transmission shifting cylinder. Make the piston of cylinder tightly against the left end of cylinder.

When the shift lever is changed from the low speed area to the high speed area or from the high speed area to the low speed area, the residual air in the cylinder can be discharged to the atmosphere from the outlet 3 or outlet 5 of double H air valve through the connecting air pipes.

● Inspection of Failure of Pneumatic System

1. The inspection of the pneumatic system shall be performed when the engine is stopped and the air pressure of the vehicle is at the maximum nominal value.
2. Inspect whether the installation of each pneumatic pipe is correct, whether any crosses exist.
3. Inspect whether the joints of all air pipes have any leakage.
4. Inspect whether any cracks are available in the air pipes, whether they are clamped by other members, influencing the passage of airflows.

● Inspection of Regulator of Air Filter

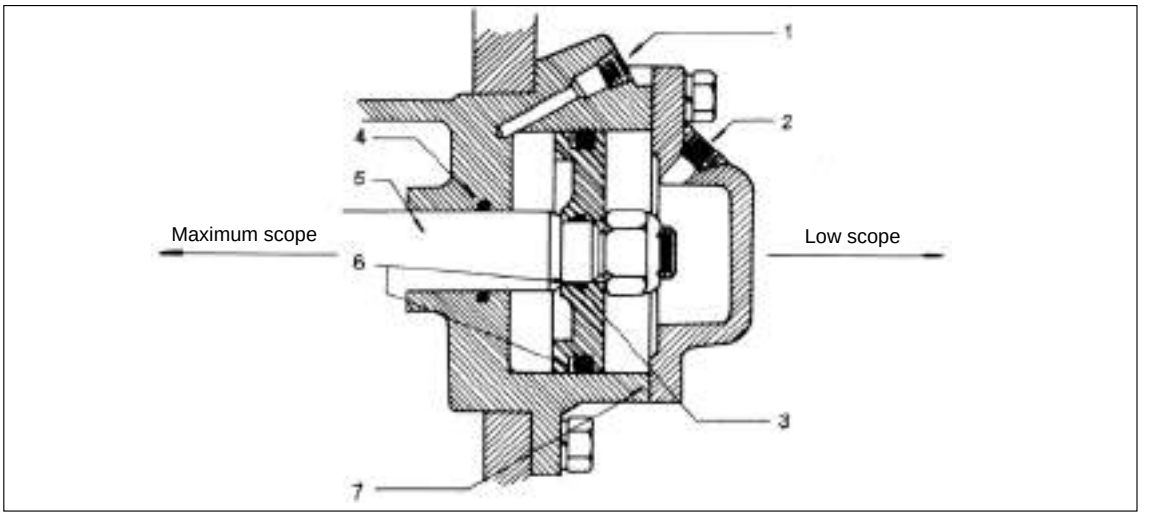
1. Whether the parts have any defects, leakage.
2. When the air pressure of the vehicle reaches 7~8bar, install one barometer in the outlet, observing whether the air pressure is regulated to 4.1~4.4bar, if the readings do not conform to the requirements, replace the regulator.

● Inspection of Double H Air Valve

1. Inspect whether there are any defects.
2. Inspect whether the reciprocating of the column pin is freely performed, whether any over big wear exists.
3. Inspect whether the compressed airs can be only flowed out from the outlet 4 after they are introduced, whether when the column pins are in the original location. When the column pin is returned to the lowest position because of the applied force, whether the compressed airs can be only flowed out from the outlet 2 after they are introduced. If so, the double H air valve can be applied, otherwise, it shall be changed.

● Inspection of Shifting Cylinder for Auxiliary Transmission

If the shifting problems still exist after performing the above inspection, it's possible that the defects of O type ring of the cylinder piston or other sealing parts. Refer to the below chart.



Failure Analysis

1. Air holes in low scope: reverse gear, low gear, and 1-4 gear.
2. Air holes in high scope: 5-8 gear.
3. Piston
4. The leakage of O ring prevents the shift from getting into the low scope gears and increases the voltage of the transmission.
5. Shifting fork bar
6. The leakage of O ring prevents the shift from getting into the low scope gears and high scope gears, which can also lead to the continuous leakage of valve breather device.
7. The gasket leakage can cause the high scope gears engaged slowly.

►Instructions of Failure Diagnosis

9-1 Basic Procedures of Failure Diagnosis for Transmission

(1) Initial Inspection

① Observe and inspect: collect the damage evidences, pay attention to the key parts, such as installation points, joints or support; inspect the pneumatic lines.

② Inquire the vehicle owner or the driver: collect the related documents, such as work conditions, failure histories, and etc.

③ Establish the related files: including maintenance and lubrication period, the appeared failure, ran mileage and time.

(2) Disassembly of transmission

① Save the oils and prepare for the inspection of the contents of impurities as necessary.

② During the disassembly process, inspect whether the parts are installed correctly, whether any parts are installed or not and any pinchbeck parts are used.

③ Clean and inspect each part carefully.

(3) Determine the failure types

(4) Determine the failure reasons and eliminate it.

►Instruction Table of Failure Diagnosis

Refer to the below table for the failures of transmission, possible reasons and elimination methods.

Failures	Possible Reasons	Elimination Methods
Throw-out of gear at high speed and low speed area for auxiliary transmission	1. Defects of pressure regulating valve	②
	2. Loosened hoses or joints	⑨
	3. Air pipes or joints are clamped flatly.	⑩
	4. The gears are influenced by shaft twisting, leaving the gear matching position.	② ④
	5. The coupling gears have taper.	②
Throw-out of gear or jump-out for main transmission	1. Shifter fork wears.	②
	2. Lock spring is weakened or omitted.	② ⑦
	3. The gears are influenced by shaft twisting, leaving the gear matching position.	② ④
	4. The coupling gears have taper.	②
	5. Sliding sleeve fork groove wears.	②
	6. The motion of the connecting rod is blocked.	⑩
	7. Improper adjustment of connecting rod.	⑥
	8. Damage of engine bearing	②
	9. The engine is not aligned to the transmission.	② ⑥
Slow gear changing or incapable of changing gear for high speed and low speed	1. Defects of pressure regulating valve.	
	2. Loosened hoses or joints.	②
	3. The hoses are clamped flatly.	⑨
	4. Plunger of double H air valves is blocked.	⑩
	5. O ring of shifting cylinder is damaged.	⑫ ⑬
	6. The nuts of cylinder piston are loosened.	⑫ ⑬ ②
	7. The cylinder piston has cracks.	⑨ ⑫
	8. Damage of the spring for synchronizer.	② ⑬
	9. Damage of synchronizer.	②
	10. No lubricants in O ring of cylinder.	②
	11. Excessive lubricants in O ring of cylinder.	⑬
Difficult gear changing or incapable of changing gear for main transmission	1. Bending of fork shaft.	② ③
	2. Burrs on fork shaft.	⑤
	3. Over hard of lock springs.	②
	4. Cracking of shifting mechanism.	②
	5. The gears are influenced by shaft twisting, leaving the gear matching position.	② ④
	6. Main shaft twisting.	②
	7. Not use clutch.	① ④
	8. Obstructed motion of connecting rod.	⑩
	9. Improper adjustment of clutch.	⑥
	10. Damage of engine support bearing.	② ④
Not able to be interlocked	1. The installation of interlocked steel balls is omitted.	②
	2. Interlock pin omitted.	②

Failures	Possible Reasons	Elimination Methods
Quacking noises occur when the shifting lever is operated.	1. Shifting fork wears.	②
	2. The gears are influenced by shaft twisting, leaving the gear matching position.	② ④
	3. Brake of countershaft does not work.	② ⑨ ⑧
	4. The motion of the connecting rod is blocked.	⑩
	5. Improper adjustment of connecting rod.	⑥
	6. Abrasion of inner bushing in the housing of the shifting mechanism.	②
	7. Improper adjustment of clutch.	②
Gears can not be changed.	1. The main shaft is twisted.	②
	2. The motion of the connecting rod is blocked.	⑩
	3. Improper adjustment of connecting rod.	⑥
Big noises.	1. The gears are influenced by shaft twisting, leaving the gear matching position.	② ④
	2. Gears have cracks or the gear teeth have burrs.	⑤ ②
	3. Over big tolerance of main shaft gears.	⑥
	4. The inner ring of front bearing in the countershaft for the auxiliary transmission is peeled off.	⑦
	5. Damage of bearings.	②
	6. Too low of oil levels.	② ④
	7. Inferior quality of lubrication oils.	② ④
	8. Not duly oil change.	② ④
	9. Mixing of different oils.	②
Humming gears during idle rotation process	1. Over big tolerance of main shaft gears.	⑥
	2. Unstable running of engine	⑥
Big vibration	1. Damage of engine support.	②
	2. Insufficient tightening torque of nuts for output shaft.	⑥
	3. Improper installation of transmission shaft.	⑥
	4. Wear of suspension support	② ⑥
Main shaft washer is burned down	1. Too low oil level	② ④ ⑥
	2. Vehicle towing or improper sliding method	② ④ ⑥
Wear or damage of spline of input shaft	1. Starting at too high speed	① ②
	2. Impact load	① ②
	3. Improper adjustment of clutch	② ⑥
	4. Failure of clutch	② ⑥
	5. The engine is not aligned to the transmission.	⑥ ②
	6. Improper installation of transmission shaft.	⑥
Damage of clutch housing	1. Damage of engine support.	②
	2. The engine is not aligned to the transmission.	②
	3. The auxiliary support is not installed in the transmission.	⑦
Damage of synchronizer	1. The pressure-regulating valve has defects.	②

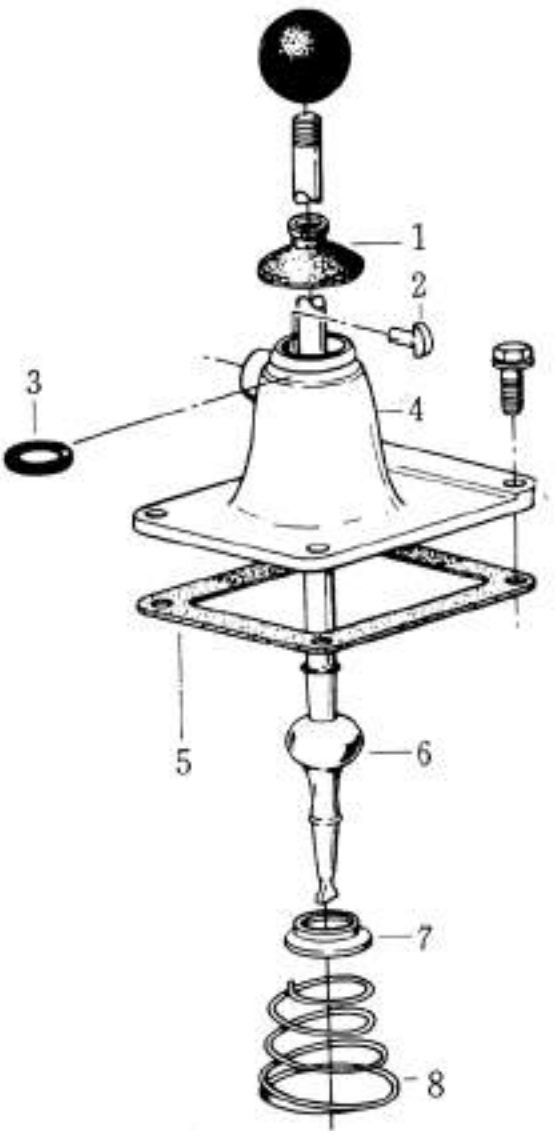
Failures	Possible Reasons	Elimination Methods
Damage of synchronizer	2. The shifting fork is assembled oppositely.	② ⑥
	3. Damage of spring for synchronizer.	② ⑦
	4. Worse quality of lubrication oils.	② ⑥
	5. Mixing of different oils.	② ⑥
	6. Improper operation and application methods.	①
Over heat	1. The gears are influenced by shaft twisting, leaving the gear matching position.	② ④
	2. Damage of bearings.	②
	3. The inner ring of front bearing in the countershaft for the auxiliary transmission is peeled off.	②
	4. Too low oil level.	⑥ ④
	5. Too high oil level.	⑥ ④
	6. Inferior quality of lubrication oils.	② ⑥
	7. Too big operation tilt angle for transmission.	② ⑥
	8. Not duly oil change.	② ⑥
	9. Mixing of different oils.	② ⑥
Twisting of main shaft	1. Starting at too high speed	① ②
	2. Too big impact loads.	① ②
Overlapping of gears	1. Wrong connection of the hoses.	⑧ ⑥
Bearing burnt	1. The inner ring of front bearing in the countershaft for the auxiliary transmission is peeled off.	②
	2. Too low oil level.	② ④ ⑥
	3. Inferior quality of lubrication oils.	② ④ ⑥
	4. Not duly oil change.	② ④ ⑥
	5. Mixing of different oils.	② ④ ⑥
Oil leakage	1. The air holes are blocked.	⑩
	2. Too high oil level.	⑥
	3. Housing has casting defects.	② ④
	4. Damage of rear oil seals.	② ④
	5. The fastened screws are loosened or omitted.	⑥ ⑦

Code Meanings of Elimination Method

① Instruct the drivers to apply the proper driving method.
② Change parts.
③ Loose the lock screws, and retighten them at the proper torque.
④ Look for the damages.
⑤ Grind the surface by the sand papers.
⑥ Readjust according to the stipulations.
⑦ Install the omitted parts.
⑧ Inspect the air pipes.
⑨ Fasten the parts.
⑩ Eliminate the interference caused by the parts.
⑪ Recheck the gear matching conditions.
⑫ Clean parts
⑬ Apply one thin layer of silicone oil lubricate.
⑭ Apply sealant

Dismantling and Assembly of Shanxi FAST Twin Countershaft Transmission

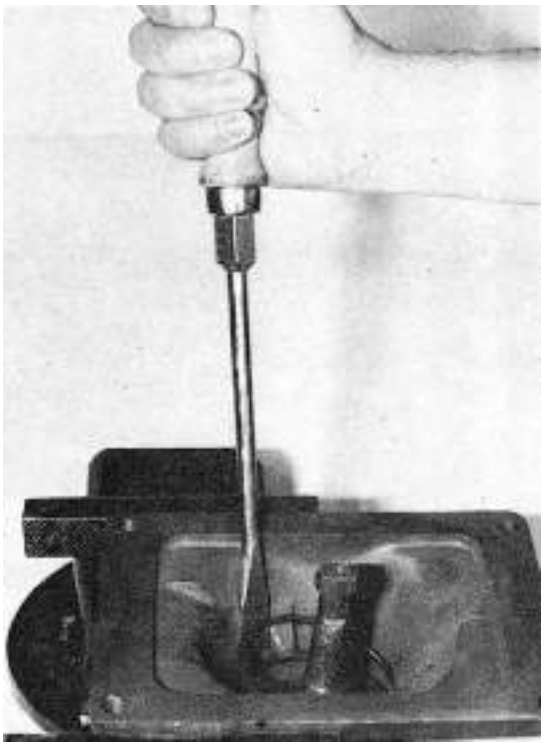
►Control Mechanism of Shifting



Disassembling and Assembling of Direct Controlled Shifting Lever

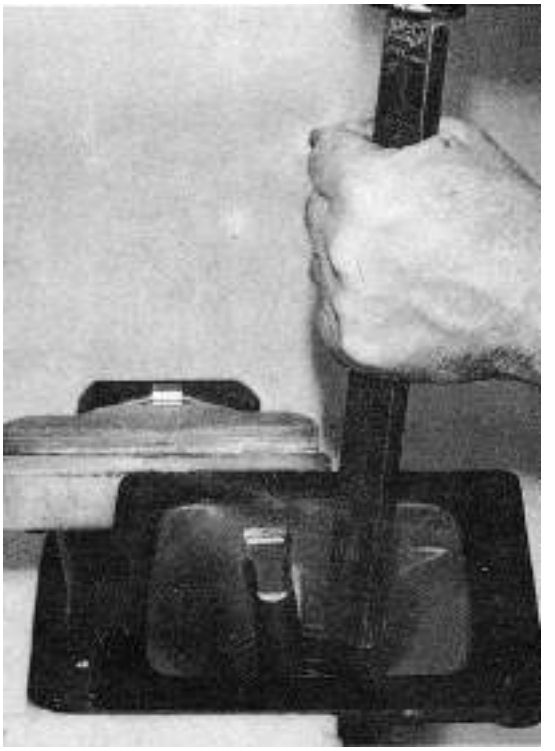
1. Guard cover	2. Pin	3. O Type Ring	4. Housing
5. Gasket	6. Rod 7.Washer	8. Spring	

Fig. 7-1 Direct Controlled Shifting Lever



A. Dismantling

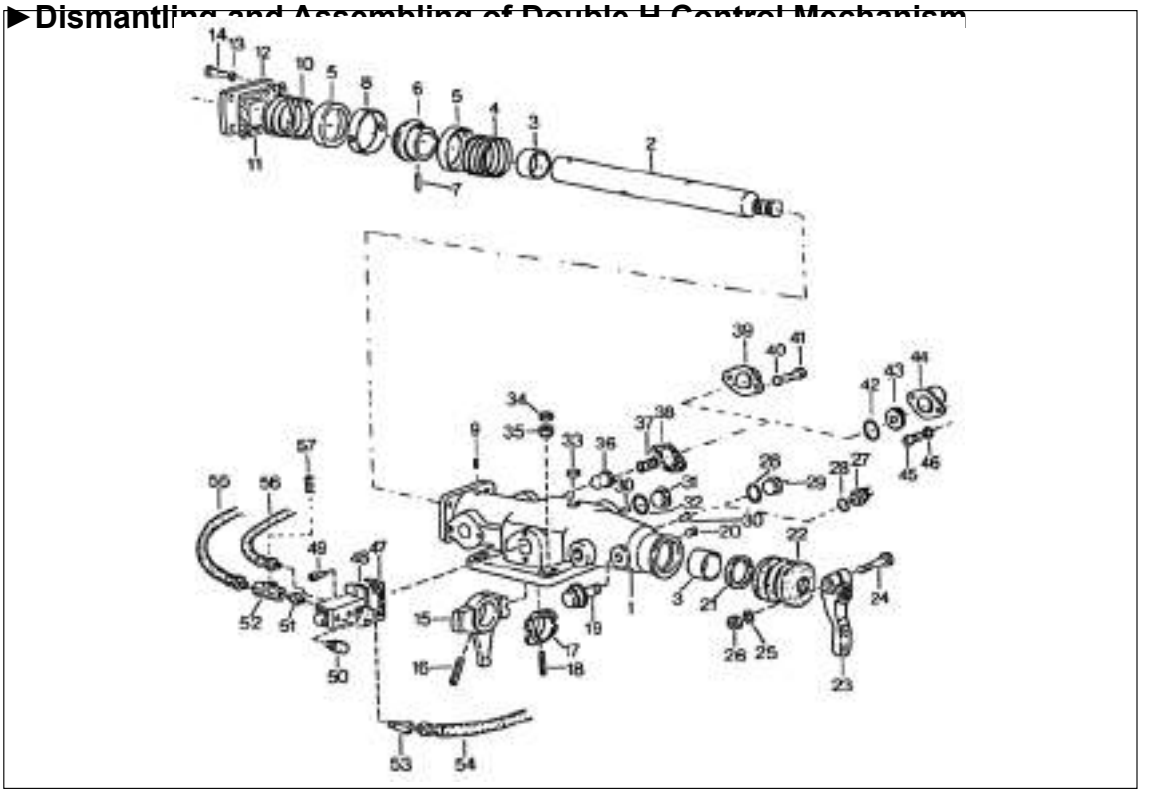
1. Screw out four screws from the housing. Lightly knock the screw to damage the seals of gasket, and then take off the upper cover from the shifting lever.
2. Clamp the housing by the vise, apply a big screwdriver to lift the springs around the projecting handle, and then take off the springs.
3. Take out the pivot pin, nuts and washer from the housing. If it is necessary, take out the O ring.



B. Assembly

1. Assemble the pivot pin and O ring in the hole of the housing. Assemble the washer and nuts on the pivot pin.
2. Assemble the shifting lever in the housing, matching the groove on the ball lever to the pivot pin.
3. Press the spring to the washer, and then press the taper end of the spring downward.
4. Apply an installation tool to assemble the springs on the projecting end of the housing.
5. Enable the 3 positioning springs and steel balls to locate in the hole of upper cover, assemble the housing of the shifting lever and washer to the upper cover.

►Dismantling and Assembling of Double H Control Mechanism



1. Housing
2. Shifting shaft
3. Sliding bearing
4. Spring
5. Spring seat
6. Positioning ring
7. Elastic column pin
8.Spring spacer
9. Lock bolt
10. Spring
11. Gasket
12. Housing cover
13. Spring washer
14. Screw
15. Shifting fork head
16. Cylindrical pin
17. Elastic cylindrical pin
18. Reverse switch control bloc
19. Air plug
20. Cock screw
21. Oil seals
22. Gas bag
23. Shifting rocker arm
24. Screw
25. Spring washer
26. Nut
27. Switch of back-up lamp
28. Gasket
29. Cock screw
30. Pin
31. Cock screw (switch in neutral gear)
32. Gasket
33. Plug
34. Lock nut
35. Hexagonal nut
36. Piston
37. Spring
38. Gasket
39. Cover
40. Spring washer
41. Screw
42. O ring
43. Piston
44. Cover
45. Screw
46. Spring washer
47. Gasket
48. Directional gas valve
49. Internal hexagonal screw
50. Air plug
51. Screw joint
52. Tee union
53. Angular pipe union
54. Air pipe
55. Air pipe
56. Air pipe
57. Cock screw
58. End cover

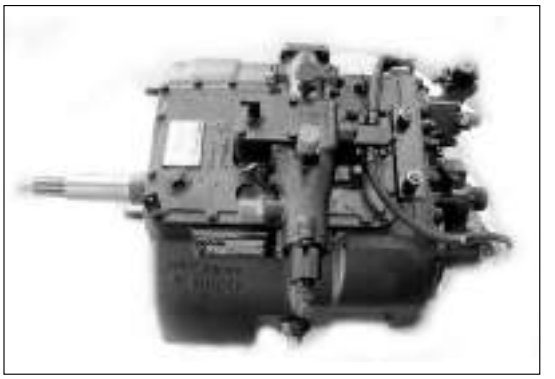
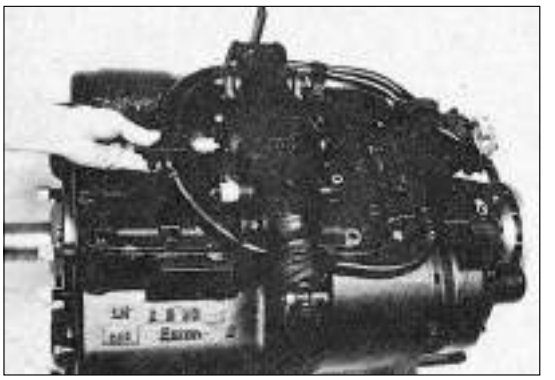


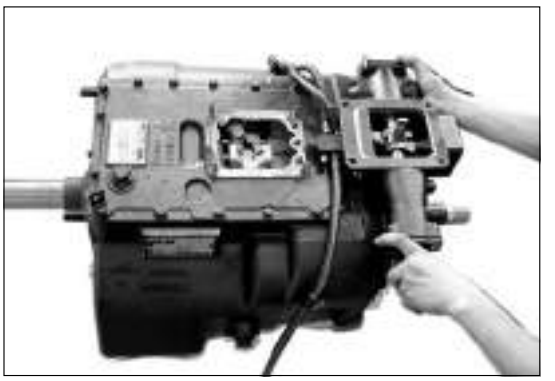
Fig. 7-2: Double H Control Mechanism

A. Dismantle Double H Control Mechanism

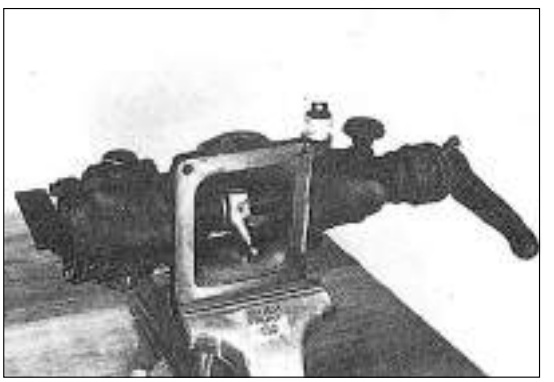
1. Pneumatic shifting double H control mechanism of high and low speed



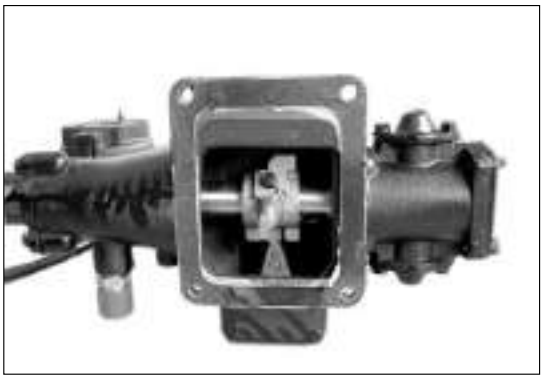
2. Take off double H air valve and other connection parts from double H device.



3. Take off double H control mechanism from the upper cover of the transmission.



4. Apply the vise to clamp the housing of double H control mechanism.



5. Disassemble the rear cover and take off spring and spring seat.

6. Dismantle the side cover and take off spring and plunger.

7. Remove another side cover and take off spring and plunger.

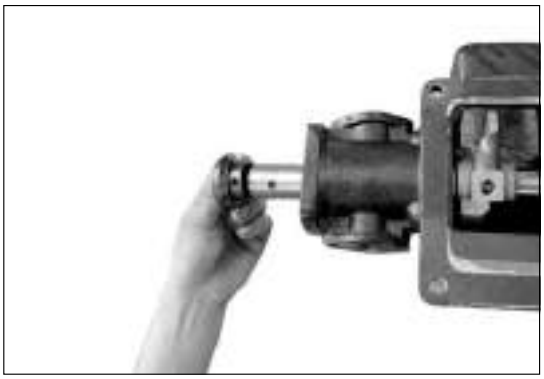
8. Take off shifting rocker arm and gas bag.

9. Take off lock iron wire and pull out the plug from the cylindrical pin (see the arrow).

10. Pull out the cylindrical pin.

11. Take off lock bolt.

12. Take off the shifting shaft, shifting fork head and reverse switch control block from the housing.



13. Disassemble the positioning ring.

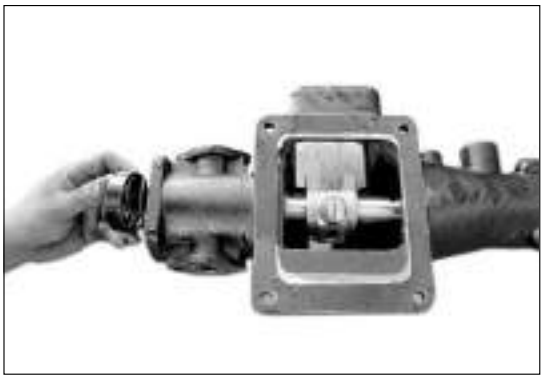
14. Shifting fork head and reverse switch control block.

Caution ⚠

The retainer ring in the housing is loaded by spring.

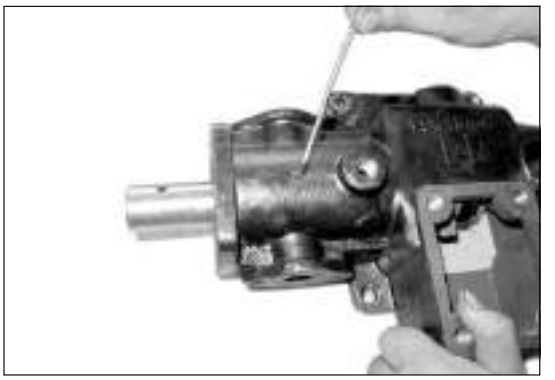
Pay attention to the safety.

15. Sequence of spring, spring seat, spring spacer and positioning ring.



B. Assemble Double H Control Mechanism

16. Put spring, spring seat and spring spacer in the housing.



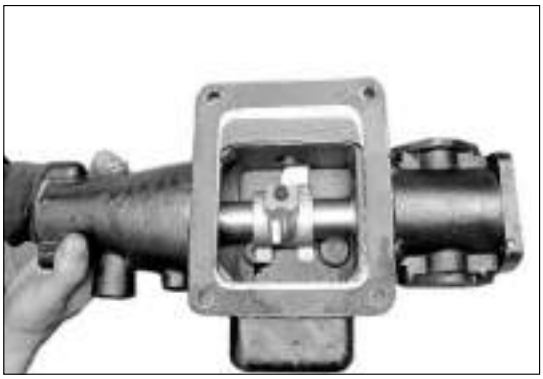
17. Apply the lock bolt to fasten the retainer ring in the proper hole.

Caution ⚠

The retainer ring is loaded by spring. Pay attention to the safety.

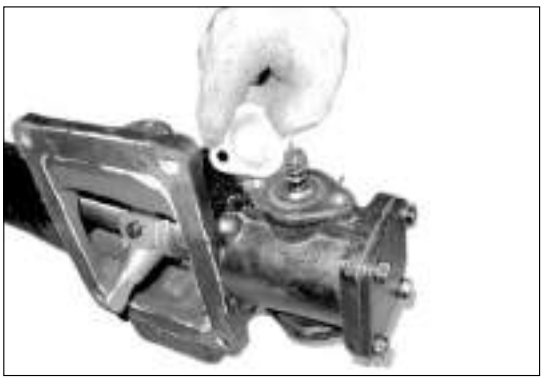
18. Put the shaft, shifting fork head and reverse switch control block into the housing. Knock the elastic cylindrical pin into the control block.

19. Rotate shaft and control block so as to make back-up lamp switch function.

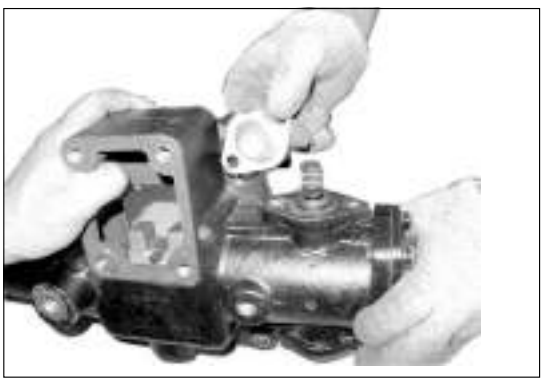


20. Knock the cylindrical pin into the shifting fork head and lock it by iron wires.

21. Assemble the spring and seat and baffle.



22. Put the plunger and spring in and assemble the spring protection cover.



23.Put the plunger and spring in and assemble the spring protection cover.

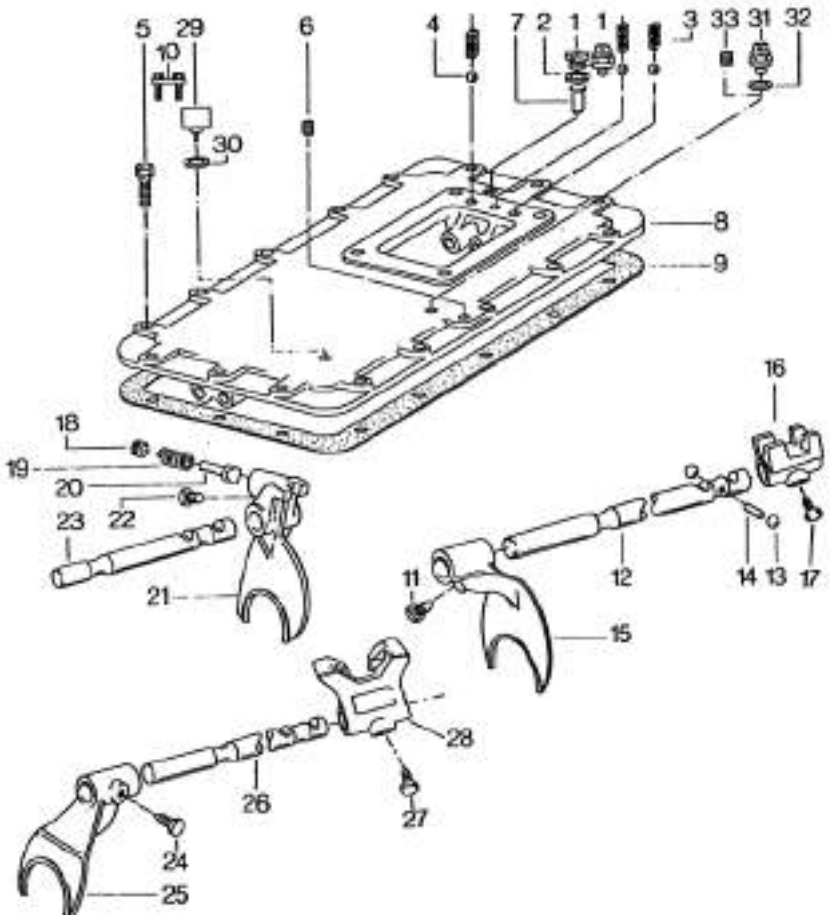
24. Assemble the coupling sleeve.

25. Assemble the coupling short shaft.

26. Assemble the reverse switch, switch of neutral gear and air plug.

27. Assemble the shifting selection device, and check whether double H device can work properly.

►Dismantling and Assembling of the Upper Cover Assembly

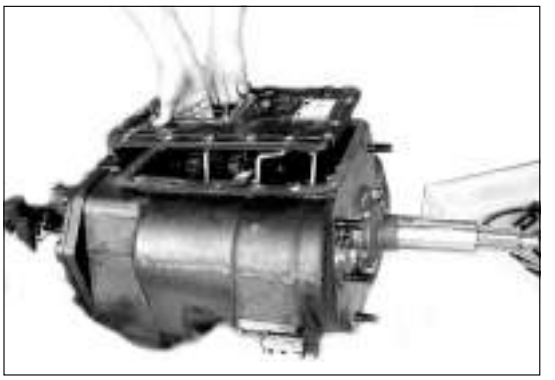


1 Plug/back up lamp switch 2 Gasket 3 Tension spring (3)
4 Steel ball (3) 5 Screw (16) 6 Plug cock
7 Back up lamp pin (optional) 8 Upper cover 9 Gasket
10 Hexagonal screw support (optional) 11 Lock screw 12 Shifting fork lever
13 Interlocked steel ball 14 Interlocked pin
15 One and two gears, five and six gears shifting fork
16 One and two gears, five and six gears shifting fork
17 Lock screw 18 Plug cock 19 Spring
20 Reverse lock plunger 21 Low and reverse gears shifting fork
22 Lock screw 23 Shifting fork lever 24 Lock screw
25 Three and four gears, seven and eight gears shifting fork
26 Shifting fork lever 27 Lock screw
28 Three and four gears, seven and eight gears shifting fork
29 Air valve (optional) 30 Seal ring (optional) 31 Neutral switch (optional)
32 Seal ring (optional) 33 Cock screw

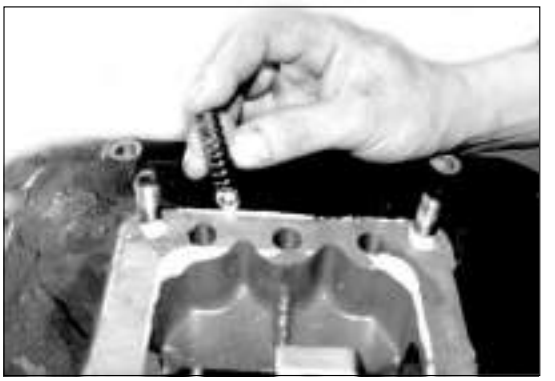
Fig. 7-3 Upper Cover Assembly

A. Dismantle upper cover assembly

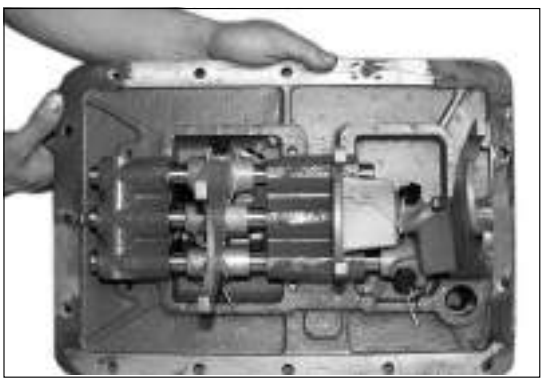
1. Disassemble long distance control device (i.e. Double H control device)



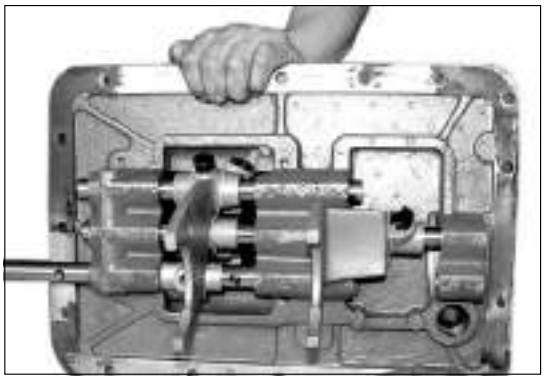
2. Take off the upper cover from the transmission.



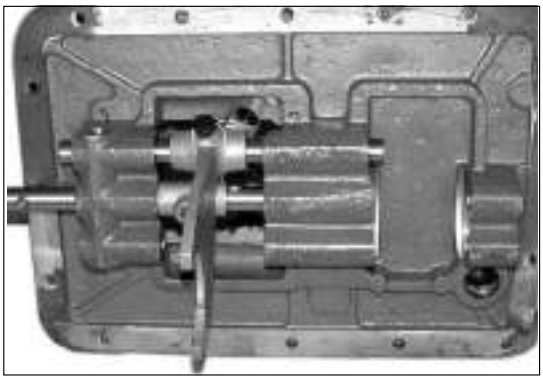
3. Disassemble the gear changing self-lock steel ball and spring.



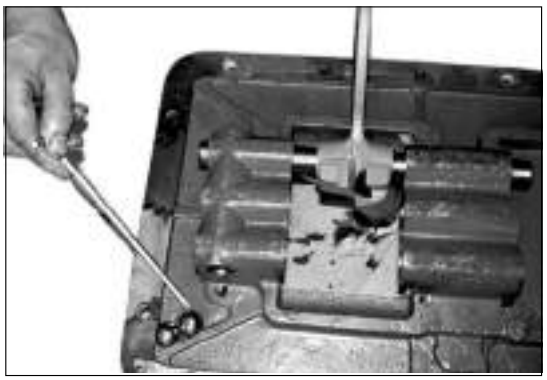
4. Assemble the upper cover to the vise.



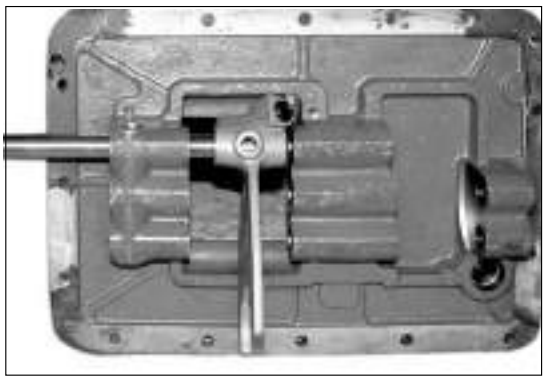
5. Remove lock screw, shifting fork lever, shifting fork and shifting block of three and four gears (seven and eight gears).



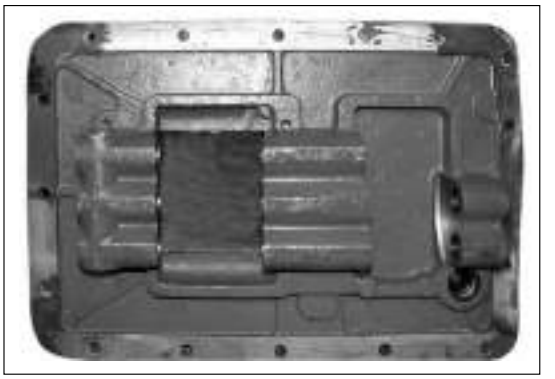
6. Remove lock screw, shifting fork lever, shifting fork and shifting block of one and two gears (five and six gears).



7. Take off two steel balls (location of arrows).

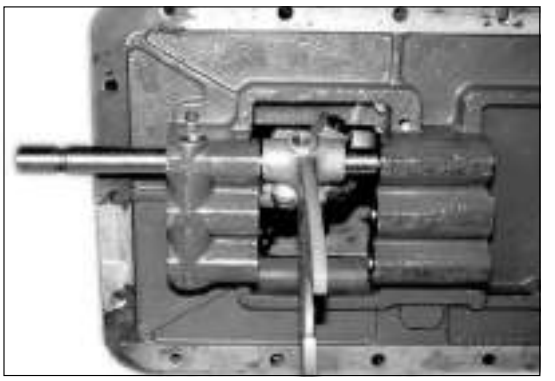


8. Dismantle reverse/low speed lock screw, shifting fork and shifting fork lever.



9. Disassemble the upper cover of the gear changing control mechanism.

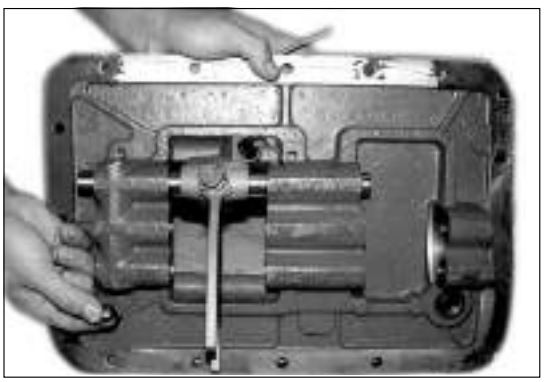
10. If it is necessary, disassemble reverse/low speed shifting fork.



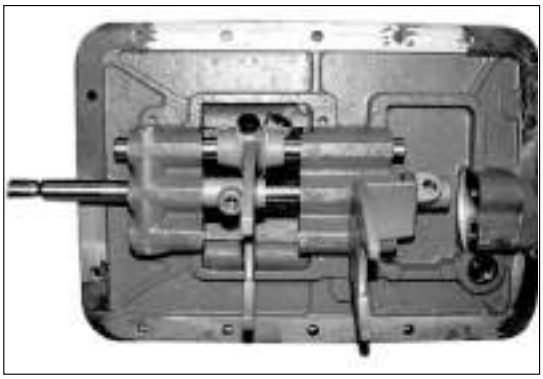
11. Install reverse/low speed shifting fork and shifting fork lever. Install and fasten the lock screw.

Caution ⚠

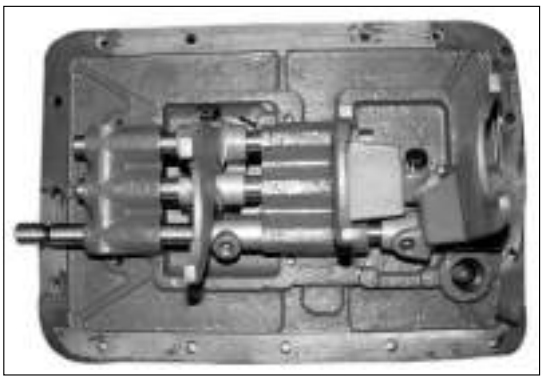
Openings applied to lock the shifting in all shifting fork levers shall face to the upper cover.



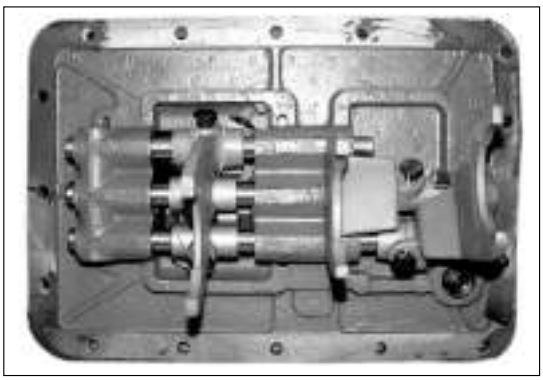
12. Assemble the shifting interlocked steel ball.



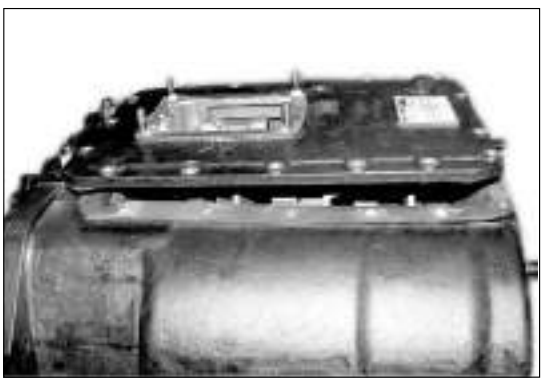
13. Assemble shifting fork, shifting block, shifting fork lever and lock pin of one and two gears (five and six gears). Install the interlocked steel ball for shifting (location of arrow). Install and clamp the lock screw.



14. Assemble shifting fork, shifting block, shifting fork lever of three and four gears (seven and eight gears).



15. Install and lock the lock screw.



16. Assemble the upper cover to the transmission and lock it.

17. Install the self-lock steel ball and compressed spring.

►Auxiliary Transmission Part

Disassembling of Auxiliary Transmission

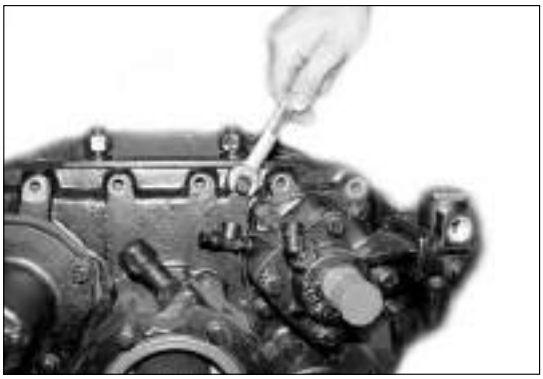
A. Disassembling of Auxiliary Transmission and Output Flange

Caution ⚠

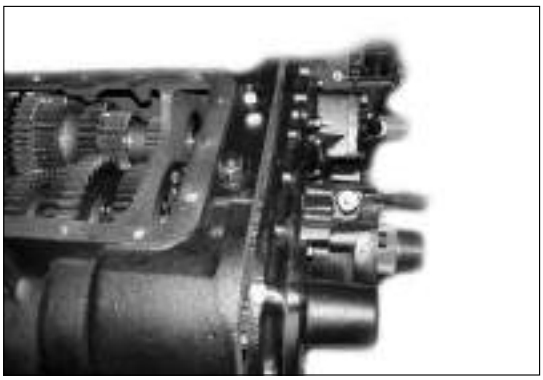
Discharging of gear oils.

1. Apply two gears to clamp the transmission, use the proper tools to unscrew the output flange nuts.
2. Take off the driving gear of speedometer or spacer and output flange from the output shaft, and then take off the driven gear of speedometer.

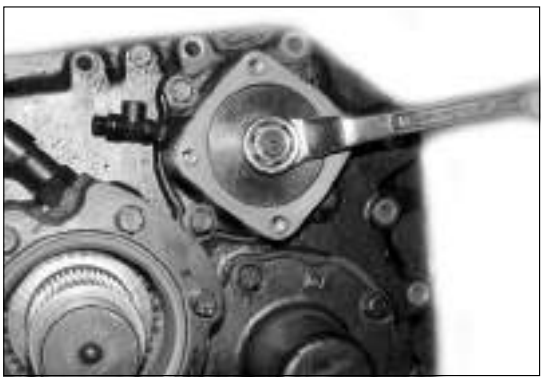
3. Take off the screw connecting the housings of main transmission and auxiliary transmission.



4. Screw the thread cutting screw in 3 screw holes at the edge of the auxiliary transmission, and uniformly screwing in, moving it backward about 13mm.

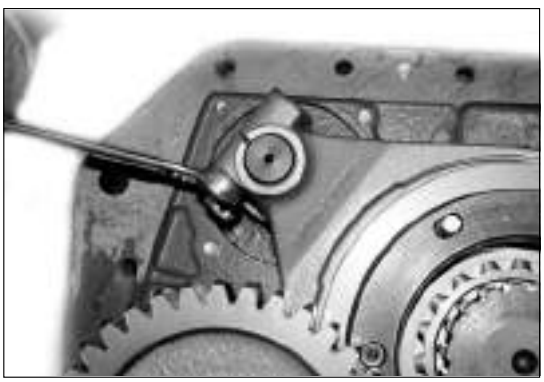


5. Install one hanger support in the auxiliary transmission, moving it backward, releasing the positioning box of the main transmission. Put the auxiliary transmission on a vise, pay attention to prevent from damaging the machining face of the edge.



B. Dismantling of the Shifting Cylinder

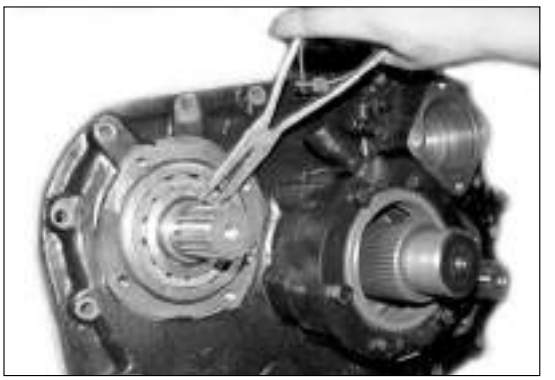
1. Take off four screws and shifting cylinder head. Disassemble the nuts on the end of the shifting fork lever.



2. Cut off lock iron wires, screw out 2 lock screws for shift fork.

3. Push the shifting fork lever backward to push it out of the housing. Take off the piston from the shifting fork lever. If it is necessary, take off O ring from the piston.

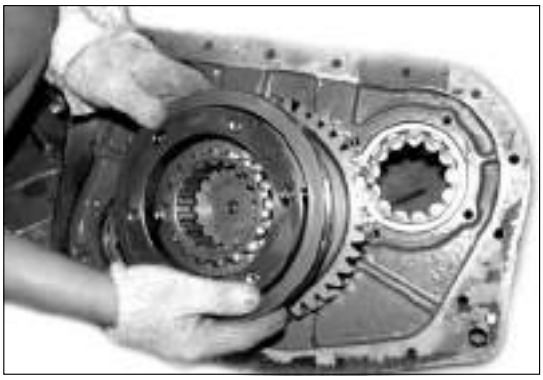
4. Take off shift fork, screw out four screws. Take off cylinder housing from the housing of auxiliary transmission. If it is necessary, take out O ring from the inner hole of housing.



C. Taking off the Countershaft of the Auxiliary Transmission

1. Screw out screws and take off the rear bearing cap in the countershaft. Take off the split ring from the two shafts.

2. Knock out the bearing from the countershaft by the soft bar. Then re-knock the bearing backward by the soft bar, releasing it from the housing. Knock the outer ring of the bearing lightly, so as to prevent from damaging the bearing.

