Tiger Truck

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Table of Contents

Chapter 1 Diesel Engine

1.1 General introduction of diesel engine

1.1.1 Specifications of diesel engine

Table 1-1

Engine model	YND485Q	490QB	490QZL	4100QB	4100QB-2
Type	In-line, water cooling, four-stroke, direct ejection		Exhaust gas turbo mid-cooling and supercharging	Vertical, in-line, water cooling, four-stroke, direct ejection	
Number of cylinders-bore x stroke (mm)	4 - 85×90	4 - 90×105	4 - 90×100	4 - 100×105	4 - 100×115
Cylinder sleeve style	wet				
Total displacement, L	2.156	2.67	2.54	3.298	3.612
Compression ratio	18	18	17	17.5	
Rated power and speed （KW/r/min）	13～36/1500～3200	48/3200	52.5/3200	58.8/3200	66.2/3200
Maximal torque/speed （N.m/min）	≥56.4	166.6/2200	183/2000~2240	201/2000~2200	230/2000~2200
Fuel consumption at rated working condition, g/kw.h	≤247	≤265.2	≤255	≤238	
Oil consumption g/kw.h	2.72	≤2.72	≤1.63	≤2	
Highest	Speed at rated power +10%				

non-load speed, r/min						
Lowest non-load stable speed, r/min		≤900	650 ~ 750		≤750	
Firing order		1 - 3 - 4 - 2				
Lubricating method		Forced and splash lubrication				
Cooling method		Positive water cooling				
Starting method		Motor starting				
Valve clearance (cold)	exhaust, mm	0.25 ~ 0.30	0.35 ~ 0.40		0.30 ~ 0.35	
	Intake, mm	0.2 ~ 0.25	0.35 ~ 0.40		0.35 ~ 0.40	
Intake method		Natural aspirating		Supercharging and mid-cooling	Natural aspirating	
Oil temperature,		≤100	≤95		≤95	
Oil pressure, MPa		0.2 ~ 0.4	0.2 ~ 0.45		0.186 ~ 0.6	
Oil capacity, L			6		9 ~ 9.5	
Net weight, KG		200	230	240	300	320
Outline dimension (excluding clutch), Length x Width x Height (mm)		697×510×638	720×530×700	720×650×677	892×622×730	895×622×745

1.1.2 Matching clearance and wear limit of major parts

Table 1-2 Unit: mm (wear limit only used for reference)

Engine model	YND485Q		490QB, 490QZL		4100QB, 4100QB - 2	
	Matching clearance	Wear limit	Matching clearance	Wear limit	Matching clearance	Wear limit

Between connecting rod neck and connecting rod bushing hole	0.040 ~ 0.105	0.2	0.060 ~ 0.127	0.25	0.052 ~ 0.118	0.25
Between piston pin and connecting rod small end hole	0.025 ~ 0.044	0.1	0.025 ~ 0.050	0.1	0.025 ~ 0.048	0.1
Between piston skirt and cylinder hole	0.1 ~ 0.155	0.4	0.13 ~ 0.195	0.4	0.13 ~ 0.195	0.4
Between first piston ring and piston ring slot	0.06 ~ 0.092	0.2	0.08 ~ 0.112	0.2	———	———
Between second piston ring and piston ring slot	0.04 ~ 0.072	0.18	0.03 ~ 0.062	0.15	———	———
Between oil ring and piston ring slot	0.03 ~ 0.067	0.18	0.03 ~ 0.062	0.15	———	———
Open gap of first piston ring	0.3 ~ 0.45	1.6	0.3 ~ 0.45	———	0.3 ~ 0.45	1.5
Open gap of second piston ring and oil ring	0.25 ~ 0.45	2.2	0.3 ~ 0.45	———	0.25 ~ 0.40	1.5
Between crank shaft main journal and	0.07 ~ 0.139	0.25	0.07 ~ 0.149	0.25	0.04 ~ 0.144	0.25

main bushing hole						
Between camshaft journal and bushing hole	0.05 ~ 0.1	0.18	0.05 ~ 0.114	0.18	0.1 ~ 0.176	0.25
Crank shaft axial clearance	0.075 ~ 0.265	————	0.095 ~ 0.232	————	0.07 ~ 0.262	0.4
Camshaft axial clearance	0.05 ~ 0.22	————	0.06 ~ 0.25	————	0.095 ~ 0.318	0.5

1.1.3 Tightening torque of main bolts

Table 1-3 Unit: N.m

Engine model	YND485Q	490QB, 490QZL	4100QB, 4100QB-2
Bolt on cylinder head	175 ~ 195	130 ~ 170	160 ~ 200
Main bearing bolt	110 ~ 130	140 ~ 180	200 ~ 240
Connecting rod bolt	50 ~ 60	100 ~ 140	100 ~ 140
Flywheel bolt	60 ~ 70	100 ~ 140	100 ~ 140
Bolt on clutch casing			

1.1.4 Selection of diesel oil

The designation of diesel oil used in diesel engine should be determined according to the starting temperature. During winter with low temperature, the diesel oil with low freezing point should be used. On the contrast, in summer, the users may select diesel oil with reference to the following table.

Relationship between diesel oil designation and lowest allowable temperature Table 1-4

Diesel oil designation	10#	0#	-10#	-20#	-35#
Cetane value	50	50	50	45	43
Freezing point ( )	+10	0	-10	-20	-35
Lowest allowable temperature (diesel engine working ambient temperature) ( )	+18	+8	-2	-12-	27

The diesel oil must be highly cleaned and be free from deterioration of dust and impurity.

Before being injected into oil tank, the diesel oil should be placed at rest for above 72 hours and only the upper layer can be used, which is very important to prevent premature wear of diesel injection pump piston.

1.1.5 Selection of lubricating oil

In order to guarantee the normal operation and longer service life of diesel engine and improve the exhaust of diesel engine, only 15W/40APICC diesel engine oil which conforms to the Standard GB11122 can be used.

1.1.6 Selection of cooling liquid

Cooling liquid is as important as diesel oil and lubricating oil to diesel engine. Many failures related to cooling system, such as diesel engine overheat, water pump leakage and heat radiator blockage, can be avoided by the proper maintenance of cooling system.

1) Generally, cooling liquid is composed of three compositions: water (distilled water or deionized water), additive and glycol.

Glycol may be ethylene glycol or propylene glycol. Glycol is used in most common heavy working cooling liquid/freezing mixture. When the ratio of glycol and water is 1:1, ethylene glycol and propylene glycol can provide familiar boiling and freezing resistance. The working capacity of cooling liquid is shown in Table 1-5.

Table 1-5

	Concentration	Protection to freezing ( )	Protection to boiling ( )
Ethylene glycol	50%	-36	106
	60%	-51	111
Propylene glycol	50%	-29	106

When propylene glycol is used, its concentration should not be more than 50%. Under the condition that extra boiling and freezing resistance is required, ethylene glycol should be used.

1.2 Intake/Exhaust system

Intake/exhaust system is composed of air filter, supercharger, mid-cooler, intake pipe, exhaust pipe, etc.

When diesel engine is working, air filter sends the filtered air into supercharger. After being compressed by supercharger, the air enters into mid-cooler, from which it is cooled, and then into intake pipe, and into cylinder via intake pipe. The exhaust gas produced from combustion in cylinder is sent by piston into exhaust pipe and then into supercharger turbo inlet so as to make the supercharger rotate. After that, the exhaust gas flows out from turbo outlet and exhausts from exhaust manifold. See Fig. 1-1 and 1-2.

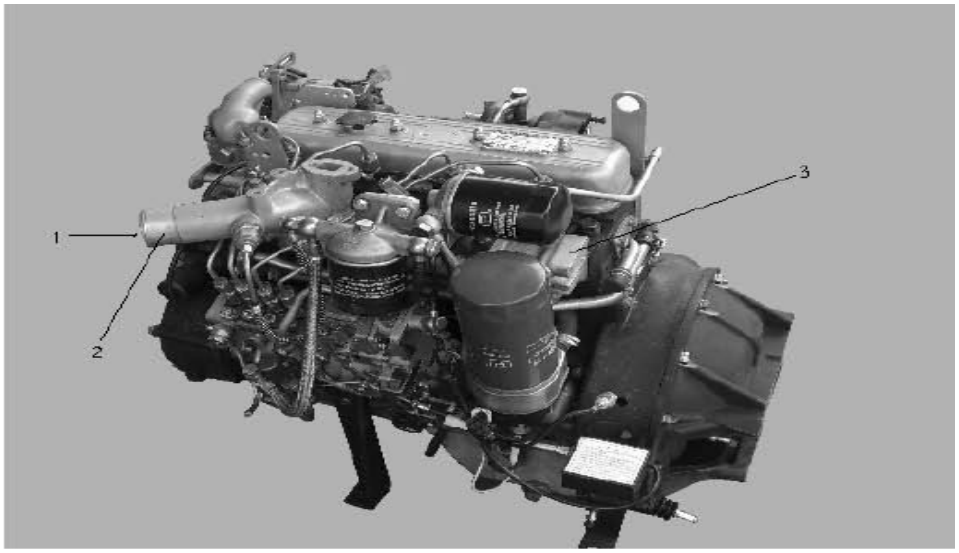


Fig. 1-1 Intake system

1-from mid-cooler; 2-intake connecting pipe; 3-intake pipe

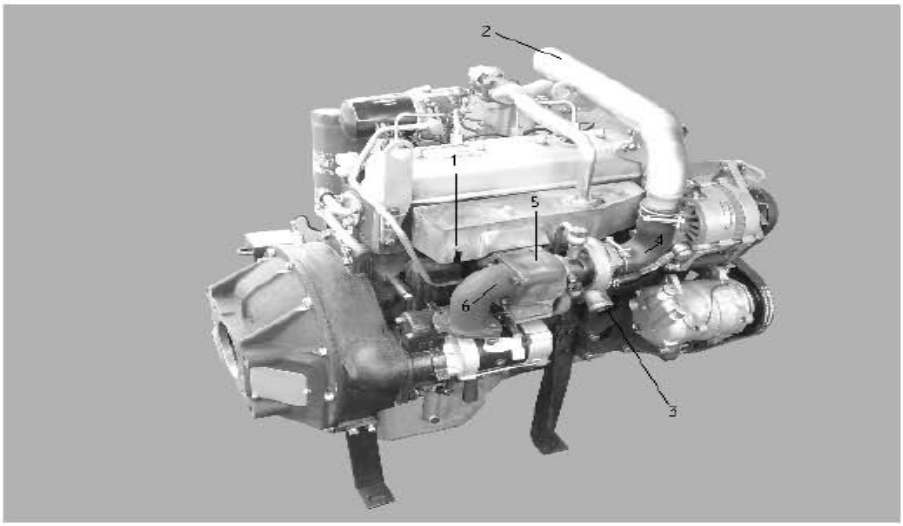


Fig. 1-2 Exhaust system

1-exhaust pipe; 2-connecting with air filter; 3-to mid-cooler; 4-into supercharger; 5-supercharger; 6-connecting with exhaust pipe

1.2.1 Connecting pipe of mid-cooler

1. Description: the connecting pipe of mid-cooler is used to send the supercharged air into mid cooler.

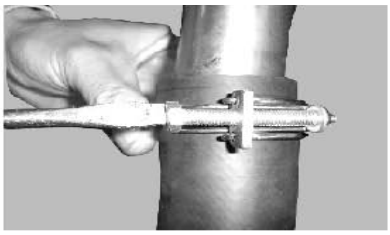
2. Change and repair

(1) Tools: Wrench or screwdriver

A. Disassemble:

Loosen the connecting rubber hose clamp between mid-cooler connecting pipe and supercharger outlet.

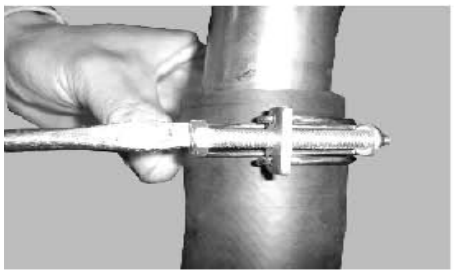
Loosen the connecting rubber hose clamp between mid-cooler connecting pipe and mid-cooler inlet.



B. Installing:

Connect the other end of mid-cooler connecting pipe with mid-cooler outlet rubber hose.

Tighten rubber hoses on the two ends of mid-cooler connecting pipe with clamps.



1.2.2 Supercharger

1. Description: Supercharger is used to increase the air pressure in diesel engine cylinder.

Supercharger is connected to exhaust manifold with flange.

2. Change and repair

A. Disassemble:

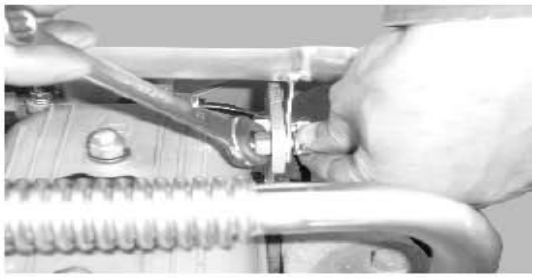
Prior work:

Disassemble mid-cooler connecting pipe heat insulating plate and EGR connecting pipe.

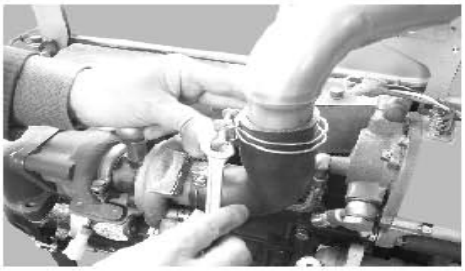
Tools: Wrench, screwdriver

Loosen the connecting rubber hose clamp between air filter connecting pipe and supercharger inlet. Disassemble air filter connecting pipe.

Loosen the fastening bolt between air filter connecting pipe and diesel engine front ring.

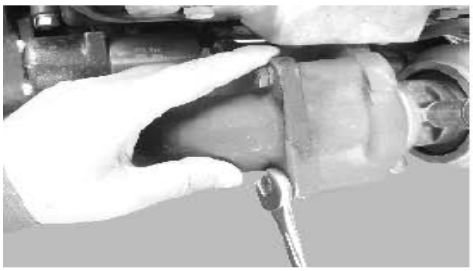


Loosen the connecting rubber hose clamp between air filter connecting pipe and supercharger inlet. Disassemble the connecting rubber hose.



Tool: Wrench

Loosen the fastening bolt between supercharger turbo outlet and exhaust manifold to separate exhaust manifold from supercharger.

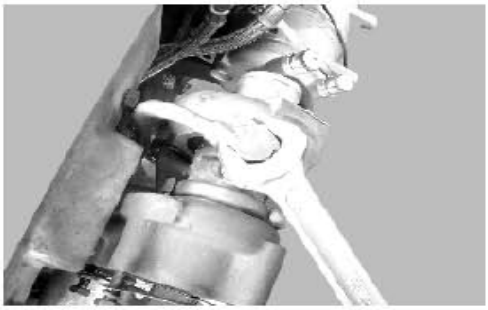


Tool: Wrench

Loosen the fastening bolt of supercharger oil return pipe to separate the oil return pipe from supercharger.

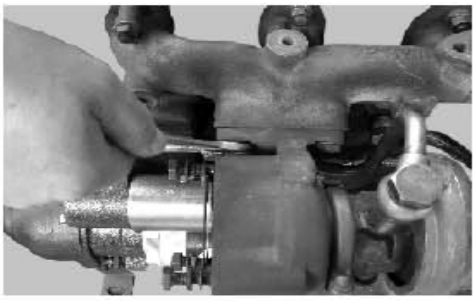
Tool: Wrench

Loosen the fastening bolt of supercharger oil inlet pipe to separate the oil pipe from supercharger.



Tool: Wrench

Loosen the fastening bolt between supercharger and exhaust and disassemble supercharger and washer.



Check whether the sealing surface and fastening bolt are damaged.

If the supercharger will not be changed at this moment, cover the air inlet to prevent foreign matters into it.

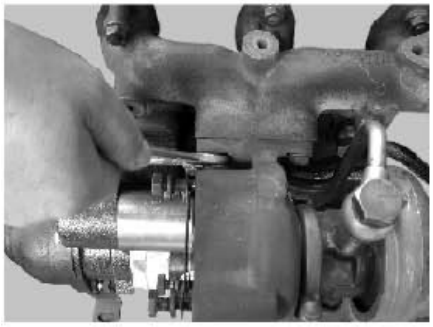
B. Installing:

Install the washer between supercharger and exhaust pipe.

Caution: the washer must be also changed when the supercharger is changed.

Tool: Wrench

Install supercharger and tighten the fastening bolt between supercharger and exhaust pipe flange.

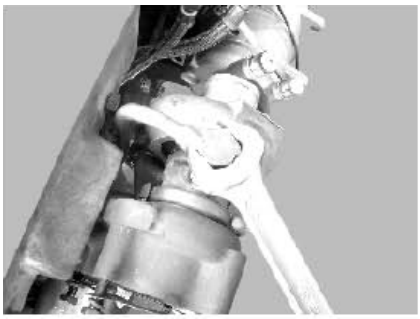


Inject 50-60ml clean engine oil into oil filler, rotate turbo blade to make engine oil into bearing chamber.

Caution: before the starting of newly installed supercharger, lubricating oil must be injected.

Tool: Wrench

Tighten supercharger oil inlet pipe.



Tool: Wrench

Tighten supercharger oil return pipe.

Tool: screwdriver

Connect air filter connecting pipe inlet with rubber hose and tighten the clamp.

Tool: Wrench

Connect exhaust manifold to supercharger turbo outlet with bolt and then tighten the bolt.

Follow-up work: install mid-cooler connecting pipe.

1.2.3 Exhaust pipe

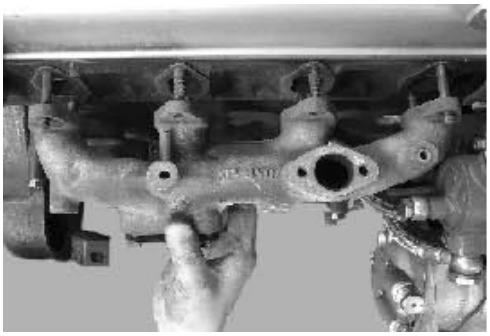
Description: Exhaust pipe is used to lead the exhaust gas produced from combustion in cylinder into supercharger turbine so as to make the turbine rotate.

A. Disassemble:

Prior work: disassemble supercharger

Tool: Wrench

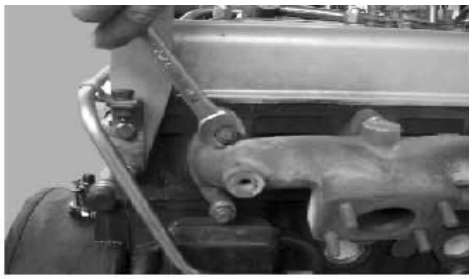
Disassemble the fastening bolt between exhaust pipe and cylinder head and take down exhaust pipe and its washer.



B. Installing:

Tool: Wrench

Install exhaust pipe and washer. Tighten the bolt.



Follow-up work: install supercharger; install other disassembled components.

1.3 Fuel supply system

Fuel supply system is composed of fuel delivery pump, fuel filter, fuel spray pump, speed regulator and fuel pipeline. See Fig. 1-3.

When diesel engine is working, fuel delivery pump sucks fuel from fuel tank and send it to fuel filter from which the fuel goes into fuel spray pump. After pressurization in fuel pump, according to the fuel demand of different working condition, the fuel goes into fuel spray pump through high-pressure fuel pipe and at last, into combustion chamber from fuel sprayer hole as a state of mist. The small amount of fuel flowing from fuel sprayer return pipe, after coming together with return oil of fuel spray pump at fuel return pipe connector of fuel spray pump, flows into fuel return tank.

1.3.1 Low pressure fuel pipe, boost compensator pipe and lubricating oil pipe

1 Description

·low pressure fuel pipes include fuel delivery pipe and fuel sprayer return pipe.

·There are two fuel delivery pipes: one is used to send fuel from fuel delivery pump to fuel filter, another is used to send the filtered fuel to fuel inject pump inlet cavity. Fuel injector return pipe sends the redundant fuel flowing back from fuel injector back to fuel inject pump return connector and then to fuel return tank.

·Boost compensator pipe is used to lead the air coming from supercharger compressor outlet into fuel compensator of fuel inject pump so as to regulate fuel supply according to the change of boosting pressure of diesel engine.

·Lubricating oil pipe is used to lead the lubricating oil in oil channel of lubricating oil filter mount to fuel inject pump so as to lubricate parts in lubricating oil pump.

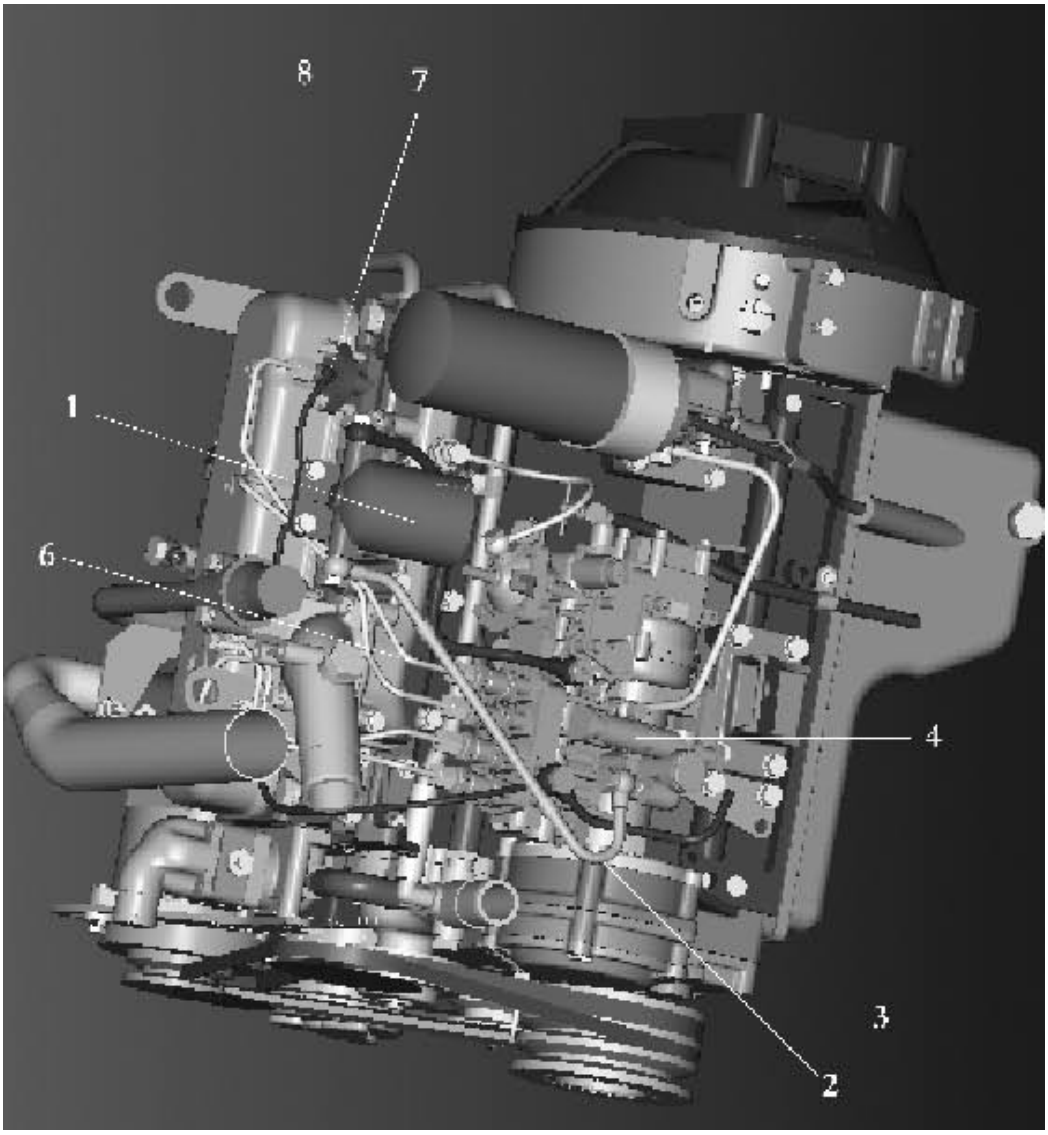


Fig. 1-3 Intake system of fuel supply system

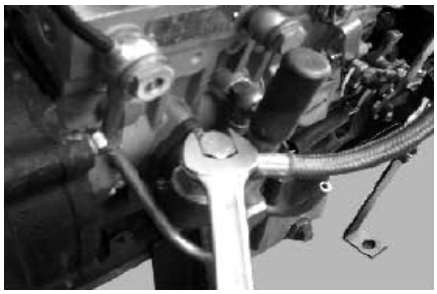
1-fuel filter; 2-fuel pipe-to fuel inject pump; 3-fuel pump-to fuel filter; 4-fuel delivery pump; 5-fuel inject pump; 6-high pressure fuel pump; 7-fuel return pipe of fuel injector; 8-fuel injector.

2. Change and repair

A. Disassemble:

Tool: Wrench

Disassemble the fuel delivery pipe between fuel delivery pump and fuel filter.



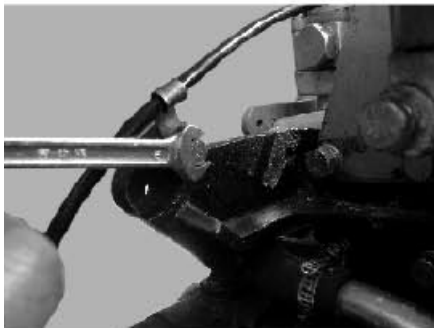
Disassemble the fuel delivery pipe between fuel

filter and fuel inject pump.

Tool: Wrench

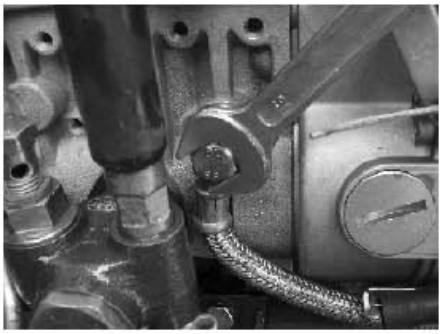
Disassemble the fuel return pipe clamp between fuel inject pump and fuel injector.

Disassemble the fuel return pipe between fuel injector and fuel inject pump.



Disassemble the boost compensator pipe between intake pipe and fuel inject pump.

Disassemble the lubricating oil pipe between lubricating oil filter mount and fuel inject pump.

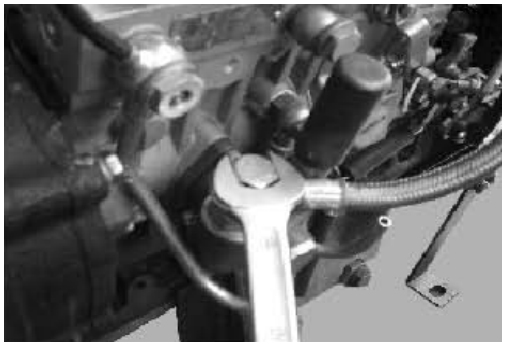


Caution: when disassembling the above pipes, clean the external surfaces of all the connectors and parts/components to prevent foreign matters from entering fuel system.

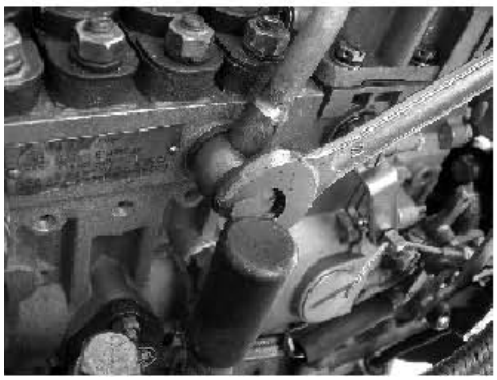
B. Installing:

Tool: Wrench

Install the fuel delivery pipe between fuel delivery pump and fuel filter.

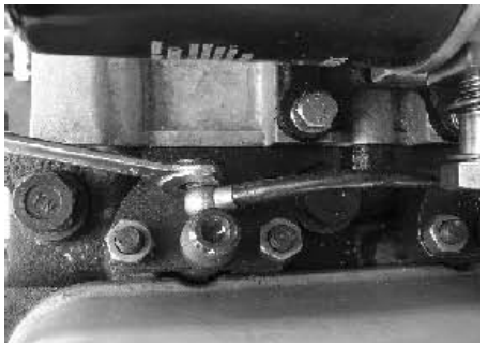


Install the fuel delivery pipe between fuel filter and fuel inject pump.



Tool: Wrench

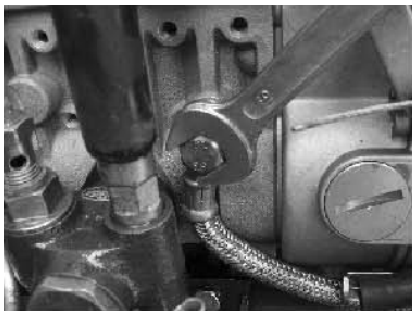
Install the fuel return pipe of fuel injector between fuel injector and fuel pump.



Tool: Wrench

Install the boost compensator pipe between intake pipe and fuel inject pump.

Install the lubricating oil pipe between lubricating oil filter mount and fuel inject pump.



1.3.2 High pressure fuel pipe assembly

1 Description

·High pressure fuel pipe is used to deliver the high pressure fuel supercharged by fuel inject pump to fuel injector.

The four high pressure pipes have different shapes but the same length and are fastened by several pipe clamps at relevant portion. The pipe clamps will fix the high pressure fuel pipes as so to reduce their vibration.

2. Change and repair

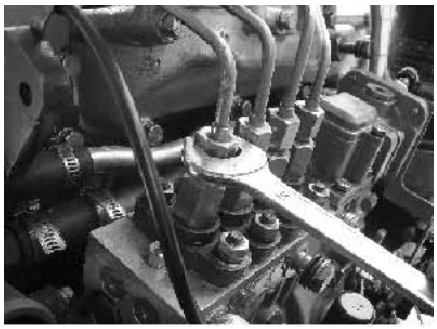
A. Disassemble:

Tool: Wrench

Loosen the bolt of high pressure fuel pipe clamps and disassemble the clamps.

Tool: Wrench

Loosen the connecting bolts between high pressure fuel pipes and fuel inject pump as well as between fuel injector and high pressure fuel pipes and disassemble high pressure fuel pipes.



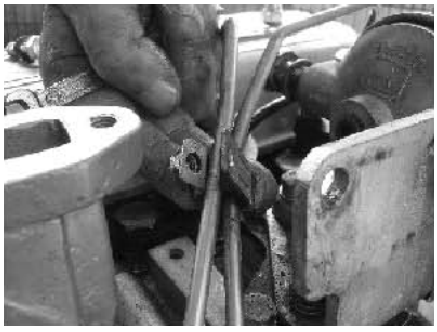
B. Installing:

Tool: Wrench

Connect the connecting bolts at two ends of high pressure fuel pipe respectively to fuel inject pump and fuel injector inlet and then tighten the nuts.

Tool: Wrench

Tighten the high pressure fuel pipe clamp bolts at their original position.



1.3.3 Fuel filter

1 Description

·Fuel filter is used to filter out impurities and water in diesel fuel so as to guarantee the high cleanness.

·After a car has driven for 10,000km or a diesel engine has operated for 100 hours, the filter core of fuel filter should be replaced.

·In this section, the replacement of filter core of fuel filter is demonstrated.

2. Change and repair

A. Disassemble:

Tool: Wrench

Disassemble the connecting pipe connector of fuel filter and screw out the filter core.

B. Installing:

Tool: Special wrench

Apply a thin layer of clean lubricating oil evenly on the O-shaped rubber sealing ring of the filter core. Tighten fuel filter.

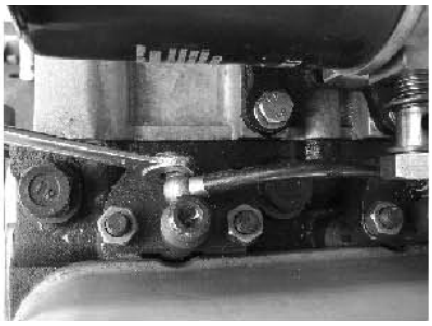
1.3.4 Fuel injector assembly

1. Description: fuel injector injects the diesel fuel sent from high pressure fuel pipe into combustion chamber with certain pressure, speed and direction. As a result, the diesel fuel is properly distributed in combustion chamber as a state of mist, well mixed with air and burned.

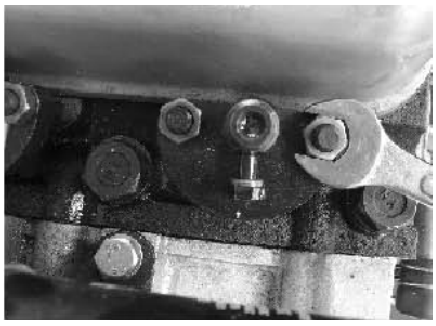
2. Replacement and repair: Disassemble high pressure fuel pipe assembly.

A. Disassemble:

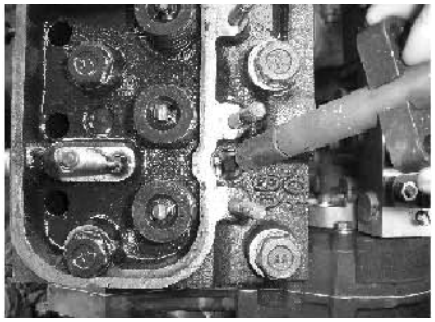
Tool: Wrench



Loosen the platen nut of fuel injector.



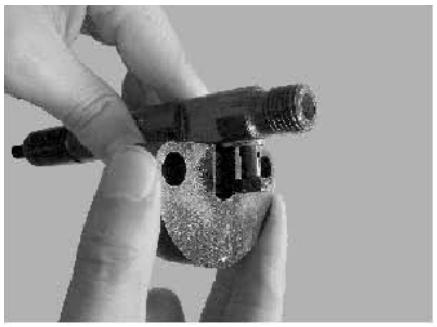
Disassemble fuel injector platen as well as fuel injector.



B. Installing:

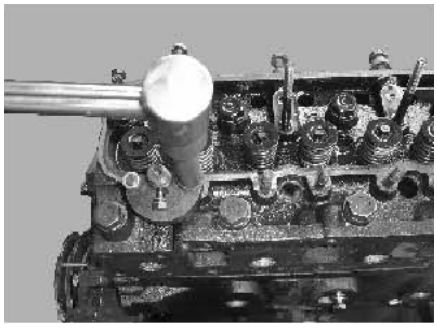
Set fuel injector into cylinder head. Install fuel injector platen and its bolt.

Caution: the positioning pin on the top of fuel injector must be in the positioning slot of the platen.



Tool: Wrench

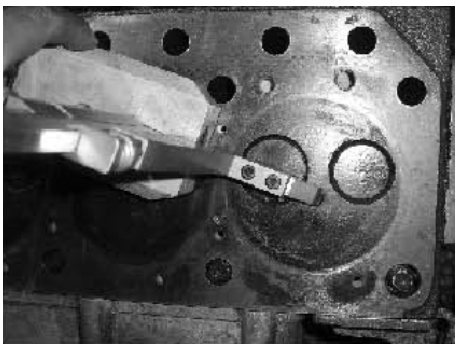
Tighten the platen nut of fuel injector.



Tool: depth vernier gauge

Measure the distance between the top point of injecting nozzle and the bottom plane of cylinder head.

Specified value: 3.0±0.1mm



Follow-up work: install high pressure fuel pipe; install other disassembled parts/components.

1.3.5 Fuel inject pump

1 Description

·Fuel inject pump is used to increase the pressure of fuel. It can deliver high pressure fuel of certain quantity at certain time through high pressure fuel pipe to fuel injector according to the relevant working conditions

·The fuel inject pump is a kind of in-line plunger pump. It together with speed regulator and fuel delivery pump forms fuel inject pump assembly.

2. Change and repair

A. Disassemble:

Prior work:

（1） Disassemble high pressure fuel pipe;

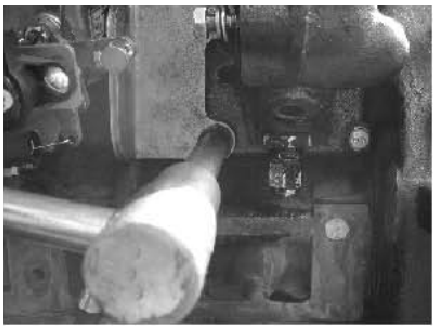
（2） Disassemble connecting bolts between low pressure fuel pipes, boost compensator pipe, lubricating oil pipe, and, fuel inject pump;

（3） Disassemble throttle wire and fuel shut-off solenoid valve wire;

（4） Disassemble front plate of gear chamber cover.

Tool: Sleeve

Disassemble bolt of auxiliary bracket of fuel inject pump.

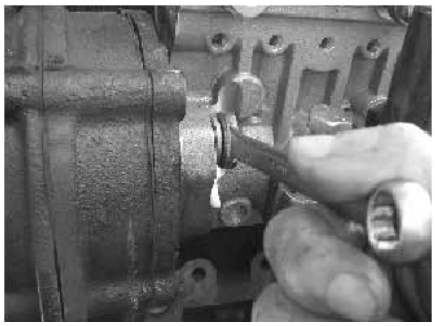


Tool: Sleeve

Disassemble fastening nuts of fuel inject pump and advance device.

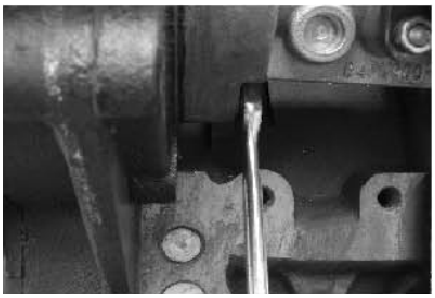
Tool: Wrench

Disassemble the bolt outside medium flange of fuel inject pump.

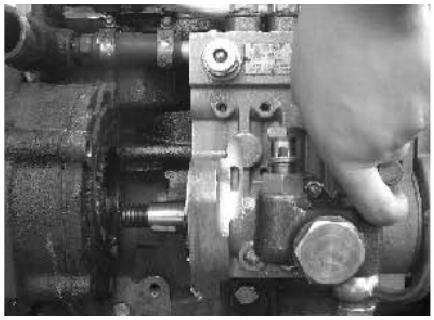


Tool: Wrench

Disassemble the two bolts at the internal bottom of medium flange of fuel inject pump.

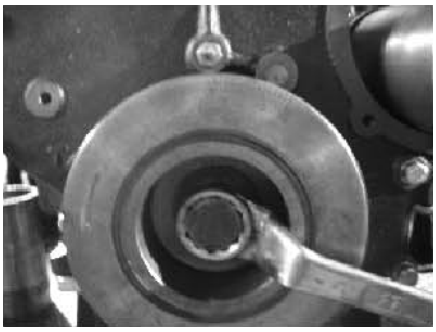


Take down fuel pump.



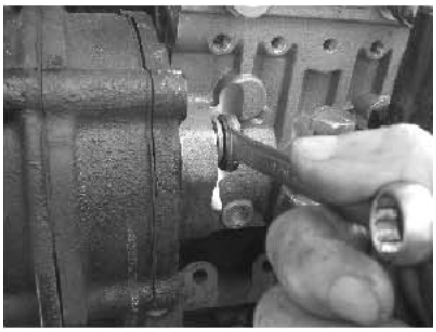
B. Installing:

Rotate flywheel counterclockwise (facing the flywheel end) to the position of 8 degrees of crankshaft before upper dead center of the first cylinder. The needle on gear chamber cover should point to the position of 8 degrees on crankshaft belt disk.



Tool: Wrench

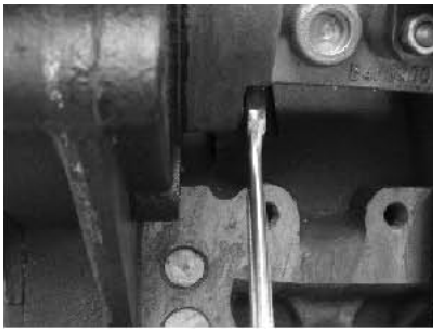
Wash fuel pump and mounting surface of gear



chamber fuel pump connecting block. Install fuel pump into gear chamber.

Fasten the bolt outside fuel pump.

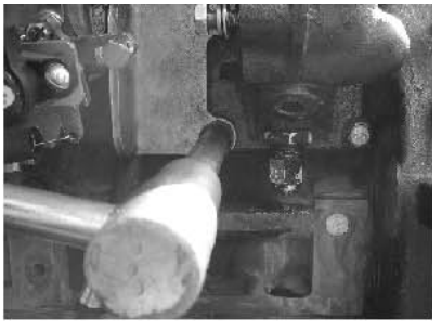
Fasten the bolt at the internal bottom of fuel pump.



Tool: Wrench

Tighten bolt of auxiliary bracket of fuel inject pump.

Install advance device components and tighten nut.



Wash front cover mounting surface and tighten front cover.

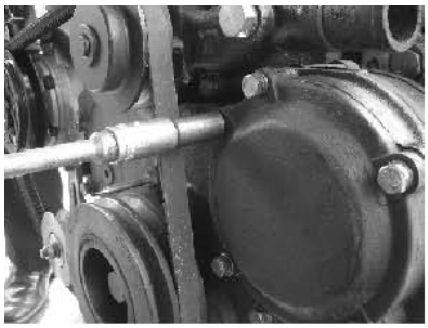
Follow-up work:

Tighten low pressure fuel pipes, boost compensator pipe and lubricating oil pipe;

Install high pressure fuel pipe; (the first cylinder loosened)

Install throttle wire and fuel shut-off solenoid valve wire;

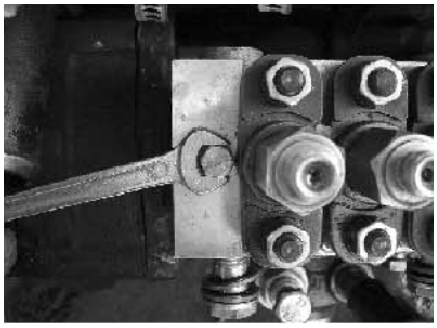
Install other disassembled parts/components.



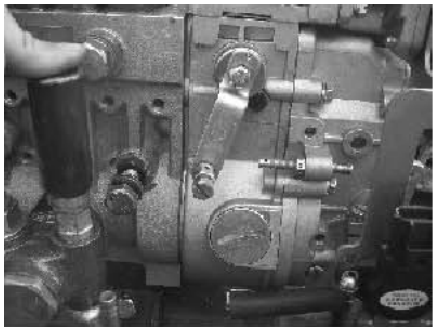
C. Eliminate air in fuel system

Tool: Wrench

Loosen bleed bolt of fuel inject pump.



Press fuel delivery pump handle repeatedly until there is no any bubble in the diesel fuel flowing out from near the bleed bolt.



1.4 Lubricating system

The friction pair surface of main moving parts of diesel engine is lubricated by pressure and splash. Main parts/components of lubricating system include lubricating oil pump, lubricating oil cooler, lubricating oil filter, lubricating oil collector assembly, etc.

Lubricating system woks like this: when lubricating oil pump rotates, the lubricating oil in oil pan is sucked into body oil channel through oil collector and then to oil cooler. The cooled oil flows into oil filter and then into main body oil channel (see Fig. 1-4).After passing main oil channel, the oil is divided into several branches which lubricate main journal and main bearing, connecting rod journal and bearing, crankshaft journal and bearing, rocker and its shaft, gear shaft and its bearing, inject pump (via oil delivery pipe), etc respectively. Some branches cool piston via piston cooling nozzle (see Fig. 1-5 and 1-6).By splashing of lubricating oil, gears are lubricated.

In addition, most filtered oil goes into main oil channel and a small amount into supercharger to lubricate it.

1.4.1 Oil pan and oil collector assembly

1 Description

·Oil pan is used to contain oil and its capacity is about 6.5L.

·Oil collector assembly is used to suck the oil from oil span into cylinder channel so as to lubricate parts/components of diesel engine.

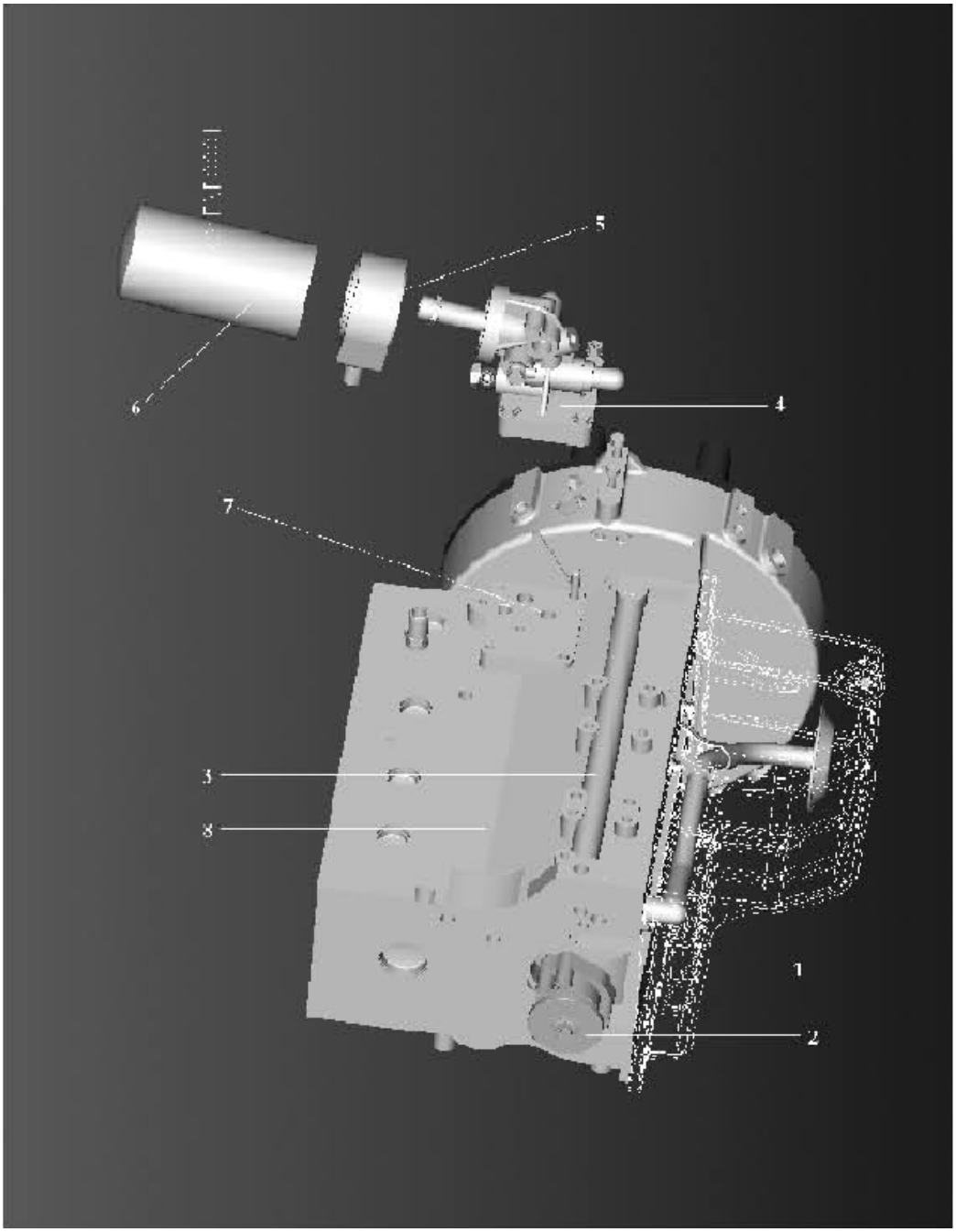
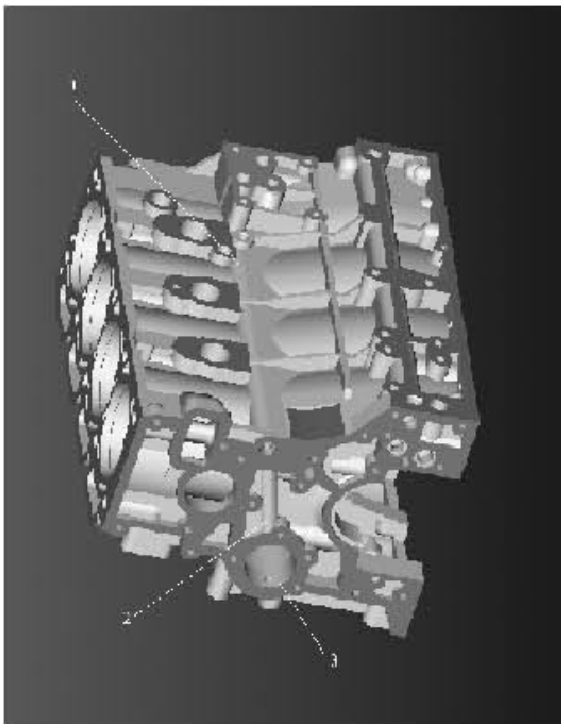
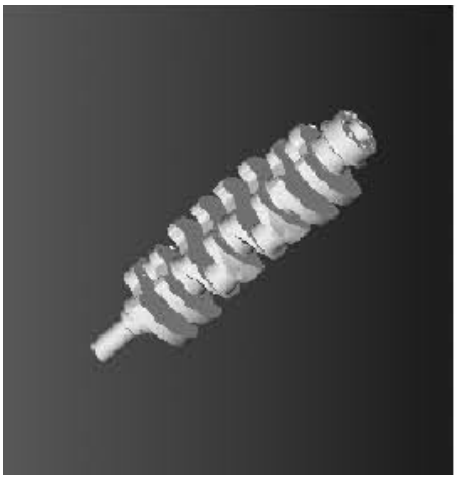


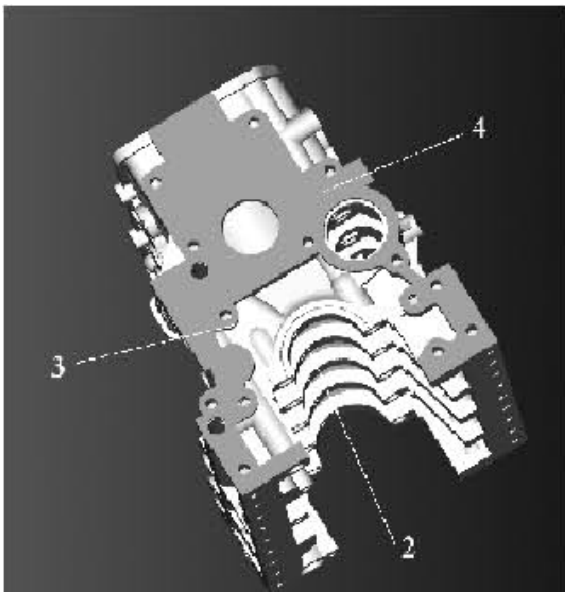
Fig. 1-4 Confluent filter of oil cooler

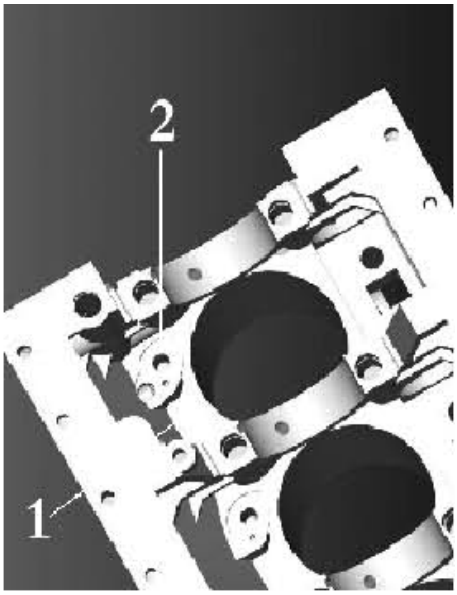
1-oil collector assembly; 2-oil pump, 3-medium body oil channel; 4-oil cooler mount; 5-oil cooler; 6-oil filter (with bypass valve); 7-oil return hole of filter; 8-oil return hole; 9-oil pump channel; 10-supercharger oil channel



1. main body channel
2. channel lubricating crankshaft bearing
3. channel lubricating main bearing
4. to cylinder channel







1. Main body channel
2. to piston cooling nozzle

Fig. 1-5 Lubricating of moving parts/components (I)

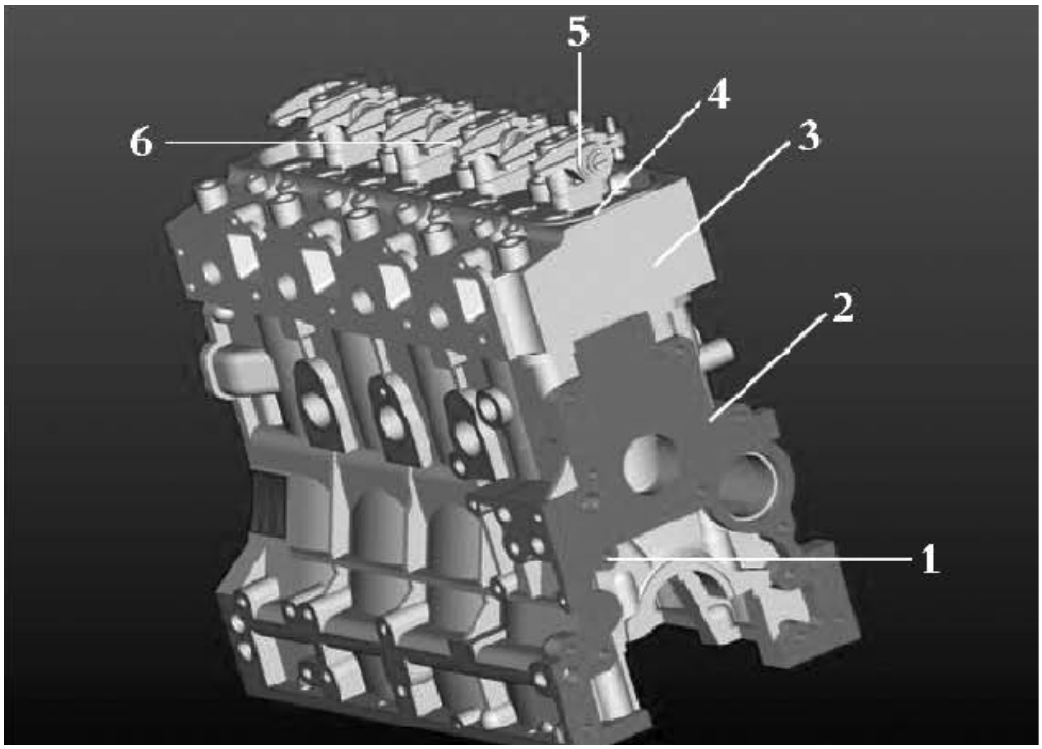


Fig. 1-6 Lubricating of moving parts/components ( )

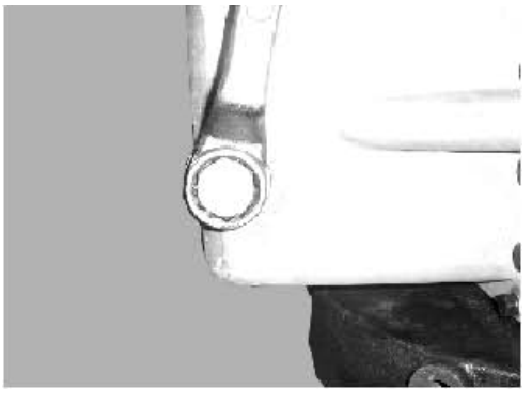
1. main channel; 2. to oil delivery hole on cylinder head; 3. oil delivery hole on cylinder head; 4. channel in rocker shaft; 5. rocker shaft; 6. oil hole in rocker

2. Change and repair

A. Disassemble:

Tool: Wrench

Loosen oil draining screw plug of oil pan to drain off oil.

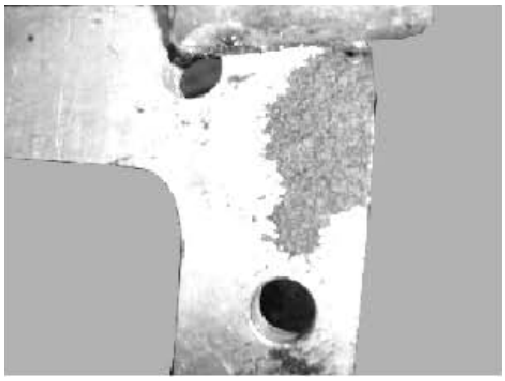


Tool: Sleeve

Loosen the fastening bolts of oil pan and cylinder body bottom, take down oil pan.

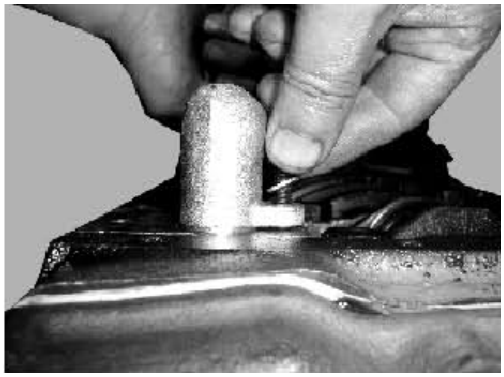
Tool: scraper

Take down oil pan washer. Clean the jointing surface of cylinder body bottom and oil pan.



Tool: Wrench

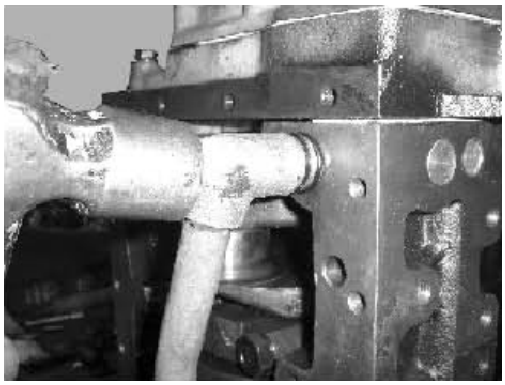
Unscrew 3 fastening bolts between oil collector and body. Take down oil collector.



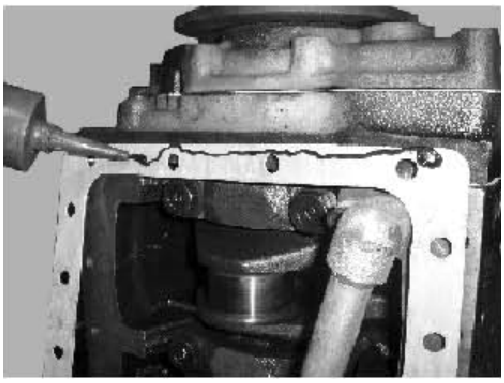
B. Installing:

Install sealing ring in oil collector and apply oil.

Install oil collector on body and screw on bolts.

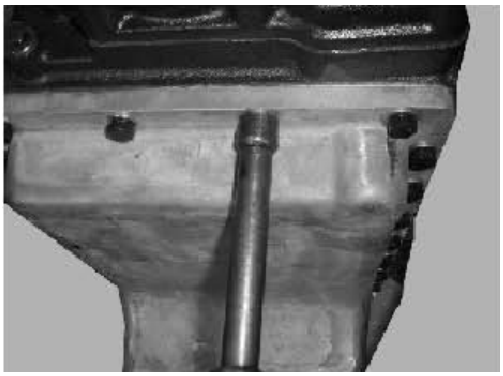


Apply sealant on the two sides of oil pan washer. Place oil pan washer on cylinder body bottom.



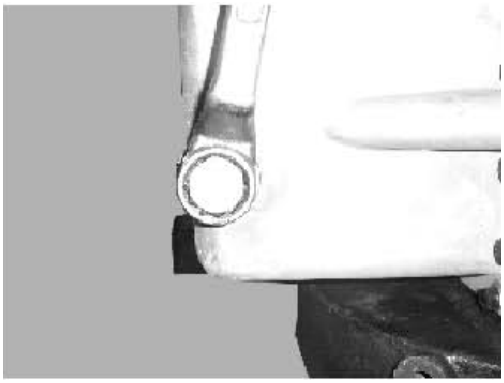
Tool: Sleeve

Cover oil pan and screw in bolts and tighten them.



Tool: Wrench

Fit oil drain screw plug with sealing washer and screw it in screw hole.



1.4.2 Oil cooler and filter assembly

1 Description

·Oil cooler and filter assembly cool lubricating oil using coolant so as to keep the oil temperature within normal range. The filter on the assembly is used to filter out impurities in oil.

·Pressure regulator is used to regulate the pressure of the oil going into cylinder body oil channel to keep it stable; safety valve is used to make the oil go directly into oil filter instead of its core when the oil filter core is blocked to ensure that the oil supply of diesel engine will not be interrupted. The core of oil cooler is composed of a group of fins which transfer the heat from oil to coolant.

·After a car has driven for 15,000km or a diesel engine has operated for 300 hours, or for every three months, the filter core of fuel filter should be replaced.

·In this section, the repair of pressure regulator, filter core of oil cooler and oil filter in oil cooler and filter assembly is demonstrated.

·oil cooler and filter assembly includes oil filter, oil cooler, oil filter mount, oil filter of supercharger, pressure regulating valve, safety valve (inside oil filter), oil delivery pipe and connectors.

2. Change and repair

Prior work:

（1） Disassemble water inlet and return pipes of cooler;

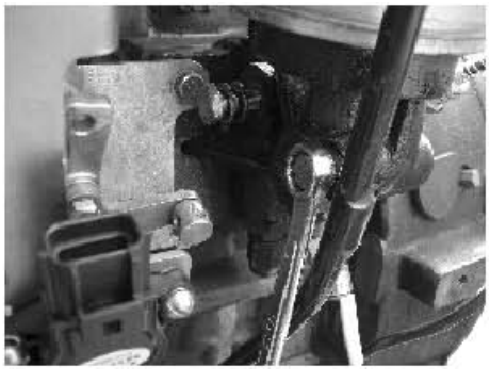
（2） Disassemble oil dipstick funnel;

（3） Disassemble oil filter.

Tool: Special tool

Disassemble oil filter.

Disassemble oil cooler and O-sealing ring.



3. Valve core and spring of pressure regulating valve

Tool: Wrench

Screw out fastening nut, disassemble valve core and spring. Check valve core and spring of pressure regulating valve.

4. Oil filter mount

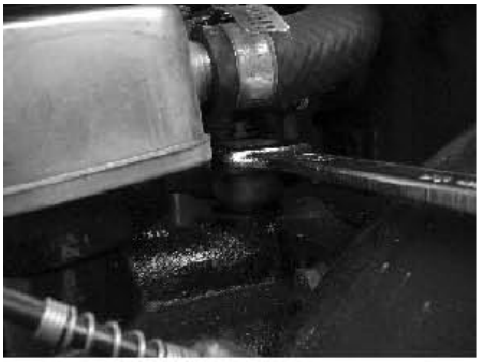
Tool: Wrench

Screw out 4 bolts and take out rubber sealing ring.

5. Oil filter of supercharger

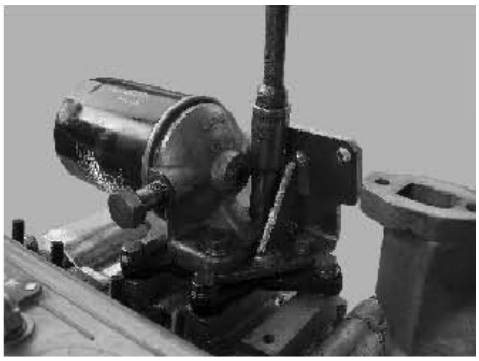
Tool: Wrench

Disassemble oil inlet and outlet bolts of oil filter.



Tool: Wrench

Disassemble fixing bolt of oil filter.



6. Disassembly of oil inlet and outlet pipes of supercharge filter

Tool: Wrench

Disassemble oil inlet pipeline, bolt and its chuck.

Disassemble oil outlet pipeline, bolt and its gasket.

Tool: Wrench

Disassemble chuck bolt.

Install:

1. Pressure regulating valve

Tool: Wrench

Install pressure regulating valve, valve core and spring into mounting hole of pressure regulating valve successively. Tighten fastening

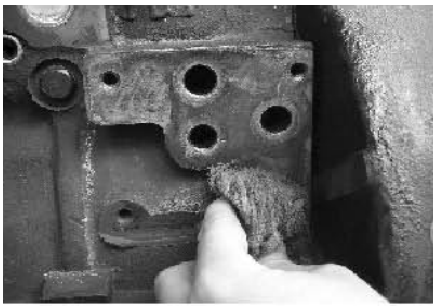
nut.

2. Oil filter mount

Tool: Wrench

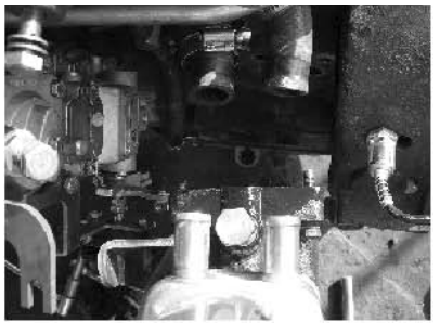
Wash body mounting surface and oil filter mounting surface.

Install relevant O-sealing ring at inlet and outlet holes in mounting surface. Tighten bolt.



3. Oil cooler

Install oil cooler on oil filter mount with its inlet and outlet facing the body.

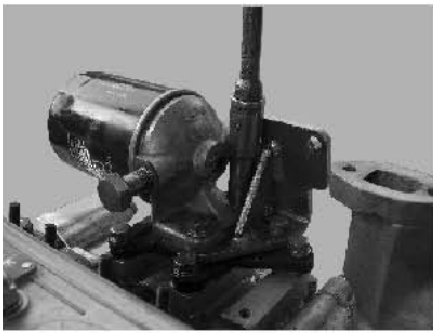


4. Oil filter

Tool: Special tool

Install sealing ring on oil cooler, screw oil filter into cooler body. When sealing ring contacts with mounting surface, continue to screw in 1/2 turn.

5. Oil filter of supercharger



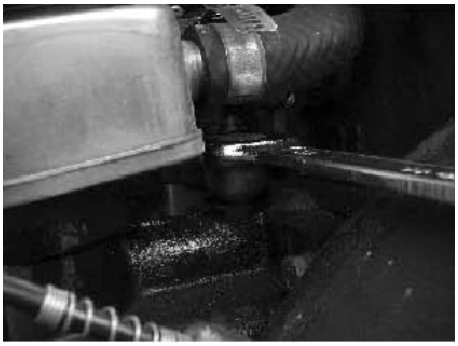
Tool: Wrench

Install oil filter of supercharger on intake pipe and fasten it with bolt.

6. Oil inlet pipe of oil filter of supercharger

Tool: Wrench

Tighten oil inlet pipe on oil inlet, oil filter mount and oil outlet of supercharger and filter using hinge bolts.



7. Oil outlet pipe of oil filter of supercharger

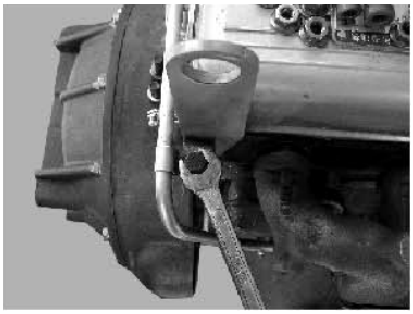
Tool: Wrench

Connect oil outlet pipe to supercharger and supercharge filter, tighten it with bolts to ensure that there is no oil leakage.

8. Fixing of oil outlet pipe of oil filter of supercharger

Tool: Wrench

Fix oil outlet pipe on bracket using fastening bolt to prevent it from vibration.



Install inlet water pipe of oil cooler.

1.5.3 Oil pump assembly

1 Description

·Oil pump of gear type is used to deliver oil in oil pan into main cylinder channel under certain pressure.

·Oil pump is driven by oil pump driving gear installed on crankshaft. Safety valve in oil pump assembly is used to control oil supply pressure under specified value.

2. Change and repair

A. Disassemble:

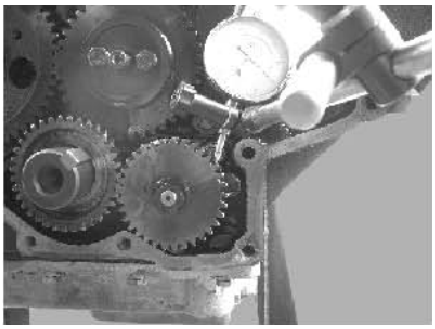
Prior-work: disassemble gear chamber cover.

Gauge: dial indicator

Measure side clearance between oil pump gear and oil pump driving gear. Determine the wear condition of gear surface.

Specified value: 0.030~0.330;

Limit value: 0.400.

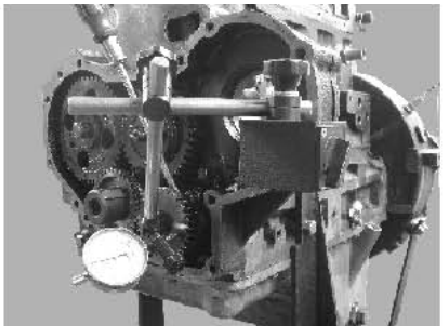


Gauge: dial indicator

Measure axial clearance between oil pump gear end and platen. Determine the wear condition of gear end and cover plate.

Specified value: 0.0250~0.120;

Limit value: 0.180.



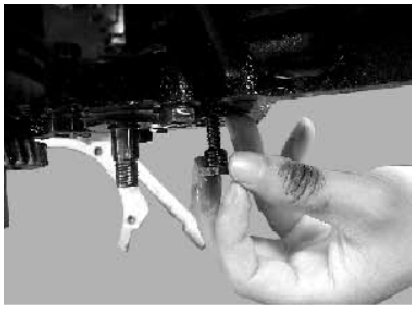
Tool: Wrench

Loosen the fastening nut between driven gear and oil pump driving gear shaft, take down driven gear.

Tool: Wrench

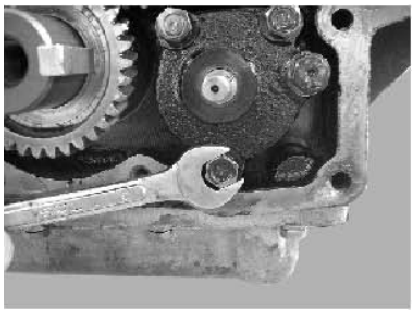
Disassemble hexagon plug of oil pump safety valve.

Take out spring and valve core.



Tool: Wrench

Take down the fastening bolt of oil pump platen and cylinder body, take out oil pump assembly.



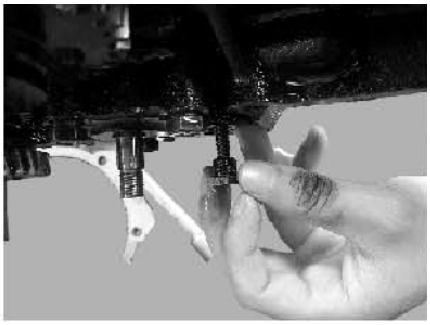
Check spring and valve core.

Check rotors in oil pump. Observe whether there is any abnormal damage.

B. Installing:

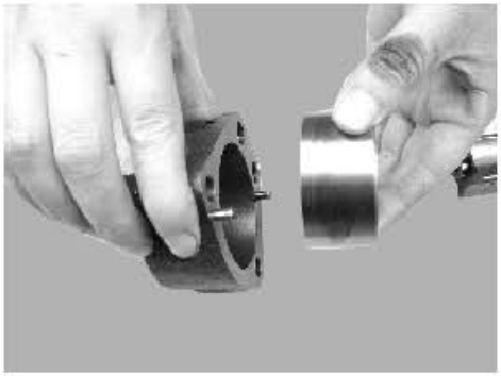
Tool: Wrench

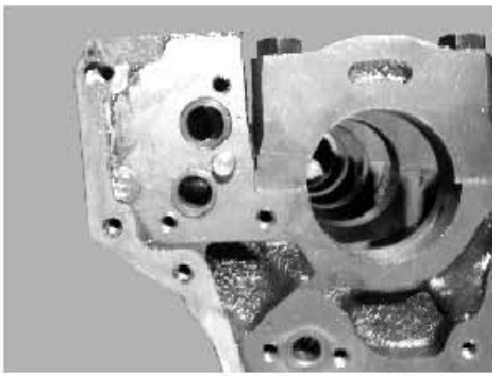
Place valve core, spring into oil pump and safety valve successively. Then, sleeve the copper gasket on the plug to press the spring. Tighten the plug on safety valve mount of oil pump.



Tool: Wrench 13mm

Install oil pump assembly. Aligning gear shaft with positioning pin, close oil pump platen. Install sealing rings at oil inlet and outlet. Fasten oil pump assembly on cylinder body using positioning pin and bolt.



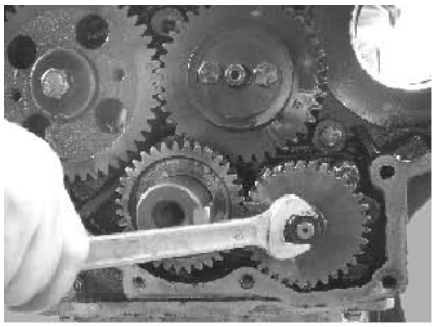


Tools: Wrench, dial indicator

Install driven gear on driving gear shaft and fasten it with bolt.

Tightening torque: 28-35N.m

Check the backlash between driven gear and oil pump driving gear and it should be within 0.030-0.330mm.



Follow-up work:

Install gear chamber cover;

Install other disassembled parts/components.

1.5 Cooling system

Cooling system adopts forced closed circulation liquid cooling. Its main parts/components include water pump, water tank, thermostat, water filter, etc.

Working process of cooling system: water pump sucks a small amount of coolant cooled by water tank and delivers it to oil cooler. Most of coolant flows into cylinder body water cavity so as to cool cylinder body (see Fig. 1-7), to cylinder cover water cavity to cool cylinder cover, and then to thermostat (see Fig. 1-8) from water outlet pipe of whose cover the coolant flows into water tank, thus completing a circulation.

When diesel engine begins to work, water outlet valve of thermostat is closed and all the coolant of diesel engine refluxes to water pump through thermostat bypass valve to recycle (small circulation).When the temperature of the coolant through thermostat reaches 76 , water outlet valve is opened and a part of coolant flows to water tank. When the temperature rises to 86 , water outlet valve is opened completely and bypass valve closed completely (big circulation) (see Fig. 1-9), all the coolant flows to water tank.

1.5.1 Air-conditioning compressor belt, water pump belt pulley, tension pulley and crankshaft pulley

1. Description: belt passes across air-conditioning compressor belt pulley, water pump belt pulley, tension pulley, and crankshaft pulley.

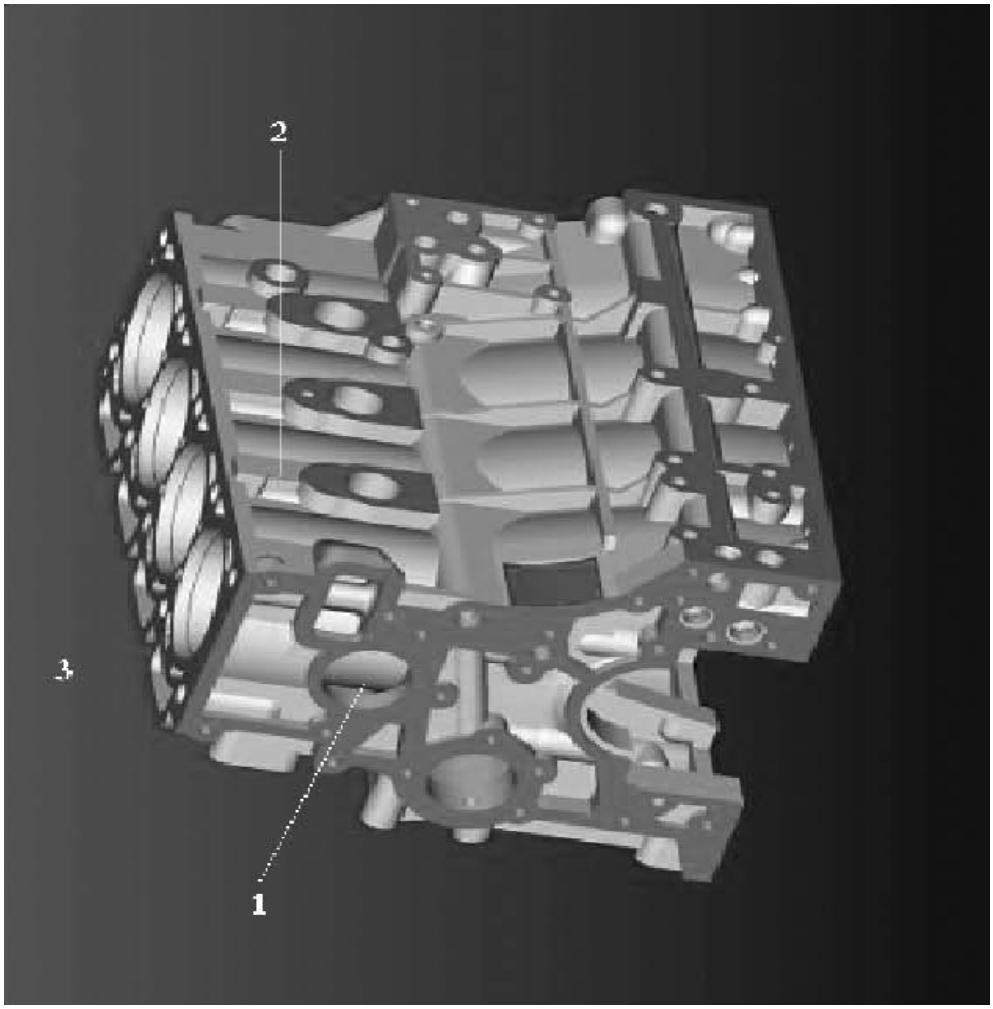
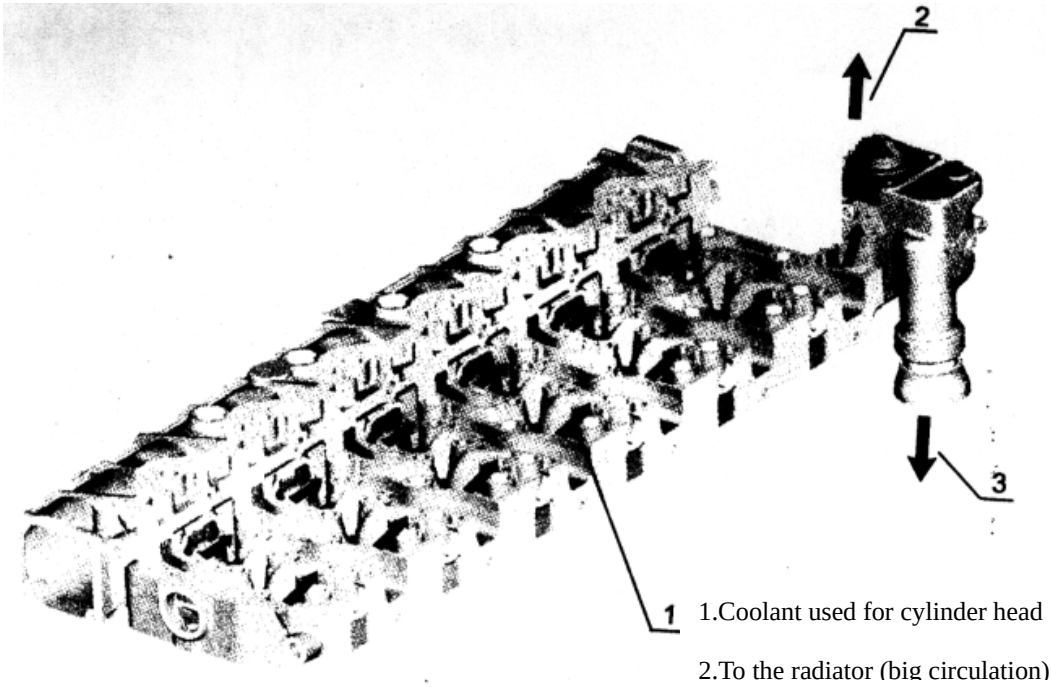


Fig. 1-7 Cooling system

1-from water pump; 2-to water jacket around cylinder; 3-to cylinder head



1.Coolant used for cylinder head

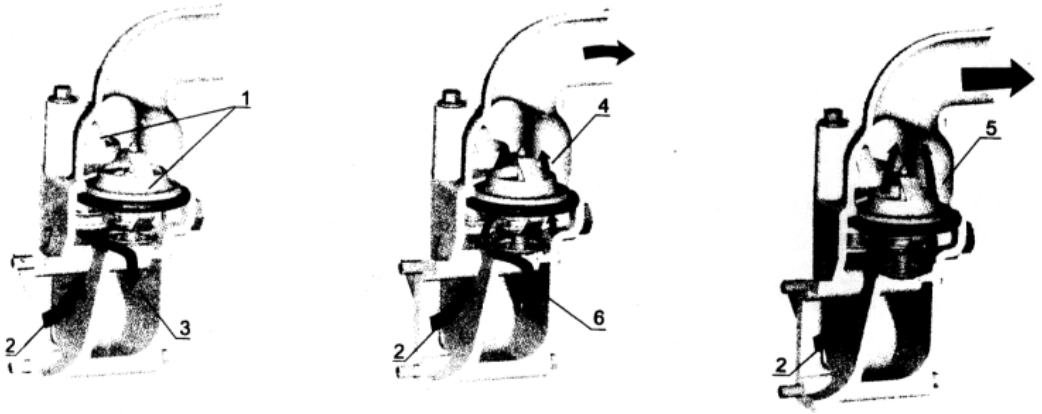
2.To the radiator (big circulation)

3.To the water pump (small circulation)

Cylinder head

Fig. 1-8 Cooling system

;



Close (small circulation) Half-open open (big circulation)

Fig. 1-9 Thermostat

1-thermostat; 2-from cylinder head; 3-flow back to water pump (small circulation); 4-flow partially to radiator; 5-flow to radiator (big circulation); 6- flow partially back to water pump

1.5.2 Tension pulley assembly

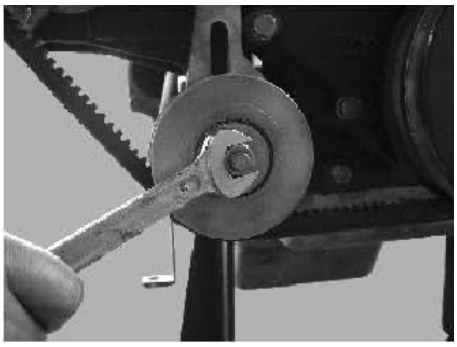
1. Description: tension pulley is used to tension water pump belt.

2. Change and repair

A. Disassemble:

Tool: Wrench

Loosen hold-down bolt of tension assembly.



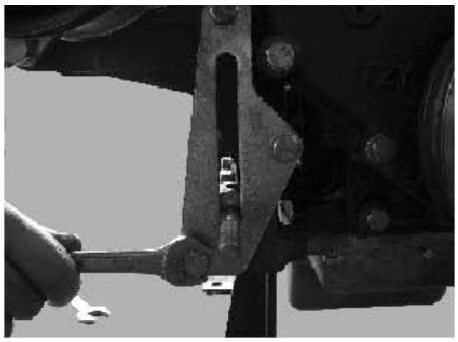
Tool: Wrench

Take down tension pulley clutch and tension pulley.

Tool: Wrench

Loosen bolts of tension pulley support plate and support block.

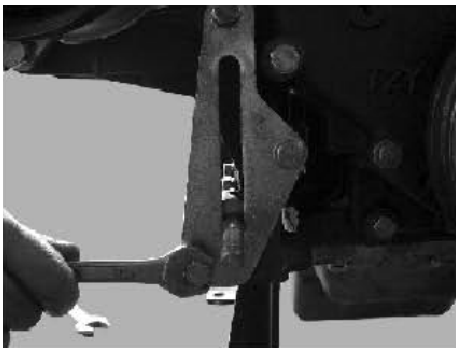
Disassemble support plate and support block.



Install:

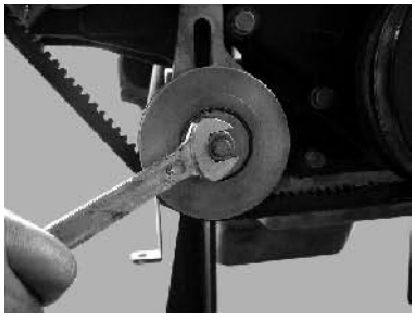
Install support plate and support block of tension pulley assembly on the proper position of tension pulley bracket and press tightly.

Sleeve on tension pulley and plate clutch and tighten hold-down bolts.



Tool: Wrench

Sleeve on water pump belt, tighten regulating bolts of tension pulley assembly. At last tighten hold-down bolts of tension pulley.



1.5.3 Thermostat

1. Description: thermostat is used to regulate the working temperature of diesel engine coolant automatically (see description at the beginning of this chapter). In this system a single wax thermostat is adopted.

2. Change and repair

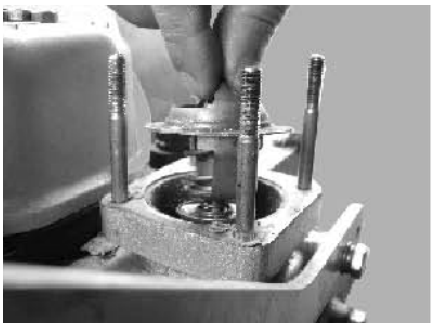
A. Disassemble:

Prior-work: drain coolant.

Tool: Wrench

Loosen fastening bolt between thermostat cover and body, disassemble thermostat cover block.

Take out thermostat.



B. Installing:

Wash the mounting surfaces of thermostat cover and thermostat casing.

Tool: Wrench

Install thermostat cover on thermostat casing, tighten the connecting bolts.

Follow-up work:

Fill coolant to cooling system.

1.5.4 Water pump

1. Description: water pump is used to increase the pressure of coolant and to realize accelerated circulation of coolant in cooling system.

2. Change and repair

A. Disassemble:

Prior-work: (1) drain coolant;

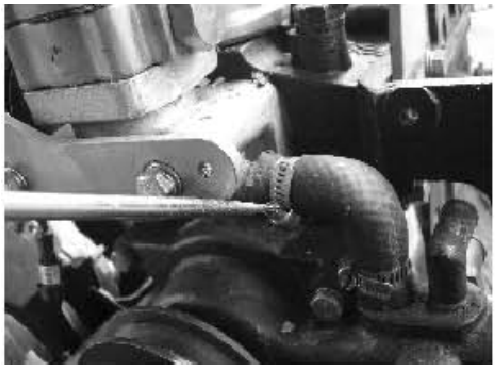
(2) Disassemble tension pulley assembly;

(3) Disassemble belt.

Tool: Wrench

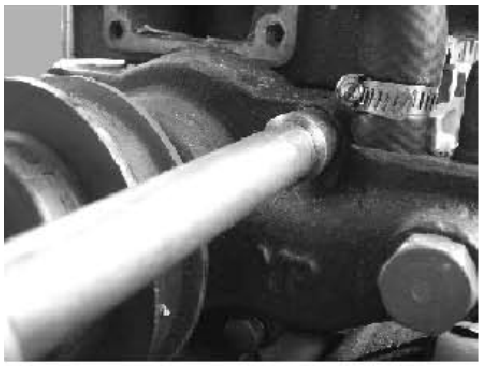
Disassemble hoops and connecting pipes between oil cooler water pipe and water pump.

Disassemble heater water pipe, water pump hoops and connecting pipe.



Tool: Wrench

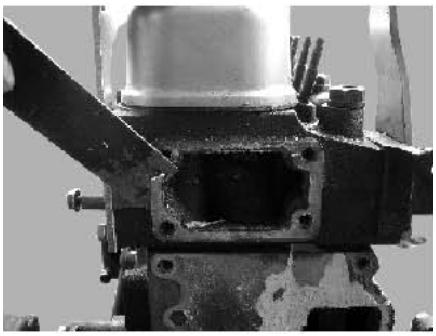
Loosen fastening bolts and nuts between water pump and body. Disassemble water pump.



B. Installing:

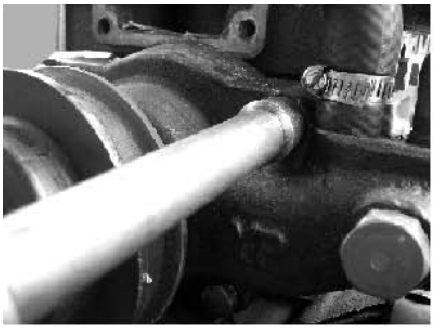
Tool: scraper

Clean the sealing surface of body where body mates with water pump thermostat casing and cylinder cover.



Tool: Wrench

Install water pump and water pump washer assembly. Tighten bolts and nuts.



Follow-up work:

Install tension pulley assembly;

Fill coolant.

1.6 Electrical system

Electrical system is composed of battery, starter, generator, starting circuit wire, control circuit wire, ignition switch, etc.

When ignition switch is switched on, starter solenoid switch begins turning on. Under the combined effect of forces of switch attracting coil and holding coil, main circuit is turned on, and switch dynamic and static core are closed. The end magnetic force produced by holding coil maintains the turning on of main circuit until starting process is completed. The driving gear of starter engages with flywheel ring gear of diesel engine, transferring the output power to diesel engine. After diesel engine starts, ignition switch is disconnected; solenoid switch of starter is powered off. Under the action of return spring, starter driving gear and flywheel ring gear of diesel engine are disengaged.

After diesel engine is started, the belt pulley at the front end makes generator rotate by belt. The accumulated battery supply excitation for diesel engine. When the speed of generator is more than 1000r/min, the generator begins generating electricity. When its speed is more than 1500r/min, it can provide a certain amount of current.

1.6.1 Starter

1 Description

·The function of starter is to overcome the starting resistance of diesel engine and realize the transfer from static state of diesel engine to operating state. When the lowest starting speed is reached, diesel engine begins to burn diesel and keeps operating.

2. Change and repair

A. Disassemble:

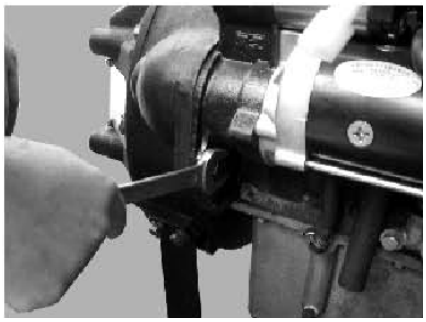
Prior work:

Disassemble grounding cable of battery;

Make labels for wires to guarantee correct installing.

Tool: Wrench

Loosen fastening bolt of starter and flywheel casing. Take down starter.



B. Installing:

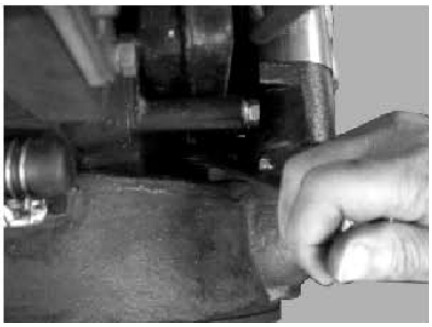
Tool: Wrench

Connect starter and flywheel and tighten connecting bolt.

Follow-up work:

Connect wires well;

Install grounding cable of battery.



1.6.2 Generator

1 Description

·Generator is one of power supply of electrical equipment of diesel engine. When diesel engine operates, generator supplies electricity for battery and all electrical parts on engine at the same time.

2. Change and repair

A. Disassemble:

Prior work:

Disassemble cable on negative pole terminal of battery.

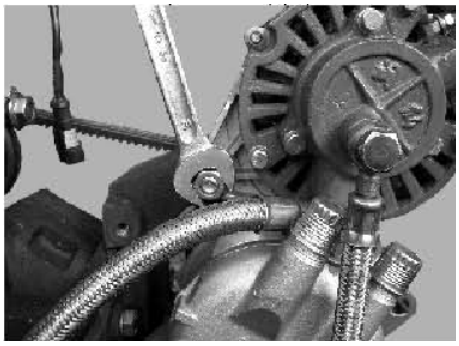
Make labels for wires to guarantee correct installing.

Tool: Wrench

Disassemble connecting bolt on engine upper support.

Tool: Wrench

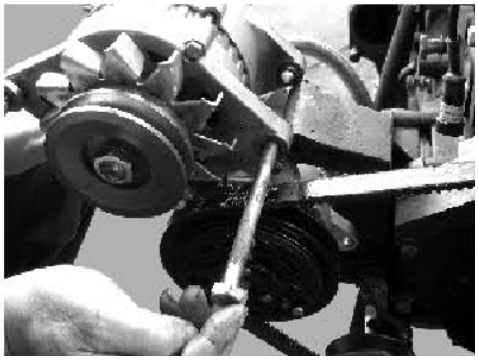
Loosen fastening bolt between generator and lower bracket and take down generator.



B. Installing:

Tool: Wrench

Connect generator with lower bracket with bolt.



Tool: Wrench

Connect generator bolt with generator upper support and tighten bolt.

Follow-up work:

Connect all wires; install cable on batter negative pole terminal.

1.7 Main parts/components of diesel engine

The parts/components of diesel engine involved in this chapter are those that are not included in the above section, including most of parts/components of air supply and crank and connecting rod mechanism. It is inappropriate to classify some assemblies into traditional diesel engine systems. These assemblies are also demonstrated in this chapter to keep the general completeness of diesel engine parts/components maintenance.

The order of this chapter is generally the same as the disassembly sequence of parts/components. If a customer wants to have some parts/components, it is possible to have to firstly disassemble other parts/components or assemblies which will be introduced firstly. The parts/components or assemblies having certain disassembly/installing stage will be demonstrated in the same section. Each section is both independent and continuous with each other.

1.7.1 Crankcase ventilator assembly

1 Description

·Crankcase ventilator assembly is used to lead out the fuel gas in crankcase via oil separator to prevent the adverse effects of increased gas pressure, oil deterioration and risen oil temperature. Oil separator leads oil into oil pan via connecting pipe.

·In this section, the maintenance of parts/components of crankcase ventilator assembly is demonstrated.

2. Change and repair

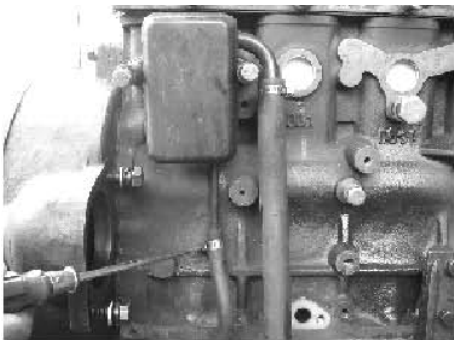
A. Disassemble:

Tool: Wrench

Disassemble the bolt on the right of ventilator device.

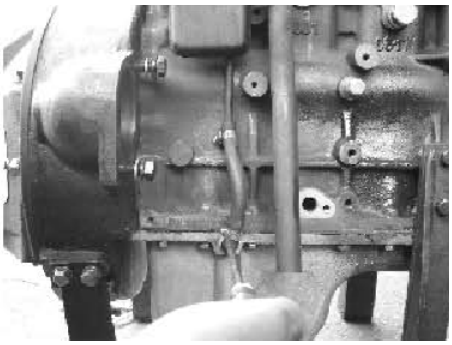
Tool: screwdriver

Take down the clamp on oil return rubber hose of ventilator.



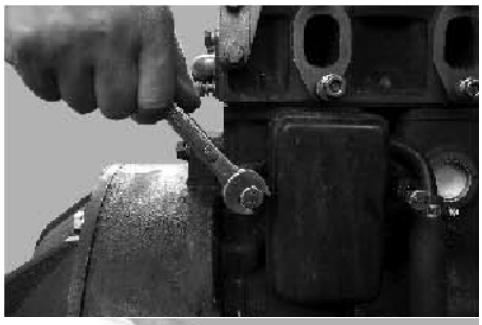
Tool: screwdriver

Take down the clamp between oil return rubber hose and oil pan.



Tool: Wrench

Disassemble the bolt on the left of ventilator and take down the hook.



B. Installing:

Tool: insert O-ring into ventilator mounting plane.

Tool: Wrench

Fix the ventilator hook assembly on which O-ring has be sleeved on cylinder body using two hexagon bolts.

Tool: screwdriver

Fasten the clamp on oil return rubber hose.

1.7.2 Cylinder head cover assembly

1 Description

·Cylinder head cover is used to cover moving parts such as air bleed and rocker to prevent dust and foreign matters from entering and oil from splash out as well as to insulate noise.

·At the top of cylinder head cover is there an oil filler for filling lubricating oil. There is a diesel engine nameplate attached on the top of cylinder cover.

2. Change and repair

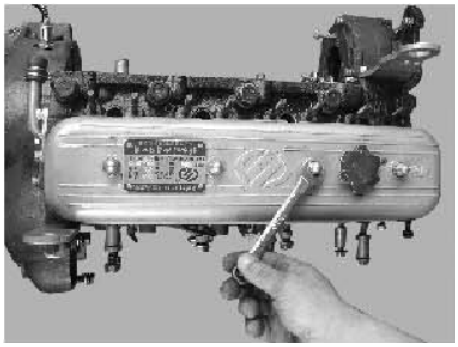
A. Disassemble:

Prior work:

If there are supercharger and compressor intake and outlet pipes on the top of cylinder head cover (different according to engine type), they should be disassembled firstly.

Tool: Wrench

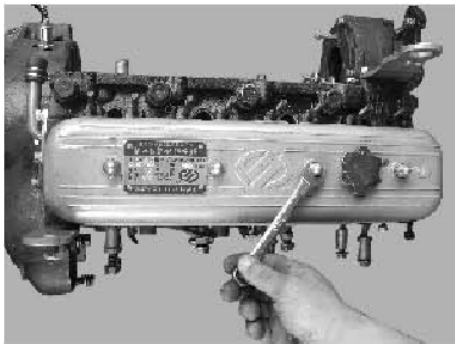
Disassemble the cap nut on cylinder head cover and take down cylinder head cover assembly.



B. Installing:

Tool: Wrench

Tighten the cap nut on cylinder head cover.



1.7.3 Rocker, rocker shaft and push rod

1 Description

·Rocker is a drive part between push rod and air valve and it changes the direction of the force transferred by push rod so as to make it take action on rocker and control the open and close of air valve.

·each cylinder of diesel engine has an intake valve rocker and an exhaust valve rocker. There is an oil hole in rocker through which lubricating oil lubricates rocker ball socket and rocker top face.

·Rocker shaft is used to support rocker.

·Rocker shaft has a tube-shaped structure. The cavity in the middle forms an oil channel.

There are lubricating oil holes on the external surface of the shaft mating with internal rocker hole to lubricate rocker and its shaft.

·Push rod makes the force transferred by camshaft act on the end of rocker so as to control the movement of valve.

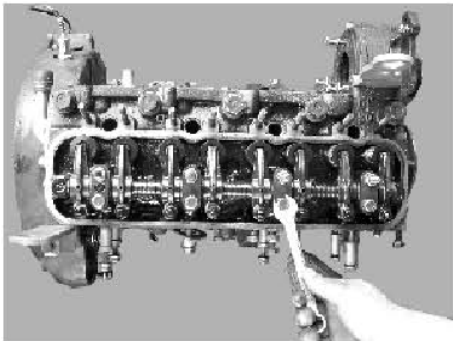
2. Change and repair

·Disassemble

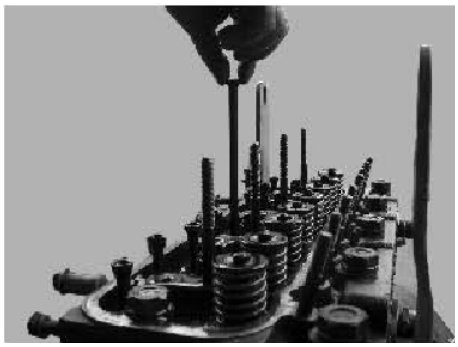
Prior-work: Disassemble cylinder cover assembly.

Tool: Wrench

Loosen the fastening bolt between rocker shaft support and cylinder cover. Take down rocker mechanism components.

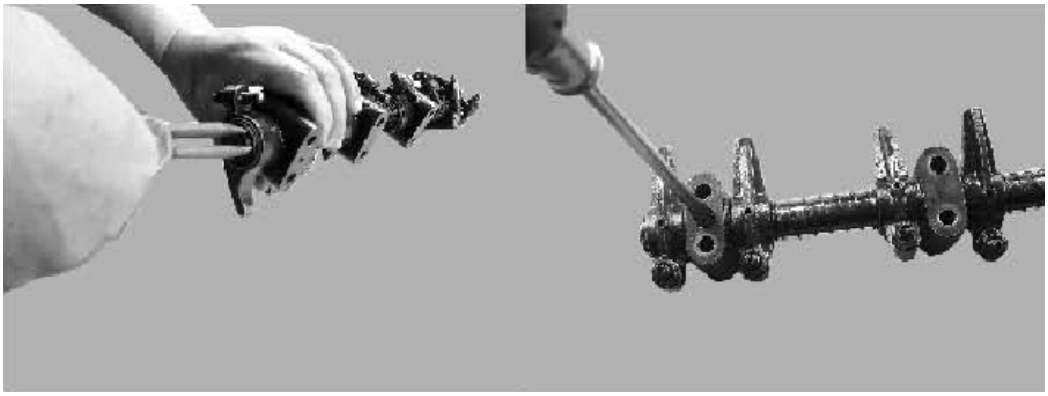


Take push rod out of its hole.

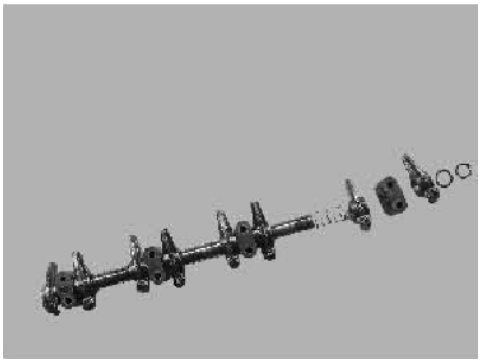


Tools: Spring pliers, screwdriver

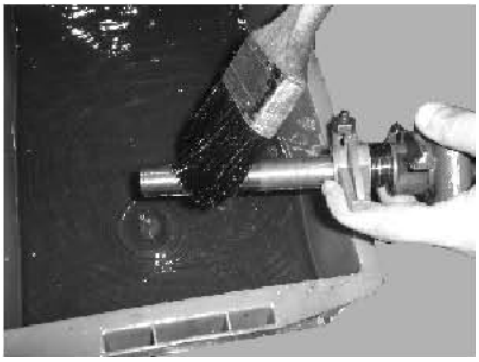
Loosen the fastening screw and locking screw of rocker bearing on rear rocker shaft support. Disassemble snap springs on two ends using spring pliers.



Disassemble front and rear rocker shaft support, spring and rocker assemble from rocker shaft.



Wash rocker and its shaft on gasoline or other cleaning solution.



Blow out rocker and its shaft using compressed air.

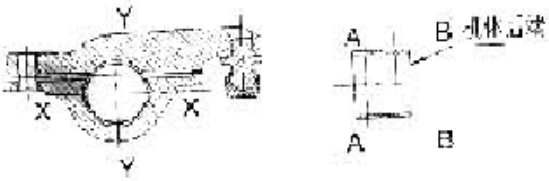
Check the wear condition of rocker bushing hole.

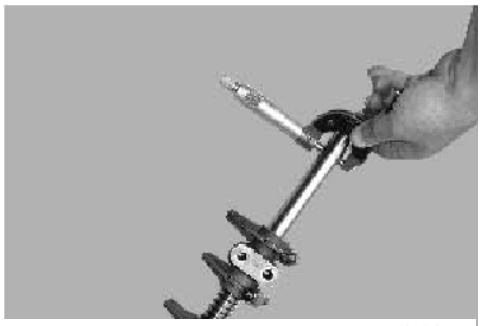
Gauge: dial indicator

Measure the diameter of rocker bushing hole and judge the wear condition of bushing hole.

Drawing size: Φ19±0.033

The measuring position and direction are shown in the right figure.





Gauge: Spiral micrometer

Measure the diameter of rocker shaft and judge its wear condition

Drawing size: $\Phi 19^{-0.02}_{-0.01}$

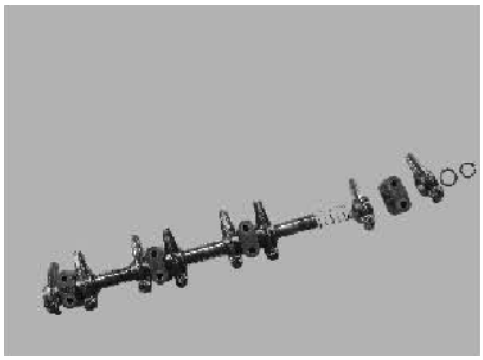
The matching clearance between rocker bushing hole and rocker shaft is 0.02-0.074, the wear limit is 0.200.

The measuring position and direction are shown in the figure.

B. Installing:

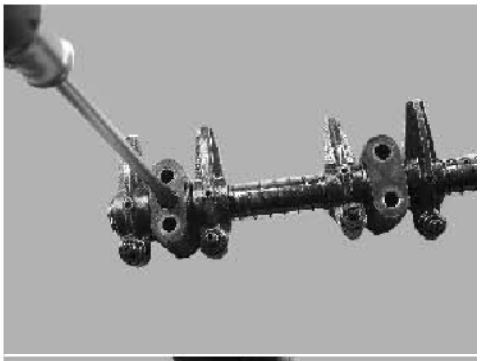
Apply a proper amount of lubricating oil in the internal hole of rocker bushing.

Install shaft retaining ring, gasket, exhaust valve, rocker, rocker spring, rocker shaft brackets on rocker shaft according to their relevant position.

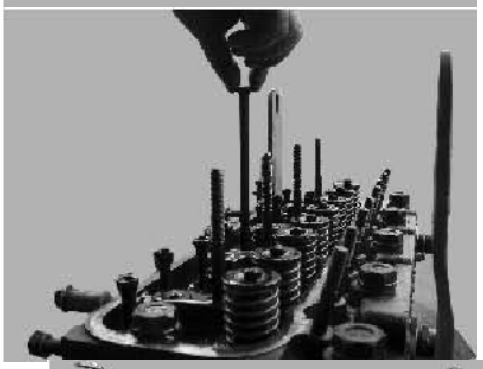


Tools: Wrench, screwdriver

Screw locking screw in rear rocker shaft bracket and tighten relevant nut, install retaining ring on the rear end of rocker shaft.

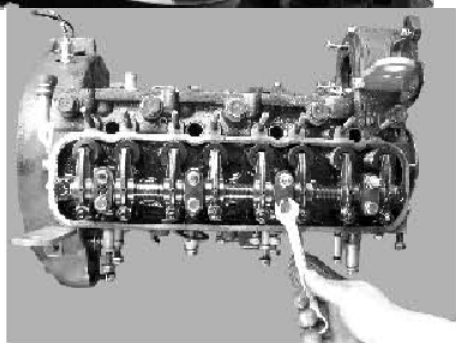


Install push rod in lifter socket.



Tool: Wrench 13mm

Fix rocker mechanism on cylinder cover using bolt.

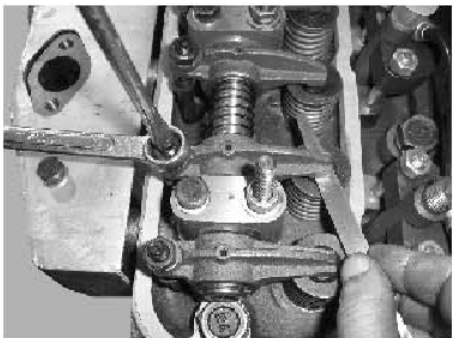


Regulate valve clearance

Tool: thickness gauge

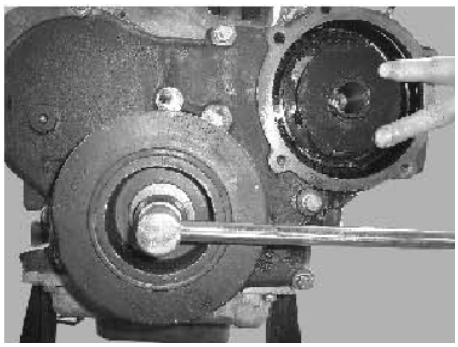
Clearance of intake valve: 0.20-0.25

Clearance of exhaust valve: 0.20-0.25

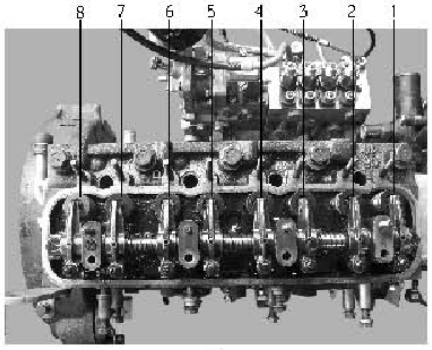


During measuring or regulating valve clearance, diesel engine should be in cold state. The measured clearance is the right one when the thickness gauge can slide between rocker and valve top face, but, at the same time, adhesive resistance can be felt.

Using socket wrench, turn diesel engine slowly. When the needle aligns with the scale mark “0” on belt pulley, the pistons of the first cylinder and the



fourth cylinder are positioned at their top dead centers. Slide intake and exhaust valves of the first cylinder, if any loose, adjust valve clearance according to the method in Fig. A; otherwise, adjust valve clearance according to the method in Fig. B.



A

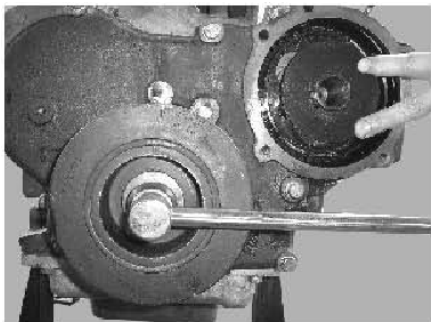
Tools: Wrench, screwdriver

In Fig. A, the piston of the first cylinder is at top dead center.

Check or adjust clearances of valves 1, 2, 4 and 5.

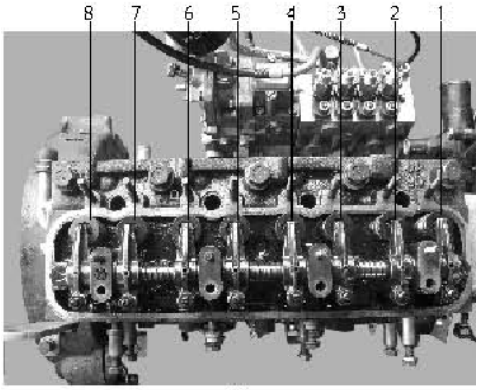
Tighten rocker locking nut, check valve clearances again.

Note: the numbers of rockers in Fig. A and B are from 1 through 8 in the order from front end to rear end.



Rotating crankshaft belt for 360°, align the needle with the scale mark “0” on belt pulley again. At this time, slide intake and exhaust valve rockers of the fourth cylinder, they should be loose. It indicates that diesel engine is at the top dead center of the fourth cylinder.

Adjust the clearances of valves 3, 6, 7 and 8.Tighten rocker locking nut. Check valve clearances again.



B

1.7.4 Cylinder head assembly, intake/exhaust valve and cylinder cover gasket

1. Description

·Cylinder head assembly is installed on the top of cylinder body. It is used to seal the upper plane of cylinder as well as forms combustion chamber together with cylinder and piston top. Cylinder head assembly together with cylinder head, valve tube, valve seat ring, oil injector copper sleeve and bowl-shaped stopper forms a relatively independent integer.

·Cylinder head has an integral structure and is shared by four cylinders. There are water cavity and lubricating oil channel in cylinder head.

·Intake/exhaust valves insulate combustion chamber from intake/exhaust channels. The open/close of intake/exhaust valves just in time ensure that the air intake is adequate, exhaust is thorough, and the diesel engine functions efficiently.