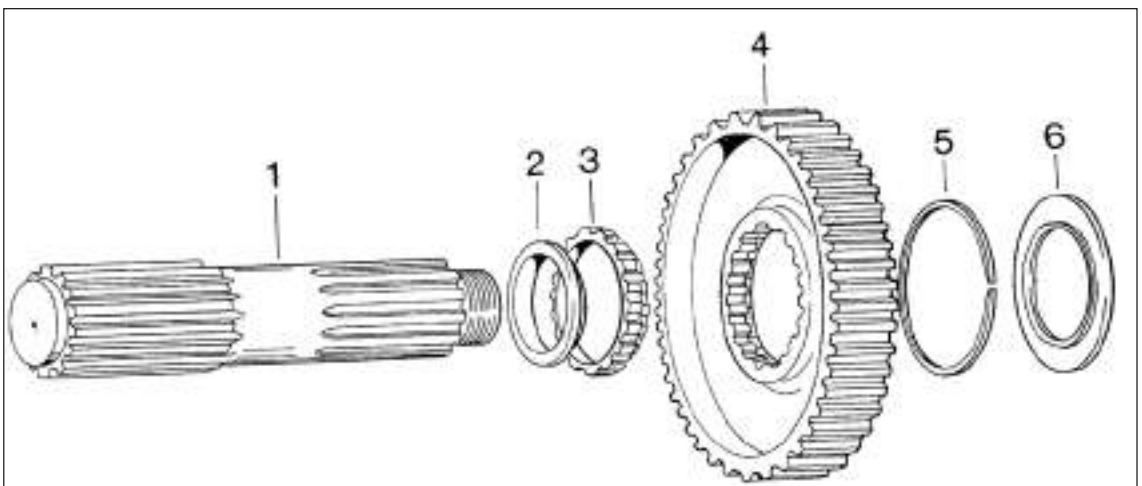


D. Dismantling of the Synchronizer Assembly

1. Pull out the synchronizer assembly, releasing it from the output shaft.

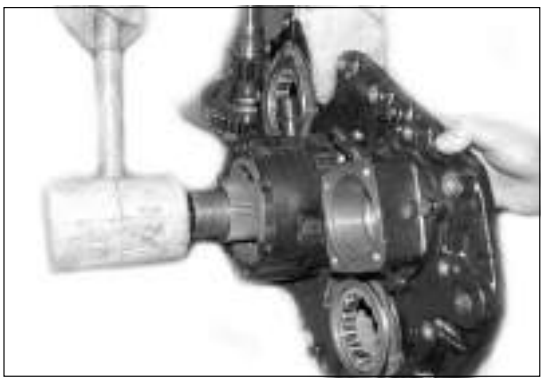
2. Pull out the taper ring of high speed synchronizer from the low speed lock pin of synchronizer. Wrap the taper ring of high speed synchronize by clothes, so as to prevent from the loss of three compressed springs. Take off the sliding gear sleeve of synchronizer from the conical ring of low speed synchronizer.

E. Dismantling of the Output Shaft and Reduction Gear of Auxiliary Transmission



1. Output shaft
2. Washer
3. Spline housing
4. Reduction gear
5. Split ring of reduction gear
6. Rear washer of reduction gear

Fig. 7-4: Output Shaft Assembly of Auxiliary Transmission



1. Knock the output shaft forward by soft bar.

2. Take off the inner ring spacer sleeve from the shaft.

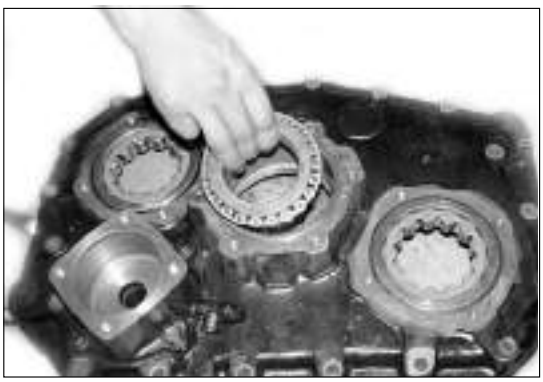
3. Regarding the front face of the gear as the bottom, press down the output shaft and pass it through the gear and bearing. If necessary, take off the split ring from the gears.

4. Take off the spline sleeve and washer from the shaft.

5. Screw out the screw and take off rear bearing cap from the housing of the auxiliary transmission. Take off the inner ring of the rear conical bearing. If it is necessary, use the hand hammer or the punch to knock the oil seals out of the cover.

Caution ⚠

During the disassembling process, oil seal would be damaged, so do not take it off when it is unnecessary to change



6. Apply the soft tools to knock it backward carefully. Take out the outer rings and outer spacer sleeves of two conical bearings from the transmission holes. Pay attention to prevent from scratching the machining surface of bearing hole.

►Assembling of Auxiliary Transmission

A. Installation of Reduction Gears and Output Shaft

1. Put the thread end of output shaft on the workbench upward, and put the shoulder of the washer downward, ring one side of the small outer ring on the shaft upward.

2. Ring one side of the small outer ring of spline sleeve on the shaft upward and against the washer.

3. In case of pre-disassembly, put one split ring into the inner ring groove of the gear, assemble the gear into the shaft and against the spline sleeve and the surface end shall be put upward.

4. Ring the washer onto the shaft and the shoulder faces to the gear and stand up to the gear.

Caution ⚠

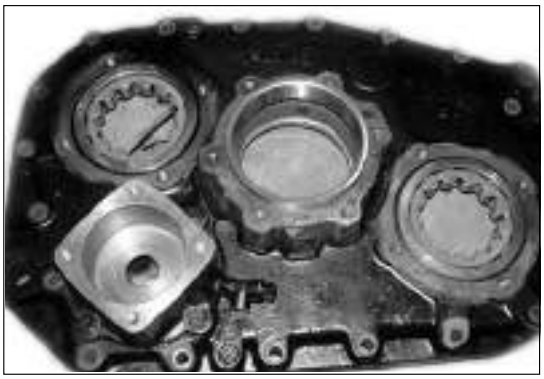
Conical bearing and spacer are the special parts, which are purchased by sets. The (axial) accuracy problems of two bearing cones are not existed. All parts have been marked.

5. Heat the inner ring of the front conical bearing and assemble it to the shaft, making it against the washer above the gears.

6. Assemble the inner rings of bearing to the shaft.

Caution ⚠

It is only required to heat the inner ring of the bearing to 135℃ (maximum).



7. Assemble the outer ring of the front conical bearing into the transmission hole, its conical face shall point to the lower side.

8. Knock the outer spacer sleeve of bearing and outer ring of the rear conical bearing to the transmission hole and the shoulder side shall be placed upward.

B. Assembling of the Synchronizer

1. Assemble the sliding gear sleeve to the lock pin of conical ring of low speed synchronizer.

2. Assemble 3 compressed springs into the conical ring of high speed synchronizer.

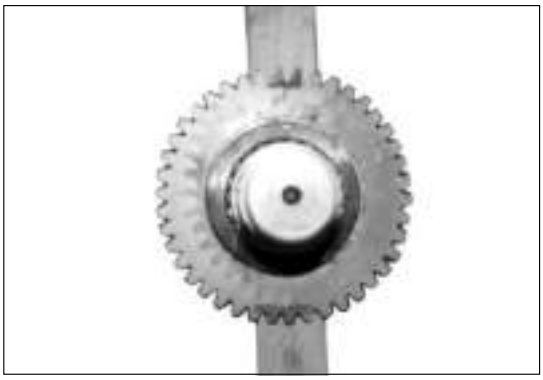
3. Assemble the conical ring of high speed synchronizer to the lock pin of conical ring of low speed synchronizer.

4. Rotate and press down the conical ring of high speed synchronizer against the tension of the spring, assemble the conical ring of low speed synchronizer to the holes above the lock pin.

C. Assembling of the Countershaft and Output shaft for Auxiliary Transmission

1. Take out the inner and outer rings of bearings by the extractor in the process of changing bearings. Pay attention to assemble new bearing, the shoulder of bearing is installed against the gear.

2. Mark the gear tooth which prints letter “O” in each pinion of countershaft.



3. Mark any two adjacent gear teeth in the reduction gear, and then mark the opposite two gear teeth.

4. Put the synchronizer assembly on a wood block with the height of about 50 mm, the conical ring of high speed synchronizer is faced downward.

5. Put the output shaft on the synchronizer, and match the spline of shaft to the spline grove of sliding gear sleeve.

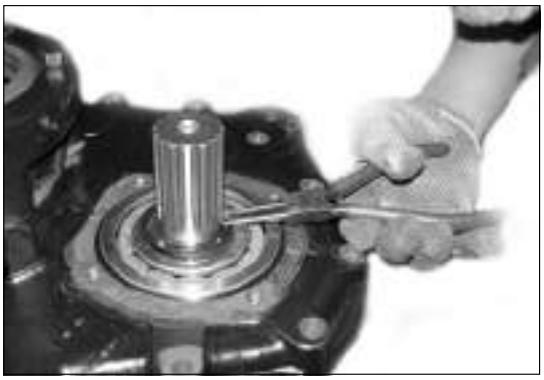
6. Install two countershafts against the output shaft. Two marked gear teeth on each countershaft shall be located between two marked gear teeth of low speed gear.

7. Put the housing of the auxiliary transmission downward and assemble it above the output shaft. The countershaft shall be aligned to the bearing hole of housing.

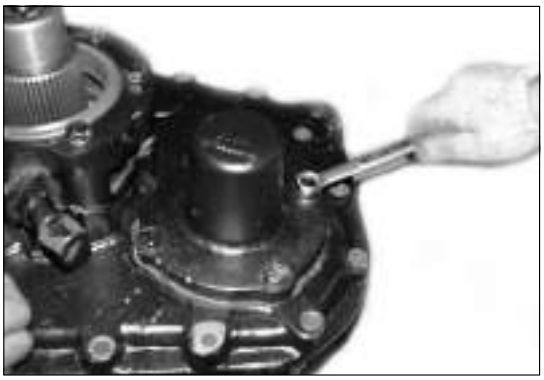
8. Heat the inner rings of rear conical bearing and press it to the output shaft.

9. In case of having been dismantled, assemble the oil seals of output shaft to the housing of speedometer. The smooth surface shall be upward.

10. Assemble the housing of speedometer and gasket to the housing of the auxiliary transmission and fasten it.



11. Assemble the rear bearing to the countershaft and apply the bearing installation tool T-10324 to knock it into the transmission hole, and then install the split ring.



12. Tighten the rear bearing cover and gasket on the countershaft.

D. Assembling of Scope Gear Cylinder

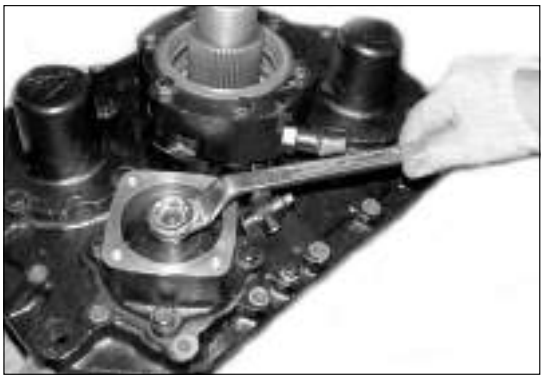
1. Assemble the cylinder housing and gasket to the housing of auxiliary transmission and the air pipe hole shall be upward. In case of having been dismantled, assemble two O rings in the cylinder. Pre-apply a thin layer of silicone grease lubricant to the O ring.

2. Assemble the shift fork to the sliding gear sleeve of the synchronizer and insert the shifting fork lever, passing it through shift fork and cylinder housing. Apply two lock screws to fasten the shift fork and use the iron wire to block it.

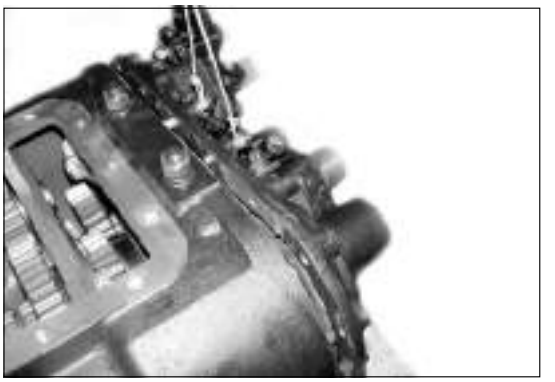
3. Install O ring inside and outside the cylinder. Pre-apply a thin layer of silicone grease lubricant to the O ring. Insert the piston to the shifting fork lever, and then assemble it into the cylinder, the surface end shall be outward.

Caution ⚠

The shift fork is not symmetrical. Install the screw from the bottom.



4. Install the elastic lock nut and washer.



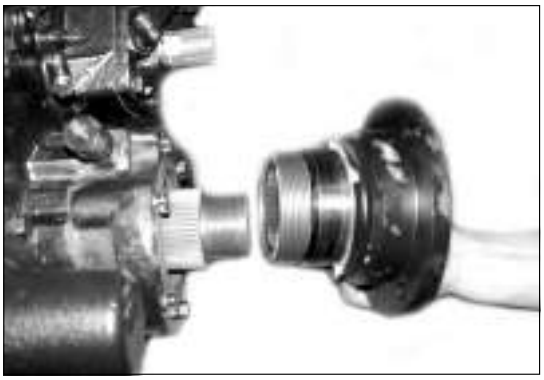
E. Assembling of the Auxiliary Transmission and Output Flange

1. Assemble the gasket at the edge of the housing of the auxiliary transmission. Install one hanger support and hanger chain in the auxiliary transmission, and align them to the positioning pin of the main transmission. Two countershafts shall be meshed with the driving gear, and the front end of each countershaft shall be inserted into the bearing on the partition of main transmission. Move the auxiliary transmission to the main transmission stably without applying any forces. Rotate the driving gear of auxiliary transmission if necessary, so as to mesh the gear properly.

2.Assemble screws.

Caution ⚠

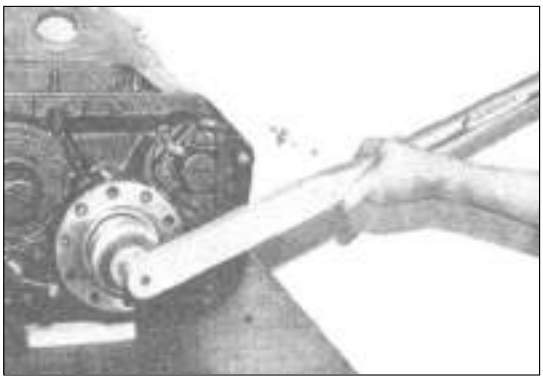
The installation of auxiliary transmission can apply the vertical method. Place the main transmission on the wood block vertically and descend the auxiliary transmission by the hanger chain assembled in the hanger support of output shaft.



3. Assemble the driving gear of speedometer or its substitute- spacer sleeve to the shaft of flange. Ring the flange to the spline of the output shaft.

Caution ⚠

While installing the auxiliary transmission to the main transmission, the synchronizer shall be located in the low speed location in the initial phase.



4. Move two sliding sleeves in the main transmission, meshing them with two gears, and lock the main transmission part. Apply the torque wrench to tighten the flange nut with the torque of 610 Nm to 680Nm.

►Main Transmission Part

Disassembling of Main Transmission Part

A. Disassembling of Driving Gears of Auxiliary Transmission

1. Take out the split ring at the rear side of shaft two. Be careful to the possible forcing out of the split ring when it is taken out.

2. Assemble the shift fork to the sliding gear sleeve of the synchronizer and insert the shifting fork lever, passing it through shift fork and cylinder housing. Apply two lock screws to fasten the shift fork and use the iron wire to block it.

3. Insert three threaded screws to three holes of positioning plate, tighten them uniformly, and the lock screws can also be applied. Take out the driving gear of auxiliary transmission from the holes of the housing.

4. Take off the split ring from the driving gear of auxiliary transmission and press the positioning plate and bearing out of the gears.

B. Disassembling of the Intermediate Wheel of Left Reverse Gear

1. Take out the split ring from the reverse gear.

2. Move forward the reverse gears as possible, mesh it to the slide sleeve.

3. Take off the bearings from the holes of the transmission housing.

4. Screw out the self-lock nut and washer from the intermediate wheel screw.

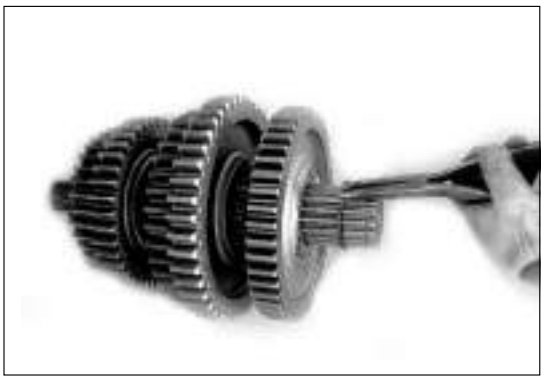
5. Screw out the plug cock from the intermediate wheel, and install one impact extractor on the countershaft, and take off the countershaft from the housing of the transmission with it.

6. Take off the intermediate wheel and thrust washer from the housing. Press the outer ring of the bearing out of the gears if necessary.

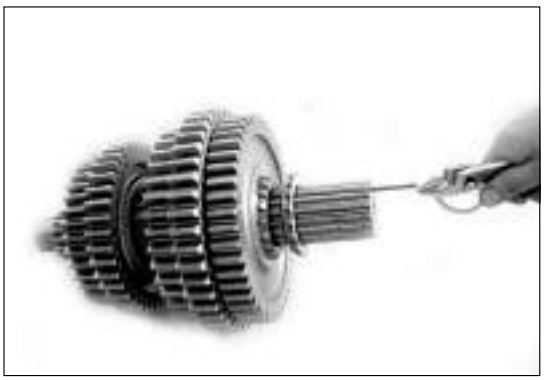
7. Take off the inner ring and washer of bearing from the intermediate wheel shaft.

D. Disassembling of Shaft Two

1. * Clutch right countershaft against the transmission wall. Make the reverse gear against the low speed gear tightly, move the whole shaft two and its gears to the rear side so as to release them from shaft one. Tilt the whole shaft two and its gears upward, and lift it from the transmission housing. Pay attention that the reverse gear is free, which can be slid from shaft two.



2. Take off the slide sleeve from the front end of shaft two, and take off the split rings from its rear end.

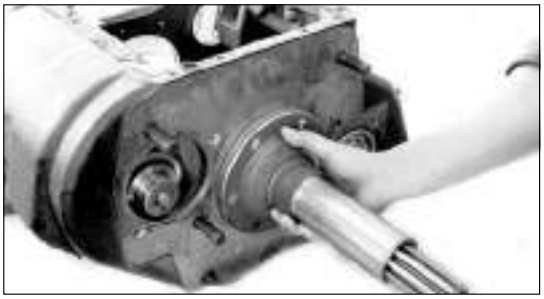


3. Pull out the single key from shaft two, which will loose the aligning gasket, releasing it from shaft two.

*: In order to dismantle shaft two, it is required to dismantle the power take off device and the brake still installed in the transmission from the side window.

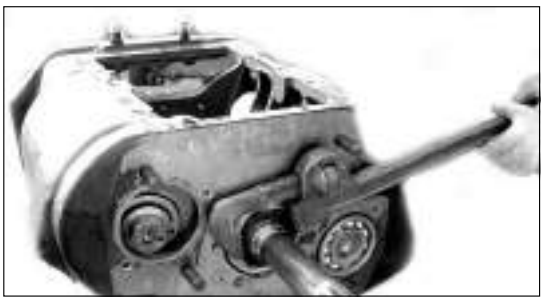
4. Take off the reverse gear adjustment gasket and spline gasket from the shaft.

5. Locate the front end of the shaft two upward and twist it to and fro. The gears will be slid from shaft two at the rear end of the main shaft according to the proper assembly sequence. Take off the split ring of each gear if necessary.



E. Disassembling of Shaft One

1. Take off the front bearing cap from shaft one.



2. Disassemble nuts of shaft one.

3. Knock shaft one forward from the inside of the housing, taking off the split ring from the bearing. Take off shaft one from the inside of the housing.

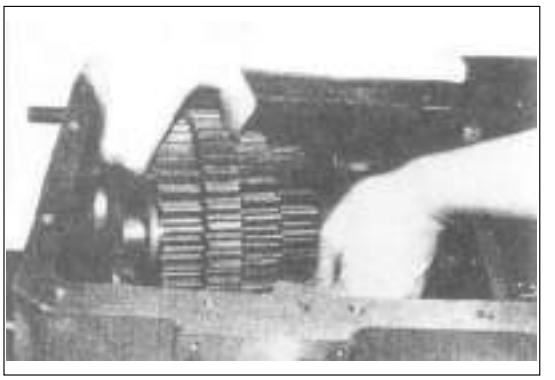
4. Press the shaft out of the bearings and gears. Take off the split ring from the inner side of gears of shaft one if necessary. Check the sleeve in the shaft one, and change the damaged or worn one.

5. Dismantle the right bottom intermediate wheels.

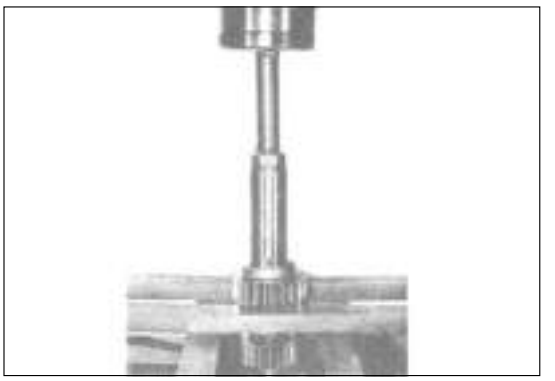
F. Disassembling of the Countershaft

Caution ⚠

Except the gear numbers of the power take off gear, all countershaft assemblies are the same.



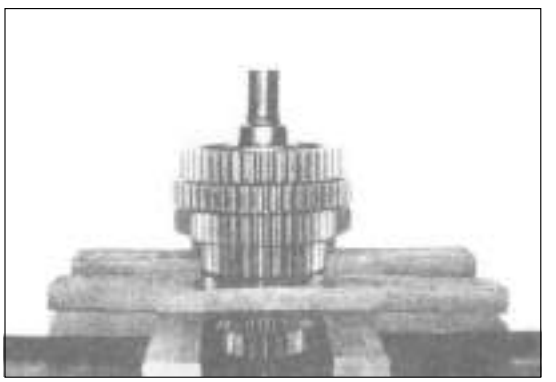
1. Lift countershaft out of the gearbox housing.



2. Press out four gears above each shaft (which requires one pressing machine of at least 20 tons.); apply the metal guard as the safety protection measures.

Caution ⚠

Shall not apply the power take-off gears as the foundation of pressing the gears of countershaft, because this kind of big diameter gears are easily crushed.



3. Press out the remained gears from the shaft. Take off long key and whitney key from the shaft if necessary.

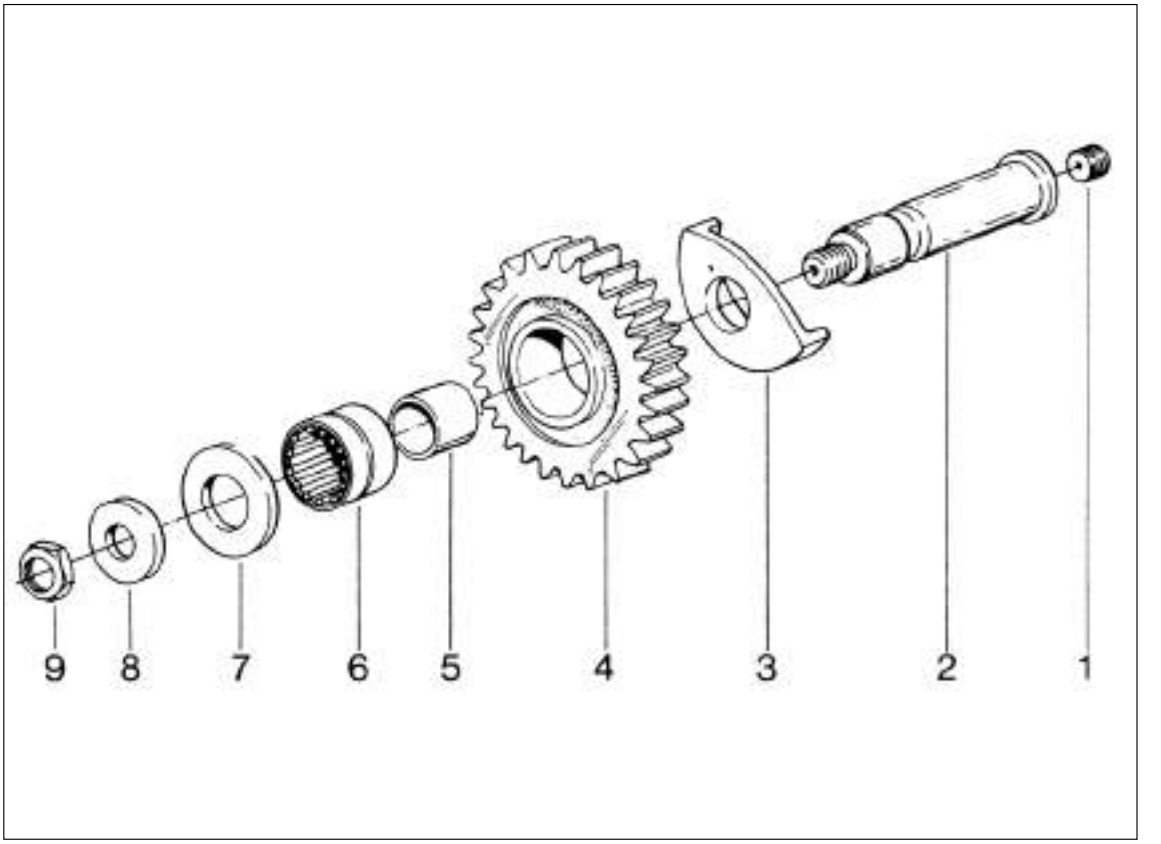
G. Disassembling of Right Reverse Intermediate Wheel

Caution ⚠

The right reverse intermediate wheel is the same as the left one. Apply the same method for disassembling.

►Assembling of the Main Transmission Part

A. Assembling of the Right Reverse Intermediate Wheel

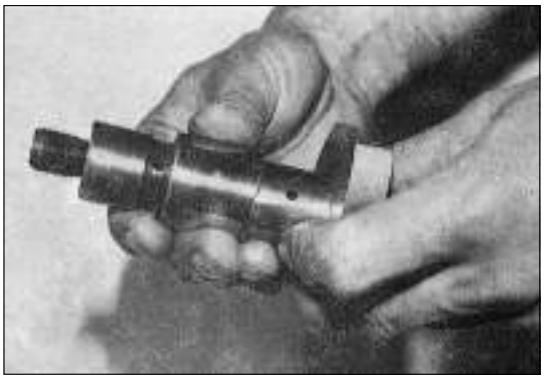


1. Plug cock
2. Intermediate wheel shaft
3. Gear gasket
4. Reverse intermediate wheel
5. Inner ring of bearing
6. Bearing of intermediate wheel
7. Thrust gasket
8. Nut retainer ring
9. Elastic lock nut

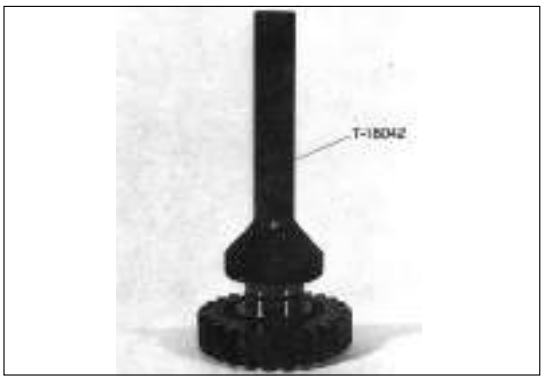
Fig. 7-5: Reverse Intermediate Wheel Assembly

Caution ⚠

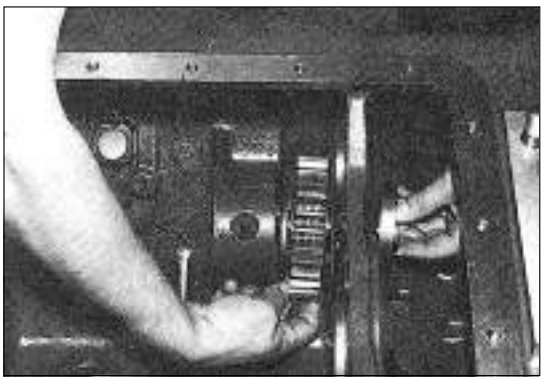
Clean the metal scraps on three magnets at the bottom of housing prior to assembling. If the magnets become loose, apply the adhesive to adhere them to the bottom of the housing.



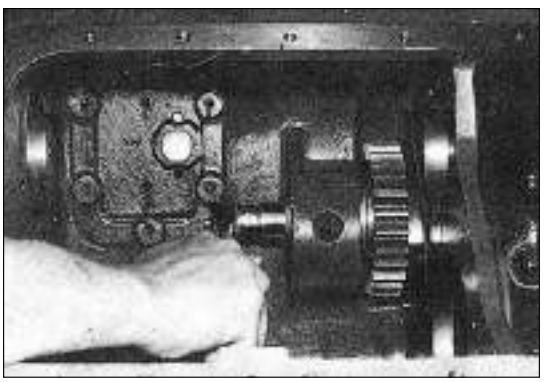
1. Assemble the plug cock, washer and inner ring of bearing to the shaft.



2. Press the outer ring of the bearing to the hole of intermediate wheel.

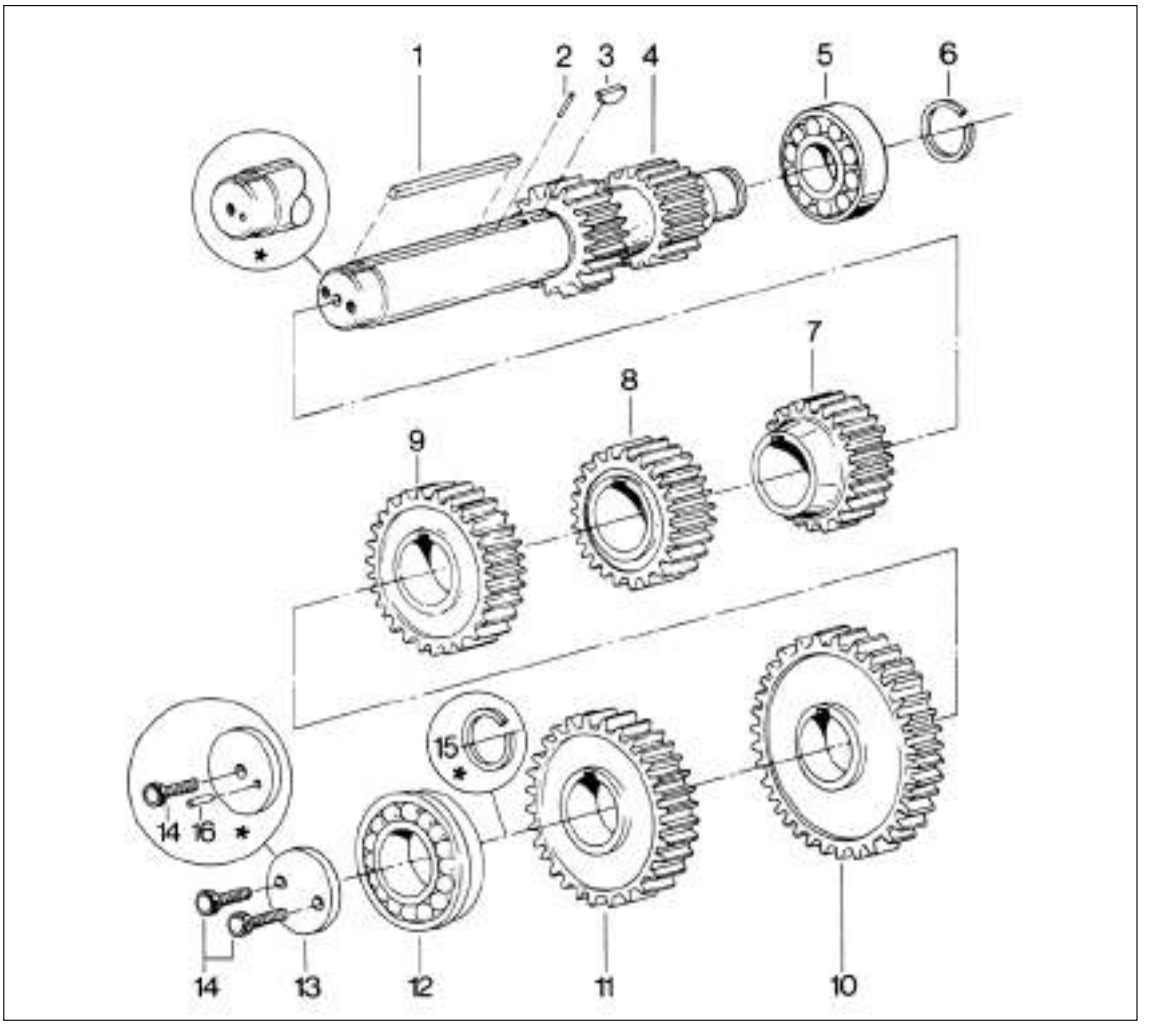


3. Press the outer ring of the bearing to the hole of intermediate wheel.



4. Install the elastic lock nuts and washers.

B. Assembling of the Countershaft



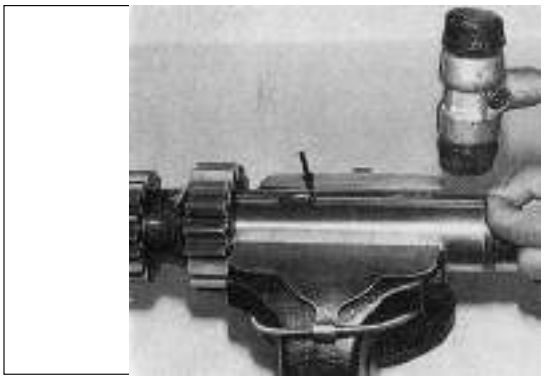
1. long key
2. needle roller
3. whitney key
4. countershaft
5. rear bearing
6. split ring
7. one speed gear
8. two speed gear
9. three speed gear
**10. power take-off gear
11. four speed(transmission) gear
**12. front bearing
3. retaining plate
14. lock screw
15. split ring
16. lock pin

*:New improved type

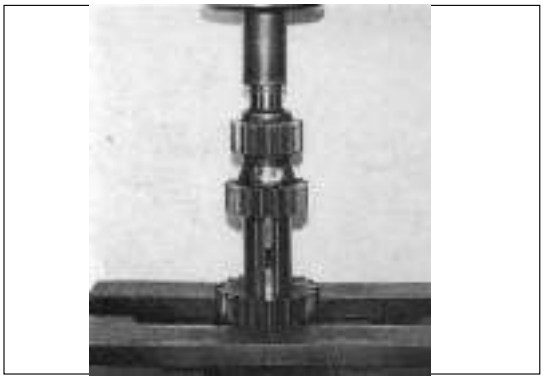
**:In RTO/RTX/RTOX transmission, the location of gear three and gear four is opposite. Location 9= four speed (transmission) gear. Location 11= three speed gear.

Caution ⚠

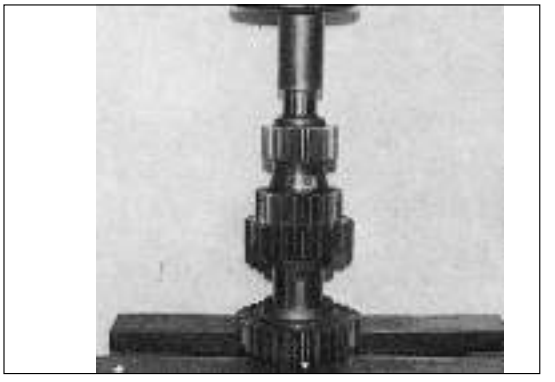
Except the gear numbers of the power take off gear, all countershaft assemblies are the same. It is suggested to apply the proper parts catalogue in assembling the countershaft, so as to provide the correct gear part number and its location.



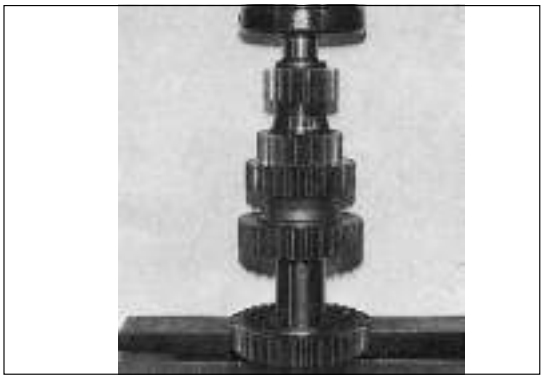
1. If it has been dismantled, assemble the needle roller, whitney key and long key on each shaft.



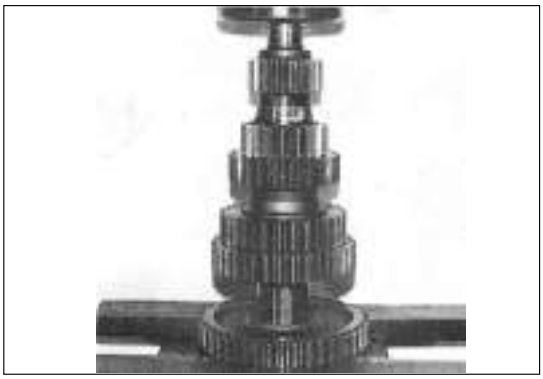
2. Press one speed gear to the countershaft, the projecting part is downward.



3. Press two speed gear to the countershaft, the projecting part is upward.

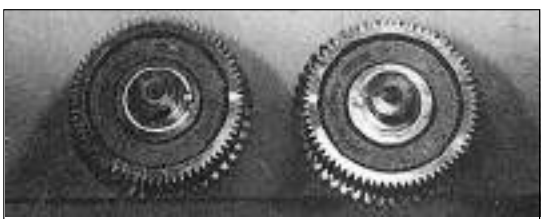


4. Press three speed gear to the countershaft, the projecting part is downward.

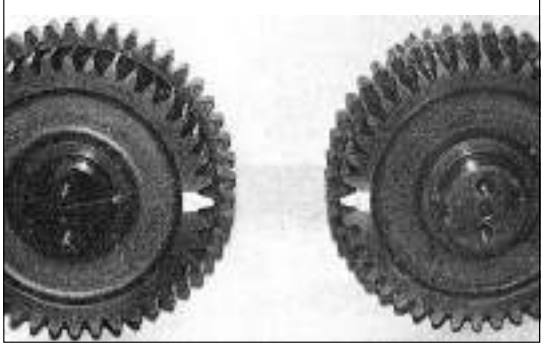


5. Press the power take-off gear to the shaft, and the end of the gear tooth reversed circular angle is upward.

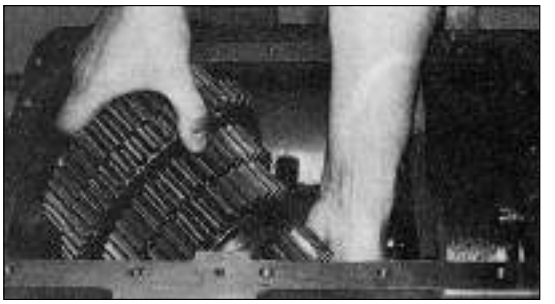
6. Press the transmission gear to the shaft, and the projecting part is upward.



New type



7. Make the matching gear marks on the transmission gear of each countershaft. This gear tooth is aligned to the key groove and printed letter “O”.



8. Install the countershaft at the bottom into the hole of transmission, and then place the countershaft at the top side to the transmission. Big power take-off gear should be installed on the bottom (left) countershaft. Do not install the bearing at this time.

C. Assembling of Shaft One

1. If it has been dismantled, install one split ring inside the gears of shaft one, and install the gear of shaft one to the spline shaft, the side with split ring is forward.

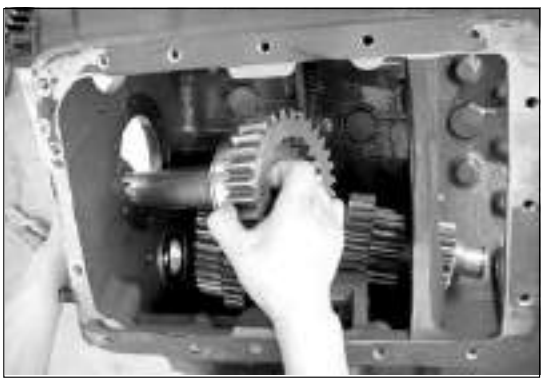
2. Install one spacer in the shaft, making it against the split ring.

3. Press the bearing of shaft one to the shaft, and apply the guard board to block the front side.

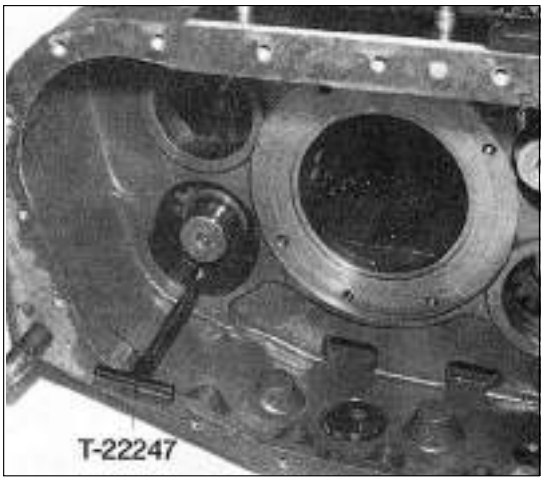
4.Clean the screw of the shaft and nuts, and apply Loctite sealing glue to the gear nuts of shaft one.

5. Install the nuts to the shaft (left hand screw) by the torque of 340 to 410 N.m. Knock the projecting edge of nut to two grooves of shaft.

6. Make marks on any two adjacent gear teeth of shaft one, and then make marks on two corresponding gear teeth. Check the axle bush, and ensue that it is located in the shaft and in good conditions.

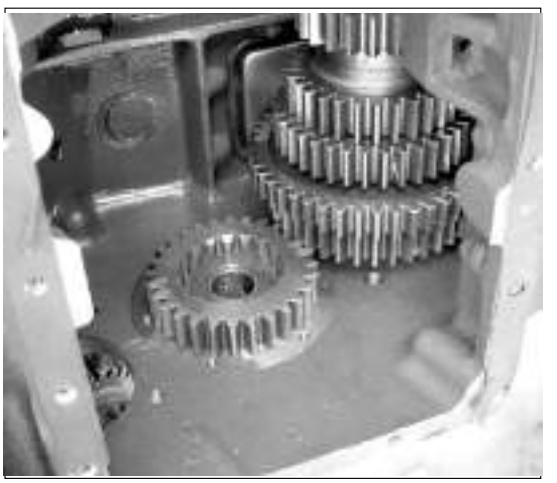


7. Take off the split ring from the bearing, and then insert shaft one into the housing hole from the inner side of the housing, reserve the space in the middle, so as to install the bearing in the housing holes. Reinstall the split ring to the outside of the bearing.

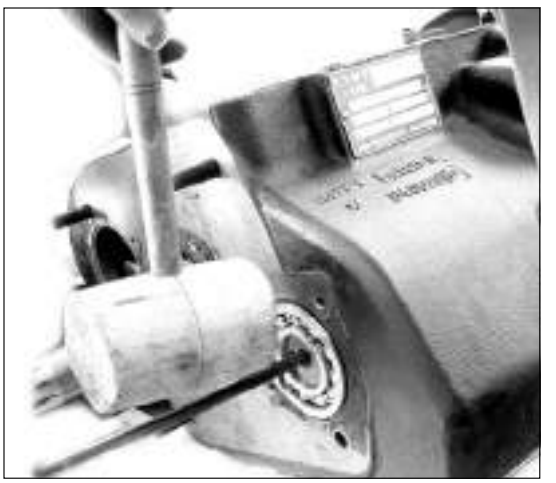


D. Matching Gears and Installing the Left Countershaft

1. Align the rear end of the left countershaft to the housing hole.



2. Locate the marked gear tooth of the transmission gear on the countershaft between two marked gear teeth on shaft one gear.



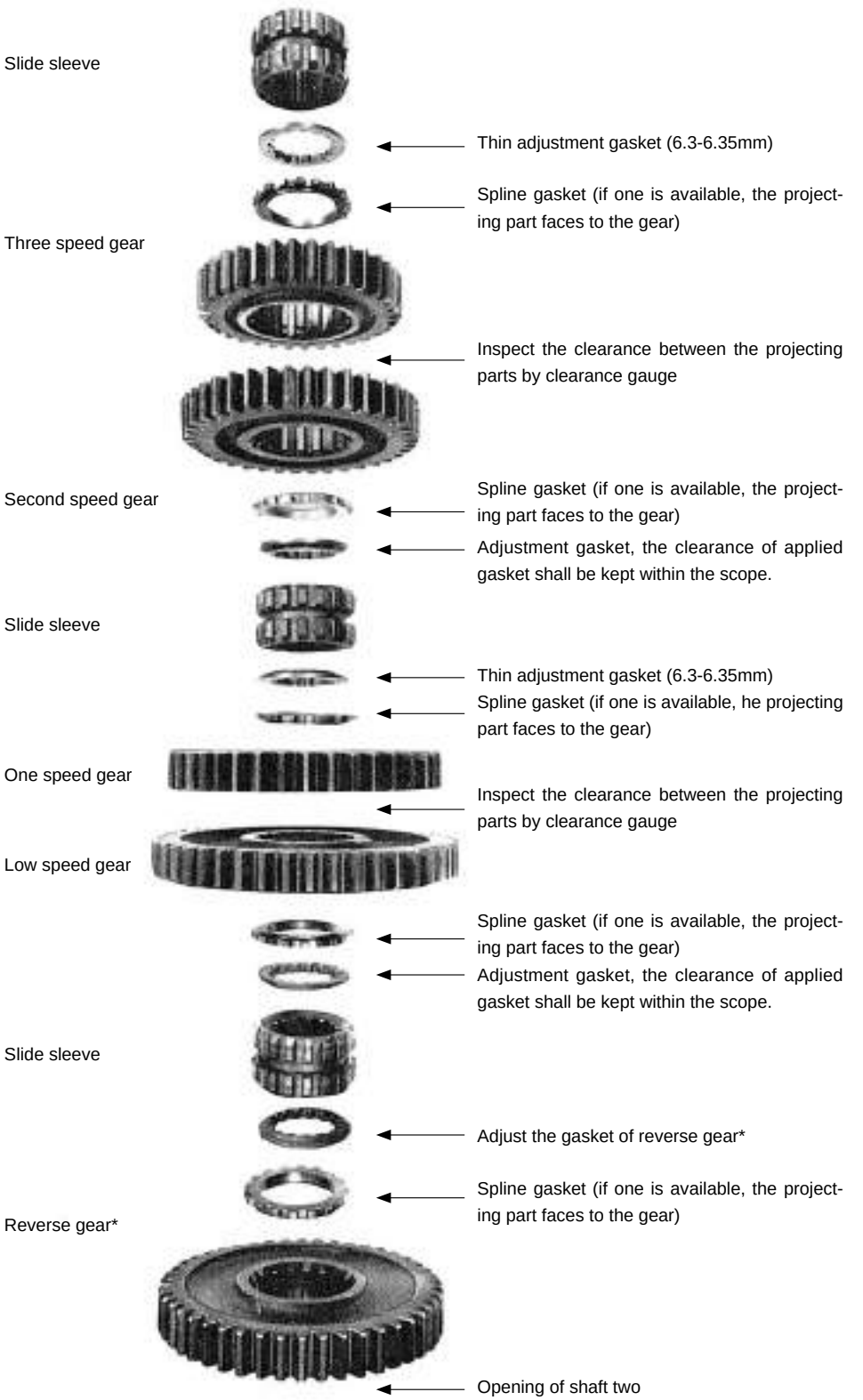
3. Install on the front bearing of left countershaft.

4. Take off centering tool, install rear bearing.

5. Apply two lock screws to install the retainer plate to the front bearing, and lock it with the iron wires.

6. New improvement type: apply the lock pin to install the front bearing guard cover.

7. Install the split ring to the ring groove at the rear end of shaft.


Slide sleeve
Thin adjustment gasket (6.3-6.35mm)
Spline gasket (if one is available, the projecting part faces to the gear)
Three speed gear
Inspect the clearance between the projecting parts by clearance gauge
Second speed gear
Spline gasket (if one is available, the projecting part faces to the gear)
Adjustment gasket, the clearance of applied gasket shall be kept within the scope.
Slide sleeve
Thin adjustment gasket (6.3-6.35mm)
Spline gasket (if one is available, he projecting part faces to the gear)
One speed gear
Inspect the clearance between the projecting parts by clearance gauge
Low speed gear
Spline gasket (if one is available, the projecting part faces to the gear)
Adjustment gasket, the clearance of applied gasket shall be kept within the scope.
Slide sleeve
Adjust the gasket of reverse gear*
Spline gasket (if one is available, the projecting part faces to the gear)
Reverse gear*
Opening of shaft two
Ring

►Adjustment of Proper Axial Clearance of Shaft Two Gear

The scope of axial clearance:
Reverse gear: – 0.30 to 0.90mm.
Forward speed gear: – 0.13 to 0.30mm.
The adjustment gasket can be applied to obtain the proper clearance scope; the below adjustment gaskets with six kinds of thickness are available in its application:

Thickness scope	Color marking
6.30mm~6.35mm	Whit
6.43~6.48mm	Green
6.55~6.60mm	Orange
6.68~6.73mm	Violet red
6.80~6.86	Yellow
6.93~6.99mm	Black

Refer the parts catalogue to find the part numbers.

- Four speed gear – available only in RTO/RTX and RTOX transmission.
- The adjustment of axial clearance for reverse gear is as follows: Install the split ring to the reverse gear, assemble the adjustment gasket (6.3-6.35) to shaft two, screw it into the lock groove and block it by key. Assemble the spline gasket to the shaft two and install it against the adjustment gasket, apply the split ring to block it.
- Install the reverse gear and driving gear of auxiliary transmission to shaft two and block it by split spring.
- Measure the clearance between the reverse gear and driving gear.
- Change the adjustment gasket at the front of the reverse gear if necessary.

E. Assembling and Placing Shaft Two

1. If it has been dismantled, assemble the split ring in all the gears of shaft two expect the reverse gears. Ensure to place the elastic cylindrical pin in the middle hole of spline for shaft two.

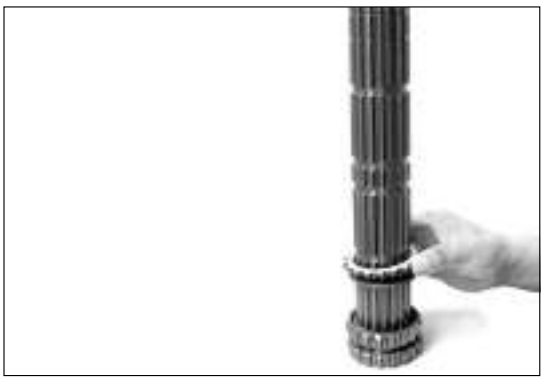
Caution ⚠

It is suggested to apply the proper parts catalogue in assembling shaft two, so as to provide the proper gear part number and its location.

2. Clamp the shaft two in the vise, and the leading end is at the bottom. Place one three speed gear washer in the ring groove of the lowest layer of shaft two, its surface end is at the top, rotate it and block it with a single key.

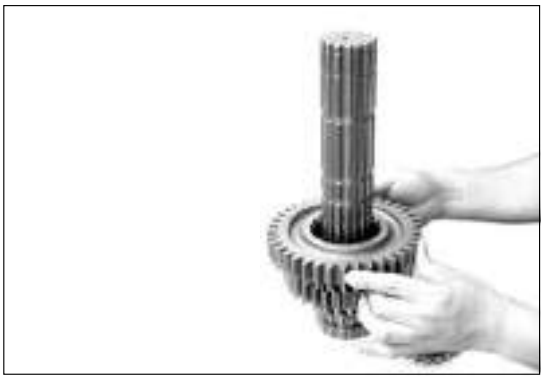
Caution ⚠

Ensure that the big opening in the inner spline is off the key groove in installing washer.