·Each cylinder has two valves, namely an intake valve and an exhaust valve. The diameter of intake valve is bigger.

·Cylinder head gasket, sealing part between cylinder head and cylinder body, is used to compensate the irregularity of matching face so as to guarantee the reliable sealing of oil, water and gas.

2. Change and repair

A. Disassemble:

Prior work:

Drain coolant;

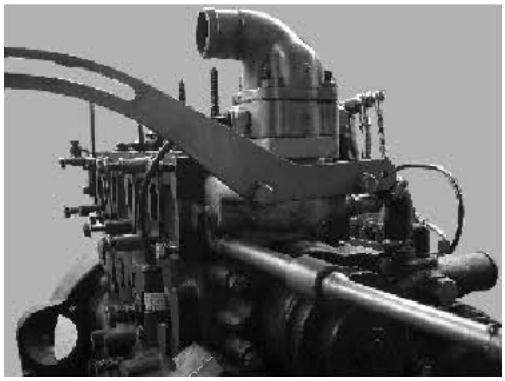
Disassemble crankshaft ventilator assembly;

Disassemble intake/exhaust pipes of supercharger compressor;

Disassemble supercharger;

Disassemble exhaust pipe;

Disassemble cylinder head cover;



Disassemble high pressure fuel pipe assembly and connectors of low pressure fuel pipes and cylinder head;

Disassemble fuel injector components;

Disassemble rocker mechanism components and push rod.

Tool: Wrench

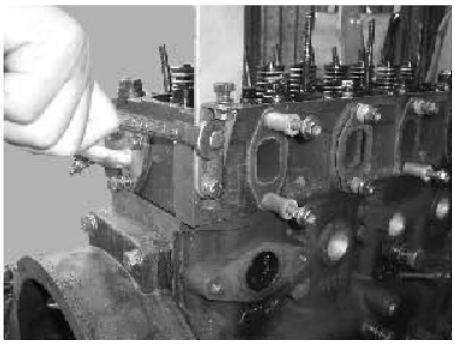
Disassemble the fastening bolt between thermostat component and cylinder head. Disassemble the hook between small circulation rubber hose and water pump. Take down thermostat component together with small circulation rubber hose.

Tool: Wrench

Disassemble the three fastening bolts fixing rear platen, take down rear platen and gasket.

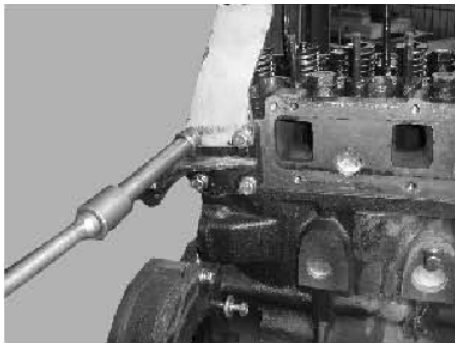
Tool: Wrench

Disassemble rear hook and the bracket fixed on it.



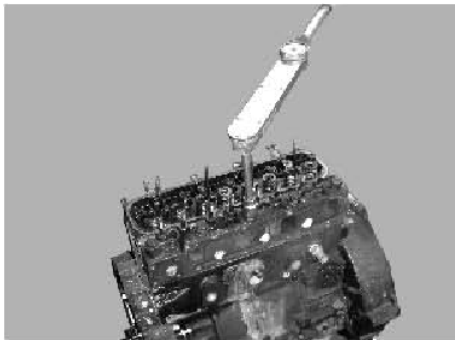
Tool: Socket wrench

Loosen bolts fixing front hook and power steering pump bracket; disassemble power steering pump bracket and front hook.

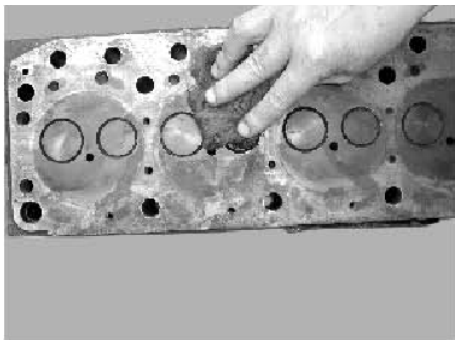


Tool: Wrench

Disassemble 10 bolt fixing cylinder head according to the sequence in Fig. 1-2 of Chapter 1. Disassemble the whole cylinder head.



Erect cylinder head and wipe away oil stains on lower surface.

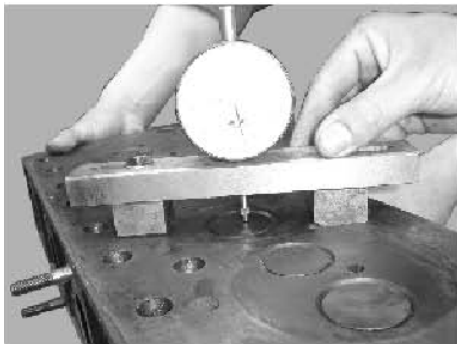


Gauge: depth indicator

Measure sink depth of intake/exhaust valves; check the wear condition of their heads.

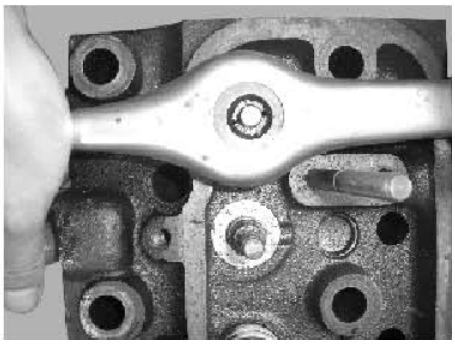
Drawing size: 0.7-0.9mm

Limit value: 1.50



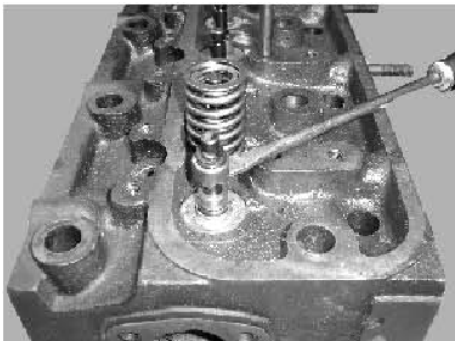
Tool: Special tool

With cylinder head facing downward, loosen valve mechanism component using special tool.

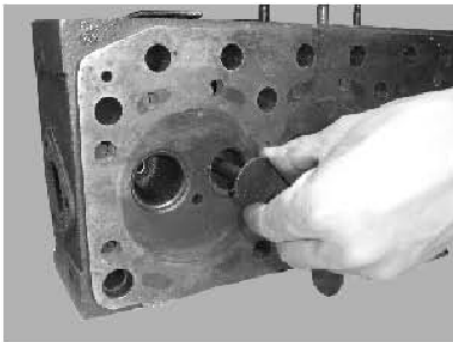


Take down valve spring upper seat, valve clip and valve spring.

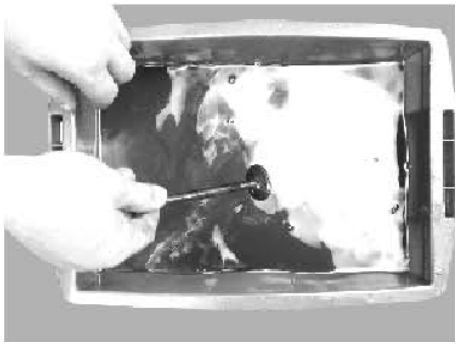
Take down valve rod sealing ring from valve tube; take out valve spring lower seat.



Take out intake/exhaust valves from cylinder bottom.



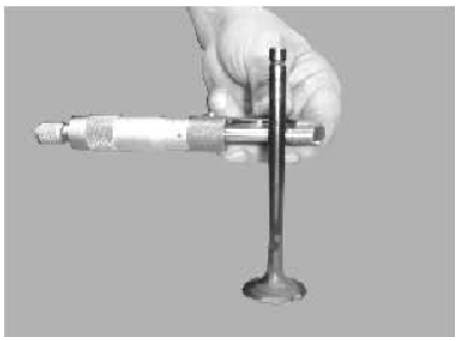
Wash intake/exhaust valves with gasoline or other cleaning agents and blow them out with compressed air.



Observe the burning erosion of the sealing surface of valve head.

Gauge: Spiral micrometer

Measure valve rod diameter and check its wear condition.



Drawing size: intake valve: $\Phi 8^{-0.025}_{-0.01}$

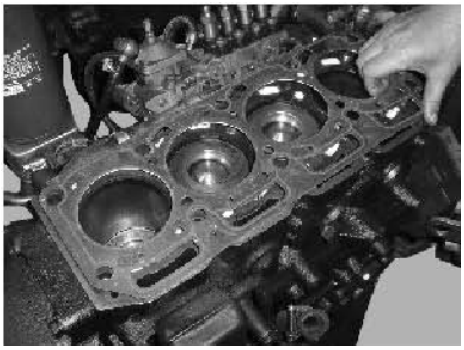
Exhaust valve: $\Phi 8^{-0.01}_{-0.055}$

The matching clearance between intake valve and valve tube is 0.025-0.062;

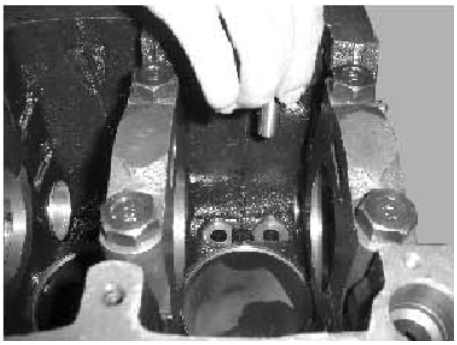
The matching clearance between exhaust valve and valve tube is 0.040-0.077; the wear limit is 0.150.

The measuring position and direction are shown in the figure.

Take down cylinder head gasket.



Take lifter from its hole.



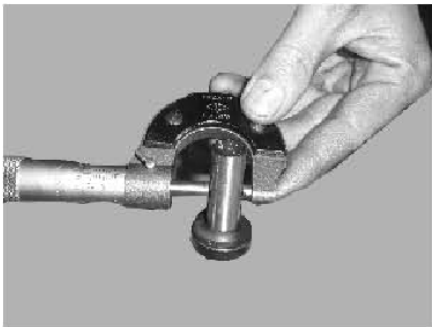
Wash lifter in gasoline and blow it out.

Observe the wear condition of lifter bottom.

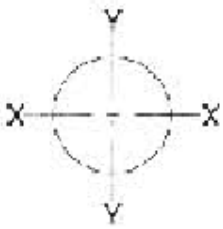
Gauge: Spiral micrometer

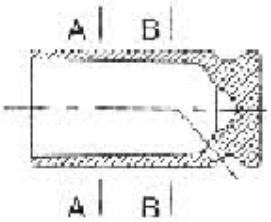
Measure the external diameter of lifter and check its wear condition.

Drawing size: $\Phi 13^{-0.016}_{-0.030}$. The matching clearance between lifter and cylinder body lifter hole is 0.016-0.052, the wear limit is 0.180.



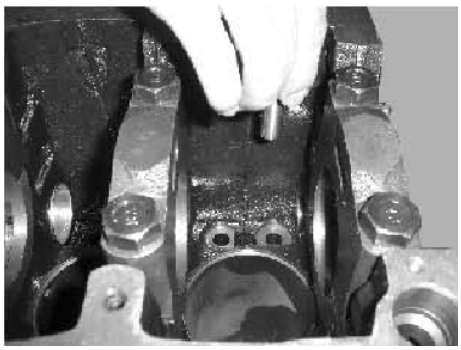
The measuring position and direction are shown in the figure.



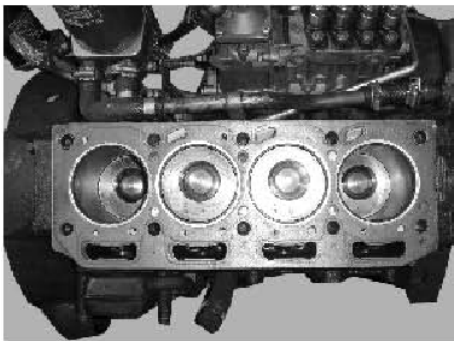


B. Installing:

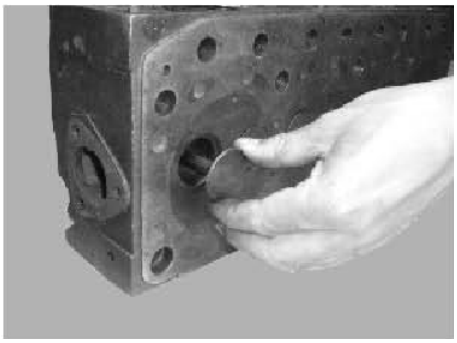
Insert lifter after immersed by oil into cylinder lifter hole. Lifter should rotate and move smoothly in cylinder body lifter hole.



Aligning two positioning pin holes of cylinder gasket with positioning pins on cylinder body, install cylinder body top.



Place cylinder head with intake side upward. Insert intake/exhaust valves into the relevant tube holes.

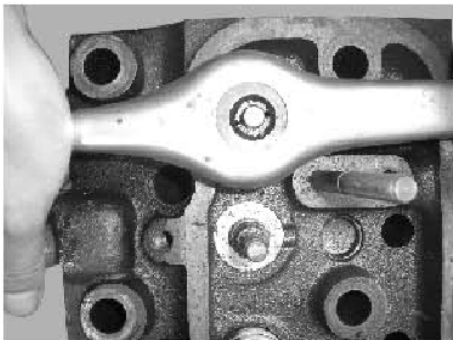


Place cylinder head with its bottom downward.

Install valve spring lower seat and valve tube sealing ring assembly successively into the relevant valve tubes. Place intake valve spring and exhaust valve spring around the relevant tubes.

Put on spring seat. Install clips with two as one group on intake/exhaust valves.

Press-fit spring seat and clips using special tool.



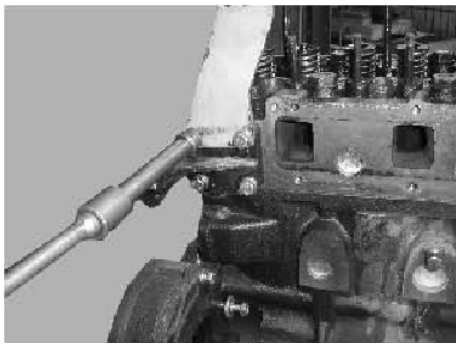
Install fuel injector component.

See the relevant contents in Chapter 3 Fuel Supply System.

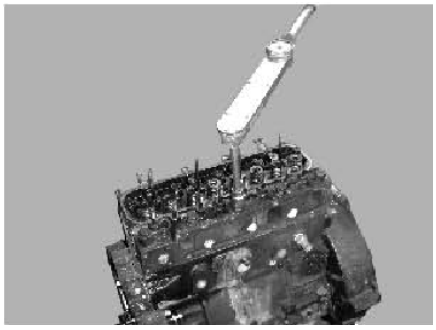
Tool: Wrench

Fix front lug and rear lug respectively on the relevant positions of front and rear ends of cylinder head using bolts.

Tightening torque: 39±7N.m.

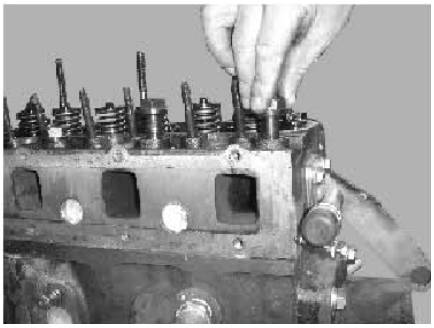


Aligning the above cylinder head components with plane locating pin, install cylinder body top.



Tool: Wrench

Install cylinder head bolt and screw in 2-3 turns. Apply lubricating oil on thread end. Apply MoS2 or lubricating oil on bearing surfaces of bolt and flange.

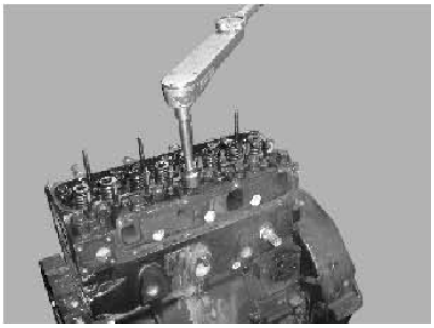


Tighten cylinder head bolt by the method of graded tightening.

Pre-tightening torque: 75N.m.

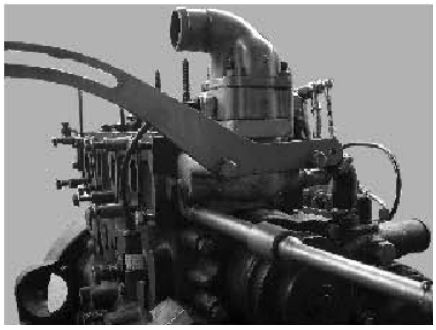
Tighten three times to complete the process.

See Fig. 1-2 in Chapter 1 for tightening sequence of cylinder head bolts.



Tool: Wrench

Fix thermostat component on cylinder head using bolts. At the same time, tighten small circulation water pipe on the relevant position using clamp.



Follow-up work:

Install push rod and rocker mechanism components;

Tighten low pressure fuel pipe connector assemblies;

Install cylinder head cover;

Install high pressure fuel pipe;

Install exhaust pipe;

Install supercharger;

Install intake/exhaust pipes of supercharger compressor;

Install crankshaft ventilator components;

Fill coolant.

1.7.5 Flywheel assembly and rear oil seal

1. Description

·the major function of flywheel is to store the energy of power stroke, overcome the resistance of auxiliary stroke and keep crankshaft rotate evenly so as to ensure the stable operation of diesel engine.

·Flywheel bolt fixes both flywheel and crankshaft timing gear on the rear end of crankshaft.

·Rear seal plays a role of sealing lubricating oil preventing its leakage.

·External round and internal hole of rear oil seal match with flywheel casing internal hole and external round of the rear end of crankshaft.

Prior work:

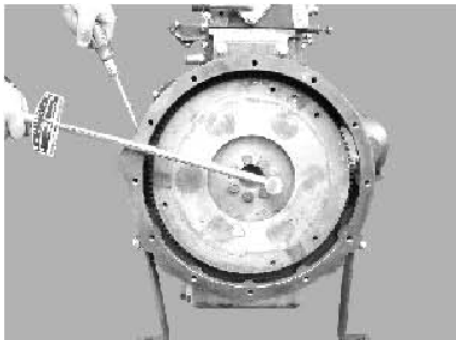
Disassemble flywheel casing needle.

2. Change and repair

A. Disassemble:

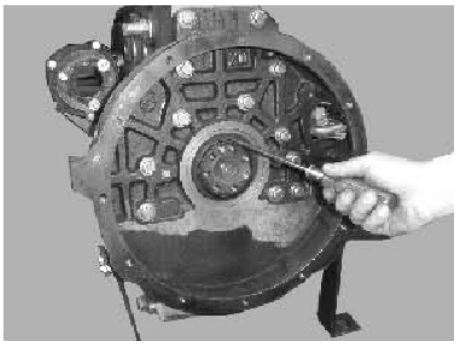
Tool: Wrench

Loosen the fastening bolt between flywheel and crankshaft, disassemble flywheel assembly.



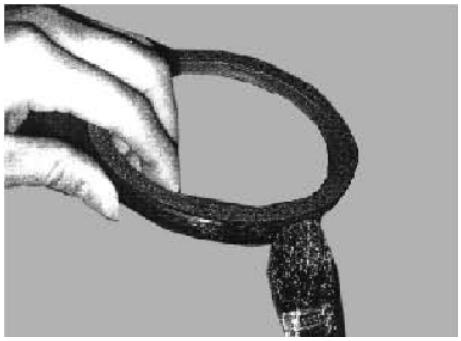
Tool: screwdriver

Disassemble rear oil seal of crankshaft.



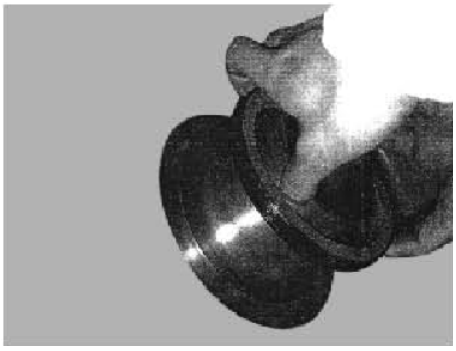
B. Installing:

Apply Vaseline to the outer edge of rear oil seal.

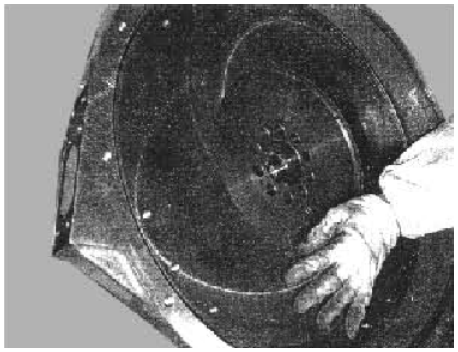


Tool: Guide sleeve

Sleeve rear oil seal onto flywheel casing using guide sleeve. Sleeve lip on timing gear on the rear end of crankshaft.



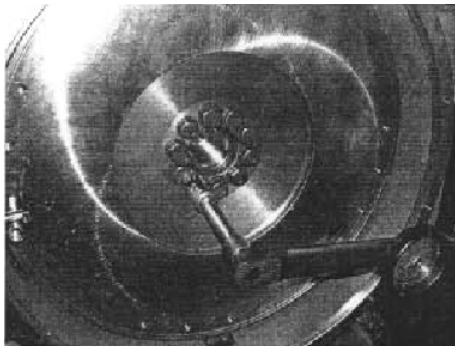
Align flywheel with locating pin on crankshaft rear end.



Tool: Wrench

Fix flywheel on crankshaft with bolt.

Tightening torque: 60N.m.



1.7.6 Steering pump

1. Description

·Steering pump is used in mobile steering system and it can produce high pressure oil and send it to all parts of hydraulic system.

Prior work:

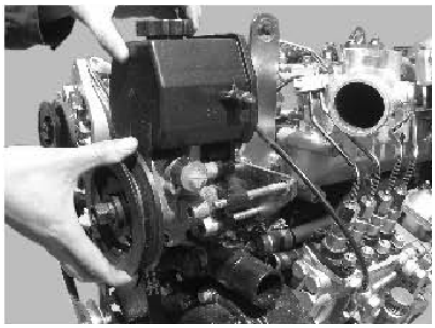
Disassemble generator belt.

2. Change and repair

A. Disassemble:

Tool: Wrench

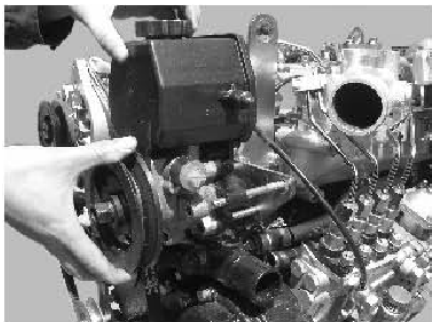
Disassemble installing bolt of steering pump from steering pump bracket. Take down steering pump.



B. Installing:

Tool: Wrench

Fix steering pump on its bracket with bolt and tighten bolt.

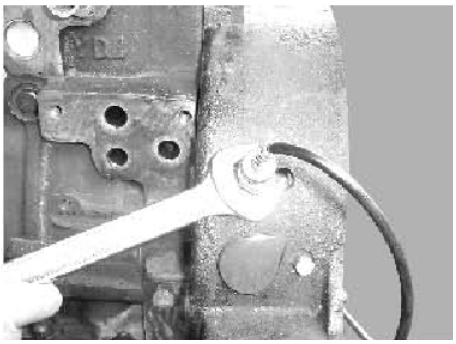


Follow-up work:
Install generator belt.

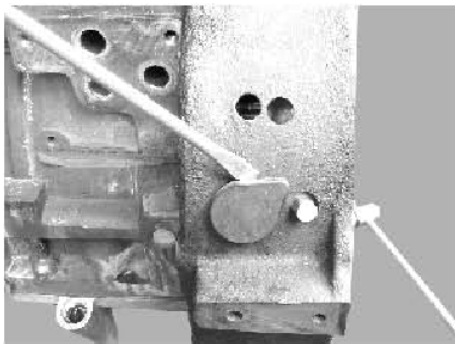
1.7.7 Flywheel casing

1. Description
There are starting motor, needle and observing hole cover, etc installed on flywheel casing.

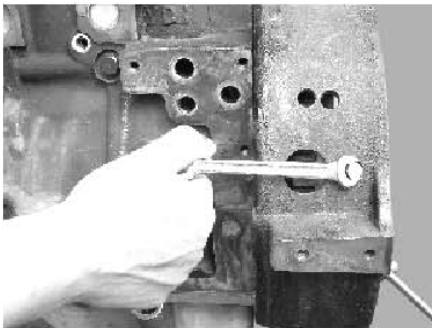
2. Change and repair
A. Disassemble:
Prior work:
Tool: Wrench
Disassemble speed sensor;
Disassemble starting motor;
Disassemble clutch casing mounting plate;
Disassemble clutch casing.



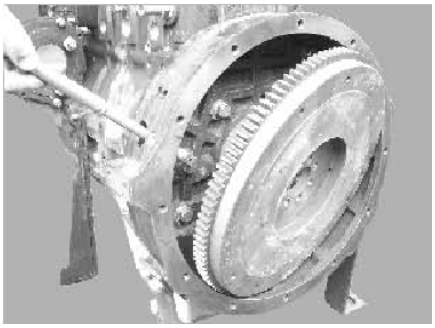
Disassemble observing hole cover.



Tool: Wrench
Disassemble flywheel casing needle.

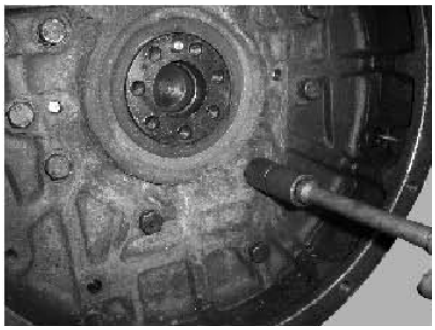


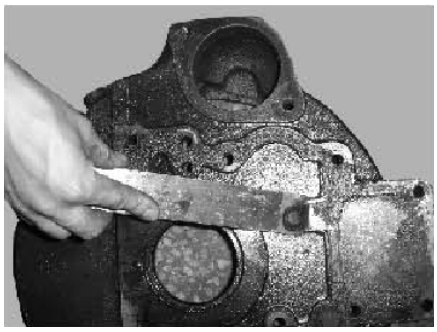
Tool: Wrench
Screwdriver. Disassemble flywheel.



Tool: Wrench 16mm

Disassemble flywheel casing.





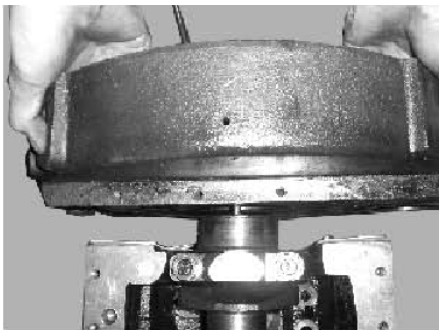
Tool: blade

Remove paper pad on the mating surfaces of flywheel and cylinder.

B. Installing:

Tool: Socket wrench 16mm

Apply glue on two side of flywheel casing gasket and install it on cylinder body. Then fix flywheel casing on cylinder body.



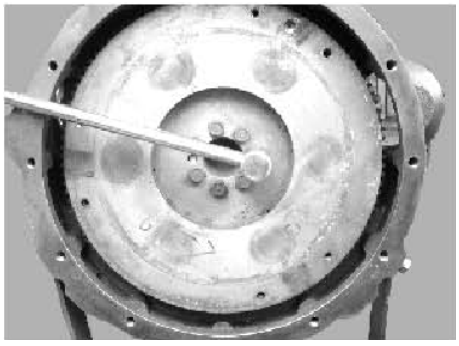
Caution: ensure that the glue line is continuous.

Tool: Wrench 13mm

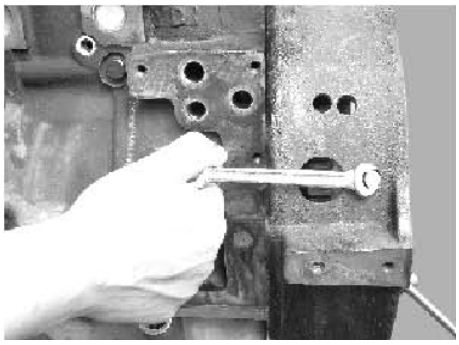
Connect flywheel casing and oil pan with bolt and tighten it.

Tool:

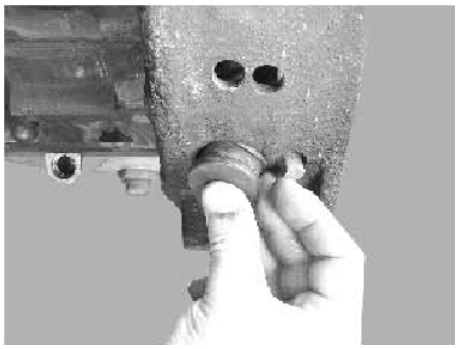
Socket wrench, screwdriver assemble flywheel.



Tool: Wrench 10mm
Install needle on flywheel casing.



Tool: Wrench 18mm
Put observing hole cover on flywheel casing.



Follow-up work:
Install starting motor;
Install clutch pressure plate;
Install clutch casing;
Install clutch cylinder;
Install speed sensor.

1.7.8 Air-conditioning compressor

1. Description

·Air-conditioning compressor is used as mobile air-conditioner compressor to regulate cab temperature. Normally it performs refrigeration.

2. Change and repair

A. Disassemble:

Prior-work: disassemble generator belt (air-conditioning compressor driving belt).

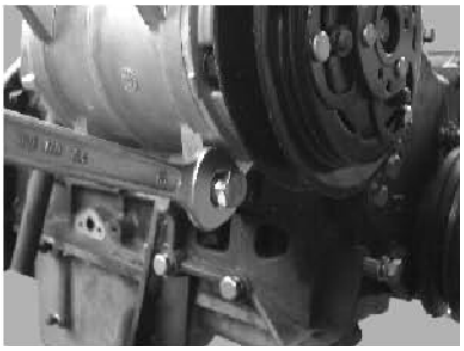
Tool: Wrench 17mm

Loosen four bolts between air-conditioning compressor bracket and air-conditioning compressor. Disassemble air-conditioning compressor.

B. Installing:

Tool: Wrench 16mm

Fix air-conditioning compressor on its bracket with four bolts.



Follow-up work:

Install generator belt (air-conditioning compressor driving belt).

1.7.9 Damper

1. Description

·The function of damper is to consume the energy produced by crankshaft torsional vibration by friction inside damper, the friction resistance attenuates the amplitude of torsional vibration, namely, there would not be large amplitude to be produced even under strong resonance.

·Damper pulley is fixed by bolt, forming pulley damper assembly which is fixed on the front end of crankshaft by bolt.

2. Change and repair

A. Disassemble:

Prior-work: disassemble generator belt and water pump belt.

Tool: Wrench 27mm

Loosen damper bolt and disassemble pulley damper assembly.

B. Installing:

Tool: Wrench 27mm

Install crankshaft damper pulley on crankshaft.

Follow-up work:

Install fan belt and generator belt.

1.7.10 Front oil seal

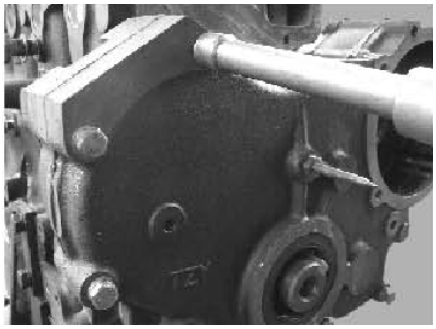
1. Description

Front oil seal is used to seal lubricating oil preventing it from leaking from around main journal of crankshaft.

Replace and Repair:

A. Disassemble:

Prior work: disassemble damper.



Tool: Wrench 13mm

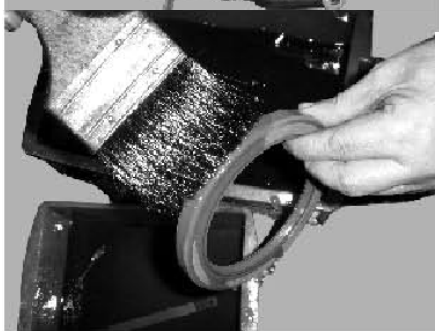
Loosen fastening bolt on gear chamber cover.

Tool: screwdriver

Disassemble front oil seal.

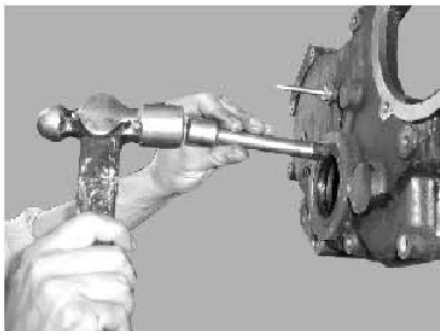
B. Installing:

Apply Vaseline on the outer edge of front oil seal.

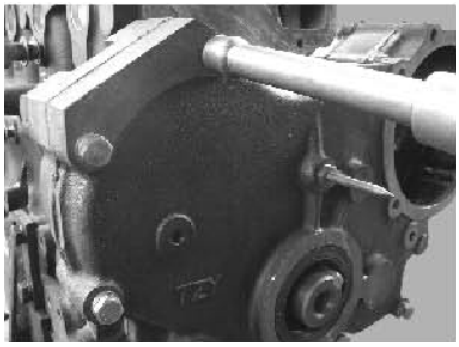


Tool: Special tool

Press-fit front oil seal in gear chamber cover.



Fasten gear chamber cover on gear chamber using bolt.



Follow-up work:

Install damper;

Install other disassembled parts/components.

1.7.11 Camshaft, timing gears and their shafts

1. Description

·Camshaft is used to control the open and close time of intake/exhaust valves.

·there are cams for intake/exhaust valves installed on camshaft during whose rotation rams push lifters and transmit power.

·The time gears mentioned in this section are timing idler and camshaft timing gear.

·Gears are used to transmit power and movement.

·Timing idler transmits the power transmitted by crankshaft timing gear to inject pump timing gear and camshaft gear which drive camshaft to rotate.

·There are marks on gears engaging with each other to ensure correct transmission relationship.

·Timing idler shaft is used to support idler. In the middle of the shaft are oil channel, and, at its peripheral are oil holes from which lubricating oil flows out and lubricates shaft and gear holes.

2. Change and repair

A. Disassemble:

Prior work:

Disassemble cylinder head cover;

Disassemble rocker shaft assembly;

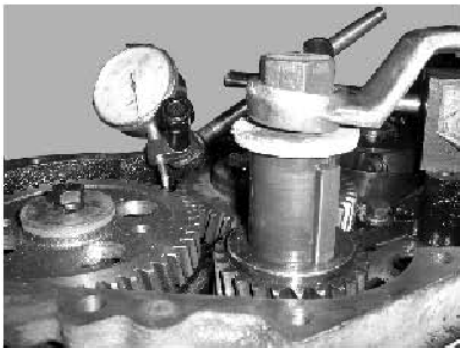
Install gear chamber cover.

Gauge: dial indicator

Measure the side clearance between camshaft timing gear and timing idler. Check the wear condition of gear face.

Specified value: 0.08-0.19

Limit value: 0.0400

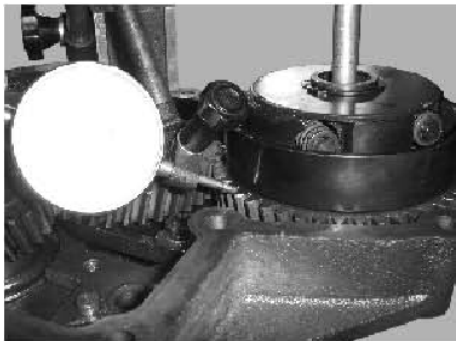


Gauge: dial indicator

Measure the side clearance between inject pump timing gear and timing idler. Check the wear condition of gear face.

Specified value: 0.08-0.19

Limit value: 0.0400



Gauge: dial indicator

Measure the axial clearance between timing idler and idler shaft. Check the wear condition.

Specified value: 0.065-0.15

Limit value: 0.200

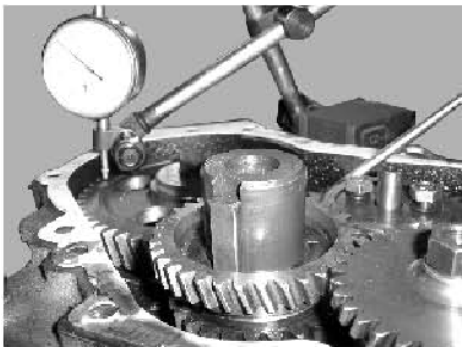
Gauge: dial indicator, 21mm wrench

Measure the axial clearance between camshaft thrust plane and thrust washer. Check the wear condition.

Specified value: 0.08-0.22

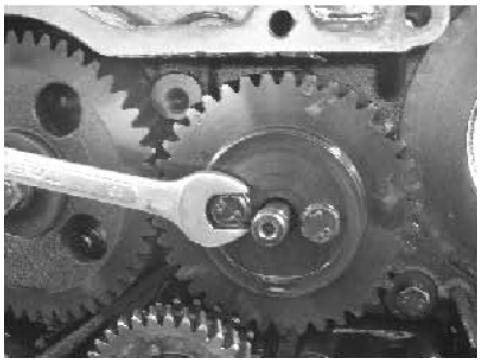
Limit value: 0.500

Loosen fastening bolt of camshaft gear.



Tool: 13mm hex allen wrench

Loosen the fastening bolt of idler platen, disassemble idler and its shaft.



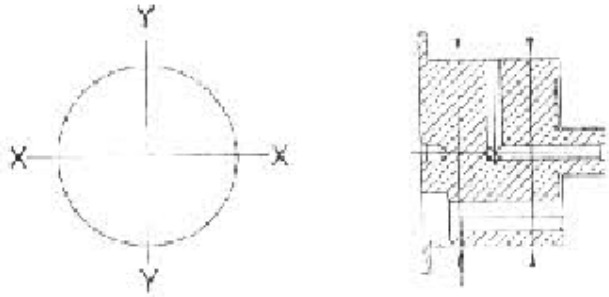
Wash timing idler shaft in gasoline.

Gauge: Spiral micrometer

Measure the external diameter of timing idler shaft and check its wear condition.

Drawing size: $\Phi 45^{-0.025}_{-0.05}$

The measuring position and direction are shown in the right figure.



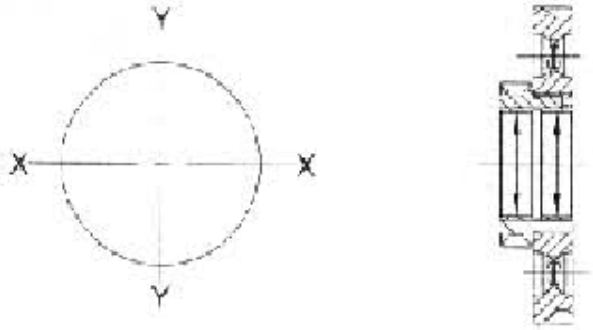
Gauge: dial indicator

Measure the hole diameter of timing idler assemble and check its wear condition.

Drawing size: $\Phi 48^{-0.01}_{-0.015}$

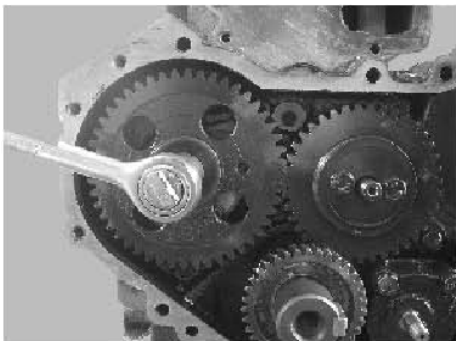
The fit clearance between timing medium idler bush hole and gear shaft should be 0.04-0.09, the limit value is 0.200.

The measuring position and direction are shown in the right figure.



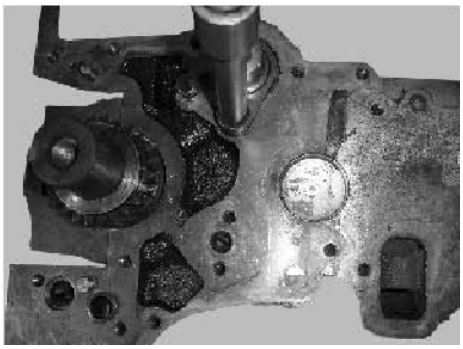
Tool: Wrench 21mm

Disassemble fastening bolt of camshaft timing gear. Disassemble camshaft gear.

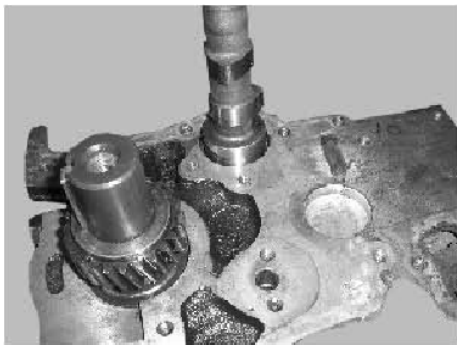


Tool: Wrench 10mm

Loosen two hexagon flange bolts of camshaft thrust washer and cylinder body, disassemble thrust washer.

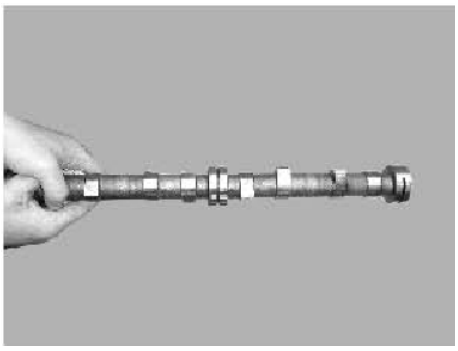


Disassemble camshaft.



Wash camshaft in gasoline or other cleaning agent and blow it out.

Check whether there are any abnormal damages on all position of camshaft.



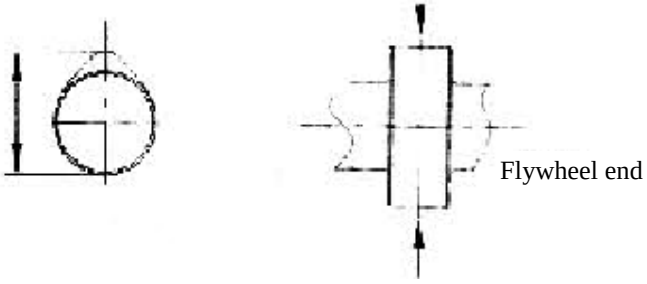
Gauge: Spiral micrometer

Measure diameters of camshaft journals to determine their wearing condition.

Drawing size: $\Phi 44^{-0.05}_{-0.06}$

The fit clearance between camshaft journal and camshaft bushing should be 0.05-0.126 and the limit one should be 0.160.

The measuring position and direction are shown in the right figure.



Gauge: Spiral micrometer

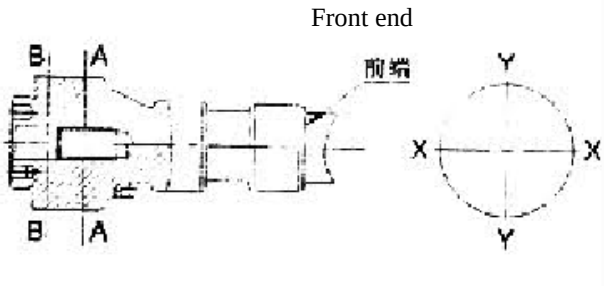
Measure the clearance between cam top of camshaft and cylindrical bottom to determine wear condition of cam.

Drawing size:

Intake cam: 36.62±0.05

Exhaust cam: 36.8±0.05

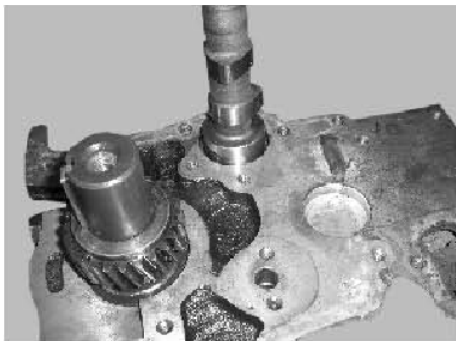
The measuring position and direction are shown in the right figure.



B. Installing:

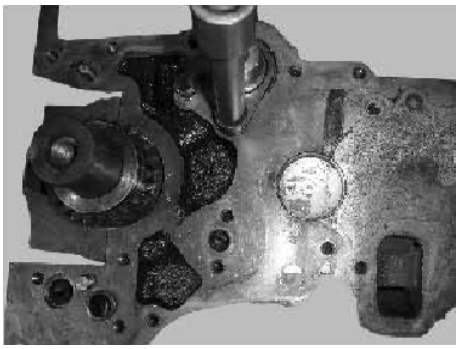
Tool: copper hammer

Applying lubricating oil on camshaft journal, put camshaft into camshaft hole in cylinder body.



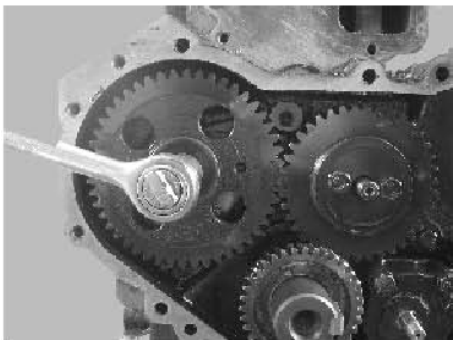
Tool: Wrench 10mm

Install thrust washer. Fasten it with two hexagon flange bolts. The face with slot should be outward.



Tools: Wrench 21mm, screwdriver

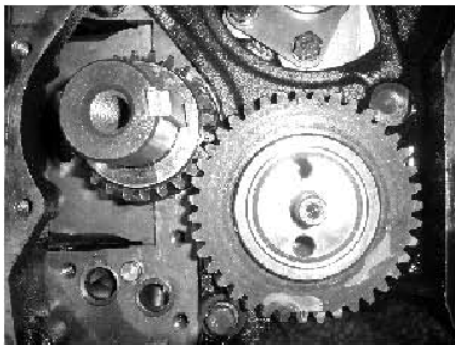
Fix camshaft timing gear on camshaft using special bolt; apply MoS2 or lubricating oil on matching surfaces of bolts and gear.



Tool: Wrench 13mm

Align the above components with locating hole in cylinder body and install them. At the same time engage timing idler with both camshaft timing gear and timing medium gear according their marks and then tighten hexagon bolt.

Check the axial clearance should be 0.065-0.15.



Tools: Wrench 21mm, dial indicator

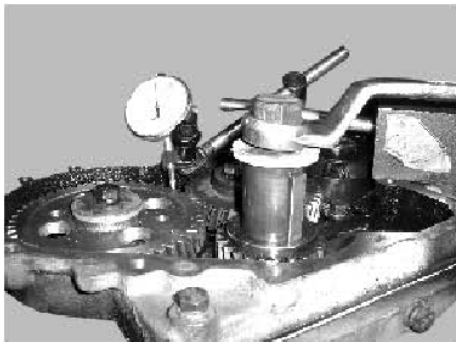
Tighten camshaft timing gear fixing bolt.

Tightening torque: 60±2N.m;

Rotate another 120°;

Check the axial clearance of camshaft should be 0.08-0.22.

Check side gear clearance.



The clearance between camshaft and timing idler should be 0.080-0.190; the clearance between timing inject pump gear and timing medium gear should be 0.080-0.190.

Follow-up work:

Install gear chamber platen;

Install rocker shaft assembly;

Install cylinder head cover;

Install other disassembled parts/components.

1.7.12 Piston connecting rod component

1. Description

·Piston connecting rod component is used to transform the reciprocating movement in cylinder into the rotating of crankshaft.

·Piston connecting rod component is composed of piston, piston ring, piston pin, connecting rod, rod bearing, etc.

·The function of piston is to bear the pressure of gas in cylinder and transmit it to connecting rod; the top of piston together with cylinder head forms combustion chamber.

·There are three piston rings. The first and the second are gas rings. The first gas ring is half keystone ring. The second one is negative torsion ring. The third one is spiral hold spring oil ring.

·The main function of gas ring is to ensure the sealing between piston and cylinder wall and prevent the high pressure gas at the upper of cylinder from going into crankshaft case; the function of oil ring is to scrape down the redundant lubricating oil on cylinder wall and make it return crankshaft case thus reducing the oil consumption.

·The function of piston pin is to connect piston and minor end of connecting rod and transmit the force acted on piston to connecting rod.

·The function of connecting rod is to transmit the force acted on piston to crankshaft making it rotate.

·The connecting rod bearing is inlaid in big end hole of connecting rod and used to bear connecting rod journal.

·In this section, the disassembly and installing of piston connecting rod component and its parts are demonstrated.

2. Change and repair

A. Disassemble:

Prior work:

Disassemble cylinder head cover;

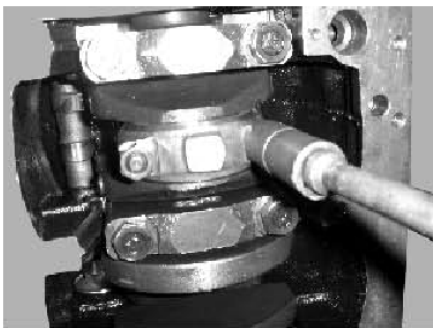
Disassemble oil pan;

Disassemble oil collector and filter assembly;

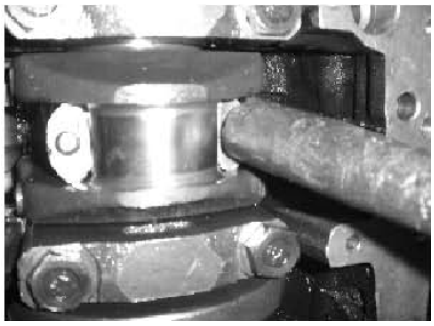
Disassemble injector component.

Tool: Wrench 21mm

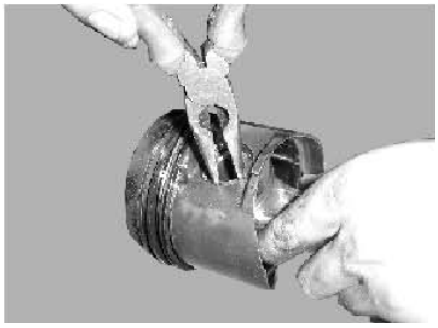
Loosen connecting rod nut and disassemble connecting rod cover.



Tool: plastic hammer (or nylon rod)
Push piston and connecting rod out of cylinder.



Tool: internal spring pliers
Take out retaining rings on two ends of piston pin.

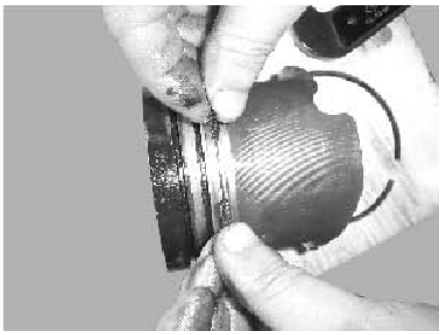


Tool: Disassemble piston pin and take out connecting rod body.

Disassemble shaft bearing inside connecting rod body and connecting rod cover.

.

Take the first and the second gas ring and oil ring out of piston ring slot.



B. Washing

Wash using gasoline or other cleaning agents. After washing, blow out with compressed air or swap out with dry cloth.

Washing of piston: prior washing, piston may be immersed in cleaning agent for a longer time in order to loosen the coke on it.

Wash piston ring.

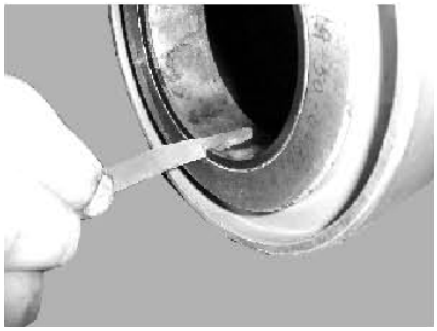
Wash piston pin.

Wash connecting rod body and connecting rod cover.

Wash connecting rod bearing.

C. measurement

Prior to measurement, reinstall the relevant parts/components. The objective of measurement is to determine wear condition of parts and decide whether they are needed to replace.



Gauge: Plug meter, special ring gauge

Measure closed clearance of piston ring.

Drawing size:

First ring: 0.25-0.45;

Second ring: 0.40-0.60;

Third ring: 0.20-0.40

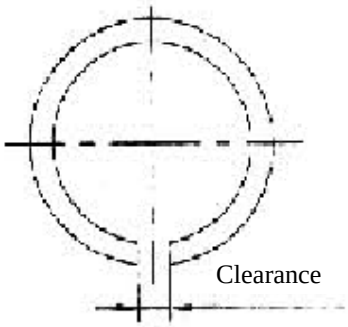
Limit value:

First ring: 1.50

Second ring: 2.00

Third ring: 1.50.

The measuring portion is shown in the figure on the right side;



Gauge: Plug meter

Measure clearance between piston ring and piston ring slot plane.

Drawing size:

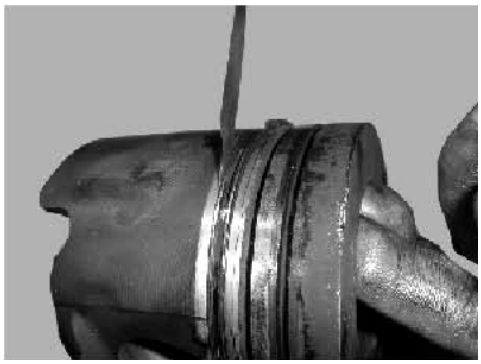
Second ring: 0.04-0.075;

Third ring: 0.03-0.070;

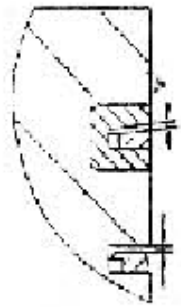
Limit value:

Second ring: 0.22;

Third ring: 0.15.



The measuring portion is shown in the figure on the right side;

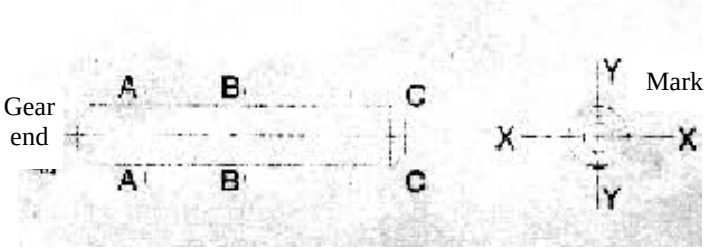


Gauge: Spiral micrometer

Measure piston pin diameter.

Drawing size: $\Phi 28^{0}_{-0.008}$

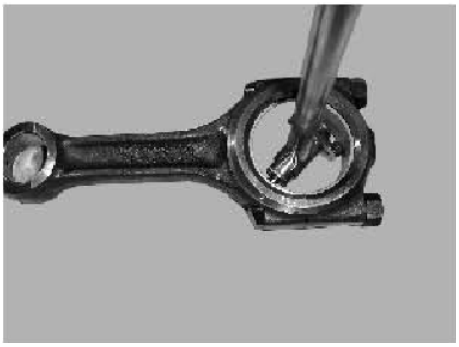
The measuring position and direction are shown in the right figure.



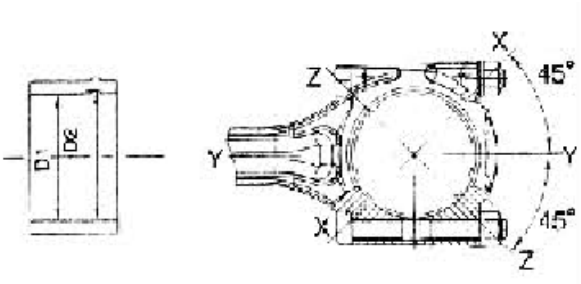
Gauge: dial indicator

Measure connecting rod bigger end diameter (after pressed into shaft bearing).

Drawing size: $\Phi 52^{-0.036}_{-0.04}$



The measuring position and direction are shown in the right figure.



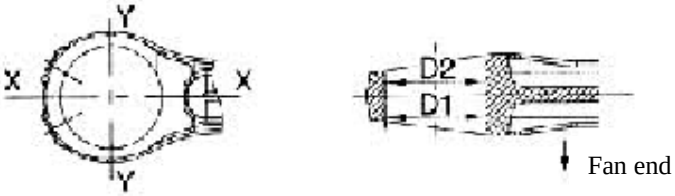
Gauge: dial indicator

Measure connecting rod smaller end diameter (after pressed into shaft bearing).

Drawing size: $\Phi 28^{-0.008}_{-0.025}$

The fit clearance between connecting rod smaller end and piston pin should be 0.025-0.044; the wear limit is 0.100.

The measuring position and direction are shown in the right figure.

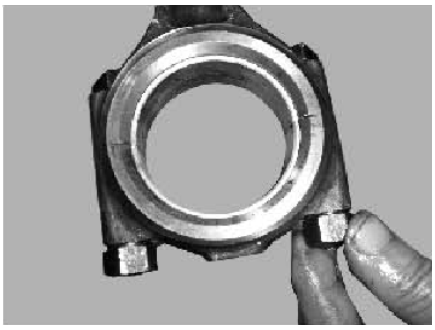


D. Installing:

Install connecting rod shaft bearing into connecting rod body and connecting rod cover.

Caution: align the rabbet on shaft bearing with the slot on connecting rod bigger end.

Close connecting rod cover, install bolt and screw in nut. Ensure that the matching marks on connecting rod body and connecting rod cover on the same side.

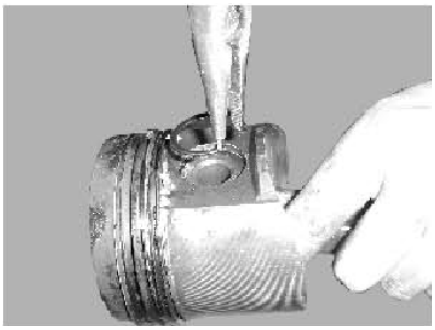


Apply lubricating oil on piston pin and align it with piston pin hole and push it into the hole.

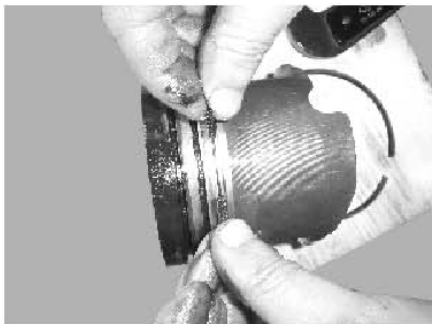
Caution: do not knock on piston pin with hammer.

Tool: internal spring pliers

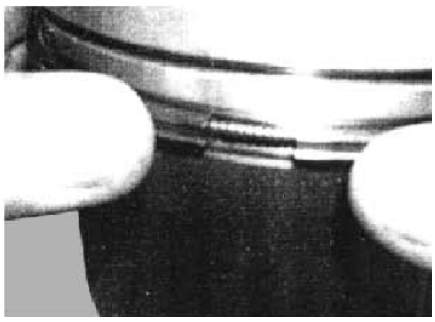
Inlay retaining rings at the two ends of piston pins.



Sleeve oil ring lock spring into oil ring slot of piston. Lock it with steel locking wire.



Make the oil ring open and sleeve it on lock spring, turn oil ring gap to the position of 180° related to lock spring closed gap.

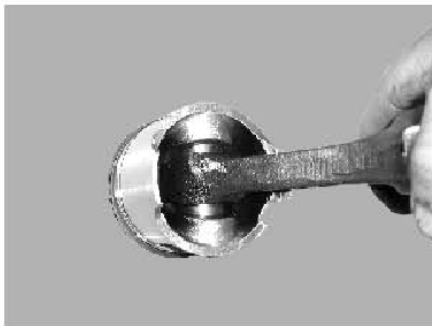


Install the first and the second gas rings.

Caution: ensure that the cone of the first gas ring faces upwards and, for the second gas ring, the side with TOP mark faces upwards.

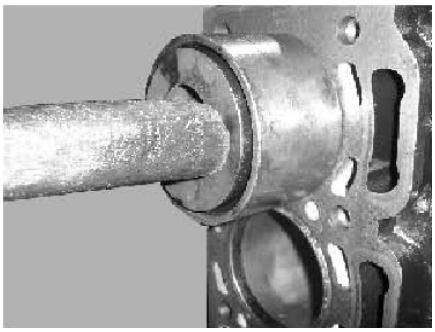
All the rings should be able to rotate smoothly in ring slots.

Ensure that there should be 120°between the open gaps of three piston rings with each other.



Check that the piston pin should rotate smoothly in small end bushing of connecting rod. Furthermore, after piston rod is assembled, when connecting rod swing right and left, its small end should not collide with piston top and combustion chamber bottom.

Fill connecting rod bearing and cylinder bushing hole with clean oil.



Tool: Guide sleeve

Install piston connecting rod component into cylinder bushing hole.

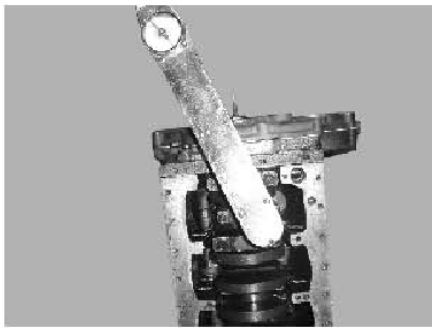
Caution: ensure that the slot of piston skirt faces with the side with nozzle installed on cylinder body.

Tool: Wrench 21mm

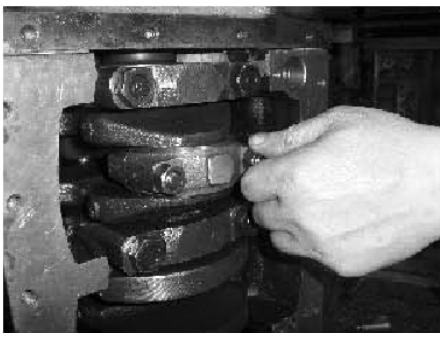
Close connecting rod body using connecting rod cover. After applying the bearing surface of connecting rod bolt and the mating surface of connecting rod cover with MoS2 or diesel engine oil, screw in connecting rod bolt.

Caution: the matching marks on connecting rod cover and body should be on the same side.

Tighten connecting rod nut, pre-tighten to the torque of 70-80N.m by torque method.



Feel with hands that there should be axial clearance between big end of connecting rod and connecting rod journal.



Follow-up work:

Install oil collector and filter assembly;

Install oil pan;

Install cylinder head;

Install other disassembled parts/components.

1.7.13 Crankshaft, main shaft bearing, thrust washer, piston cooling nozzle

1 Description

·Crankshaft is used to transfer the gas force delivered by piston and connecting rod into torque so as to drive the power units connecting with it.

·Crankshaft is made of ductile iron and its journal and fillet are reinforced. All the main journals of crankshaft and connecting rod journal are equipped with oil hole to supply lubricating oil so as to lubricate journals and the relevant bearing. There is a balance block on crank.

·Main bearing is used to support main journal of crankshaft.

·Main bearing is divided into upper one and lower one. The upper main bearing has oil holes and is inlaid into main bearing hole of cylinder body. Around the middle of its internal circumference is oil slot. The lower main bearing without holes and with short oil slot is inlaid into main bearing cover.

·Thrust washer is used to bear the axial thrust of crankshaft.

·The side of thrust washer with oil slot faces with the outside of bearing cover and contacts with crankshaft thrust plane.

·Piston cooling nozzle is used to inject a part of lubricating oil in oil channel of cylinder body into piston and make it cooled so as to reduce the heat load of piston.

2. Change and repair

A. Disassemble:

Prior work:

Disassemble cylinder head cover;

Disassemble oil pan;

Disassemble oil collector assembly;

Disassemble gear chamber cover;

Disassemble damper;

Disassemble gear chamber assembly.

Gauge: dial indicator

Measure the side clearance between crankshaft timing gear and timing medium idler. Check the wear condition of gear.

Specified value: 0.1~0.16;

Limit value: 0.400.

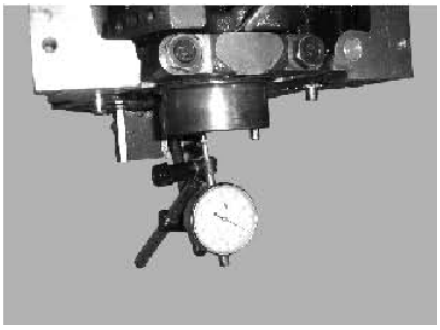
Disassemble timing medium idle gear.

Gauge: dial indicator

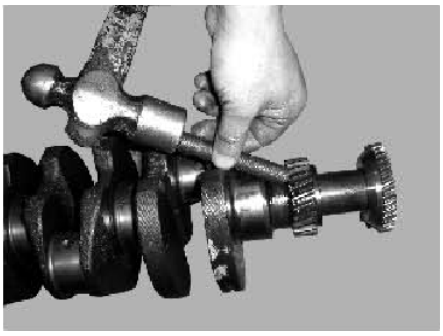
Measure the axial clearance between thrust plane of crankshaft main journal and thrust washer. Check the wear condition.

Specified value: 0.1~0.25;

Limit value: 0.400.



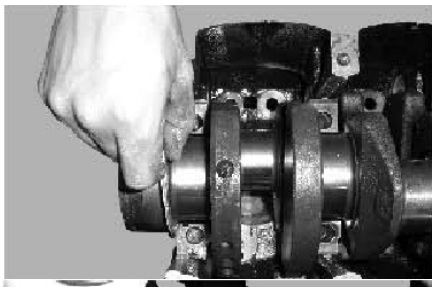
Disassemble crankshaft timing gear.



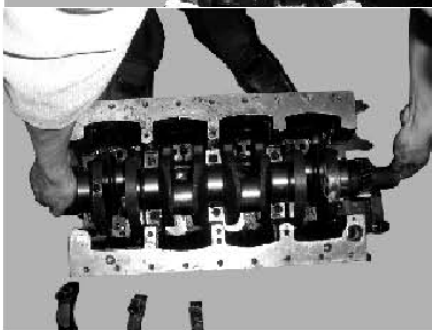
Tool: Wrench 21mm

Loosen fastening bolts on main bearing cover and at the bottom of cylinder body. Disassemble main bearing cover.

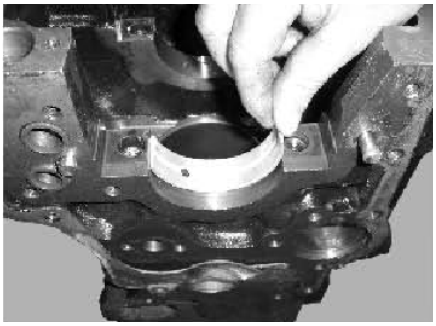
Take out 4 thrust washers at the rear end of crankshaft.



Disassemble crankshaft.



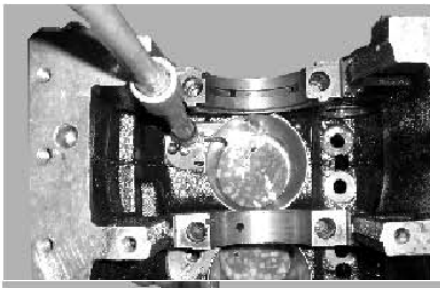
Disassemble main bearing inside main bearing seat of cylinder body.



Disassemble main bearing inside main bearing cover.

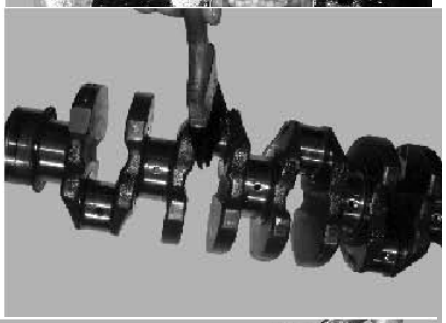
Tool: Wrench 16mm

Loosen connector bolts of piston cooling nozzle and disassemble piston cooling nozzle.



B. Washing

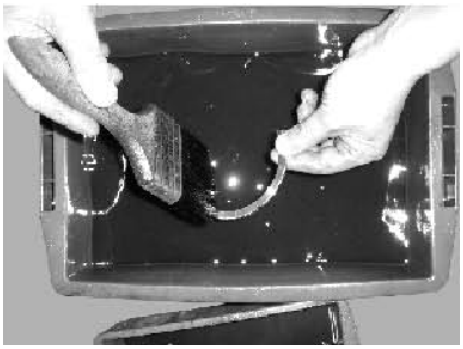
Wash crankshaft in cleaning agent. Brush oil channel and external surface of crankshaft.



Blow out the oil channel and external surface with compressed air. The oil channel should be and without scrap iron and other foreign matters.

Wash main bearing with gasoline or other cleaning agent. Rub up with dry cloth after washing.

Wash crankshaft thrust washer with gasoline or other cleaning agent and then rub up with dry cloth.



C. measurement

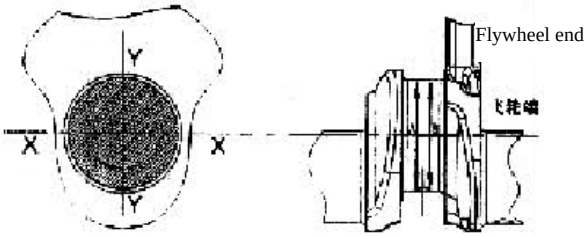
Before the measurement of main bearing hole, reinstall the relevant parts. The purpose of measurement it to examine the wear condition of parts so as so determine whether the relevant parts need replacing.

Gauge: Spiral micrometer

Measure the main journal of crankshaft.

Drawing size: $\Phi 65^{0}_{-0.079}$.

The measuring position and direction are shown in the right figure.



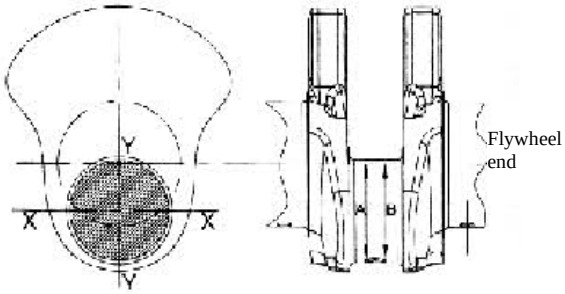
Gauge: Spiral micrometer

Measure the journal of crankshaft connecting rod.

Drawing size: $\Phi 52^{0}_{-0.079}$

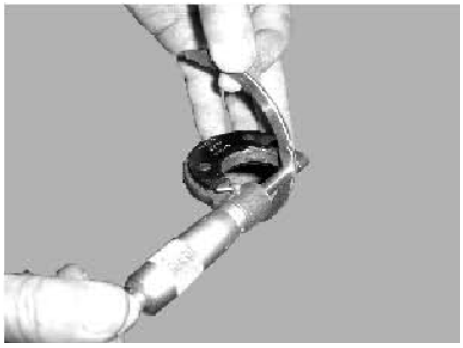
The fit clearance between crankshaft connecting rod journal and connecting rod big end should be 0.04-0.105; the wear limit is 0.250.

The measuring position and direction are shown in the right figure.



Gauge: Spiral micrometer. Measure the thickness of thrust washer.

Drawing size: $3^{-0.025}_{-0.05}$



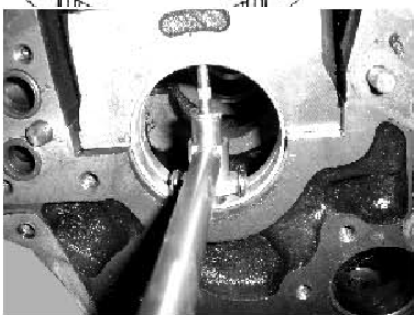
The measuring portion is shown in the figure on the right side;

Gauge: dial indicator

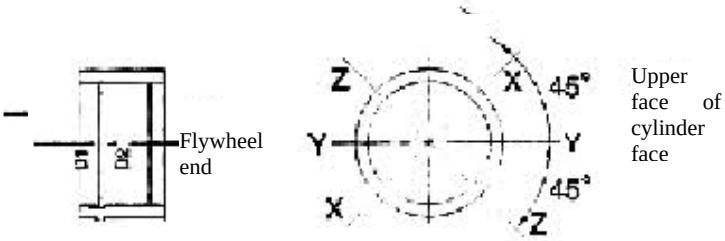
Measure the diameter of main bearing hole.

Drawing size: $\Phi 65^{-0.113}_{-0.174}$

The fit clearance between main journal of crankshaft and main bearing hole should be 0.074-0.132; the wear limit should be 0.25.



The measuring position and direction are shown in the right figure.



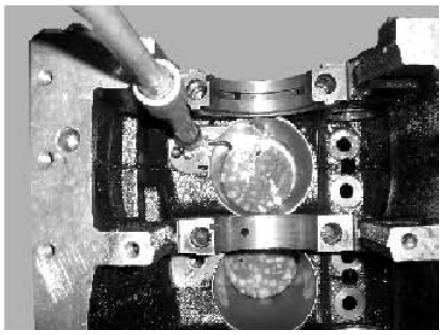
C. Installing:

Tool: Wrench 16mm

Aligning cooling nozzle with pin hole in cylinder body, install the cooling nozzle and fix it by tightening connector bolt.

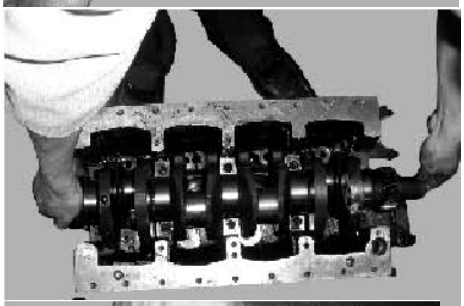
Tightening torque: 35-40N.m

If necessary, check whether the pressure of nozzle and the injected oil meet the requirements.



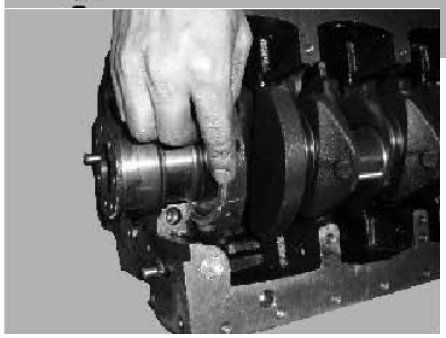
Inlay the upper and the lower main bearing respectively into cylinder body seat and main bearing cover.

Put oil pump driving gear into electrical blast heating box and heat it to 190-250 .



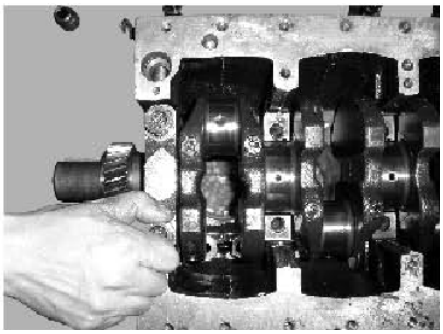
Apply the main shaft bearing with clean oil and place crankshaft on bearing seat of cylinder body.

Inlay thrust washer into the two sides of the fifth stop main bearing cover and the relevant cylinder body bearing with the slotted side facing outside and connecting with crankshaft.



Sequentially close bearing seat with main bearing cover, place main shaft bolt and loose it for 1-2 turns.

Apply MoS_2 or diesel engine oil to bolt jointing end and oil to bolt thread.



Tool: Wrench 21mm

Tighten main bearing bolt according to Fig. 1-1 in Chapter 1.

Tightening torque: 140-160N.m.

Check the axial clearance of crankshaft should be 0.10-0.25.

1.7.14 Cylinder sleeve

1 Description

·Cylinder sleeve is a guide part for reciprocating movement of piston and connecting rod.

·Cylinder is of a dry type.

2. Change and repair

A. Disassemble:

Prior work:

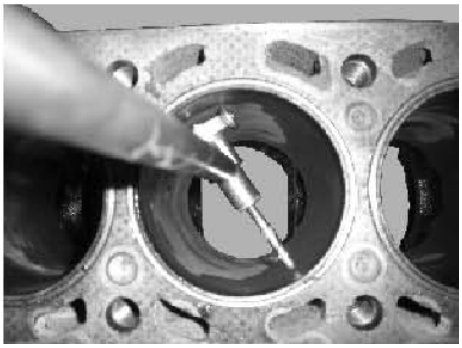
Disassemble cylinder head;

Disassemble piston and connecting rod component

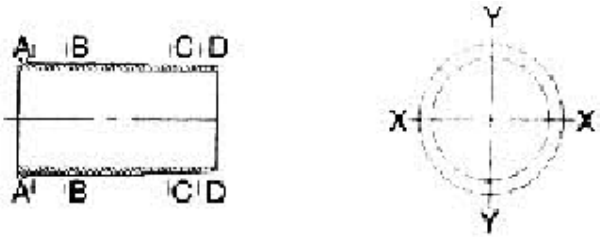
Gauge: dial indicator

Measure the diameter of cylinder sleeve internal hole to determine its wear condition.

Drawing size: $\Phi 85_{0}^{0.035}$



The measuring position and direction are shown in the figure.



Tool: Special tool

Disassemble cylinder sleeve from cylinder body.

Gauge: dial indicator

Check the distance that the upper end of cylinder sleeve protrudes from the top face of cylinder body and it should be within the specified range.

Specified value: 0.045~0.09.

The protruding value between two cylinders adjacent to each other should not be more than 0.03.

Follow-up work:

Install piston and connecting rod component

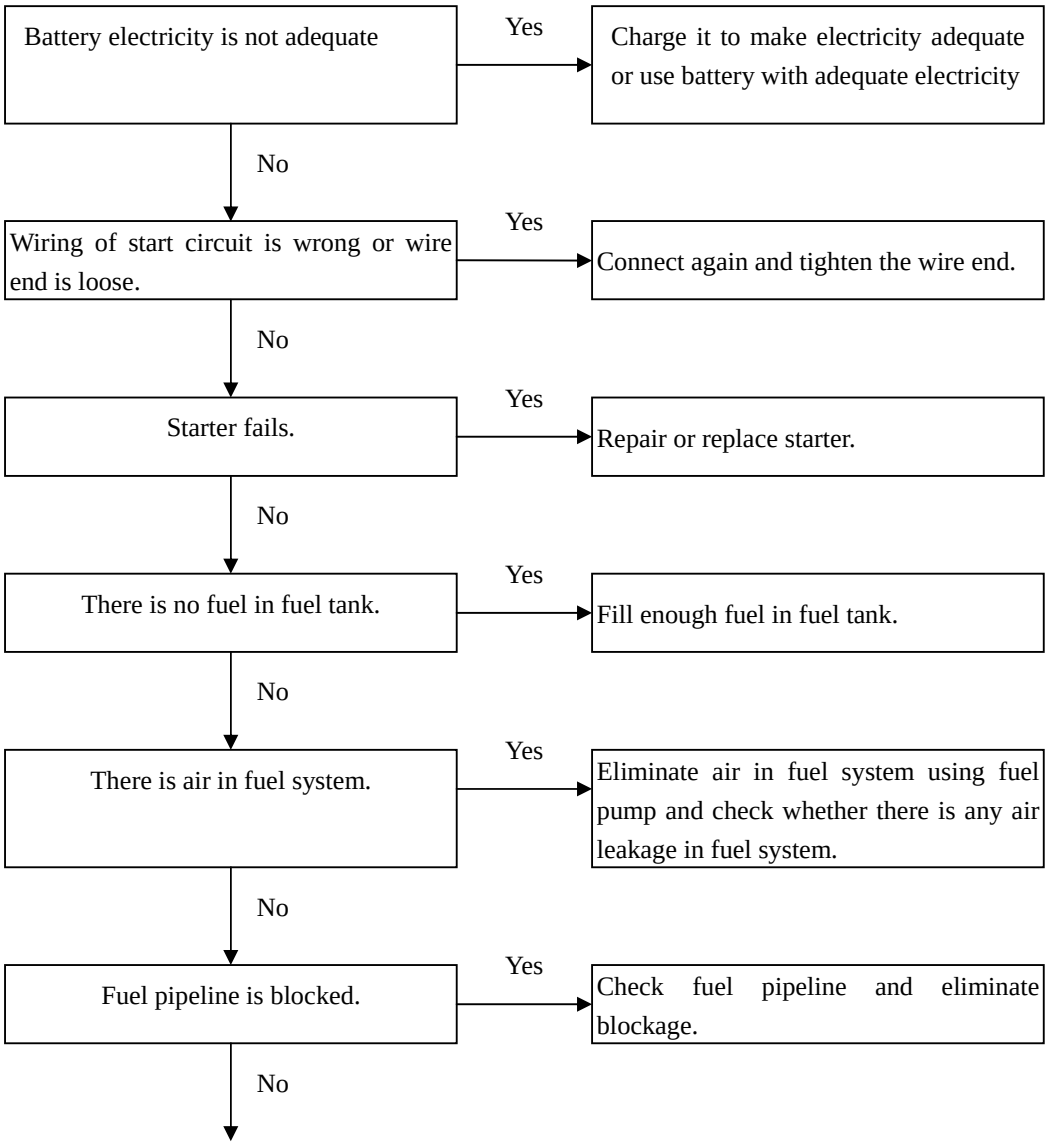
Install cylinder head;

Install other disassembled parts/components.

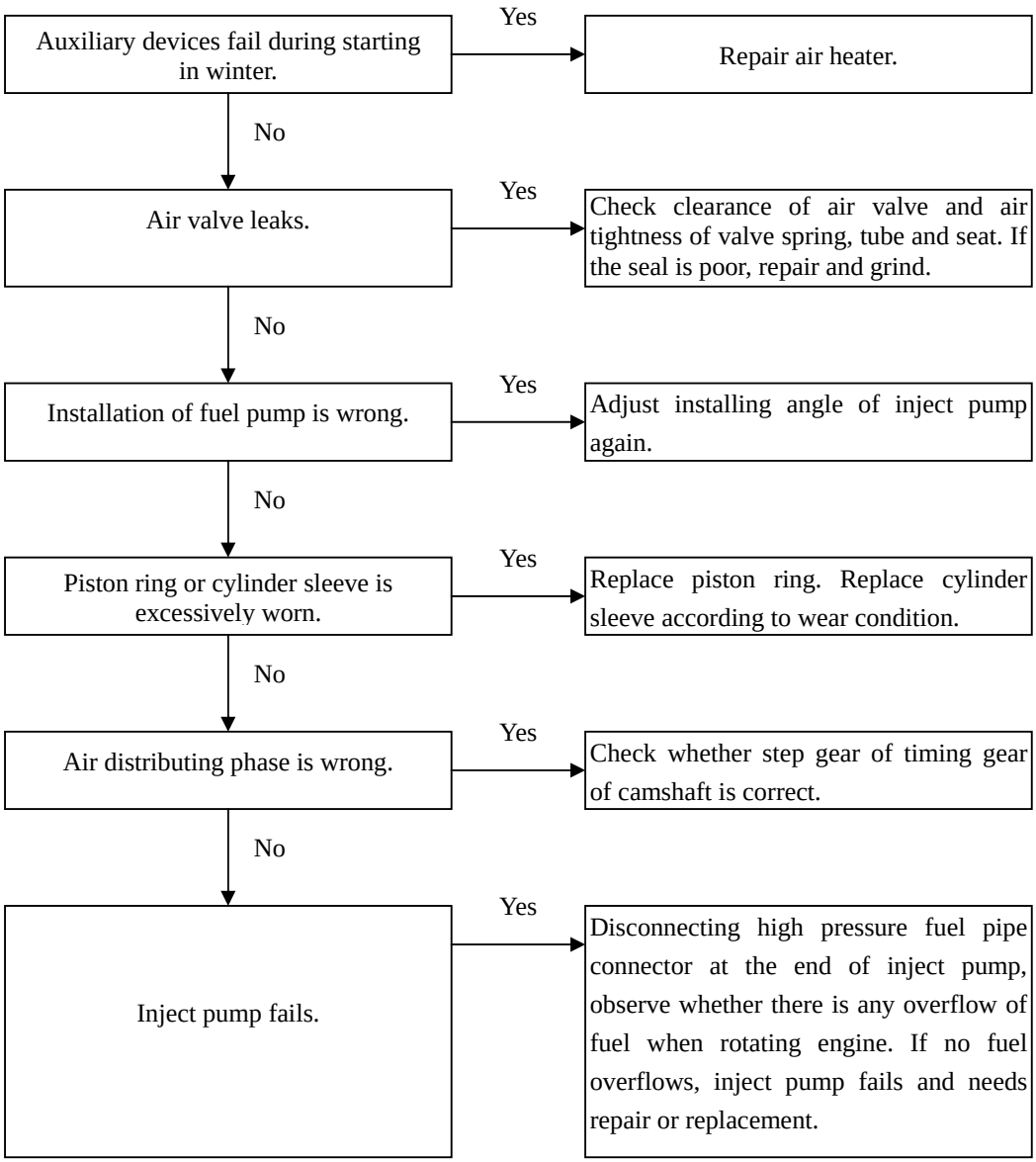
1.8 Diesel engine common failure analysis and troubleshooting

1.8.1 Diesel engine is difficult to start or can’t keep operating after starting

Reason	Troubleshooting

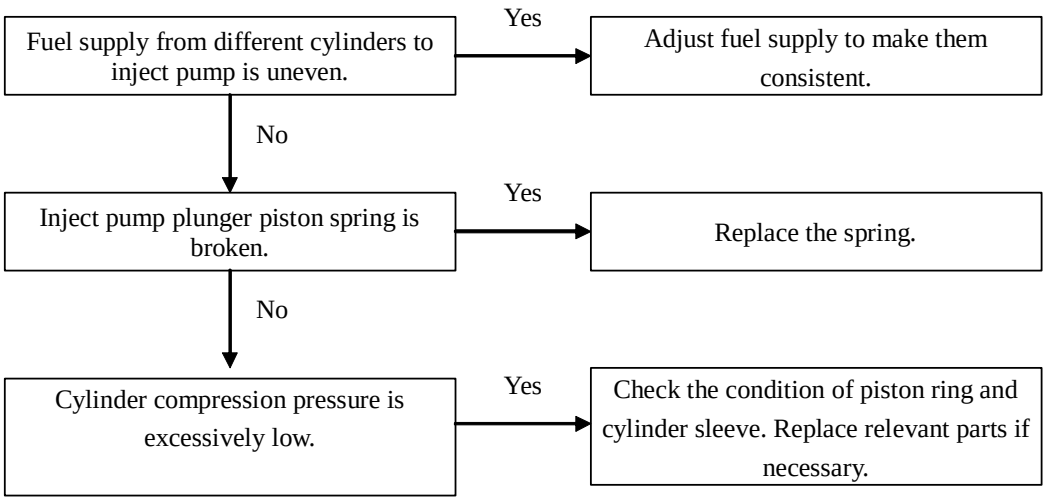

Battery electricity is not adequate
Yes
Charge it to make electricity adequate or use battery with adequate electricity
No
Wiring of start circuit is wrong or wire end is loose.
Yes
Connect again and tighten the wire end.
No
Starter fails.
Yes
Repair or replace starter.
No
There is no fuel in fuel tank.
Yes
Fill enough fuel in fuel tank.
No
There is air in fuel system.
Yes
Eliminate air in fuel system using fuel pump and check whether there is any air leakage in fuel system.
No
Fuel pipeline is blocked.
Yes
Check fuel pipeline and eliminate blockage.
No


Fuel pump doesn’t deliver fuel or delivers fuel intermittently.
Yes
Check whether plunger piston of fuel pump or fuel stop valve is sealed, and whether spring is broken and loses elastics.
No
Fuel filter is blocked.
Yes
Drain water or other impurities in fuel filter or replace fuel filter core.
No
Fuel is polluted.
Yes
Drain the polluted fuel in fuel pipeline and fill clean fuel.
No
Air filter core is blocked seriously.
Yes
Eliminate dust on air filter or replace air filter.
No
Fuel injector doesn’t inject fuel or inject little or poor atomization.
Yes
Disassemble and clean injector couple pairs, regulate pressure again. Replace injector if necessary.
No
Idle peed is excessively low.
Yes
Adjust idle speed and increase it.
No
Start with load.
Yes
Release diesel engine from drive device or set gear box at neutral position.
No

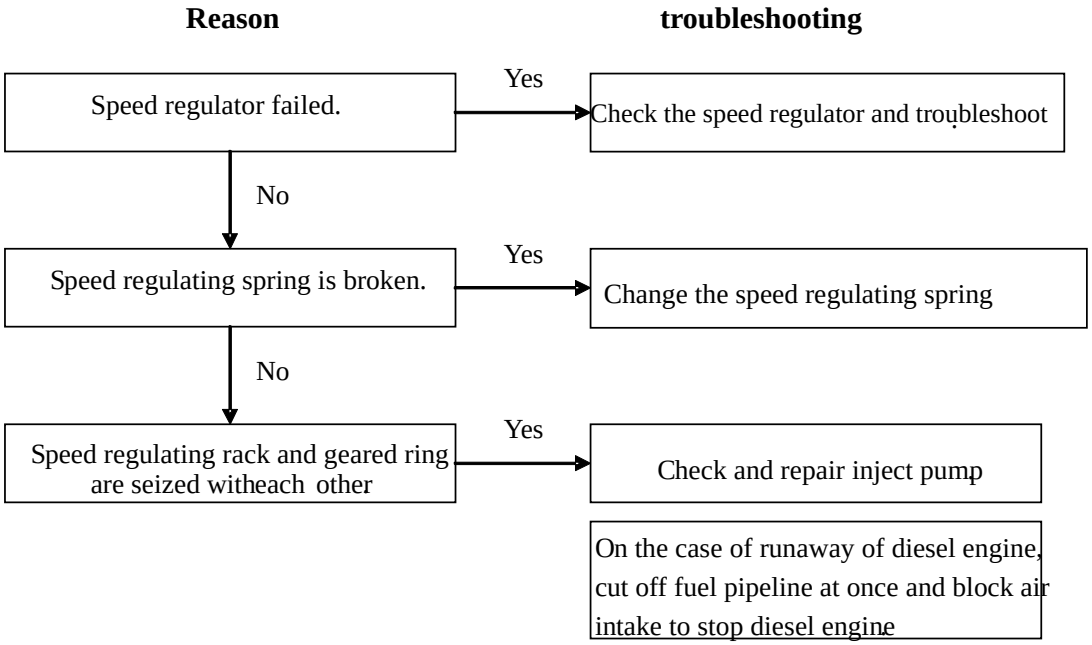

Auxiliary devices fail during starting in winter.
Yes
Repair air heater.
No
Air valve leaks.
Yes
Check clearance of air valve and air tightness of valve spring, tube and seat. If the seal is poor, repair and grind.
No
Installation of fuel pump is wrong.
Yes
Adjust installing angle of inject pump again.
No
Piston ring or cylinder sleeve is excessively worn.
Yes
Replace piston ring. Replace cylinder sleeve according to wear condition.
No
Air distributing phase is wrong.
Yes
Check whether step gear of timing gear of camshaft is correct.
No
Inject pump fails.
Yes
Disconnecting high pressure fuel pipe connector at the end of inject pump, observe whether there is any overflow of fuel when rotating engine. If no fuel overflows, inject pump fails and needs repair or replacement.

1.8.2 Unstable operation of diesel engine

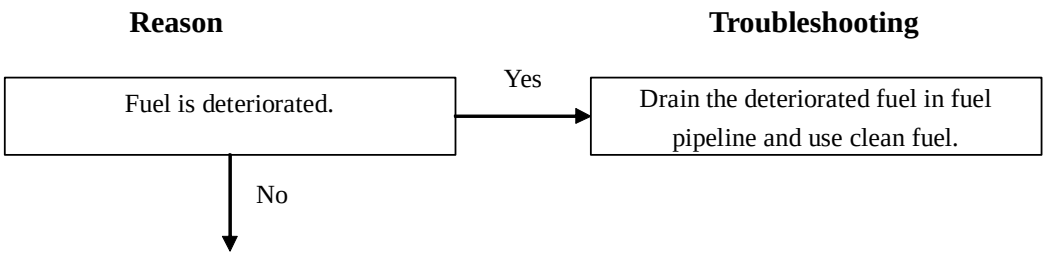
Reason		Troubleshooting
Fuel level of fuel tank is low.	Yes	Fill adequate fuel into fuel tank.
	No	
There is air in fuel system.	Yes	Eliminate air by fuel deliver pump hand and check the sealing of fuel pipelines from fuel tank to fuel injector.
	No	
The idle speed is adjusted excessively low.	Yes	Adjust idle speed limit screw.
	No	
Fuel pipelines are blocked.	Yes	Determine the blocked position in fuel pipeline and eliminate it.
	No	
Fuel filter is blocked.	Yes	Drain water in filter and other impurities or replace filter core.
	No	
Inject timing is not correct.	Yes	Adjusting inject timing again.
	No	
Injector works abnormally.	Yes	Check, wash or replace injector.
	No	
Model of high pressure fuel hose is wrong.	Yes	Use correct high pressure fuel hose.
	No	
Air valve isn't air tight.	Yes	Check clearance of air valve and sealing condition of valve seat. If there is any defect of sealing, repair and grind it.
	No	

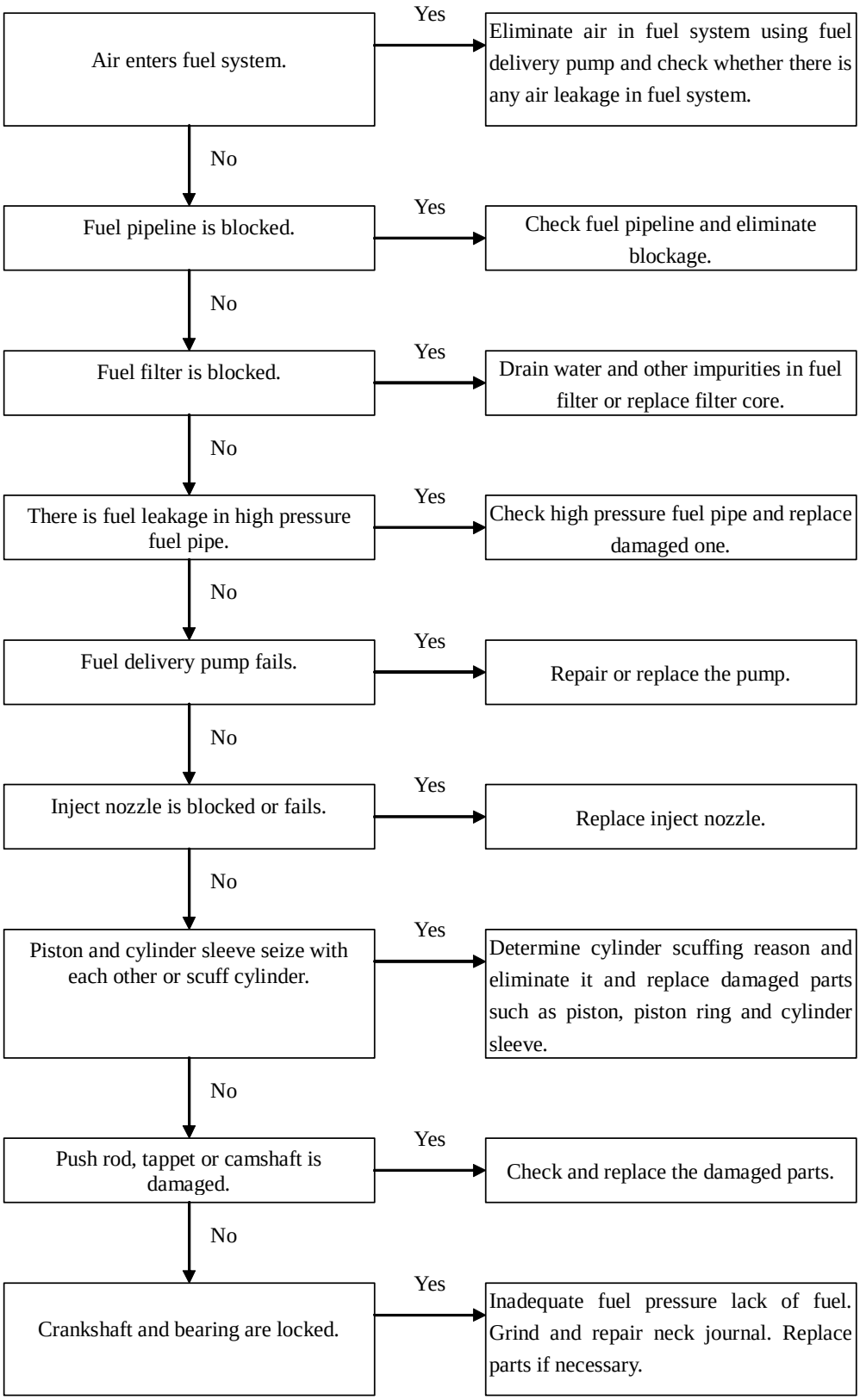


1.8.3 Runaway of diesel engine

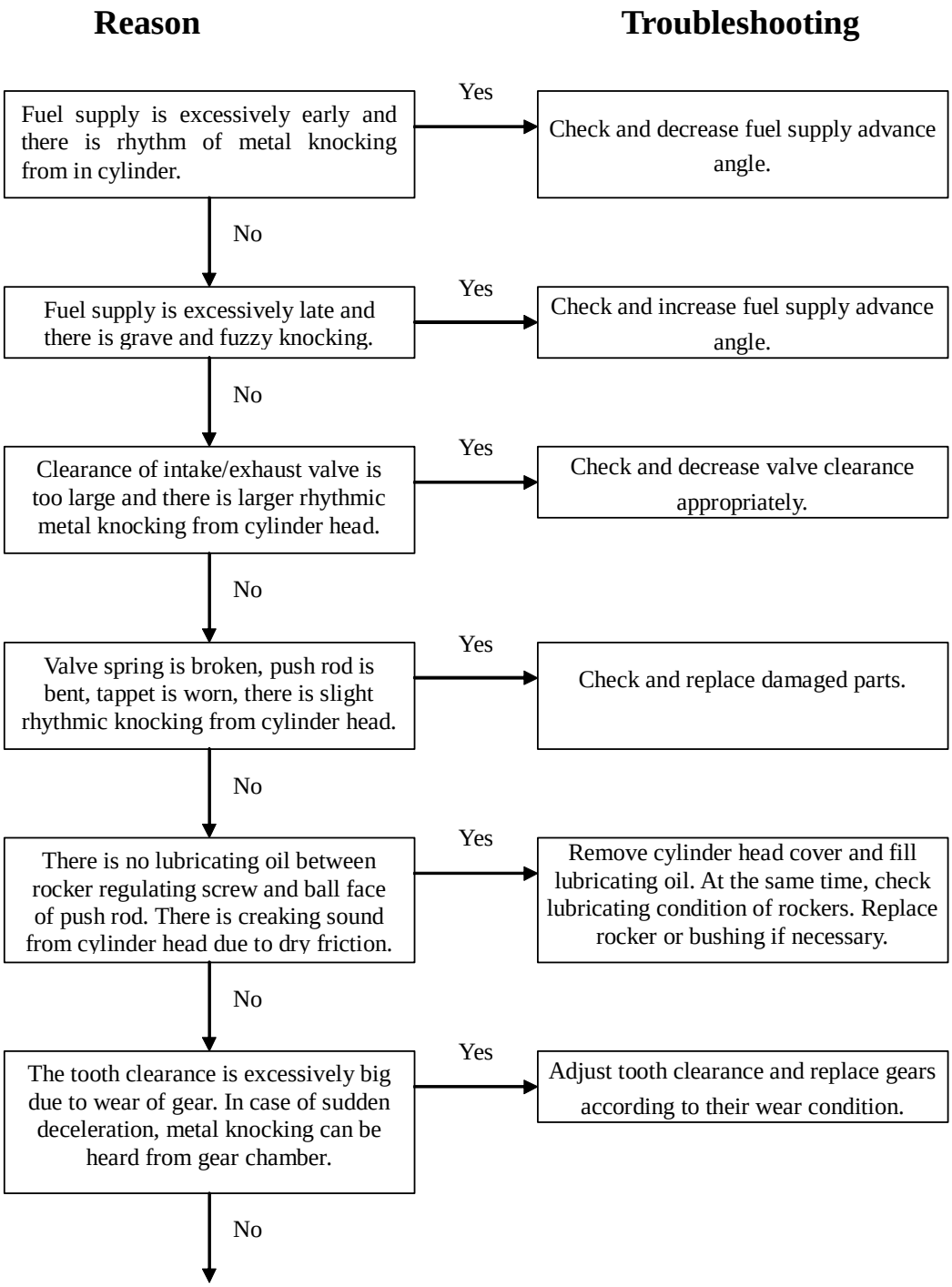


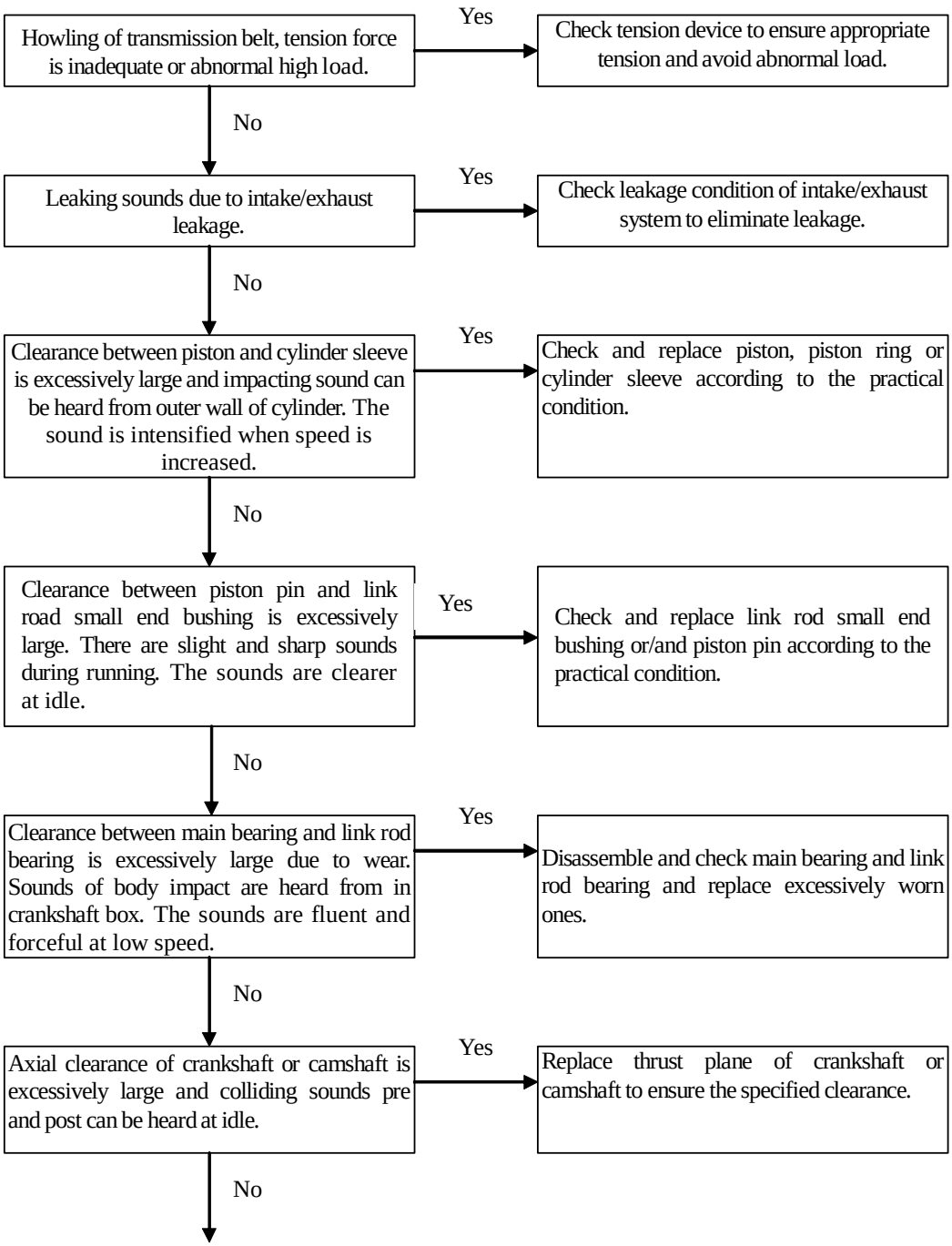
1.8.4 Diesel engine stops automatically

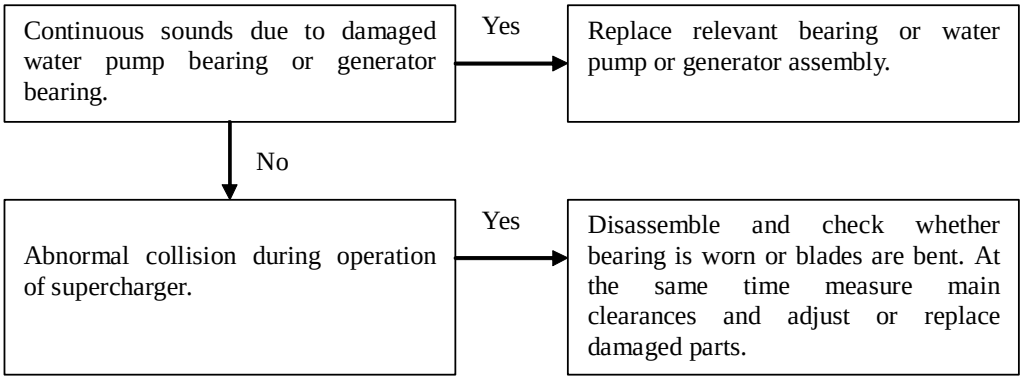



Air enters fuel system.
Yes
Eliminate air in fuel system using fuel delivery pump and check whether there is any air leakage in fuel system.
No
Fuel pipeline is blocked.
Yes
Check fuel pipeline and eliminate blockage.
No
Fuel filter is blocked.
Yes
Drain water and other impurities in fuel filter or replace filter core.
No
There is fuel leakage in high pressure fuel pipe.
Yes
Check high pressure fuel pipe and replace damaged one.
No
Fuel delivery pump fails.
Yes
Repair or replace the pump.
No
Inject nozzle is blocked or fails.
Yes
Replace inject nozzle.
No
Piston and cylinder sleeve seize with each other or scuff cylinder.
Yes
Determine cylinder scuffing reason and eliminate it and replace damaged parts such as piston, piston ring and cylinder sleeve.
No
Push rod, tappet or camshaft is damaged.
Yes
Check and replace the damaged parts.
No
Crankshaft and bearing are locked.
Yes
Inadequate fuel pressure lack of fuel. Grind and repair neck journal. Replace parts if necessary.