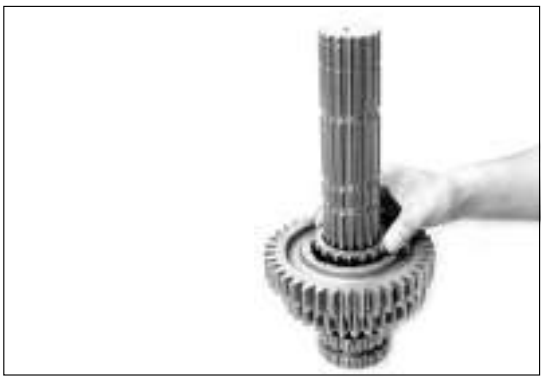


3. Assemble three speed gear spline washer to the shaft and locate it against the adjustment gasket.

4. Assemble three-speed gear above the spline washer, and the coupling gears are at the bottom.



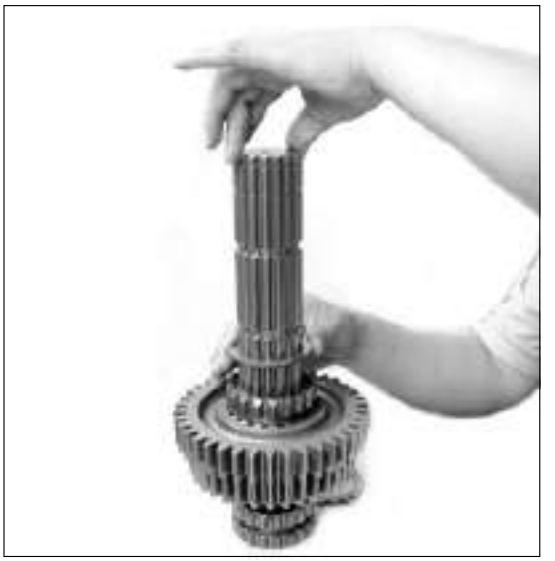
5. Assemble all two-speed gears above the three-speed gear, and the coupling gears are at the top.



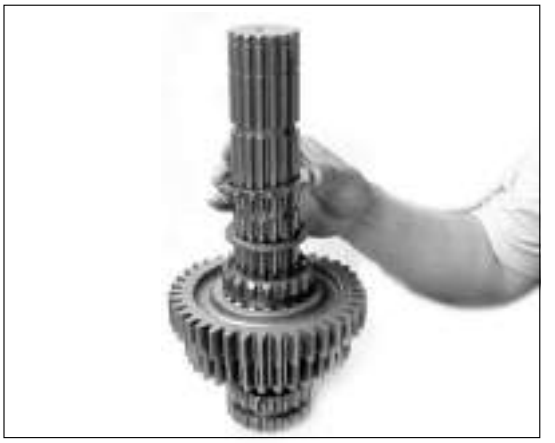
6. Assemble the spline washer in the two-speed gear, and the surface side is at the top.

7. Take off the single key, assemble the adjustment gasket of two-speed gear to the shaft, and the surface end is at the bottom. Rotate the adjustment gasket in the projecting parts of gear, and align it to the spline of shaft two, meanwhile, pay attention not to rotate the gears on the shaft. Select the proper adjustment gasket, so as to obtain the proper end clearance. The clearance between the projecting parts of gear shall be inspected by the clearance gauge. Reinstall the single key to the key groove.

8. Install one and two speed slide sleeve to the shaft, align the key groove of slide sleeve to the key of shaft two.



9. Take off the single key, and assemble the adjustment gasket of one speed gear to the shaft, the surface end is at the top. Reinstall the single key to the key groove.

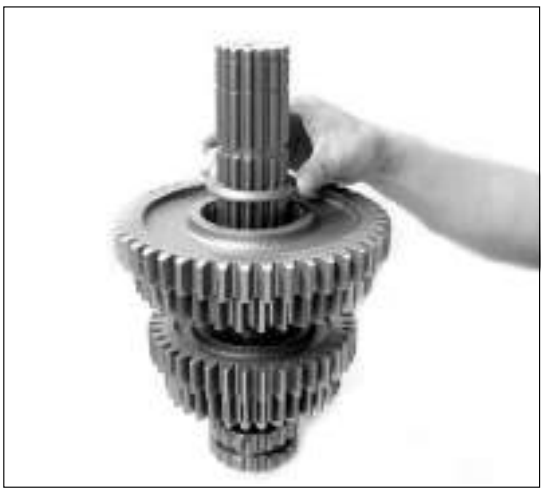


10. Assemble the spline gasket to the shaft and install it against the adjustment gasket, the surface end is at the bottom.

11. Assemble one speed gear to the shaft, and the coupling gears are at the bottom.

12. Assemble low speed gear to the shaft, and the coupling gears are at the top.

13. Assemble the spline gasket to the projecting parts of low speed gear. The surface end is at the bottom.



14. Take off the single key, and assemble the adjustment gasket to the shaft, the surface end is at the bottom. Rotate the adjustment gasket in the projecting parts of gear; align it to the spline of shaft two. Reinsert the single key, and inspect the clearance of projecting parts of gear.

15. Assemble the low and reverse speed slide sleeve to the shaft, and align the key groove of the slide sleeve to the key on shaft.

16. Take out the single key, and assemble the adjustment gasket of reverse gear, the surface end is at the top. Reinsert the single key.

17. Assemble the spline gasket to the shaft and install it against the adjustment gasket. The surface end is at the bottom.

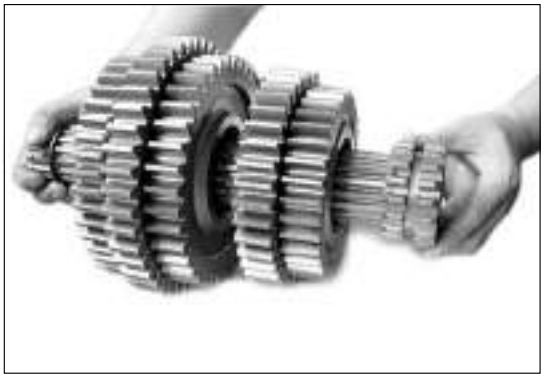
18. Assemble the reverse gear to the shaft. The coupling gear is at the bottom.

19. Install the split ring to the second ring groove from the top, and the opening of the split ring shall be avoided from the key groove.

Adjusting and Inspecting the End Clearance of Reverse Gear

20. Assemble the driving gear of auxiliary transmission to the shaft two, and apply the split ring at the end of shaft two to block it.

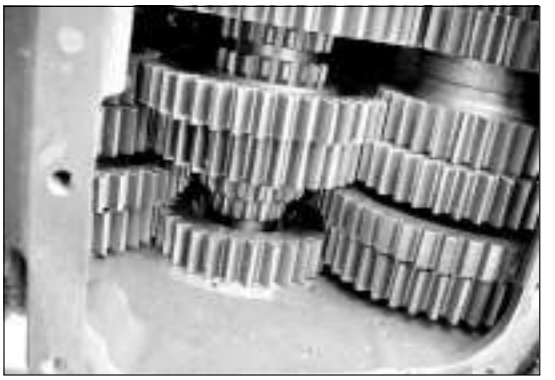
21. Insert two screwdrivers between the driving gear of auxiliary transmission and the reverse gear and lift them upward. Insert two clearance gauges to the projecting edges of two gears to inspect the clearance. Change the adjustment gasket of reverse gear and re-measure the clearance if necessary.



Installing Shaft Two

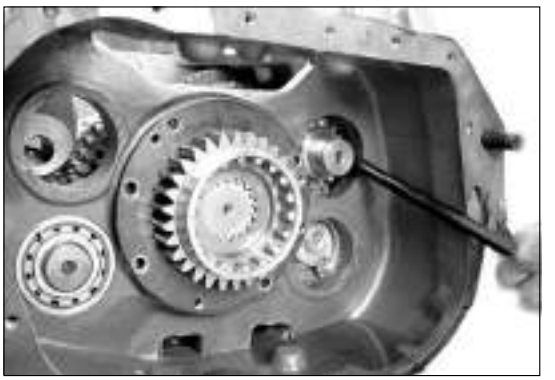
22. Take off shaft two from the vise, and assemble three and four gear slide sleeve to the shaft.

23. Push the countershaft forward to locate it against the inner wall of housing. Put shaft two on the housing of the transmission. It is still necessary to locate it against the reverse gear tightly at this time. Move shaft two forward through the driving gear hole of auxiliary transmission, locate the shaft end in the sleeve of shaft one.



F. Matching Gears and Installing Right Countershaft

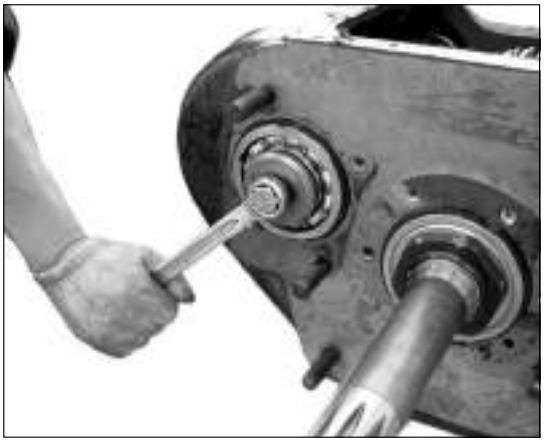
1. Locate the marked gear tooth of transmission gear in countershaft between two marked gears in shaft two, and ensure that the left countershaft are in the gear matching state at the same time.



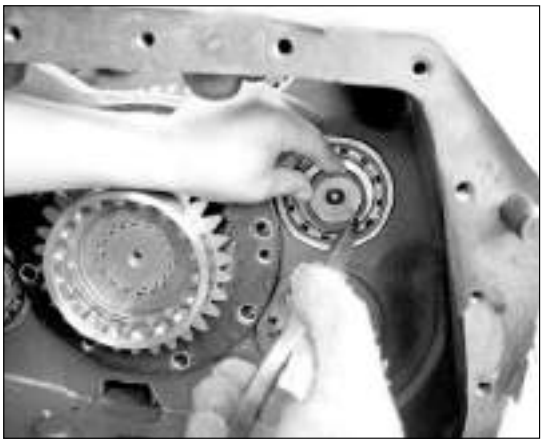
2. Center the rear end of shaft two and countershaft in the housing hole. The centering accuracy of shaft two is very important. Partially install the driving gear of auxiliary transmission to the hole so as to center shaft two.

3. Install the bearings to the front end of the countershaft.

4. Install the bearings to the rear end of the countershaft.



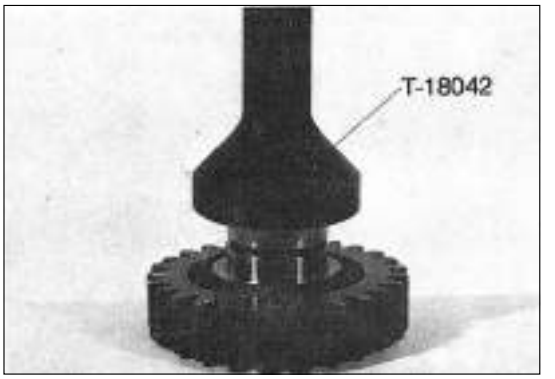
5. Install retainer plate of front bearing and lock it by iron wires.



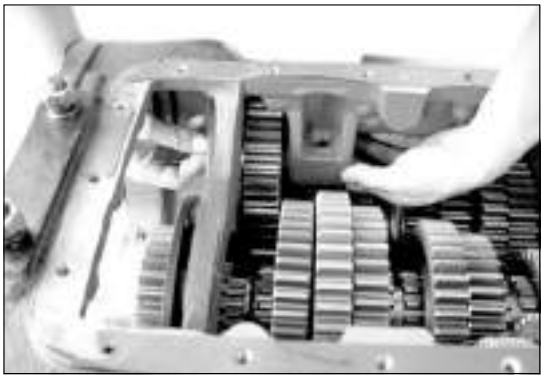
6. Assemble the split ring to the ring groove at the rear end of shaft.

G. Assembling and Installing Left Reverse Intermediate Wheel Shaft

1. Screw the plug cock into the shaft and slide the retainer plate and the inner ring of bearing slide along the shaft.



2. Press the outer ring of bearing into the hole of intermediate wheel.



3. Locate the thrust gasket and intermediate wheel in the housing hole, inserting the reverse intermediate wheel shaft into the hole by passing the intermediate wheel.

4. Ensure that the outer ring is aligned to the inner ring of bearing.

5. Assemble the gasket and nut to the shaft.

6. Assemble the outer ring of front bearing in the countershaft of auxiliary transmission into the housing hole of reverse intermediate wheel.

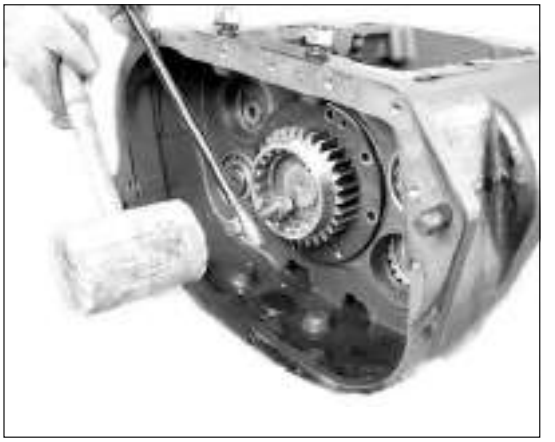
7. Mesh the reverse gears of shaft two to two reverse intermediate wheels, and place the split rings inside of reverse gear for shaft two.

H. Assembling and Installing the Driving Gears of Auxiliary Transmission

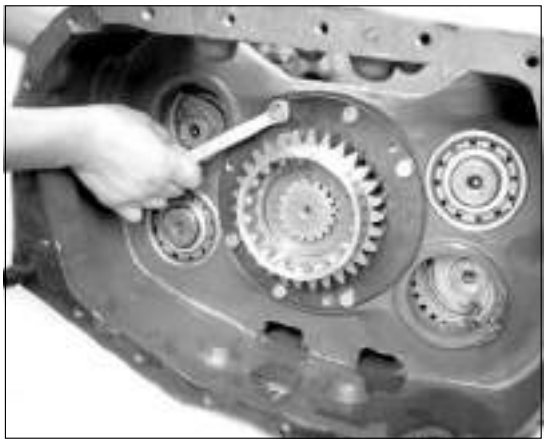
1. Install the positioning plate to the driving gear, and locate the surface end against the gears.

2. Press the bearings to the driving gears. The end of the split ring is upward.

3. Assemble the split ring to the ring groove of the shoulder of gear.



4. Assemble the driving gear of auxiliary transmission to the spline of shaft two. Locate the bearing in the rear hole of housing.



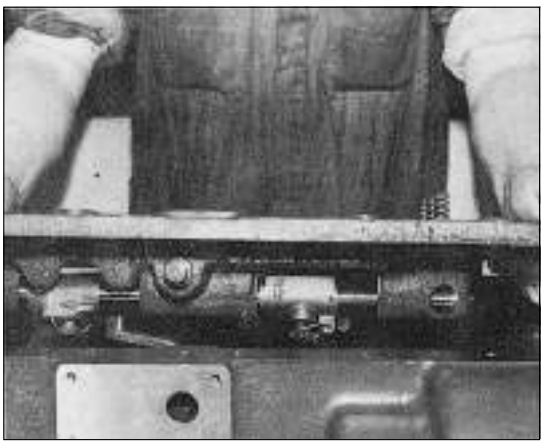
5. Lock the retainer ring and gear by six screws. Lock the screws by iron wires by two groups.

6. Assemble all the split rings to the ring groove of shaft two.

►Changing Shaft One

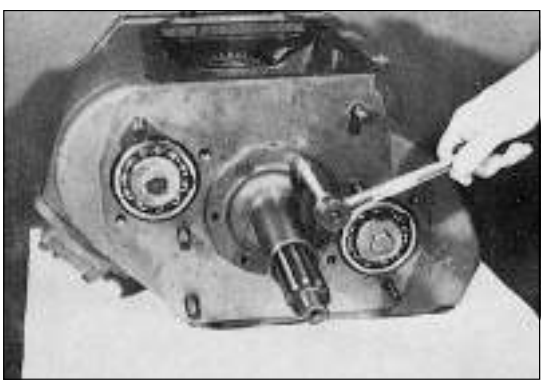
It is necessary to only change one shaft one in some conditions, which belong to the maintenance scope. The splines are worn due to frequent clutching of these shafts.

Under these conditions, shaft one can be taken out without dismantling the transmission (taking off the upper cover). Taking off the clutch housing is not necessary, and the detailed procedures are as the below.

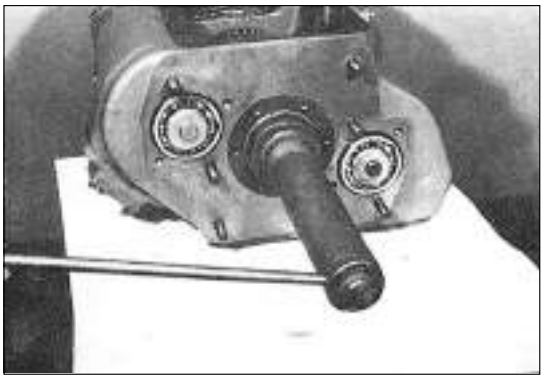


Disassembling Shaft One

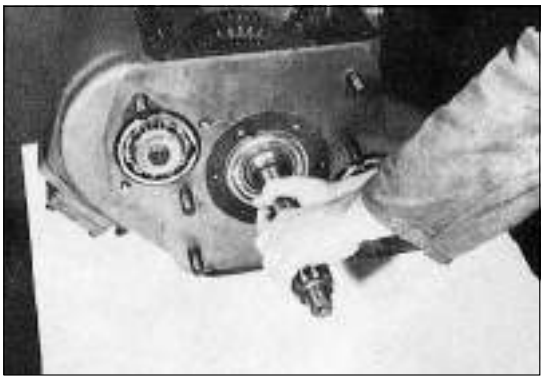
1. Take off the housing of shifting lever (double H control device) and upper cover from the transmission.



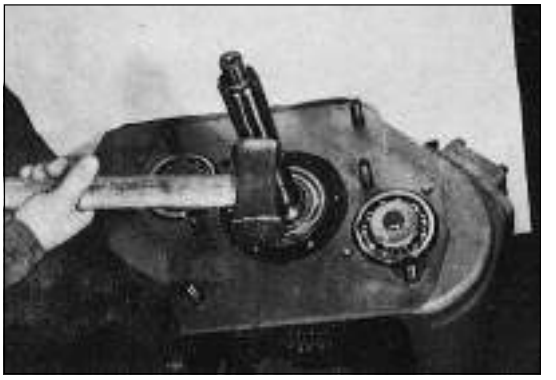
2. Take off the front bearing cover.



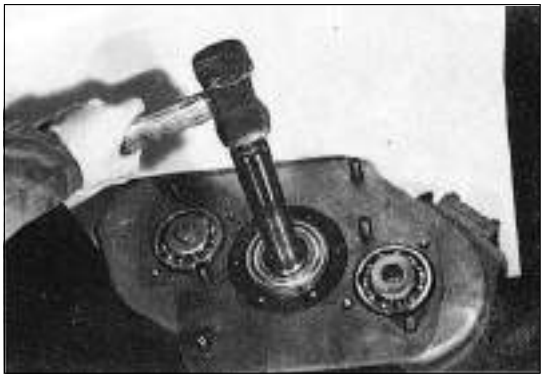
3. Mesh the slide sleeves of shaft two to two gears, and take off nuts of gear bearings for shaft one (left hand screw).



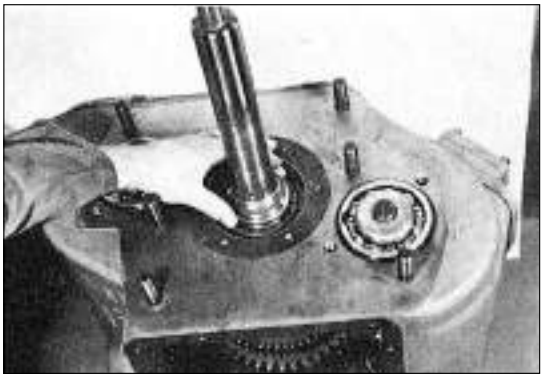
4. Move the shaft and bearing forward.



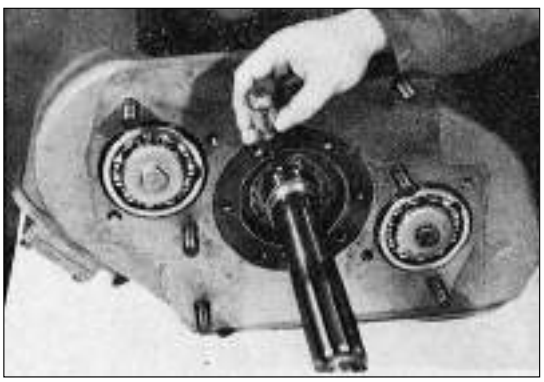
5. Knock the shaft one to lift the bearing.



6. Take off bearings. Repeat the procedures in Fig. 4, 5 and 6 if necessary.

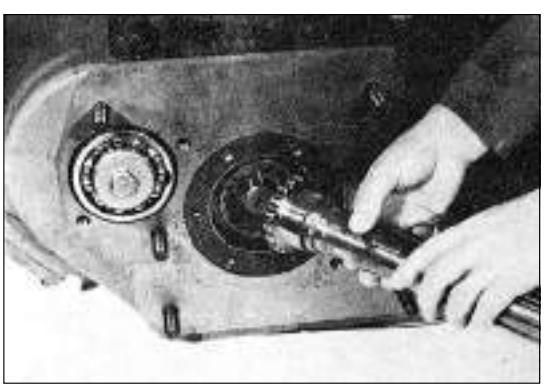


7. Take off washer from shaft one.



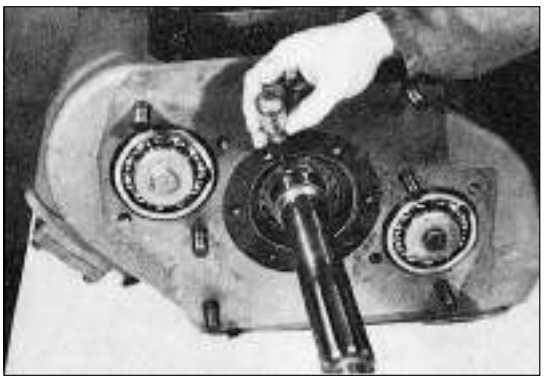
8. Take off split ring inside the gear of shaft one from the front side.

9. Move the shaft one forward to release it from gear spline on shaft one.

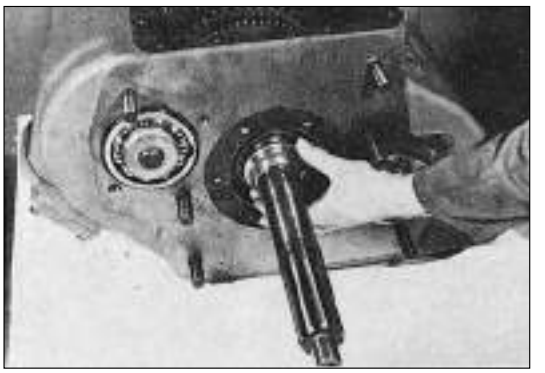


Assembling Shaft One

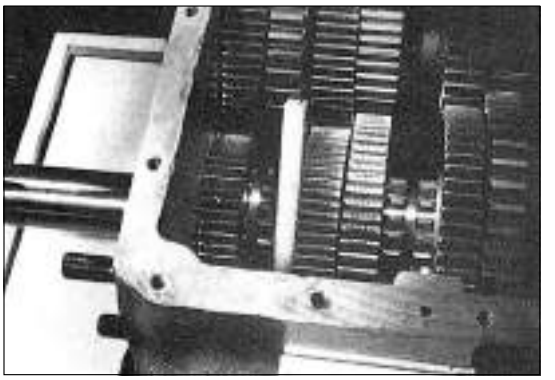
1. Install new shaft one to the gear spline of shaft one, properly and completely expose the ring groove of split ring inside the gear of shaft one.



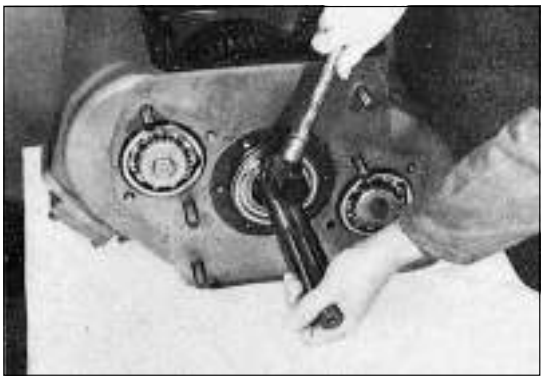
2. Assemble the split ring to the inside of the gear for shaft one.



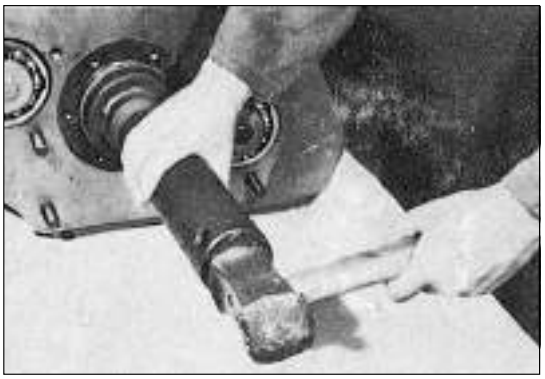
3. Couple the gasket to the shaft one.



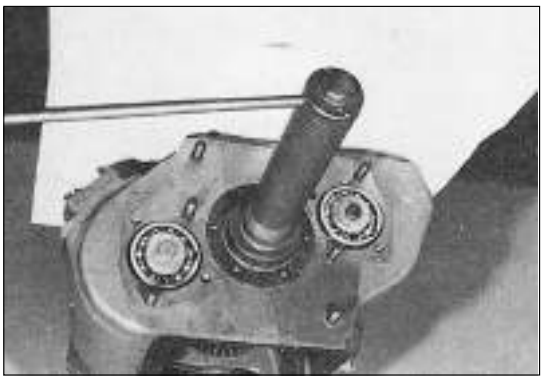
4. Engage gear 4 and insert wood blocks between three-speed gears and the rear side of slide sleeve, so that shaft one can be fastened in the proper location to properly install the bearings in the process of installing bearings.



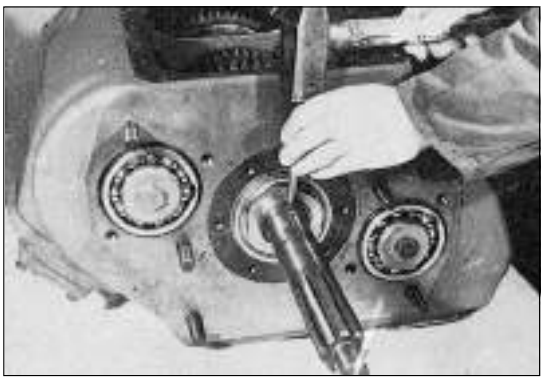
5. Assemble the bearings.



6. Assemble gear bearings of shaft one to the shaft, and install them in the housing holes, ensure that the wood block is kept still in the slide sleeve.



7. Apply the sealing glue to the screw of nut and tighten it.



8. Knock nuts and embed them into two milled grooves in the shaft.

9. Assemble the front bearing covers, clutch housings and etc.

Caution ⚠

The above instructions are only applied to change shaft one, if it is required to change gears in shaft one, the main transmission part shall be completely dismantled.

Precautions of Disassembly and Assembly

►Precautions of Disassembly and Inspection of Easily Worn-out Parts

● Cautions of Disassembly

1. Bearing – carefully clean and inspect whether the raceway has pitting, whether the roller is complete. Apply the special tools in the assembling process.
2. While disassembling various assemblies, place all parts on the clean work bench according to the sequence of disassembly, thus, it is convenient to follow the procedures for reassembly and reduce the possibility of part loss.
3. Shaft one can be disassembled without removal of the gears of countershaft, shaft two and shaft one.
4. The maintenance works shall be done in a clean field, do not allow the dusts or its impurities go inside the transmission. Carefully clean the outside of the transmission prior to disassembly.

● Inspection of Easily Worn-out Parts

Carefully inspect each part for transmission prior to reassembly, preventing from installing the damage part into the transmission, resulted in unnecessary loss.
The below is the recommended inspection procedure:

A. Bearing

1. Wash all bearings in the clean solution. Inspect whether the steel ball, roller and bearing raceway have pitting or peeling.
2. Clean undamaged bearing, and inspect the axial and radial clearances. Change the bearings with over big clearance.
3. Inspect the fitting between the bearing and housing hole. If the outer ring can freely rotate in the hole, the housing shall be changed.

B. Gear

1. Inspect whether the gear tooth surface has pitting, change the gears producing pitting on the gear surface.
2. Inspect all meshed gears. Change any worn gears with taper or reducing the meshing length due to collision of shifting.
3. Inspect the axial clearance of gear. Check whether the split ring, washer, adjustment gasket and the projecting edge of gear have excessive abrasion in case any over big clearances are found. The axial clearance of forward speed gear of shaft two shall be kept between 0.13 and 0.30mm, and that of the reverse gear is kept between 0.30 and 0.90mm.

C. Spline

Inspect the wear degree of splines on all shafts. If the slide gear sleeve and output flange are deflected to the side of spline due to abrasion, they shall be changed.

D. Thrust Gasket

Inspect the surface conditions of all thrust washers. Change any gaskets with scratches or washers with reduced thickness.

E. Parts of Gray Cast Iron

Inspect all cast iron parts, whether there are any cracks or damages. The big casting parts can be welded or brazed, however, the produced thermal cracks shall not be extended to the bearing hole or the connecting surface of bolts.

F. Bearing Cap

1. Inspect the wear conditions of stop hole.
2. Inspect the oil seals for bearing caps in shaft one and for housings of speedometer. If the sealing function of the lip parts is failed, the sealing parts shall be changed.

G. Synchronizer

1. Inspect whether the high and low speed synchronizer has burrs, uneven places, and whether the contact surface has any excessive abrasion conditions.
2. Inspect whether the lock pin has excessive abrasion.
3. Inspect whether the contact between high and low speed gears and synchronizer has any excessive abrasion conditions. The burned synchronizer or high and low speed gears with burned contact surface shall be changed.

H. Slide Sleeve

1. Inspect whether all shift forks and shift fork grooves of slide sleeves have any excessive abrasion or discolor due to over heat.
2. Inspect the coupling gears of slide sleeve, to see whether the contact zone has any deflection.

I. O Ring

Inspect for the breakage and deformation conditions of all O rings. Change any worn parts.

►Cautions of Assembly

The following cautions shall be complied with in assembly process:

1. Gasket- New gaskets shall be applied in reassembling transmission.
2. Screw – In order to prevent from oil leakage, all screws shall be applied the screw sealing glues. The corresponding torque value shall be executed according to the specified value.
3. O Ring – lubricate all O rings by silicone grease lubricant.
4. Initial lubrication – the lubrication greases shall be applied to all thrust washers as the application of initial lubrication in assembly process, which can prevent from scratch or wear.
5. Axial clearance – maintain the axial clearance of 0.13 to 0.30mm for original forward gears of shaft two, the axial clearance of reverse gear is 0.30 to 0.90mm.
6. It is recommended to use the bearing assembly and disassembly device with projecting end to install bearings, applying this kind of assembly and disassembly device equals to applying forces to the inner and outer rings of the bearings, which can prevent from the damage of steel balls and inner and outer

rings, and keep the concentricity of bearing, shaft and hole. If the pipe type assembly and disassembly device is applied, the forces can only be applied to the inner rings.

7. Tighten the flange nuts of output shaft. Tighten the nuts of output shaft by applying the torque of 610 to 680 Nm. Otherwise, the serious consequences will be caused.

►Tightening Torque

Seq. No.	Application Part	Bolt (Nut)	Recommended Tightening Torque
1	Clutch housing	6-M16×1.5	244~271Nm
2	Clutch housing	4-M12	108~135Nm
3	Bearing cap for shaft one	6-M10	47.5~61Nm
4	Gear of shaft one	M54×1.5-left	338~406Nm
5	Double H control device	8-M10×1	47.5~61Nm
6	Upper cover	16-M10	47.5~61Nm
7	Lock screw of shift fork	5-M12×1.25	67.5~88Nm
8	Shift fork of auxiliary transmission	2-M12×1.5	67.5~88Nm
9	Support of air filter	2-M6	13.5~20.3Nm
10	Output shaft	M50×1.5	609~677Nm
11	Rear cover of auxiliary transmission	19-M10	47.5~61Nm
12	Oil discharge hole	Z3/4"	61~74.5Nm
13	Oil filling hole	Z1 1/4	81~101.5Nm
14	Positioning plate of driving gear for auxiliary transmission	6-M10	47.5~61Nm
15	Countershaft of reverse gear	2-M16×1.5	67.5~81Nm
16	Rear cover of countershaft for auxiliary transmission	8-M10	47.5~61Nm
17	Bottom cover for power take-off	8-M12	67.5~88Nm
18	Brake cover for countershaft	8-M10	47.5~61Nm
18a	Side window cover for transmission	6-M10	24.5~31Nm
19	Rear bearing cap for main shaft	6-M10	47.5~61Nm
21	Housing of shifting cylinder	4-M10	47.5~61Nm
22	Cylinder head	4-M10	47.5~61Nm
23	Bottom cover of clutch housing	4-M8	20~27Nm
24	Countershaft	2-M16×1.5	122~162Nm
25			

►Special Tools

Special tools for Shanxi FAST transmission are the specially designed and manufactured maintenance tools to disassemble and assemble Shanxi FAST transmission.

Special tools for Shanxi FAST transmission are composed of several parts, such as: front bearing stripper for countershaft, stripper for countershaft of reverse gear, stripper for outer ring of front bearing in countershaft for auxiliary transmission, disassembly lever and disassembly sleeve for rear nuts of shaft two, the structure is reasonable and its application is convenient, which are the necessary tools to disassemble and maintain Shanxi FAST transmission.

Applying special tools for Shanxi FAST transmission can produce better results with less effort. Please choose special tools for Shanxi FAST transmission to repair, disassemble and assemble Shanxi FAST transmission.

►List of Special Tools

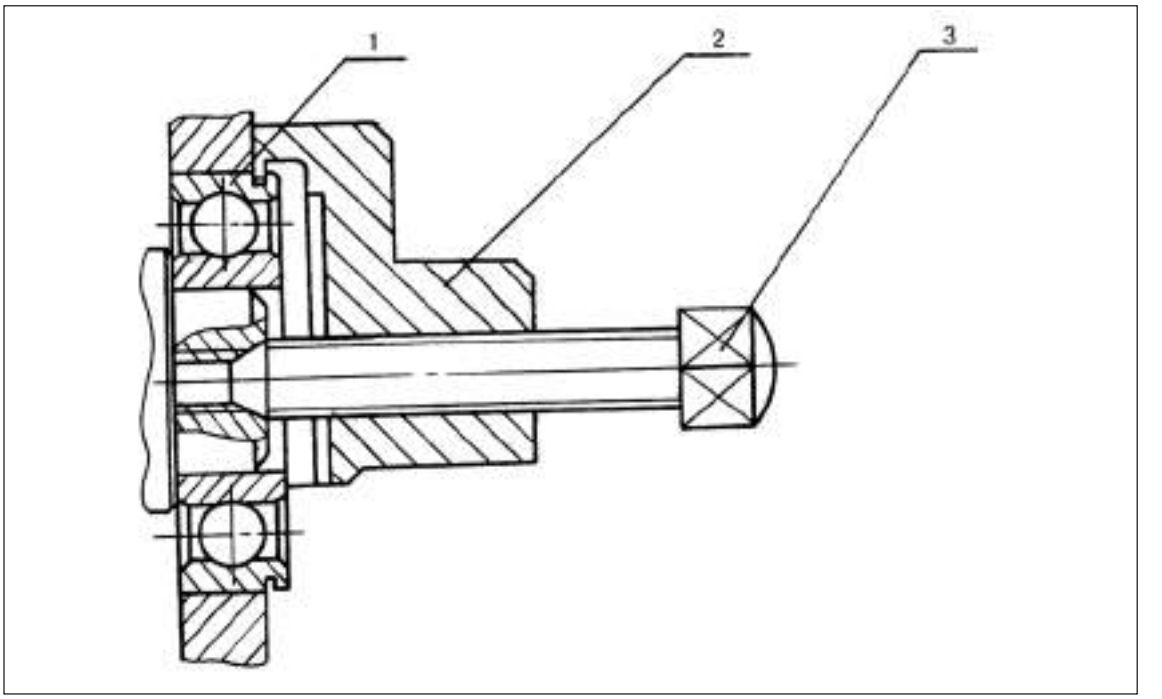
For convenience to disassemble and repair Shanxi FAST transmission, the following special tools are prepared, the users can choose them according to the actual conditions.

Seq. No.	Drawing No.	Name	Application Part	Part Number and Part Name
1	BW-Z01	Front bearing stripper for countershaft	Front bearing of countershaft for main transmission	Z01-01 Force acting plate Z01-2 Screw arbor
2	BW-Z02	Stripper for outer ring of front bearing in countershaft for auxiliary transmission	Outer ring of front bearing in countershaft for auxiliary transmission	Z02-01 Screw arbor Z02-02 Gripper carrier Z02-03 Fixed sleeve Z02-04 Pull plate
3	BW-Z03	Stripper for countershaft of reverse gear	1. Inner ring of rear bearing of countershaft for auxiliary transmission 2. Countershaft of reverse gear for main transmission	Z03-01 Strip joints Z03-02 Stud joints Z03-03 Force acting lever Z03-04 Impact sleeve Z03-05 Pin Z03-06 Handle
4	BW-Z04	Sleeve joints	Self-lock nut for output shaft of auxiliary transmission	
5	BW-Z05	Snap ring installer for holes	Each speed gear of shaft two for main transmission	Z06-01 Screw driver Z06-02 Nut Z06-03 B Nested handle ball
6	BW-Z06	Disassembly lever	Each shaft end and part surface	

►Application of Special Tools

The following figures are applied to explain how to use the special tools properly.

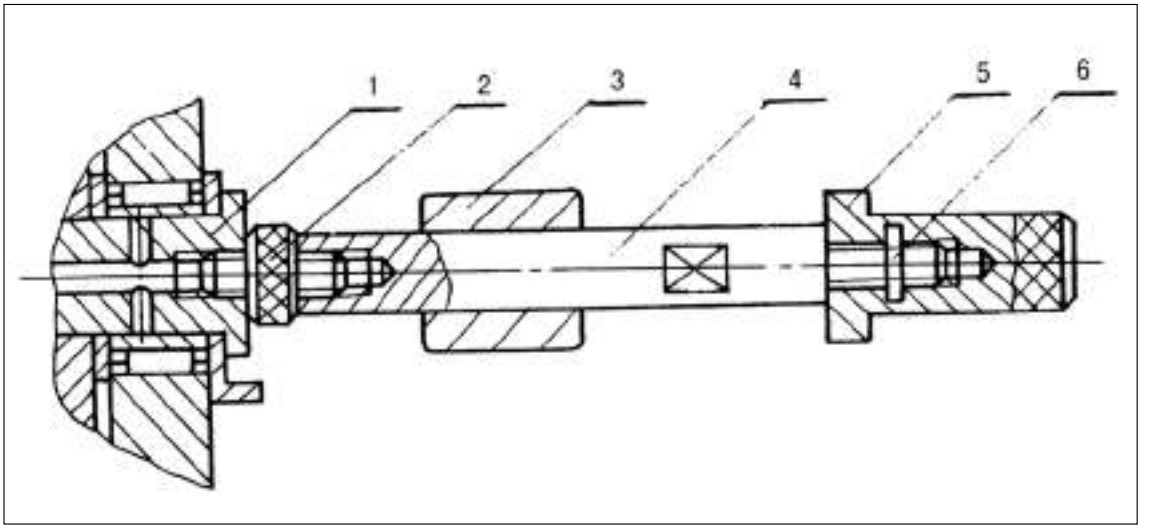
1. Front bearing stripper for countershaft



1. Front bearing of countershaft 2: Force acting plate 3: Screw arbor

Fig. 1: Disassembly Chart for Front bearing of Countershaft

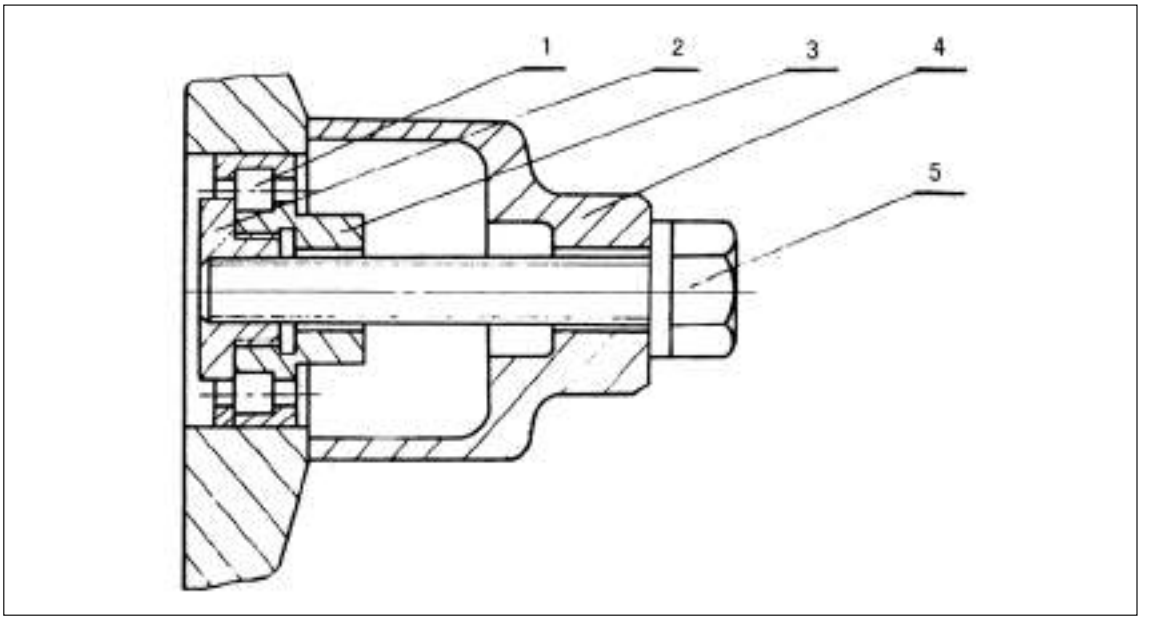
2. Stripper for countershaft of reverse gear



1. Countershaft of reverse gear 2. Stud joints 3. Impact sleeve
4. Force acting lever 5. Handle 6. Pin

Fig.2: Disassembly Chart for Countershaft of Reverse Gear

3. Stripper for outer ring of front bearing in countershaft for auxiliary transmission



1. Outer ring of bearing 2. Pull plate 3. Fixed sleeve
4. Gripper carrier 5.Screw arbor

Fig 3: Disassembly Chart for Outer Ring of Front Bearing in Countershaft for Auxiliary Transmission

4. (Rear bearing of countershaft) disassembly lever

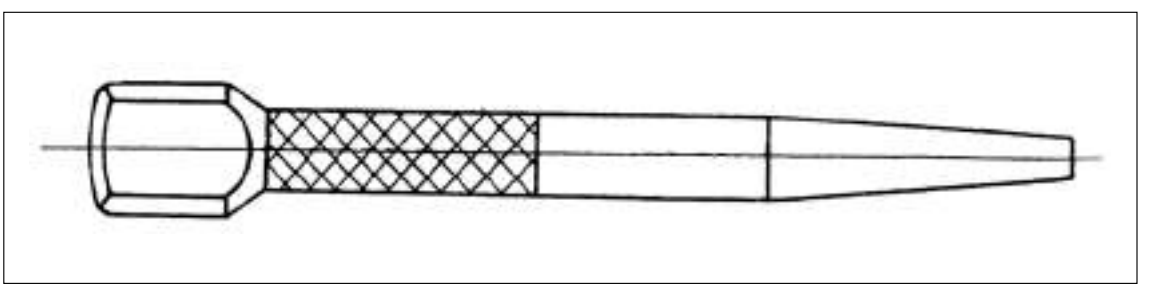


Fig. 4: (Rear Bearing of Countershaft) Disassembly Lever

5. Disassembly Bar

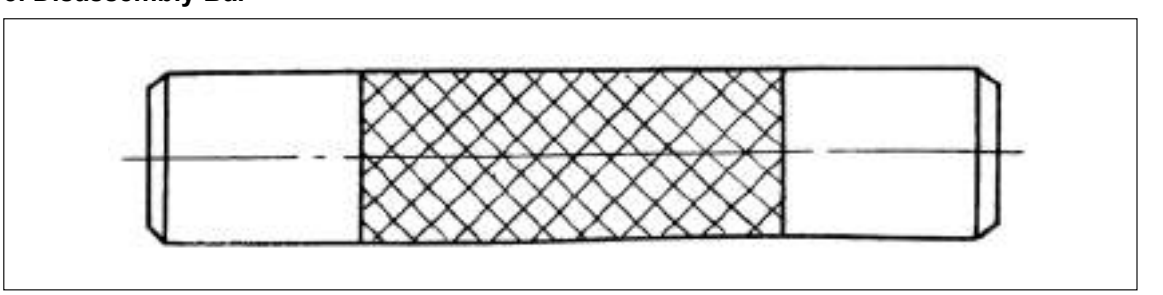


Fig. 5: Disassembly Bar

6. Snap ring installer for holes

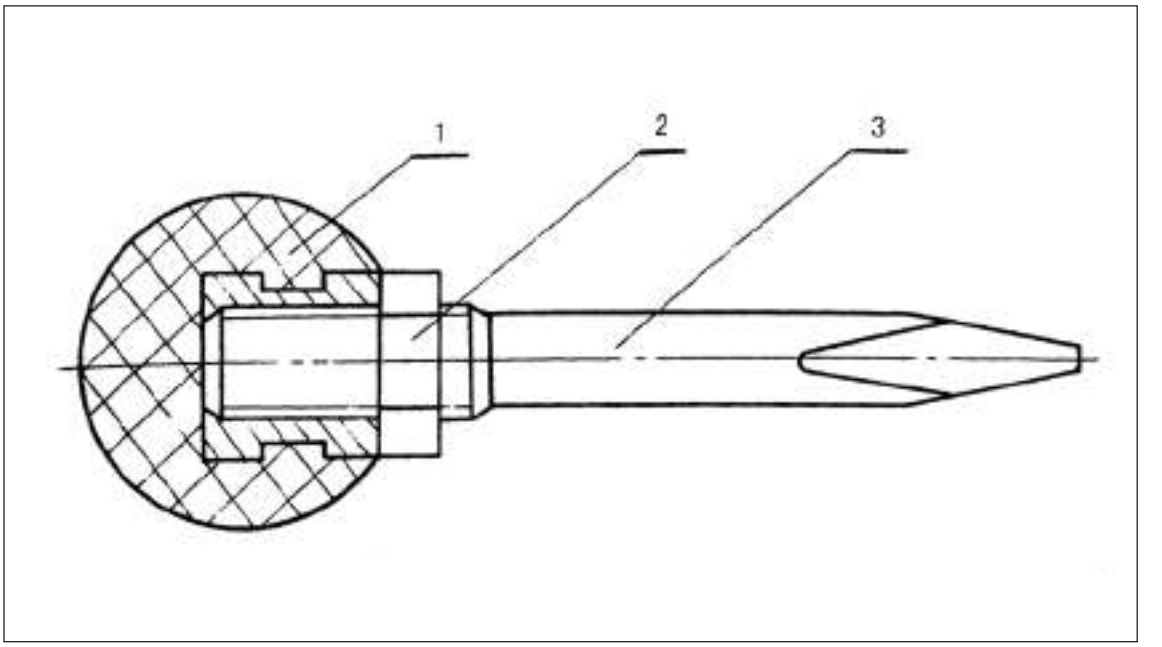


Fig. 6: Snap Ring Installer for Holes

7. Sleeve Joints

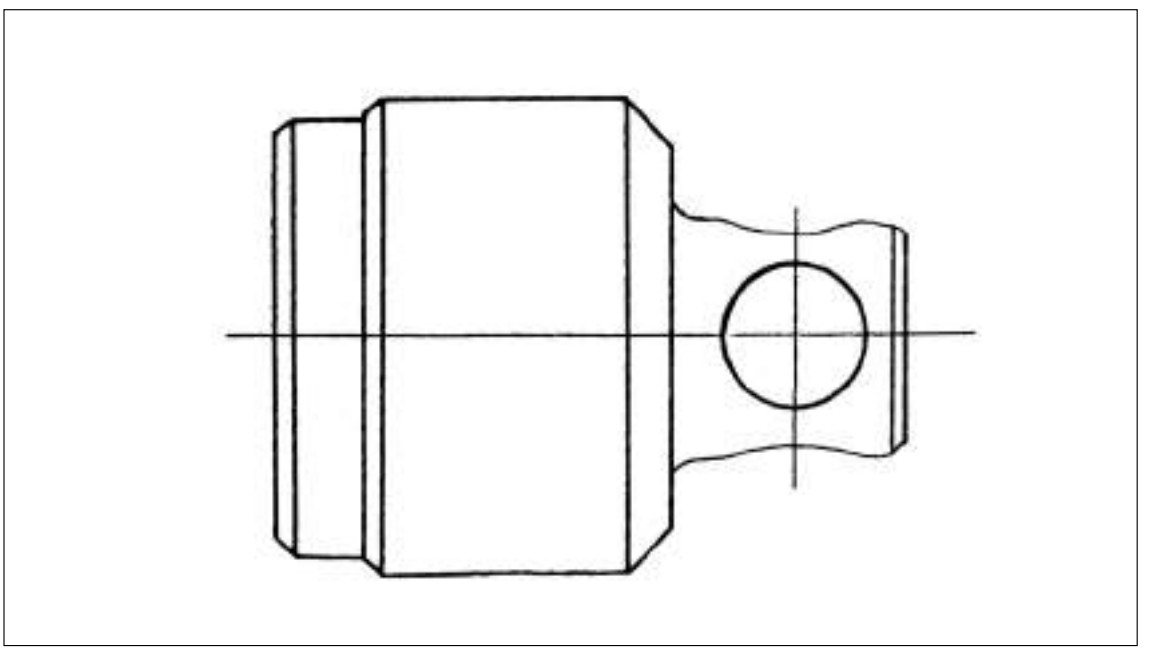


Fig. 7: Sleeve Joints

15 Braking System

Basic structure of braking system

This vehicle adopts dual circuit pneumatic braking system, fitted with pneumatic foot brake acting on wheels and energy storage spring brake acting on rear wheels. The energy storage spring brake is operated by manual control valve, and can also be used for emergency braking.