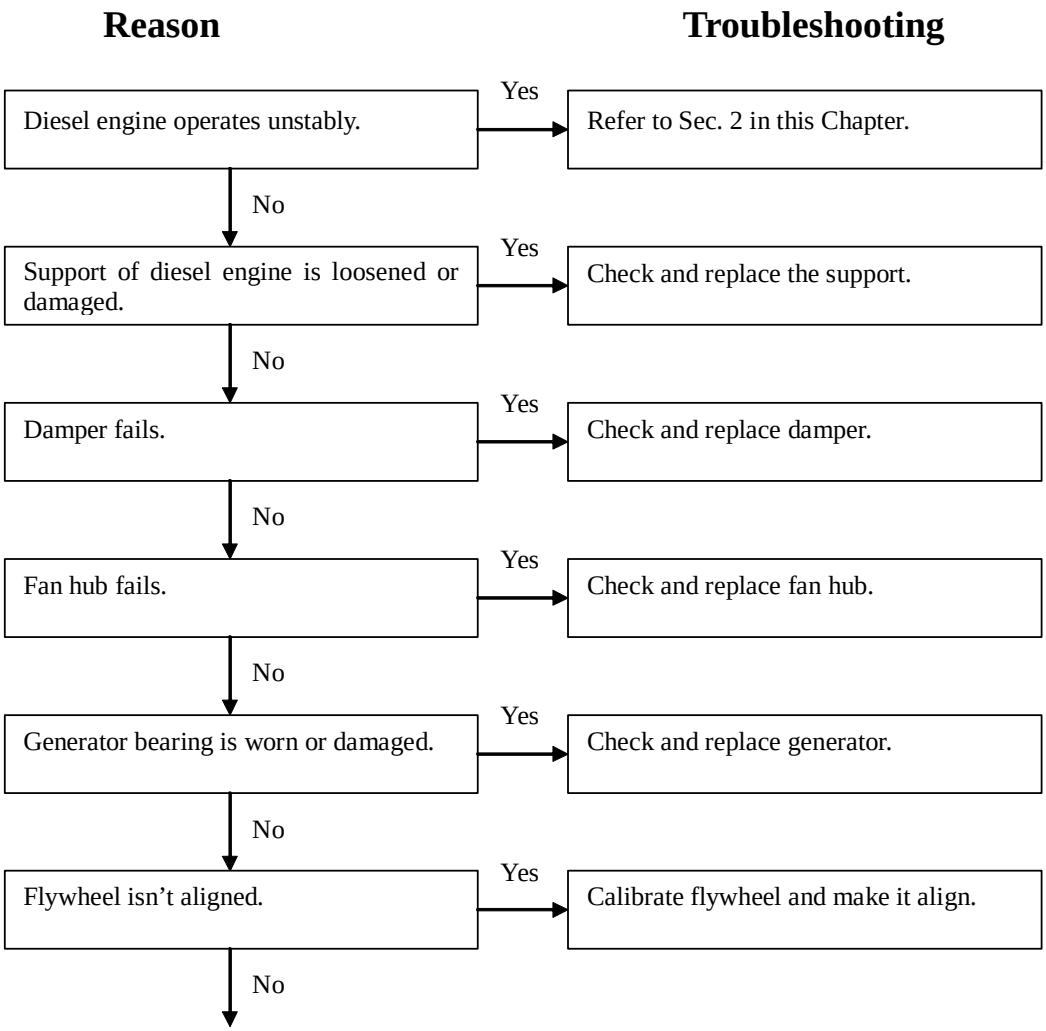
1.8.5 Abnormal noise when diesel engine operates




Howling of transmission belt, tension force is inadequate or abnormal high load.
Yes
Check tension device to ensure appropriate tension and avoid abnormal load.
No
Leaking sounds due to intake/exhaust leakage.
Yes
Check leakage condition of intake/exhaust system to eliminate leakage.
No
Clearance between piston and cylinder sleeve is excessively large and impacting sound can be heard from outer wall of cylinder. The sound is intensified when speed is increased.
Yes
Check and replace piston, piston ring or cylinder sleeve according to the practical condition.
No
Clearance between piston pin and link road small end bushing is excessively large. There are slight and sharp sounds during running. The sounds are clearer at idle.
Yes
Check and replace link rod small end bushing or/and piston pin according to the practical condition.
No
Clearance between main bearing and link rod bearing is excessively large due to wear. Sounds of body impact are heard from in crankshaft box. The sounds are fluent and forceful at low speed.
Yes
Disassemble and check main bearing and link rod bearing and replace excessively worn ones.
No
Axial clearance of crankshaft or camshaft is excessively large and colliding sounds pre and post can be heard at idle.
Yes
Replace thrust plane of crankshaft or camshaft to ensure the specified clearance.
No



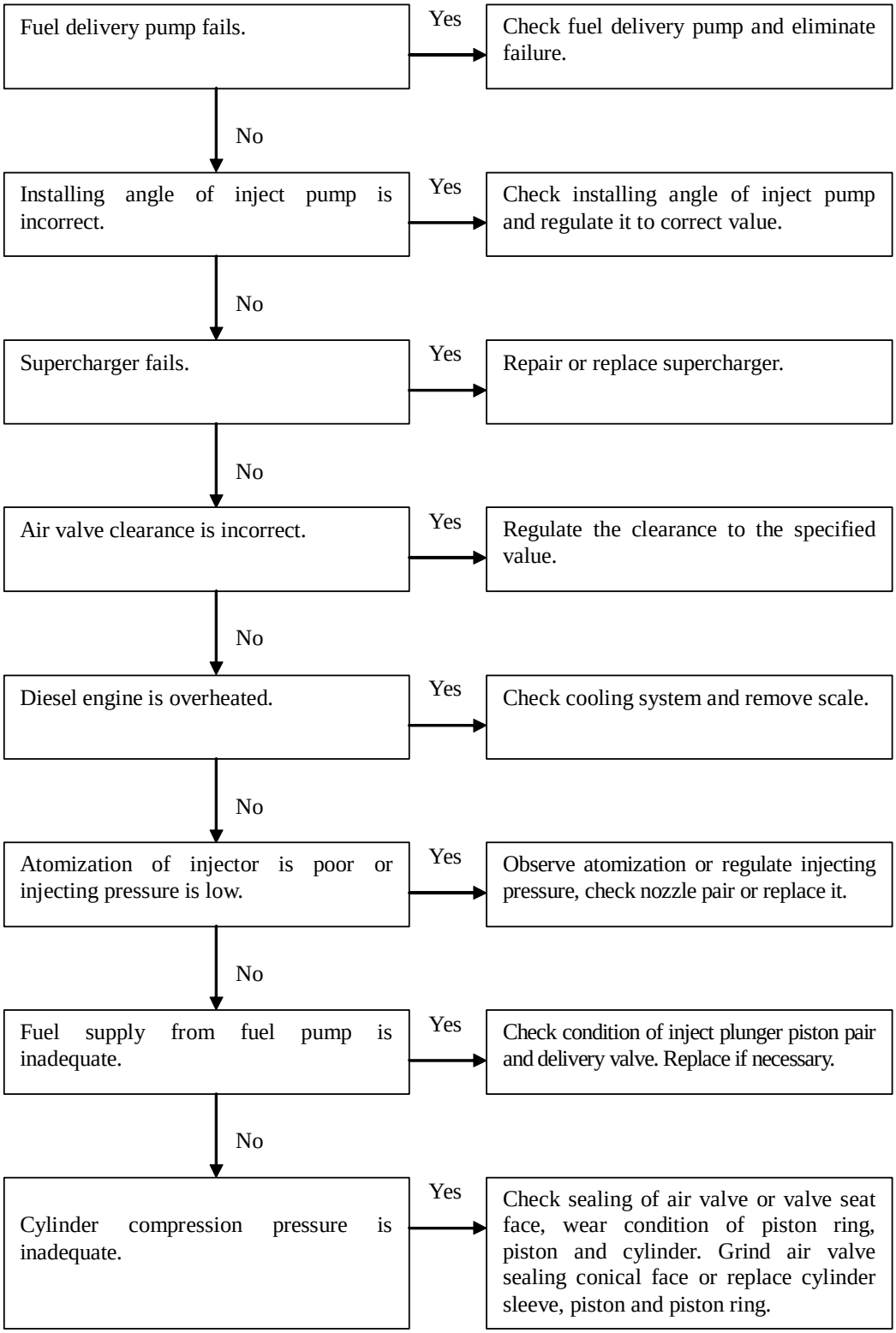
1.8.6 Abnormal vibration of diesel engine



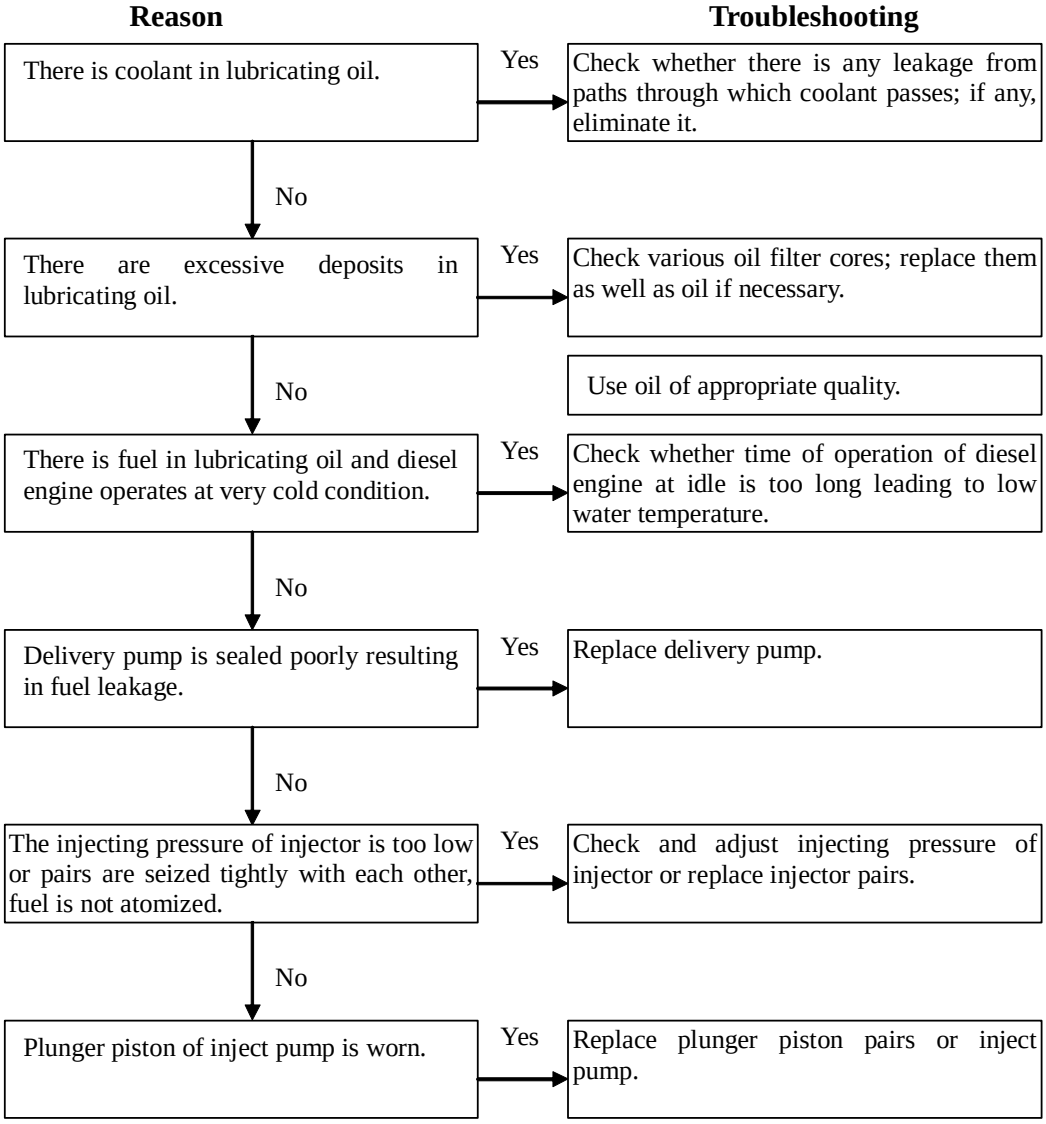
Moving parts are loosened or damaged.	Yes →	Check the damage reason and unbalance condition of moving parts and replace damaged parts.

1.8.7 Inadequate power of diesel engine

Reason		Troubleshooting
Vehicle is overloaded.	Yes →	Reduce load or shift to lower stop.
	No ↓	
Oil lever is excessively high.	Yes →	Drain oil to obtain suitable level.
	No ↓	
Air filter is blocked.	Yes →	Remove dust on filter core or replace filter core.
	No ↓	
Exhaust pipe or/and muffler is/are coked seriously.	Yes →	Remove cokes from exhaust pipe or/and muffler.
	No ↓	
Air leakage between supercharger and intake/exhaust pipeline	Yes →	Check leakage condition of intake/exhaust pipelines and eliminate it.
	No ↓	
The quality of fuel is poor.	Yes →	Replace with fuel suitable for use.
	No ↓	
Fuel pipeline is blocked.	Yes →	Check fuel pipeline and eliminate blockage.
	No ↓	
Fuel filter is blocked.	Yes →	Drain water or other impurities in filter or replace filter core.
	No ↓	

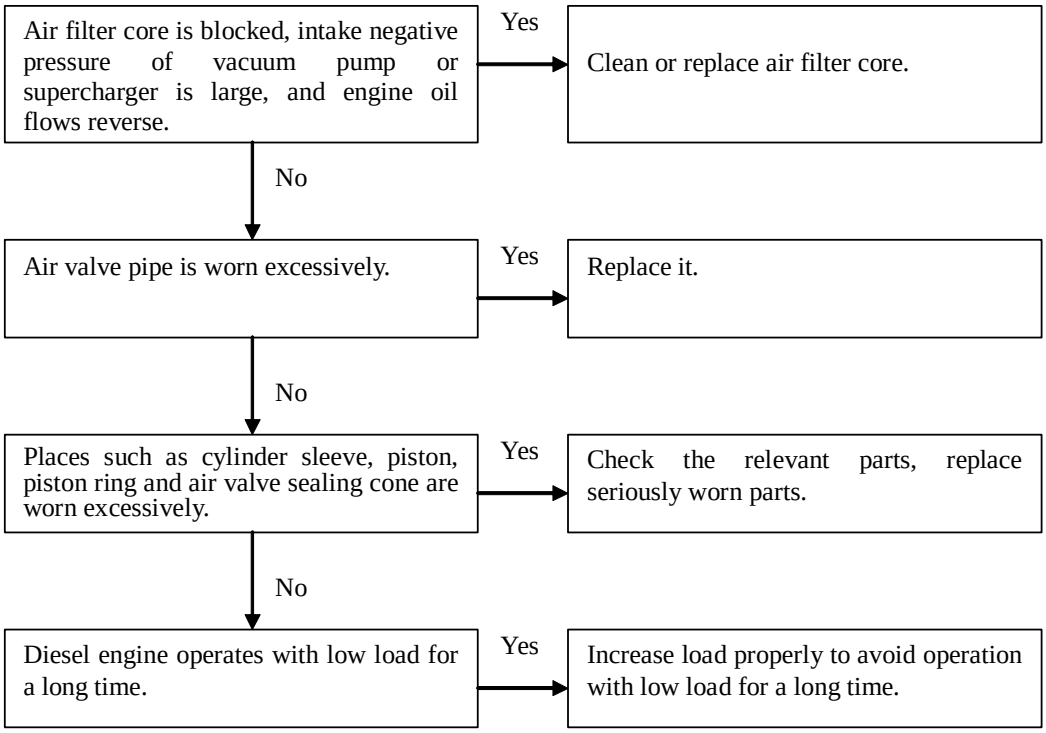

Fuel delivery pump fails.
Yes
Check fuel delivery pump and eliminate failure.
No
Installing angle of inject pump is incorrect.
Yes
Check installing angle of inject pump and regulate it to correct value.
No
Supercharger fails.
Yes
Repair or replace supercharger.
No
Air valve clearance is incorrect.
Yes
Regulate the clearance to the specified value.
No
Diesel engine is overheated.
Yes
Check cooling system and remove scale.
No
Atomization of injector is poor or injecting pressure is low.
Yes
Observe atomization or regulate injecting pressure, check nozzle pair or replace it.
No
Fuel supply from fuel pump is inadequate.
Yes
Check condition of inject plunger piston pair and delivery valve. Replace if necessary.
No
Cylinder compression pressure is inadequate.
Yes
Check sealing of air valve or valve seat face, wear condition of piston ring, piston and cylinder. Grind air valve sealing conical face or replace cylinder sleeve, piston and piston ring.

1.8.8 Lubricating oil deterioration

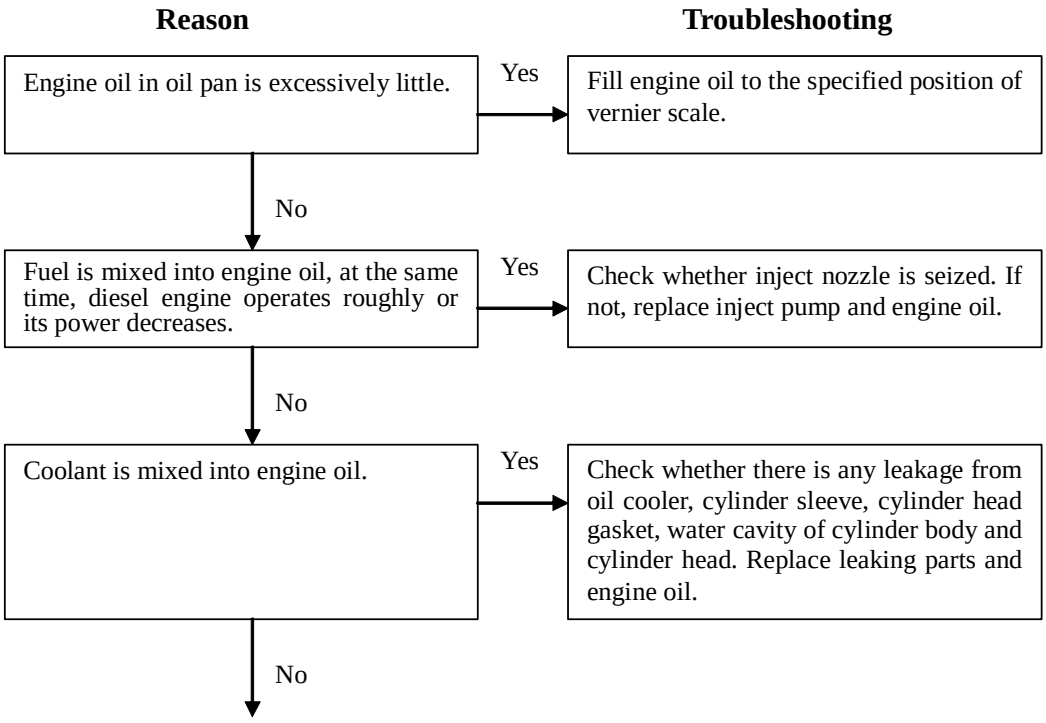


1.8.9 Excessive consumption of lubricating oil

Reason		Troubleshooting
Engine oil is leaked seriously.	Yes →	Check possible leaking places outside diesel engine and the front and rear oil seals. Replace damaged parts.
↓ No		
Oil in oil pan is excessively full.	Yes →	Drain engine oil to the highest position specified on vernier scale.
↓ No		
Quality of engine oil is improper.	Yes →	Use engine oil with specified quality.
↓ No		
Oil cooler leaks oil.	Yes →	Check whether there is engine oil in coolant. If any, disassemble oil cooler and replace damaged parts or assembly.
↓ No		
Oil leakage in vacuum pump.	Yes →	Replace vacuum pump.
↓ No		
Elastic sealing device of supercharger fails.	Yes →	Disassemble elastic sealing ring and check whether it is burnt or its elastics is lost. Replace it if necessary.
↓ No		



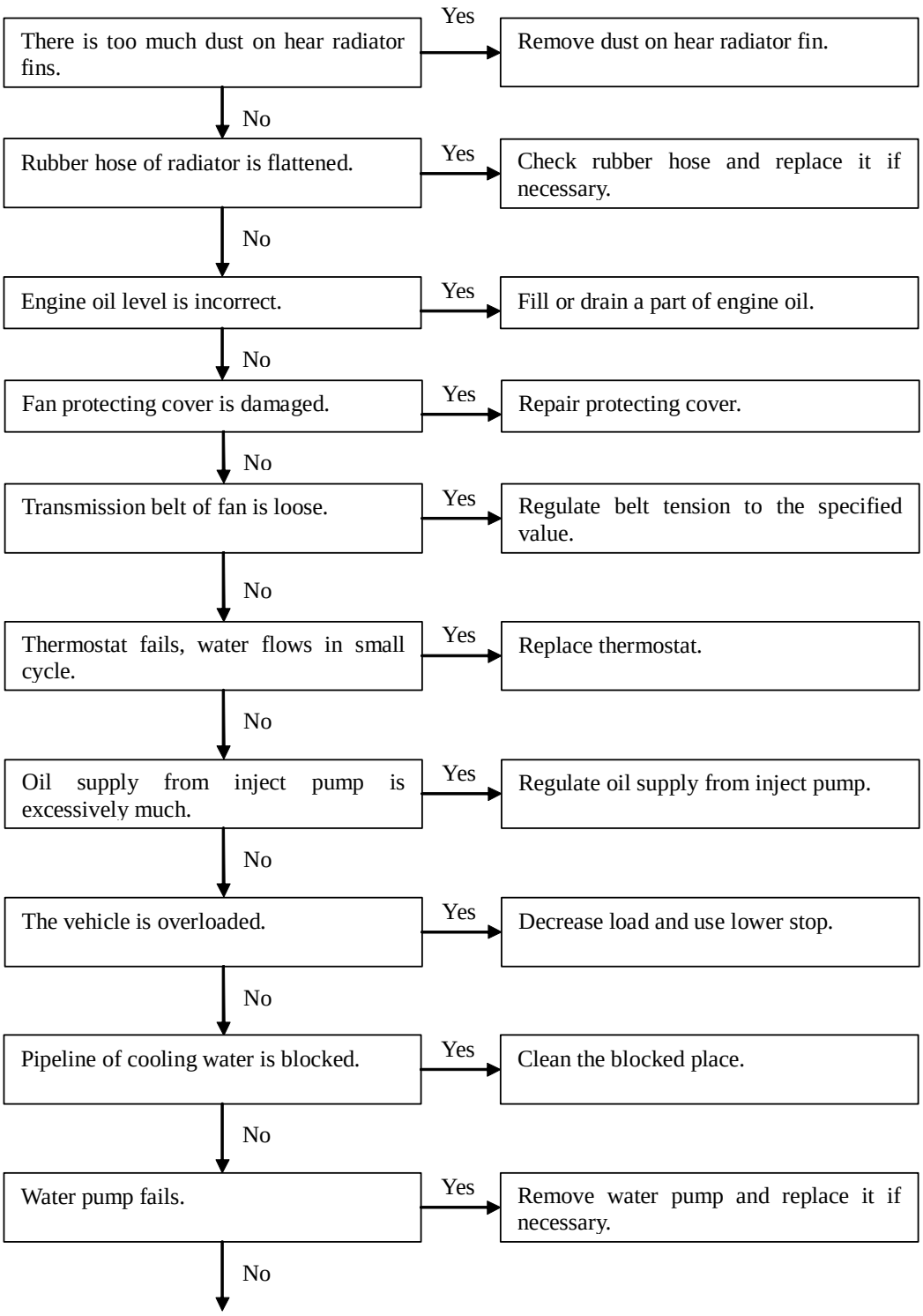
1.8.10 Excessive low pressure of lubricating oil



Engine oil specification is not correct.	Yes →	Use engine oil of specified specification.
↓ No		
Oil filter is blocked.	Yes →	Clean or replace oil filter core.
↓ No		
Oil cooler is blocked.	Yes →	Clean or replace oil cooler core.
↓ No		
Oil collector is blocked.	Yes →	Clean oil collector to make it straightway.
↓ No		
Oil pump gear, bearing and casing planes are worn.	Yes →	Replace oil pump.
↓ No		
Pressure limit valve or pressure regulating spring is broken.	Yes →	Replace the spring.
↓ No		
Crankshaft neck journal and main bearing and link rod bearing are worn resulting in excessive clearance.	Yes →	Replace worn bearing or crankshaft.

1.8.11 Excessive high temperature of coolant

Reason		Troubleshooting
Coolant is inadequate.	Yes →	Fill coolant.
↓ No		


There is too much dust on hear radiator fins.
Yes
Remove dust on hear radiator fin.
No
Rubber hose of radiator is flattened.
Yes
Check rubber hose and replace it if necessary.
No
Engine oil level is incorrect.
Yes
Fill or drain a part of engine oil.
No
Fan protecting cover is damaged.
Yes
Repair protecting cover.
No
Transmission belt of fan is loose.
Yes
Regulate belt tension to the specified value.
No
Thermostat fails, water flows in small cycle.
Yes
Replace thermostat.
No
Oil supply from inject pump is excessively much.
Yes
Regulate oil supply from inject pump.
No
The vehicle is overloaded.
Yes
Decrease load and use lower stop.
No
Pipeline of cooling water is blocked.
Yes
Clean the blocked place.
No
Water pump fails.
Yes
Remove water pump and replace it if necessary.
No

There is air in cooling system.

Yes → Check whether the clamping portion of water sucking hose of water pump leaks. Check whether there is air leakage from cylinder head gasket. Replace if necessary.

No ↓

Water thermometer fails.

Yes → Check water thermometer. Repair or replace it if necessary.

1.8.12 Excessive loss of coolant

Reason		Troubleshooting
There is water leakage from water tank.	Yes →	Check water tank and determine leaking place and eliminate it.
↓ No		
There is water leakage on the outer surface of diesel engine.	Yes →	Check the possible leaking places of water channel sealing gasket and the relevant parts and eliminate it.
↓ No		
Diesel engine is overheated or coolant in water tank overflows due to leakage of compressed gas.	Yes →	Determine the reason of overheating (see Coolant Temperature Is Excessively High) and leaking condition of cylinder. Replace relevant parts if necessary.
↓ No		
Water leakage from engine oil cooler.	Yes →	Repair or replace engine oil cooler.
↓ No		
Water leakage from cylinder head gasket.	Yes →	Repair cylinder head gasket.
↓ No		
Cylinder head is cracked or perforated.	Yes →	Replace cylinder head.
↓ No		
Water leakage from cooling water channel of cylinder body.	Yes →	Replace cylinder body.

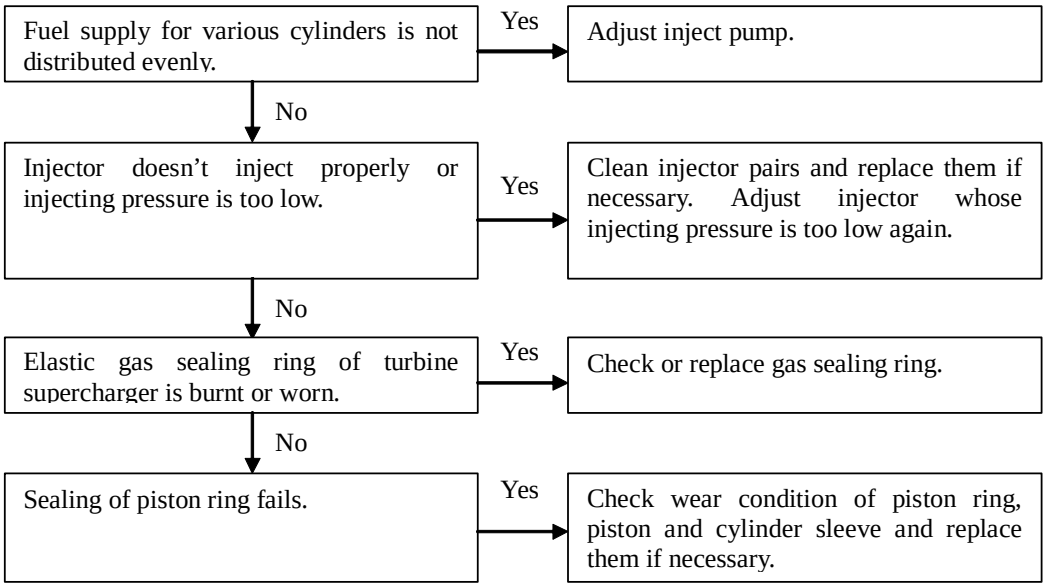
1.8.13 Excessive consumption of fuel

Reason		Troubleshooting
Fuel system leaks.	Yes →	Check and repair fuel system pipeline.
↓ No		
Resistance of intake system increases.	Yes →	Check air filter core. Eliminate dust or replace if necessary.
↓ No		
Fuel supply advance angle of inject pump is incorrect.	Yes →	Check and adjust fuel supply advance angle.
↓ No		
Adjusting of inject pump is incorrect.	Yes →	Check and adjust fuel quantity of inject pump on pump test bench.
↓ No		
Fuel injector fails.	Yes →	Disassemble and check fuel injector, repair or replace pairs.
↓ No		
Inner surface of diesel engine if worn seriously.	Yes →	Check wear condition of cylinder sleeve, piston and piston ring and sealing of air valve and air valve seat. Check wear condition of moving parts and repair them.

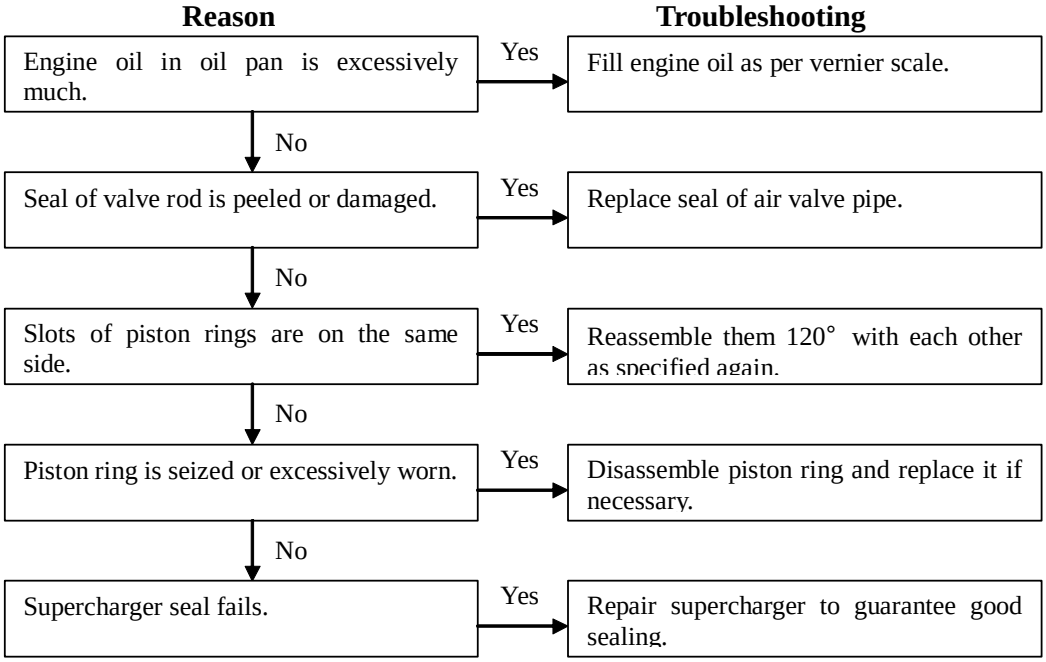
1.8.14 Abnormal of diesel engine exhaust

(1) Black smoke

Reason		Troubleshooting
Diesel engine is overloaded	Yes →	Reduce load properly
↓ No		
There is air in fuel system	Yes →	Drain air by fuel delivery pump and check the leakage condition of fuel sucking part
↓ No		
Air filter is blocked	Yes →	Clean dust in air filter or replace filer core.
↓ No		
Air valve clearance is incorrect. Air valve sealing is poor	Yes →	Adjust air valve clearance, check sealing conical face and eliminate defects
↓ No		
Installing angle of inject pump is incorrect.	Yes →	Adjust installing angle again
↓ No		
Intake pipeline leaks	Yes →	Check and repair intake pipeline and enhance sealing condition
↓ No		
Joint portion between high pressure fuel pipe and injector body is poorly sealed.	Yes →	Reinstall.
↓ No		
Fuel delivery pump fails.	Yes →	Check fuel delivery pump and eliminate failure.
↓ No		


Fuel supply for various cylinders is not distributed evenly.
Yes
Adjust inject pump.
No
Injector doesn't inject properly or injecting pressure is too low.
Yes
Clean injector pairs and replace them if necessary. Adjust injector whose injecting pressure is too low again.
No
Elastic gas sealing ring of turbine supercharger is burnt or worn.
Yes
Check or replace gas sealing ring.
No
Sealing of piston ring fails.
Yes
Check wear condition of piston ring, piston and cylinder sleeve and replace them if necessary.

(2) Blue smoke


Reason
Troubleshooting
Engine oil in oil pan is excessively much.
Yes
Fill engine oil as per vernier scale.
No
Seal of valve rod is peeled or damaged.
Yes
Replace seal of air valve pipe.
No
Slots of piston rings are on the same side.
Yes
Reassemble them 120° with each other as specified again.
No
Piston ring is seized or excessively worn.
Yes
Disassemble piston ring and replace it if necessary.
No
Supercharger seal fails.
Yes
Repair supercharger to guarantee good sealing.

(3) White smoke

Reason		troubleshooting
When diesel engine is started, there is no combustion in individual cylinder (especially in winter).	Yes →	Increase speed and load properly and operate for a longer time.
↓ No		
Coolant leaks from inside cylinder.	Yes →	Check sealing condition; check whether there is any crack in cylinder head and whether cylinder sleeve is perforated or cracked.
↓ No		
Atomizing effect of injector is poor and there forks fuel drips. Injecting pressure is excessively low.	Yes →	Check injector pairs, repair by grinding or replace them. Adjust injecting pressure to the specified value.
↓ No		
Water in fuel is too much.	Yes →	Replace with fuel of specified designation.
↓ No		
Installing angle of inject pump is incorrect.	Yes →	Adjust installing angle again.

Chapter 2 Clutch

2.1 Structure of clutch

Clutch is mainly composed of driving part, driven part, compression mechanism and control mechanism. Engine flywheel and pressure plate are driving components and friction plate is driven component. Compression spring and pressure plate assembly form the compression mechanism of clutch. Disengaging lever, release bearing swing arm, etc form control mechanism of clutch.

Clutch is one of normally engaged type. During power transferring, spring pushes compression spring forward and impact friction plate between flywheel and pressure plate thus delivering the power from engine to transmission input shaft via friction plate hub. If the power transmission needs to be interrupted, press down clutch pedal pushing release shaft forward and thrusting spring disengaging lever; at this time, pressure plate moves backward thus releasing the power transmitted to transmission input shaft by flywheel via friction plate.

Chang'an SC series truck adopts two types of clutches-spiral spring and diaphragm spring controlled by main/individual pump and mechanical stay wire respectively. The diagrams of clutch are shown in Fig. 2-1 and 202.

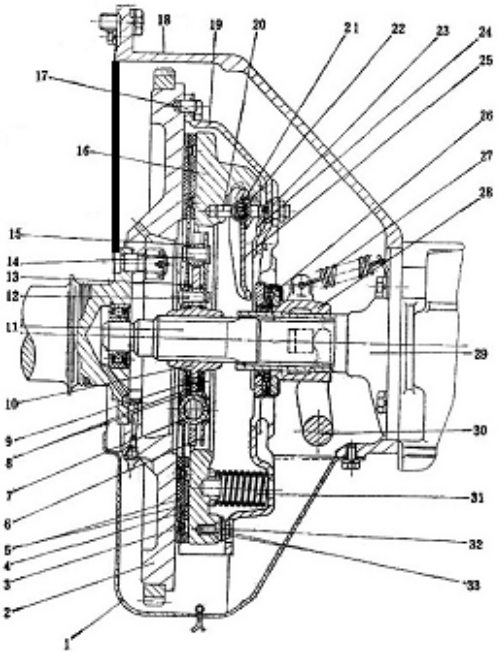


Fig. 2-1 Multi-coil spring clutch

1-clutch case bottom cover; 2-engine flywheel; 3-friction washer rivet; 4-driven disk body; 5-friction washer; 6-damper disk; 7-damper spring; 8-damping disk; 9-damping disk rivet; 10-driven disk hub; 11-first shaft of transmission (clutch driven shaft); 12-damping spring; 13-damper damping spring; 14-driven disk rivet; 15-distance bushing of driven disk rivet; 16-pressure plate; 17-locating pin of clutch cover; 18-clutch case;

19-clutch cover; 20-support column of release lever; 21-swing tablet; 22-floating pin; 23-adjusting nut of release lever; 24-spring of release lever; 25-releas lever; 26-release bearing; 27-return spring of release sleeve; 28-release sleeve; 29-bearing cover of transmission first shaft; 30-release fork; 31-pressure spring; 32-driving strap rivet; 33-driving strap

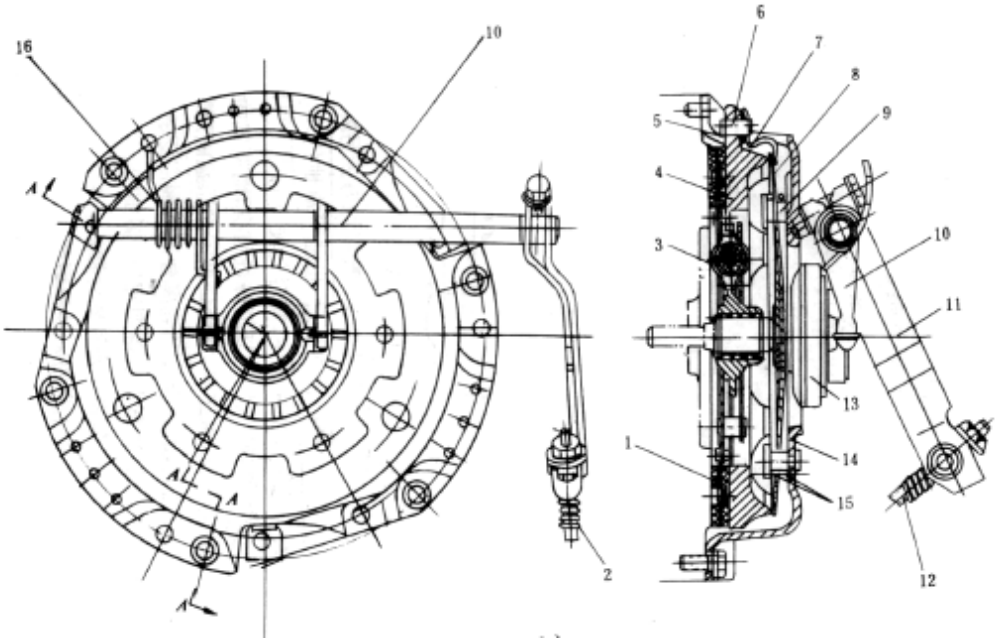


Fig. 2-1 Diaphragm spring clutch

1-driven disk; 2-flywheel; 3-torque damper; 4-pressure disk; 5-pressure disk transmission strap; 6-fixing rivet of transmission strap; 7-release spring hook; 8-diaphragm; 9-fixing rivet of release spring; 10-release fork; 11-relese fork arm; 12-control cable unit; 13-release bearing; 14-clutch cover; 15-diaphragm spring support ring; 16-return spring of release fork

2.2 Wear analysis of main components

2.2.1 Driven disk

Driven disk is the friction component of clutch and its common wear types are abrasion, ablation, crack, oil stain, loose rivet and distortion of steel plate. Abrasion, ablation and deterioration become the major wear types because of great sliding of clutch during release and, especially, engaging. Oil stains are resulted from the oil leakage from the first splined shaft due to the deteriorated oil return capability of oil return helical line of the first shaft of transmission. The distortion of driven disk steel sheet is often resulted from the misalignment between the first shaft of transmission and the center line of crankshaft thus making the driven disk distorted periodically during operation, which is one of main reasons that intensify the damage of clutch driven disk.

Furthermore, wear of driven disk spline, damping spring and damping disk is often become the major reason of rejection of driven disk.

2.2.2 Pressure spring

Elastic force decrease and fracture, usually resulted from fatigue due to long time operation, are major failure modes of pressure spring. For diaphragm spring, there may be abrasion at the place where its internal end contacts with release bearing.

2.3.3 Pressure plate and clutch cover

Abrasion and ablation of working surface are the main wear modes of pressure plate.

It is inevitable that the force transmission portions of pressure plate and clutch cover is worn. Sometimes there may be distortion and crack on clutch cover. Distortion is often resulted from improper assembly or installing process, assembling without special tools, or the screws around is not tightened symmetrically and evenly during installing.

2.2.4 Release parts and control/transmission parts

Abrasion of matching portions is the main wear mode of release lever, release bearing and control transmission parts.

Among the above parts, driven plate and control parts are ones of the highest wear rate not only in clutch but also in the whole vehicle. This is especially true for mine vehicle, port vehicle and city vehicle whose clutches are operated frequently. Thus, the replacement or repair of driven plate, replacement of release bearing as well as adjusting work resulted from wear have become main minor repair and maintenance of clutch.

2.2.5 Effect of parts wear on work reliability of assembly

The above wear of clutch will reduce its working reliability. The main phenomena may be slipping, trembling when starting, incomplete release and noise.

The slipping is the relative slipping of clutch driving parts and driven parts during force transmission with clutch engaged. The root reason is that the decrease of friction coefficient of friction elements or the decrease of pressing force of pressing elements make their capability of torque transmission reduced. So, all the factors that reduce friction coefficient and pressure force, such as oil stains of friction parts, ablation, worn friction elements, disabled pressure spring, insufficient pedal free travel, etc, may result in slipping of clutch.

Trembling is that the uneven slipping of friction elements during engaging of clutch results in unstable force transmission. Its root reason it that the friction force produced around during engaging of driving and driven disks is uneven. Thus, all the factors that result in uneven friction force, oil stained friction washer, ablation, uneven spring pressing force, unequal height of release lever, etc, will make clutch trembled during starting.

Incomplete release is that, in released status, driving and driven disks can’t be disengaged

completely. Thus, fracture or distortion of driving and driven disks, unequal height of release lever, excessive low adjustment, excessive long free travel of pedal, etc, will result in incomplete disengagement of clutch.

Noise is the impact sound during operation in the case of excessively large fit clearance between parts such as transmission portion of pressing disk, damping spring, release bearing, etc.

2.3 Repair of main parts

2.3.1 Driven disk

The slight oil stains on friction disk can be removed by gasoline washing and blast lamp flame drying; slight hardening and ablation can be removed by grinding with abrasive cloth; it should be replaced with new one in the cases of serious wear, embedded depth of rivet head of less then 0.5mm, crack, falling off, serious ablation or oil stains.

For steel sheet distortion, the peripheral end run-out should not be more than 0.5mm-0.8mm. If it is more than the specified value, correct using special wrench or replace it with new one. The fit clearance between driven disk and first shaft spline of transmission should accord with the specifications. If the clearance is excessively large, replace the driven disk with new one.

2.3.2 Pressure disk

If ablation, crazing, scratch of working surface of pressure plate are not very serious, grind it smooth using oil stone. If the groove depth is over 0.5mm or flatness error is over 0.12mm-0.20mm, repair by grinding. But the total grinding amount should not exceed the limit, generally, 1mm-1.5mm.After grinding, balance the pressure disk again.

2.3.3 Clutch cover

If there are cracks on steel sheet stamped clutch cover, weld repair it. If its force transmission window (hole) is worn to appear steps, repair it by surfacing. If any distortion, correct it.

2.3.4 Pressure spring

The elastic force of pressure spring should accord with specifications. Its free length difference should not be more than 2mm. The error of perpendicularity between spring cylindrical outside surface and its end should not exceed 2mm.The wearing depth where the inside end of diaphragm spring contacts with release bearing should not exceed 0.6mm.Generally, the spring which can’t meet the requirements should be replaced. The inside end of diaphragm spring should be within the same plane and its maximum error should not be more than 0.5mm.Generally, the spring which can’t meet the requirements should be replaced. The measurement can be carried out

using special gauges or plug gauges or using height vernier scales on flat plane. If the measured values exceed the specified values, correct using wrench.

2.3.5 Release parts

If the wear of the inside end of release lever exceeds the specified value, repair it by welding.

Release bearing should turn smoothly without jamming or abnormal sound. The axial clearance should not be more than 0.6mm. Otherwise, replace it with new one. Don't wash new bearing with gasoline. Just wipe it.

If release fork shaft and sleeve are worn and loosened, repair by plating the shaft or replacing the sleeve.

2.4 Disassembly of clutch

1. Lift the car by jack or lift, support using safety bracket or lock the lift mechanism;

2. Remove the backing light switch plug connector of transmission (Fig. 2-3);

3. Disconnect bond strap from at battery;

4. Loosen transmission shaft bolt from at drive bridge (Fig. 2-4);

Fig. 2-3 Disassemble backing light switch plug connector

1-backing light switch plug connector; 2-transmission case

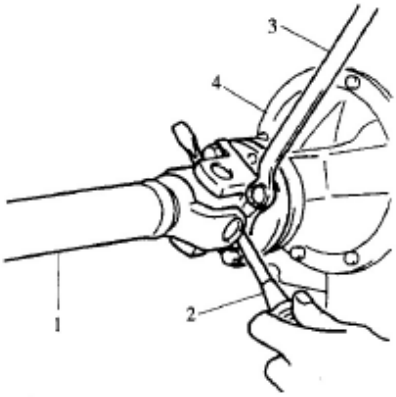


Fig. 2-4 Disassemble transmission shaft

1-transmission shaft; 2-flat screwdriver; 3-wrench; 4-drive bridge

5. Disassemble transmission shaft from at drive bridge, take down transmission shaft assembly (Fig. 2-5);

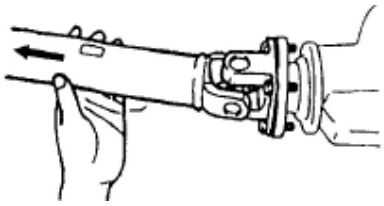


Fig. 2-5 Take out transmission shaft

6. Disassemble the flexible shaft of trip indicator from at transmission extension box;

7. Disconnect connectors of transmission stick and shifting control stick;

8. Disassemble clutch slave cylinder;

9. Support engine and transmission by bracket, remove transmission suspension bolt and nut respectively;

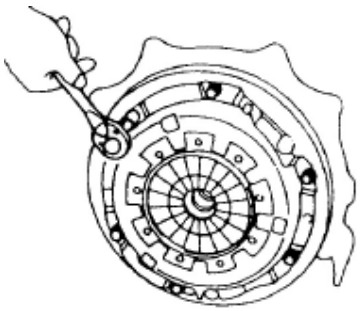
10. Check and ensure that there is no any connection between transmission and vehicle body, engine and other components, remove transmission and clutch assembly;

11. Lock flywheel with flywheel retainer (Fig. 2-6);

12. Unscrew the fastening bolt of clutch cover using wrench; take down clutch assembly from flywheel (Fig. 2-7);

13. Remove release bearing from transmission input shaft (Fig. 2-8);

14. Disassemble input shaft bearing (Fig. 2-9);



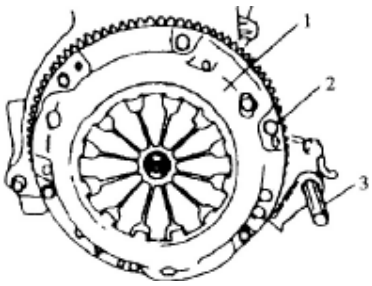
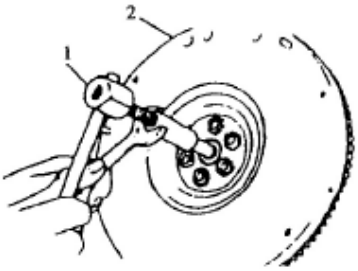


Fig. 2-6 Install flywheel retainer Fig. 2-7 Disassemble clutch cover

1. clutch cover; 2. flywheel; 3. flywheel retainer



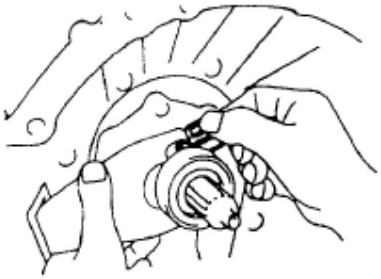


Fig. 2-8 Disassemble release bearing Fig. 2-9 Disassemble input shaft bearing

1-special disassembling tool; 2- flywheel

2.5 Installing and adjusting of clutch

2.5.1 Key points and precautions of clutch installing

(1) The friction washer should be clean. Apply a little lubricating oil to movable joints and friction surface.

(2) The spring of multi-spring clutch should be distributed evenly around peripheral according to their free length so as to press evenly. Install using special tool (see Fig. 2-10) preventing the distortion of clutch cover.

Fig. 2-10 Special tool for clutch disassembling and installing

(3) Pay attention to the assembling and installing marks. Assemble according to the original marks or locations between clutch cover and pressure disk, between balance tablet and clutch cover, and between clutch cover and flywheel in order to avoid breaking the balance.

(4) Pay attention to the direction of driven disk: the side with short spline hub should be faced with flywheel.

(5) To guarantee the coaxial between driven disk and crankshaft and the installing of transmission, during installing clutch, the another transmission first shaft of the same vehicle model or special guide shaft may be inserted into driven disk, and the guide bearing hole at the rear end of crankshaft may be used to locate.

(6) The overhauled clutch should be balanced together with crankshaft flywheel before its installing.

2.5.2 Adjusting of clutch

1) Adjusting of height of release lever

The height of release lever is the distance from the inside end of release lever to flywheel surface or pressure plate or other specified plane. It should meet the following requirements: the distance from the inside end of release lever to the rear plane of damper disk should be 32.4mm (Fig. 9-11); the differences of lever heights with each other should not exceed 0.2mm.

Adjusting method of height difference of release lever: adjust by the adjusting nut of fulcrum bolt of release lever. After adjusting nut (bolt), lock the nut.

The release lever which accords with the height specifications has little movement interference, high transmission efficiency. Furthermore, when the heights are consistent, clutch may disengage completely and engage stably. The heights will increase gradually due to wear of

friction elements during use even though they have been adjusted during overhaul. So they should be adjusted during maintenance in time. In addition, sometimes the friction washer with excessive thickness will make the release lever too low to adjust. In this case, a U-shaped washer with proper thickness may be inserted between clutch cover and flywheel and pulled out when the friction washer is worn thinner. This method can prolong the service life of friction washer, but the clutch cover should be checked whether any of its portions collide with flywheel case.

2) Adjusting of pedal free travel

Under normal condition, pedal free travel is the reflection of the clearance between release lever inside end (or diaphragm spring inside end) and release bearing on pedal. It should be adjusted after repair and assembly to accord with the value of 1.5-2mm (Fig. 2-11).During use, the above clearance and travel will decrease gradually due to the wear of clutch friction elements, so it still need to be checked and adjusted periodically.

The adjusting method of pedal free travel is as follow:

The wear of the matching portions of transmission parts of mechanical control mechanism will reduce the transmission efficiency and increase the pedal free travel, which is unrelated to the clearance between release bearing and release lever. Thus, in order to guarantee the complete disengagement of clutch, when the above matching clearance increases and transmission efficiency declines, the free travel of pedal should be properly adjusted to a smaller value during maintenance.

The adjusting method of pedal free travel is as follow:

(1) Mechanical control mechanism: the adjusting of pedal free travel of mechanically controlled clutch is realized by adjusting the length of pulling rod or steel cable through release fork adjusting nut.

(2) Hydraulic control mechanism: the free travel is generally the reflection of two clearances-between main cylinder piston and its push rod and between release lever inside end and release bearing on pedal. Thus the adjusting of pedal free travel is actually the adjusting of these two clearances.

During adjusting, firstly adjust the clearance between main cylinder piston and push rod by adjusting the length of push rod using adjusting nut. The free travel reflected by this clearance on pedal should be 15-20mm.

Secondly, adjust the clearance between release bearing and release lever by adjusting the length of release fork push rod to ensure that the pedal free travel accords with the requirements-the total free travel of 15-20mm.In this manner, the clearance between release

bearing and release lever will also be within the specified value.

For certain vehicle models, the pedal height is also adjustable, namely, the pedal height limit device is adjusted by stud. The pedal height should be adjusted before the adjusting of pedal free travel.

2.6 Common failures and diagnostics

The common failures of clutch are incomplete disengagement, trembling during starting, transmission slipping, abnormal sound, etc.

2.6.1 Incomplete disengagement

(1) Phenomenon: when engine operates at idling, step down clutch pedal and engage gear in site, there is the sound of gear collision and it is difficult to engage gear; under more serious condition, after in site engaging gear, the engine blows off.

(2) Reason:

the free travel of clutch pedal is excessively large;

The inside end of release lever is too low or not in the same plane;

the newly replaced friction washer is too thick or the driven washer is installed reverse;

Steel sheet of driven plate distorts or friction washer ruptures;

the axial turn of driven plate on splined shaft is not smooth;

the hydraulic system is leaked and the oil quantity is not enough or there is air.

(3) Diagnostic method: diagnose as the following method. The flowchart is shown in Fig. 2-12.

2.6.2 Trembling during starting

(1) Phenomenon: when vehicle starts at low gear, loosen clutch pedal gradually according to the operating specification and press down accelerator pedal slowly, the clutch can’t engage stably and trembles, even makes the whole vehicle buffet.

(2) Reason:

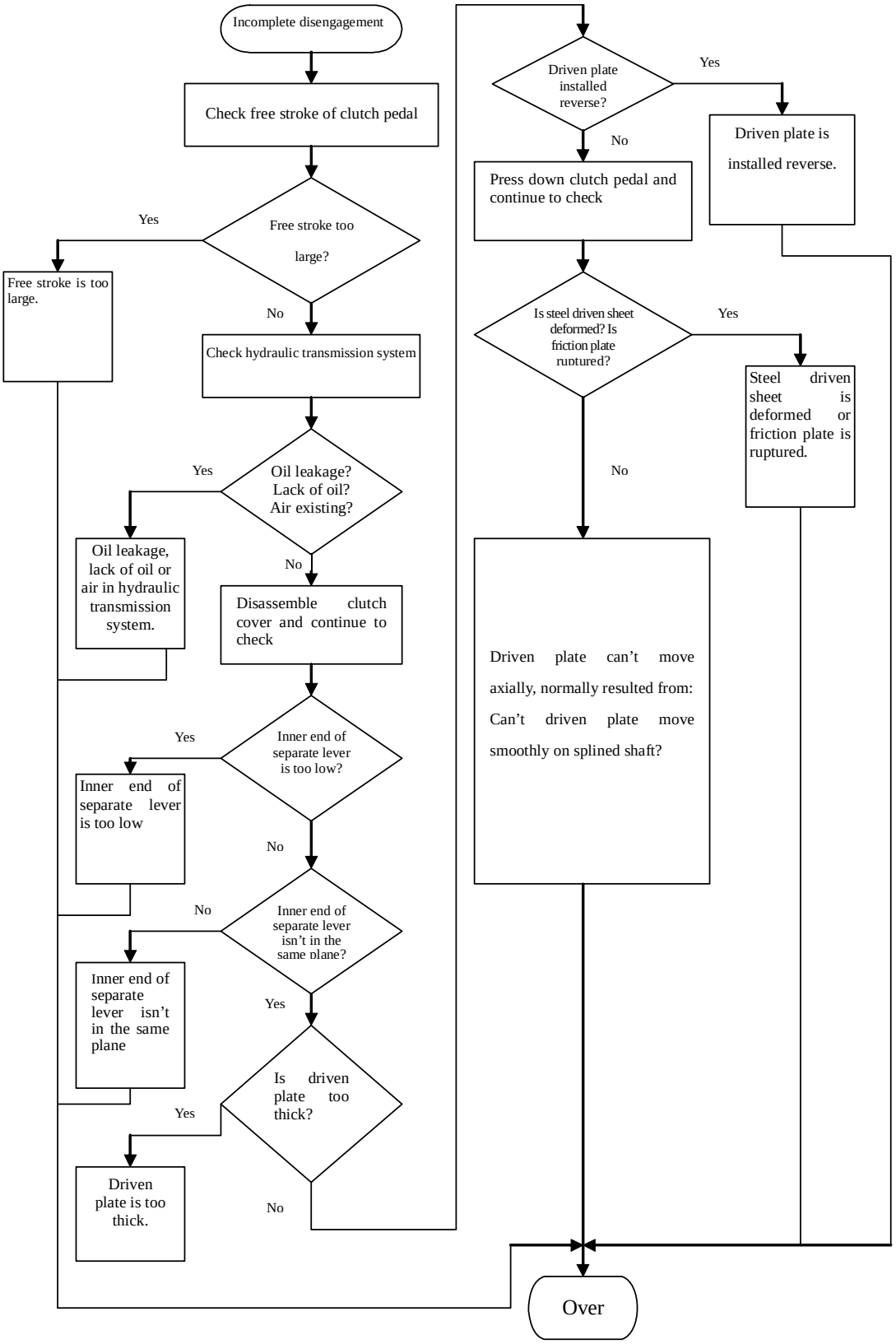


Fig. 2-12 Diagnosis flowchart of incomplete disengagement

Steel sheet of driven plate or pressure plate distort;

the working end of flywheel run-outs seriously;

The heights of inside end of release lever are not in the same plane;

buffer plate on driven plate ruptures, damping spring fatigues or breaks;

There are oil stains, ablation, surface hardening, uneven surface on driven friction washer, rivet head is exposed, rivet is loosened or broken;

individual pressure spring fatigues or breaks;

Fastening screws of flywheel, clutch case or transmission are loosened;

There are serious oil stains and dust between release bearing sleeve and its pipe so that the release bearing can’t return its position.

(3) Diagnostic method: diagnose as the following method. The flowchart is shown in Fig. 2-13.

2.6.3 Transmission slipping

(1) Phenomenon: when the vehicle starts at low gear, it can’t start at all or start very insensitively even though the clutch pedal is lifted very high; when the vehicle drives at high speed, the speed can’t be increased with the increase of engine rotation and, at the same time, the clutch is heated and produces such phenomena as burned taste or smoke; tension the parking brake when the vehicle starts at low gear, the engine can’t blow off.

(2) Reason:

the clutch pedal has no free travel so that the release gear presses on release lever;

Oil stains, ablation, surface hardening, uneven surface or exposed rivet head on driven friction washer;

the working faces of driven friction washer, pressure plate and flywheel are worn seriously and their thickness is reduced.

pressure spring is annealed or fatigues;

there is adjusting washer installed between clutch cover and flywheel or the fixing screw is loosened;

Release bearing sleeve can’t return its position due to oil stains and dust between the sleeve and its pipe or jamming.

(3) Diagnostic method: diagnose as the following method. The flowchart is shown in Fig. 2-14.