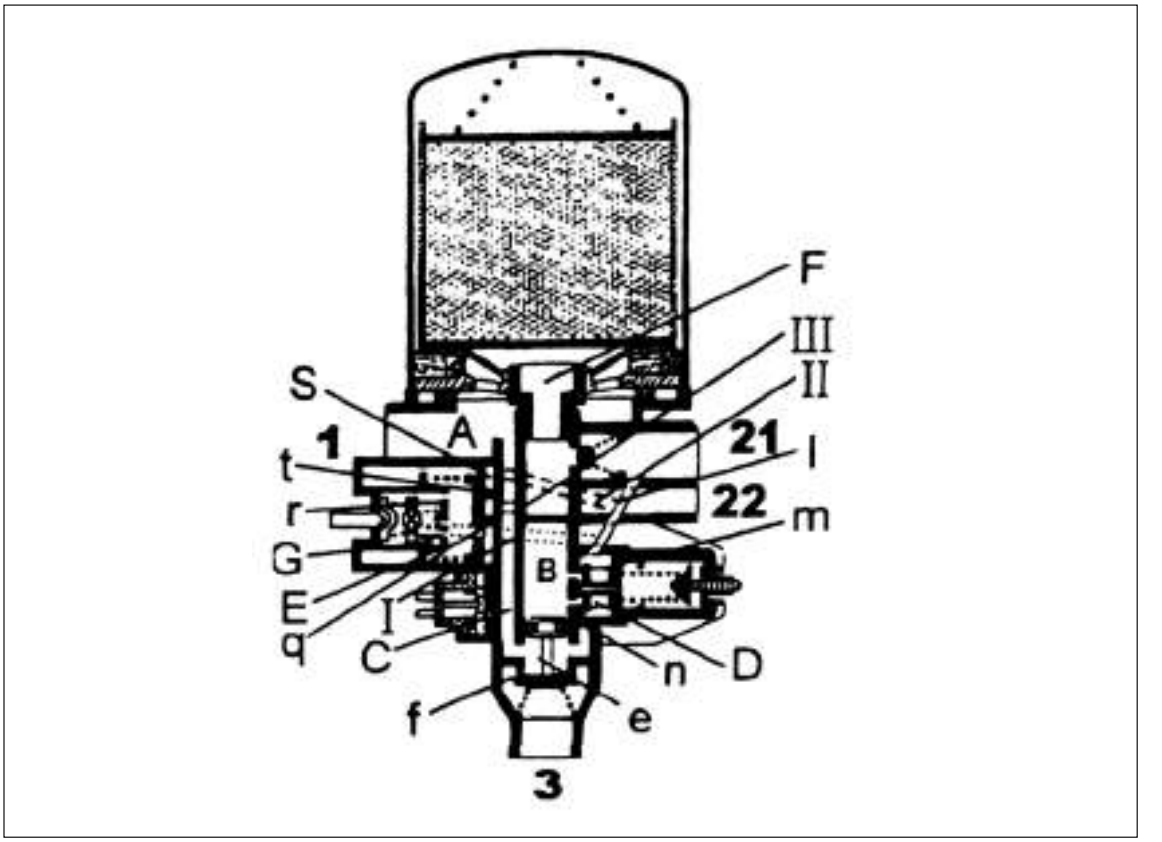
►Air source

This part consists of air compressor, air drier, air reservoir, 4-circuit protection valve, and other related accessories.

1. Air drier

Purpose of air drier: It uses the integrating structure with that of unloading pressure control valve, load relief exhaust action process is utilized so that dry compressed air in air reservoir (an accessory) flows past desiccant cylinder in reverse direction, and water absorbed on desiccant surface is taken away and vent to atmosphere, realizing regeneration of molecular sieve and long-term and effective absorption of water in compressed air, providing clean and dry compressed air for pneumatic circuit, and increasing service life of desiccant.

Air drier operating principle: refer to figure.



● **Operating principle:**

● During air charging, compressed air output by air compressor enters chamber A via interface 1. At this time, due to decrease of temperature, condensate will be generated and drained via passage C and exhaust valve F.

● Compressed air flows past filter J in drying and filtering cylinder, and arrives at upper part of drying and filtering cylinder B via circular passage K. When the air flows past desiccant, water content is absorbed by desiccant and stays on its surface. Via one-way valve c and port 21, dried air flows to air reservoir and break apparatus connected with cylinder. At the same time, dried air flows to regeneration air storage cylinder via port 22.

● When exhaust valve f is closed, port 22 supplies air to the air reservoir. At the same time, on one hand, compressed air from port 21 enters cavity G via passage I, opening valve r, entering cavity E, and acting on upper part of diaphragm t; on the other hand, this compressed air enters cavity S via passage II. Open valve 8 and connect the two cavities before and after port 21 one-way valve. When the system reaches cutoff pressure, compressed air from pressure control valve will enter cavity D via oblique hole I, and act on diaphragm m. When the pressure exceeds spring pressure, air intake n opens, and air pressure acts on piston e, moving it down and opening exhaust valve f. Compressed air from air reservoir passes passage II, cavity S and passage II to enter cavity F, taking away water on surface of desiccant a, passing passage c and exhaust valve f and vented to air via exhaust port 3. When return flow pressure of passage III exceeds a set value, the diaphragm closes valve 8 and stop return flow, till air supply by pressure control valve is restored, at which time drying process will start again.

● Air drier is also fitted with an automatic heater g to prevent freezing of piston, which possibly result in fault.

● Periodically check effect of drying. Check accumulated water in air reservoir (recommended once a month). If accumulated water is found in the air reservoir that is farthest from drier, this indicates that desiccant is no longer effective and drying cylinder shall be replaced (recommended once a year). Method to replace drying cylinder: Right-handed thread connection is used between drying cylinder and lower casing. Use hand to unscrew existing drying cylinder, and screw new cylinder on. Note that the rubber seal ring between drying cylinder and lower casing shall be cleaned and placed in proper position.

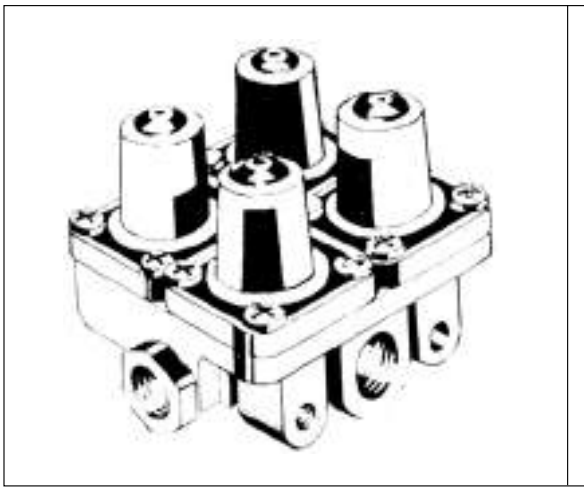
● For vehicles with air drier, use air compressor of less oil blow-by, good piston ring and oil retaining ring as much as possible. This is because oily dirt can reduce absorptive power of desiccant.

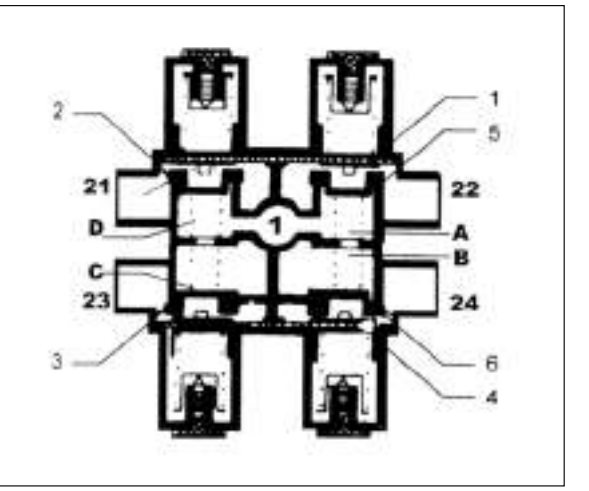
2. Air reservoir

This system is provided with an isolated chamber type air reservoir with 4 chambers, namely front axle air reservoir, rear axle air reservoir, spring braking air chamber air reservoir, and main air reservoir.

3. 4-circuit protection valve

4-circuit protection valve is used to ensure isolation of air reservoir. During running of the vehicle, in case of damage and air leakage of any circuit connected to this valve, pressure in other circuits will first fall below safety air pressure, and then pressure in sound circuits will rise above safety air pressure. Minimum safety pressure is 670Kpa.

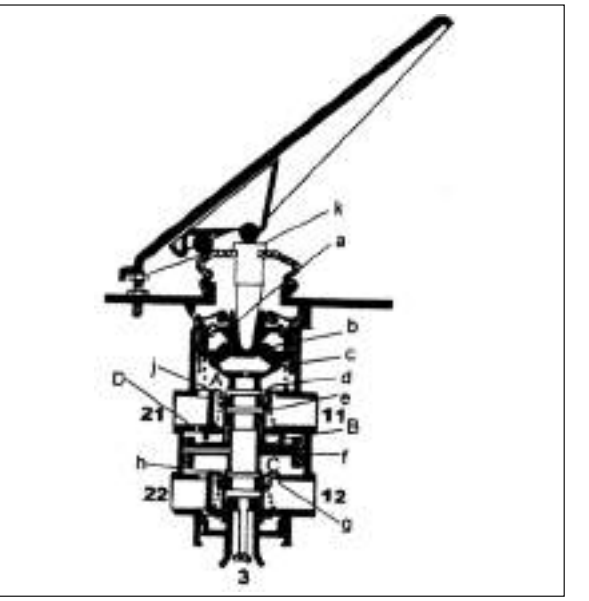




● **Operating principle:**

Pressurized air enters via port 1 to cavities A, D, B and C simultaneously. When reaching valve opening pressure, valves 2, 3, 5 and 6 will be opened and compressed air is sent to air reservoir via port 21, 22, 23 and 24. In case of fault in a certain circuit, e.g. circuit 21, due to one-way action of valves 3, 5 and 6, it is ensured that air pressure in circuits 22, 23 and 24 will not leak through port 21. At the same time, air pressure of ports 22, 23 and 24 acts on diaphragm 4 and right half of diaphragm 1, so that air pressure from port 1 can easily open valves 3, 5 and 6, and continue to supply air to circuits 22, 23 and 24. When charging pressure reaches or exceeds opening pressure of valve 2, air pressure will leak from faulty circuit 21, while pressure in other circuits (not damaged) can still be ensured.

► Common braking adopts dual circuit control, which is realized by dual cavity series brake valve. Upper cavity of this brake valve controls rear circuit, while lower cavity controls front circuit.



1. Brake valve

- By means of pedal control device, control mandrel K and mandrel seat A, brake valve is activated.
- During braking, mandrel seat a pushes piston c down via rubber spring b, closing exhaust valve d and opening intake valve i. Compressed air from port 11 arrives at cavity A, and then is output to brake pipeline I via port 21. At the same time, air flow arrives at cavity B via hole D, and acts on piston F, so that piston F moves down, closing exhaust valve h and opening intake valve g. Compressed air from port 12 arrives at cavity c, and is then output to brake pipeline II from port 22.
- When relieving braking, air pressure from ports 21 and 22 will be vent to atmosphere via exhaust valve d and h respectively and exhaust port 3.
- In case the first circuit fails, valve assembly e pushes piston f down, closing exhaust valve h and opening intake valve g, so that second circuit can operate normally. In case of failure of the second circuit, normal operation of the first circuit will not be affected.
- Pressure established in cavity A acts on bottom face of piston C, overcoming force of rubber spring b for upward movement, till force balance is achieved between upper and lower surfaces of piston. At this position, intake valve j and exhaust valve d are closed at the same time, reaching a balanced position.
- With the same mode, pressure rising in cavity C moves piston F upward till a new balanced position is achieved here. Intake and exhaust valves will close at the same time.
- Under full-braking operating conditions, Piston C is moved to its lower thrust position, and intake valve i remains open. Pressure acting in cavity B via hole d also pushes piston f to its lower thrust position, and maintains intake valve g open.
- Air in the air reservoir flows into the two brake circuits freely.
- Air exhaust in the two circuits adopts totally inverse sequence, and can be controlled in the same way. Compressed air in cavity A and cavity C moves pistons C and F upward. Via open exhaust valves d and h and exhaust port 3, the two circuits vent partially or completely corresponding to different positions of the tappet.
- In case of air leakage in one circuit, e.g. circuit 2, circuit 1 will continue to operate in the described mode. Conversely, in case of air leakage in circuit 1, during braking, piston f is pushed down by valve e, exhaust valve h is closed, intake valve g is open, and balance is achieved in the mode described above.

►Parking brake

Parking brake makes use of spring brake air chamber fitted on rear axle and is operated by means of hand control valve.

1. Hand control valve

Operating principle of hand control valve:

- A brief structural diagram is shown in Fig.9-5. Running state: push handle 10 and drive cam 5 to rotate to running position. Upper piston 3 falls and presses down balance spring 2. Push lower piston 18 down to close exhaust valve. Push open intake valve, so that compressed air in cavity 6 enters cavity a. At this time, compressed air in cavity a is divided into 2 lines: one line enters spring brake air chamber via port 21 to relieve spring braking; the other line enters trailer control valve via port 22 to relieve braking of trailer. At this time, the vehicle is in a state totally out of braking.

- Parking brake state: Push handle 10 to parking braking position. Due to function of the balance spring, it has a good performance of follow-up during operation and emergency braking can be carried out.
- When handle 10 reaches parking braking position, upper piston 3 moves up, load on balance spring 2 is relieved, lower piston 18 moves up correspondingly, intake valve is closed, exhaust valve is open, air pressure in cavity a is vented, and the vehicle is in a totally braked state. Inspection state: Further push handle 10 to inspection position, boss teat 17 at side of cam 5 presses down ballast 1, pushing tappet 15 down, closing passage between cavity 13 and cavity b, and pushing intake valve 1 open, so that air pressure in cavity c enters cavity 13, and parking brake for trailer is relieved by trailer brake valve. In this way, you can check if requirements by parking on a slope can be satisfied by parking brake of only the traction vehicle. Release the handle to return to parking brake position automatically.

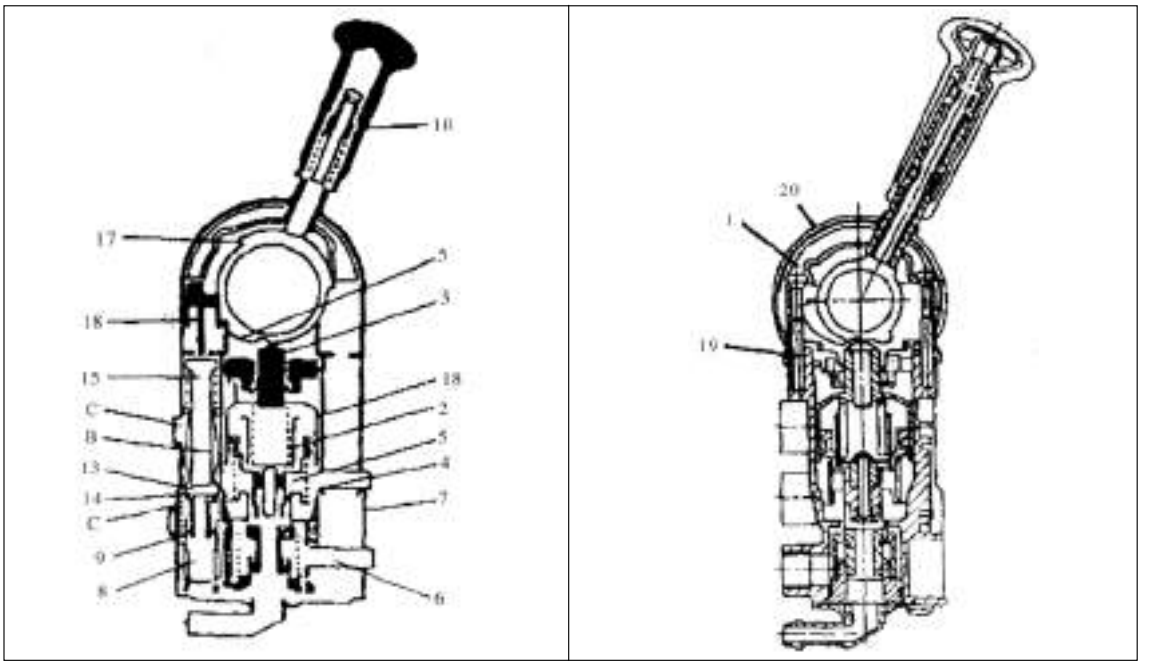


Fig9-5 Structural schematic diagram of hand control valve

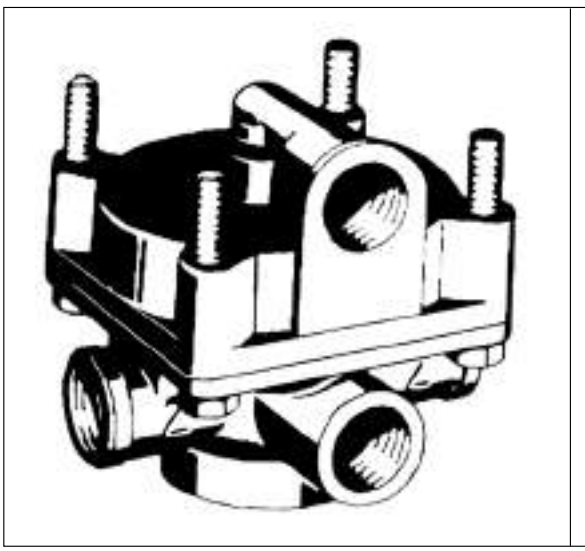
1. Hand control valve 2. Balance spring 3. Large piston
4. Piston return spring 5. Cam 6. Valve return spring
7. Valve body 8. Exhaust port 9. Lo and pack
10. Handle 11. Air intake 12. Seal
13. Inner cavity 14. Intake valve 15. Push tappet
16. Ballast 17. Boss teat 18. Lower piston
19. Screw rod 20. Hood
21. Air outlet (connected to spring brake air chamber)
22. Air outlet (connected to trailer valve) a. Air cavity b. Air pad c. Air cavity

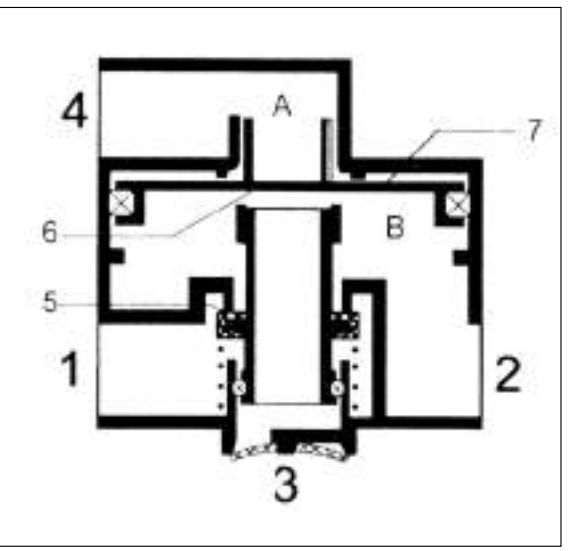
2. Relay valve

● Purpose:

The relay valve is used to shorten brake response time and brake relief time in operation air path, thereby functioning as acceleration and fast relief.

● This valve is applicable to medium and heavy duty vehicles with pneumatic brake, and already used in Steyr, Hongyan series and Beifang Benz etc.





● Operating principle:

● During normal running of vehicle, compressed air from air reservoir enters via port 1, closing intake valve 5 and opening exhaust valve 6, and outlet 2 connected to brake sub-chamber will be vent to atmosphere.

● During braking, compressed air from brake valve enters cavity A via port 4, so that piston 7 moves down and close exhaust valve 6. Consequently, intake valve 5 will be open, and compressed air will flow to the sub-chamber via port 1 and port 2. When balance is achieved, intake valve and exhaust valve will be closed at the same time.

● To relieve braking, air pressure in cavity A is zero, piston 7 rises, opening exhaust valve 6 and closing intake valve 5. Air pressure in sub-chamber is quickly vented to atmosphere via port 2, exhaust valve 6 and exhaust port 3, allowing quick relief.

►Auxiliary braking

Braking by engine exhaust is used as auxiliary braking to mitigate thermal deterioration of brake due to frequent use of foot brake. To some extent, this can prevent passive over-speed rotation of engine and extend service life of friction discs. The device of exhaust brake is shown in Fig.9-7 and the operating principle is shown in Fig.9-8.

● When the driver uses exhaust brake, operate exhaust brake switch so that the solenoid valve charges air into exhaust brake valve and the butterfly valve switch on exhaust brake valve closes exhaust pipe, enhancing resistance to engine rotation.

● In control circuit, we have provided acceleration switch and clutch switch, so that when driver steps down throttle and clutch, exhaust brake will be automatically relieved.

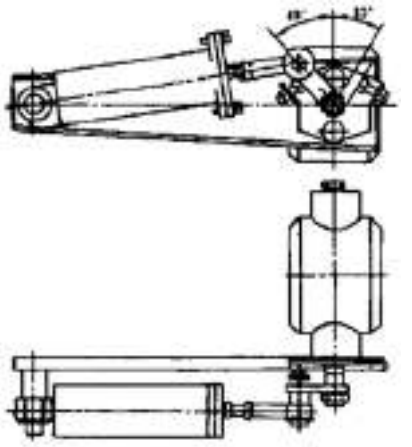


Fig.9-7 Diagram of exhaust brake device

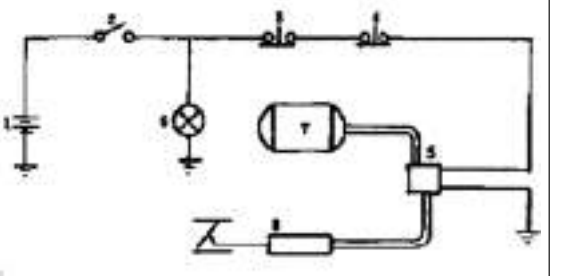


Fig.9-8 Theoetical diagram of exhaust brake system

1. Power supply
2. Exhaust brake switch
3. Acceleration switch
4. Clutch switch
5. Solenoid valve
6. Indicator
7. Air reservoir
8. Exhaust brake valve

►Signal indication

- Pressures in air reservoirs of front and rear circuits are indicated by 2 barometers on cab instrument board respectively. On each of these air reservoirs, a low pressure alarm switch is fitted. When pressure in one of these cylinders is lower than 450kpa, an alarm will be sent to the driver.
- Brake lamp switch is controlled by foot pedal and is a mechanic switch. In case of part failure of brake circuit, the brake switch can still be connected.
- One indicating lamp is provided for exhaust brake and parking brake respectively. When the driver uses exhaust brake or parking brake, corresponding lamp on instrument board will give indication.

►Brake

CAMC series vehicles adopt Archimedes curve cams. Front and rear brake cams are S-shaped asymptote cams. Brake shoes are roller type cast shoes. Cast brake back plate is adopted. Rear brake air chamber is spring brake air chamber. Front break air chamber support is separated from brake back plate. Brake air chamber is installed on steering knuckle. Rear axle spring brake chamber support is fitted on brake back plate.

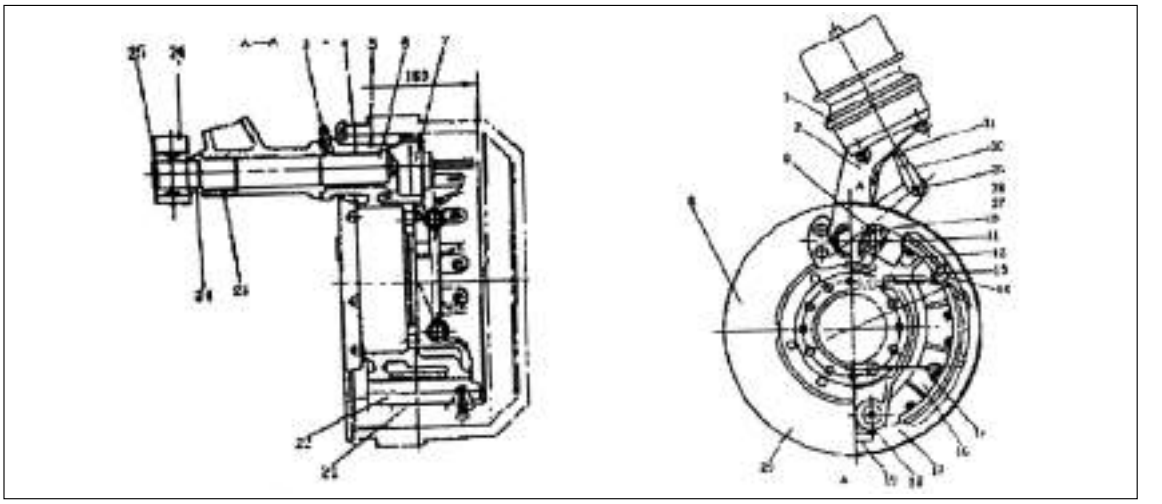


Fig.9-9 Structure and Theory of Brake

1. Brake chamber (with spring)
2. Brake chamber support
3. Oil filling nozzle
4. Liner
5. Brake back plate
6. Oil seal
7. Camshaft
8. Rubber clog
9. Roller
10. Elastic retainer ring
11. Roller pin
12. Friction disc
13. Reversing spring
14. Bolt
15. Reversing spring
16. Brake
17. Dust cover
18. Locating screw
19. Locking wire
20. Dust guard
22. Bushing
23. Brake shoe pin
24. Retainer ring
25. One-way retainer
26. Adjusting arm
27. Flat pin
28. Split pin
29. Flat washer
30. Fork-shaped connector
31. Lock screw

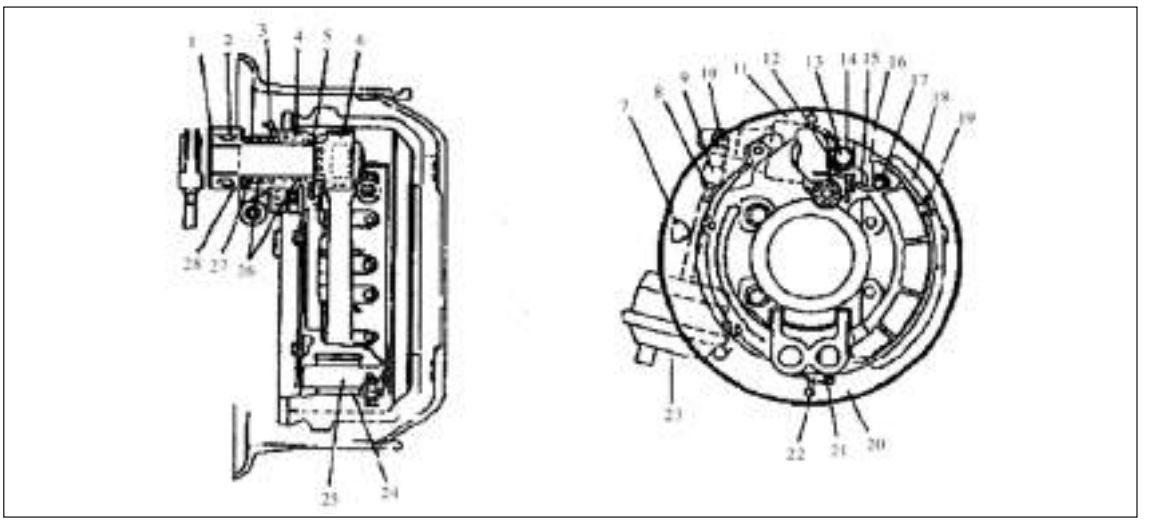


Fig.9-10 Structure and Theory of Front Brake

1. Spring retainer ring
2.Adjusting rod
3. Grease nozzle
4. Brake back plate
5. Oil seal
6. Camshaft
7. Rubber clog
8. Lock shoe pin
9. Fork-shaped connector
10. Flat head pin
11. Dust cover
12. Roller
13. Roller pin
14. Elastic retainer ring
15. Reversing spring
16. Brake
17. Spring pin
18. Frication disk
19. Rivet
20. Dust guard
21. Locating screw
22. Lock wire
23. Brake
24. Bushing
25. Shoe disc shaft
26. Bushing
27. Dust ring
28. Camshaft shield ring

Adjustment and maintenance of braking system

►Adjustment and maintenance of air compressor

(1) Adjustment of air compressor. Air compressor supply pressure shall reach 800kPa or higher. When this pressure is low, make adjustment (of intake and exhaust valve disc) to eliminate oil or air leakage.

(2) Maintenance of air compressor. In case of air compressor fault that cannot be settled by adjustment, remove the air compressor and disassemble it for maintenance. Someone says that air compressor is like a small engine, and learning repair of engine can start with learning repair of air compressor. All those who can repair engine can maintain normal operation of air compressor. If the air compressor cannot be repaired, replace it with a new compressor assembly.

►Adjustment of brake pedal

Foot brake pedal is connected to dual cavity serial piston type foot brake valve. Properly adjusted foot brake valve connecting rod, piston, and other moving parts shall move freely and flexibly without stagnation, jamming and poor return to original position. Foot brake pedal shall move freely and has suitable free travel and pedal travel. When brake pedal is pressed down, moving parts must not interfere with any neighboring part, and shall be able to fully return to its position.

►Maintenance of wheel brake

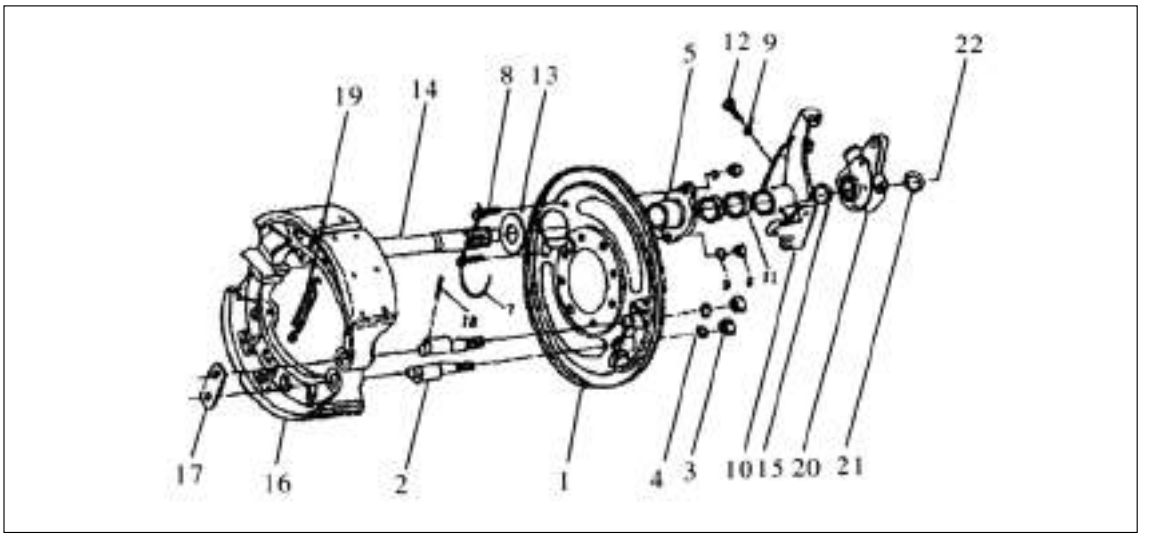


Fig.9-11 Rear wheel brake disassembling and assembling diagram

1. rear brake disc assembly
2. rear brake shoe disc shaft
3. nut
4. spring washer
5. bearing seat
6. bolt
7. steel locking wire
8. nut
9. spring washer
10. rear brake cam left/right support
11. bushing
12. bolt
13. support pad
14. left/right rear brake cam
15. adjusting shims
16. rear brake shoe disc assembly
17. pad
18. split pin
19. brake shoe release spring
20. rear brake adjusting arm assembly
21. washer
22. split pin

Fig.9-11 is disassembling/assembling diagram for rear wheel brake. For maintenance, first remove rear wheel and hub assembly, and then brake drum assembly, to expose wheel brake.

(1) First remove brake shoe release spring 19, and loosen rear brake shoe assembly 16. Brake shoe shall be able to rotate around rear brake shoe shaft 2. First check damage of brake shoe and shoe bearing

(2) Remove split pin 18 of the two brake shoe shafts, take off pad 17, and remove the two brake shoe assemblies. Check friction disc for thickness. Use vernier caliper to measure distance between friction disc working surfaces and rivet head. If less than 0.5mm, replace with new friction disc. For replacement, replace friction discs of both left and right wheels, and if necessary, for all 4 wheels. Ensure totally consistent materials of brake shoes. Riveting shall be fitted tightly while riveting.

(3) Remove 2 nuts 3 and spring washers 4. Then, remove rear brake shoe shaft 2. Check for damage of rear brake shoe shaft. If necessary, replace with new parts. Quality of replacement parts shall be ensured.

(4) Remove pin shaft connecting brake air chamber pushrod connecting fork and rear brake adjusting arm assembly 20, to separate from brake air chamber.

(5) Remove shaft end split pin 22 and washer 21. Remove bolt 12 and spring washer 9. Remove rear brake cam left/ right support 10 and camshaft bearing seat 5. Remove left/right rear brake cam 14. Check wear of cam and camshaft. Check wear of bearing holes. If necessary, replace with new parts.

(6) Check rear brake disc assembly 1. If seriously damaged, replace with new parts. Remove bolts connecting with axle casing and separate it. For seriously worn brake assembly, replace with a new assembly. For replacement, brake assemblies of left and right wheels or of 4 wheels shall be replaced at the same time. Wheel brakes replaced shall be of good quality.

(7) For reassembling of wheel brake, first use clean cloth to remove dust on friction disc and inner surface of brake drum, and clean surfaces of other parts. The reverse sequence of disassembling shall be used while reassembling. First install each part on camshaft, and then install shoe shaft, brake shoe and brake release spring. To install shoe shaft, off centers on the shaft shall be fitted near each other, so that dimensions of ex-circle of brake disc is minimum; otherwise it may be impossible to fit it inside brake drum due to its dimension larger than brake drum inner circle dimension (particularly for newly replaced friction disc). To fit brake shoe on shoe shaft, apply a thin layer of grease and prevent contamination of friction discs. During assembling pay attention to adjusting axial clearance of camshaft (shall not exceed 1.0mm). Adjust by selecting or replacing thickness of shaft end adjusting shim 15. After adjustment, the cam shall rotate freely and axial clearance shall be small.

►Adjustment of wheel brake

(1) Entire adjustment: as shown in Fig.9-11. This adjustment includes adjustment of brake cam and shoe shaft positions. Final purpose is to adjust brake clearance.

① Loosen nut 3 fixing shoe shaft so that this shaft can rotate. Rotation of shoe shaft changes position of brake shoe lower support, and hence changes lower clearance between friction disc and brake drum.

② Loosen clamp nut 8 of clamp bolt 6 of camshaft bearing seat 5, so that axial line position of camshaft can be adjusted and position of cam can be changed, thus changing position of friction disc upper support and clearance between friction disc and brake drum lower end.

③ Rotate shoe shaft so that shoe shaft end position marks are near to each other.

④ Remove dust hood at worm shaft end of adjusting arm. Press down lock sleeve and rotate worm shaft so that brake friction disc is pressed toward brake drum. Use feeler gauge for close mating of upper and lower end of friction discs at both sides with brake drum from the brake clearance inspection hole

of brake drum. If there is clearance or the clearance is excessive, obtain close mating by rotating shoe shaft. With complete mating, tighten shoe shaft nut and cam bearing seat clamp bolts and nuts and lock them.

⑤ Connect brake adjusting arm to brake air chamber pushrod link fork. Rotate worm shaft of adjusting arm and adjust brake clearance between brake drum and upper/lower ends of brake friction disc. The lower end (shoe shaft end) is naturally formed by inward adjustment of brake friction disc.

- Adjusted brake clearances shall ensure consistency of left and right wheels, so as to ensure that brake air chamber pushrod travels of left and right wheels are consistent in the same axle. Difference of these pushrod travels shall normally not exceed 5mm.

(2) Local adjustment

- This adjustment refers to adjustment of only worm shaft of adjusting arm to obtain required braking clearance. If installed position of shoe shaft is changed in the adjustment, entire adjustment will be necessary.
- Brake performance of vehicle of adjusted wheel brake shall be verified.

Common Failures and troubleshooting for braking system

The braking system is a mechanic braking system of pneumatic control. Common faults mainly include faults in pneumatic system and mechanic faults in braking system, namely: insufficient brake force, failure of braking, dragging of braking, wander of braking, and noise in braking system etc.

►Checking of no braking and insufficient brake force

During running of vehicle, the fault of no braking and insufficient brake force is the most serious fault in braking system and sufficient attention must be paid to it.

(1) Check of braking system. On all modern vehicles, braking system is installed to ensure safety. Only when safety is ensured can dynamic performance of vehicle be fully used. Safe running of vehicle at a high speed is a main technical measure to increase vehicle transport productivity. Main functions of vehicle braking system are: to force speed reduction or stop of vehicle when the vehicle is running at any speed; to limit vehicle speed when going down a slope; and keep stopped vehicle standstill on ground or slope. One vehicle shall have at least two sets of independent braking systems, i.e. running braking system and parking braking system. Main function of running braking system is to allow fast or gradual speed reduction during running. Main requirements of the braking system are reliable operation and stable braking performance. Braking effect shall satisfy requirements on braking, and allow convenient operation position and easy braking. Any form of vehicle shall feature such basic performance.

- Running brake is normally operated by right foot. After stepping down brake pedal by right foot, a series of actions of the running braking system will reduce speed or stop the vehicle. To put it in a simple way, action at the brake will stop the vehicle. This is like watching TV: when the switch is turned on, picture will appear on TV screen and sound played at speakers. If not, the system is faulty. Systematic inspections can be carried out in case of no braking and weak running braking force.

(2) Road braking test of vehicle. This test can be performed at any time for a running vehicle. For running safety, some drivers would step down brake to check braking shortly after start of the journey and with no obstacle in front. Driver can feel braking effect inside the vehicle, or get down (when necessary) to check braking print left by emergency braking. This method (braking print) is an easy and feasible method widely used in road braking test, and can reflect braking performance in an intuitionistic manner.

● Up to now, small automobile repair factories around the nation still adopt road test method. For this test, first try brake pedal; braking force shall be felt and braking effect shall be good, pedal operation shall be free and light and braking force shall be good. Later, run the vehicle on a flat and straight asphalt road surface or cement road surface or compacted macadam road surface in a straight line at the speed of 30km/h; sharply step down brake pedal to reach 1/2 or 3/4 stroke, and then quickly release the pedal; braking of vehicle shall be apparently felt and driver body shall lean forward, and arms holding steel wheel shall feel larger force. Before the vehicle stops, there shall be apparent impression on road surface and no wander shall occur. Later, run the vehicle at 20km and in a straight line. Apply emergency braking: quickly step down brake pedal to bottom to stop the vehicle. The 4 wheels shall leave the same dragging print, and there shall be no wander of vehicle and dragging print, to be determined as qualified braking. Flickering on barometer during braking is a proper sign, just like when sitting at home and watching TV, flash of light indicates startup of refrigerator in kitchen and a slight sound indicates normal operation of the refrigerator.

(3) Inspection of testing equipment. There are many instruments for testing of vehicle braking performance, mainly for check of vehicle braking effect. Braking inspection instruments can normally detect vehicle braking distance, braking time, braking deceleration, and braking torque etc. Some equipment can also test stability of vehicle braking. Braking stability refers to the capability of vehicle to maintain straight-line movement (or no deflection when turning) during braking.

(4) Brake inspection method using barometer. The barometer on fascia is connected to pipeline of vehicle braking pneumatic system and can directly reflect braking air pressure. Each braking operation of vehicle will consume some compressed air, and this is reflected on barometer. During braking, amount of compressed air consumption is closely related to vehicle braking force. Therefore, experienced driver can roughly estimate braking effect according to fluctuation on barometer. For example, in the process of speed reduction, some drivers adopt a series of point braking, followed by a series of braking exhaust sound. If noted, the barometer will show a series of pointer fluctuation. When stopping the vehicle, some drivers check air pressure and braking by a number of consecutive stepping down of brake pedal to generate braking actions and listen to the sound of continuous action of brake shoes. Also, pointer on barometer will fall time and again, normally indicating normal braking effect of the vehicle. Later, rotate engine to allow pumping of air by air compressor.

(5) Sound inspection method for braking system. To check the braking system, you can step down brake pedal with the vehicle stopped, provided that the barometer indicates normal braking air pressure. This inspection can be carried out in a relative quiet environment, so that sounds can be determined accurately. You can stop the engine for this purpose.

● Sound can be checked by driver alone or by two persons jointly. In the latter case, one person shall operate brake pedal in the vehicle, while the other listens to sound of braking beside wheels.

- When brake pedal is stepped down, apparent air charging sound of brake air chamber can be heard, as well as sound of brake cam rotation and apparent collision sound of brake shoe plate jammed between inner walls of brake drum. The last sound is quite heavy and can be apparently felt. You can imagine that the brake drum is apparent and you can feel braking action. When brake pedal is released, you can also hear sound of separation of brake shoe plates. This is true for one wheel, but also true for 4 wheels. In nighttime when it is quite (no interference noise), such sounds will be clearer. If braking system is normal, when stepping down brake pedal, the sound of swelling and jamming of brake shoe plates can also be heart. If braking system operation is abnormal, this sound may be weak or have a delay. In this case, further inspection of braking system is required. Normally, causes of braking system malfunction can be found.

(6) Straightforward inspection method. For inspection of braking system, straightforward method can also be used when necessary. Normally, straightforward inspection is carried out incidentally in combination with replacement of brake shoe plates or tires. When necessary, this inspection can also be carried out separately. This inspection is carried out for suspected fault of wheel brake. For this inspection, jack up a driving wheel with a jack and support it by a steel bracket, so that this wheel is off ground and can rotate freely. Start engine and engage low gear so that this wheel rotates. Allow the wheel to reach certain speed. For non-driving wheel, rotate it manually. At this time, driver performs emergency braking and someone will observe if this wheel can be immediately locked and stopped. The observer can stand at a side of the vehicle and observe driver braking action and wheel braking at the same time (listening to sound of braking). If action and braking are totally synchronized, normally, operation of braking system can be deemed normal. If braking of wheel is slightly delayed or rotation is dragging, malfunction of braking system shall be considered. Repeat the test for a number of times; fault can normally be located.

(7) Dynamic characteristics test of braking system. For difficult and complicated fault in braking system, or for inspection of braking performance of a batch of vehicles, system dynamic characteristics test can be carried out.

- During this test, install contact signal sensor on brake pedal, and pressure sensor on brake valve and brake air chamber. These signals undergo certain electric amplification and are then connected to light indicator. Time signals are also provided in the light indicator. These signals are also recorded on photosensitive recording paper of the light indicator.
- During the test, actual braking will be performed on the vehicle. These braking signals will be reflected on photosensitive recording paper. Through analysis of dynamic testing records, brake performance can be accurately evaluated and braking fault can be located.

(8) Individual phenomenon and overall phenomenon. During and after inspection of braking system, note if the braking failure is individual phenomenon or overall phenomenon. During inspection, if only one or two wheels are found without braking, this fault may be individual and due to improper adjustment of brake clearance or fault in brake air chamber. If braking on 4 wheels fails, this may be an overall phenomenon. For example, 4 lights in an office are controlled by one switch. When this switch is turned on, if all 4 lights do not light up, this may be due to power failure or damaged switch. The possibility of all 4 light bulbs damaged is extremely small. Overall fault phenomenon shall be

looked up in general control part, e.g. brake valves themselves and their control part. It is easier to locate individual phenomenon in a single place.

►Insufficient braking force

(1) Phenomenon

During vehicle braking performance test, it is found that vehicle braking force is insufficient, braking distance or braking time is too long, hence poor braking performance.

(2) Causes

① Braking air pressure is too low: faulty air compressor; worn air cylinder, damaged piston ring or broken piston ring; air leakage at air cylinder gasket; poor sealing between intake/exhaust valve plate and valve seat; poor assembling adjustment.

② Brake drum worn and no longer circular; burnt friction shoe plate, oil on friction surface; friction disc surface hardened, deformed and worn.

③ Excessive clearance between friction disc and brake drum.

④ Air leakage from braking system valves, broken, poor sealing of pipelines.

(3) Correction method

① Service and adjust air compressor. Clean and grind valve plate and valve seat to meet sealing requirements. Replace cylinder gasket. Replace piston and piston ring. If necessary, replace air compressor assembly.

② Remove brake and re-bore brake drum. Grind surface of friction shoe plate. Replace brake shoe friction plate. Re-assemble and adjust.

③ Use feeler gauge to check clearance between brake drum and friction disc via drum side inspection hole or hole on dust hood. In case of excessive clearance, you can reduce the clearance by rotating adjusting arm adjusting bolt head. If necessary, adjust lower end support of friction shoe plate along with the above adjustment.

④ Check air pressure regulator, 4-circuit protection valve, quick release valve, manual brake valve and foot brake valve for maladjustment or air leakage. Check all pipelines for air leakage and correct the faults. With compressed air not used, run engine at idling speed for 10min. Allow braking system air pressure to reach 700-800Kpa. If air leakage point cannot be accessed for inspection, carefully listen to air leakage sound at each pipe connector, or apply soap solution for inspection. Later, make adjustment.

►Dragging of braking

(1) Phenomenon:

After braking of the vehicle, brake shoe plates cannot totally separate from brake drum; running resistance is high and normal running can only be achieved by supplying more fuel; overheat of brake drum is found (as felt by hand or water: fast evaporation).

(2) Causes:

① Too small clearance between brake shoe friction disc and brake drum. Due to improper adjustment,

hub bearing clearance and braking clearance are not correct. For example, barking clearances are all less than 0.40mm. With wheels on ground and during running with load, deflection may occur, eliminating local clearance. During high-speed running of vehicle, dragging and heating of brake drum will occur.

② Brake cam is jammed and will not return. Camshaft and camshaft support seat are deflected, resulting in staggered force during braking.

③ Brake shoe support pin (shoe shaft) is rusted, affecting return.

④ Softened or broken brake shoe plate release spring.

⑤ Improper adjustment of brake air chamber pushrod, resulting in deflection and jamming, and no response. Clogged by mud or frozen by accumulated snow, resulting in jamming in return.

⑥ Improper adjustment of brake pedal free travel and poor operation of brake valve, so that exhaust by exhaust valve is not free and exhaust port is clogged.

(3) Correction method

① Adjust clearance between shoe plate and brake drum. Adjust wheel hub bearing clearance in advance.

② Adjust cam support and camshaft bearing seat so that camshaft axis and camshaft bearing seat axis are in the same line. Tighten clamp bolts and check cam action for rotation without defection.

③ Lubricate brake shoe shaft and remove dirt.

④ Replace brake shoe plate release spring.

⑤ Adjust brake air chamber pushrod and remove dirt.

⑥ Adjust brake pedal free travel and adjust brake valve.

► Wander during braking

(1) Phenomenon

Wander during braking and emergency braking. Whipping during braking. The vehicle can still be used in case of light wander, but accident may occur in case of serious wander.

(2) Causes

① Braking force of 4 wheels is not even. Improper adjustment of one wheel brake or 2 diagonal wheel brakes, resulting in reduced wheel brake force. In case of low braking air pressure, braking of wheels is not consistent, resulting in wander.

② When the vehicle runs on slippery road surface, even if 4 wheel brakes have been carefully adjusted, they are not totally consistent, resulting in wander. If 4 wheels are not adjusted consistently, wander will be serious, and the vehicle may even turn around.

③ Uneven clearance between brake friction disc and brake drum at different places.

④ Friction discs have different materials, or friction disc of some wheel is contaminated or has water on it, reducing friction coefficient.

⑤ Brake drum inner circle is deflected, resulting in poor contact with friction disc.

⑥ Brake back plate is installed loose, resulting in deflection during braking.

⑦ Release spring weakened or damaged, resulting in jamming during braking.

⑧ Causes of vehicle running wander, e.g. inconsistent tyre pressure, poor alignment of front wheels, broken leaf spring, deformed frame and unbalanced loading etc., will aggravate wander during braking.

(3) Correction method

① Adjust brakes of 4 wheels as good as possible. Adjustments shall be consistent. Properly adjust wheel hub bearings.
② Run at reduced speed on slippery road surface and avoid frequent use of emergency braking.
③ Carefully adjust clearances of wheel braking.
④ Replace inconsistent friction discs and remove dirt.
⑤ Bore and grind brake drum of each wheel and repair friction discs.
⑥ Adjust installation of brake back plate; properly adjust brakes.
⑦ Replace damaged release spring.
⑧ Eliminate wander during running.

►Screeching during braking

(1) Phenomenon

When braking is needed for speed reduction or stopping, rear wheel brakes screech to different extents. In particular, screeching is serious at full load, even interfering passengers and pedestrians.

- Sometimes, cause of screeching is not found after inspection by maintenance technical personnel and repair workers. In the opinion of most people, screeching does not affect braking and use of the vehicle. If maintenance is carried out, some time will be taken and operation revenue will be affected. Screeching of rear wheels during braking is not limited to one vehicle and people can only tolerate. Drivers are accustomed to screeching and even will make screeching if not have any, to be more comfortable. Even though, the fault of screeching shall still be settled.

(2) Main causes of screeching:

① For new retrofitted vehicles, rear suspension is normally long, vehicle body is relatively heavy, load is relatively large, so that weight distributed to rear axle is relatively large, and rear axle and rear wheels are operating in an overload status.
② Due to heavy load, designed dimensions of rear brake are relatively large, e.g. large brake drum diameter and width, and large brake shoe plate diameter and width.
③ Brake drum has large dimensions, hence subject to damage. When installed on wheel bearing, deflection can occur. Wheel is installed at outside of brake drum. Deflection of locating surface will cause deflection of wheel. Under heavy load, brake drum is inclined relatively to brake shoe, so that during each braking, not all friction shoe plate surface is in contact with inner wall of brake drum evenly, accelerating damage of brake drum.
④ Brake shoes have large dimensions (diameter and width etc.) and are subject to deform during operation. During braking, not all friction surface is in contact, hence wornout of place and burning are likely to occur.
⑤ Friction discs are worn when being used; even those with exposed rivets are still used. Braking quality of friction discs is poor, such as, local hard core or hollow space or uneven quality. During repeated braking, local damage occurs, friction plates are broken, and even local peeling can occur. Some peelings may exist between brake drum and friction disc, accelerating wear of friction disc.
⑥ Deform of brake back plate. Force on brake is mainly born by brake back plate. Unbalanced load or other causes may result in deform of brake back plate, causing deform of brake shoe plate at its installed position.

⑦ Improper adjustment of wheel bearing clearance (too large); wear of bearing during use, resulting in enlarged clearance, and deflection of wheel and brake drum, and their working positions; all of these led to abnormal wear.

⑧ Bearing pin installed on brake back plate is loose, brake camshaft is loose, or piston in brake wheel cylinder is worn, resulting in deflection of brake shoe.

● In case of screech of vehicle during braking, make up your mind to check the brake and find out causes of the noise. Take correction measures to make the vehicle more comfortable.

(3) Main inspection methods:

① Check air pressure of braking system. Some vehicles have higher air pressure in braking system and drivers like to step brake pedal a number of times when parking in a station to reduce air pressure, so that at next braking, screeching will be small. Use barometer on instrument board to check air pressure. If the accuracy of this barometer is doubted, connect a calibrated pressure gauge in the braking system for measurement. If air pressure in braking system is too high, adjust air pressure regulating valve of air compressor.

② Check brake drum. This inspection shall be carried out with brake drum removed and placed on lathe or brake drum boring machine. For inspection, use outside plane as reference for positioning. Center of rotation shall use center of brake drum as reference. Check deflection and loss of circularity of brake drum, and check for abnormal damage of brake drum inner surface. In case deflection of brake drum is found, process die hole for correction. Remove trace of abnormal wear on inner surface so that requirements on degree of eccentricity of inner hole and degree of surface finish are met.

③ Check brake shoe plates. For this inspection, put on bearing pin and check margin of brake shoe plates. Push brake shoe with brake cam to check for deflection of movement of brake shoe.

④ Check brake back plates. Check for deform of these plates. Check if installation of bearing pin and brake camshaft on these plates is vertical.

⑤ Check rear shaft journal and wheel bearings. Adjust tightness of bearings to ensure correct installation position of brake back plate and brake drum.

⑥ If necessary, perform excitation test of brake drums and brake shoe. Measure natural frequency and noise, so as to find out causes of screeching during braking, and eliminate them.

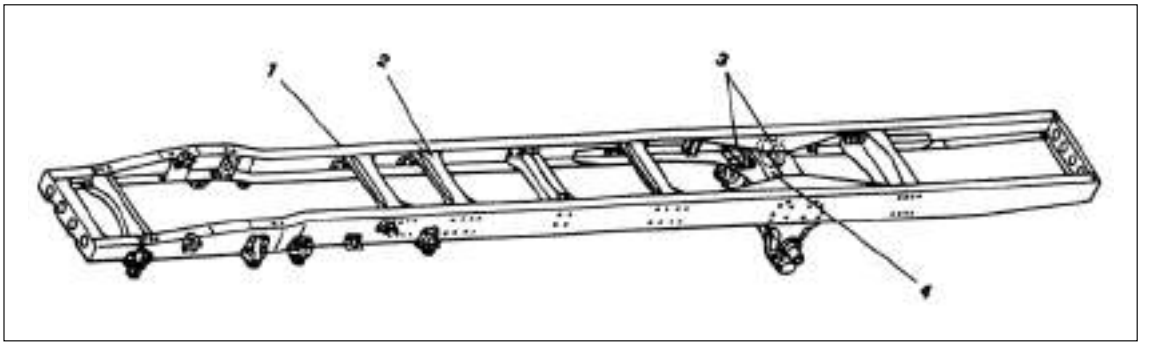
16 Frame

Specifications

Item	Specification
Frame type	Ladder shape
Shape of side-member cross section	冂: Shape (open structure)

Structure and Working Principle

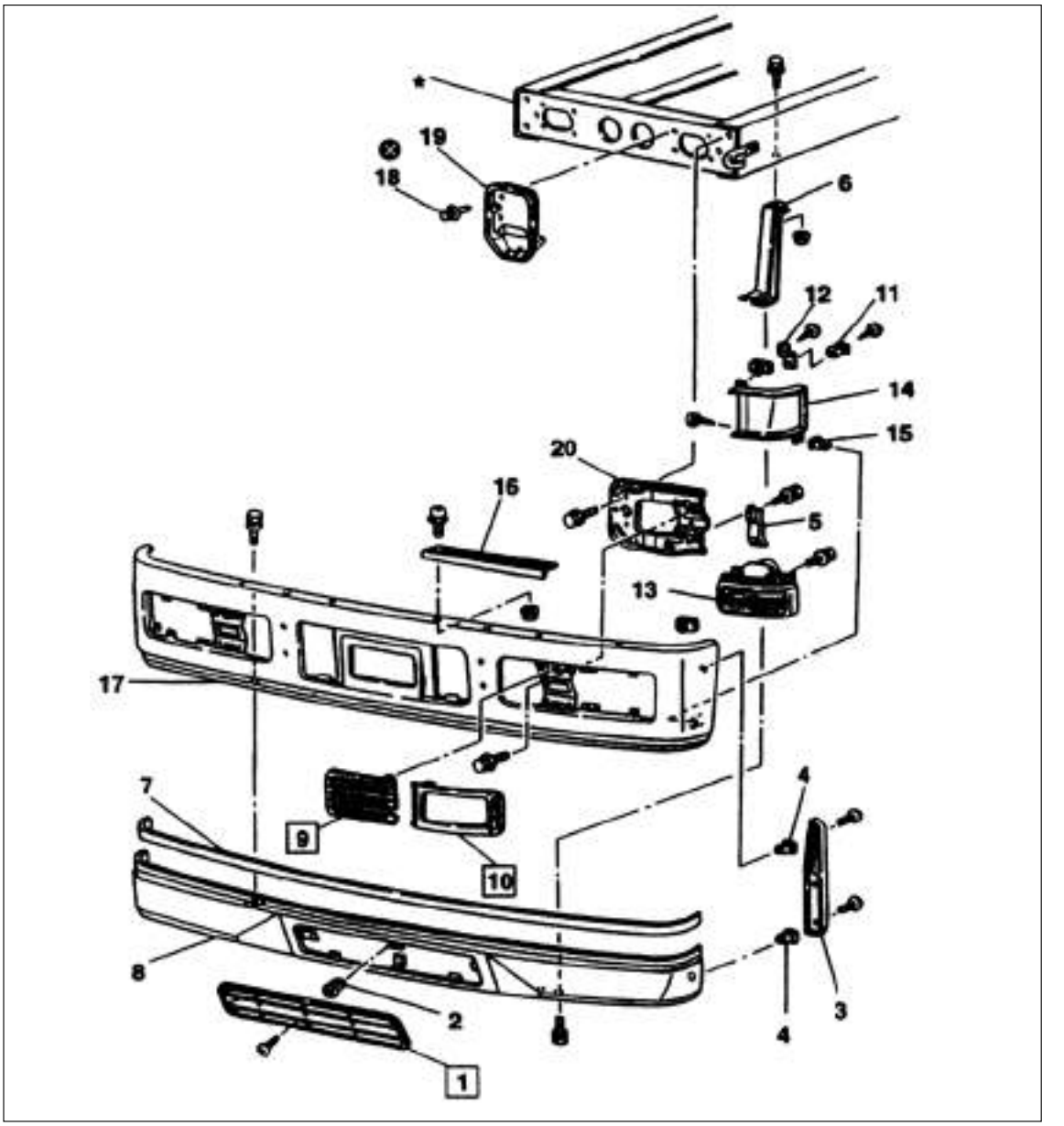
Frame



1 Side member
2 Cross member
3 Master bracket of pivot (pivot suspension)
4 Pivot cross member (pivot suspension)

- Side member 1 and cross member 2 are connected at the web (transversal side of side member). This kind of connection can significantly reduce the load on the joints. Therefore, rivets at such joints rarely become loose. High torsional rigidity of the rivets ensures a long lifetime.
- Unlike the connection to the brink (top surface and bottom surface) of channel steel, the connection to web makes the frame free from rivets, which greatly facilitates body installation.

Memo

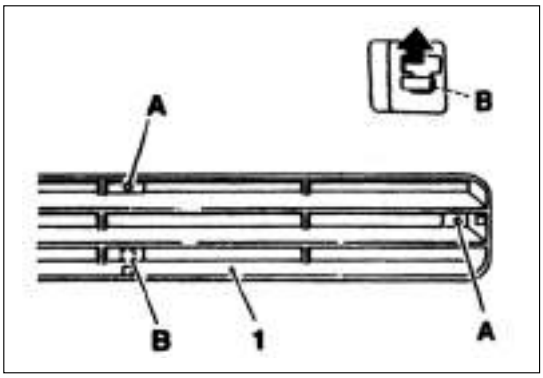


● Dismantling Sequence

1 Bumper grille
2 Screw grommet
3 Bumper cover
4 Plastic nut
5 Side support of bumper
6 Side bracing piece
7 Bumper insertion strip
8 Bottom edge bar of bumper
9 Bumper trim
10 Fog light cover
11 Plastic nut
12 Pipeline trestle
13 Front combination light
14 Side air duct
15 Plastic nut
16 Bumper guard
17 Front bumper
18 Rivet
19 Step cover
20 Bumper brace
*:Frame
⊗: Parts not to be used repeatedly

● Assembling Sequence

Proceed in the reverse sequence of dismantling.



►Maintenance Method

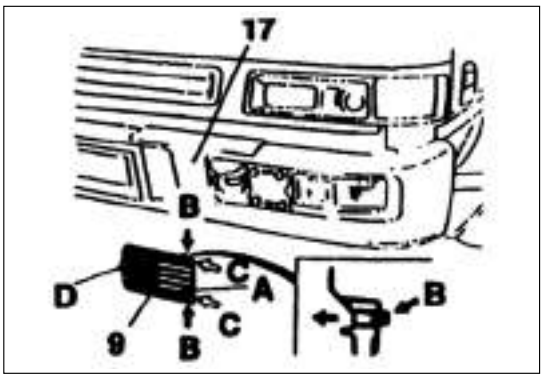
1 Bumper grille

[Dismantling]

Remove screws from installing places A for the right, left and upper-middle parts of bumper grille (1), then prize the end of snap B with a plat screwdriver to loosen the snap. Following remove the bumper grille.

[Assembling]

Remove the snap B remaining on the bottom edge bar of bumper (8) and insert it into bumper grille (1), then install bumper grille.



9 Bumper trim

[Dismantling]

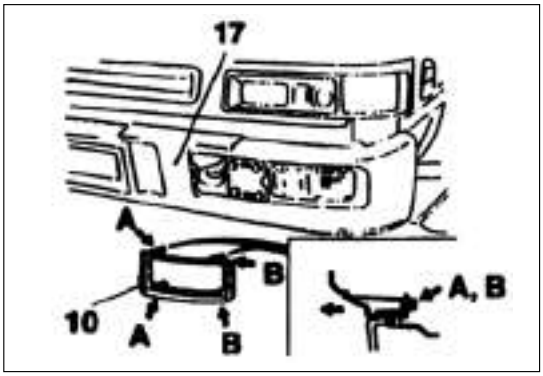
- Put a finger on the incision A of bumper trim (9), push vane B(in 2 places) forward, and then remove bumper trim from front bumper (17).
- If it's difficult to remove bumper trim (9), please insert the plat screwdriver into Place C with an arrow indication and prize it out, then you can easily take the bumper trim off.

Caution ⚠

Attention not to damage the plastic parts when using the screwdriver.

[Assembling]

In order to install bumper trim (9), please insert vane D into front bumper (17), and then press the bumper trim into its place.

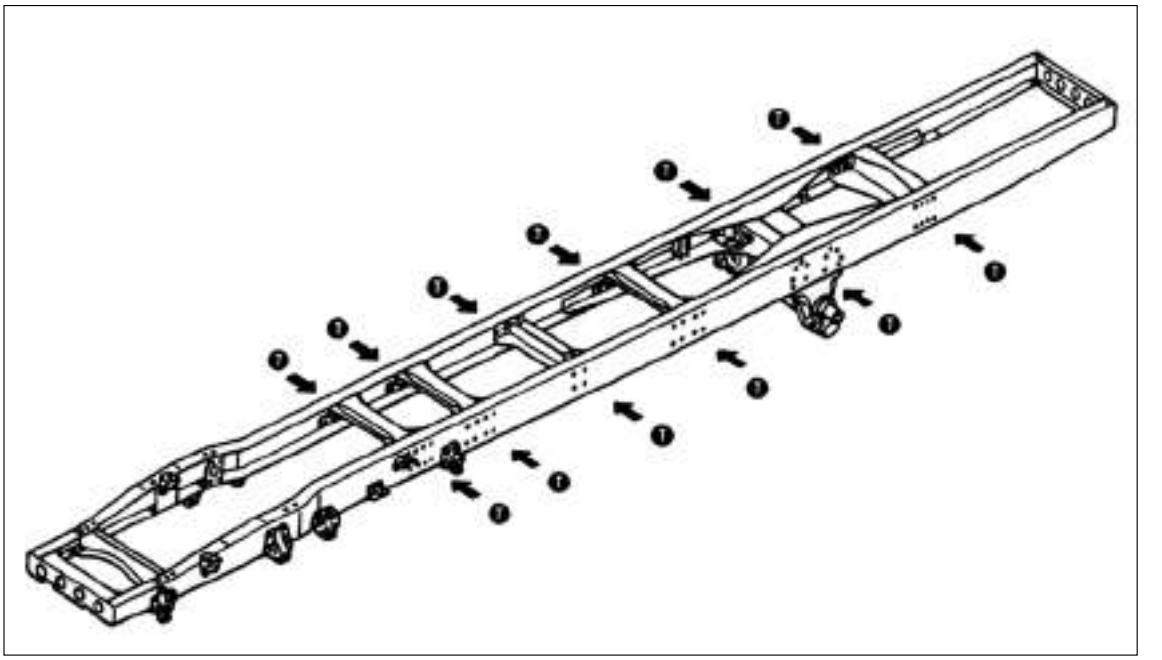


10 Dismantling the light cover

To dismantle fog light cover (10), please push vane A and B forward.

A:Side vane (in 2 places) for front bumper (17)

B:Side vane (in 2 places) for front combination light (3).



Tightening toque

Unit: N•m(kgf•m)

Location	Parts tightened	Tightening torque	Remark
-	Nut (for fixing the cross members to the side member web plate at rear spring)	157-215{16-22}	M14×1.5
-	Flange nut ((for fixing the cross members to the side member web plate)	200-270{20.4-27.5}	M14×1.5
-	Flange nut ((for fixing the main pivot stand to the side member web plate)(pivot suspension)	304-411{31.0-41.9}	
-	Flange nut (for fixing the main pivot stand to the side member web plate)(pivot suspension)	431-582{43.9-59.3}	M18×1.5

►Maintenance Method

● Cleaning of the frame

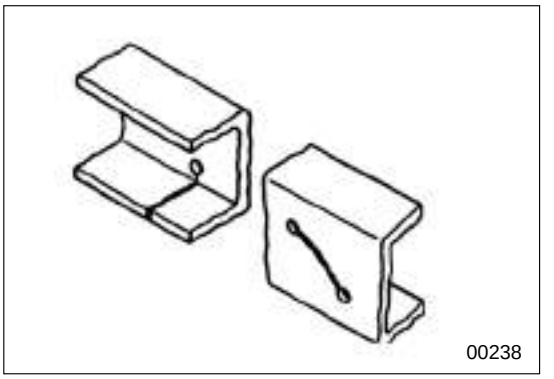
Remove the dirt, grease and rusts, etc. on the inner and outer surfaces of the frame

● Examination of frame deformation

Repair frame if any deformation is detected.

● Examination of frame crack

- Raze paint on the parts where faults are possible to occur and check carefully.
- If it's difficult to check visually, examine it with color-comparing infiltration examination method or other methods.
- Make the following repairs if detecting cracks.

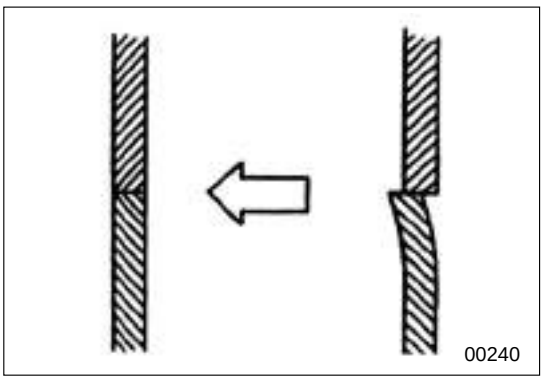


● Repair of frame crack

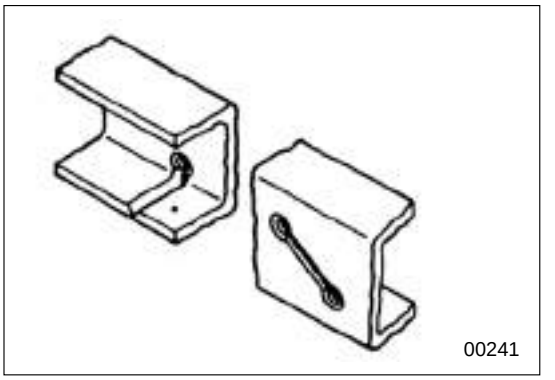
- Keep the frame balanced when the car is under no-load condition.
- Drill a hole 10mm to the end of crack with a diameter to be two times of frame thickness,

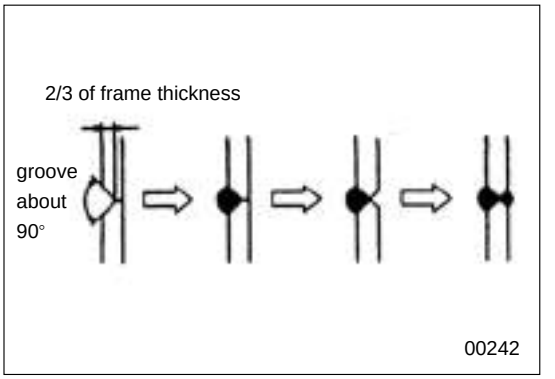
Remarks

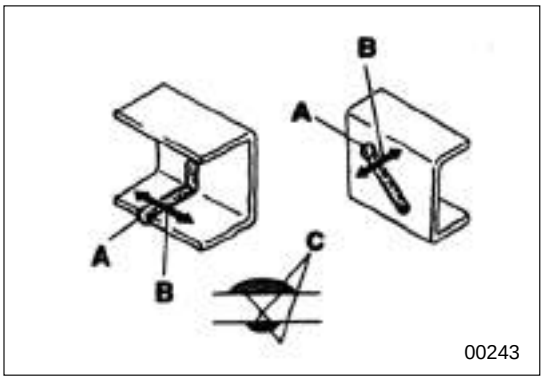
If a split is found inside the frame, drill a hole at both ends of the split.



- If both sides of the split are not in flush with each other, make them flush.







● Grind a V-shape groove of 90°, with a 2/3 frame thickness using a grinding wheel, then do welding.

Caution ⚠

● Gas welding is not allowed, because it will generate high temperature which can change the material property and weaken the welding position. Electric welding must be used.

● Pull off the negative terminal of the accumulator and connect the grounding wire to a place near the parts to be welded to prevent reverse current of the welding machine from burning the electrical elements.

● Cover the flammable materials near the welding site, such as piping, nylon pipes, wiring, rubber pieces and oil tank.

● Always protect trims, such as main threshold against high temperature with insulation materials.

Remark

● Always check the parts to be electrically welded before welding.

● To avoid harmful defects (civility, porosity, etc.), welding should be done with low-hydrogen-CO2 protected electric arc welding electrode.

● when the temperature inside the workshop is below 0℃, preheat the parts to be welded to 50~350℃ before welding.

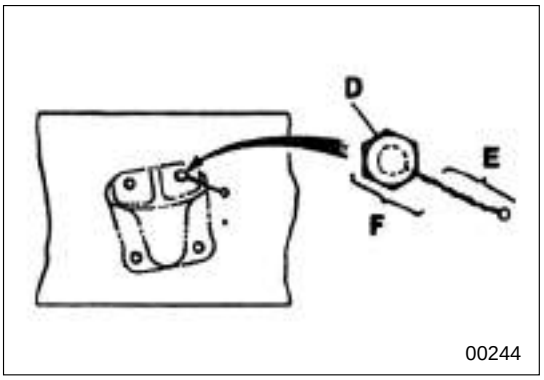
● Then grind a above-mentioned V-shape groove on the opposite side of welding and weld. Meanwhile, fill the holes on the both ends of the split through welding.

Remark

In cold areas, heat the welded parts to 200℃ after welding.

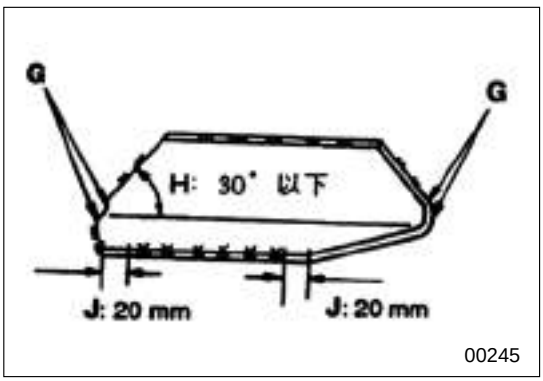
● After welding, grind weld A along upright direction B, grind section line part C indicated in the fig until the surface becomes flat.

● Make finish machining to the surface to keep the thickness of the frame at its original value.



►Repair splits caused by rivets or bolts

- In order to align the edge of the hole in the cracked part, tighten bolt D in the hole temporarily.
- Weld splits on Part E which are more than 20mm away form the center of the bolt. For the welding methods, please refer to the methods of repairing the above cracks.
- Remove the bolt and align the edge, weld the remaining Part F and fill the hole.
- After drilling a hole at the filling part, install a rivet or a bolt.

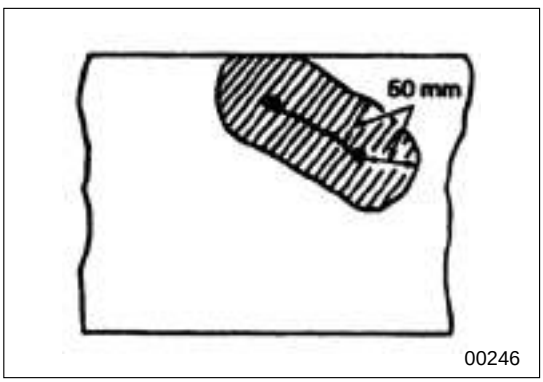


►Repair with reinforced plate

- In order to prevent stress concentration on reinforced plate G end, two ends of the plate to be welded should have a inclination H of 30°. Don't weld Part J.
- Reinforced plate must ensure enough strength on the cracking part.

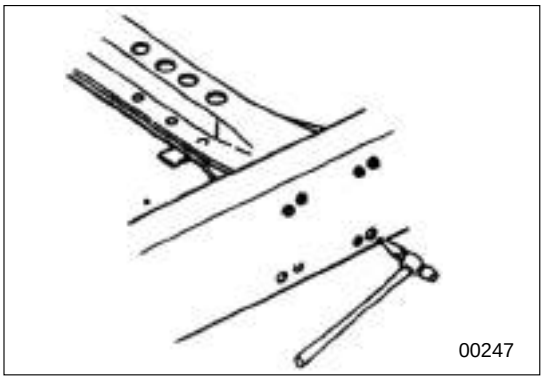
Remark

- The thickness of reinforced plate: thick as the frame
- Material of reinforced plate:SAPH55 (hot-rolled steel plate for cars), KFP55 (high tensile strength steel) or products of similar strength.
- After welding, heat section line to 600~700℃.



Caution ⚠

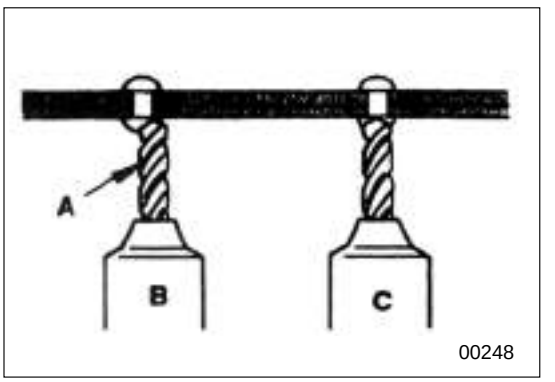
Always protect trim against high temperature with insulation materials, etc., such as main threshold.



►Examination of loose rivet

- Knock the rivet head slightly with a hammer, and examine with your finger to see if it is vibrating or giving sound for judgment.
- If there is rust corrosion between rivet and frame, it indicates the rivet has become loose.

The loose rivets must be replaced, because they may break or cause splits around the rivet hole on the frame, which in the end will lead to accidents.



►Repair of rivet

- When dismantling rivets, punch a protrusion in the middle of rivet head with a center hole punch and then drill it off or grind it off with driller A.

B: incorrect

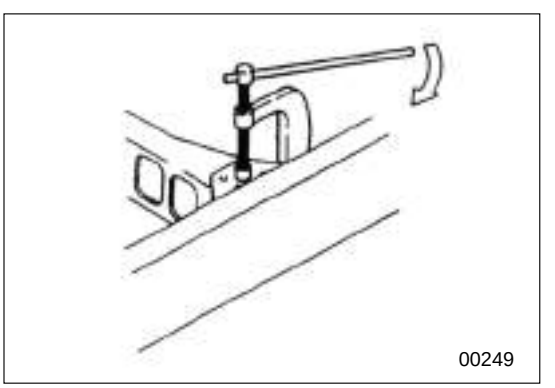
C: correct

Caution ⚠

Take care not to damage the rivet hole.

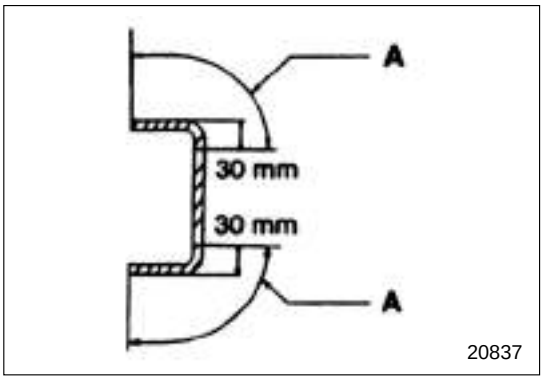
- When riveting, first clamp two plates with clips near rivet hole to eliminate the clearance between the two plates.
- Insert (cold-riveting)the rivet with a riveting machine.
- If riveting is impossible, ream the rivet hole, knock in a tight bolt and tighten the nut and then weld it at this place.

Flange bolts and nuts can be used as tightening bolts and nuts.



►Examination of loose bolts and nuts

- Examine if the set bolt on the cross member becomes loose. Tighten the loose bolt to specified torque.



Pay attention to the following issues if you are going to drill holes on the frame.

Caution ⚠

- Avoid drilling holes in the side member A area indicated in the fig, because this may lead to splits on the frame.
- Remove burrs generated in the hole after drilling, or it will cause splitting on the frame.

17 Wheels and Tyres

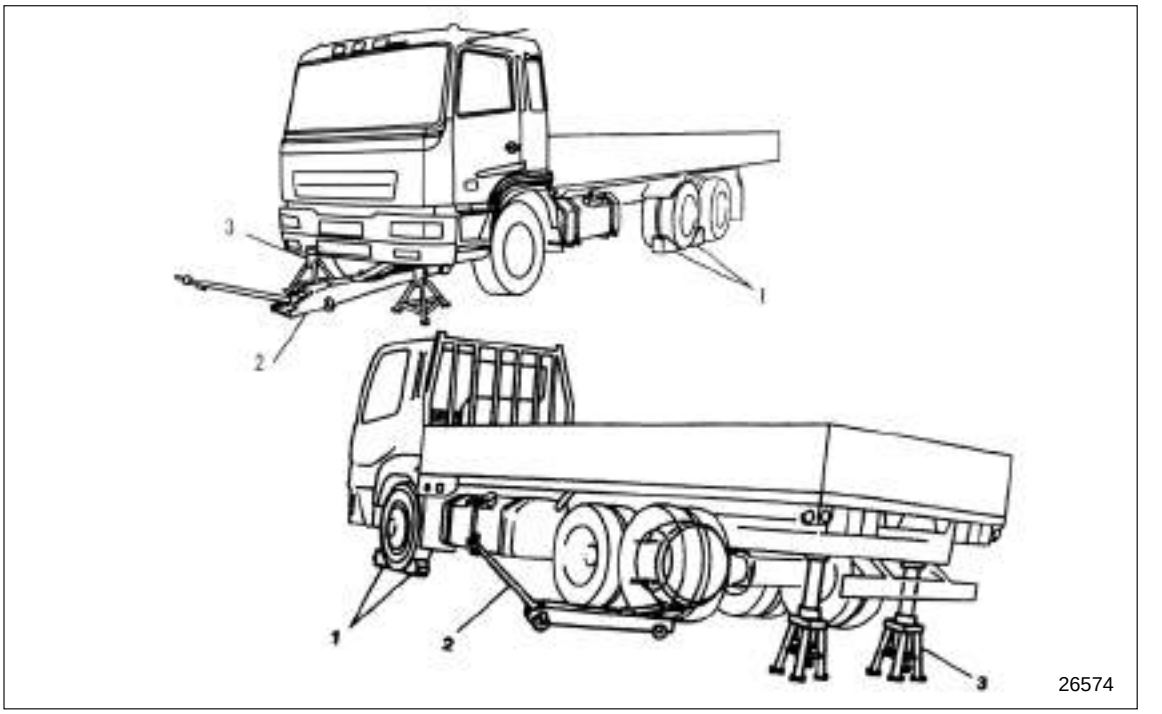
Technical Parameter

Dimensions of Tyres	Inflating Pressure kPa{kgf/cm2}	Applicable Wheels
11.00-20-16PR	675{6.75}	20×8.00V-172.5-12
12.00-20-18PR	750{750}	20×8.50V-175-12
12.00-24-18PR	725{7.25}	20×8.00V-172.5-12
11.00-R20-16PR	675{6.75}	20×8.50V-175-13
12.00-R20-18PR	775{7.75}	22.5V8.25-170-12
11.00-R22.5-16PR	725{7.25}	22.5V9.0-175-13
13.00-R22.5-18PR	775{7.75}	24×8.50V-180-13

Common Failures and Troubleshooting

Possible Cause \ Failures			Two-side abrasion	Central abrasion	Outside abrasion	Inside abrasion	Feather abrasion from outside to inside	Feather abrasion from inside to outside	Wave abrasion	Disc abrasion (one or more places)	Spot (hollow) abrasion on entire periphery	Jagged abrasion	Remarks
Filtration		Insufficient	○										
Tyre Inflating Pressure		Excessive	○						○	○	○	○	
		Excessive		○									
Wheel positioning	Front wheel toe-in	Insufficient			○		○						
		Excessive				○							
	Camber angle	Excessive			○								
		Insufficient				○							
	Excessive tyre toe-out					○		○					
	Maladjustment of front-wheel positioning		○		○	○	○	○	○	○	○		
Bent steering knuckle arm					○	○	○	○					
Different lengths of left and right steering tie rods							○						
Improper wheel balancing									○	○	○	○	
Loose wheel bearing									○	○	○	○	
Loose ball joint										○			
Loose steering tie rod jaw										○			
Eccentric brake drum										○	○		
Bent front and rear axles									○	○			
Abrupt start, excessive brake or fast cornering										○	○		
Incorrect turning radius of left and right front wheels												○	
Influence of pavement					○	○							

Dismantling and Installation of Wheels and Tyres



►Before dismantling:

1 Put wheel chocks.

2 Put the garage jack under the center of axle to prop up front or rear axle.

3 Use a solid tripod to support the frame.

Warning ⚠

- Use chocks to block wheels so that the vehicle cannot move.
- Chocks must not be taken way until the whole work has been finished.
- It's extremely dangerous to prop up the vehicle with garage jack only. Always use a solid tripod to support the frame.
- Put garage jack and tripod in place during the whole work. Do not take them away before finishing the work.

►After installation:

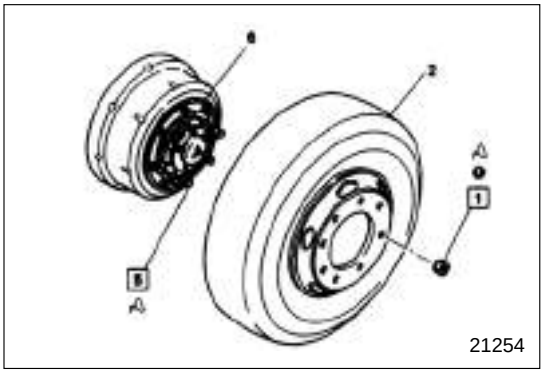
As per the contrary order to that of dismantling.

Memo

Remarks

Right-hand thread wheel nuts with “R” marks are used for right wheels; left-hand thread wheel nuts with “L” marks are used for left wheels.

（Single tyre）



►Dismantling order

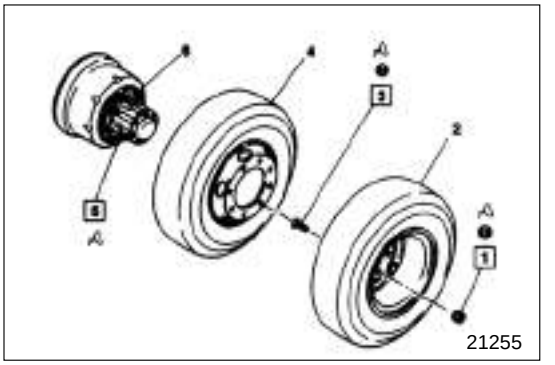
1 Wheel nuts.
2 Tyre assembly.
5 Hub bolts.
6 Hub.

- **Cleaning and grease application before installation.**

- **Installing order**

As per the contrary order to that of dismantling.

(Double tyre)



►Dismantling order

1 Wheel nuts (outside).
2 Tyre assembly.
3 Wheel nuts (inside).
4 Tyre assembly.
5 Hub bolts.
6 Hub.

- **Cleaning and grease application before installation.**

- **Installing order.**

As per the contrary order to that of dismantling.

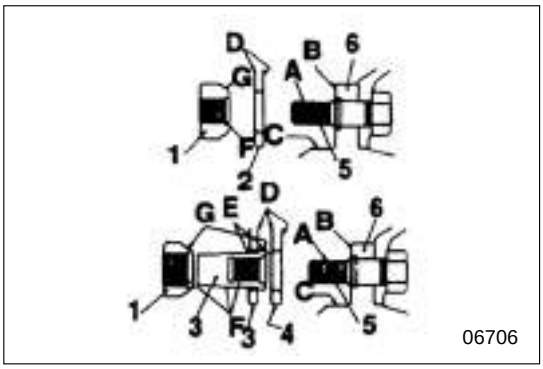
Tightening Torque

Unit: N•m{kgf•m}

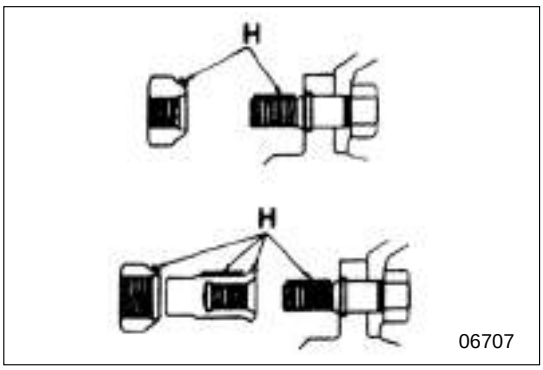
Position	Parts tightened	Tightening torque	Remarks
1,3	Wheel nuts	400-440{41-45}	Wet

Lubricant:

Position	Application place	Prescribed lubricant	Amount
1	Spherical surface of wheel nuts.	Chassis grease [NLG No.1(calcium-soap)] or wheel bearing grease [NLG No.1(calcium-soap)].	As required.
2	Threads and spherical surface of wheel nuts (inside).		
3	Threads of hub bolts.		



06706



06707

►Maintenance methods

• Cleaning and grease application before installation.

[Cleaning]

To prevent wheel nuts 1 and 3 and hub bolt 5 from being loose, as well as installed parts (tyre assembly 2 and 4 and hub 6) from being damaged, the following positions must be cleared of rust, dust, redundant paint, impurities, etc.:

A: Threads of hub bolts,
B: Mounting surface of wheel on hub,
C: Contact surface of wheel on hub,
D: Mating surface of wheel disc,
E: Mounting surface of wheel nuts,
F: Threads of wheel nuts,
G: Spherical surface of wheel nuts,

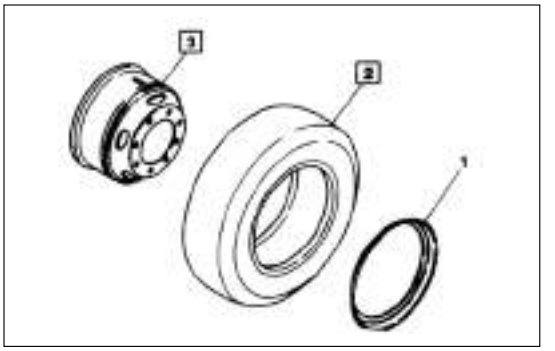
[Grease application position]

H: Grease application position.

Warning ⚠

Never use grease containing molybdenum sulfide, which can cause tightened bolts or screws loose.

Wheels and Tyres



►Tyre assembly

● Disassembling order:

1 Side rings
2 Tyres
3 Wheel discs.

● Assembling order:

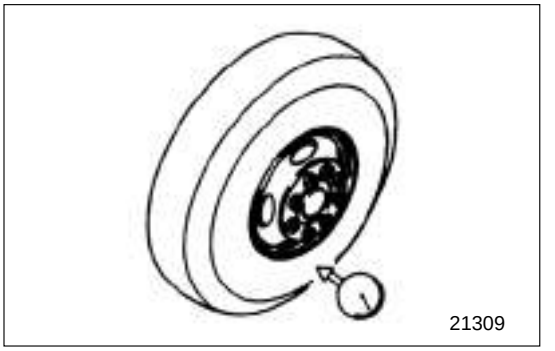
As per the contrary order to that of disassembling.

►Standard of Maintenance:

Unit: mm

Position	Maintenance item		Standard value	Limit	corrector method
value	Correction method				
1	1 Side ring clearance (after inflation)		2-7	—	—
2	2 Lateral bounce of wheel (after assembly)		Below 3.5	—	—
3	3 Wheel disc	Flatness	Below 0.3	—	—
		Lateral bounce	Below 2.2	—	—
		Radial bounce	Below 2.0	—	—

*: Optional Parts:

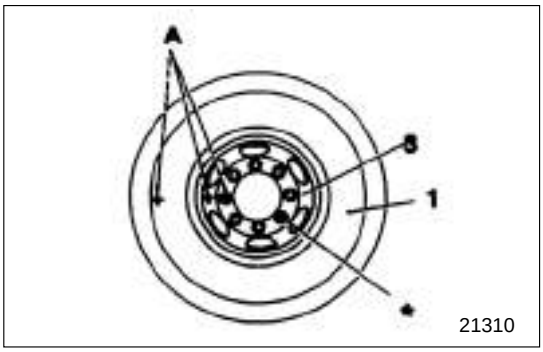


►Maintenance method:

2 Bounce of wheel

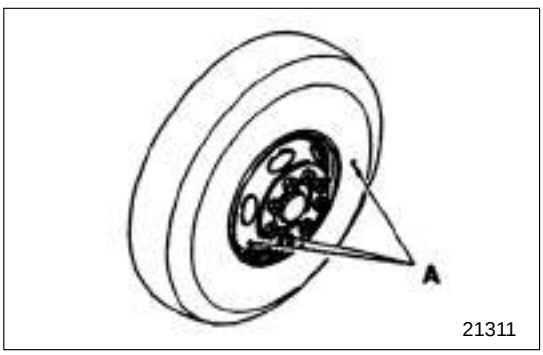
[Inspection]

Correct with the following methods if measured values are higher than limit values.

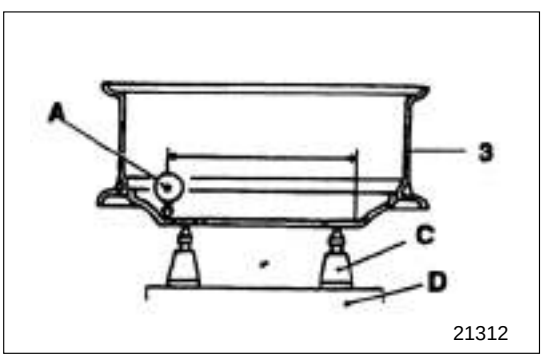


[Correction]

- Use a chalk to mark "A" on tyre 2, wheel disc 3 and hub bolt * at the highest point of bounce.
- Remove tyre 2 from wheel disc 3.



- Measure the bounce of wheel disc 3. If the highest point of bounce is near the "A" mark on the wheel disc, re-install tyre 2, the mark on the tyre being 180°away from that on the wheel disc.



3 Wheel disc inspection

(1) Flatness

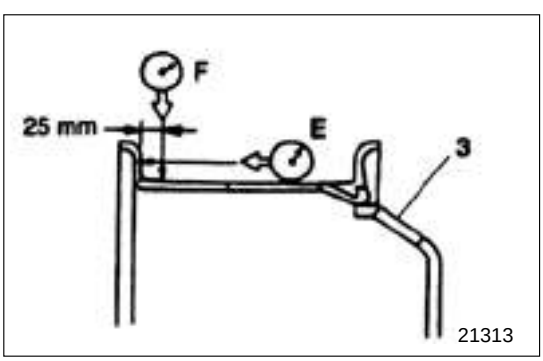
- Check the flatness of prescribed position B from center of wheel disc 3. Take measured values of 16 equant points on a circle.

A: Micrometer

C: Portable screw jack (supporting 4 places)

D: Platform

- Change wheel disc 3 if measured values are higher than limit values.



(2) Bounce

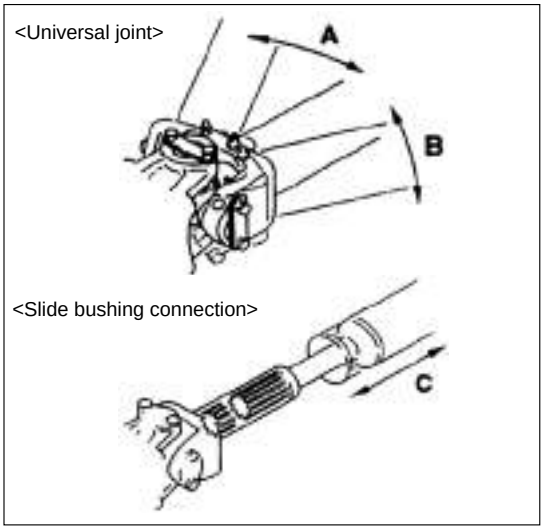
Change wheel disc 3 if measured values are higher than limit values.

E: Lateral bounce measuring point

F: Radial bounce measuring point

18 Universal Joint and Drive Shaft

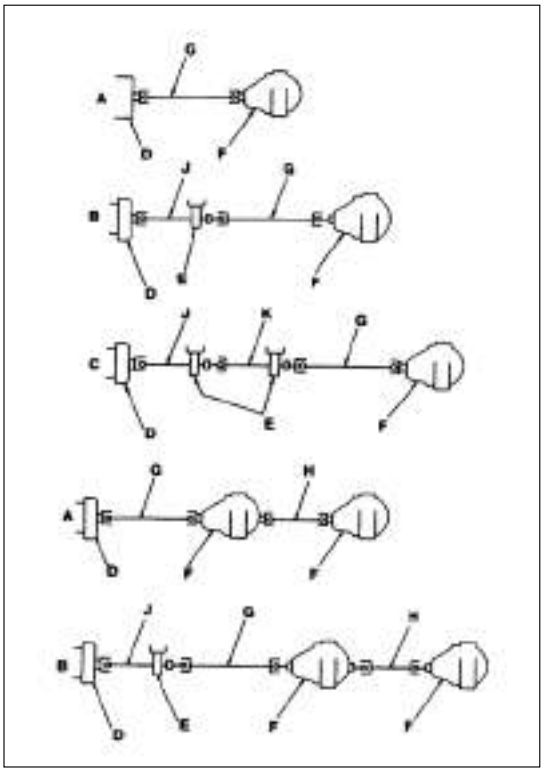
Structure and Working Principle



►Movement of Driving Shaft

A: Transverse shaking
B: Longitudinal shaking
C: Back-and-forth movement

- The gearbox rear axle varies in position with road unevenness, vibration and load changes during running. The universal joint and slide bushing connection are used to reduce the impact by these factors.



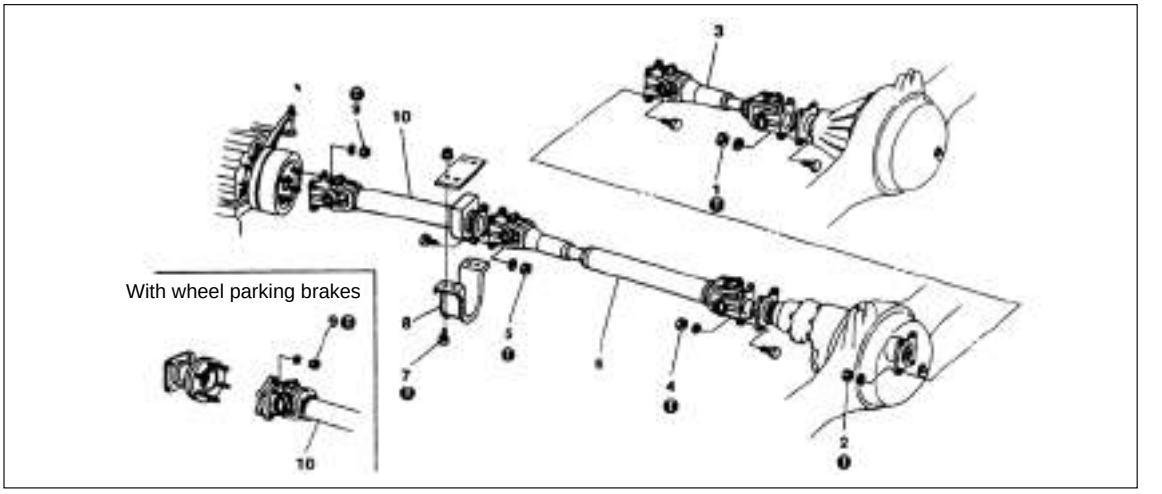
►Connecting Type of Driving Shaft

A: Single shaft connection
B: Dual shaft connection
C: Three shaft connection
D: Gearbox
E: Intermediate bearing
F: Rear axle
G: Rear driving shaft
H: Dual driving
J: 1st front driving shaft
K: 2nd front driving shaft

Common Failures and Troubleshooting

Failures / Possible Causes		Driving shaft vibration		Driving shaft noise		
		Vibrating during high speed	Vibrating during low speed	Noises at start or sliding	Noise at constant speed running	Click noise
Flange fork installed in wrong direction		O				
Over tightening torque for matching flange						O
Sliding bushing connection	Lubrication not enough				O	
Universal joint	Spline clearance too big		O	O		
	Crosshead axial clearance too big		O		O	
	Needle bearing lubrication not enough				O	
	Needle bearing worn out	O		O	O	
Intermediate bearing Dual- and 3-shaft connection Driving shaft	Poor lubrication				O	
	Sticking, wear or difficult rotation	O			O	
	Buffer rubber aged or deformed			O		
	Bracket fixing bolt loose			O		
	Fixing bolt loose	O		O		
	Bending	O				
	Dynamic balance wrongly adjusted	O				
Gear position selected too high			O			

Adjustment and Maintenance



►Before disassembly

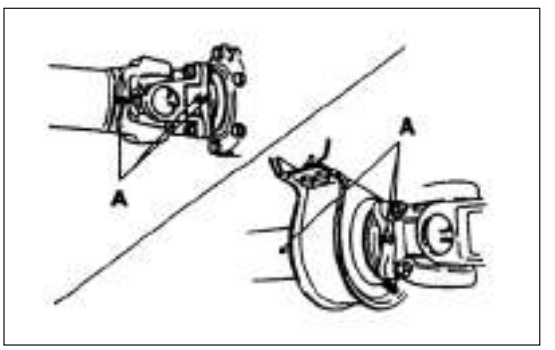
● Disassembly sequence

1 Nut
2 Nut
3 Double driving shaft
4 Nut
5 Nut
6 Rear driving shaft
7 Bolt
8 Intermediate bearing bracket
9 Nut
10 Front driving shaft

Tightening torque

unit: N.m{kgf.m}

Position	Parts tightened		Tightening torque	Remark
1,2	Nut (for drive shaft installation)	P8,P13	7-100{7-10}	-
4,5,9		P10,P11,P12	120-180{12-18} 180-250{18-26}	-
7	Bolt (for installation of intermediate bearing bracket)		43-65{4.4-6.6}	-



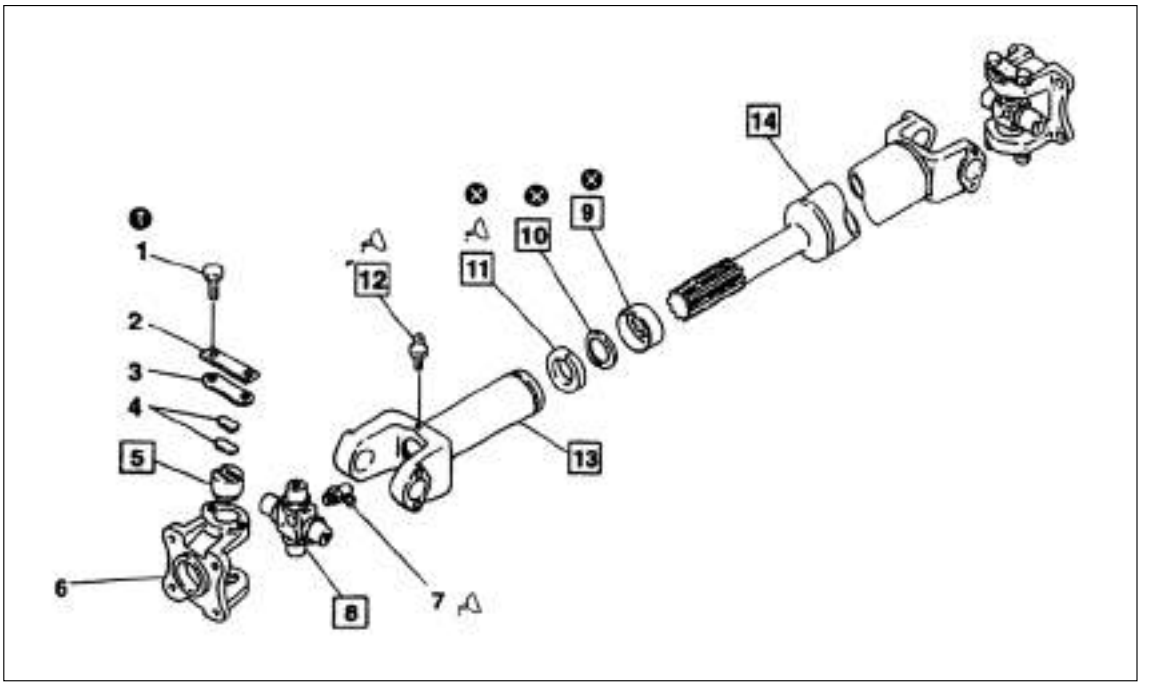
►Maintenance method

● Check prior to disassembly

Warning ⚠

- Stop the truck with wheel stops to avoid movement.
- Do not remove the wheel stops until all the work is finished.

Matching mark A must be made prior to disassembly.



►Check before disassembly

● Disassembly sequence

1 Nut
2 Lock plate
3 Bearing shell baffle
4 Adjusting gasket
5 Needle bearing
6 Flange yoke
7 Grease nipple
8 Crosshead
9 Dust ring
10 Retainer ring
11 Cork seal
12 Grease nipple
13 Sliding bushing connection
14 Double or rear driving shaft
⊗: Parts not to be reused

Caution ⚠

The needle bearing 5 is provided with a seal ring, so take care during disassembly to avoid its damage.

● Assembly order

Do in the sequence just contrary to that of the disassembly.
Maintenance kit: universal joint crosshead kit.