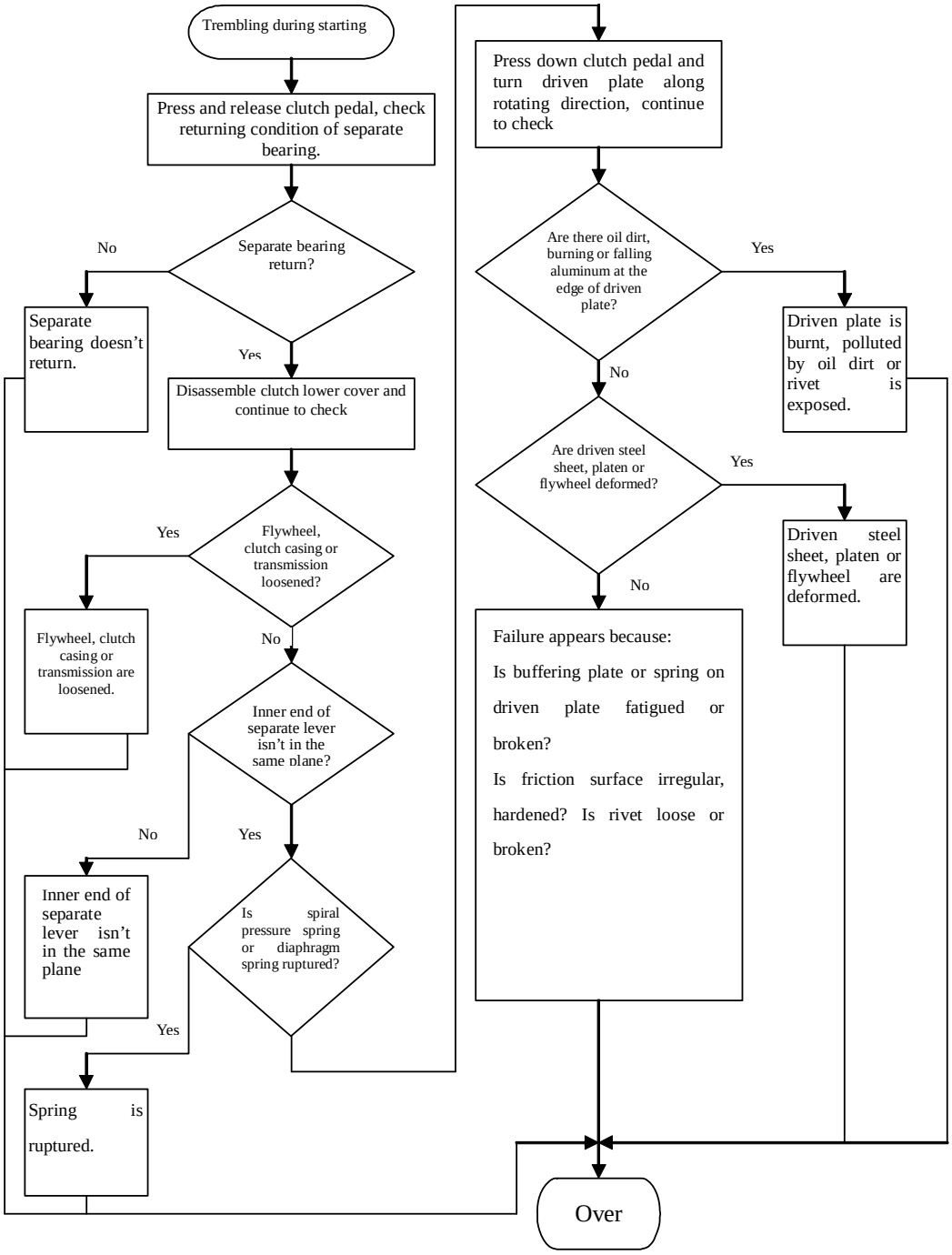


Fig. 2-13 Diagnostic flowchart of trembling during starting

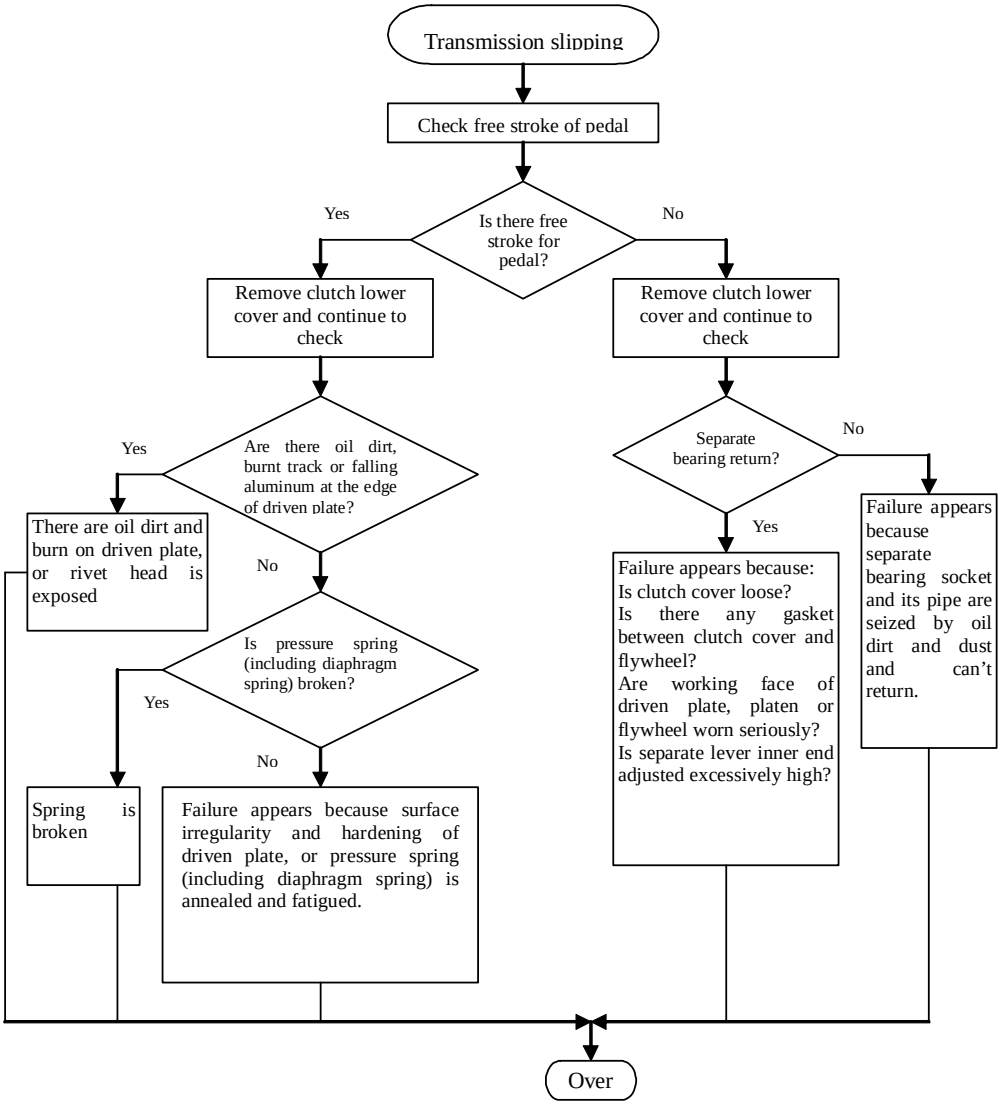


Fig. 2-14 Diagnostic flowchart of transmission slipping

2.6.4 Abnormal sound

(1) Phenomenon: there is abnormal sound produced during clutch disengaging or engaging.

(2) Reason:

Release bearing is dry ground in lack of lubricating oil or the bearing is damaged;

the fit clearances between transmission pin on flywheel and transmission hole in pressure plate or between the driving hole in clutch cover and the bump on pressure plate are excessively large;

the connection between release lever and clutch cover is loosened or the support spring of release lever is fatigued, broken or fallen off;

the fit between driven plate spline hole and its shaft is loosened;

the rivet of driven friction washer is loosened or its head is exposed;

there are serious oil stains and dust between release bearing sleeve and its pipe, or return

springs of release bearing and clutch pedal are fatigued, broken, fallen off thus resulting in bad return of release bearing;

there is no clearance between release bearing and release lever;

damping spring of driven plate is annealed, fatigued or broken.

(3) Diagnostic method: diagnose as the following method. The flowchart is shown in Fig. 2-15.

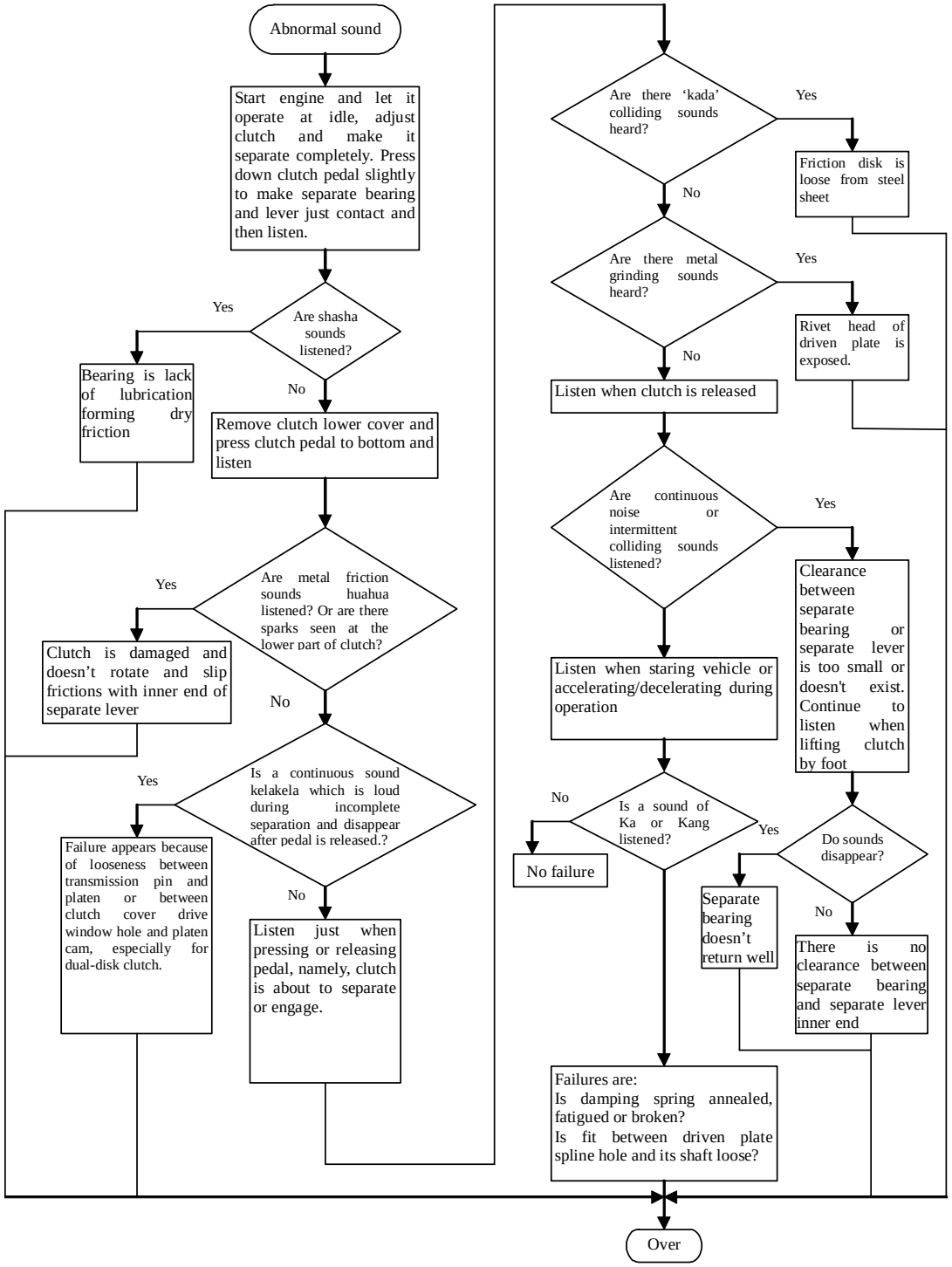


Fig. 2-5 Diagnostic flowchart of abnormal sound

Chapter 3 Transmission

3.1 Diagram of transmission

LG515, CAS520 and CAS525 five-stop transmissions are adopted for Chang'an light truck and they match with engines YND485Q, 485ZL, 490QB, 490QZL, 4100QB and 4100QB-2 respectively.

The diagram is shown in Fig. 3-1.The transmission is an ordinary gear-three shaft one which has five forward stops and one back stop. The transmission is realized by three synchronizers. Stops are shifted by full synchronizer.

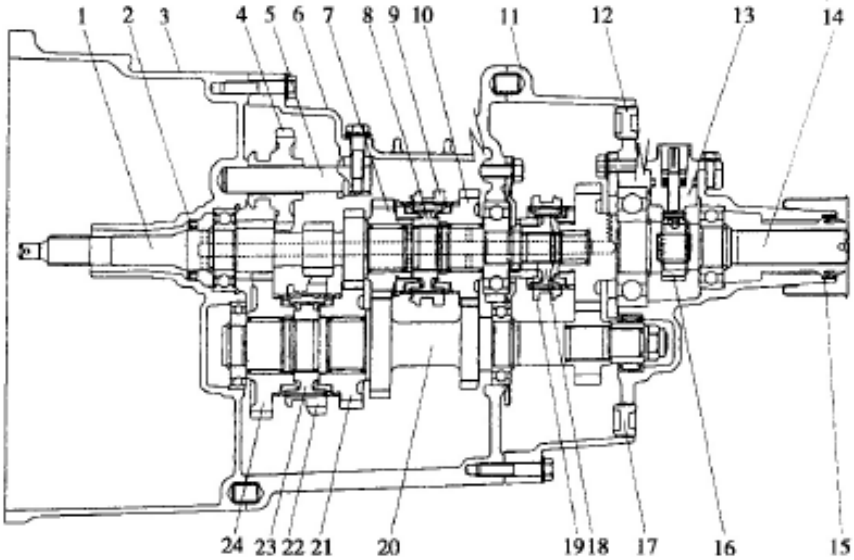


Fig. 3-1 Diagram of five-stop transmission

1-input shaft; 2-input shaft seal; 3-front casing; 4-back stop slip setting wheel; 5- back gear bearing; 6-rear casing; 7-input shaft third stop gear; 8-high speed synchronizer gear hub; 9-high speed synchronizer gear sleeve; 10-input shaft fourth gear; 11-extension tank; 12-oil filler; 13-speed meter driven gear; 14-main shaft; 15-extension tank rear seal; 16-speed meter driving gear; 17-oil drain; 18-fifth stop synchronizer gear hub; 19-fifth stop synchronizer gear sleeve; 20-medium shaft; 21-second stop gear of medium shaft; 22-low speed synchronizer gear sleeve; 23-low speed synchronizer gear hub; 24-first stop gear of medium shaft

3.2 Main parameters of transmission

Table 3-1

Transmission model		LG515	CAS520	CAS525
Center distance (mm)		70	85	85
Max. input torque (N.m)		150	200	250
Lubricating oil designation		80W/90		
Lubricating oil capacity (L)		1.1	1.7	1.7
bearing	Input, output	Ball bearing		
	Medium shaft	Conical roller bearing	Heavy conical roller bearing	Conical roller bearing

stop		Five stops for forward (synchronizer), one stop for backward		
Transmission ratio	I	4.008	6.478	6.478
	II	2.244	3.295	3.349
	III	1.336	1.902	1.902
	IV	1	1.345	1.345
	V	0.839	1	1
	R	3.522	5.830	5.830
Sealing glue	At thread	LOCTTTE 222,242,262		
	At plane	YH - 24R		
Axial clearance of medium shaft conical bearing (mm)		0～0.55		
Tightening torque of locking nut at ends of shafts (N.m)		180~200	180～200	200～250

3.3 Structure of transmission

3.3.1 Structural components, see drawing list.

3.3.2 Power transmission

Neutral

Synchronizer component jointing sleeve on main shaft is at neutral position and makes the stop gears on main shaft engage with the relevant gear and operate without loading so that no power can be transmitted to main shaft via synchronizer.

Power transmission of first stop

When gear lever is set at “low speed”, selector fork of low speed gear pushes low speed synchronizer to low speed driving gear which engages with dog tooth, making low speed gear on main shaft engage with low speed driving gear of medium gear component. In that manner, the power from input shaft component is transmitted to medium gear shaft component after one stage of deceleration and then from medium gear shaft component to main shaft via another stage of deceleration.

Power transmission of second stop

When gear lever is set at “Second stop”, the same low speed gear selector fork pushes low speed synchronizer to another direction making the second stop gear of medium shaft engage with main shaft gear. At that time, similar with the first stop power transmission, after two stages of deceleration, the power produced by engine is transmitted to driving shaft via transmission input shaft gear, medium shaft gear, medium shaft second stop gear and main shaft

second stop gear.

Power transmission of third stop

When gear lever is set at “Third Stop”, high speed shift fork stirs mesh collar of synchronizer to make the third stop gear on intermediate shaft and the third stop gear assembly on main shaft engage and synchronize, so the power from input shaft is sent to main shaft via intermediate shaft and synchronizer realizing power transmission of the third stop.

Power transmission of fourth stop

When gear lever is set at Fourth Stop, high speed shift fork make high speed synchronizer connect with gear of input shaft assembly via dog gear thus directly coupling input shaft assembly and main shaft assembly. At this case, there is no deceleration happened and engine crane shaft drives main shaft directly via input shaft.

Power transmission of fifth stop

The fifth stop is also called overgear. When gear lever is set at Fifth Stop, shift forks of back and fifth stop gears push synchronizer sleeve to make the sleeve engage with fifth stop gear of main shaft and transfer the power of intermediate shaft to main shaft thus driving the vehicle.

Back power transmission

When gear lever is set at Back, shift forks of back and fifth stop gears push synchronizer sleeve to make the sleeve engage with back gear of main shaft and transfer the power delivered to intermediate shaft by input shaft to main shaft via back shaft.

3.4 Wear analysis of main components

The main wear of transmission parts includes wear of matching pairs, casing deformation and cracks. These wears will reduce the working reliability of transmission and bring failures such as automatic disengagement, disturbed engagement, difficult shift, noise, leakage, etc.

Automatic disengagement is the most common failure of transmission. The essence is that there is an axial force produced on tooth face during transmission of engaged sliding gear or synchronizer sleeve, which is more than the lock force (the sum of the friction force of tooth face and the self locking force of shift fork) and pushes the gear from engagement to the neutral position automatically. Thus the formation of axial force is the root reason of automatic disengagement. Theoretically, there should not be any axial force produced by transmission of spur gear or synchronizer sleeve, but the worn parts or deformed casing may disturb the theoretical engagement condition and produce axial component force. Furthermore, the reduction of lock force is the conditional factor of automatic disengagement. Insufficient tooth length, disabled lock mechanism, etc will weaken the locking conditions.

Disturbed engagement refers to the incorrect engagement of gear lever resulted from the excessively large

clearance of the matching positions of gear lever. Lever trembling is the projection of radically or axially vibration and swing of change gear on gear lever. Noise is resulted from the impact during gear transmission. For transmission with synchronizer, difficult shift is resulted from the disabled function of synchronizer components or locking components.

The main wear principles and their effects on assembly working reliability are analyzed as follows:

3.4.1 Transmission casing

The main wear of transmission casing includes cracks, deformation and wear of bearing hole. They are mainly resulted from working load and self gravity.

The working load is the force acted on the casing via shaft and bearing by gear during torque transmission. For common car transmission with the first and second shafts at its top, intermediate shaft at its bottom, front engine and rear drive, the effect principle of working load on transmission casing wear is:

It can be seem from the transmission process that the radical component forces of transmission between the first shaft and intermediate shaft and between intermediate shaft and the second shaft act on the front and rear ends of the casing via shaft and bearing. Their differences in size and direction will result in eccentric wear of bearing hole and deformation of casing thus making the space between the upper and the lower axes increase and that the space between the front ends is more than between the rear ends. This will produce parallelism error in the common plane of the two axes. In the same way, the difference of size and direction of peripheral component forces during gear transmission will make the casing twisted resulting in parallelism error (oblique) in different planes in the direction that is perpendicular to the common plane of the upper and the lower axes and the flatness error of the upper plane (warpage).During emergency braking (including central parking brake), the casing may also be twisted but its twisting direction is reverse to that produced by working load. When the vehicle runs often at low speed stop under heavy working condition, the casing will bear great twisting moment and so the shape and position error resulted from the above deformation will be observed more easily.

The above parallelism error of axis produced on transmission casing will make the transmission of cylindrical gear (or jacketed gear) familiar with that of bevel gear and helical gear and produce component force leading to automatic disengagement of transmission. At the same time, the non-parallelism of axial lines will make the meshing area of gears smaller, the unit pressure increased and the elastic deformation larger resulting in edge engagement. This will increase the speed variation and the unevenness of torque during transmission of gear. It is one of the reasons that produce engagement impact noise and aggravate gear wear.

The flatness error of the jointing plane between transmission casing and cover may result in oil leakage.

Under the action of gravity and impact, the front end face of the transmission which is fixed at the rear end face of engine body or flywheel casing will produce fretting corrosion and deformation, even rupture at the fixing bolt hole. The greater pressing force acted on the lower portion of the plane and thus the greater wear and deformation

will make the front end face of the casing non-perpendicular to the axes of the first and the second shafts. The result is the same as the occasion that the rear end face of the flywheel casing is non-perpendicular to the axis of the crankshaft-the direct stop of transmission is easy to disengage, the bearing of the first shaft is easy to damage, oil leakage is easy to happen at the oil return helical line of the first shaft as well the driven disk of the clutch is easy to damage.

3.4.2 Shaft, bearing and gear

The wear and looseness between neck journal and bearing and between neck journal and gear not only produce noise but also will increase their matching clearance leading to the increase of central distance of engaged gears and the destruction of normal engagement. For stationary shaft, if the back shaft or stationary intermediate shaft fit tightly or transitionally with the casing, when their clearances are worn excessively, oil leakage will occur. If the clearances between shaft and gear and between shaft and flange matching spline are worn excessively, both transmission noise and oil leakage from output shaft spline will occur.

Normally engaging gears are easy to damage but slipping shift gears are prone to wear. Frequently, because of impact during stop shift, the gears will be worn and their teeth will be shortened. At the same time, the axial component force resulted from wear of hand lever, excessive gear axial clearance, incomplete engagement, etc becomes the common reason of automatic disengagement.

3.4.3 Synchronizer

The common deteriorations are wear of friction conical spiral groove, wear of lock chamfer of lock ring or lock pin. If the spiral tip is worn excessively, the oil film will not be broken making synchronous time lengthened and stop shift difficult. The wear of lock chamfer will make the locking effect unreliable and engagement before synchronization will occur and produce engaging noise.

3.4.4 Control parts

The wear of control parts mainly occur at matching position. It is the main reason of incorrect engagement that the wear at the matching positions of the spherical joint and shift fork. Wear of self-lock device and wear between shift fork and groove are one of reasons resulting in automatic disengagement.

3.5 Repair of main parts

3.5.1 Transmission casing and cover

The average cracks can be repaired by welding, but if there are cracks that pass through bearing hole or ones at installing and fixing position, the parts should be discarded.

When the shape and position error between transmission casing and planes exceeds the specifications in Table 3-2, these planes should be repaired. The methods may be filing, scraping or grinding.

Specifications for shape and position error between transmission casing and planes

Table 3-2

Error description	Specifications (mm)
Flatness error jointing surface between casing and cover The length of jointing surface is not more than 250mm. More than 250mm	 No more than 0.15 No more than 0.20
Parallelism error between jointing surface of casing and cover and the common axis of the first and the second shafts	No more than 0.20
Flatness error of the front end face of casing The max. measurable diameter of end face: more than 50-120mm More than120-250mm More than 250-500mm More than 500mm	 No more than 0.08 No more than 0.10 No more than 0.12 No more than 0.15
End face circular run-out of casing front end to the common axis of the first and the second shafts The max. measurable diameter of end face: more than 50-120mm More than120-250mm More than 250-500mm More than 500mm	 No more than 0.08 No more than 0.10 No more than 0.12 No more than 0.15
Flatness error of the rear end face of casing	No more than 0.15
End face circular run-out of casing rear end to the common axis of the first and the second shafts	No more than 0.15

If the shape and position errors relevant to all the bearing holes exceed the specifications listed in Table 3-3 because the casing deformation or bearing hole wear, they should be repaired, or, seriously, discarded. Sleeve insertion method may be adopted during repair, not only the shape error of hole and its matching error with bearing but also the position error of all axes must be guaranteed. During maintenance, if the shape and position errors of transmission casing are excessive resulting in excessive nose or automatic disengagement, they should be generally discarded.

Specifications for shape and position error between transmission casing and shaft

Table 3-3

Error description	Specifications (mm)
Parallelism error between axes	Not 0.02 more than the original design
Dimension error between bearing holes	Not 0.02 more than the original design
Roundness error of bearing holes	No more than 0.008
Fit error between bearing hole and rolling bearing Basic dimension: more than 5—80mm More than 80-120mm More than 120-180mm	 Not 0.02 more than the original design Not 0.025 more than the original design Not 0.04 more than the original design

If the fit error between casing and fixing shaft is 0.015mm more than the original design error, it can be repaired by brush plating or spay coating neck journal or brush plating shaft hole.

If the wear of bearing hole on the cover matching with the spherical joint at the middle of gear lever makes its diameter 0.50mm more than the original design, discard it or repair it by partial replacement.

The matching clearance between shift fork shaft and the cover (or the casing) should be 0.04-0.20. If the maximum value is exceeded, brush plate or replace the shaft or cover (casing) with new one as appropriate.

3.5.2 Gear and spline

There should not be any obvious defect or irregular wear on the meshing face of gear. For slight defect, grind it with oil stone; for serious defect, replace it with new one. Check as shown in Fig. 3-2.

For wear of tooth end of jointing gear or slipping gears matching with each other, the overhaul limit should not exceed 15% of the tooth width, the use limit is 30% of the tooth width; the overhaul limit of meshing side clearance of normally engaging gear should be 0.15-0.50mm and the use limit should not be more than 0.80mm; the overhaul limit of meshing side clearance of jointing gear should be 0.10-0.40mm and the use limit should not be more than 0.60mm; the engaging imprint of gears should be at the middle of the engaging face and should not be less than 60% of the engaging face. Except sleeved gears which may be repaired by build-up welding, if the above requirements can’t be met, all parts should be replaced with new ones. In addition, both parts in one pair must be replaced to guarantee the engaging imprint.

The side clearance between slipping gear and shaft spline should not be 0.15mm more than the original design. The side clearances between gear seat, flange and other non-slipping parts and shaft spline should accord with the original design. If the specification is exceeded, the shaft spline may be repaired by build-up welding, but the side with less wear should be welded.

Check the slipping splines of shafts determine whether there are phenomena such as serious wear, distorted tooth, broken tooth, etc. If any, replace the shaft. Check of slipping spline (Fig. 3-3)

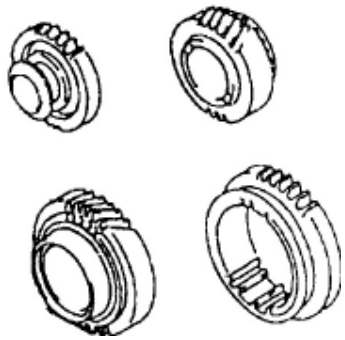


Fig. 3-2 Check of gear

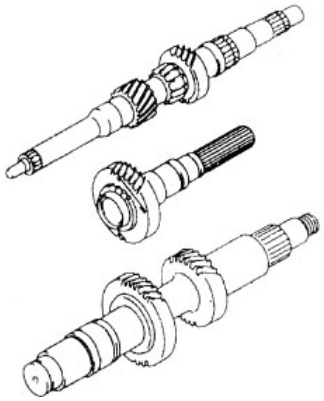


Fig. 3-3 Check of slipping spline

3.5.3 Shaft

For the first, the second and the intermediate shafts, when taking the common axis of neck journals at two ends as datum, the radical run-out at the meddle should not be more than 0.03mm and 0.06mm (for shafts with length of more than 120-250mm and more than 250-500mm respectively).If the error exceeds the specification, correct it by pressure.

Check bearings of input shaft, output shaft and intermediate shaft to determine whether they rotate smoothly, whether there is looseness between internal and external rings, and whether there are any abnormal phenomena, such as sounding, looseness and jamming.

fit between rolling bearing or gear and neck journal: for interference fit, there should no clearance after overhaul and the maximum interference fit value should not exceed the original design; for transitional fit, the clearance is allowed to 0.003mm more than the original design; for clearance fit, the clearance is allowed to 0.002mm more than the original design. If the specification is exceeded, the neck journal may be repaired by brush plating.

Fit between bushing and neck journal and bearing hole: for clearance fit or transitional fit, the clearance is allowed to 0.02mm more than the original design;

For interference fit, the original design should be met. If the specification is exceeded, replace the bushing with new one.

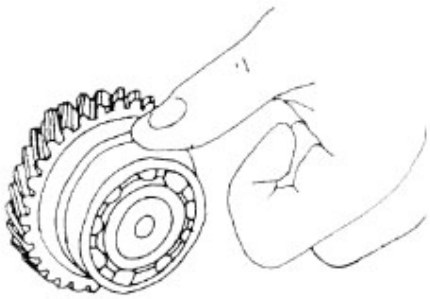


Fig. 3-4 Check of various drive shaft and support shaft

3.5.4 Control parts

The end wear of shift fork should not be more than 0.4mm. The fit clearance between this end and gear ring groove should be 0.2-1.0mm.If the specification is exceeded, the worn end of shift fork may be repaired by build-up welding. The perpendicularity error of shift fork end to the axis of fork shaft hole should not be more than 0.2mm.If the error exceeds the specification, correct it by pressure. The inspection of perpendicularity error is as shown in Fig. 3-5. It can be carried out at transmission cover using square ruler.

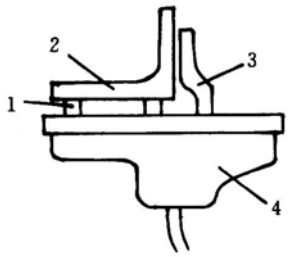


Fig. 3-5 Inspection of perpendicularity of shift fork on transmission
1-fill cushion; 2-square ruler; 3-shift fork; 4-transmission cover

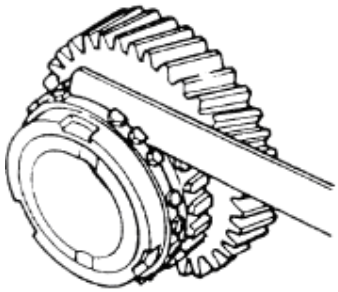


Fig. 3-6 Inspection of joint clearance between synchronizer gear ring and hub

The wear of ball end of gear lever and shift fork groove should not be more than 0.4mm and 0.6mm respectively; the wear of the locating slot of gear lever should not be more than 0.4mm.If the above wear exceeds the specifications, repair by build-up welding.

3.5.5 Synchronizer

If the clearances between lock ring and joint gear end (lock ring type) or between friction cone ring and internal end face of cone disk (lock pin type) is less than the specified one because of wear of spiral slot of friction cone (the inspection of joint clearance of synchronizer gear ring and hub is shown in Fig. 3-6), the synchronizer should be replaced with new one. In addition, if the lock chamfer is worn, repair it by build-up welding, but during machining after welding, the chamfer angle should be guaranteed to accord with the original design requirement.

If the bulge at the middle of the slipping block of lock ring type synchronizer is worn, replace it with new one.

3.6 Disassembly of transmission

3.6.1 Disassembly of transmission assembly

The disassembly of transmission is as follows:

1. Remover the negative pole and the positive pole wires from battery terminals (Fig. 3-7);

2. Remove the backing light switch plug connector of transmission (Fig. 3-8);

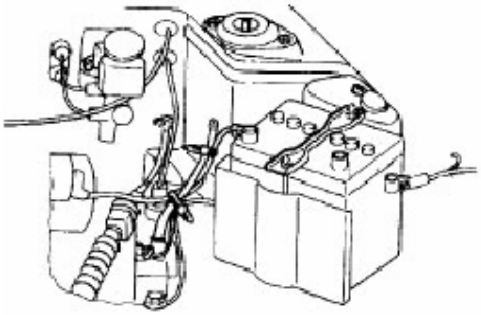


Fig. 3-7 Remove battery wires

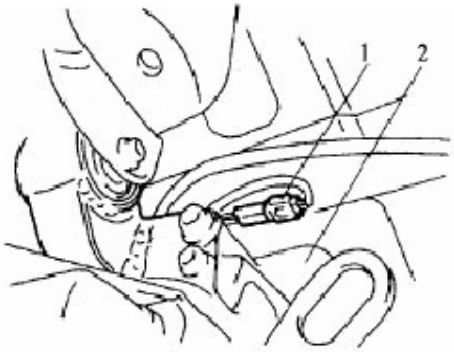


Fig. 3-8 Disconnect backing light switch plug connector

1-backing light switch plug connector; 2-transmission casing

3. Loosen drive shaft bolt from at drive bridge (Fig. 3-9);

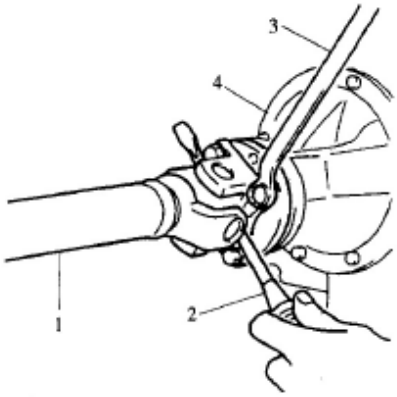
4. Disassemble drive shaft from at drive bridge, take down drive shaft assembly (Fig. 3-10);

5. Disassemble the flexible shaft of trip indicator from at transmission extension box;

6. Disconnect connectors of transmission stick and shifting control stick;

7. Remove clutch component pump;

8. Support engine and transmission by bracket, remove transmission suspension bolt and nut respectively;



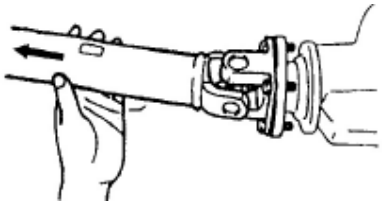


Fig. 3-9 Disassemble drive shaft Fig. 3-10 Remove drive shaft

1-drive shaft; 2-flat screwdriver; 3-wrench; 4-drive bridge

9. Check and ensure that there is no any connection between transmission and vehicle body, engine and other components, remove transmission and clutch assembly.

3.7 Assembly and adjusting of transmission

There are different assembly processes for transmissions with different structure. During assembly, pay attention their features. Main points, precautions and technical requirements of general assembly and adjusting are as follows:

3.7.1 Assembly of subassembly

Generally, some subassemblies (mainly intermediate shaft, second shaft and transmission cover) need to be assembled before assembly of transmission.

1) Intermediate shaft

Generally, transmission intermediate shaft is a rotating shaft. There is a gear that is connected by a key and interference fits with the shaft. During assembly, pay attention to the position and direction of gear and washer which should be pressed into place by press machine.

2) Second shaft

(1) when assembling constant mesh gears, adjust their axial clearance using washers to make them accord with the requirements of the relevant car model. Generally, it should be 0.10-0.30mm in overhaul and its limit value in use is 0.30mm.

(2) Pay attention to the direction of gear. Especially for tooth sleeve and seat of direct gear, they are often equipped with automatic disengagement proof structure, if the gear is installed reverse, the function will be disabled.

(3) During installation of synchronizer, the axial clearance of synchronizer conical ring must be adequate to

avoid elevated local temperature and expansion due to friction during operation, resulting in wear and damage of friction conical face.

3) Transmission cover

(1) After installed and fixed with locating pin, the gear lever should rotate smoothly without jamming.

(2) Install special tool for shift fork shaft (Fig. 3-11) to avoid self-locking steel ball from popping out.

(3) Set the firstly installed fork shaft at neutral position and then install other shafts.

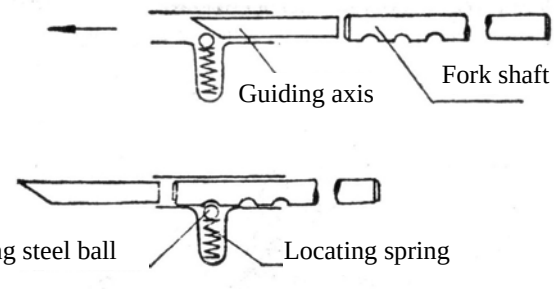


Fig. 3-11 Install shift fork shaft by the guide of guiding axle

(4) Don’t omit self-lock or interlock balls and their specifications should meet the requirements.

(5) The reverse lock device should meet the requirements. The spherical end of reverse lock pin should flush with shifting block notch or extrude less than 0.5mm.

3.7.2 Technological points and precautions during transmission final assembly

(1) The sequence of final assembly is generally intermediate shaft, back shaft, then the first and the second shafts, and, at last, transmission cover.

(2) The end clearance of back gear, intermediate shaft (fixed axis) fixed cone pulley is generally 0.10-0.35mm and the use limit is 1.00mm.If the clearance is excessively large, adjust it by gaskets.

(3) Check the axial clearances during installation. The axial clearance of the first shaft should not be more than 0.10mm and the clearances of other shafts should not be more than 0.30mm.

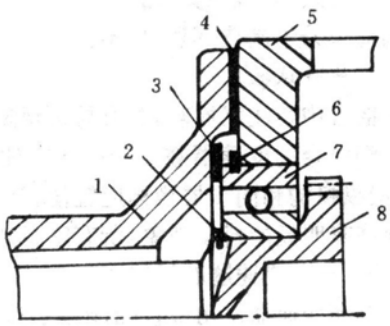


Fig. 3-12 Adjusting of axial clearance of first shaft of transmission

1-bearing cover; 2, 6-clip spring of bearing; 3-metall adjusting gasket; 4-sealing gasket; 5-transmission casing; 7-bearing; 8-first shaft

Generally, the axial positioning of spin axis is realized by the bearing at its one end, so the ideal adjusting status is that bearing cover presses external ring of bearing to guarantee no axial clearance existed. This will not only be beneficial for gear transmission but also reduce the slipping chance between bearing external ring and transmission casing thus reducing wear loss.

Adjusting method: increase or decrease the thickness of sealing gasket 4 of bearing cover, or increase or

decrease the thickness of sealing gasket 3 of bearing external ring (Fig. 3-12).The principle to determine the thickness of gasket is that, under the premise that there is no oil leakage from bearing cover sealing, press the end face of bearing external ring ad tight as possible, namely, reduce the axial clearance as possible.

(4) The planes of odometer drive gear and the cam of the second shaft should be even to avoid oil leakage.

(5) The normally engaging gear pair between intermediate shaft and the second shaft should align with each other. If they don't align with each other, adjust by adjusting the position of intermediate shaft at the front and the rear end.

(6) For assembled gear transmission mechanism, check whether the gear engagement accords with the requirements;

Engaging clearance: 0.10-0.50mm for normally engaging gear, the use limit is 0.80mm; 0.10-0.40mm for jointing gear, the use limit is 0.60mm.

Engaging impression: should at the middle of gear engaging face and should not be less than 60% of the engaging surface.

(7) When covering transmission cover, check that there should be no any foreign matter remained in the cover, all gears of various stops and shift fork should be at neutral position; after installation, perform engagement test for all stops, there should not be any abnormality.

3.8 Maintenance of transmission

The main work of transmission maintenance is inspection and replacement of gear oil.

3.8.1 Inspection of gear oil

Park the vehicle on horizontal ground and unscrew oil level check plug, check whether the level of transmission gear oil meets the requirements and whether the gear oil is dirty or deteriorated. Replace gear oil if necessary.

3.8.2 Replacement of gear oil

Set transmission gear at neutral position, start engine and engage clutch. Let the engine operate at idle for 3-5min and then stop it and drain out transmission gear oil entirely. Fill flesh gear oil of specified brand with specified quantity.

3.9 Common failures and diagnostics

The common failures of transmission are oil leakage, abnormal sound, automatic disengagement, mixed disengagement, etc.

3.9.1 Oil leakage:

(1) Phenomenon: there are obvious oil trace at peripherals of transmission cover, peripheral of side cover of

casing, filler port plug, drain port plug, oil return thread of the first shaft, oil seal of the second shaft (or oil return thread) or bearing cover.

(2) Reason:

The jointing plane is deformed or machined roughly;

The sealing gasket at the jointing plane is excessively thin, hardened or damaged;

The fixing screws at transmission cover, casing side cover and bearing cover are loosened or their tightening sequence doesn't accord with the requirements; The oil seal and neck journal are misaligned during installation, the oil seal is installed reversely or worn, hardened, or the neck journal is misaligned with shaft;

The oil return thread is misaligned with neck journal, there are serious dirty deposits in the groove of oil return thread or there are machining burrs which hinder oil return;

The neck journal of oil seal is worn into grooves;

Oil filer, oil drain port plug is loosened or its thread is damaged;

There are casing defects or cracks.

(3) Diagnostic method: diagnose as the following method. The flowchart is shown in Fig. 3-13.

3.9.2 Abnormal sound:

(1) Phenomenon: the noises of engagement of transmission gear, bearing operating, etc are excessively loud; there are abnormal sounds such as dry grinding, impact, etc from transmission.

(2) Reason:

①. The rolling bearing is lack of oil (for example, the leading bearing of the first shaft); its rolling balls are worn and out of circularity; there are pits, delamination, bruises in raceway; the inner or outer raceway rolls on shaft or in casing, or the clearance between bearing is excessively large;

②. The gear rotates offset or its teeth are deformed because that the machining precision is low or the heat treatment process is improper;

③. The tooth clearance is excessively large or the matching clearance of spline is excessively large;

④. The burrs, projections, etc on the repaired tooth face are not trimmed;

⑤. The tooth face has flakes, delamination, defects, excessive wear or the gears are not replaced by pair;

⑥. The first, the second or the intermediate shafts is bent and deformed;

⑦. After repaired by boring and nesting, the central clearance of the two bearing holes in casing changes or the two axes are not parallel;

⑧. The camber of shift fork after repair is wrong, or the build-up welding at single side is excessively thick resulting in incorrect position of the relevant gears;

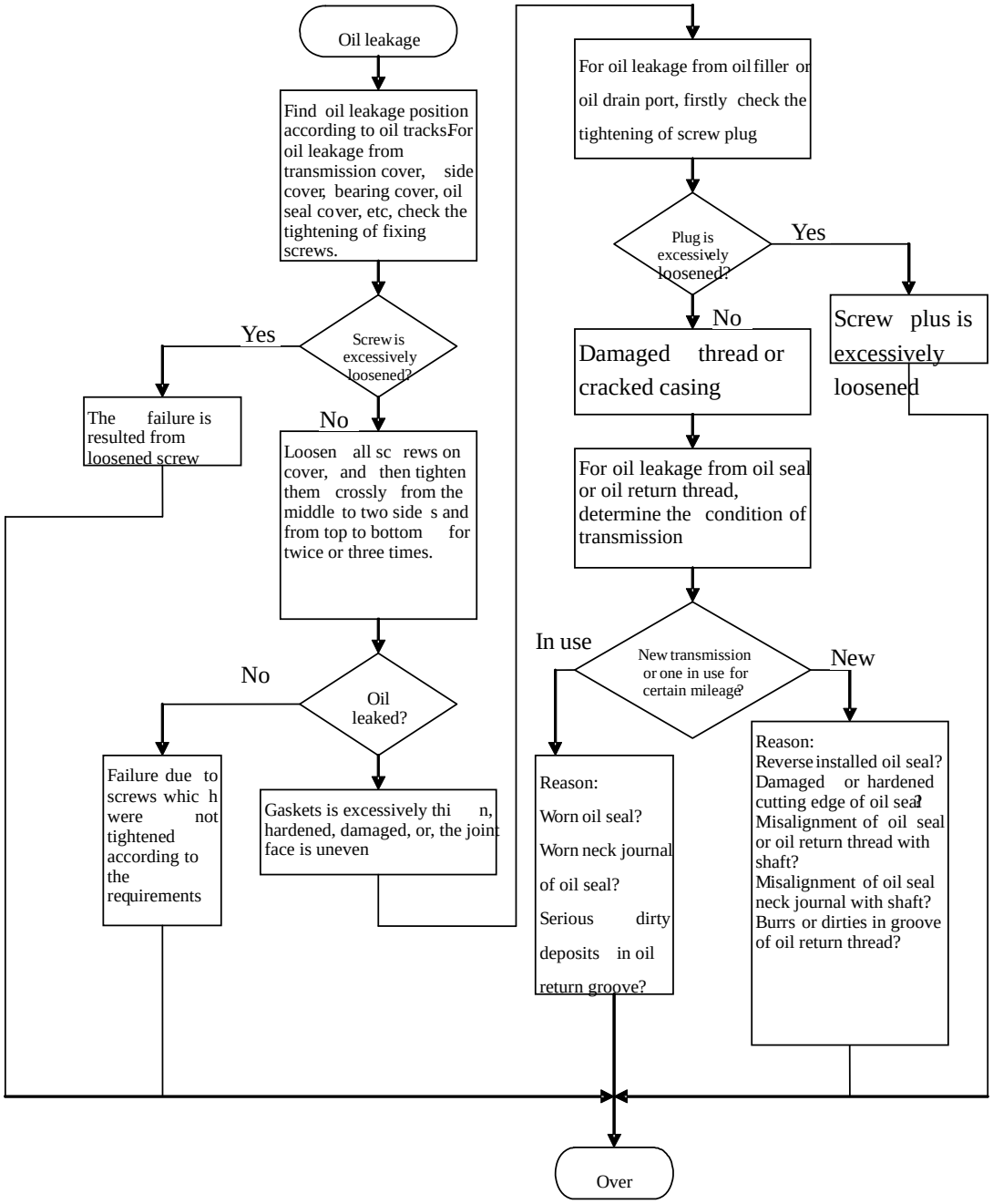


Fig. 3-13 Diagnostic flow chart of oil leakage of transmission

⑨. The fixing nut of the second shaft is loosened or the axial positioning of other shafts is incorrect;

⑩. The groove and steel ball of self lock device are excessively worn, or, the self lock spring is fatigued or broken leading to offset during engagement;

⑪. Individual gear teeth are broken;

⑫. The gear oil is inadequate or deteriorated, or its designation doesn't accord the requirements, or there are odds and ends in the gear oil.

(3) Diagnostic method: diagnose as the following method. The flowchart is shown in Fig. 3-14.

3.9.3 Automatic disengagement:

(1) Phenomenon: sometimes when the vehicle accelerates with heavy load or climbs, the gear shift shifts

automatically from certain stop back to the neutral position.

(2) Reason:

The engaging portion of the pair of gears engaging with each other is worn to form conical shape;

Because of the change of the position of the hole behind clutch casing, the change of perpendicularity of the jointing plane between clutch casing and transmission casing to the axis of crankshaft, or the bearings of the first shaft and the second shaft are excessively loosened, the first shaft, the second shaft and crankshaft are not on the same axial line;

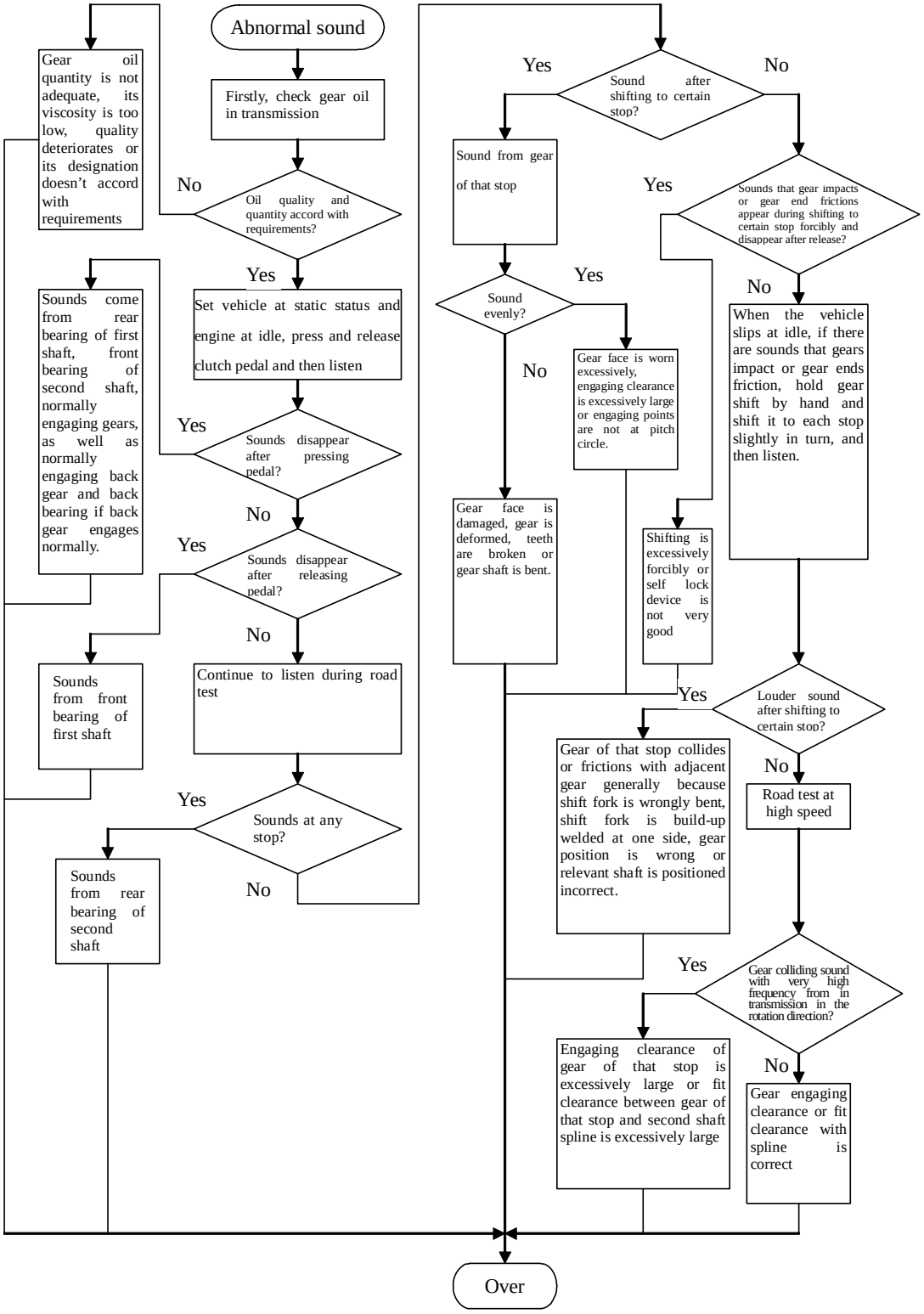


Fig. 3-14 Diagnostic flow chart of abnormal sound of transmission

After engagement, the engagement of gear can't reach the whole length of its teeth or the self lock steel ball doesn't enter groove;

The axial clearances or the radical clearances of various shafts are excessively large;

For transmissions with several normally engaging gears, the axial clearance or radical clearance of the normally engaging gear installed on the second shaft is excessively large;

The groove and steel ball of self lock device is worn seriously, or self lock spring is fatigued or broken.

(3) Diagnostic method: diagnose as the following method. The flowchart is shown in Fig. 3-15.

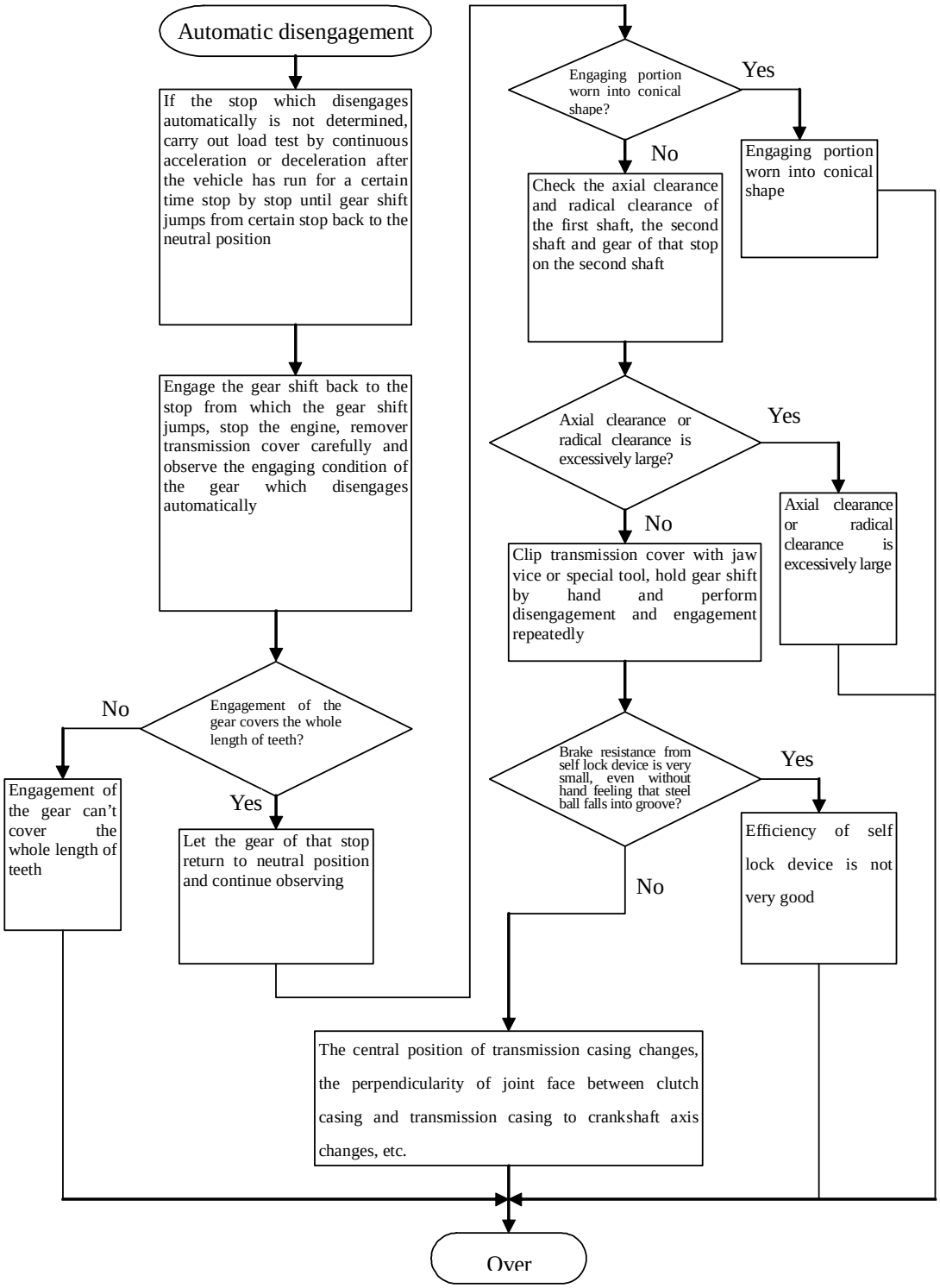


Fig. 3-15 Diagnostic flow chart of automatic disengagement of transmission

3.9.4 Speed disorder

(1) Phenomenon: under the condition that the clutch separates completely, engagement or disengagement can't be realized; engagement for certain speed is performed results in another speed.

(2) Reason:

interlock device is damaged;

the length of the lower end of gear lever is inefficient, the working surface of the lower end is excessively worn, or, guide slot of guide block on transmission fork is excessively worn;

locating pin of ball end of gear lever is loosened or broken, or ball end or sphere hole is excessively worn.

(3) Diagnostic method: diagnose as the following method. The flowchart is shown in Fig. 3-16.

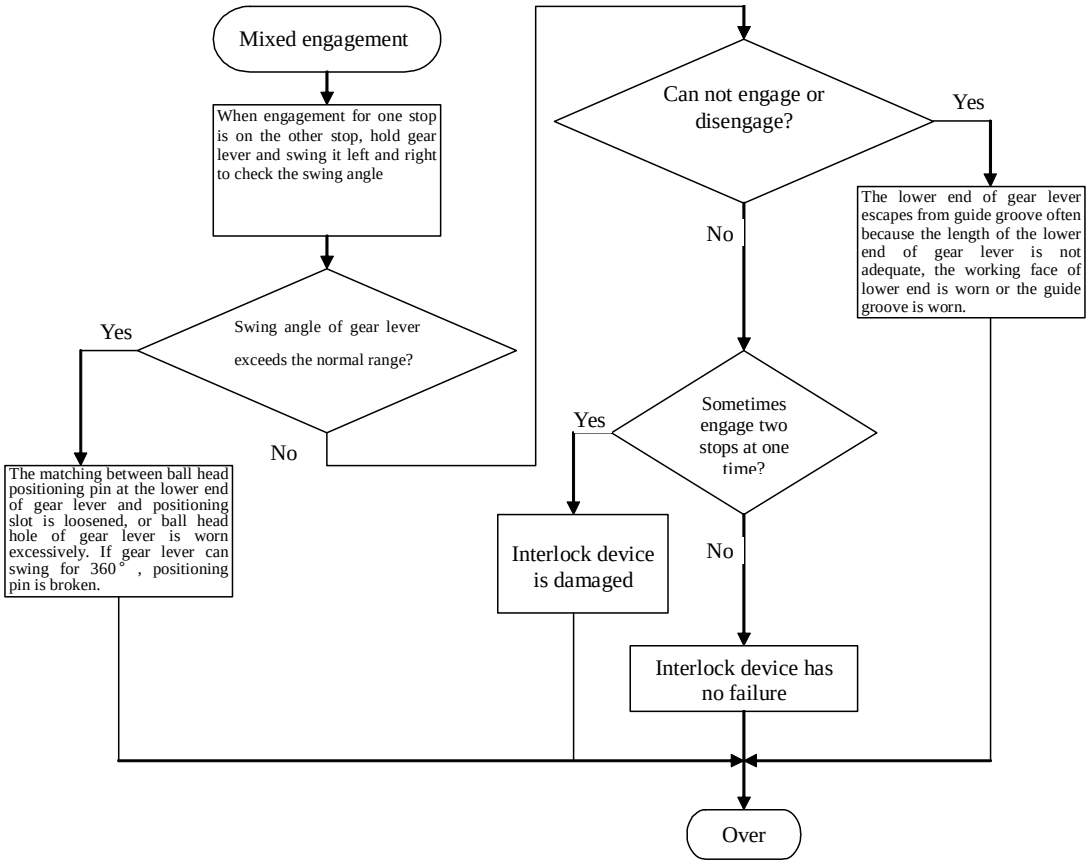


Fig. 3-16 Diagnostic flow chart of speed disorder of transmission

Chapter 4 Drive shaft

4.1 Structure of drive shaft

The drive shaft assembly is made up of drive shaft, front and back universal joints, which is connected to active bevel gear of driving axle and output shaft of the transmitter via flange joint.