Maintenance Standard

Unit: mm

Location	Maintenance items		Standard value ([ ] basic diameter)	Limit value	Correction method
1-8	Axial clearance of crosshead		0-0.15	-	Adjust
5,6 13,14	Clearance between needle bearing and flange yoke,sliding sleeve connection, double driving shaft or rear driving shaft （"-"before the standard value means interference）	P8, P10,P11, P12,P13	[44]0.010-0.031 [46]0.030-0.011 [52]0.037-0.012	0.1 0.1 0.1	Change Change Change
5,8	Clearance between needle bearing and crosshead	P8 P10,P11 P12,P13	[28.56]0.02-0.07 [30.494]0.02-0.08 [36.25]0.02-0.08	0.2 0.2 0.2	Change Change Change
13,14	Clearance between sliding sleeve connection and double driving shaft or rear driving shaft in direction of rotation	P8 P10,P11, P12,P13	0.07 – 0.18 0.01-0.17	0.3 0.3	Change Change
14	Bending of double driving shaft or rear drive shaft（center）		-	0.6	Correct or change

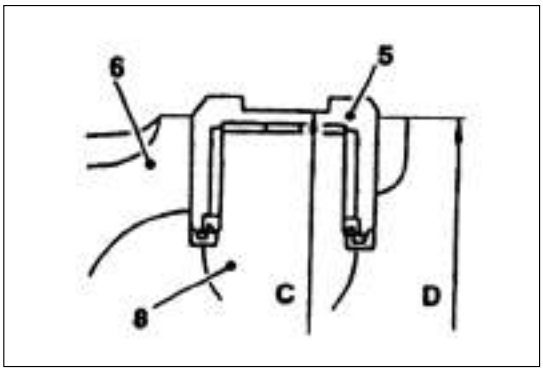
Tightening torque

Unit：N.m{kgf.m}

Location	Parts tightened		Tightening torque	Remark
1	Bolt （for needle bearing installation）	P8,P10,P11	18-26{1.8-2.7}	-
		P12,P13	35-33{3.6-5.4}	-

Lubricants

Location	Application position	Lubricant specified	Quantity
7	Infill by grease nipple [NLGIN0.2（lithium soap base）]	Wheel bearing grease	Fill in until grease overflows from the dust cover of crosshead.
11	Inner round of cork seal [NLGIN0.2（lithium soap base）]	Wheel bearing grease	As needed.
12	Infill by grease nipple [NLGIN0.2（lithium soap base）]	Wheel bearing grease	Fill in until grease overflows from the hole of the dust cover.



◆ Maintenance method

● Check before disassembly

Axial clearance of the crosshead

Measure the clearance of the needle bearing 5 (Allowable adjustment value for the adjusting gasket=D-C). If the measured value is more than the standard value, change the thickness of the adjusting gasket 4. (Type of adjusting gasket).

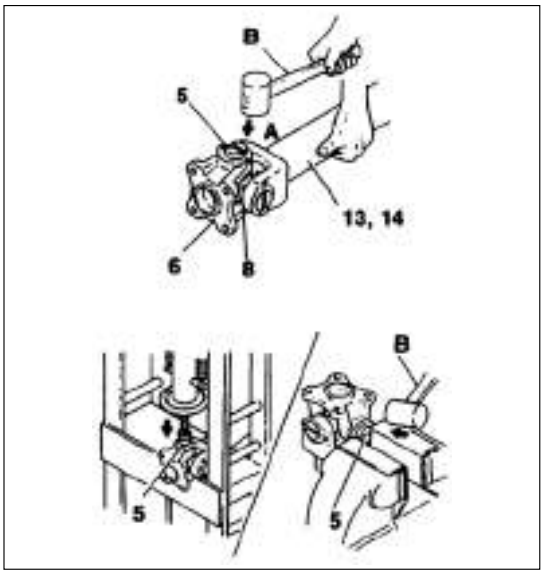
Parts	Thickness
Adjusting gasket A	0.1mm
Adjusting gasket B	0.2mm

Caution ⚠

Do not have the adjusting gasket A protrude the surface of flange yoke 6.

Remark:

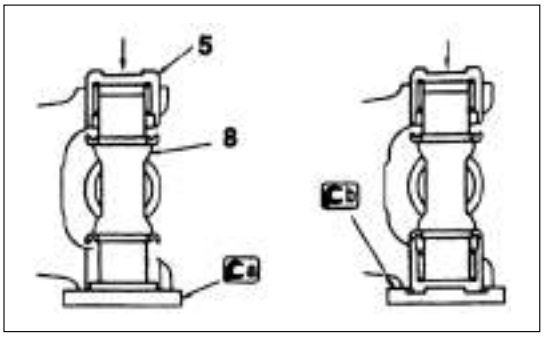
It is suggested that adjusting gaskets A of the same thickness be used on both sides to ensure rotary balance.



5 Needle bearing

[Disassembly]

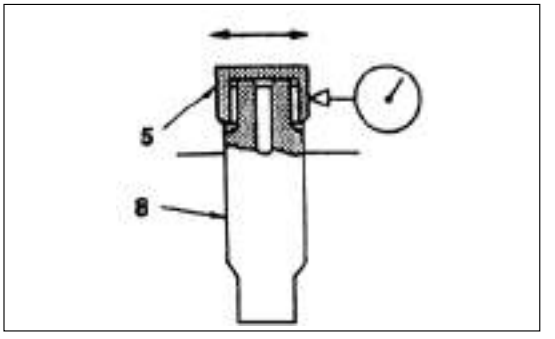
- Make match mark on the needle bearing 5 and crosshead 8.
- Make match mark on the flange yoke 6, sliding bushing connection 13, double driving shaft or rear driving shaft 14.
- Tap on the shoulder A of the flange yoke with a plastic or copper hammer B to have the needle bearing 5 spring out.
- If the needle bearing 5 cannot spring out easily, it's possible to place it on the press to have it pressed out from the flange yoke before removing it by means of vices



[Assembly]

Ca: Crosshead assembly support A

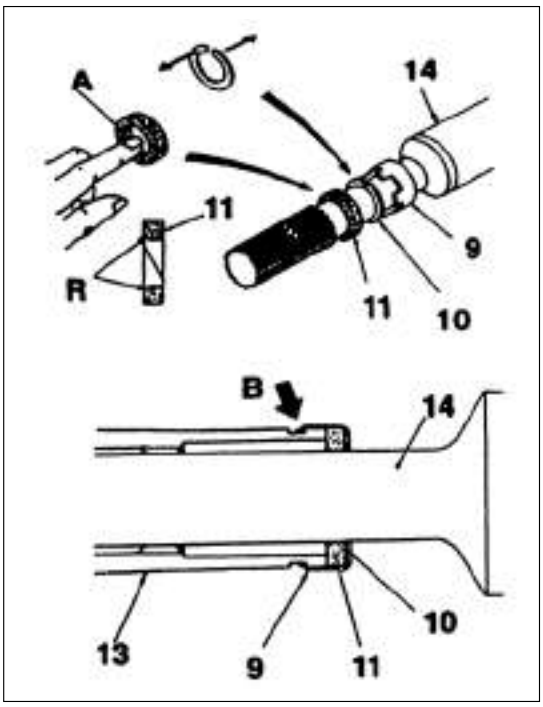
Cb: Crosshead assembly support B



5 8 Clearance between the needle bearing and crosshead

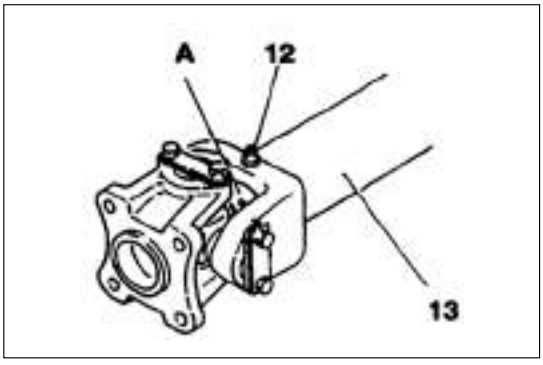
Measure the clearance between needle bearing 5 and crosshead 8.

If the measured value is more than the limit value, change it by the maintenance kit for universal joint crosshead.



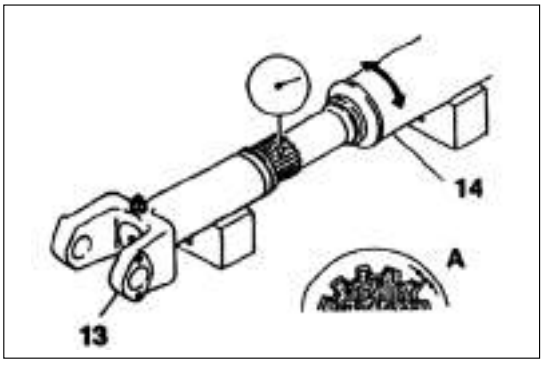
9 11 Fixing of dust ring, retainer ring and cork seal

- Insert the dust ring 9 into the double driving shaft or rear driving shaft 14, carefully open the retainer ring 10 and fix it on the double or rear driving shaft. Then release the retainer ring to let it restore to its original shape.
- Apply lubricant to the inner surface A of cork seal 11, then fix it on the spline shaft, in the same way as that for retainer ring 10. Face its arc R to the spline.
- While pressing the dust ring 9 onto the sliding bushing connection 13, compress the cork seal 11 by 1 or 2 mm before tightening the lock B.

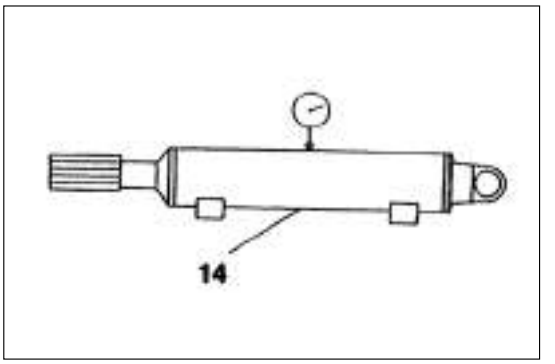


12 Fill in lubricant by grease nipple

Fill in lubricant by grease nipple 12 until grease overflows out of the hole in dust plug A of sliding bushing connection 13.



13 14 The clearance between sliding bushing 13 and the double or rear driving shaft 14 in direction of rotation. Measure the clearance A between sliding sleeve connection 13 and the double or rear driving shaft 14 in direction of rotation. If the measured value is more than the limit value, change the damaged parts.



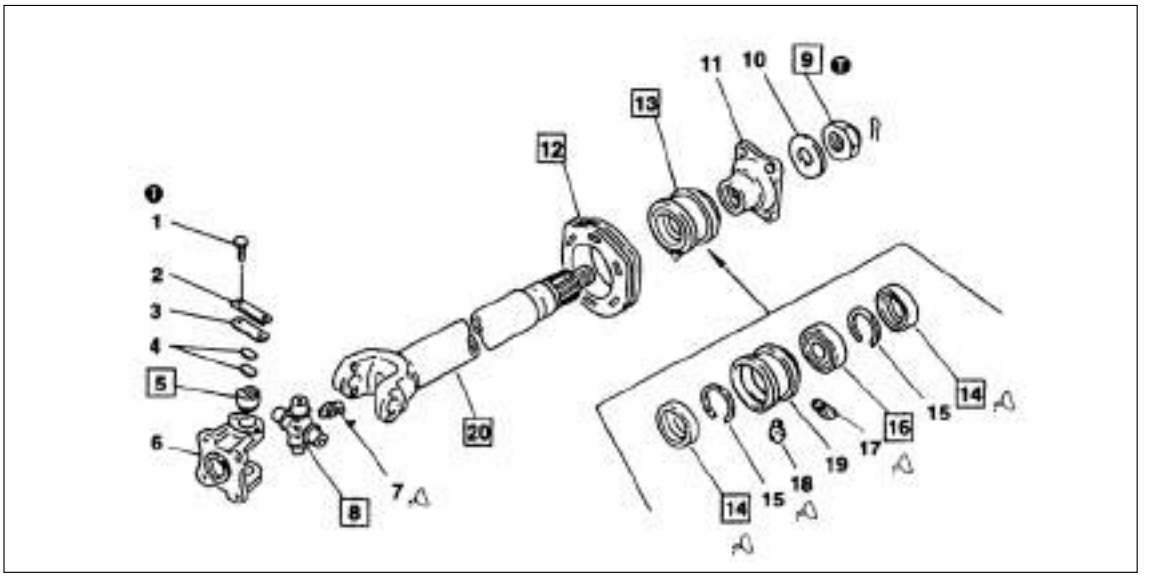
14 Bending of the double or rear driving shaft
Measure the bending at the center of double or rear driving shaft. If the measure value is more than the limit value, correct or change it.

Caution ⚠

After correcting the bending by press machine, check the shaft welds for any cracks.

Remark

Turn the shaft for a whole turn while measuring the bending of the double driving shaft or rear driving shaft 14, and read the indication from the dial gauge. The bending shall be half of the indicating value.



►Thorough check before disassembly

• Disassembly sequence

1 Nut
2 Lock plate
3 Bearing shell baffle
4 Adjusting gasket
5 Needle bearing
6 Flange yoke
7 Grease nipple
8 Crosshead
9 Nut
10 Washer
11 Matching flange
12 Buffer rubber
13 Intermediate bearing assembly
14 Oil seal
15 Elastic retainer ring
16 Intermediate bearing
17 Safety valve
18 Grease nipple
19 Iintermediate bearing shell
20 Front driving shaft

Caution ⚠

Be careful when removing the seal ring fixed in the needle bearing 5, to avoid its damage.

● Assembly order

Follow the sequence contrary to that of disassembly.

Maintenance kit: universal joint crosshead kit.

Maintenance Standard

Unit: mm

Location	Maintenance items		Standard value ([ ]basic diameter)	Limit value	Correction method
1-8	Axial clearance of crosshead		0-0.15	-	Adjust
5,6 20	Clearance between needle bearing and flange yoke,and front driving shaft ("-"before the standard value means interference)	P11	[46]0.030-0.011	0.1	Change
		P12	[52]0.037-0.012	0.1	Change
5,8	Clearance between the needle bearing and crosshead	P11	[30.494]0.02-0.08	0.2	Change
		P12	[36.25]0.02-0.08	0.2	Change
20	Bending of the front driving shaft (center)		-	0.6	Correct or change

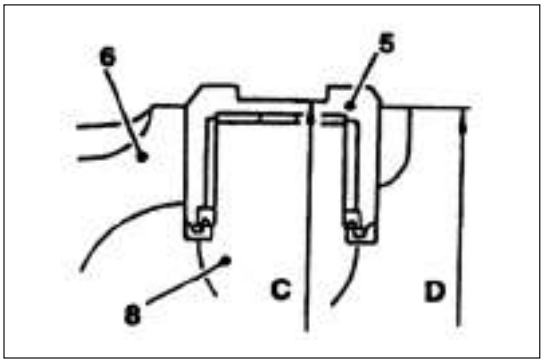
Tightening torque

Unit: N.m{kgf.m}

Location	Parts tightened		Tightening torque	Remark
1	Bolt (for fixing of needle bearing)	P11	18-26{1.8-2.7}	-
		P12	35-33{3.6-5.4}	-
	Nut (for installation of matching flange)	P11,P12	540-740{55-75}	

Lubricants

Location	Application position	Specified lubricant and/sealant	Quantity
7	Fill in by grease nipple	Wheel bearing grease [NLGIN0.2（lithium soap base）]	Fill grease until it overflows out from the crosshead dust ring.
14	Oil seal lip	Wheel bearing grease [NLGIN0.2（lithium soap base）]	As needed
16	Fill in among balls of the intermediate bearing	Wheel bearing grease [NLGIN0.2（lithium soap base）]	As needed
18	Fill in by grease nipple	Wheel bearing grease [NLGIN0.2（lithium soap base）]	Fill grease until it overflows out from the safety valve.



◆ **Maintenance method**

● **Check before disassembly**

Axial clearance of crosshead

Measure the clearance of the needle bearing 5 (Allowable adjustment value for the adjusting gasket=D-C). If the measured value is more than the standard value, change the thickness of the adjusting gasket 4. (Type of adjusting gasket).

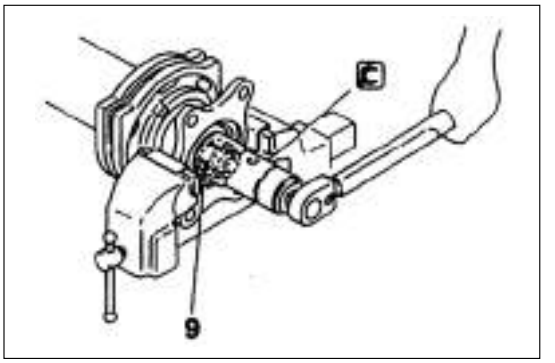
Parts	Thickness
Adjusting gasket A	0.1mm
Adjusting gasket B	0.2mm

Caution ⚠

Do not have the adjusting gasket 4 protrude the surface of flange yoke 6.

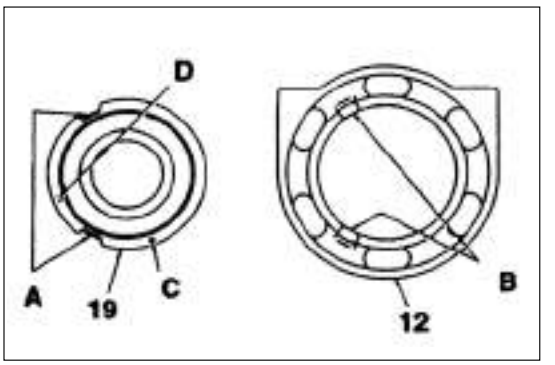
Remark:

It is suggested that adjusting gaskets 4 of the same thickness be used on both sides to ensure rotary balance.



9 Nut removal and fixing

: Socket wrench

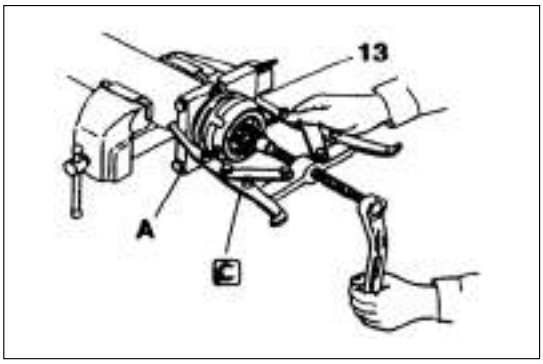


12 Buffer rubber fixing

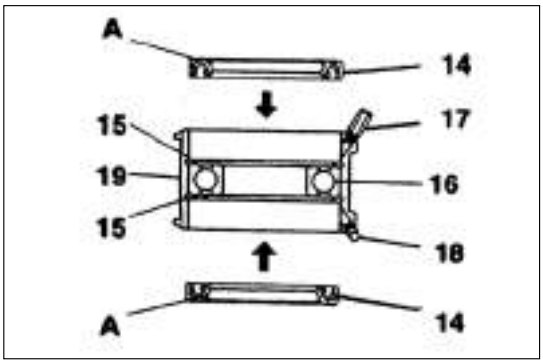
- Match the "B" of buffer rubber 12 with the "A" of intermediate bearing shell 19 to have them assembled. Soapy water may be applied if hard to assemble them.
- When assembling, the fixing hole of the grease nipple 18 of the intermediate bearing shell 19 shall be faced downward.

C: Fixing hole of safety valve

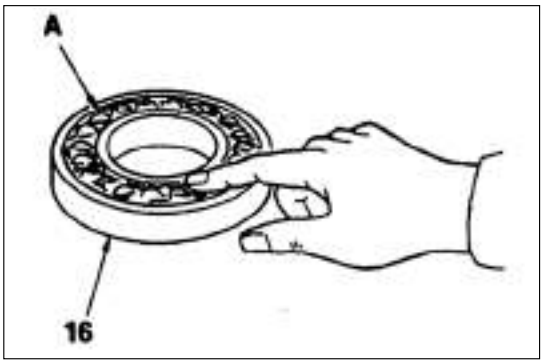
D: Fixing hole of the grease nipple



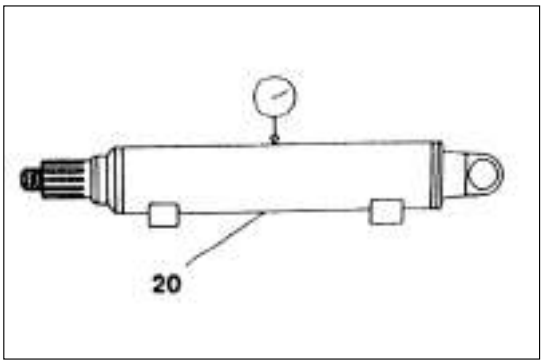
13 Removal of intermediate bearing assembly
Use gear die to remove the intermediate bearing assembly 13 by way of accessory A.



14 Fixing of oil seal
- Apply grease on the lip A of the oil seal 14, and fix the oil seal as per the direction shown.
- When fixing, the oil seal 14 shall be flush with the end surface of intermediate bearing shell 19.



16 Grease fill-in for the intermediate bearing
Fill in grease among the balls A of the intermediate bearing 16.



20 Bending of the front driving shaft
Measure the bending at the center of the front driving shaft 20. Correct or change if the measured value is more than the limit one.

Caution ⚠

After correcting the bending with press machine, check the shaft welds for any cracks.

Remark

Rotate the shaft for a whole turn while measuring the bending of the front driving shaft 20, and read the indication from the dial gauge, and the bending shall be half of the indicating value.

Adjustment after Assembly

(1) After the driving shaft bending is corrected, or the flange yoke and universal joint are changed, balancing machine should be used to measure the unbalance of the driving shaft assembly after its maintenance. The unbalance shall be within the tolerance.

(2) The dynamic balance can be corrected by polar coordinates method or 90° component force method.

(When polar coordinate method is used, the correction should be done at the bearing installation side for the driving shaft that is provided with intermediate bearings.)

(3) Allowable unbalance

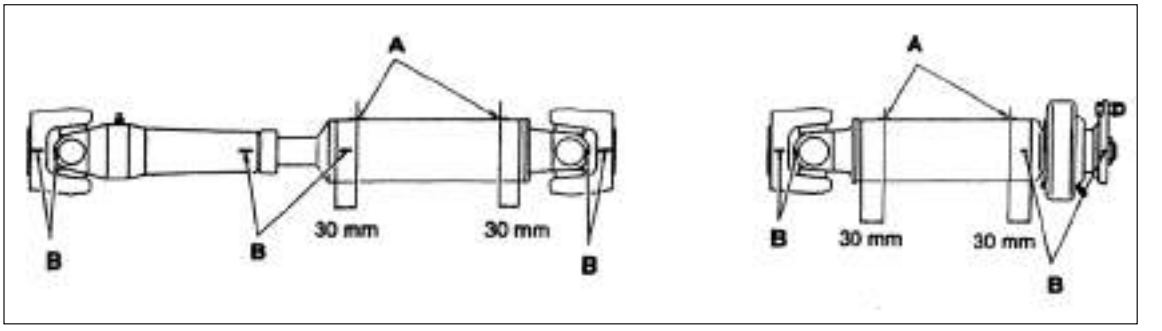
0.49Ncm{50gf.cm}/1600rpm（outer periphery of the pipe）

Remark:

When align and correct a driving shaft with a big unbalance, it is better to adopt 90° component force method, because less balancing tabs will be used.

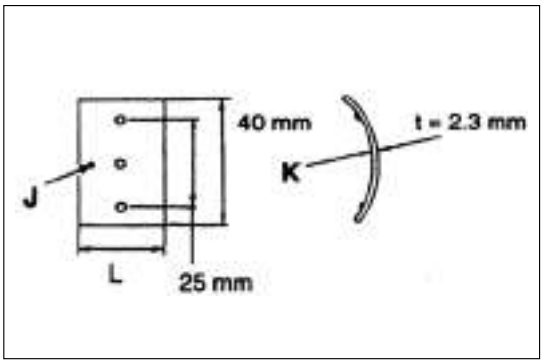
(4) Use the polar coordinate method in correction.

Position of balancing tabs installation (double or rear driving shaft) (front driving shaft)



A: Installation position of balancing tabs

B: Match mark



● **Types of balancing tabs**

（P8，P10，P11，P12）

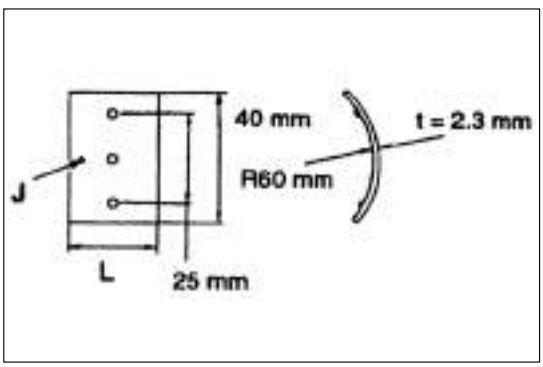
Parts	Mass (g)	Size (Lmm)
Balancing tab G	10	14
Balancing tab A	20	26
Balancing tab B	40	55.7
Balancing tab C	60	83.5

J: Mass mark

K: The radius of balancing tab G is 41.3mm, and those of other balancing tabs are 45mm.

Remark:

- The max. allowable mass of balancing tabs at one place is 120g.
- Combination of min. number of balancing tabs shall be used.



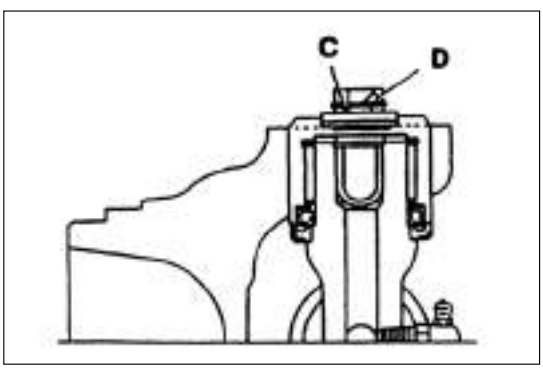
<13>

Parts	Mass (g)	Size (Lmm)
Balancing tab A	10	14
Balancing tab B	20	26
Balancing tab C	40	55.7
Balancing tab D	60	83.5

J: Mass mark

Remark:

- The max. allowable mass of balancing tabs at one place is 120g.
- Combination of min. number of balancing tabs shall be used.



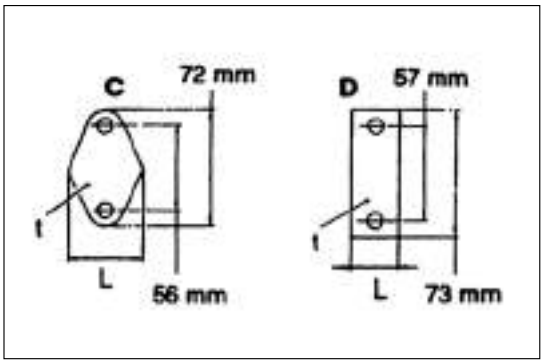
(5) 90° component force method shall be used in correction.

● Balancing tab fixing

Punching the positions for match marks are the same as polar coordinate method.

C: Balancing tab

D: Lock plate



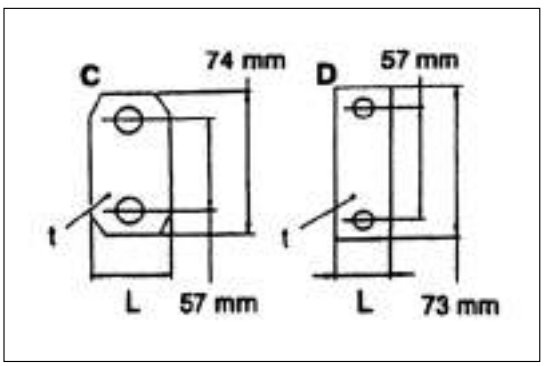
● Types of lock plate and balancing tab

<P8>

Parts	Mass g	Size Lmm	Thickness tmm
Lock plate	8	18	0.8
Balancing tab A	20	34	1.6
Balancing tab B	35	26	3.2
Balancing tab C	50	50	3.2

Remark:

- The max. allowable mass of balancing tabs at one place is 120g.
- Combination of min. number of balancing tabs shall be used.

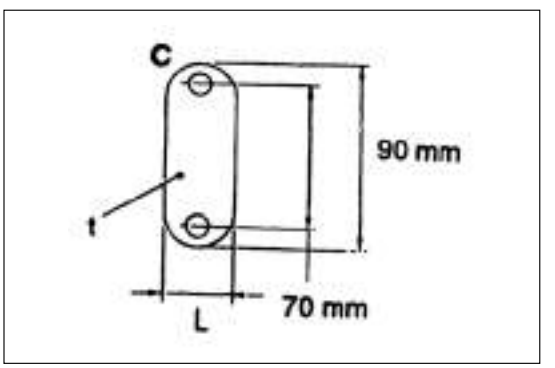


<P10,P11>

Parts	Mass g	Size Lmm	Thickness tmm
Lockplate	8	18	0.8
Balancing tab A	20	25	1.6
Balancing tab B	35	21.6	3.2
Balancing tab C	50	32.2	3.2

Remark:

- The max. allowable mass of balancing tabs at one place is 120g.
- Combination of min. number of balancing tabs shall be used.



<P12, P13>

Parts	Mass g	Size Lmm	Thickness tmm
Balancing tab A	7	28	0.35
Balancing tab B	20	32	1.0
Balancing tab C	35	29	2.0
Balancing tab D	50	36	2.3

Remark:

- The max. allowable mass of balancing tabs at one place is 120g.
- Combination of min. number of balancing tabs shall be used.

19 Operation Instruction of ABS

Performance of ABS System

- ABS is an electric system that monitors and controls vehicle speed during brake. It works with normal air brake system.
- ABS monitors wheel speed during all the time, and controls brake when wheel trends to lock braking. This system improves vehicle's stability. By reducing lock braking during brake, this system also improves vehicle's control performance.
- This system controls every wheel. If ABS failed on one wheel, normal brake of this wheel still acts.

►Advantage of ABS

- Keep vehicle's controllable performance. Under condition of emergent brake, drivers can still rotate steering wheel and keep away from barrier.
- Shortened brake distance. Under the same condition, it can shorten 10% at maximum on normal road (concrete, bitumen, etc); it can shorten 30% at maximum on smooth road (ice, snow, etc).
- Reduce wear of tyre and repair cost.
- Reduce driver's spirit burden.
- Reduce traffic accident.

Composition of ABS System

►Composition of ABS system

- Gear ring, sensor, solenoid valve, lead for sensor and solenoid valve, ECU, ABS warming lamp, etc
- Gear ring and sensor are fitted to produce induction voltage signal. Electronic control unit receives and deals with electric signal from sensor, and sends signal to solenoid valve. According to the signal sent by electronic control unit, solenoid valve adjusts brake pressure in the brake chamber. ABS warming lamp is used to remind the driver if ABS system works normally.

►Arrangement of ABS system

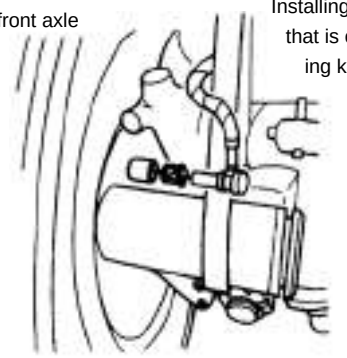
Arrangement of ABS system depends on the quantity of sensor and solenoid valve. For ABS of D-ECU, there are four normal displacement methods: 4S/3M(4 sensors and 3 solenoid valves).

4S/4M (4 sensors and 4 solenoid valves)

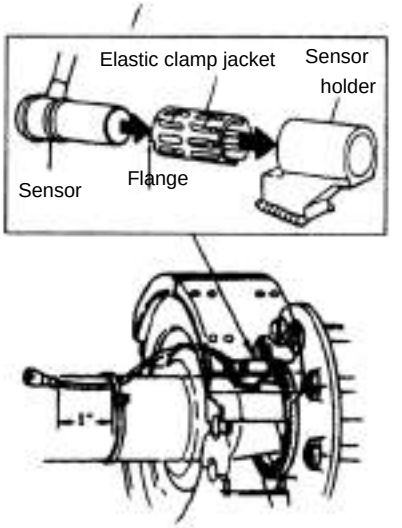
6S/4M (6 sensors and 4 solenoid valves)

6S/6M (6 sensors and 6 solenoid valves)

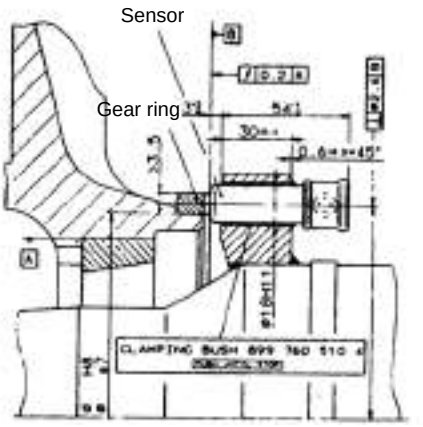
Installation of sensor in front axle



Installation of sensor in rear axle



Fit of sensor and gear ring



Installation and Testing of ABS Components

►Installation of gear ring

- Use safe and reliable method to install gear ring on hub. At the same time, consider driving condition (temperature, etc). For fit of gear ring and hub, recommend using H8/S7.
- There are two methods to install gear ring: One is heating and installing. If surface treatment of gear ring allows heating temperature exceed 150℃,heat gear ring to about 180℃~200℃, and keep 5~10 minutes. Then, it is unnecessary to apply huge force. The other method is pressing and installing. Use special tool to apply force evenly along the ring on press machine. The force should not be excessive. During installing, do not use hard object to knock gear ring, avoiding surface and shape of gear ring being damaged. After installation, axial deflection should be less than 0.2 mm, height deflection between adjacent teeth is less than 0.04 mm.

►Sensor

1. Installation of sensor

In general, mounting hole of clamp jacket for front shaft sensor is on brake back plate or steering knuckle. Installation of rear shaft needs a holder that is used to fix sensor. This holder should be installed on static part of the shaft, and there should be enough rigidity and stability to reduce the influence of vibration. Axial direction of sensor should be vertical to radial direction of gear ring, and maximum angle deflection is +2.50. Before installing, apply grease to sleeve first. Install clamp jacket until flange contacts clamp jacket. Then, turn greased sensor into sleeve. Push sensor until it contacts gear ring. After wheel rotates, sensor and gear ring will produce a clearance automatically. During installing, do not use hard object to knock sensor. Installation of sensor for front & rear axle, please refer to figure 1 and figure 2.

2. Fit of sensor and gear ring

Clearance between sensor and gear ring should be less than 0.7 mm, maximum clearance should be not more than 2 mm. Ratio of maximum induction voltage and minimum induction voltage for sensor should be not more than 2.2-2.5. Generally, installation of gear ring & sensor, and voltage testing should be done in axle plant. If eligible, they are delivered to vehicle manufacturing plant. Installing and cooperating figure of sensor and gear ring, please refer to figure 3.

3. Testing of sensor

After installing gear ring and sensor, test induction voltage of sensor:

a) Rotate wheel to 30 rpm with hand.

b) Use multi-meter to measure voltage between two poles of sensor.

c) If wheel speed exceeds 30 rpm, sensor voltage must be more than 0.20 V. Otherwise, ABS does not work and ABS warming lamp will illuminate. Sensor resistance is between 1100Ω and 1250Ω.

►Solenoid valve

1. Installation of solenoid valve

Solenoid valve is installed on car frame. Connecting pipe between solenoid valve and brake chamber should be as short as possible. Maximum length of connecting pipe is not more than 1.5 m, and diameter of that pipe is more than 9 mm. Port 1 is connected to air supply, port 2 is connected to brake chamber. Exhaust port of solenoid valve is downwards, and deflection is ±300.

2. Testing of solenoid valve:

a) Apply brake, and hear exhaust sound of solenoid valve.

b) Start the engine, and hear the circulating sound of solenoid valve. If there is no circulating sound, check connection of circuit.

c) Drive the vehicle, and verify if ABS lamp works normally. Resistance between each terminal of solenoid valve and grounding is 14-15.5Ω.

►Connection of lead

Connection of lead should be according to figure 841 801 151 0. Installation of connector should be according to technical requirement of WABCO, and should use special tool. Use special binding band to fix lead.

►Electronic control unit (ECU)

- There are two power supplies to connect ECU. One is from battery, which is the power supply of solenoid valve; the other is from ignition switch, which is the power supply of ECU, two power supplies: 30V for highest voltage and 18V for lowest voltage.
- Installation of ECU: ECU of ABS-D Basic should be installed in sealing compartment, to prevent water from immerging. It should be far way from heat source, and avoid impact with other objects.

How to Judge if ABS Works Normally

Generally, observe ABS warming lamp and emergent brake with speed higher 40 km/h, judge if ABS works normally.

►Observing ABS warming lamp

Function of ABS warming lamp is to make driver know about condition of ABS system, and to display diagnosis flash code.

Work condition of ABS warming lamp is as following:

Turn on ignition switch	ABS Illuminates instantly and the lightness is high (about 3 seconds), then extinguishes	That Indicates ABS system is normal.
		If speed is higher than 7 km/h and lamp extinguishes, which indicates ABS system is normal. If speed is higher than 7 km/h, and lamp does not extinguish, which indicates ABS system failed.

Note:

After a diagnosis, if ABS system is normal, ABS warming lamp will not extinguish until speed is higher than 7 km/h. The following condition is as mentioned in the table above.

►Emergent brake

On wide flat road, when speed is higher than 40 km/h, step on clutch and step on brake pedal fiercely to apply emergent brake, and then observe brake trace. If there is no brake trace, which indicates ABS worked; if all wheels or one wheel has trace, which indicates ABS does not work or ABS of one wheel does not work. If this situation exists, diagnose and repair ABS system or ABS of one wheel.

►Confirm ABS is working.

a) Turn on ignition switch.

b) Wait ABS lamp to extinguish.

c) Listen the circulating sound of ABS solenoid valve: 1-2-3-4-1 &2-3-4, 6 sounds together

1- Right front wheel

2- Left rear wheel

3- Left front wheel

4- Right rear wheel

►Diagnosis method of ABS system

1. Use diagnostic apparatus to diagnose: diagnose launched vehicle

1 Function of diagnostic apparatus

- Memorize fault
- Make ABS parts (such as ABS lamp, solenoid valve) act

● Measure voltage, wheel speed
● Read ECU parameter
● Diagnose ABS system
● Act as multi-meter. Measure voltage, resistance, etc

2 Diagnosis system of diagnostic apparatus is made up of the following parts:
● WABCO diagnostic apparatus 446 300 320 0
● Diagnostic line 894 603 303 2
● D-diagnostic card 446 300 732 0

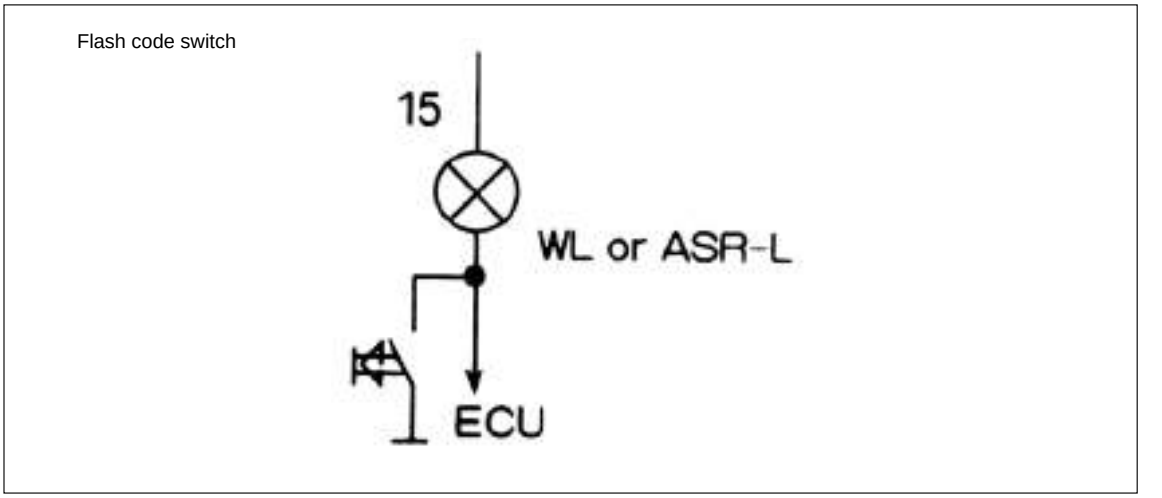
2. PC diagnosis: diagnose launched vehicle

1 function
● Memorize fault
● Make ABS parts (such as ABS lamp, solenoid valve) act
● Measure voltage, wheel speed
● Read ECU parameter
● Diagnose ABS system
● Act as multi-meter. Measure voltage, resistance, etc

2 PC diagnostic apparatus is made up of the following parts:
● Laptop
● WABCO PC software: 446 301 620 0
● Diagnostic line: 894 604 303 2
● Transducer: 446 301 021 0

3. Flash code diagnosis: it is an easy and practical diagnosing method, which is often used for repair.

1 Basic term
● Flash code: A series of flash of ABS lamp indicates fault or condition of ABS system.



● Circulation of flash code: two flash codes, time interval between two flash codes is half second.
● Flash code switch: The switch that starts flash code's diagnosis function.
● Clear: eliminate the fault of ECU.
● Diagnosis: use flash code to confirm fault of ABS system.
● Fault: ABS invalidation detected by ECU and stored in memory. System's fault can be actual or stored.
● Actual fault: existing in ABS system at present, such as loop of left front wheel sensor is invalid.
Actual fault must be repaired. Otherwise, it cannot be eliminated from memory, and cannot continue to display other faults.
● Storage fault: there are two storage faults.
a) Repaired default has not been eliminated from ECU.
b) A fault that existed before but does not exist at present, such as, loose lead contacts off and on. Because stored fault is not actual fault at present, it is not necessary to repair before eliminating it from memory.
● Structural code of the system: numerical code displayed in eliminating mode. Numerical code used for general ABS system is as:

4S/3M	Flash 3 times
4S/4M	Flash twice
6S/4M	Flash 4 times
6S/6M	Flash once

● Diagnosis mode: Press down flash code switch (grounding) and keep for a second, then release it. ABS warming lamp will flash out two groups of flash code. Based on flash code table, confirm ABS fault.
● Eliminating mode: on eliminating mode, eliminate the fault in ECU. Press down flash code switch and keep for 3 seconds, then release it. If ABS lamp flashes 8 times quickly, and then flashes structural code of the system, which indicates elimination is successful and ABS fault has been eliminated from memory. If ABS lamp does not flash 8 times, and only flashes structural code of the system, which indicates ABS still has actual fault, which must be repaired before eliminating it.

2 Diagnostic sequence of flash code

Mode	Sequence	Reaction of the system	Operation
Diagnosis	First step: turn on ignition switch	Three possible reactions 1. ABS warming lamp illuminates instantly, and then extinguishes, which indicates the system is OK	There is no actual fault in ABS. It is not necessary to take actions.
		2. ABS lamp does not illuminate, which indicates circuit is invalid or bulb is damaged.	Check circuit and bulb. Do necessary repair.
		3. ABS lamp always illuminates, which indicates there is one or several fault in the system.	Diagnose continuous flash code (to second step).
	Second step: press down flash code switch and keep for one second	ABS warming lamp begins to flash two groups of code.	Confirm that if fault is actual or stored: Actual fault: the lamp will display one code repeatedly. Stored fault: the lamp will display code of every stored fault, and then extinguish. Only display fault once.
	Third step: determine flash code according to flash times	First-group number: Flash 1-8 times, interval (1.5 seconds) Second-group number: Flash 1-6 times, interval (4 seconds)	Turn off ignition switch, and confirm the type of fault according to flash code table.
	Fourth step: correct and record fault	Actual fault	Do necessary correction. Repeat step 1, 2, and 3 until the system is OK.
		Storage fault	Record to refer. Note: The first displayed fault is the last fault that is stored by ECU.
Elimination	Fifth step: Eliminate the fault from memory. Press down flash code switch and keep 3 seconds at least.	ABS flashes 8 times at least.	All faults are eliminated, and the lamp extinguishes.
		ABS does not flash 8 times.	Actual fault still exists. Repeat step 1-5.

3. Check list of flash code

First-group fault code		Second-group fault code	
Times	**Faulted parts**	**Times**	**Faulted parts**
1	No fault	1	No fault
2	ABS solenoid valve	1	Right front wheel
3	Sensor clearance is huge	2	Left front wheel
4	Sensor is open circuit /short circuit	3	Right rear wheel
5	Sensor signal is not stable	4	Left rear wheel
6	Gear ring is damaged	5	Right wheel in third axle
		6	Left wheel in third axle
7	System function	1	Data interface
		2	ABS differential valve
		3	Relay of third brake
		4	ABS lamp
		5	Collocation of ABS
		6	Proportional valve of ABS
8	ECU	1	Voltage ratio
		2	Voltage is high
		3	Inside fault
		4	Fault of system collocation
			Grounding

4 Diagnosis and repair of flash code fault

Flash code	Check	Test and Repair
2-1…2-6	Check ABS solenoid valve and its lead and connector	Measure resistance
3-1…3-6	Check clearance between sensor and gear ring. Check if wheel bearing is loose or if hub swings and inclines	Adjust clearance between sensor and gear ring. Measure the voltage of sensor.
4-1…4-6	Check sensor and its lead and connector	Measure resistance
5-1…5-6	Check the fit of tyre and gear ring.	Check the dimension of tyre.
6-1…6-6	Check if gear ring is damaged	
7-1	Check data interface	According to connecting diagram
7-2	Check ASR valve and its lead and connector	Measure resistance
7-3	Check connection of third brake relay	According to connecting diagram
7-4	Check connection of ABS warming lamp	
7-5	Check if setting of ASR valve is appropriate	
7-6	Check if flash code is accurate, and clear ECU memory.	Diagnose flash code
8-1	Measure vehicle's voltage and the voltage supplied to ECU (18-30 V)	Measure voltage according to connecting diagram
8-2	Check vehicle's voltage (18-30v). Check if flash code is accurate. Clear ECU memory	Measure voltage Diagnose flash code
8-3	Check if flash code is accurate and clear ECU memory.	
8-4	Check if flash code is accurate and clear ECU memory. If flash code is not explicit, it is necessary to replace ECU	
8-5	Check grounding of ABS	According to connection diagram

4 Use portable diagnostic apparatus to diagnose

Diagnostic apparatus: 446 300 410 0
Diagnostic line: 894 604 303 2

1 Connection of diagnostic apparatus

a) Insert diagnostic line with 9-poled connector into corresponding interface of diagnostic apparatus.
b) Connect other end of diagnostic lead with diagnostic interface on one side of vehicle.
c) Turn on ignition switch.
d) Display screen of diagnostic apparatus will display "888" immediately.
e) About one second later, it will display "ABS".
f) Connection of diagnostic apparatus and ABS system is successful.
g) Carry out necessary diagnostic operation.

2 Looking for fault

a) After diagnostic apparatus connects with ABS system successfully, press down "ERROR" key for about one second.
b) Release "ERROR" key, the screen will display fault with three-group numbers.
position 1 position 2 position 3
fault path fault type times

For example 411: sensor of wheel D, clearance is too huge, exists once

c) First displays actual fault identified by ECU, then appears “old”. At this time, press down and release “ERROR” key, then displays stored fault.

d) After displayed all faults, it will display “ABS”.

3 Deleting fault

Precondition: there is no actual fault

a) Press down (more than 0.5 second) and release “CLEAR” key.

b) The screen will display “Clr”.

c) Then the screen will display “ABS”.

d) Disconnect ignition switch, then turn on ignition switch again.

e) All stored faults are deleted.

4 Display of system

a) Press down and release “SYSTEM” key.

b) The screen will display the type of ABS system. For example, “4-3” indicates 4S/3M ABS system. “4-4” indicates 4S/4M ABS system.

5 Format of system

a) Press down and release “SYSTEM” key.

b) The screen will display the type of ABS system, such as “4-3”.

c) Press down “SYSTEM” key for more than 2 seconds. It will display deleted one and new system in short time. Format is successful. If because of some reasons, the system cannot be formatted, the screen will display “---” immediately after pressing down “SYSTEM” key for the second time.

6 Test of function

Precondition: there is no actual fault.

a) Press down and release “SYSTEM” key. The screen will display the type of ABS system.

b) Press down “CLEAR” key for more than 2 seconds, the screen will display “SYS”.

c) Step on throttle. If the engine rotates at idle, which indicates ASR engine control is active. The screen will display the time with number (1、2-10). If it is ASR, there is a “-” in the screen.

d) Press down “CLEAR” key again for more than 0.5 seconds. The retarder will be out of function for 5 seconds. The screen will display “005….000”. If there is no retarder, the screen will display “-”.

e) If you want to pause, you can press any key.

7 Fault detection of the system

a) After detecting control of retarder, the screen will display “SYS”. Rotate every wheel without pressing the key. Wheel speed is more than 4 KM/H.

b) The screen will display the current speed of the wheel. For example, if speed of A wheel is 5 km/h, it will display “A05”. If rotates A wheel, while the screen displays the speed of B wheel or other wheel, which indicates connection of sensor is wrong.

c) After rotated wheel stops, corresponding ABS valve will act. You can judge if connection is correct according to the sound of solenoid valve.

d) After rotate C or E wheel, impulse program starts. It can measure ASR differential valve.

Operation of ABS

● Considerations in the operation of ABS:

● Do not use water to wash ECU
● Do not use multi-meter to measure ECU
● When use exterior high voltage to charge battery, disconnect ABS
● When dismantle and assemble the components, shut off power supply.
● When weld the vehicle, disconnect ABS.
● Often check if the voltage of generator is stable.
● If ABS indicator is damaged, replace it duly.
● Do not change capacity of the fuse at random.

Only when emergent brake makes wheel trend to lock braking, can ABS work. Popularly, ABS works just like drivers' quick and frequent "point brake". Frequency of drivers' "point brake" cannot be compared to ABS. ABS can change 3-5 times in one second. The truck equipped with ABS can select to mount an ABS switch. On normal road, turn off ABS. On wet and slippery road, open ABS.

With regard to the vehicle equipped with ABS, when encountering emergent brake, step on clutch quickly, and then step on foot brake fiercely. At the same time, you can rotate steering wheel to make the vehicle keep away from barrier.

Caution ⚠

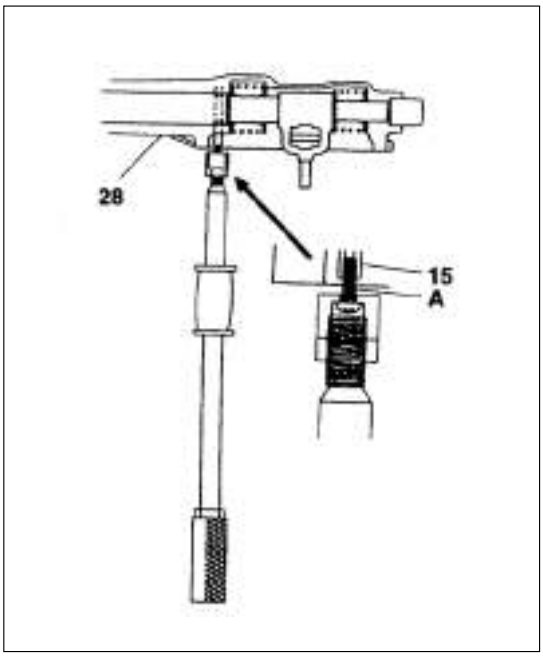
During the vehicle drives, if ABS illuminates, which indicates there is fault in ABS system. You can still drive the vehicle safely. Because normal brake of the wheel (whose ABS is faulted) still acts. Quickly diagnose and repair these vehicles in specified repair station of HUALING, to make the function of ABS system get right.

Appendix 1: Part list of ABS-D system

Serial number	Product name	Number
1	ECU（D-Basic）	446 004 310 0
2	Solenoid valve	472 195 018 0
3	Extension line of solenoid valve	449 513 XXX 0
4	Sensor	441 032 809 0
5	Extension line of sensor	449 711 XXX 0
6	Sensor sleeve	899 759 815 4
7	Plug body（14PIN）	894 110 110 2
8	Plug body（18PIN）	894 110 091 4
9	Plug	894 070 829 4
10	Plug (gold-plating)	894 070 831 4
11	Binding band	894 326 012 4
12	Grease	830 502 068 4

Lubricant and/or sealant

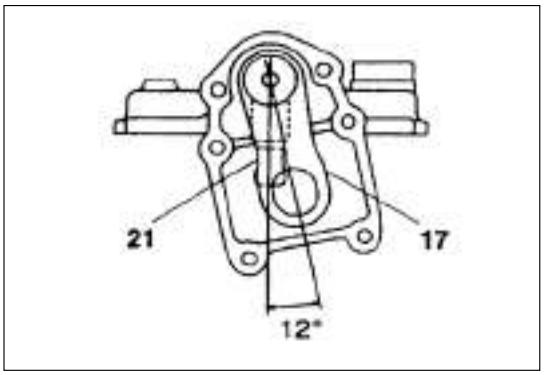
Position	Application position	Specified lubricant and/or sealant	Quantity
2	Thread of shift connector for air hose	Three-way sealant 1207B	As needed
4	The surface fitted with housing of selecting rod	Three-way sealant 1215	As needed
6	Idle switch Thread End face of plunger	Three-way sealant 1104J grease for wheel bearing	As needed As needed
7	Shift switch Thread	[NLGINo.2 (Lithium soap base)] three-way sealant 1104J	As needed
	End face of plunger	Grease for wheel bearing [NLGINo.2 (lithium soap base)]	As needed
11	Both sides of the washer	Grease for wheel bearing [NLGINo.2 (lithium soap base)]	As needed
17	Shifting rod equipped with steel ball, groove of O ring	Grease for wheel bearing [NLGINo.2 (lithium soap base)]	As needed
25	Space between oil seal lips	Grease for wheel bearing [NLGINo.2 (lithium soap base)]	As needed
26	Inner surface of sleeve which glides on shaft A of selecting rod of gear and outer surface of sleeve which contacts with body case of selecting rod	Grease for wheel bearing [NLGINo.2 (lithium soap base)] Three-way sealant 1215	As needed As needed
28	The surface fitted with transmission case	Three-way sealant 1215	As needed



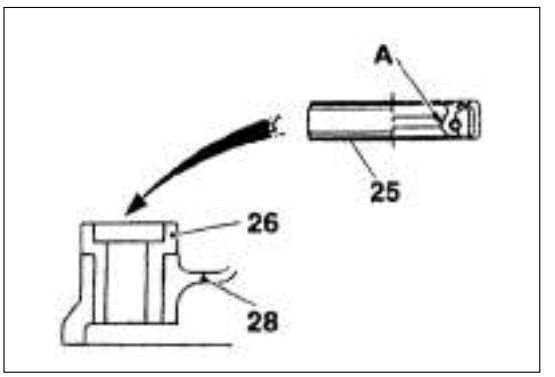
◆ Examining and Repair method

15 Dismantling of spring pin

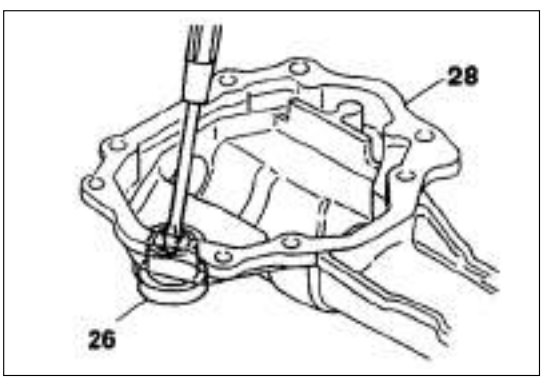
- Use M4 screw tap to tap in the hole of spring pin 15.
- Use bolt A (that has appropriate length) of M4 to install drawplate of spring pin into spring pin 15.
- Install drawplate of reverse shaft into drawplate of spring pin.
- Use spring pin drawplate and reverse shaft drawplate to pull out spring pin 15 from selecting rod 28.



17 21 Installation of shifter and gearshift rod
When install gearshift rod 12 on gearshift rod 17, aligning the spline, make the angle between gearshift rod and shifter be the same as the figure.



25 Installation of oil seal
- Apply grease to the space in lip A of oil seal 25.
- Install oil seal 25 into sleeve 26, making it towards the direction in the figure.



26 Sleeve

[Dismantlement]

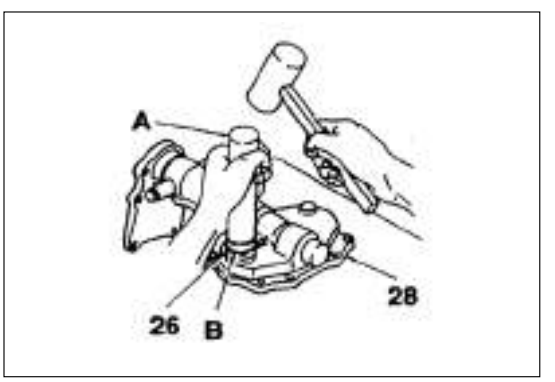
- Use driver to disassemble body case 28 of electing rod from sleeve 26.

Caution ⚠

- Be careful! Do not damage body case 28 of selecting rod.

[Installation]

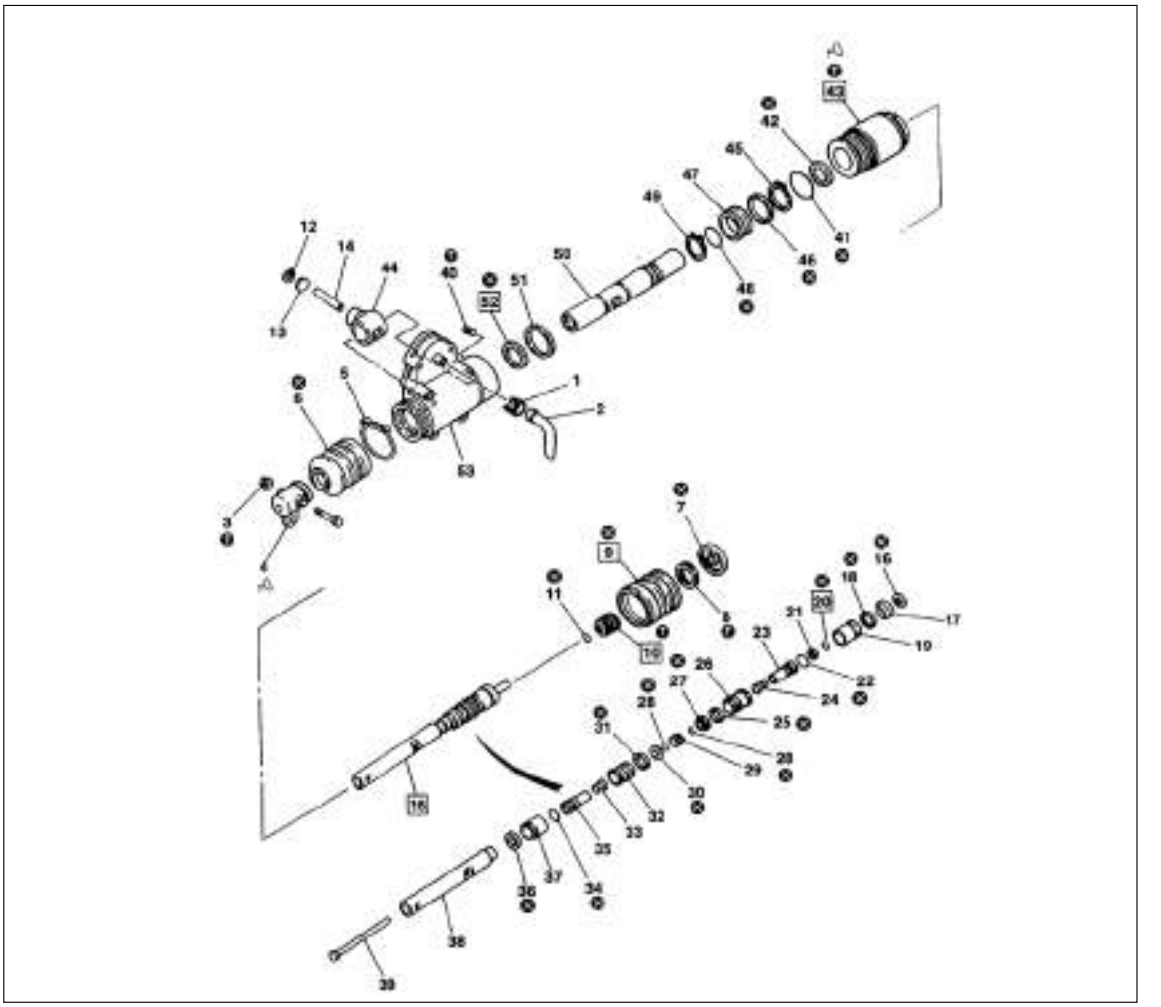
- Clean inner surface of body case 28 of selecting rod.
- Use a round bar A whose outer diameter is about 40 mm, to tap sleeve 26 into body case 28 of selecting rod.
- At this time, do not damage body case 28 of selecting rod.
- Before installation, apply sealant to mounting side B of sleeve 26.



Caution ⚠

When applying sealant to sleeve, do not apply to inner circle of sleeve 26.

►Power shift mechanism assembly



● Disassembling sequence

1 clip	2 hose	3 nut	4 rod
5 clip	6 shield	7 cover	8 nut
9 shield	10joint	11 O ring	12 retainer ring
13 flat plate	14 cylindrical pin	15 valve assembly	16 filter
17 ferrule	18 square ring	19 pipe	20 retainer ring
21 flat plate	22 O ring	23 tappet	24 spring
25 square ring	26 valve seat	27 seal ring assembly	28 O ring
29 spring	30 seal ring assembly	31 square ring	32 valve seat
33 spring	34 O ring	35 tappet	36 square ring
37 pipe	38 rod	39 pipe	40 locating screw
41 O ring	42 sealing gasket	43 cylinder	44 pin sleeve
45 retainer ring	46 sealing gasket	47 piston	48 O ring
49 retainer ring	of piston	50 shifter	51 flat plate
52 cup of oil seal	53 housing	⊗: Parts that cannot be used repeatedly.	

● Assembling sequence

It is opposite to disassembly sequence.

Repair kit: kit of power shift mechanism.

Caution ⚠

Installation of spring 24, 29 and 33 must be according to correct sequence.

Examining and Repairing standard **unit: mm**

Position	Examining and repairing item	Standard value ({} is basic diameter)	Limit value	Correction method
24	Installed load of spring (installed length is 13)	47.1N{4.8kgf}	38.2N{3.9kgf}	Replace
29	Installed load of spring (installed length is 10)	12.7N{1.3kgf}	9.8N{1.0kgf}	Replace
33	Installed load of spring (installed length is 13)	18.6N{1.9kgf}	14.7N{1.5kgf}	Replace

Tightening torque **unit: N.m{kgf.m}**

Position	Parts tightened	Tightening torque	Remark
3	Nut	23.5-26.5{2.4-2.7}	—
8	Fixing nut (joint on the side of cylinder)	59-69{6-7}	—
10	Fixing joint (the side of cylinder)	7.8-11.8{0.8-1.2}	—
40	Locating screw	2.0-3.4{0.2-3.5}	—
43	Cylinder	78-98{8-10}	—

Lubricant and /or sealant

Position	Application position	Specified lubricant and/or sealant	Quantity
4	Inner circle of rod	Grease for wheel bearing [NLGI No.2 (lithium soap base)]	As needed
43	Thread of cylinder	Loctite 242 or three-way sealant 1401B	As needed
—	All gliding surfaces	Grease for wheel bearing [NLGI No.2 (lithium soap base)]	As needed

◆ Check method

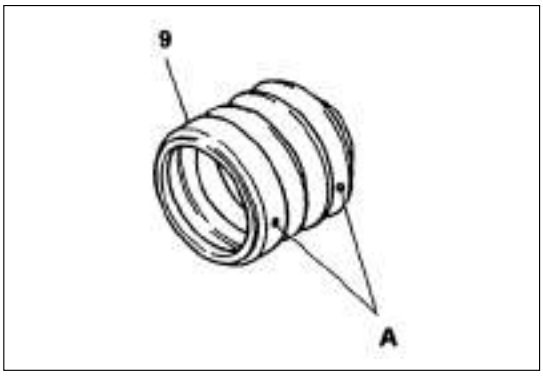
● Check before disassembly

(1) When power shift gear mechanism assembly is not active (valve is in idle) and active (valve pushes/ pulls), apply 736 kPa {7.5kgf/cm2 }pressure to joint, and check gas tightness. If measured value is beyond standard value, replace damaged parts.

Maintenance item	Standard value
When it is not active	9.8kPa
15 seconds after gas tightness test	Below {0.1kgf/cm2}
Pressure drops when it is active	Below 49kPa{0.5kgf/cm2}

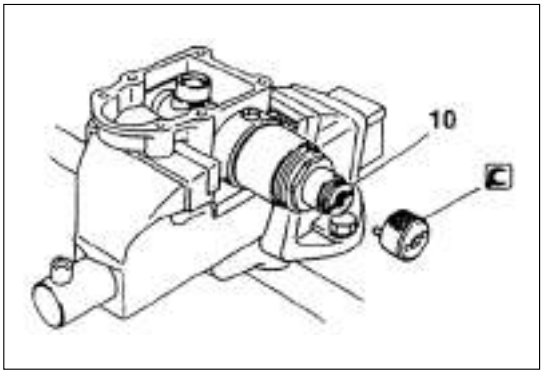
(2) Measure the sliding resistance in shifting direction. If measured value is beyond standard value, replace damaged parts or apply grease.

Maintenance item	Standard value
Sliding resistance in shifting direction	Below 38.2N{3.9kgf}

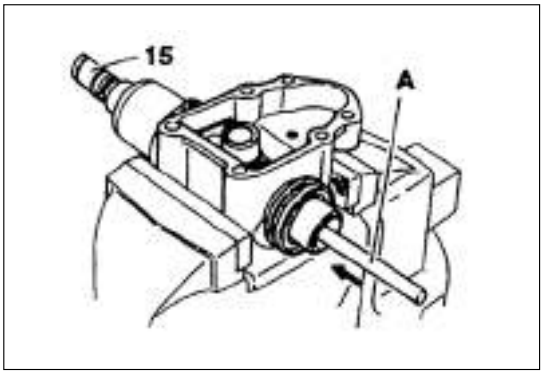


9 Installation of shield

Mount shield 9 on the housing, with oil drain A towards downwards.



10 Dismantling and installation of joint C joint



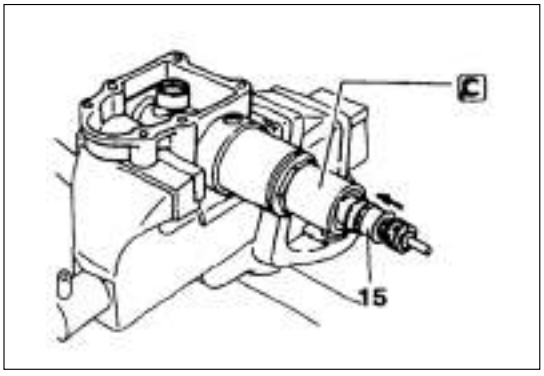
15 Valve assembly

[Dismantling]

Use a round bar A having appropriate length to push one end of the rod, to push valve assembly 15 out of shifter 50.

Caution ⚠

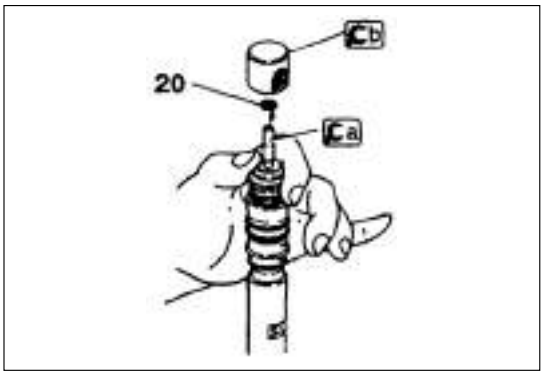
Be careful. Applying excessive fore to valve assembly 15 may damage the valve parts.



[Installation]

- Apply grease to valve assembly 15.
- Do not damage oil seal and related parts.

Use C socket to install valve assembly on shifter 50.



20 Retainer ring

[Disassembling]

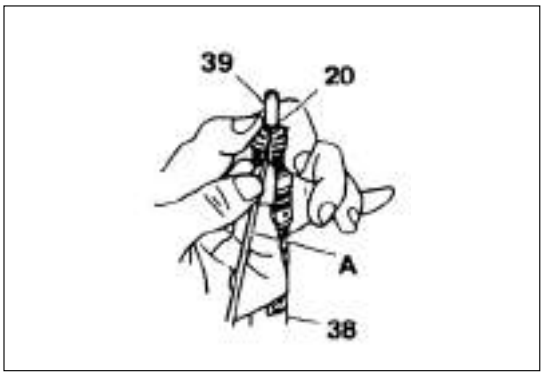
- Clip rod 38 in vices. Do not damage the rod.
- Use a needle tool A to disassemble retainer ring 20 from pipe 39.

Caution ⚠

Put valve parts in correct order, to avoid installing wrongly.

Remark

After disassembling retainer ring 20, all the valve parts can be disassembled.

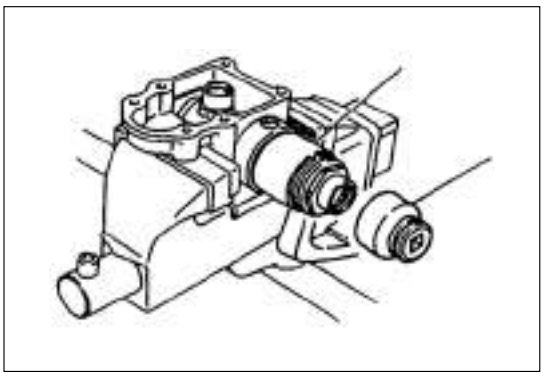


[Installation]

- Install valve parts on pipe 39.
- Put Ca tool on top of pipe 39.
- Use Cb tool to install retainer ring 20 into the groove of pipe 39.

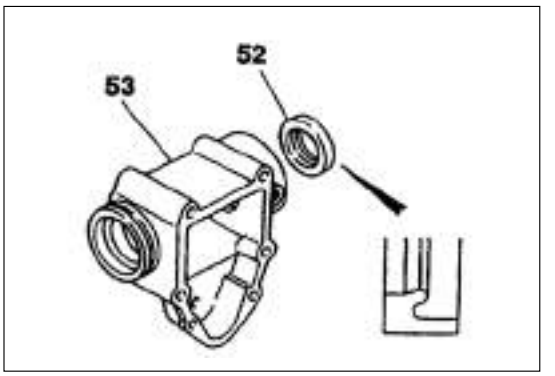
Caution ⚠

When installing retainer ring 20, do not use excessive force.



43 Dismantling and installation of cylinder

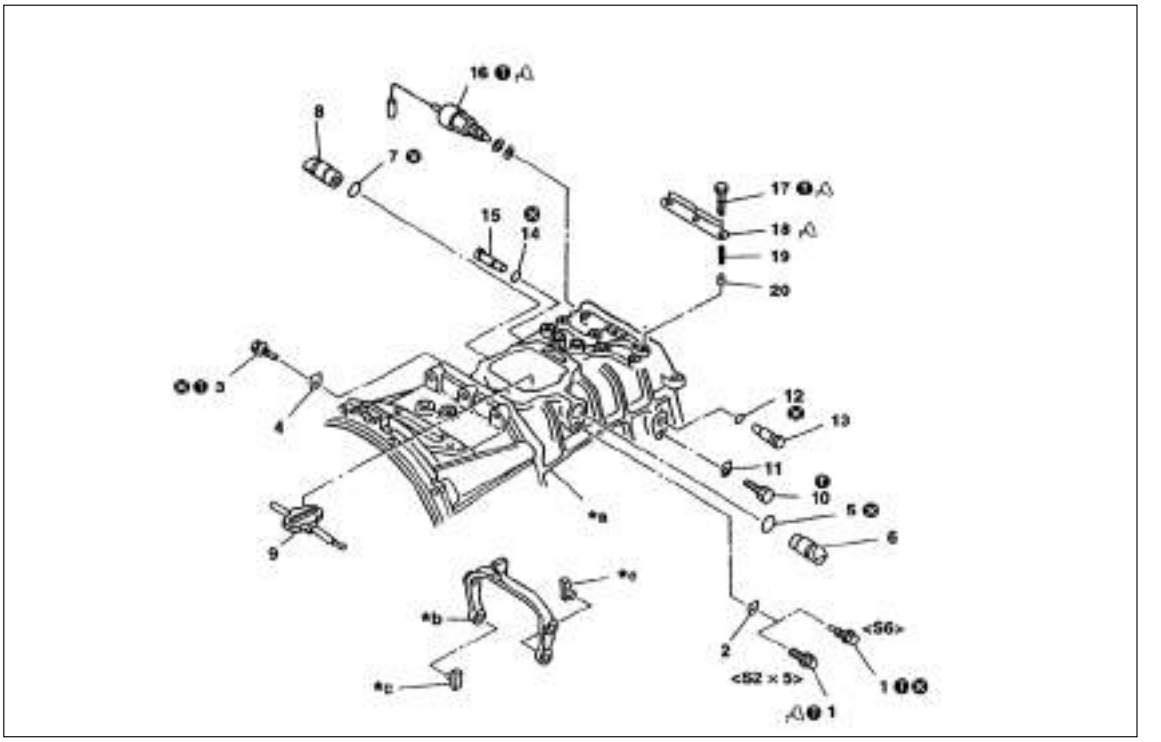
C : Socket wrench



52 Installation of sealing cup

Install sealing cup 52 on the housing 53, with it towards the direction in the figure.

►Interlock plate and reverse pin



● Disassembly sequence

1 fixing bolt(S6)、bolt(S2×5)	2 lock slice	3 fixing bolt
4 lock plate	5 O ring	6 sleeve
7 O ring	8 sleeve	9 interlock plate
10 bolt	11 lock plate	12 O ring
13 reverse pin	14 O ring	15 reverse pin
16 reversing-lamp switch	17 bolt	18 mushroom spring plate
19 mushroom spring	20 interlocking pin	*a: transmission case
*b: shifting fork for 2 and 3 gear	*c: crosshead of shifting fork	

⊗: Parts that cannot be used repeatedly.

● Assembling sequence

20→19→18→17→16　　6→15

15→14→13→12→11→10→9　　→4→3　　→2→1

8→7

● Assembling sequence

20→19→18→17→16　　6→15

15→14→13→12→11→10→9　　→4→3　　→2→1

8→7

Examining and repairing standard **unit: mm**

Position	Examining and repairing item	Standard value ([] is basic diameter)	Limit value	Correction method
6、8、9	Clearance between sleeve and interlock plate	[13]0.13-0.35	0.7	Replace
19	Installed load of mushroom spring (installed length is 30.9)	58.8N{16.2kgf}	127.4N {13.0kgf}	Replace

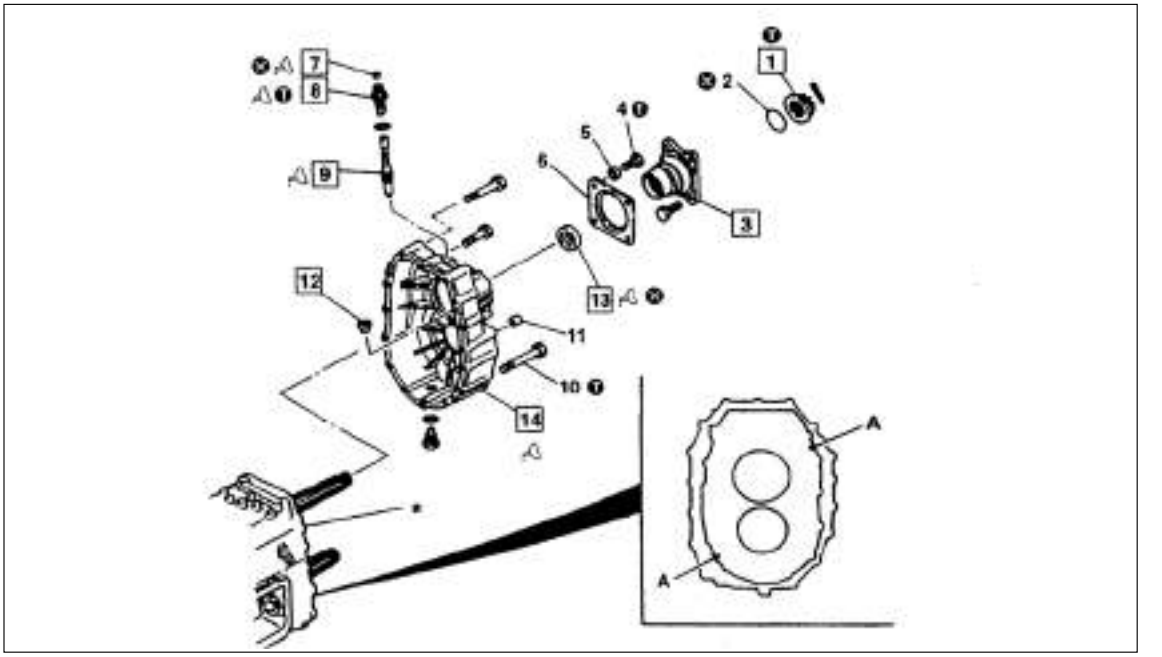
Tightening torque **unit: N.m{kgf.m}**

Position	Parts tightened	Tightening torque	Remark
1,3	Fixing bolt or bolt	133{13.6}	-
10	Bolt (used for installation of lock plate)	40{4.1}	-
16	Reversing-lamp switch	49{5}	-
17	Bolt (used for installation of mushroom spring plate)	40{4.1}	-

Sealant

Position	Application position	Specified sealant	Remark
1	Bolt	S2×5 three-way sealant 1104 J	As needed
16	Thread of reversing-lamp switch	Three-way sealant 1104 J	As needed
17	Thread of bolt	Three-way sealant 2303	If used again, As needed
18	Fitted surface between mushroom spring plate and transmission case	Three-way sealant 1215 or 1216	As needed

►Rear housing <S6>



● check before disassembly

● Disassembling sequence

1 locking nut
2 O ring
3companion flange
4 bolt
5 distance ring
6 dust cap
7 oil seal
8 sleeve of speedometer gear
9 speedometer gear
10 bolt
11 dust cap
12 sleeve A of speedometer gear
13 oil seal
14 rear housing
*: transmission case
A: locating pin
⊗: Parts that cannot be used repeatedly.

Caution ⚠

Do not dismantle oil seal 7 and sleeve A12 of speedometer gear unless replace them.

Remark

Before disassembly, check tooth clearance between speedometer gear 9 and speedometer worm that are in the transmission case.

● Assembling sequence

14→13→12→11 →10→9
8→7 →6→5→4→3→2→1

Examining and repairing standard **unit: mm**

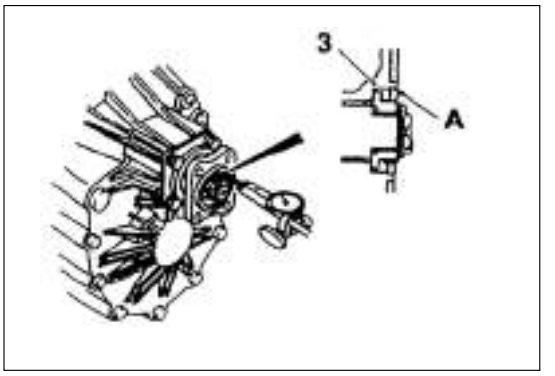
Position	Examining and repairing item	Standard value ([] is basic diameter)	Limit value	Correction method
3	Run-out of socket for companion flange	Below 0.15	0.5	Replace
8, 9	Clearance between sleeve of speedometer gear and speedometer gear	[12]0.02-0.07	0.15	Replace
9, 12	Clearance between speedometer gear and sleeve A of speedometer gear	Below [8]0.35	0.4	Replace
9, *	Clearance between speedometer gear and speedometer worm	0.13-0.29	0.36	Replace

Tightening torque **unit: N.m{kgf.m}**

Position	Parts tightened	Tightening torque	Remark
1	Locking nut	1370-1670-{140-170}	—
4	Bolt	186{19}	—
8	Sleeve of speedometer gear	196{20}	—
10	Bolt (used for installation of rear housing)	74{17.5}	—

Grease and/or sealant

Position	Applying position	Specified lubricant and/or sealant	Quantity
7	Lip of oil seal	Grease for wheel bearing	As needed
	[NLGI No.2 (lithium soap base)]		
8	Thread of sleeve for speedometer gear	Three-way sealant 1104J	As needed
9	Sliding surface of sleeve for speedometer gear	Molybdenum disulfide grease	As needed
	[NLGI No.2 (lithium soap base)]		
13	Space between oil seal lips [NLGI No.2 (lithium soap base)]		
	Grease for wheel bearing	As needed	
14	Fitting surface between rear housing and transmission case	Three-way sealant 1215 or 1216	As needed

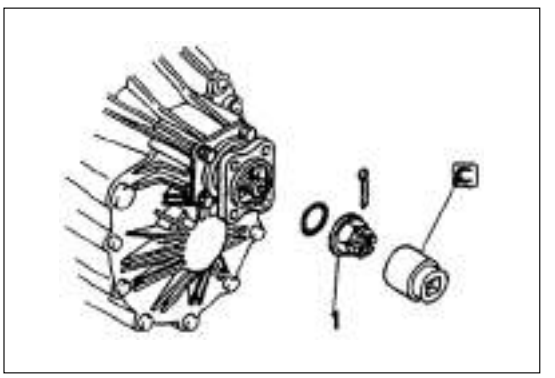


◆ Examining and repair method

● Check before disassembly

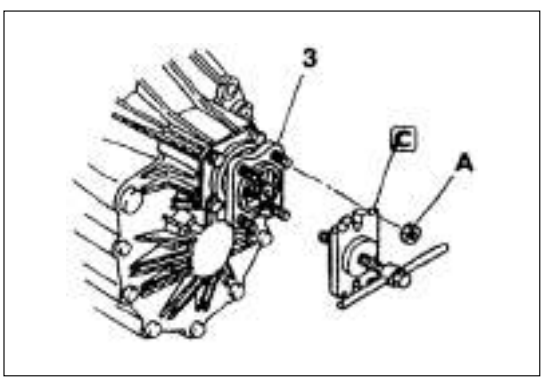
Run-out of socket for companion flange

Measure the run-out of socket A for companion flange 3. If measured value is beyond limit value, companion flange 3 should be replaced.



1 Dismantling and installation of locking nut.

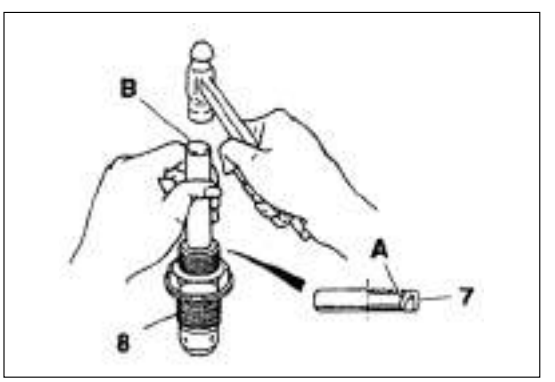
: Socket wrench



3 Dismantling of companion flange

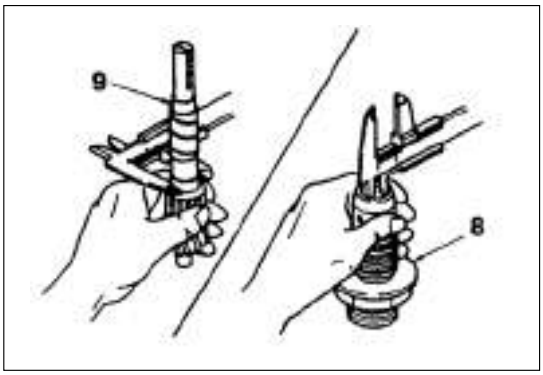
: Drawplate of flange

A: Mounting nut for propeller shaft



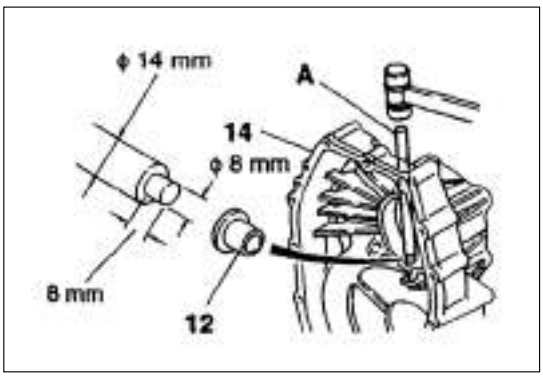
7 Installation of oil seal 7

- Apply grease to lip A of oil seal 7.
- Install oil seal 7 into sleeve 8 of speedometer gear, with it towards the direction in the figure.
- Use a round bar B whose outer diameter is about 15 mm, and install oil seal 7 into sleeve 8 of speedometer gear.



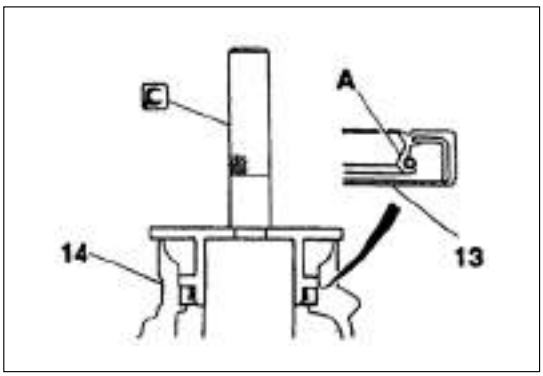
[8] [9] clearance between sleeve of speedometer gear and speedometer gear

- Measure outer diameter of speedometer gear 9 and inner diameter of speedometer gear sleeve 8, and calculate the clearance between them.
- If the measured value is beyond limit value, damaged parts should be replaced.



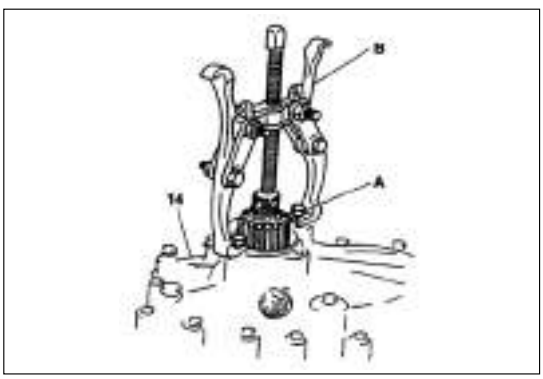
[12] Installation of speedometer gear sleeve A in rear housing.

Use the round bar A whose dimension is the same as figure, to install speedometer gear sleeve A12 into rear housing.



[13] installation of oil seal

- Apply grease to the space in lip A of oil seal 13.
- Make oil seal 13 towards direction in the figure, and use tool to knock it into rear housing 14.



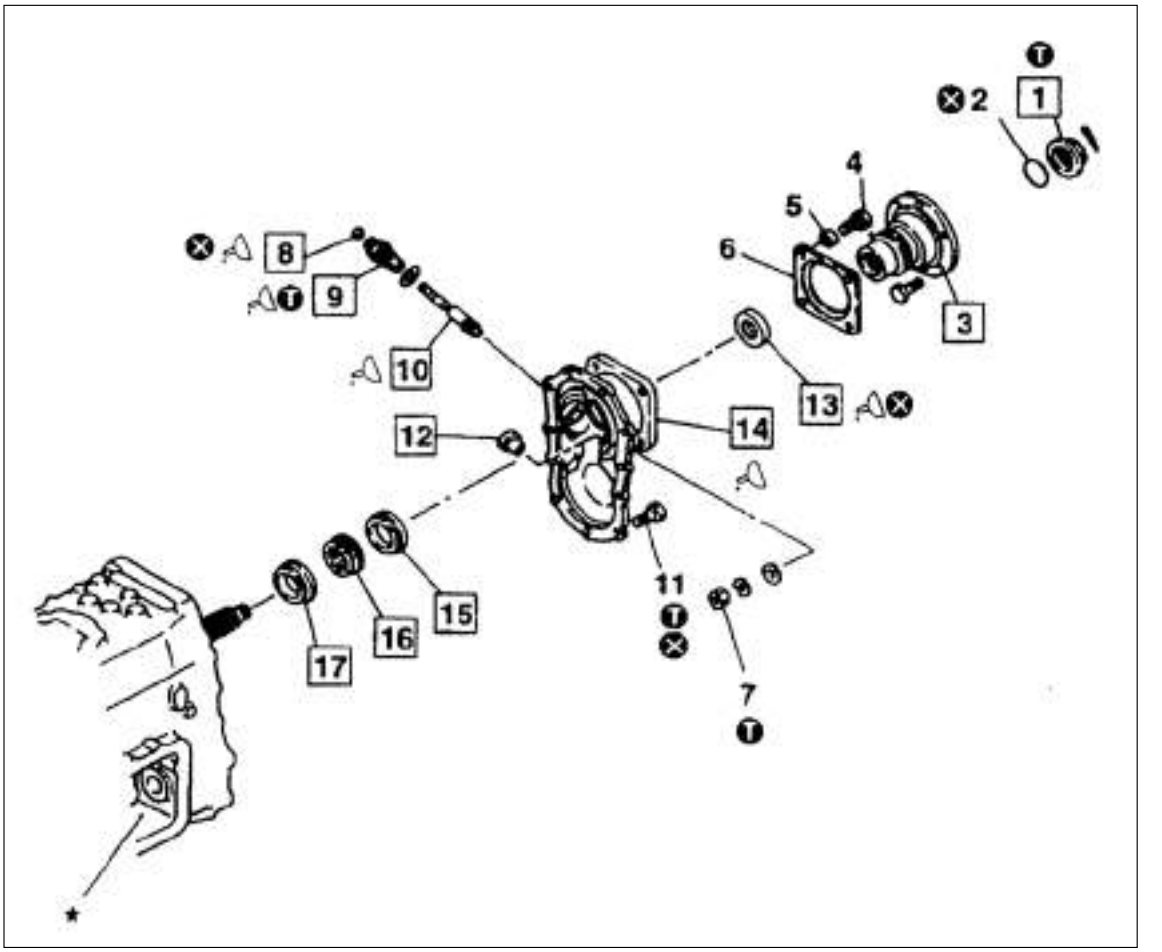
[14] Dismantling of housing

A: Mounting bolt for dust cover

B: Gear drawplate (general-purpose tools)

Use mounting bolt for dust cover A and gear drawplate B sold in the market, to dismantle rear housing 14.

►Rear cover<S2×5>



● Check before disassembly

● Disassembly sequence

1 locking nut	2 O ring	3 companion flange
4 bolt	5 distance ring	6 dust cap
7 nut	8 oil seal	9 speedometer gear sleeve
10 speedometer gear	11 bolt	12 speedometer gear sleeve A
13 oil ring	14 rear cover	15 oil baffle
16 speedometer worm	17 washer	*: transmission case

⊗: Parts that cannot be used repeatedly.

Caution ⚠

Do not dismantle oil seal 8 and speedometer gear sleeve A12 unless replace them.

Remark

Before disassembly, check tooth clearance between speedometer gear 10 and speedometer worm 16.

• Assembling sequence

14→13→12 →11→10

*→17→16→15 9→8 →6→5→4→7→3→2→1

Examining and repairing standard

Unit: mm

Position	Examining and repairing item	Standard value ([] is basic diameter)	Limit value	Correction method
3	Run-out of socket for companion flange	Below 0.15	0.5	Replace
9,10	Clearance between sleeve of speedometer gear and speedometer gear	[12]0.02-0.07	0.15	Replace
10,12	Clearance between speedometer gear and sleeve A of speedometer gear	[8] below0.35	0.4	Replace
10,16	Clearance between speedometer gear and speedometer worm	0.13-0.29	0.36	Replace

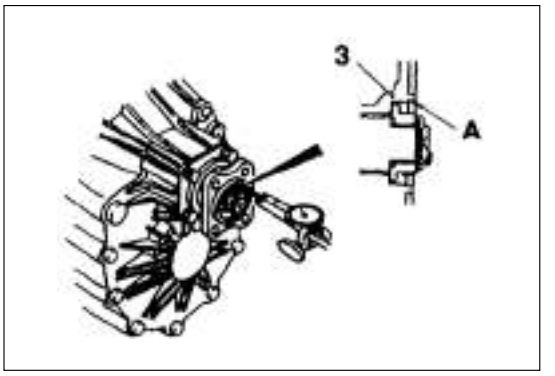
Tightening torque

Unit: N.m{kgf.m}

Position	Parts tightened	Tightening torque	Remark
1	Locking nut	1370-1670-{140-170}	—
7	Nut (used for installation of dust cover)	117-157{12-16}	—
9	Sleeve of speedometer gear	196{20}	—
11	Bolt (used for installation of rear cover)	74{7.5}	—

Lubricant and/or sealant

Position	Application position	Specified lubricant and/or sealant	Quantity
8	Lip of oil seal [NLGI No.2 (lithium soap base)]	Grease for wheel bearing	As needed
9	Thread of sleeve for speedometer gear	Three-way sealant 1104 J	As needed
10	Sliding surface of sleeve for speedometer gear	Molybdenum disulfide grease	As needed
	[NLGI No.2 (lithium soap base)]		
13	Space between oil seal lips [NLGI No.2 (lithium soap base)]	Grease for wheel bearing	As needed
14	Fitting surface between rear housing and transmission case	Three-way sealant 1215 or 1216	As needed

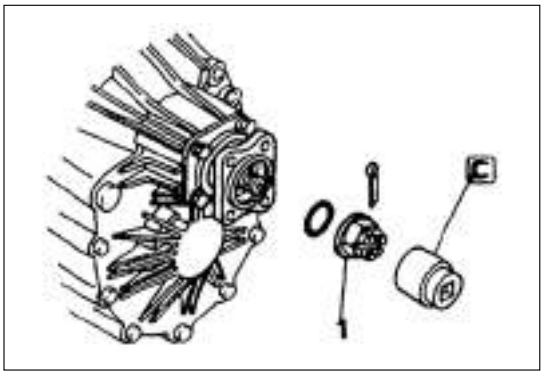


◆ Examining and repairing method

● Check before disassembly

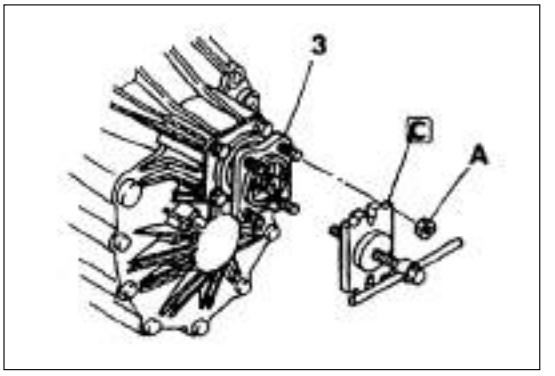
Run-out of socket for companion flange

Measure the run-out of socket A for companion flange 3. If measured value is beyond limit value, companion flange 3 should be replaced.



1 Dismantling and installation of locking nut

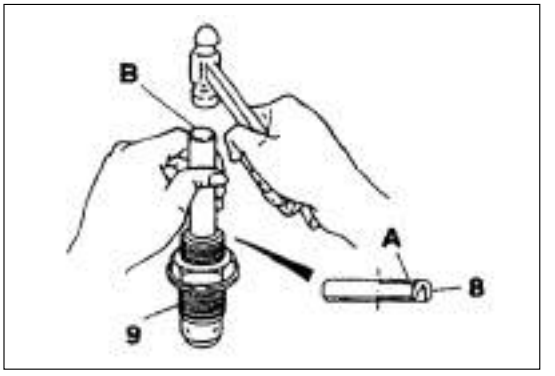
C : Socket wrench



3 Dismantling of companion flange

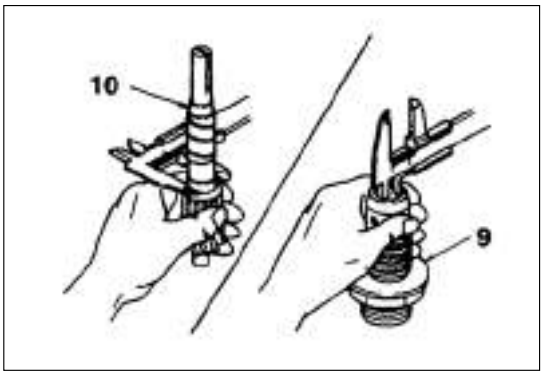
C : Flange drawplate

A: Mounting nut for propeller shaft



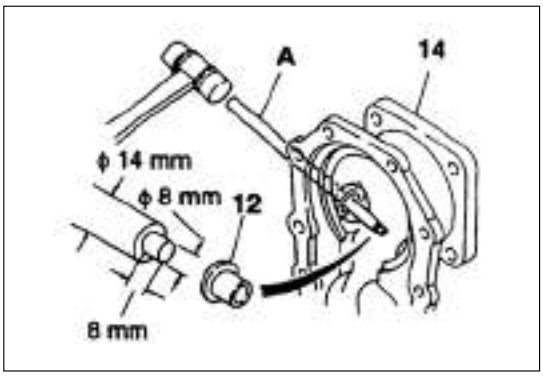
8 Installation of oil seal

- Apply grease to lip A of oil seal 8.
- Install oil seal 8 into sleeve 9 of speedometer gear, with it towards the direction in the figure.
- Use a round bar B whose outer diameter is about 15 mm, to install oil seal 8 into sleeve 9 of speedometer gear.



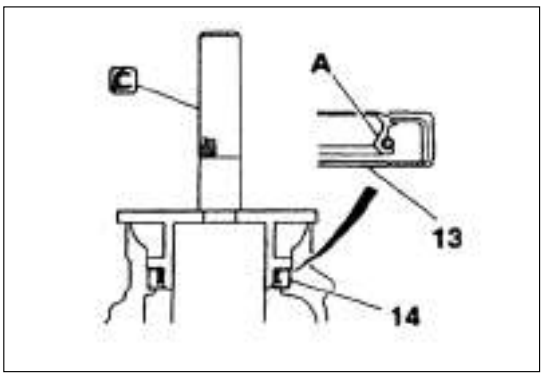
9 10 clearance between sleeve of speedometer gear and speedometer gear

- Measure outer diameter of speedometer gear 10 and inner diameter of speedometer gear sleeve 9, and calculate the clearance between them.
- If the measured value is beyond limit value, damaged parts should be replaced.



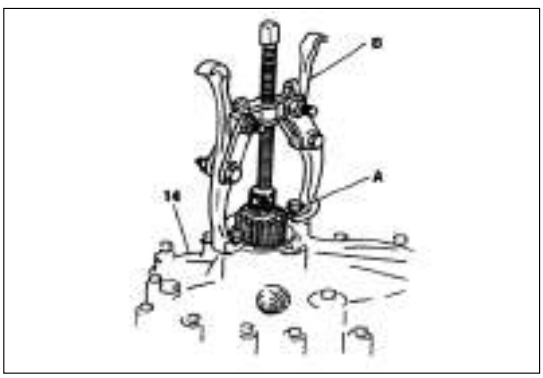
12 installation of speedometer gear sleeve A in rear cover

Use the round bar A as indicated in the figure, to install speedometer gear sleeve A12 in rear cover 14.



13 Installation of oil seal

- Apply grease to the space in lip A of oil seal 13.
- Make oil seal 13 towards direction in the figure, and use tool to knock it into rear housing 14.

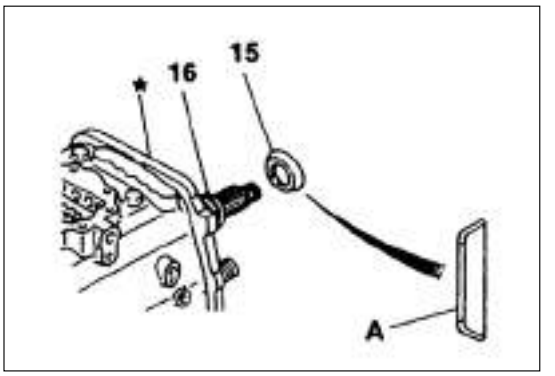


14 Installation of rear cover

A: mounting bolt for dust cover

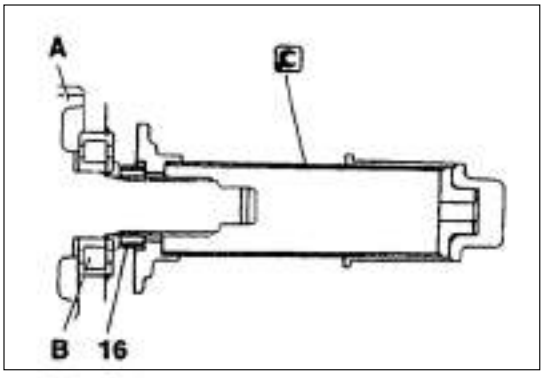
B: gear drawplate (general-purpose tools)

Use mounting bolt A of dust cover and gear drawplate B sold in the market, to dismantle rear housing 14.



15 Installation of oil baffle

Install oil baffle 15 on speedometer worm 16, with its protrusion part A towards fitting parts.



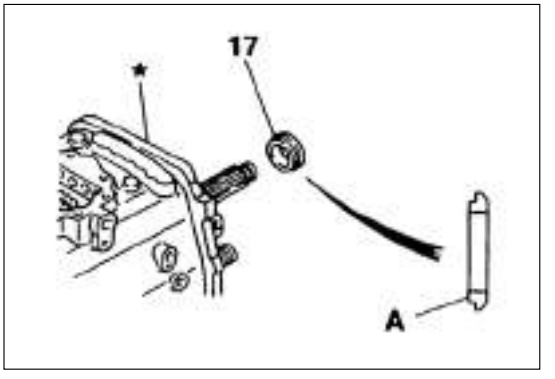
16 Speedometer worm

[Dismantling]

Disassemble speedometer worm 16, 1/gear A of main shaft, and main shaft bearing B together.

[Installation]

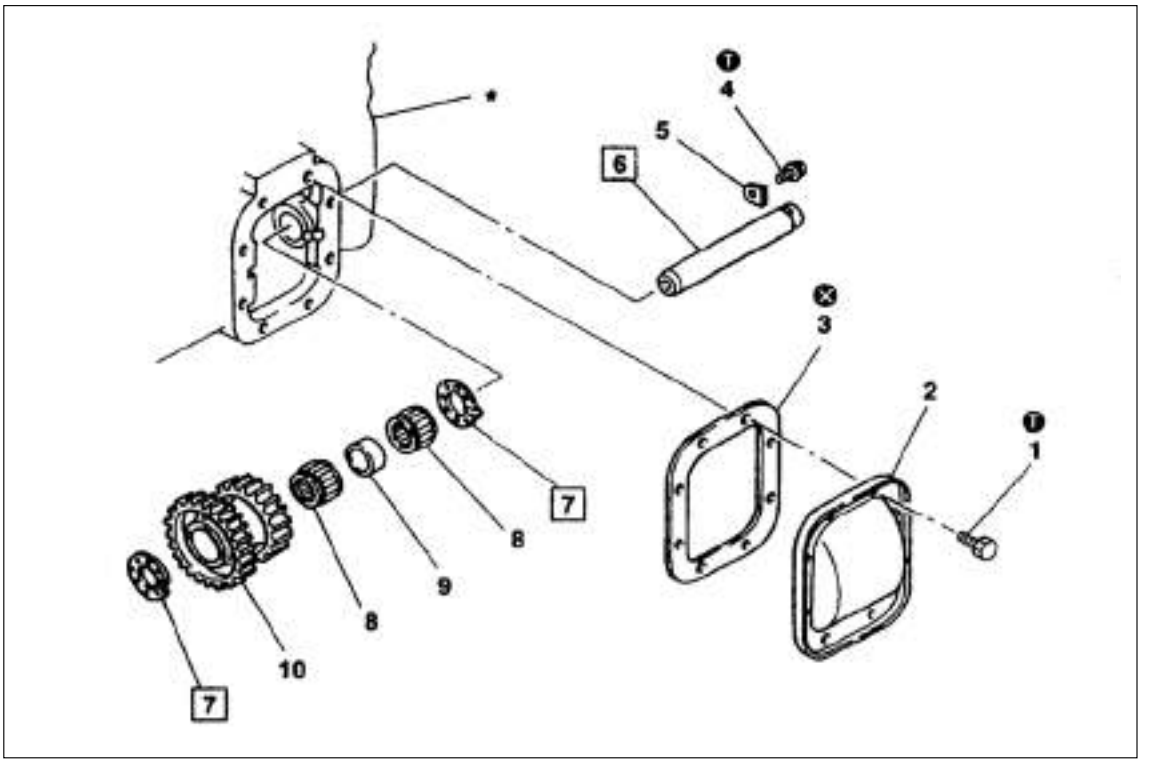
: Installing tool of bearing



17 installation of washer

Install washer 17, with its protrusion part A towards transmission case *.