Cross shaft of each universal joint is installed with 4 needle roller bearing.

Drive shaft assembly with double cross shafts can adapt relative displacement of the drive axis to the transmitter caused by change of road conditions and loads to realize constant speed transmission of output shaft of the transmitter and active input gear (Figure 4-1).

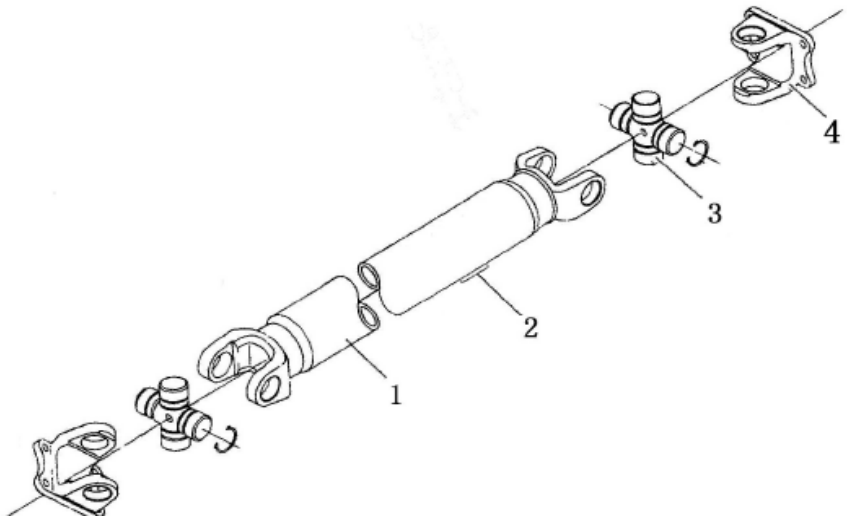


Figure 4 - 1 Drive shaft assembly

1-Drive shaft assembly; 2-Balance block; 3-Cross shaft; 4-Flange wrench yoke of universal joint

4.2 Wear analysis of main parts

Wear of the drive shaft includes spline, cross shaft and bearing, middle support and shaft neck wear and distortion and deformation of the drive shaft.

4.2.1 Part wear

The spline is one of the main wear parts of the drive shaft, which is basically one-side wear. After the wear becomes loose, the drive shaft makes sound in accelerator shifting and the vibration sound from unstable engine revolution from high shift to low shift. Besides, the spline is side centering, for excessive wear, it leads to disalignment of the spline shaft and spline sleeve to cause unbalance and sound is heard, which is increased with increasing of the revolution.

For the cross shaft and bearing perform rotation, the relative speed is very low and the lubricant film is not easy to form.

Single-side stress may lead to groove on the shaft neck and the matching clearance is increasing, which is similar with the result of increasing of the matching clearance of the spline.

Looseness of shaft neck and bearing of the middle support of the drive shaft may cause radial shimmy by non-locating of the rotation axis, with the sound increasing with the revolution.

4.2.2 Deformation of the drive shaft

Deformation of the drive shaft includes shaft tube bending, hollow and disalignment of the shaft tube and spline joint. The shaft bending and hollow may be caused by collision of projection on the road or in maintenance. Disalignment of the shaft tube and spline joint is caused by improper welding technology.

The above deformation of the drive shaft will generate an offset quantity from the rotation axis to break the balance. As mentioned above, when the unbalanced part is rotating, the centrifuge force F will be generated, namely,

$$F = mr\omega^2 = mr(\pi n/30)^2$$

Analyzed from material mechanics, for such slim parts like drive shaft, the centrifuge force will make the drive shaft further bended, the bending and deformation will be larger with higher revolution, namely, r is becoming larger. And the centrifuge force is further increasing. The additional load accelerates the support wear and the sound becomes louder with increasing revolution. Such vibration may cause unbearable resonance on the vehicle frame and vehicle body at some revolution.

In addition, sound drive shaft may generate elastic deformation caused by its own weight and make the mass center deviated from the rotation axis. In the principle, vibration will generate with higher revolution. When the revolution is close to its inherent frequency, resonance will occur, the amplitude increases dramatically and the drive shaft is finally broken. The said revolution is called critical revolution n_k. For the designed n_k is far higher than n_{max} (Generally n_k = 1.2 ~ $2n_{max}$), so such phenomena will not occur in general. However, if the drive shaft is lengthened improperly when refitting the vehicle, n_k is decreasing and such phenomena are likely to occur.

4.3 Check and repair of the main parts

4.3.1 Shaft tube

Radial total run-out of overall length of the shaft tube shall be in line with rules in table 4-1 (0.2mm less for car). When it exceeds the specified values, flame is recommended to calibrate. When pressure is used to calibrate, shape of the pressure head shall match outer diameter of the shaft tube to avoid flattening the shaft tube.

Radial total run-out of the shaft tube（mm） Table 4—1

Length of drive shaft L	600~1000	>1000

Permissible error	No more than 0.8	No more than 1.0

Note: Length of the drive shaft refers to the distance from the spline shaft end to axis of bearing hole of the shaft tube yoke.

If there is obvious hollow, severe collision or cracking and etc. on the shaft tube surface, it must be replaced.

4.3.2 Spline shaft and spline sleeve

Radial round run-out of external surface of the spline shaft and shaft neck of middle support of the drive shaft may not be more than 0.15mm. When it exceeds, cut it off and additional welding is required.

4.3.3 Universal joint yoke

Bearing hole of the universal joint yoke and bearing of the universal joint are excessive matching, when the matching clearance exceeds the specified values, new parts are used to replace.

Matching clearance of cross shaft neck of universal joint and bearing of universal joint shall be in line with rules in table 4-2. If it exceeds the rules, new parts are used to replace.

Matching of cross shaft neck and bearing (mm) Table 4—2

Diameter of cross shaft neck	≤18	>18~23	>23
Permissible maximum clearance	0.08	0.10	0.14

Verticality error of public axis of two bearing holes of shaft tube yoke to axis of drive shaft shall be in line with rules in table 4-3. When it exceeds rules, cut off the shaft tube and additional welding is required. The verticality error can be detected on the plate with the method indicated in figure 4-2.

Verticality error of public axis of two bearing holes of shaft tube yoke to axis of drive shaft (mm)

Table 4 — 3

External end surface distance of two holes of tube shaft yoke	≤75	>75~90	>90~105	>105
Vertical error no more than	0.10	0.20	0.25	0.30

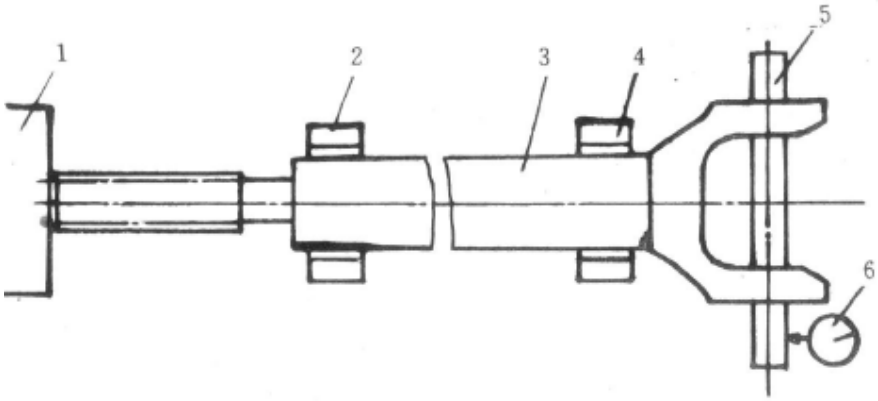


Figure 4-2 Inspection of verticality error of public axis of two bearing holes of shaft tube yoke to axis of drive shaft
1-Square box; 2, 4-V iron; 3-Drive shaft; 5-Core shaft; 6-Percent meter

4.3.4 Middle support

If bearing, oil seal and rubber parts of the middle support are damaged, they shall be replaced with new ones.

Matching quantity of bearing of middle support and shaft neck is -0.02～+0.02mm; matching of oil seal and oil seal neck shall be no more than 0.030mm. If it exceeds the above requirements, coating or embedding can be used for repair.

4.4 Balance of the drive shaft

After overhaul of the drive shaft, it needs balancing. During balancing, assemble sliding yoke, universal joint and dust-proof sleeve on the specified direction. The dynamic balance test is to be done on professional dynamic balance testing machine. Dynamic unbalance quantity of any end may not be more than values in table 4-4. The welded balance piece on each end may not be more than 3 pieces.

Permissible unbalance quantity of the drive shaft Table 4-4

Outer diameter of shaft tube of the drive shaft（mm）	≤58	> 58~80
Permissible dynamic unbalance（g·cm）	30	50

After dynamic balance is realized for the drive shaft, location marks are done on the sliding yoke and flange yoke to avoid breaking the balance.

4.5 Dismounting and disassembly of the drive shaft

4.5.1 Dismounting of the drive shaft assembly

（1） Place the vehicle on the maintenance channel or lift up the vehicle;

（2） Assembly mark is done on the connection of the flange yoke of the drive shaft and flange disc of active

bevel gear of driving axle(Figure 4 - 3);

(3) Connection bolt of flange yoke of the drive shaft and flange disc of active bevel gear of driving axle(Figure 4-4);

(4) Dismount the drive shaft assembly from the driving axle.

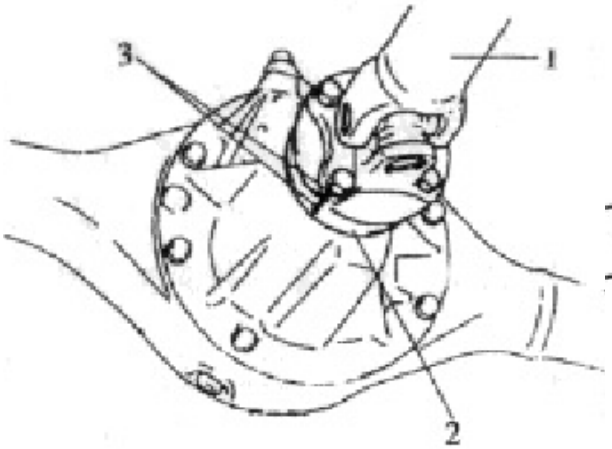


Figure 4-3 Make assembly mark of the drive shaft

1-Drive shaft; 2-Flange disc of active bevel gear; 3-Assembly mark

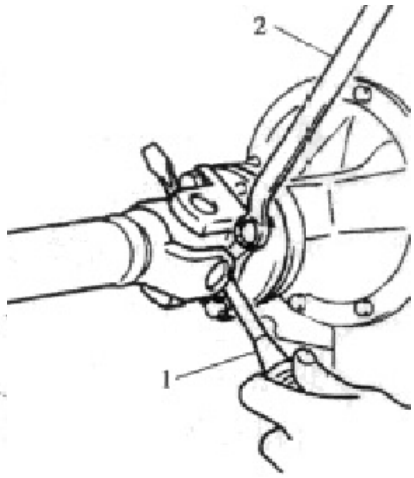


Figure 4-4 Dismount flange yoke bolt

1-Screwdriver; 2-Box wrench

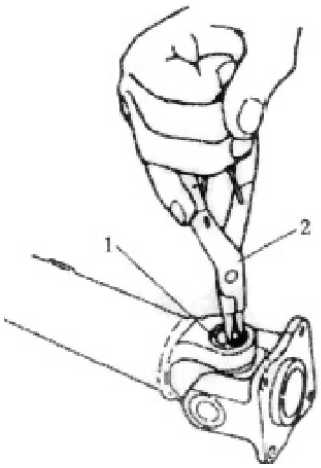
4.5.2 Disassembly of the drive shaft assembly

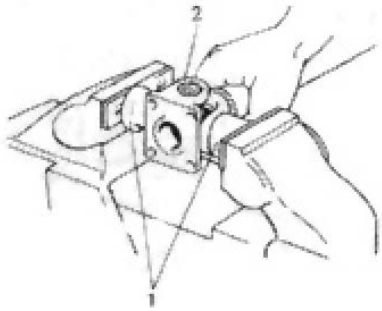
(1) Opening ring forceps is used to disassemble two clamp rings of the cross universal joint bearing (Figure 4-5);

(2) Universal joint assembler is used to pull the cross shaft bearing seat ring 3-4mm out from the universal joint yoke seat ring (Figure 4-6);

(3) Knock on the universal joint yoke of the drive shaft slightly with hammer to disassemble the cross shaft bearing seat ring (Figure 4 - 7);

(4) The same method above is used to press the bearing seat ring at the flange yoke side out, then bench clamp is used to clamp the bearing seat ring, knock on the flange yoke slightly to take the seat ring out(Figure 4-8).





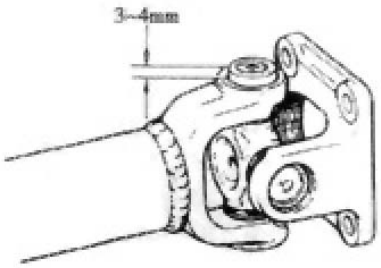


Figure 4-5 Disassemble clamp ring of bearing of universal joint

1-Clamp ring; 2-Opening ring forceps

Figure 4 - 6 Disassemble cross shaft bearing

l-Bearing assembler; 2-Flange yoke of universal joint

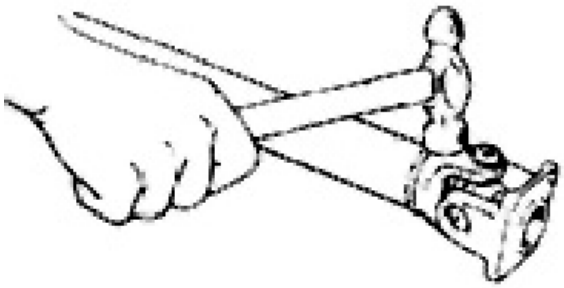


Figure 4-7 Disassemble cross shaft bearing seat ring

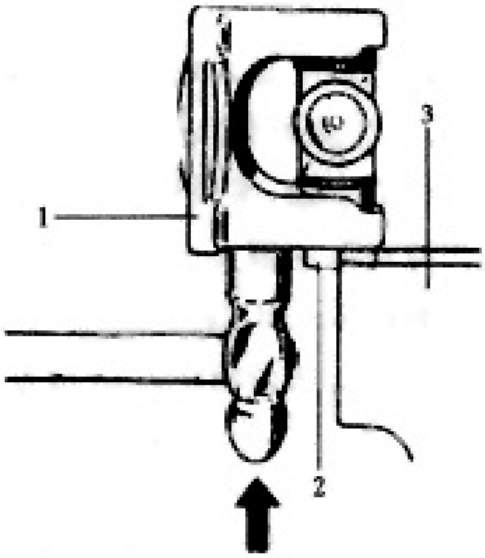


Figure 4-8 Disassemble bearing seat ring at flange yoke side

1-Flange yoke; 2-Bearing seat ring; 3-Bench clamp

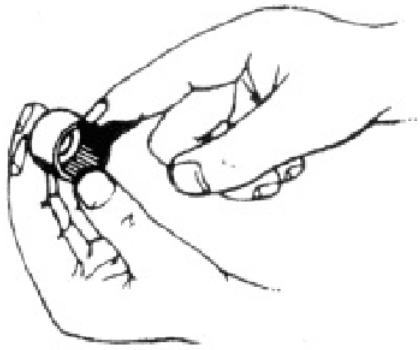
4.6 Assembly of the drive shaft

4.6.1 Lubrication of cross shaft needle bearing (Figures 4-9 and 4-10)

The needle is installed in the seat ring of the cross shaft bearing, and appropriate lubrication grease is coated on the seat ring of the cross shaft bearing and needle.

4.6.2 Assembly of the needle bearing(Figure 4-11)

After 4 needle bearings are coated with lubrication grease, the bearing seat ring is inserted into the universal joint yoke, then the cross shaft is inserted into the bearing seat ring, knock on the needle bearing seat ring with hammer slightly until it is aligned with the universal joint yoke surface.



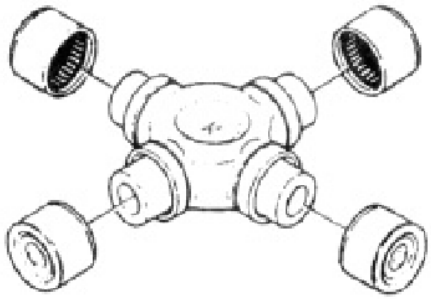
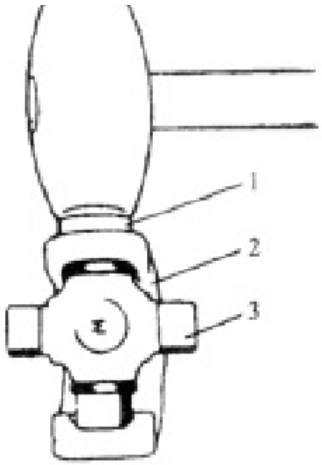


Figure 4-9 Lubrication of cross shaft bearing

Figure 4-10 Combination of cross shaft and bearing seat ring

4.6.3 Mounting of clamp ring of bearing (Figure 4-12)

After the cross shaft and needle roller are inserted into the universal joint yoke hole, 4 clamp rings are used to fix the shaft and flange of the universal joint.



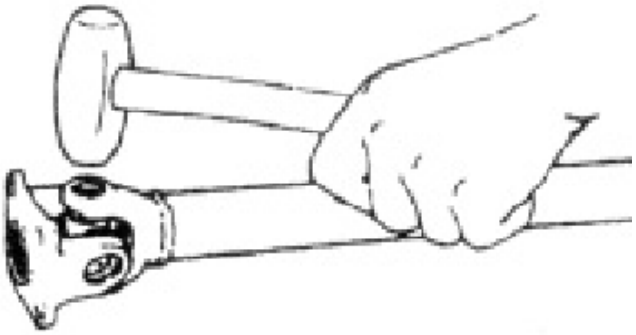


Figure 4-11 Mounting of needle bearing

Figure 4-12 Mounting of bearing clamp ring

1-Bearing seat ring; 2-Universal joint yoke; 3-Cross shaft

4.6.4 Mounting of the drive shaft

Mounting of the drive shaft is conducted according to the opposite sequence of dismounting. During mounting, assembly mark of flange yoke of the drive shaft and connecting disc of the active bevel shall be aligned. Tighten the bolt and nut according to specified fastening torque.

Tightening torque of the bolt and nut: 60～80 N·m.

4.7 Troubleshooting and experienced analysis

The common failures are abnormal sound and increasing walking angle.

4.7.1Sounding of universal joint and expansion joint:

(1) Phenomena: when the vehicle starts or changes speed, the transmission device makes an uttering sound; when the vehicle reduces speed, the transmission device makes a gobble sound.

(2) Causes:

① Looseness of bearing of the universal joint caused by wear or impact;

② Looseness of spline of expansion joint of the drive shaft caused by wear or impact;

③ Looseness of connecting bolt of flange disc of universal joint.

(3) Diagnosis methods: diagnosis is performed according to the following methods. See the flow chart 4-13.

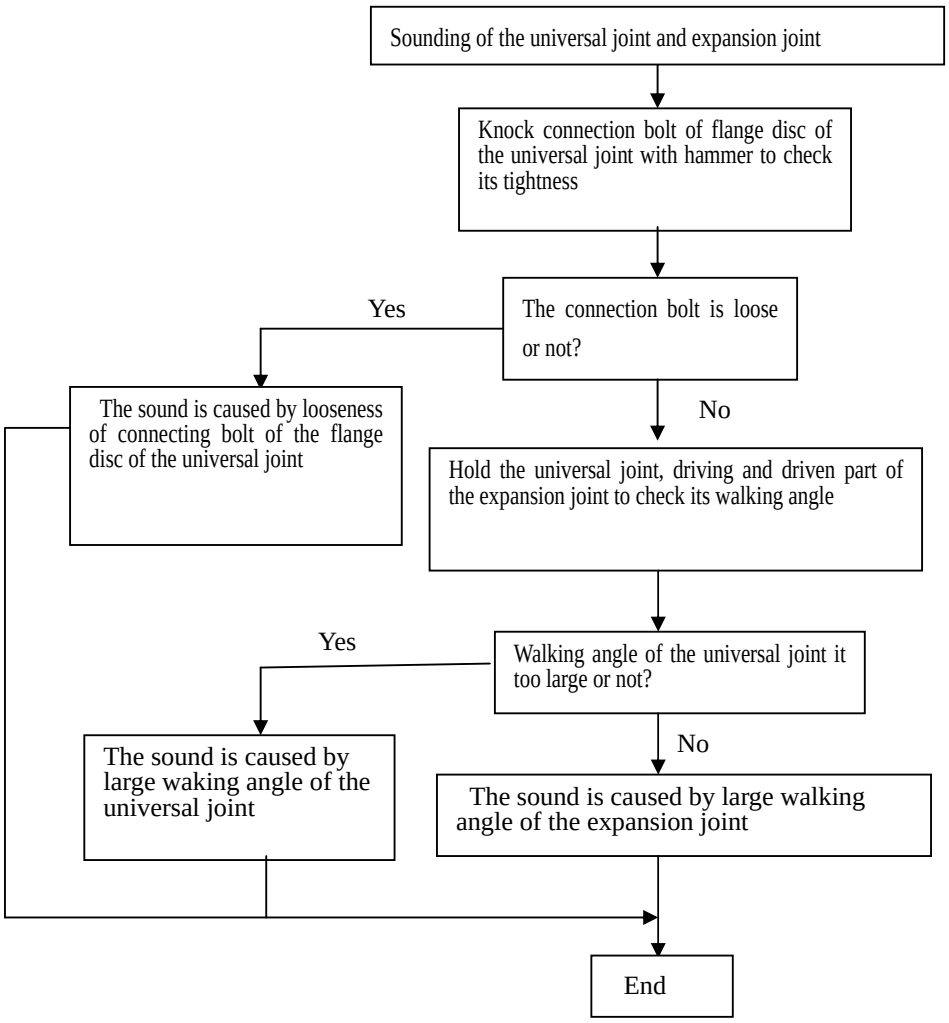


Figure 4-13 Diagnosis flow chart for sounding of universal joint or expansion joint

4.7.2 Sounding of the drive shaft:

(1)Phenomena: under sound technical conditions of the universal joint and expansion joint, the drive shaft makes regular sound during traveling of the vehicle, it increases with higher speed. If it is severe, the vehicle body vibrates and even the steering wheel feels numb.

(2) Causes:

① Bending of the drive shaft or hollow of the shaft tube;

② When the drive shaft tube and universal joint yoke are welding, it is not aligned or dynamic balance is not done for the drive shaft;

③ Balance piece on the drive shaft is dropped off;

④ The expansion joint is not installed according to the mark to make the transmission joint lose dynamic balance, or yokes at both ends of the drive shaft are not on the same plane;

⑥ Looseness of fixing bolt of hanger of the middle support or connecting bolt of flange disc of the universal joint makes the drive shaft deviated;

⑥ Fastening method of the rubber clamping middle support, which causes front end of the middle drive shaft away from the original axis.

(3) Diagnosis method: the diagnosis is performed according to the following method. See Figure 4-14.

4.7.3 Sounding of the middle support:

(1)Phenomena: during traveling of the automobile, the vehicle makes “hoot” sound, which increases with higher speed.

(2)Causes:

① Scale, spot, excessive wear or oil leakage of the rolling bearing;

② Mounting method of the middle support is not proper, which makes the rolling bearing bear additional load;

③ Damage of the rubber round ring;

④ Deformation of the vehicle frame.

(3)Diagnosis method: the diagnosis is performed according to the following method. See Figure 4-15.

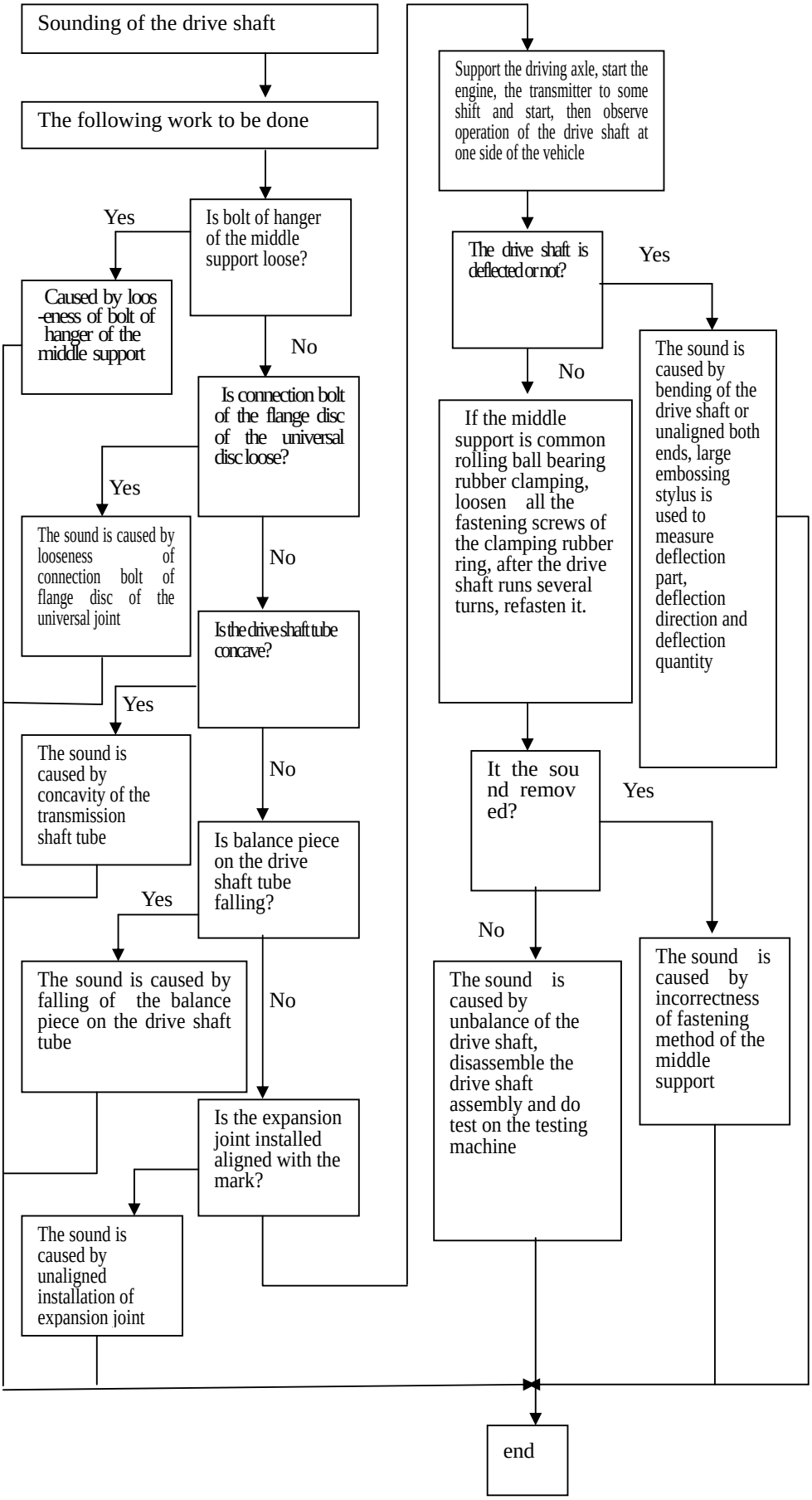

Sounding of the drive shaft
The following work to be done
Is bolt of hanger of the middle support loose?
Yes
Caused by loos -eness of bolt of hanger of the middle support
No
Is connection bolt of the flange disc of the universal disc loose?
Yes
The sound is caused by looseness of connection bolt of flange disc of the universal joint
No
Is the drive shaft tube concave?
Yes
The sound is caused by concavity of the transmission shaft tube
No
Is balance piece on the drive shaft tube falling?
Yes
The sound is caused by falling of the balance piece on the drive shaft tube
No
Is the expansion joint installed aligned with the mark?
The sound is caused by unaligned installation of expansion joint
Support the driving axle, start the engine, the transmitter to some shift and start, then observe operation of the drive shaft at one side of the vehicle
The drive shaft is deflected or not?
Yes
The sound is caused by bending of the drive shaft or unaligned both ends, large embossing stylus is used to measure deflection part, deflection direction and deflection quantity
No
If the middle support is common rolling ball bearing rubber clamping, loosen all the fastening screws of the clamping rubber ring, after the drive shaft runs several turns, refasten it.
It the sou nd remov ed?
Yes
The sound is caused by incorrectness of fastening method of the middle support
No
The sound is caused by unbalance of the drive shaft, disassemble the drive shaft assembly and do test on the testing machine
end

Figure 4-14 Diagnosis Flow Chart for Sounding of Drive shaft

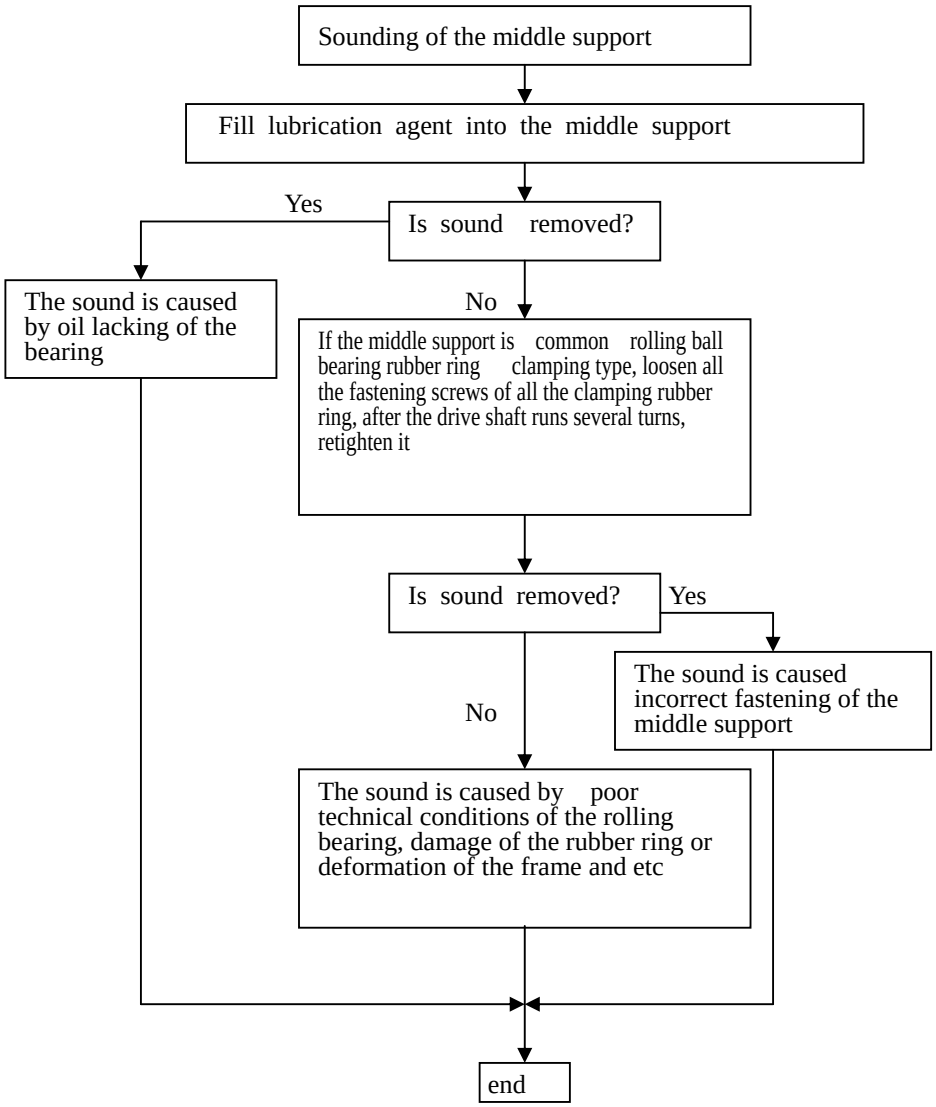


Figure 4-15 Diagnosis Flow Chart for Sounding of Middle Support

4.7.4 Walking angle:

Walking angle of the transmission system is the sum of walking angles of the clutch, transmitter, universal transmission unit and driving axle, therefore, it is also called total walking angle of the transmission system. It represents adjustment and wear of the whole transmission system.

(1)Phenomena: when the automobile starts or the speed changes suddenly, the transmission system makes an “utter” sound; the vehicle is still, the transmitter is on the shift, lift up the clutch pedal, loose the park brake, rotate the drive shaft with your hand and you can feel there is so much looseness.

(2)Causes:

① Matching of driven piece of the clutch and 1st spline of the transmitter is loose;

② Meshing space of transmission gear of the transmitter is too large or the matching of the sliding gear and spline is loose;

③ Expansion joint of universal transmission unit and the universal joints are loose;

④ Matching clearance of the main reducer and differential of the driving axle and matching of half shaft gear, half shaft gear and half shaft spline and etc.

(3)Inspection methods:

Inspection of walking angle of the transmission angle is divided into sections, and the walking angle of each section is summarized to obtain the total values. The experience is used to check the walking angle, and the angle value can be estimate with experience. The check can be conducted under the circumstances of flameout of hot conditions:

① Inspection of walking angles of clutch and transmitter: The transmitter is shifted on the shift to be inspected, loose the park brake, the clutch is engaged, then rotate output shaft of the transmitter or the park brake disc from one limit location to the other limit location with your hand. Rotating angle between the limit locations is the walking angle from shift of the clutch to output end of the transmitter. After the clutch works for each shift, walking angle of each shift is obtained.

② Inspection of walking angles of the universal transmission unit: lift up the driving axle, haul tight the park brake, then rotate flange disc of the driving axle from one limit location to the other limit location with your hand. Angle between the two limit locations is the walking angle of the universal transmission unit.

③ Inspection of walking angles of the driving axle: loosen the park brake, the transmitter is on idle shift, the driving axle landed or braked, the rotate flange disc of the driving axle from one limit location to the other limit location. Rotating angle between the two limit locations is walking angle of the driving axle.

Sum of the above three walking angles is the walking angle of the transmission system.

Chapter 5 Axle

5.1 Structure of the driving axle

The cargo carrying vehicle of SC series manufactured by the factory employs integrated driving axle, with high carrying performance and passing performance. The driving axle is located at the end of the transmission system of the vehicle, which is made up of main reducer, differential, half shaft and driving axle shell and etc. The function is: the engine torque from the universal transmission unit is transmitted to the driving wheel via main reducer, differential and half shaft to reduce the speed and increase torque; the bevel gear couple of the main reducer is used to change direction of the torque; the differential is used to realize differential speed of the wheels on both sides ensure different revolutions and directions of the internal and external wheels. See Figure 5-1.

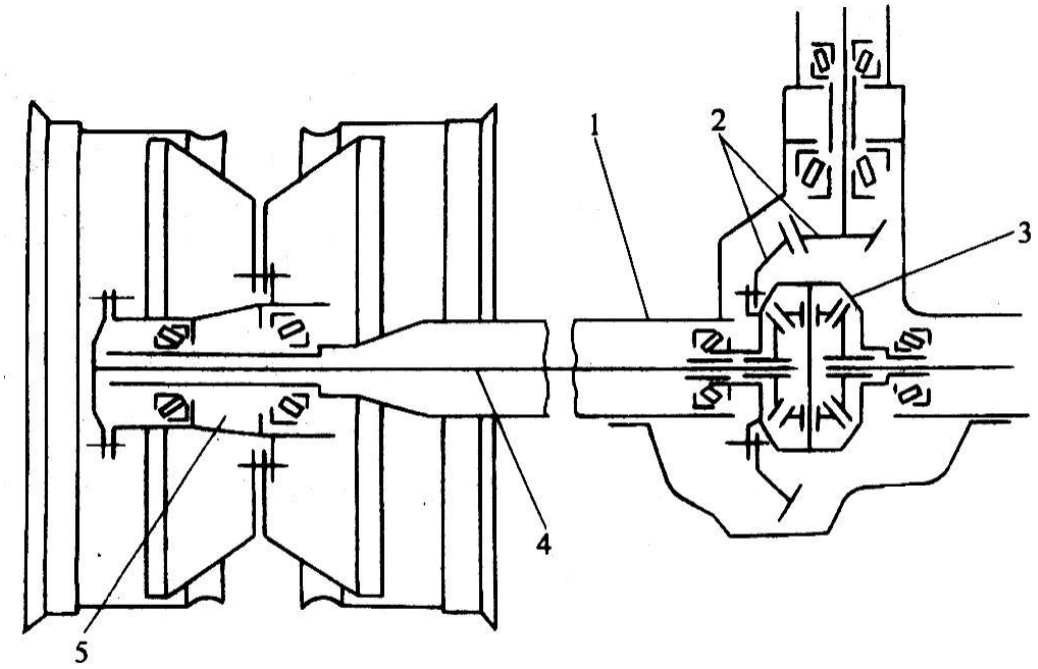


Figure 5-1 Integrated driving axle

1-Driving axle shell；2-Main reducer; 3.Differential; 4-Half shaft; 5-Wheelhub

5.2 Main technical specifications

5.2.1Technical parameters of the front axle

Internal inclination of master pin: 7.5°

Wheelbase: 1440mm

External inclination of the front wheel: 1°

Rotating angle of internal wheel: 40°

Rotation angle of external wheel: 32°

Front wheel toe-in: 2mm-4mm

5.2.2 Technical parameters of rear axle:

Wheelbase: 1485mm

Maximum output torque of the main reducer: 8000 N.m

Supporting distance: 940mm

Main reduction ratio: 5.857

Gear oil quantity in main reducer: 2.2 L

5.2.3 Tightening torque of main parts of rear axle

Table 5-1

	Item	Tightening torque N·m
Rear axle	Fastening bolt of bearing cover of differential	120 ~ 170
	Fastening nut of differential shell and driven wheel	80 ~ 100
	Bolt and nut of the half shaft	30 ~ 50
	Bolt of bearing seat of driving bevel gear	90 ~ 110
	Connection bolt of main reducer and rear axle shell	50 ~ 80
	Big nut of driving wheel	210 ~ 240
	Oil level indication and oil discharging plug	130 ~ 150
	Internal nut of rear wheel	≥280
	External nut of rear wheel	≥350
	Fixing bolt for brake bottom plate	50 ~ 80
	Bolt and nut of left and right differential shells	70 ~ 100

5.3 Wear analysis of main parts

5.3.1 Rear shell and half shaft sleeve tube

For the axle shell and half shaft sleeve tube bears impact vertical load, horizontal load (brake and

driving force) and torsion load transmitted by the main transmitter, additional load by gravity of the main reducer and etc., the stresses are so complicated and there are so many wears. It includes: bending, deformation and cracking of the axle shell; wear and deformation of combination plane of the axle shell and main reducer shell; wear of excessive combination of the half shaft sleeve tube and the axle shell; wear of shaft neck of bearing of wheel hub of half shaft sleeve tube and the matching part of bearing of external end of semi-floating half shaft and etc.

Bending and deformation of the axle shell make bending alternating stress on the half shaft which causes tiredness and cracking, meanwhile, the wheel generates internal inclination and toe-in (or negative toe-in), which accelerates wear and leads to abnormal wear.

The half shaft sleeve tube and axle shell are excessive matching, owing to micro-motion wear, the outmost shaft neck is most likely to be loosed, and it is hard to find out if we do not pull the sleeve tube out. After the matching clearance becomes larger, depending on the second outmost shaft neck support, the suspension arm is lengthened to make the support toughness reduced. At this time, the following may occur: when the wheel is overhead, the brake clearance is done; after the wheel is placed down on the ground, it is hard to brake. The cause is that when the wheel will not take the force, after it is placed on the ground, reaction of supports makes the half shaft bend upwards to reduce clearance at the lower part of the wheel brake.

Cracking of the axle shell is generally on the steel plate base with maximum bending torque and brake bottom plate with collective torsion stress.

5.3.2 Main reducer shell

Main wear of the main reducer shell

Main wear of the main reducer is wear of the bearing hole, location error between the axis and axis, axis and the plane location error out-tolerance. Especially verticality and position tolerance of axis of the driving and driven bevel gears affects most on reliability of the main reducer. When the error is excessive, there should be no correct meshing mark and meshing clearance, which causes non-conformed meshing mark and reduced area. It dose not only make noise, but also shortens service life of the gear for collective stresses.

5.3.3 Half shaft

Main wear of the half shaft includes wear, distortion and breaking of the spline. For the half shaft spline is the one bearing the maximum torque, with big wear and distortion. Breaking of the half shaft is generally at round corner of the flange root and spline end with collective stresses.

5.4 Repair of main parts

5.4.1 Axle shell and half shaft sleeve tube

The integrated axle shell takes shaft neck on both ends as basis, with parallel degree error of the front end surface no more than 0.30mm and 0.40mm (diameter of the front end surface will not be more than and more than 300mm respectively), radial jumping of the external shaft neck shall be no more than 0.30mm. The sectional axle shell takes combined cylinder surface, combined plane and internal cone on the other end as support, radial round jumping of the internal and external shaft neck shall be no more than 0.25mm. End surface round jumping of the combined plane of the axle and reducer shall be no more than 0.10mm and 0.08mm (diameter of the combined plane shall be over and no more than 200mm respectively). Radial wear of the oil seal neck of the axle shall be no more than 0.15mm. Matching of the axle and half shaft sleeve tube shall be in line with the original design rules. Matching of the sleeve tube shaft neck and bearing shall be in line with the original design rules.

When it exceeds the above rules, the plane can be repaired by scraping or grinding, the shaft neck can be repaired by galvanization, coating or surfacing welding. After repair, the radial round jumping shall be no more than 0.08mm. The oil seal neck can be repaired with surfacing welding.

End surface round jumping and radial round jumping of combination plane of the axle shell and brake hub chassis and cylinder surface to axle shell axis shall be no more than 0.10mm. Otherwise, flange of the axle can be repaired by grinding.

In case of deformation of the axle shell, it can be calibrated with pressure or flame. If heat pressure is used to calibrated, the heating temperature shall be no more than 700℃.

5.4.2 Main reducer shell

Matching of holes on the shell and the bearing (or the bearing cap) shall be in line with the original design rules. It is interference, and the limit may not exceed a matching clearance of 0.02mm.

Co-axial degree of holes of the left and right bearings of the differential may not exceed 0.10mm.

Parallel error of the cross shaft support hole axis of the reducer to the front end surface may not be more than 0.12mm and 0.10mm (the axis length may be more than and no more than 200mm).

Verticality error of the longitudinal axis to the cross axis shall be no more than 0.16m and 0.12mm (the longitudinal axis length shall be more than and no more than 300mm). The longitudinal and cross line shall be at the same plane (in addition to the hyperbola gear structure) and the location error may not be more than 0.08mm.

If it exceeds the above requirements, it can be repaired by replacement or embedding.

5.4.3 Half shaft

Crack detection shall be done for the half shaft, if there is any cracking, it must be rejected.

There should be no evident torsion on the half shaft spline, otherwise, it must be rejected. Clearance of the spline gear side may not be more than the original design rules 0.15mm, otherwise, it may be rejected or repaired by surfacing welding.

Take the spline axis as basis, radial round jumping for the unprocessed part in the middle shall be no more than 1.30mm, radial round jumping of external cylinder surface of the spline shall be no more than 0.25mm, round jumping of the internal side end surface of the flange of the half shaft shall be no more than 0.15mm. When it exceeds the rules, pressure calibration and end surface grinding can be used for repair.

5.5 Assembly and adjustment of the steering axle

To ensure correct and reliable connection of the parts, the following points shall be paid attention to:

(1) Before installing the main pin, the standard adjustment washer must be selected to make the clearance between the upper end surface of the front shaft and the steering joint in line with the standard;

(2) When installing the main pin and thrust bearing, add lubrication grease in the lining and bearing. The thrust bearing is installed in the concave seat of the steering joint with opening downwards, and wood hammer is used to knock the main pin into the main pin hole;

(3) After locking inserting hole of the cross pin of the main pin, nut on the cross pin shall be tightened to specified torque, at this time, exposed length out of the hole of big head of cross pin shall be no less than 2mm;

(4) To protect transition round corner at root of the finger shaft of the steering joint, internal chamfering of the assembled oil seal ring or spacing ring may not be less than the transition round angle;

(5) Nut is used to adjust matching clearance of the internal and external bearings of the wheel hub, the bearing shall be free of evident axial clearance to make rotate evenly.

5.6 Assembly and adjustment of the driving axle

Assembly and adjustment of the driving axle includes assembly and adjustment of the main reducer and differential and assembly and adjustment of the wheel hub. The key point is assembly and adjustment of the main reducer. The adjustment is the key for quality of assembling. In addition, adjustment of the main reducer and wheel hub bearing is one the key maintenance jobs for vehicles.

5.6.1 Assembly and adjustment key points for the differential

(1) When the driven gear is fastened on the differential shell with bolt, the bolt shall be tighten symmetrically with specified torque to avoid deformation. After fastening, check round jumping error of back of the driven gear, which shall be no more than 0.10mm;

(2) The side with oil channel of gasket of the gear of the half shaft shall aim at the half shaft gear;

(3) The planet gear shall operate smoothly and freely. Meshing clearance of the planet gear and half shaft gear shall be in line with the original design rules; when it exceeds the rules, it can be adjusted by replacing the thrust gasket or replacing the gear.

(4) When assembling the differential shell, please aim it at the assembly mark.

5.6.2 Assembly and adjustment of the main reducer

Assembly and adjustment sequence of the main reducer is before the total assembly, then adjust pre-tightness of bearings of the driving and driven gears, then adjust meshing mark and clearance during assembly. In addition, if there is a thrust device on the back of the driven bevel gear, the thrust device needs to be adjusted. For double-level main reducer, assembly and adjustment of the second reduction gear can be done.

(1)Adjustment of pre-tightness of the bearing

①The torque of 150～180N·m is used to tighten the nut of the wheel hub bearing, meanwhile, rotate the wheel to make the bearing roller at correct position;

Loosen the nut of the wheel hub bearing about 1/4-1/3 turns to make cylinder on the internal nut aim at the upper hole of the locking washer;

The torque of 150～180N·m is used to tighten the external nut, rotate 2-3 turns, then the opening pin is inserted;

Cutting force at the wheel hub bolt shall be 25～35N. At this time, the wheel hub can rotate freely without axial displacement and swinging.

Notes:

When maintaining the wheel hub, it shall be assembled or disassembled smooth to prevent cutting edge of the oil seal from damaging.

Do not make external seat ring of the oil seal lost.

When replacing internal of the wheel hub, the two edge sealed with oil shall be coated with thin lubrication grease.

After the wheel hub is adjusted, pay attention to temperature of the wheel hub in the first 10Km travel, such as heating. It means that the bearing is over-tightened and it needs re-adjusted.

(2)Adjustment of the main reducer

Main reducer of the rear axle is to increase the torque from the transmitter to reduce revolution and the torque is distributed to the left and right wheels. Bevel gear of main reducer of the rear axle and bearing have been selected and adjusted before leaving the factory, under general circumstances, it does not need to dismount and adjust. When the gear is worn, clearance at the gear side and axial clearance of the bearing is excessive or evident abnormality or damaged parts, it needs dismounting and adjusting.

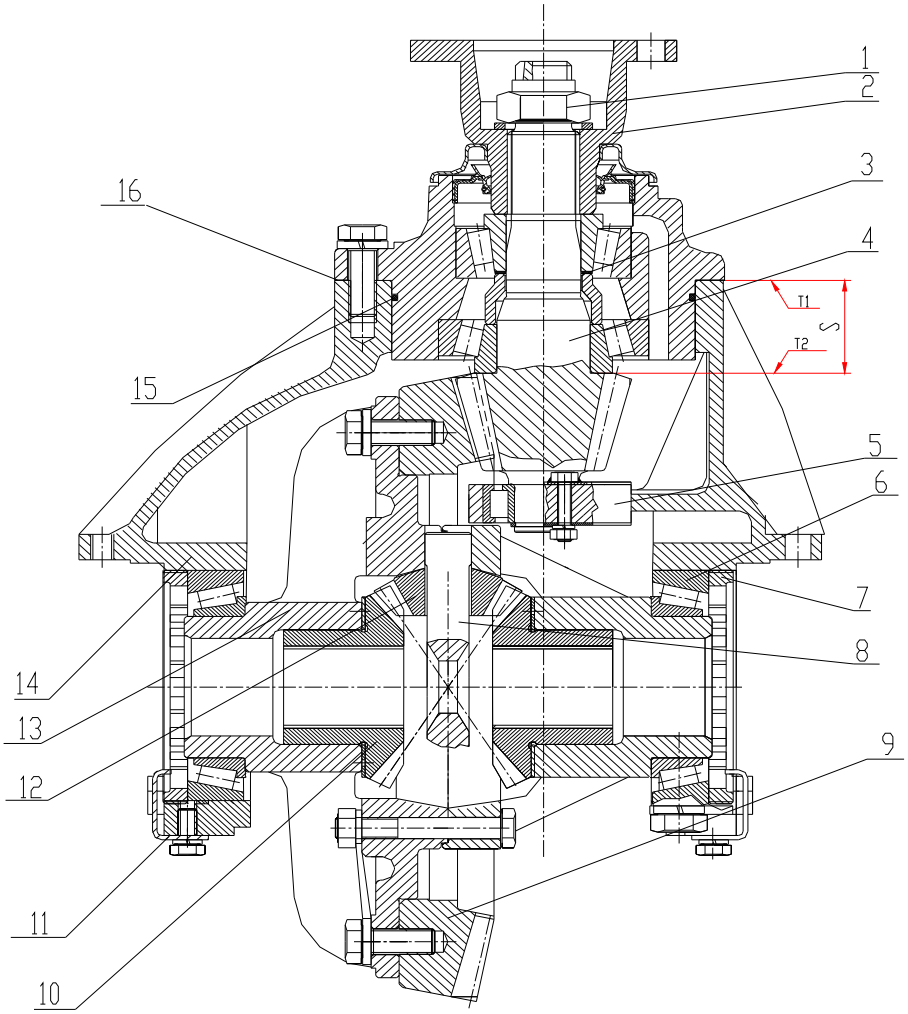


Figure 5-2 Main reducer and differential

1-Main cone locking nut; 2-Flange; 3-Adjustment gasket; 4-Main cone; 5-Rear bearing; 6-Differential bearing; 7-adjustment nut; 8-Cross shaft; 9-Driven bevel gear; 10-Half shaft gear; 11-Locking piece; 12-Plantary gear; 13-differential shell; 14-Reducer shell; 15-Seal ring; 16-Adjust gasket

1) Adjustment of pre-tightness of bearing of the main reducer

a Dismount the rear axle from the transmission, then the torque of 210～240N·m is used to tighten the flange nut 1, then the hand is used to pull the flange 2, it should be no clearance, otherwise, it needs adjusting.

b Adjustment of bearing clearance of the main reducer is realized by adjust the gasket 3 between inner ring of the two bearings. After adjustment, the force of 1.5～2.5N·m can be used to rotate the driving bevel gear by the flange 2 inner holes.

c Adjustment of pre-tightness of the differential bearing is realized by tightening nut of the differential bearing with a torque of 130～150N·m, without axial displacement and the driven gear shall be smooth. When re-assembling connection bolt of the left and right

different shell, all the screws must be cleared and fastening gel is coated for the screws (Kerui 271 screw fastening gel is used).

2) Adjustment of tooth surface meshing and tooth clearance of the main reducer

Note: if there is a great difference in adjacent teeth of the driven gear in the contact area, the driven and driving bevel gear shall be changed until it is the same.

a The tooth surface meshing employs both-side coating method to inspect on the driven bevel surface, requiring the meshing mark in the middle and close to the small end and tooth top, with length 60% of width of the tooth surface and 1.5mm away from the tooth top in height. Adjustment of the mark is realized by increasing or decreasing adjustment gaskets between the driving bevel gear bearing seat and the main reducer shell, with thicknesses of 0.1, 0.15, 0.30 and 5mm and the surface shall be flat and smooth.

b The tooth clearance is 0.15～0.30mm and change of the clearance at the gear side may not be more than 0.10mm, which is realized by adjusting differential bearing nut to move location of the driven bevel gear. If the clearance is more than the specified values, the driven bevel gear shall move to the direction of the driving bevel gear, otherwise, it will move in a reverse direction. To ensure constant pre-tightness of the differential bearing, the in and out quantity of the adjustment nuts of both ends must be consistent.

Note: if there is a great difference in adjacent teeth of the driven gear in the contact area, the driven and driving bevel gear shall be changed until it is the same.

Table 5-2

Gear contact area			Adjustment	
Convex	Concave	Appropriate		No adjustment
		Too close driving and driven gears		Small clearance, loosen the left side, fasten the right nut
		Too far driving and driven gears		Big clearance, loosen the right side, fasten the left nut
		High contact area of the driving and driven gears		Far space of driving and driven gear (reducing gasket)
		Low contact area of the driving and driven gears		Close space of driving and driven gear (increasing gasket)

5.7 Maintenance of the axle

1 . Before checking the front and rear axles, tighten the main torques of fastener and lubrication grease shall coat lubrication grease on it.

2 . After assembling, the front and rear axles shall perform a break-in operation of 1000Km. In the 200Km travel, the vehicle shall be without load. In the 200-1000Km travel, check temperature of the wheel hub, if it is heated, it is tightened by the bearing and it needs adjusting.

3 . After the break-in period, check fastening of the nuts, add lubrication oil on the upper and lower parts of the steering joint as well as the cross straight pull rod ball pin.

4 . Maintenance of rear axle

(1) During normal travel and maintenance, clear oil dirt and dust in the ventilation hole of the rear axle shell to ensure smooth venation. After the ventilation hole is blocked, pressure in the rear axle shell will be increased, which leads to oil leakage at the joint.

(2) When maintaining, check lubrication oil surface in the rear axle shell to add or replace the lubricant. The 18# hyperbola fraction gear oil must be used, otherwise, the tooth surface will be worn.

5. 6000 ~ 8000km for second-level maintenance: replace lubrication grease of the wheel hub bearing, clean main pin of the steering joint, the cross straight pull rod ball is added with lubrication grease, check oil level of the reducer and adjust the toe-in. Check fastening of the bolt and nut and adjust the brake clearance.

6 .50000km for second-level maintenance: dismount and adjust the main reducer, differential, and clean and replace the oil, dismount and check the wheel brake, there should be no wear, aging and deformation on the pump leather cup, check and dismount the steering joint and cross straight pull rod joint.

7 . Lubrication oil and lubrication grease

Table 5-3

Maintenance	No.	Lubrication part	Lubrication grease
4000km	1 2	Main pin of the steering joint Ball pin of cross pull rod	
8000km	3	Check oil level of the main reducer, if necessary, add 18# fraction hyperbola gear oil	
12000km	4	Wheel hub bearing	Lithium-base lubrication grease
24000km	5	Replacement of rear axle gear oil	18# fraction hyperbola gear oil

(1) Sulfur and phosphorous middle load (GL-4) or heavy load (GL-5) vehicle gear oil and 18# fraction gear oil is recommended for rear axle.

(2) Lubrication grease: lubrication grease is used for the wheel hub and lubrication points, GM lithium grease meeting GB5670-85 requirements for vehicle is recommended.

5.8 Troubleshooting and experience analysis

Failures of the driving axle is oil leakage, overheating and abnormal sound.

5.8.1 Oil leakage.

(1)Failure: obvious oil leakage mark can be seen from the oil adding faucet, oil discharging faucet, oil seal or the combined surfaces.