►Reverse idler gear



● Operation before disassembly

● Disassembly sequence

1 bolt	2 PTO cover	3 gasket
4 bolt	5 lock plate of reverse shaft	6 reverse idler gear shaft
7 side washer	8 needle bearing	9 distance ring
10 reverse idler gear	*: transmission case	⊗: Parts that cannot be used repeatedly.

● Assembly sequence

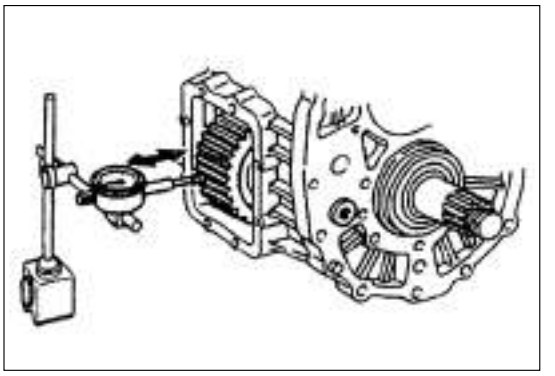
It is opposite to disassembly sequence.

Examining and repairing standard **Unit: mm**

Position	Repair item	Standard value	Limit value	Correcting method
6,8,10	Radial clearance of reverse idler gear after installing	—	0.12	Replace

Tightening torque **Unit: N.m{kgf.m}**

Position	Parts tightened	Tightening torque	Remark
1	Bolt (used for installation of PTO cover)	20{2.1}	—
4	Bolt (used for installation of lock plate of reverse shaft)	40{4.1}	—



◆ **Examining and repairing method**

● Operation before disassembly

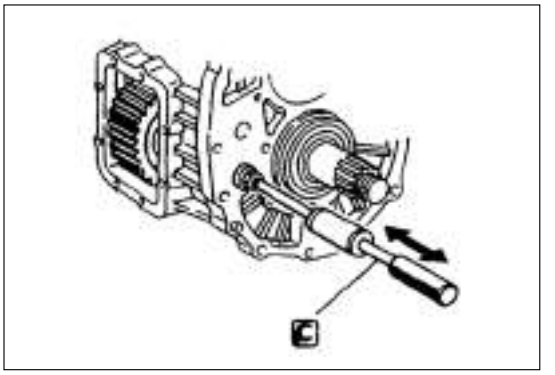
[Check]

Radial clearance of reverse idler gear

- If measured value is beyond limit value, damaged parts should be replaced.
- After installation, examine this clearance. Make sure that measured value be within the limit value.

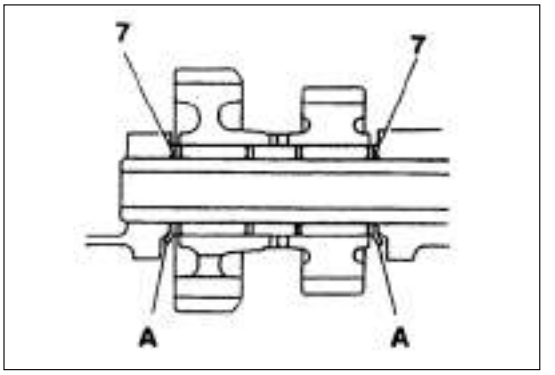
Caution ⚠

When replacing needle bearing 8, use two needle bearings that are packed with the same colored-paper, and replace them synchronously.



6 Dismantling of reverse idler gear shaft

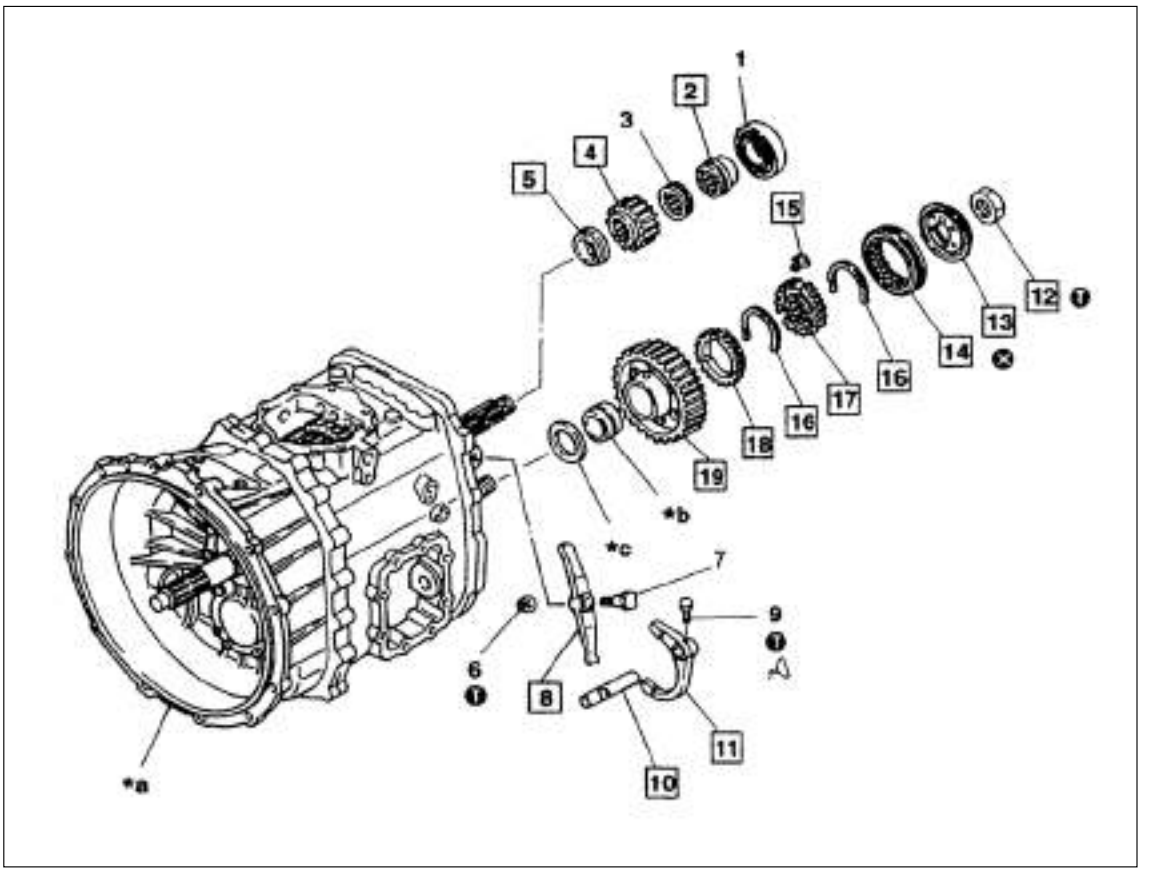
C : Drawplate of reverse idler gear



7 Installation of side washer

Install side washer 7, with protrusion part A outwards.

►6/ Gear <S6>



● Operation before disassembly

● Disassembly sequence

1 bearing
2 bearing sleeve
3 speedometer worm
4 6/gear of main shaft
5 washer
6 nut
7 shaft of over speed shifting rod
8 over speed shifting rod
9 clamping bolt
10 guide rail B of shifting rod
11 fork of shifting rod
12 locking nut
13 base ring of shift key
14 synchronizer sleeve
15 shift key
16 spring of shift key
17 synchronizer hub
18 synchronizer ring
19 6/gear of counter shaft
*a: transmission case
*b: sleeve of 6/gear
washer
⊗:Parts that cannot be used repeatedly.

● Assembly sequence

It is opposite to disassembly sequence.

Examining and repairing standard

unit: mm

Position	Examining and repairing item	Standard value ([] is basic diameter)	Limit value	Correction method
7,8	Clearance between over speed shifting rod and hole of over speed shifting rod	[19]0.02-0.08	0.2	Replace
8	Flexion of over speed shifting rod	Below 0.05	0.1	Replace
10	Flexion of shifting guide rail B for 6/gear	Below 0.02	0.04	Replace
11	Verticality of 6/gear shifting claw	Below 0.1	0.2	Replace
11,14	Clearance between 6/gear shifting fork and synchronizer sleeve	0.25-0.45	0.1	Replace
14,17	Radial clearance between synchronizer sleeves and synchronizer hub	0.06-0.14	0.3	Replace
15,17	Clearance between shift key and groove of synchronizer hub	0.05-0.35	0.5	Replace
17,18	Clearance between groove of synchronizer hub and protrusion of synchronizer ring	4.7-5.3	6.5	Replace
18,19	Clearance between synchronizer ring and 6/gear cone of counter shaft	2.0	0	Replace
19	End clearance of 6/gear for counter shaft	0.25-0.40	0.60	Replace
19,*6	Radial clearance of 6/gear for counter shaft after installed	0.14-0.18	0.3	Replace
*b	Outer diameter of 6/gear sleeve	[72]-0.132 0.20-0.155		Replace

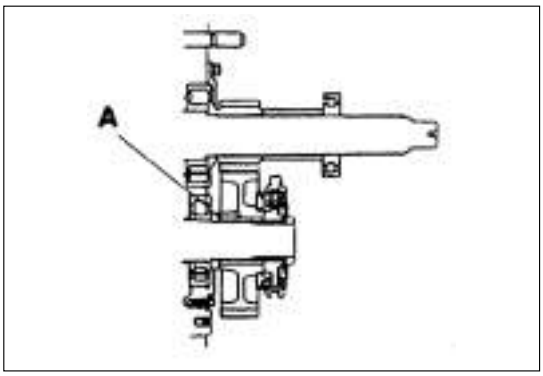
Tightening torque

Unit: N.m{kgf.m}

Position	Tightened parts	Tightening torque	Remark
6	Nut (used for installation of over speed shifting rod)	82.4{8.4}	—
9	Fixing bolt	57.9{5.9}	—
12	Locking nut	539-735{55-75}	—

Grease and/or sealant

Position	Application position	Specified lubricant and/or sealant	Quantity
9	Thread of fixing bolt	Locite 204T	If use again, As needed



◆ Examining and repairing method

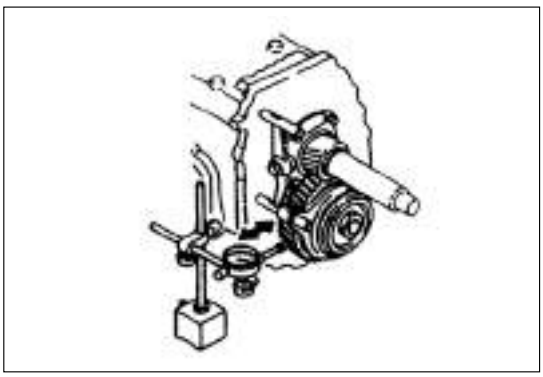
● Operation before disassembly

[Check]

(1) Axial clearance of 6/gear for counter shaft

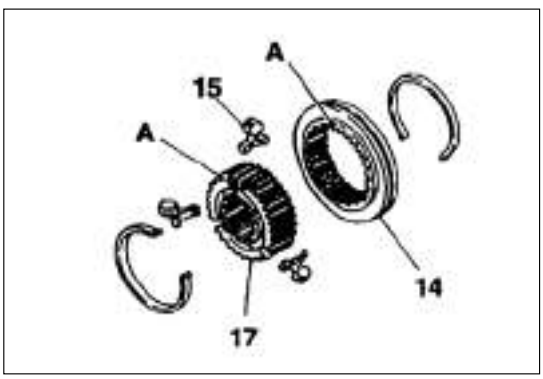
- If measured value is beyond limit value, damaged parts should be replaced.
- After installation, examine this clearance. Make sure that measured value be within limit value.

A: Measuring point of axial clearance of 6/gear for counter shaft



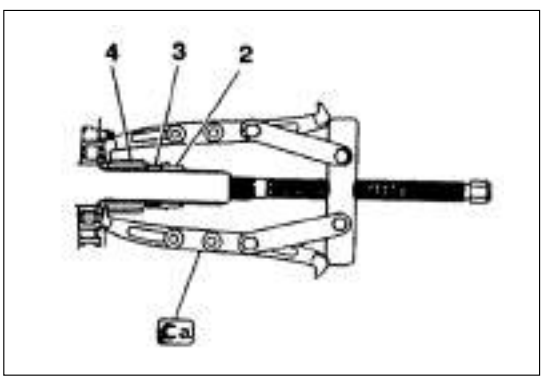
(2) Radial clearance of 6/gear for counter shaft

- If measured value is beyond limit value, damaged parts should be replaced.
- After installation, examine this clearance. Make sure that measured value be within limit value.



[Matching mark]

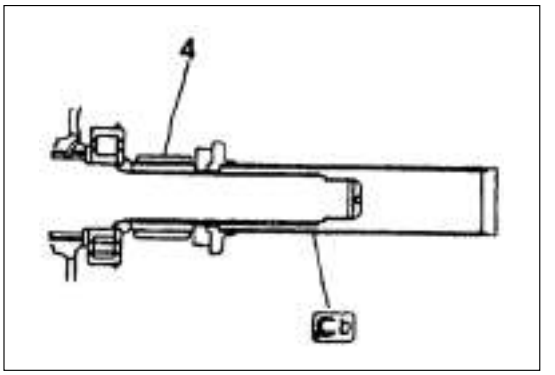
After made matching mark on installing position of shift key 15, disassemble synchronizer sleeve 14 and synchronizer hub 17. If they are reused, align these matching marks when installing.



2 4 Bearing sleeve and 6/gear of main shaft

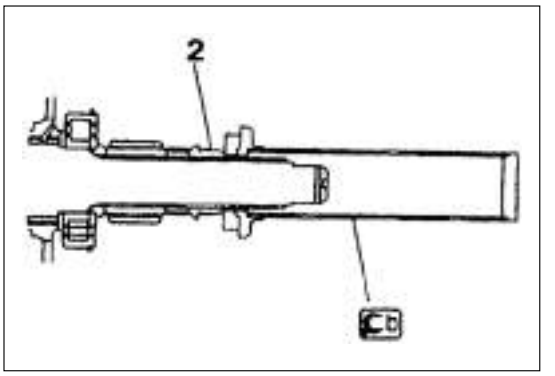
[Disassembling]

Ca: Gear drawplate

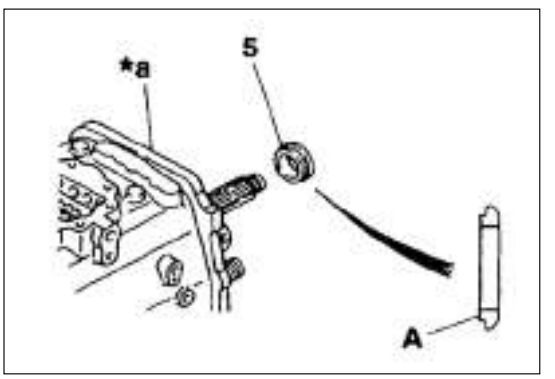


[Installation]

Cb: Installing tool of bearing

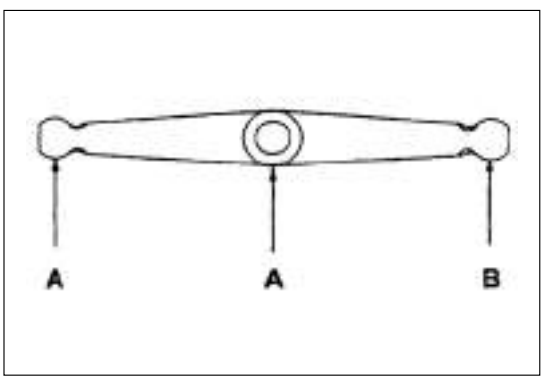


Cb: Installing tool of bearing



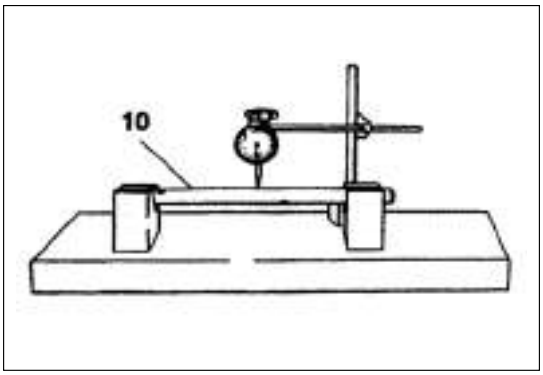
5 Installation of washer

Install washer 5, with its protrusion part A towards transmission case *a.



8 Flexion of overdrive lever

If flexion (that is relative to A-A) of B point is beyond limit value, replace overdrive lever 8.

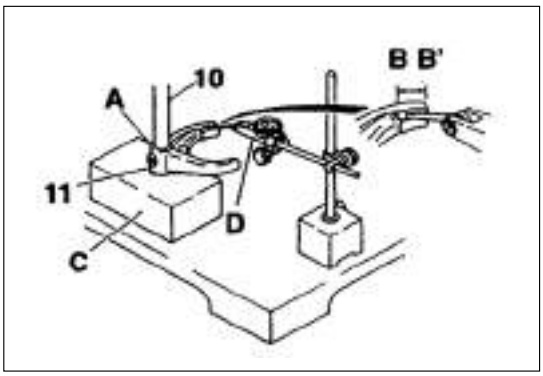


10 Flexion of shifting guide rail B for 6/gear

If measured value is beyond limit value, correct or replace shifting guide rail B10 for 6/gear.

Remark

Rotate shifting guide rail B10 for 6/gear one turn, and read the reading of dial gauge. Flexion is half of that reading.



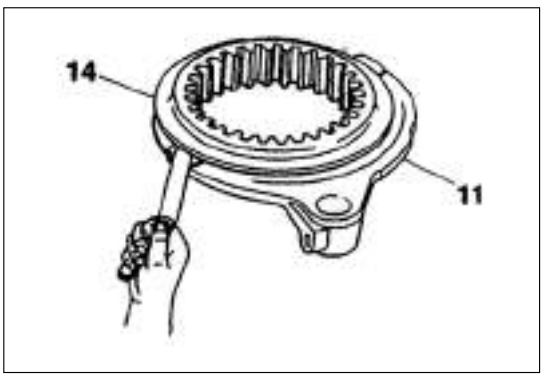
11 Verticality of 6/gear shifting claw

- Erect shifting guide rail, measure verticality of shifting claw B-B' for 6/gear shifting fork 11, which is relative to hole A of 6/gear shifting guide rail B10. (difference between B and B')

C: V block

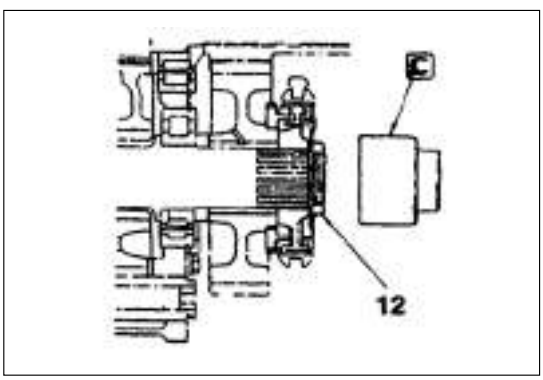
D: dial gauge

- If measured value is beyond limit value, replace 6/gear shifting fork 11.



11 14 Clearance between 6/gear shifting claw and synchronizer sleeve

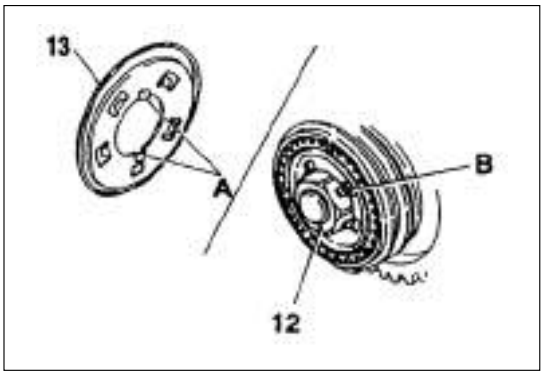
If measured value is beyond limit value, replace damaged parts.



12 Disassembly and installation of locking nut for counter shaft.

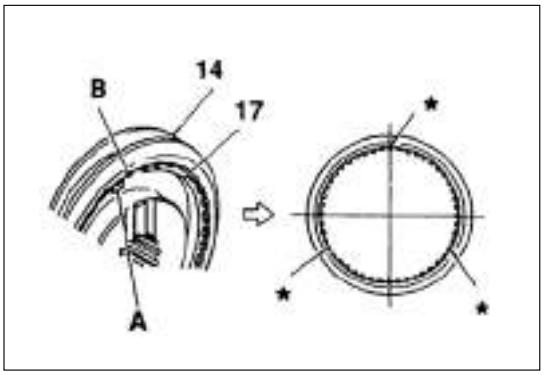
Make transmission engaged doubly to lock counter shaft.

: Socket wrench



13 Installation of seat ring for shift key

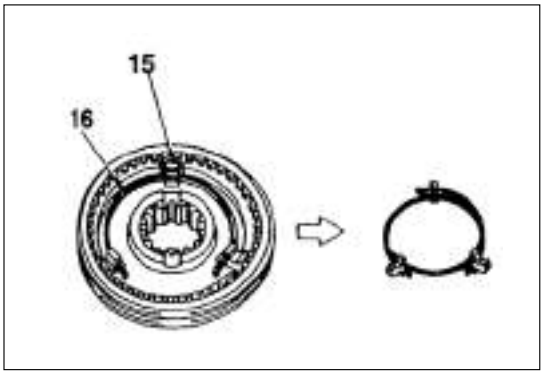
- Install protrusion A (2 places) of seat ring 13 for shift key in the groove of synchronizer hub 17.
- After tighten locking nut, bend tab B of seat ring 13 for shift key, making it lean against side face of locking nut 12 tightly.



14 -18 Installation of synchronizer assembly

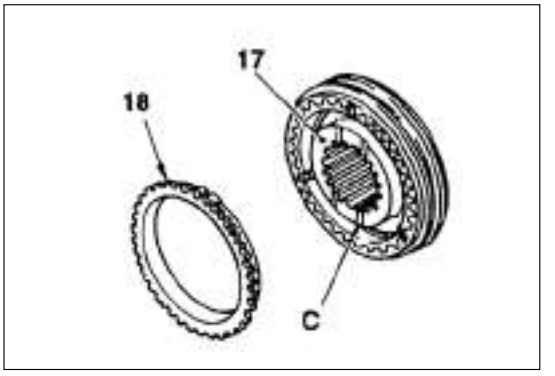
(1) To install synchronizer hub, align three key grooves A of synchronizer hub 17 to three short teeth B (shown as * in the figure) on synchronizer sleeve 14.

If reusing synchronizer hub 17 and synchronizer sleeve 14, align the match mark.

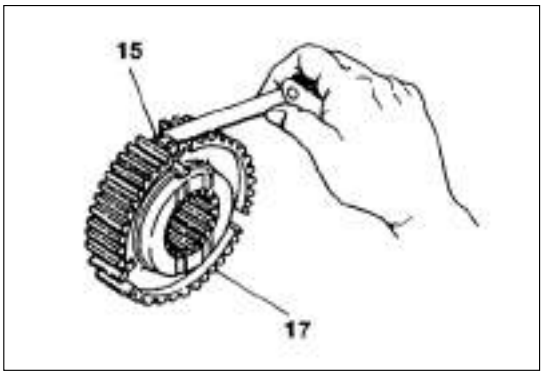


(2) After inserting shift key 15 into key groove, install spring 16 of shift key. Do not make any shift key be among spring ends.

Do not make opening of spring 16 for two shift keys align each other.

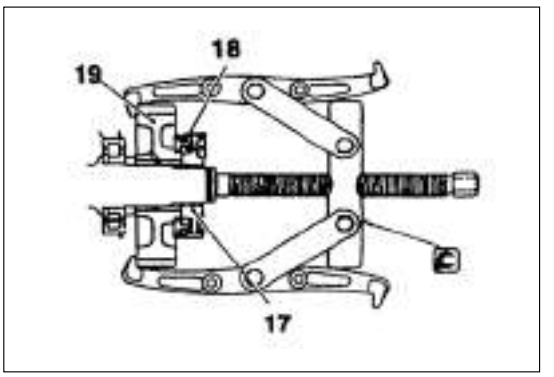


(3) Install synchronizer ring 18 on C side of oil groove for synchronizer hub 17 that aligned with key groove, and install synchronizer assembly on counter shaft.



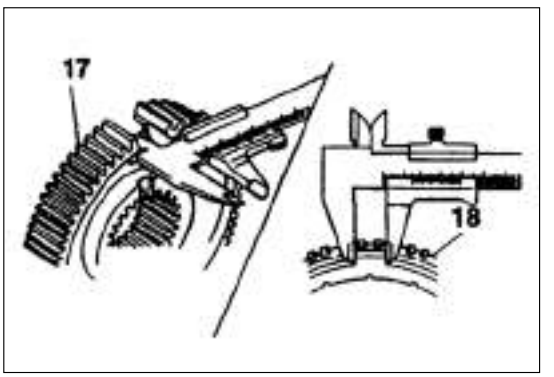
15 17 Clearance between shift key and synchronizer hub

If measured value is beyond limit value, replace damaged parts.



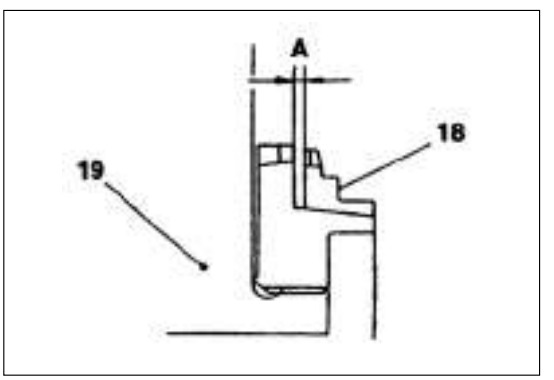
17 Dismantling of synchronizer hub

C : Gear drawplate



17 18 Clearance between synchronizer hub groove and protrusion of synchronizer ring

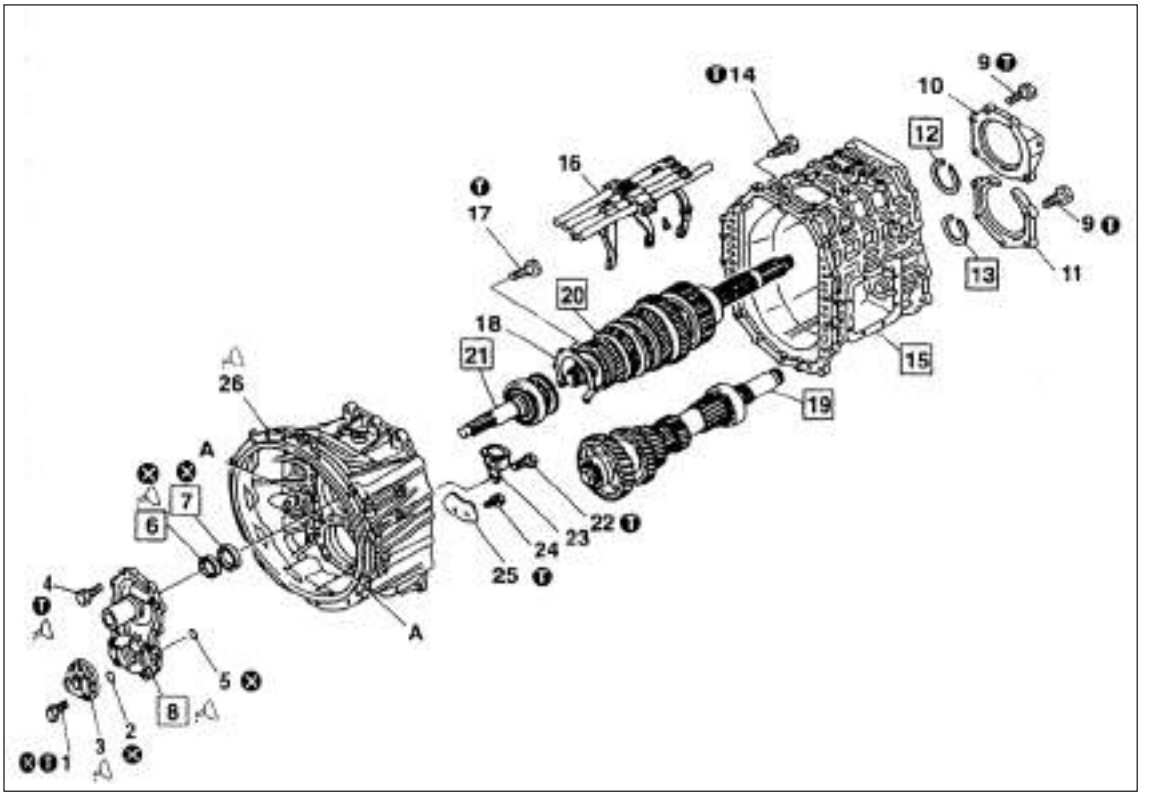
If measured value is beyond limit value, replace damaged parts.



18 19 Clearance between synchronizer ring and 6/gear of counter shaft

- Measure clearance between synchronizer ring 18 and cone of 6/gear 19 for counter shaft
- Pressing synchronizer ring 18 evenly, measure clearance of the circumference.
- If measured value is beyond limit value, replace damaged parts.

►Transmission case（S6）



● Disassembly sequence

1 bolt
2 O ring
3 oil pump
4 bolt
5 O ring
6 oil seal
7 side oil seal
8 front guard ring
9 bolt
10 guard ring for rear bearing of main shaft
11 guard ring for rear bearing of counter shaft
12 elastic retainer ring
13 elastic retainer ring
14 bolt
15 transmission case
16 shifting guide rail and shifting fork
17 bolt
18 guard ring of drive pinion bearing
19 counter shaft assembly
20 main shaft assembly
21 drive pinion assembly
22 bolt
23 fuel tank
24 bolt
25 strainer plate
26 clutch housing assembly
A: locating pin
⊗: Parts that cannot be used repeatedly.

Remark:

- After disassembling 1-8 parts, put transmission assembly on vertical position, and make clutch housing assembly 26 underside, then disassemble it.
- Take 19-21 parts as a subassembly to disassemble.

● Assembling sequence

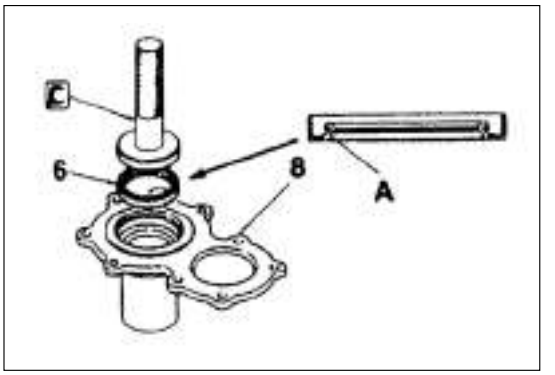
It is opposite to disassembly sequence.

Tightening torque unit: N.m{kgf.m}

Position	Parts tightened	Tightening torque	Remark
1	Bolt (used for installation of oil pump) (model of with oil cooler)	23.5{2.4}	—
4	Bolt (used for installation of front guard ring)	40{4.1}	—
9	Bolt (used for installation of guard ring for rear bearing of main shaft, guard ring for rear bearing of counter shaft)	74{7.5}	—
14	Bolt (used for installation of transmission case)	122{12.4}	—
17	Bolt (used for installation of guard ring of drive pinion bearing)	40{4.1}	—
22	Bolt (used for installation of oil tank)	23.5{2.4}	—
24	Bolt (used for installation of strainer plate)	9.8-14.7{1.0-1.5}	—

Lubricant and/or sealant

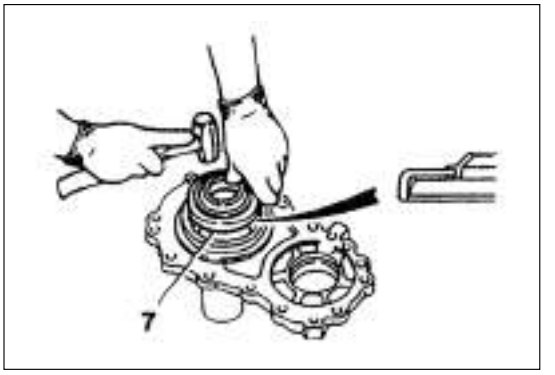
Position	Application position	Specified lubricant and/or sealant	Quantity
3	Fitting surface between oil pump and front guard ring	Three-way sealant 1215 or 1216	As needed
4	Thread of bolt	Three-way sealant 2302	
	If use again, As needed		
6	Space between oil seal lips [NLGI No.2 (lithium soap base)]	Grease for wheel bearing	As needed
8	Fitting surface between front guard ring and clutch housing assembly	Three-way sealant 1215 or 1216	As needed
26	Fitting surface between clutch housing assembly and transmission case	Three-way sealant 1215 or 1216	As needed



◆ **Examining and repairing method**

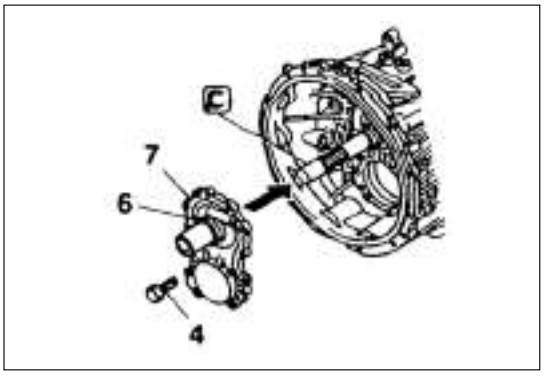
6 Installation of oil seal

- Apply grease to space between lips A of oil seal 6.
- Use tool to install oil seal 6 in front guard ring 8, with it towards the direction in the figure.



7 Installation of side oil seal

Use copper hammer to install side oil seal 7.

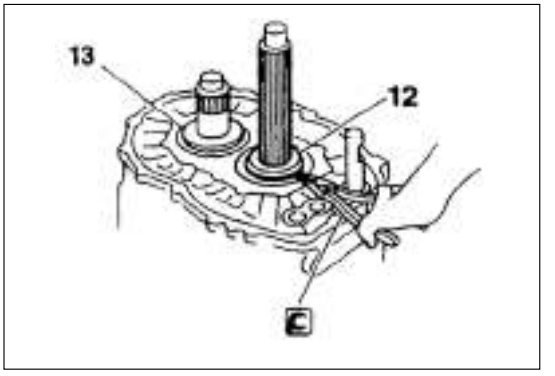


8 Installation of front guard ring

Use front bushing of oil seal, to install front guard ring 8 in clutch housing assembly 26.

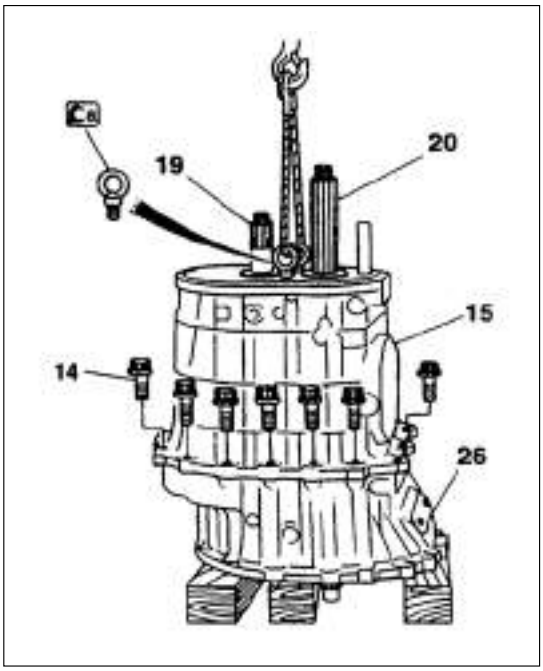
Caution ⚠

Before installing the front guard ring 8, apply sealant to mounting surface. During installation, do not damage oil seal 6 that has been installed on front guard ring.



12 13 Disassembly and installation of elastic retainer ring

: expander of elastic retainer ring



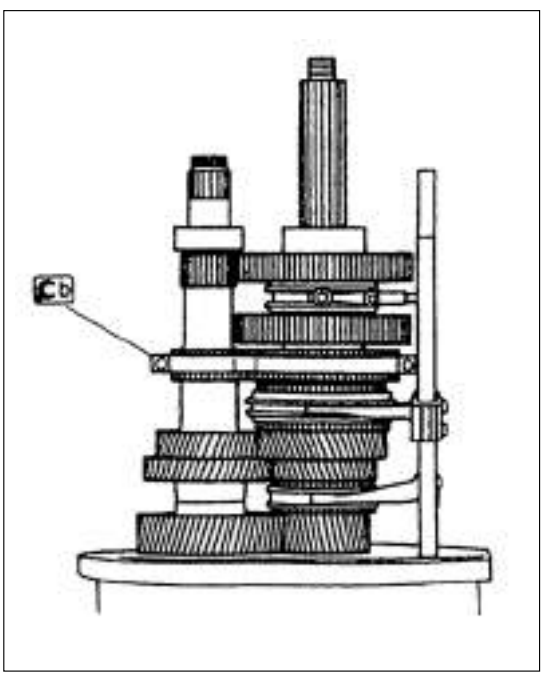
15 Disassembly and installation of transmission case

[Disassembly]

- Mount Ca eyebolt on transmission case 15. Make steel wire cable pass through eyebolt, in order to sling transmission case with hoist later.
- After disassembling bolt 14, use hoist to sling transmission case 15. At the same time, use plastic hammer or copper hammer to tap rear end of main shaft assembly 20 and counter shaft assembly 19, to make it disconnect from clutch housing assembly 26.

Warming ⚠

Use steel wire cable that can sling above 100 kg.



After disassembling transmission case 15, use Cb steel harness to fix 2/gear, to ensure that it is safe.

Caution ⚠

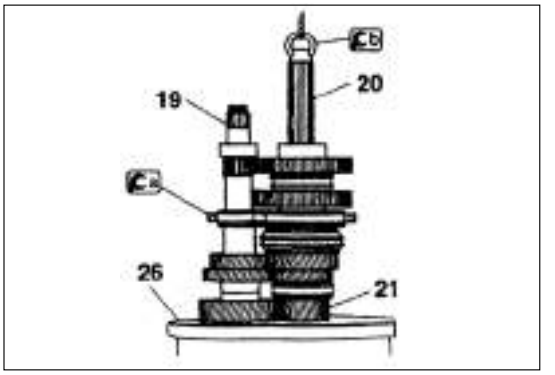
Do not make steel harness too tight, otherwise, it will damage gear and other mechanical parts. Tighten it reasonably.

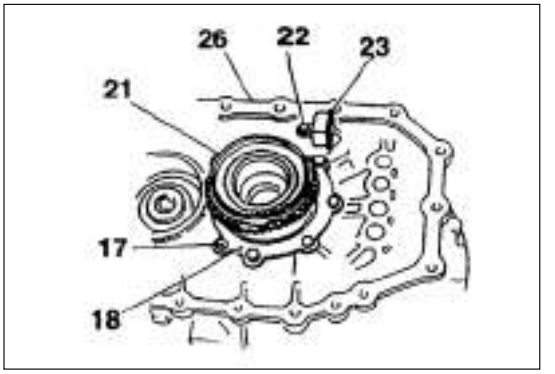
[Installation]

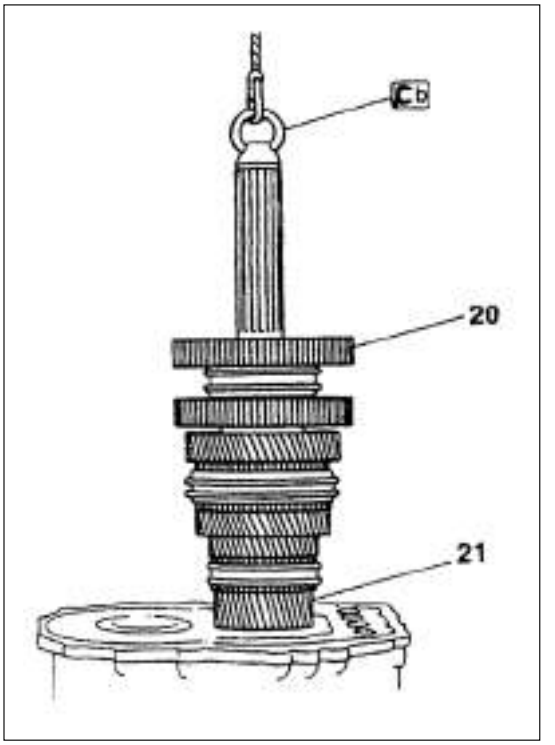
It is opposite to disassembly sequence.

Caution ⚠

Install carefully. Do not damage rear bearing of main shaft assembly 20 and counter shaft assembly 19.







19 - 21 counter shaft assembly, main shaft assembly and drive pinion assembly

[Dismantling]

Counter shaft assembly 19, main shaft assembly 20 and drive pinion assembly 21 should be disassembled and installed as a subassembly.

- After disassembling transmission case, tightening Ca steel harness on transmission case, install Cb eyebolt on rear end of main shaft so as to sling it.
- Underlay a wood block on clutch housing assembly 26, and use plastic hammer to tap wood block lightly. At the same time, use hoist to sling main shaft assembly, counter shaft assembly and drive pinion assembly 21 together.

Caution ⚠

- Do not make Cb steel harness too tight, otherwise, it will damage gear and other mechanical parts. Tighten it reasonably.
- When slinging main shaft assembly 21, support this assembly with hands. Otherwise, if main shaft assembly separates from counter shaft 19, drive pinion assembly 21 will drop.

Warming ⚠

Use steel wire cable that can sling above 300 kg.

[Installation]

Method 1

- It is opposite to disassembling sequence.

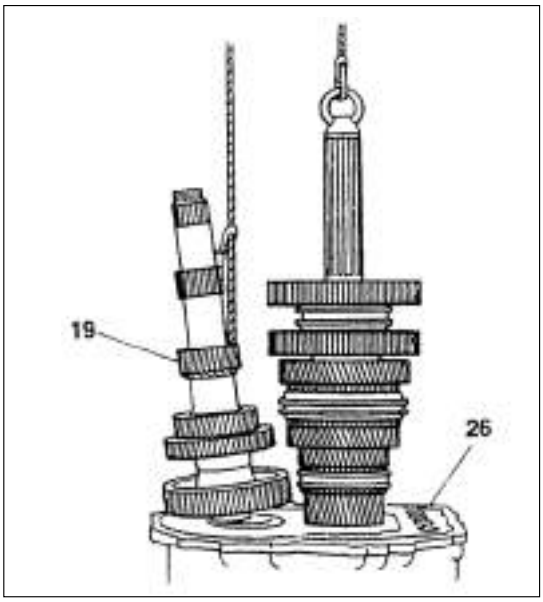
Method 2

- First, install drive pinion assembly 21 on clutch housing assembly 26. Then, install guard ring 18 of drive pinion bearing and fuel tank 23.
- Mount the Cb eye nut on rear end of main shaft assembly 20.
- Use hoist to sling main shaft assembly 20 and install it on drive pinion assembly 21.

Caution ⚠

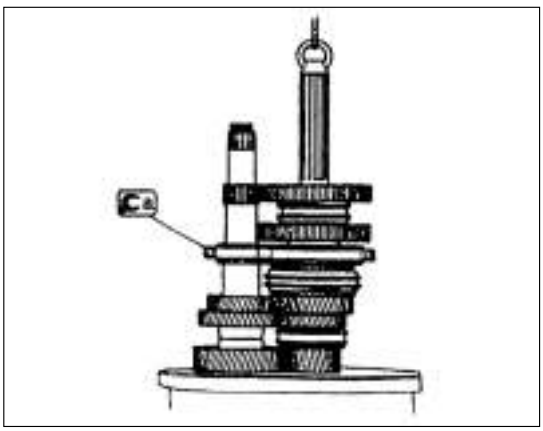
During installing, use hoist to support main shaft assembly 20, to prevent it dropping.

- Install counter shaft assembly 19 in clutch housing assembly 26.



Remark

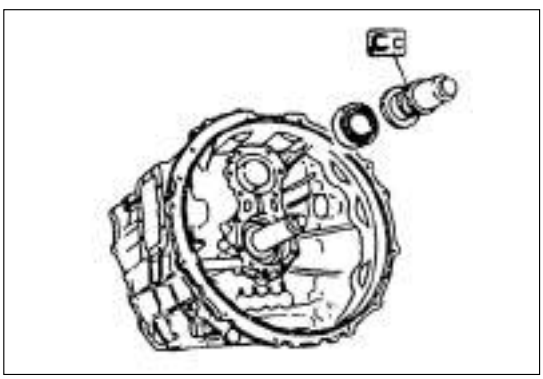
This method requires that do not install front gearing of counter shaft during operation.



- Use Ca steel harness to fix 2/gear, to ensure that it is safe.

Caution ⚠

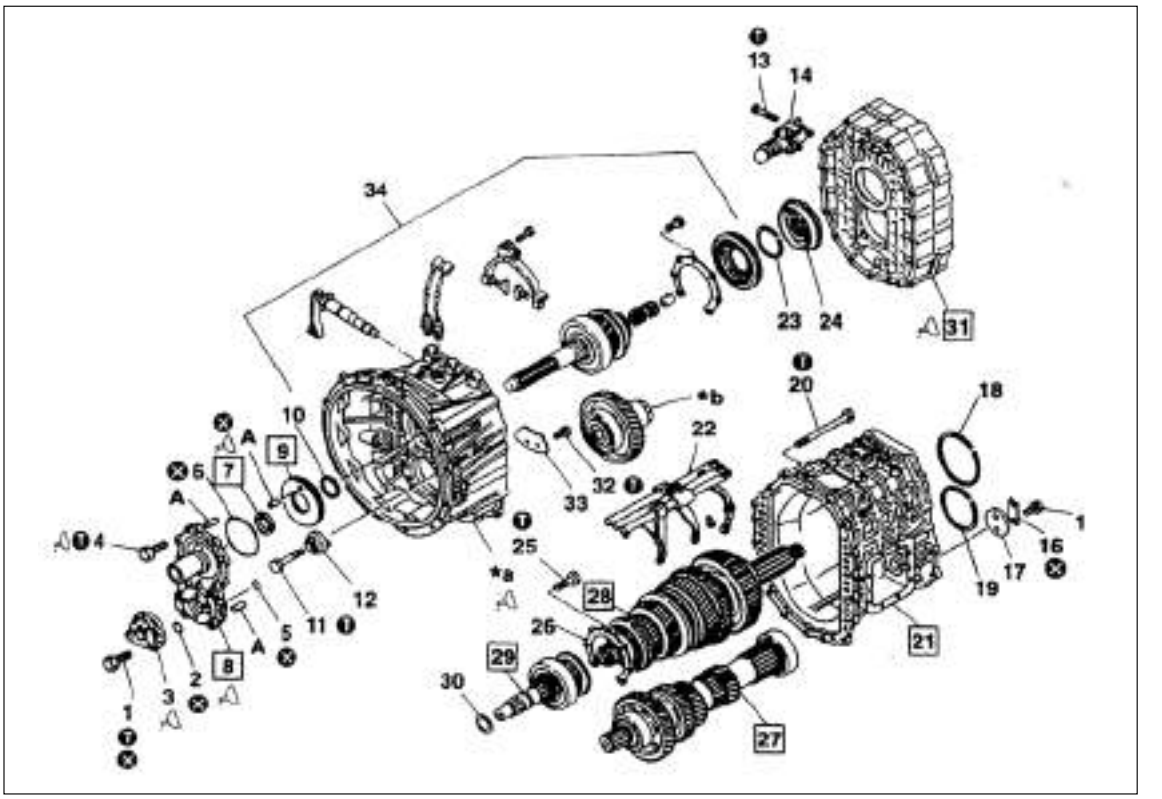
Do not make Ca steel harness too tight. Otherwise, it will damage gear and other mechanical parts. Tighten it reasonably.



- Mount shifting guide rail, shifting fork 16 and transmission case 15 in clutch housing assembly 26.
- At this time, apply sealant to mounting face of clutch housing assembly 26.
- Use Cc tool to mount front bearing of counter shaft in clutch housing assembly 26.

Caution ⚠

Mount elastic retainer ring on front bearing of counter shaft.



● Disassembly sequence

1 bolt	2 O ring	3 oil pump
4 bolt	5 O ring	6 O ring
7 oil seal	8 front guard ring	9 oil inlet plate
10 seal ring	11 bolt	12 lock plate
13 bolt	14 power cylinder	15 bolt
16 lock seat	17 lock plate	18 elastic retainer ring
19 elastic retainer ring	20 bolt	21 transmission case
22 shifting guide rail and shifting fork	23 elastic retainer ring	24 cone of transfer case synchronizer
25 bolt	26 guard ring of drive pinion bearing	
27 counter shaft assembly	28 main shaft assembly	29 drive pinion assembly
*a: clutch housing assembly	30 seal ring	*b: gear of transfer case
31 front body case A: locating pin	32 bolt : cannot be repeated	33 parts used by strainer plate
34 transfer case		

Remark

- After disassembling 1-12 parts, put transmission assembly on vertical position, and make clutch housing assembly *a underside, then disassemble it.
- Take 23-31 parts as a subassembly to disassemble.

● Assembly sequence

It is opposite to disassembly sequence.

Tightening torque

unit: N.m{kgf.m}

Position	Parts tightened	Tightening torque	Remark
1	Bolt (used for installation of oil pump)	23.5{2.4}	—
4	Bolt (used for installation of front guard ring)	40{4.1}	—
11	Bolt (used for installation of lock plate)	291{29.7}	—
13	Bolt (used for installation of power cylinder)	40{4.1}	—
15	Bolt (used for installation of lock seat and lock plate)	98{10}	—
20	Bolt (used for connection of clutch housing assembly, transmission case and front body case)	122{12.4}	—
25	Bolt (used for installation of guard ring and gasket of drive pinion bearing)	40{4.1}	—
32	Bolt (used for installation of strainer plate)	9.8-14.7{1.0-1.5}	—

Lubricant and/or sealant

Position	Application position	Specified lubricant and/or sealant	Quantity
3	Fitting surface between oil pump and front guard ring	Three-way sealant 1216	As needed
4	Thread of bolt	Three-way sealant	If use again, As needed
7	Space between oil seal lips [NLGI No.2 (lithium soap base)]	Grease for wheel bearing	As needed
8	Fitting surface between front guard ring and clutch housing assembly	Three-way sealant 1216	As needed
31	Fitting surface between front body case and transmission case	Three-way sealant 1215 or 1216	As needed
*a	Fitting surface between clutch housing assembly and front body case	Three-way sealant 1215 or 1216	As needed