(2) Causes:

Looseness of the oil adding port or oil discharging port;

Co-axial oil seal and oil neck, opposite oil seal, wear or hardening of the oil seal;

Oil seal shaft neck to be grooved;

Deformation of the combined surface or coarse processing;

Seal gasket at the combined plane is too thin, hardened or broken;

Looseness of fastening screw at the two combined surface or fixing method of the screw not conformed;

Block of the ventilation hole;

Casting defect or cracking on the axle shell

（3）Diagnosis method: diagnosis for oil leakage of the driving axle is the same as the method for oil leakage of the transmitter. Refer to relevant content.

5.8.2 Overheating

（1）Failure: after traveling some miles, touch middle of the driving axle shell, the heating is unbearable;

（2）Causes:

The gear oil is not sufficient, worsening or non-conformed brand;

The cone rolling bearing is too tightened;

Meshing clearance of bevel gear of the main reducer is too small;

Meshing clearance of planetary gear of the differential and half shaft gear is too small;

The oil seal is too tightened;

Back clearance of the thrust gasket and driven gear of the main reducer is too small.

（3）Diagnosis: it is performed according to the following method. See Figure 5-3 on the flow chart.

5.8.3 Abnormal sound:

（1）Failure: when the vehicle drives at some shift, the driving axle makes loud sound, when the vehicle drives without power or at low speed, the sound is reduced or disappeared; when the vehicle drives and run without power, the driving axle makes loud sound; when the vehicle turns, it makes loud sound, and drive in a straight line, the sound is reduced or impaired; when the vehicle starts or changes the speed, the driving axle makes the “utter” sound; when lowering the speed, the driving axle makes “goggle” sound.

（2）Causes:

Damage, severe wear or excessive looseness of the rolling bearing;

Severe wear of bevel gear of the main reducer, gear deformation, tooth broken, inappropriate adjustment of the meshing surface, too small or big of the meshing clearance, uneven meshing clearance or not replaced in couple;

Deformation of driven gear or looseness of connection of main reducer;

Looseness of fastening nut of flange disc of driving gear of the main reducer;

Deformation of shell body of the main reducer or shell of the differential;

Loose of matching of differential and cross shaft;

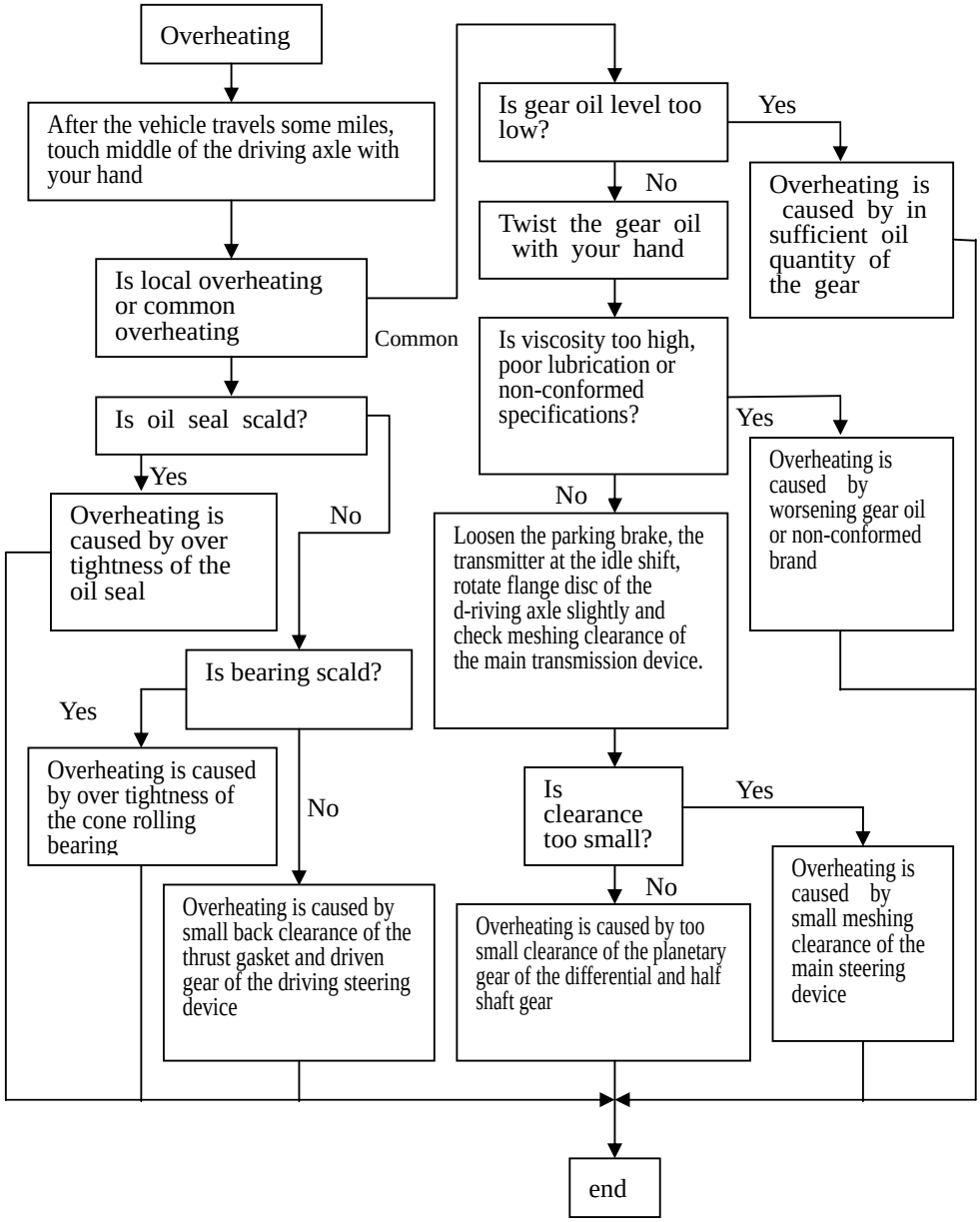


Figure 5-3 Flow Chart for Overheating Diagnosis

- Looseness of matching of the planetary gear hole and cross shaft, too small or too big meshing clearance with the half shaft gear, severe damage, deformation or cracking of meshing surface with the half shaft gear;
- Looseness of matching of half shaft gear or half shaft spline;
- Insufficient gear oil, small viscosity or non-conformed brand;
- Dirt or metal powder in the gear oil

（3）Diagnosis method: it is conducted according to the following method. See Figure 5-4 on the flow chart.

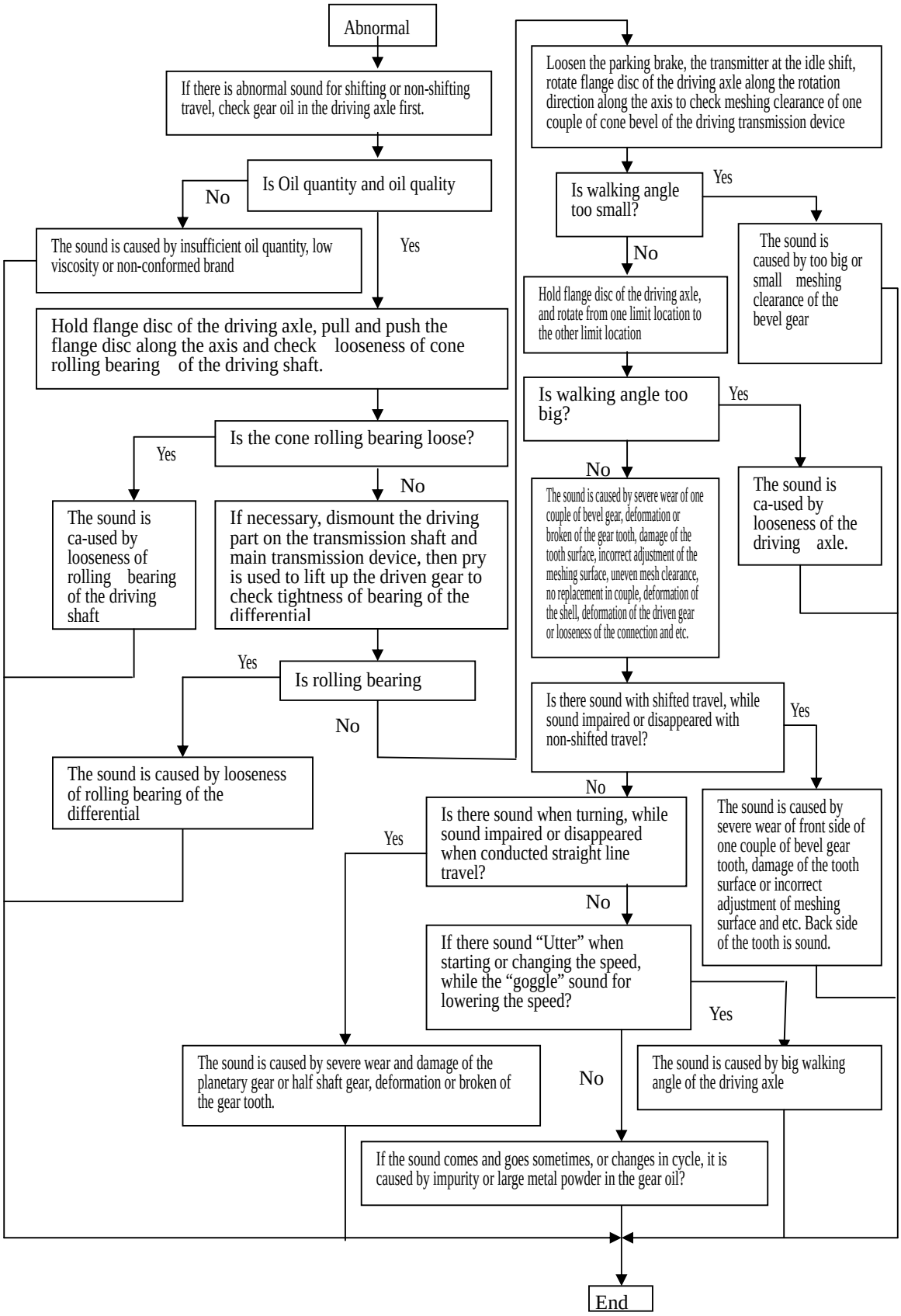


Figure 5-4 Diagnosis flow chart for abnormal sound

Chapter 6 Suspension

Suspension is the general name of all the force transmission devices between the important frame and axle in modern vehicles. It is used to transmit all the forces and torques between the frame and wheel; relieve impact load to the frame from the road as well as the vibration to ensure smoothness of the travel; ensure ideal moving features on uneven road and changed load; ensure stable operation of the vehicle and high travel capability.

The cargo carrying vehicle manufactured by the company employs non-independent suspension of vertical-laid steel plate spring as the front and back suspension, which are made up of steel plate spring, shock absorber and buffering block. In the following, we will introduce maintenance of the steel plate and shock absorber.

6.1 Sketch map of the suspension structure

See Figure 6-1 on non-independent suspension of vertical-laid steel plate spring.

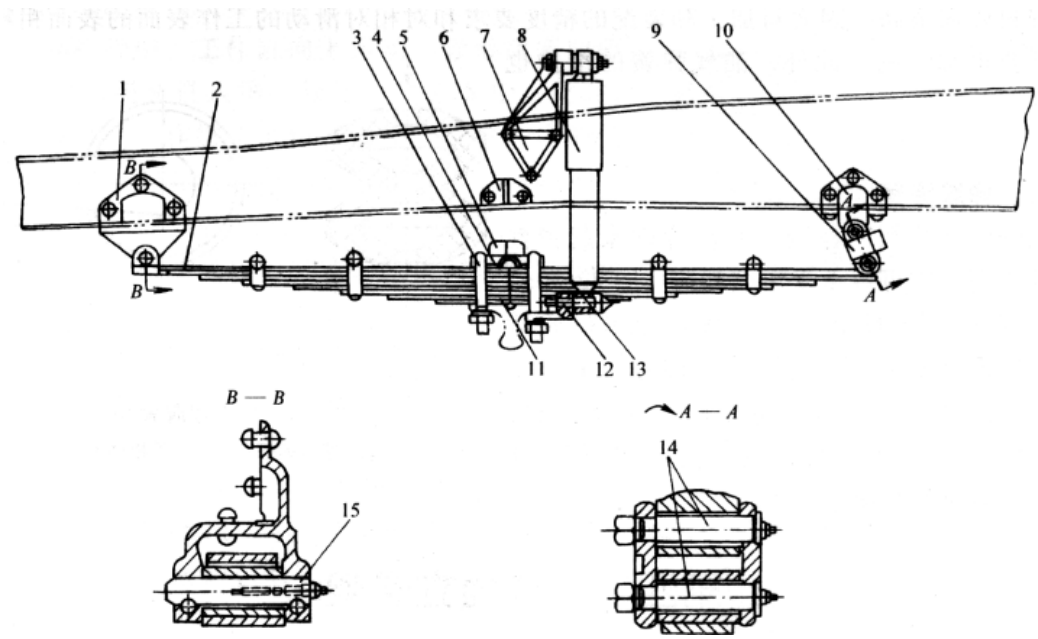


Figure 6-1 Non-independent suspension of vertical-laid steel plate spring

1-Front frame of the steel plate spring; 2-Front steel plate spring; 3-U bolt; 4-Cover board of the front board spring; 5-Buffering block; 6-Limit block; 7-Upper frame of the shock absorber; 8-Shock absorber; 9-Lifting eye; 10-Lifting eye frame; 11-Central bolt; 12-Shock absorber; 13-Connecting pin of the shock absorber; 14-Lifting eye pin of the front plate spring; 15-Steel plate spring pin.

6.2 Main technical parameters of suspension

		YND485Q	490QB, 490QZL	4100QB, 4100QB - 2
Suspension model		Non-independent suspension of vertically-laid steel plate spring		
Number of plate spring	Front	6	7	8
	Back	6+1	6+4	7+5
Arc height for full load	Front（mm）	31.5	8.5	-5
	Back（mm）	3	-5.5	51.5
Length of plate spring	Front（mm）	1255	1240	1240
	Back（mm）	1345	1400	1415
Shock absorber	Model	Bi-directional tube type shock absorber		
	Maximum length（mm）	477		
	Minimum length（mm）	287		
	Stroke（mm）	190		
	Shock absorption force - Extension（N）	2000±150		
	Shock absorption force - Contracting（N）	700±50		

6.3 Disassembly and inspection of the suspension

When disassembling the suspension, the front and back axles. For the non-independent suspension of vertical-laid steel plate spring is simple, you only need to dismount connecting bolt between the plate spring and axle body, the absorber and axle body and frame.

Inspection of the suspension:

1. Check the absorber is oil leakage or out of shock absorption and if there is any cracking or fault welding of the lifting eye and tube. If there is any non-conformity, replace the absorber assembly.
2. Check if there is any looseness and breaking on the bolt in the center of spring, the reed is displaced or not, any cracking on the reed; if there is any non-conformity, it must be repaired or replaced.
3. Check if there is any damage or deformation on the rear lifting eye and shaft pin bolt of the steel plate spring, if any, it shall be replaced.
4. Check if there is any cracking on U bolt and screw and any damage on the screw; if any, replace the U bolt.
5. Check the buffering block and rubber lining are damaged, worn, aging, deform and etc and if there is any separation between the buffering seat and steel seat, if any, replace it.
6. Check if there is any cracking or other mechanical damage on the steel plate spring seat, lower backing plate, steel plate spring pressing plate and etc., if any, replace it.

6.4 Maintenance of the suspension assembly

6.4.1 Maintenance of the steel plate spring assembly

After long-term use, the steel plate spring may face less elasticity, steel plate cracking or breaking, wear of the lining and etc.

For steel plate spring with non-conformed arc height, it shall be replaced. In addition, as for steel plate disassembled during maintenance, magnetic powder or penetration crack detection piece by piece shall be performed. If tiredness cracking is generated, it must be replaced. When replacing the plate reed, the reed with standard length, width, thickness and arc height must be used.

For overhaul, the steel plate pin lining shall be replaced, and its matching clearance of the steel plate pin must be in line with requirements of the original manufacturer. When maintaining, if matching clearance of the steel plate pin and lining exceeds the limit, it must be replace in couple.

Before reassemble the steel plate spring, remove dirt and rust on the plate reed. Meanwhile, an

appropriate amount of graphite lubrication grease is kept between the reeds. The lubrication grease is mainly used for corrosion resistance and lubrication for the second. The lubrication can not be more powerful, for friction forces between the reeds can absorb vibration. During assembling, clips of the steel plate must be provided according to specified quantity, and clearance between internal side of the clip and both sides of the steel plate spring is 0.7～1.0mm. The clip sleeve tube is about 1.0-3.0 from top of the steel plate spring to ensure that the spring can extend and contract freely. Fastening bolt on the clip of the steel plate spring can pass through from the inside to the outside, namely, the direction of the tyre to avoid damaging the tyre during travel caused by looseness of the bolts. The assembled steel plate assembly shall be closed contacted in the middle and the adjacent two pieces shall be within 1/4 of the total contact length. A small amount of clearance is allowed, no more than 1.2mm.

For assembled left and right steel plate spring assemblies, the number of reeds must be equal. The total thickness difference and arc height may not be more than the original specified rules. If there is no any rule, it shall be no more than 5mm and 10mm. besides, check side clearance of the steel plate spring and support lifting eye and the clearances on both sides shall be 0.5～1.0mm. If it is excessive, gasket is used to adjust.

6.4.2 Maintenance of the shock absorber

Main damage of the tube shock absorber is piston, working cylinder tube and etc. and failure of oil seal or seal ring gasket. When maintaining, if there is no oil leakage, experience is used to check its working performance: one iron rod passes through eye ring on both ends of the shock absorber, step on one end and the other end is pressed by hand. When it is compressed, there is resistance which becomes less; when it is extending, there is resistance which becomes more, and the working performance is sound. If conditions allow, the test can be conducted on the test bench. The contracting and extending times must be performed as per specified strength, specified efficiency and specified stroke for test and the damping force shall reach the specified values. There should be no oil leakage after placing it flatly for 24 hours. For any oil leakage found during use, the oil seal or seal ring shall be replaced. When replacing, do not damage the cutting edge. For non-conformed working performance, find out the causes; if it is caused by wear of the piston and cylinder tube or damage of the valve, new ones must be replaced; if it is caused by dirty oil,

valve blocking or insufficient oil, clean, replace oil or add oil. The added oil quantity must be in line with the rules, more or less not allowed. If there is not absorber oil provided, No.22 turbine oil of concentration of 50% and transformer oil of concentration of 50% can be mixed together. Before adding, it shall be filtered with metallic mesh of 1200～1300meshes / cm^2. If there is no filtration net provided, metallic powder or gaze shall be prevented.

Chapter 7 Steering System

7.1 Sketch map of the steering system

The vehicle steering system is divided into mechanical steering system and dynamic steering system according to the steering energy.

The mechanical steering system is made up of steering operation structure, steering device, and steering transmission structure. The system takes the driver's labor force as the steering energy and all the transmission parts are mechanical transmission. The dynamic steering system is a kind of steering system employing the driver's labor force and engine power. Under normal conditions, the vehicle's steering only needs a small part of energy provided by the driver, however, in case of failure of the dynamic steering device, the driver can take the steering independently for the vehicle. Therefore, the dynamic steering system is a mechanical steering system with a dynamic device.

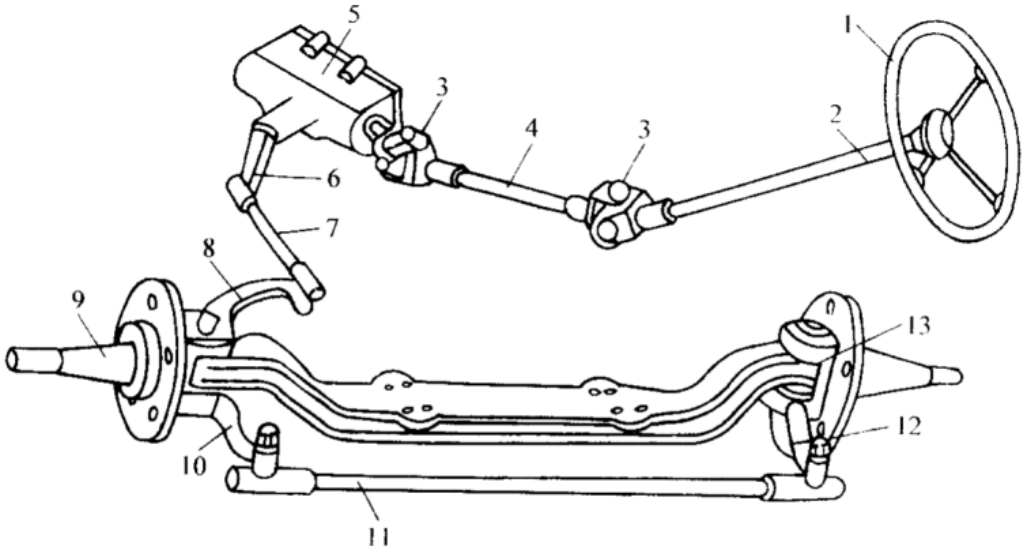


Figure 7-1 Composition of the steering system and sketch map

1-Steering disc; 2-Steering shaft; 3-Steering universal joint; 4-Steering transmission shaft; 5-Steering device; 6-Swinging arm for steering; 7-Straight pull rod for steering; 8-Steering joint arm; 9-Left steering joint; 10, 12-echelon arms; 11-Steering cross pull rod; 13-Right steering joint.

See Figure 7-1 on sketch map of the steering system. When rotating the steering disc, the steering power is transmitted to the opinion of the steering device from the steering post assembly. The opinion transmits the meshed gear rack, the direction of the power is changed and the steering force is transmitted to the steering joint of the steering wheel to realize steering.

7.2 Wear analysis of main parts

7.2.1 Operation structure

The operation structure is made up of steering disc, steering post tube, steering shaft, universal joint, steering transmission shaft and etc.

7.2.2 Steering device

The steering device is the reduction transmission device of the steering system. The cargo carrying vehicle of SC series manufactured by the company employs cycled ball steering device.

（1） Wear of the steering device

Main wear of the steering device includes: deformation and cracking of the steering device and cover, wear of the bearing and hole, wear of lining of the swinging arm shaft, damage of auxiliary working surface for meshing and etc.

（2） Maintenance of the worn parts

Maintenance of the steering device shell, cover and hole

Cracking of the steering device can be detected by penetration crack detection. If there is any cracking, it must be replaced. If the cracking is not severe, welding can be used to repair; matching clearance of the steering device shell and bearing hole on the cover and the bearing (lining) may not be more than the original design rules 0.02mm. After wear of the hole, it can be repaired by embedding or galvanization; if lining of the steering swinging arm is worn, it shall be replaced with new ones. Interference amount for pressing of the lining is 0.05～0.08mm. The lining can be processed by boring or reaming, linings of the two holes must be co-axial. Maximum matching clearance of the lining and swinging arm shaft may not be more than the original design rule 0.005mm; planarity error of the whole combined surface of the steering device shell and cap shall be no more than 0.1mm. Otherwise, it shall be grinded.

Maintenance of the transmission couple

Rolling channel from the steering device to the nut shall be no metal scale, the rolling ball specifications and quantity shall be in line with the original design rules, with diameter difference no more than 0.01mm. Matching clearance of the ball and rolling channel can be inspected by radial swinging of the nut with the percent meter against the nut, the value shall be no more than

0.05mm; hang the screw vertically, if the ball nut falls down stably under the gravity, it is normal. If it falls fast or blocks or the matching clearance exceeds the rules, it shall be replaced in couple and steel ball with larger size can be used.

7.2.3 Steering transmission unit

（1） Steering joint

Main wear of the steering joint includes: cracking at root of the finger shaft, wear of the main pin hole, wear of the shaft neck of the wheel hub bearing, damage of the end screws, wear of the upper and lower end surfaces of the main pin hole, change of angle between the main pin hole axis and root shaft axis and etc.

Inspection and repair of the steering joint:

Cracking at the root of the finger shaft can be inspected by penetration or magnetic power crack detection. In case of crack at the root of the finger shaft, it shall be replaced with new ones.

Matching clearance of main pin of the steering joint and lining shall be in line with the original rules, if it exceeds the rules, the lining shall be replaced. Processing of the lining shall employ reaming, boring or broaching. When reaming is used, long-edge reaming knife or the guide rod is used to ream two holes one time to ensure co-axial degree of the upper and lower holes. When lining is embedded, oil hole of the lining shall aim at oil nozzle of the steering joint. Matching clearance of the steering joint main pin and lining is 0.02～0.09mm and the limit is 0.15～0.20mm.

If matching of the internal and external bearing of the steering joint and shaft neck is clearance matching, it shall be in line with original rules; if it is transitional matching, when the basic size is no more than 40mm, the maximum clearance shall be no more than 0.04mm; when it exceeds 40mm, the clearance shall be no more than 0.05mm. After wear of the shaft neck, it can be repaired with galvanization or coating. Matching clearance of the wheel hub bearing and shaft neck is about 0.10mm.

Screw damage at the end may not exceed 2 teeth, otherwise, the screw shall be removed; after surfacing welding, the screw is additionally formed.

Upper and lower end surfaces of the main pin hole must be flat, otherwise, it shall be flattened.

Angle of public axis of shaft neck of the steering joint and main pin hole shall be in line with original rules, otherwise, it will be rejected.

（2） Steering swinging arm

There should be no cracking on the steering swinging arm and obvious torsion on the spline. End surface of the spline hole of the steering swinging arm shall be 2-5mm higher than that of the swinging arm shaft. If there is crack on the swinging arm or the spline shaft aligned with the hole end surface caused by wear, the steering swinging arm shall be replaced.

（3） Steering joint arm

There should be no crack on the steering joint arm. When the cone pin neck matches the cone hole on the steering joint, the small end surface of the cone pin neck shall be 1-2mm into the cone hole. Spline and spline channel of the cone pin shall match closely.

（4） Cross and straight pull rods

There should be crack and other damage on the cross and straight pull rods. There should be obvious deformation on the straight pull rod. Linear error of the cross pull rod shall be no more than 2mm, deformation of both ends of the arc cross pull rod at the front drive may not be more than 1.5mm, if it exceeds, cold pressing is used to calibrate. Depth of clip spring on the joint of the cross pull rod can not lower than 1/2 of width of the clip spring. When wear of hole of the ball joint of the straight pull rod is extended to 2mm, surfacing welding can be used to make it to standard size, or weld one piece no less than 3.5mm thick with standard size hole on it. If screw on the end of the straight pull rod is damaged, it can be repaired by re-tapping. If upper flange of joint seat hole of the cross pull rod is worn, when the thickness is less than 2mm, turning repair can be used after surfacing welding.

When wear of single side of the sphere of the ball joint pin exceeds 1mm, it shall be replaced with new ones or repaired. If the wear is excessive, the spring is failure or the faucet is damaged, it shall be replaced.

7.3 Disassembly of the steering system

7.3.1 Disassembly of the steering disc and steering post assembly

(1) Disassemble negative wire of the accumulator, and dismount upper cover for steering;

(2) Screw off lock nut of the steering disc;

(3) The steering disc and steering shaft are marked for alignment when reassembling;

(4) Special tools are used to dismount the steering disc;

(5) Dismount the upper cover and lower cover of the steering post;

(6) Dismount plugs of the combined switch and ignition switch bundle, screw off fixing screws of the combined switch to take it off;

(7) Dismount joint bolt of the lower shaft of steering device;

(8) Screw off assembly bolt of the steering post, and take the steering post assembly off.

7.3.2 Disassembly of the steering pull rod and steering device

(1) Lift up the vehicle, disassemble the wheel and screw off the opening pin and channel nut of end of the steering cross pull rod from the steering joint;

(2) Special disassemble device is used to take end of the steering cross pull rod from the steering joint;

(3) The assemble mark is done on location of the locking nut of the steering cross pull rod end and screw of the steering cross pull rod to disassemble the cross pull rod assembly;

(4) Dismount the opening pin, steering straight pull rod channel nut and bolt;

(5) Dismount the joint bolt of the lower end of the steering shaft;

(6) Dismount assembly bolt of the steering device shell, then take the steering device off;

7.4 Assembly of the steering system

The whole assembly procedure is opposite for the disassembly procedure. For it is simple and

there will be no details given.

When installing the steering device, pay attention to the following:

（1） Check oil quantity of gear of the steering device to make oil quantity of the steering device in line with the standard;

（2） Make the steering device to the limit location to one direction, then return it half to ensure it stays in the middle of the total travel;

（3） Tighten installation bolt of the steering device to make it conformed;

（4） Calcium base lubrication grease is added in the ball head pin.

7.5 Failure and experience analysis

Steering shaft of most vehicles is front shaft. Common failure of the front shaft and transmission system is abnormal wear of the front wheel tire, big free travel of the steering disc, heavy steering, automatic deviation, swinging of the front wheel and etc.

7.5.1 Abnormal wear of the front wheel tire

（1）Failure: the tire wear is accelerating, and abnormality on the tire.

（2）Causes:

1） The tire pressure is not conformed;

2） The tire is not exchanged for position for a long time;

3） Incorrect locating of the front wheel, especially matching of the toe-in and camber;

4） Looseness of the wheel hub bearing or steering joint and main pin;

5） Looseness of the longitudinal and cross pull bar or steering device;

6） Looseness of U bolt of the steel plate spring;

7） Looseness of the steel plate spring lining and the pin;

8） Jumping of the front tire radial circle or end surface circle;

9) Rotating quality of the front tire is not balanced;

10) Swinging head of the front tire;

11) Non-verticality of the front shaft and longitudinal center line of the frame or unequal wheelbase at both sides of the frame;

12) Bending and torsion of the front shaft or frame;

13) Low toughness of the front shaft;

14) Low toughness of the steering cross pull rod (especially the arc cross pull rod) or cross pull rod arm;

15) Slow brake reset or lagging brake;

16) Looseness of the tire bolt;

17) Frequent overloading, deflected loading, fast starting, turning at high speed or fast brake;

18) Traveling on road of big surround frequently;

19) The steering echelon can not ensure pure rolling of the wheels, excessive turning or inadequate turning;

20) Poor tire quality.

(3) Diagnosis method: see the Figure 7-2 on sketch map of abnormal wear of the front tire. See Figure 7-3 on the flow chart for diagnosis.

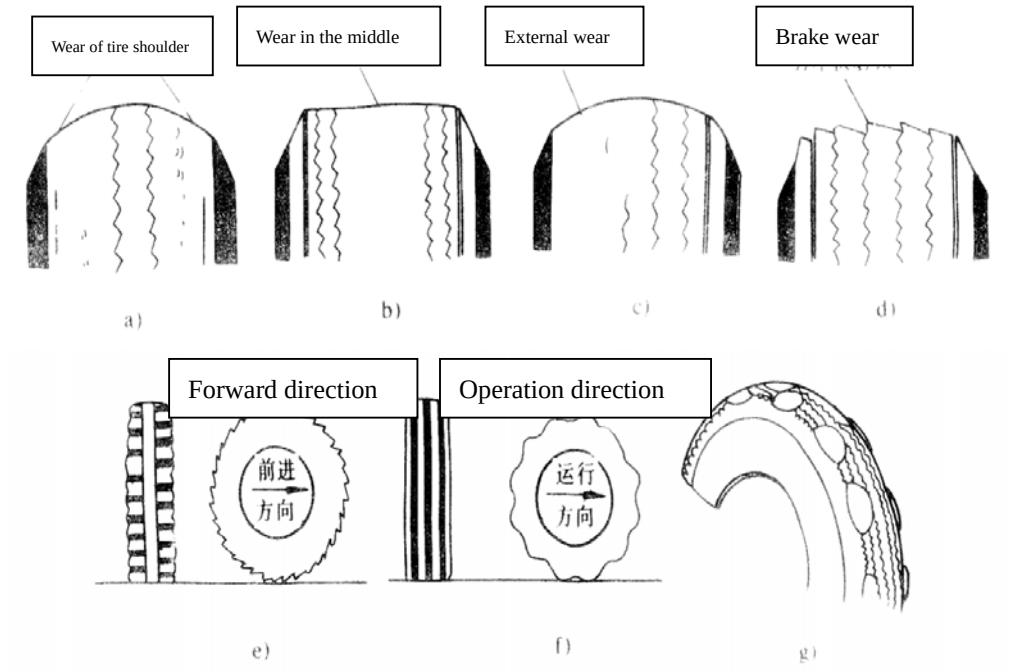


Figure 7-2 Sketch map of abnormal wear of the front tire

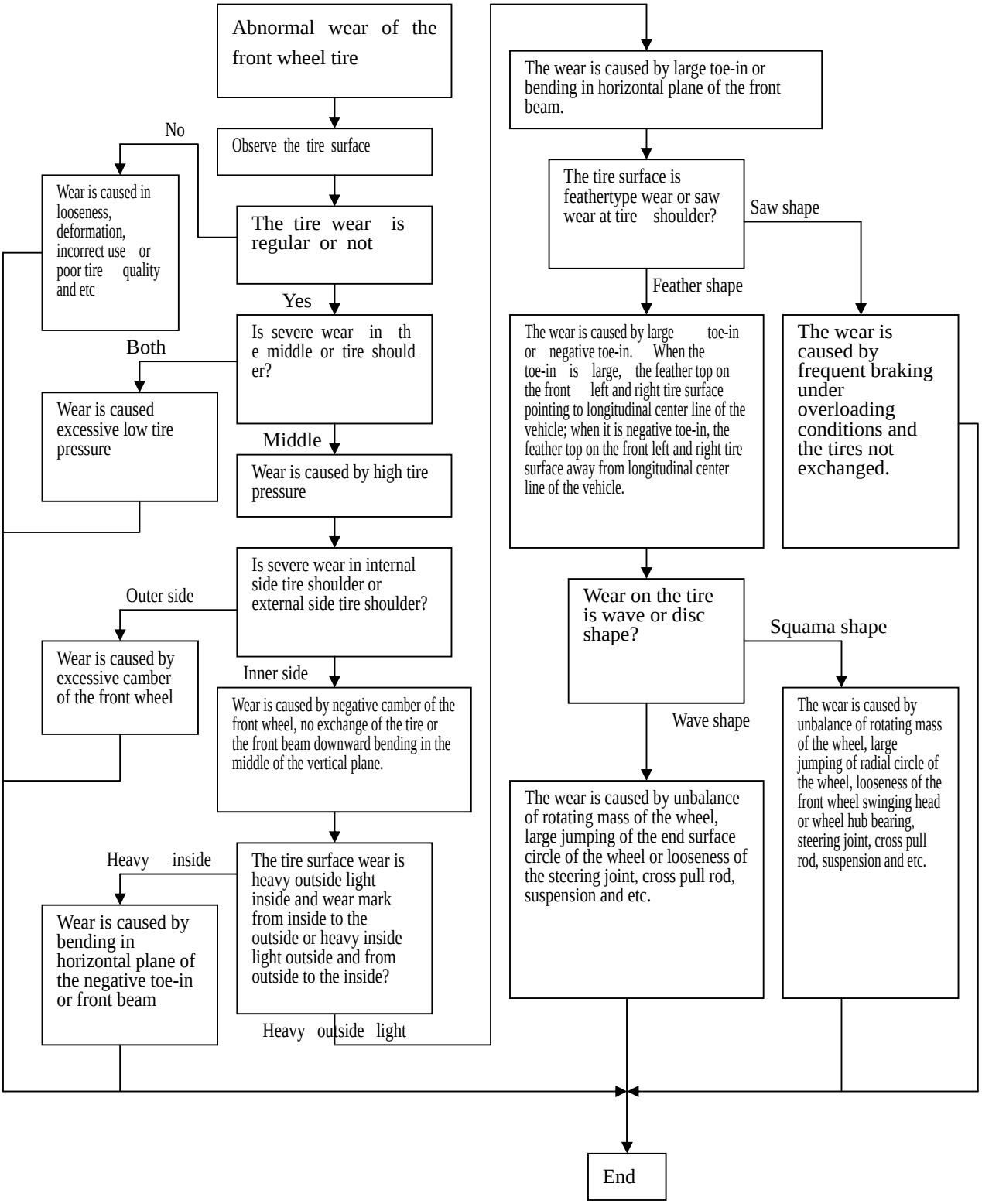


Figure 7-3 Flow chart for diagnosis of abnormal wear of the front tire

7.5.2 Big free travel of the steering disc

（1）Failure: when the vehicle keeps still when keeping the linear travel position, rotate the steering disc, the walking angle is big.

（2）Causes:

1） Looseness of driving and driven meshing parts of the steering device or bearing of the driving and driven parts;

2） Looseness of connection of the steering disc and steering shaft;

3） Looseness of connection of vertical arm shaft and vertical arm of the steering device;

4） Looseness of connection of the longitudinal and cross pull rod ball head;

5） Looseness of connection of the longitudinal and cross pull rod arms and steering joint;

6） Looseness of universal joint and main pin;

7） Looseness of the wheel hub bearing.

（3）Diagnosis method: it is required according to the flow chart 7-4.

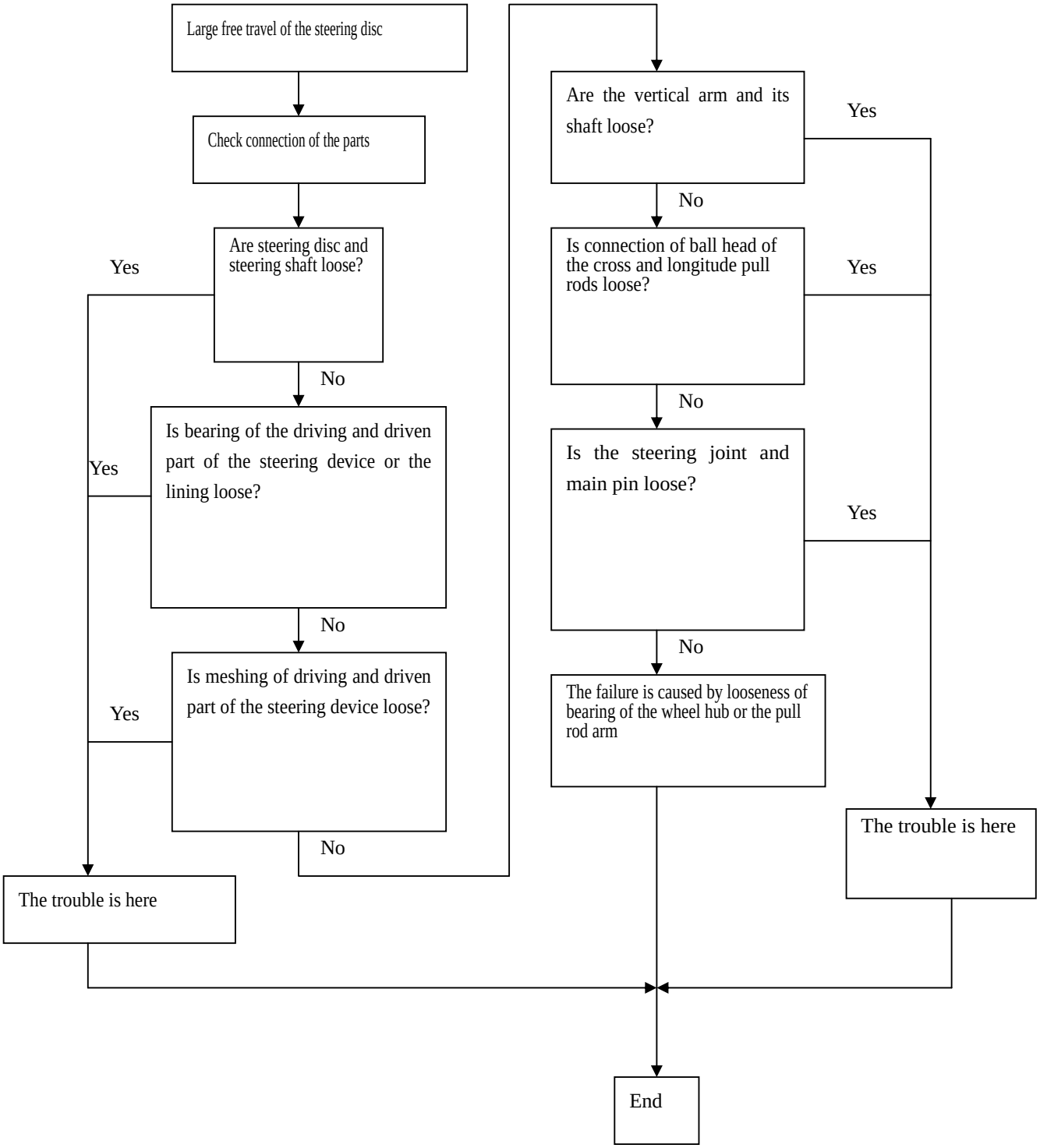


Figure 7-4 Flow chart for big free travel of steering

7.5.3 Heavy steering

（1）Failure: during travel, when the driver rotate the steering wheel leftwards or rightwards, he feels heavy; when the vehicle turns at low speed or changes the direction, it is hard to rotate the steering wheel even can not work.

（2）Causes:

1） Insufficient tire pressure;

2） Matching of the steering joint and the main pin is too tightened or lacking oil;

3） Connection of the cross and longitudinal pull rod ball head or lacking in oil;

4） Pre-tightening force of bearing of the driving part of the steering device is too large or matching of the driven part and lining is too tightened;

5） Meshing of driving and driven parts of the steering device is too tightened;

6） There is no oil or not sufficient oil in the steering device;

7） Thrust bearing of the steering joint lacks oil or is damaged;

8） Bending of steering shaft of the steering device or collision by concavity;

9） Excessive back inclination of the main pin, kingpin of the main pin or negative camber of the front wheel;

10） Deformation of front beam and frame causes incorrect locating;

（3）Diagnosis method: it is performed according to the following method. See 7-5 on the flow chart.

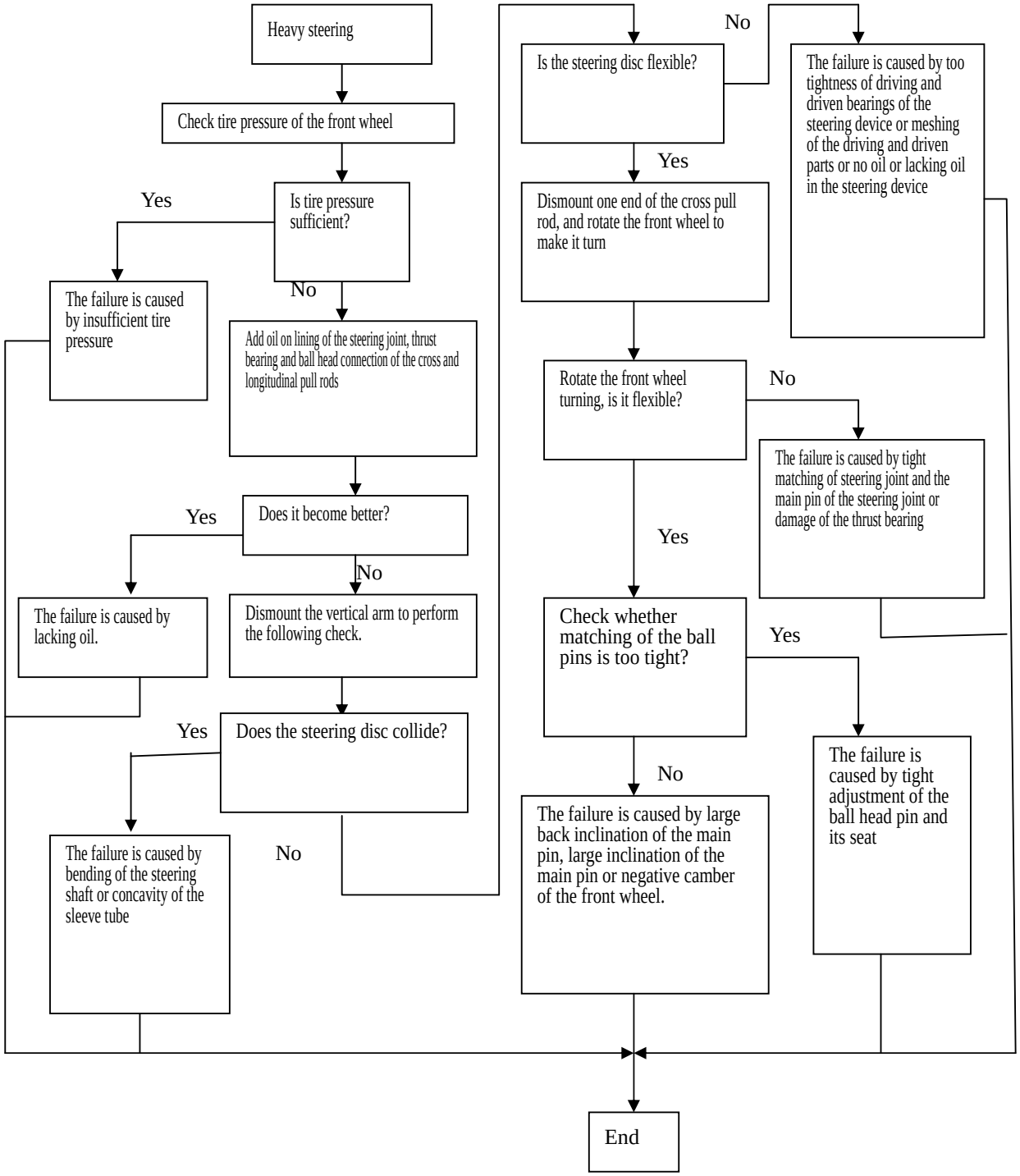


Figure 7-5 Flow chart for heavy steering

7.5.4 Automatic

（1）Failure: during travel, the vehicle runs to the other side automatically, holding the steering wheel can keep straight line running.

（2）Causes:

1） Uneven tire pressure or inconsistent diameter of the front two wheels or uneven loading;

2） Unequal spring flexibility or uneven spring of the left and right steel plate;

3） Bending in the shaft tube of the front beam or rear axle or bending in the horizontal plane of the frame;

4） Unequal wheel base at both sides of the vehicle;

5） Inconsistent tightness of the wheel hub bearing or oil seal of the front two wheels;

6） Single brake or single lag for wheel with front and back axles;

7） Unequal camber of the front two wheels, back inclination angle of the main pin or internal inclination of the main pin;

8） Large toe-in or negative toe-in;

9） Large arching factor of the road surface or with side wind.

（3）Diagnosis: it is conducted according to the following method. See the flow chart 7-6.

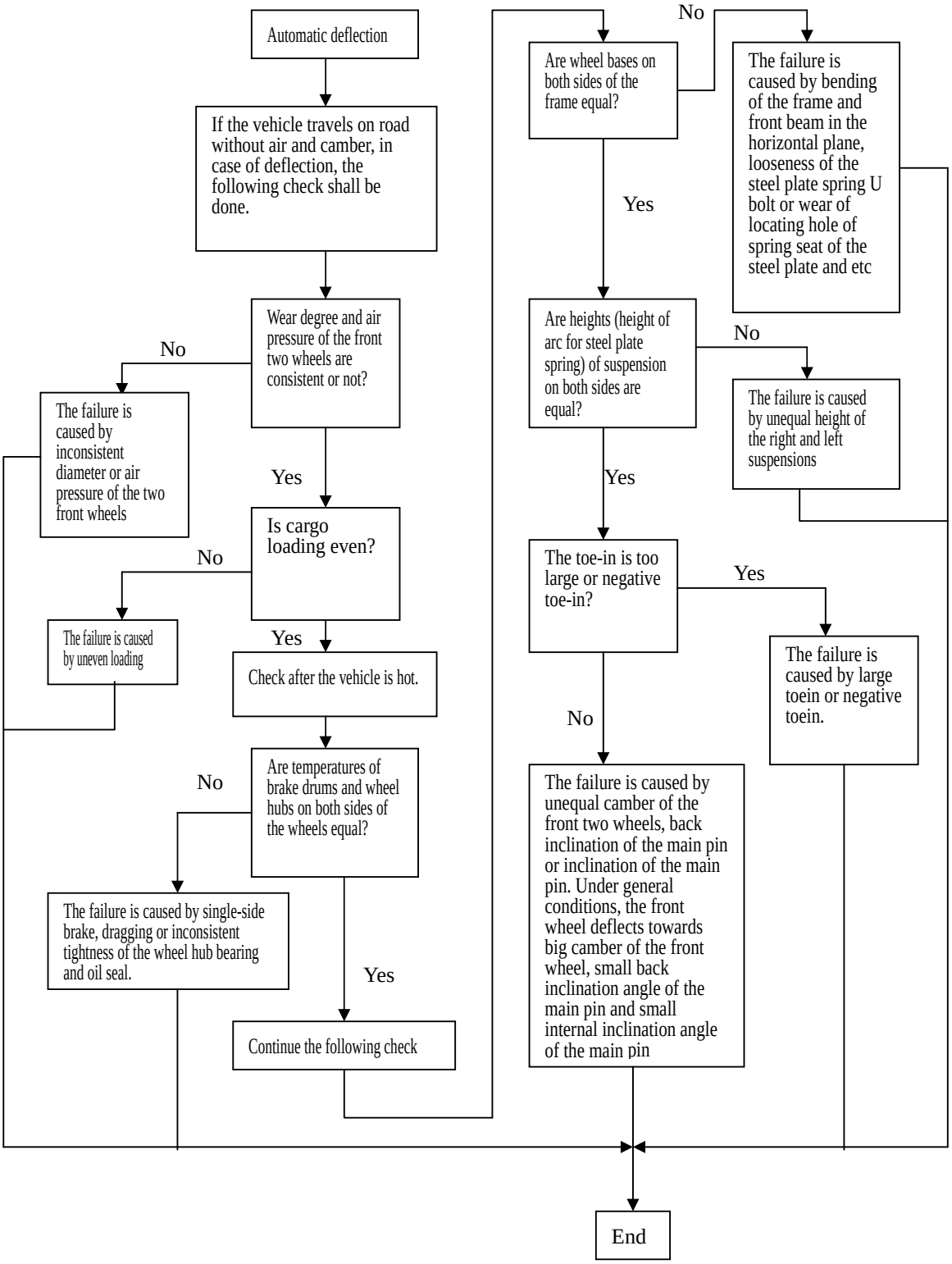


Figure 7-6 Flow chart for diagnosis of automatic deflection

7.5.5 Swinging head of the front wheel

(1) Failure: when the vehicle travels at low speed or high speed, the front two wheel may rotate with its main pin for angle vibration, called swinging head of the front wheel. Especially at high speed, the front wheels swings severely, the hand feels numb and the head is swinging seen from the cab.

(2) Causes:

1) Unbalance of rotating mass of the front wheel (including tire, wheel rib, brake drum or disc, wheel hub and etc.);

2) Large jump of radial circle of the front wheel or end surface circle;

3) Renewed tire is used for the front wheel;

4) Small camber of the front wheel, large toe-in, negative back inclination of the main pin or large back inclination of the main pin;

5) Inconsistent back inclination angle or internal inclination angel of main pin of the front two wheels;

6) Bending or deformation of the front beam or frame;

7) Interference f the steering system and front suspension;

8) Low toughness of the steering system (such as cross pull rod, cross pull rod arm, vertical arm and etc.);

9) Large meshing clearance or bearing clearance of the driving and driven part of the steering machine;

10) Matching looseness of vertical arm of the steering machine and its shaft;

11) Looseness of connection of ball head of the longitudinal and cross pull rods;

12) Looseness of the steering joint and main pin or matching of steering joint and fist part of the front beam along axis of the main pin;

13) Looseness of bearing of front wheel hub;

14) Looseness of connection on the frame of the steering machine;

15) Failure of shock absorber of the front suspension or inconsistent shock absorption performance of the left and right absorber;

16) Inconsistent height or toughness of the left and right suspensions (thickness, length, number of piece, arc height or new and old degree for steel plate spring);

17) Looseness of U bolt of the front steel plate spring or matching of the steel plate pin and the lining;

18) Large unevenness of the road, the impact frequency of road the wheel is consistent with inherent frequency of angle vibration of the front beam, affected by gyroscope effect, the front wheel swings.

(3) Diagnosis: it shall be performed according to the following methods. See the flow chart7-7 for detail.

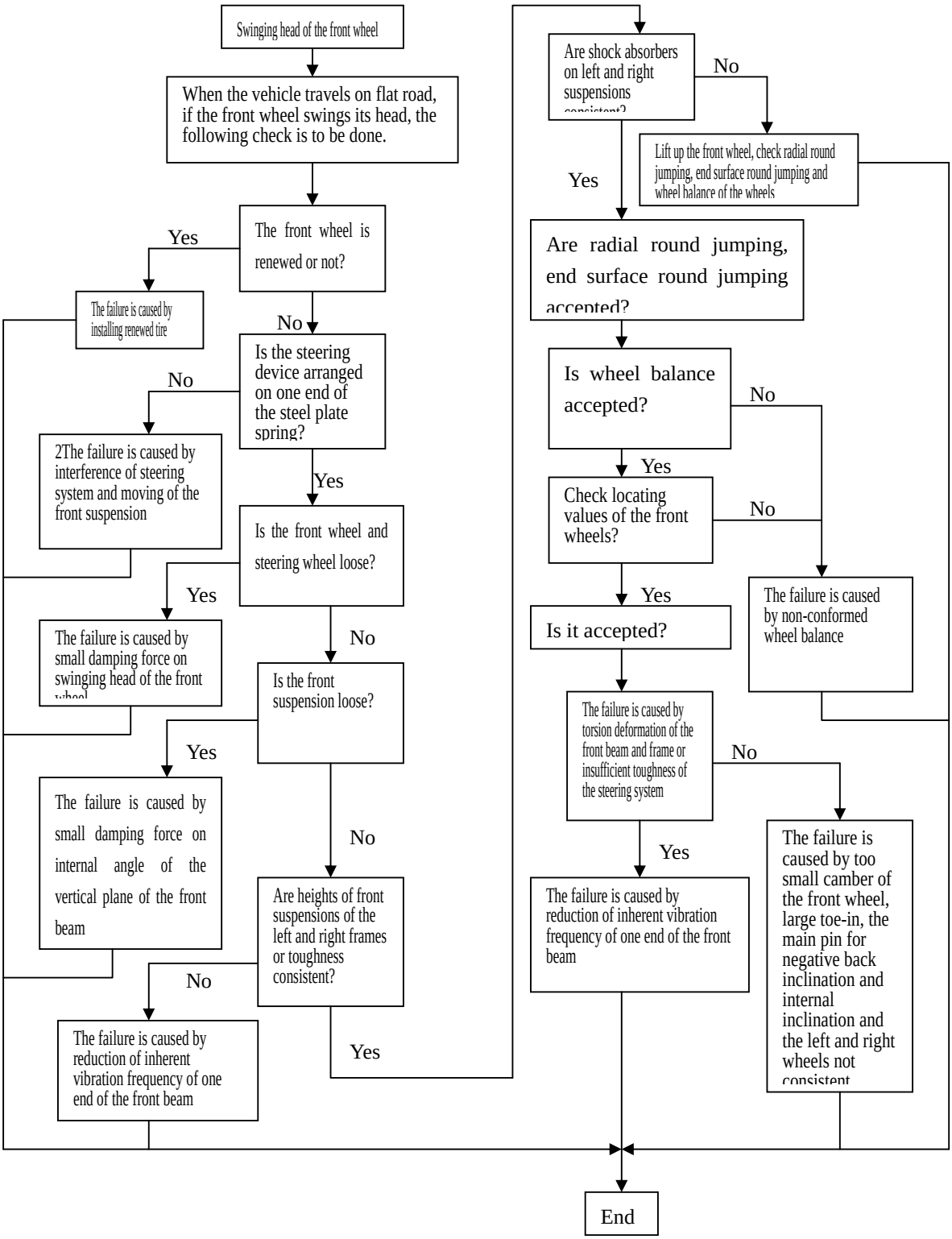


Figure 7-7 Flow chart for swinging of the front tire

Chapter 8 Braking System

8.1 Layout diagram and structure of braking system

8.1.1 Layout diagram of braking system

Braking system of Changan Automobile includes two systems of service brake and parking brake. Refer to the layout diagram (Fig. 8-1).

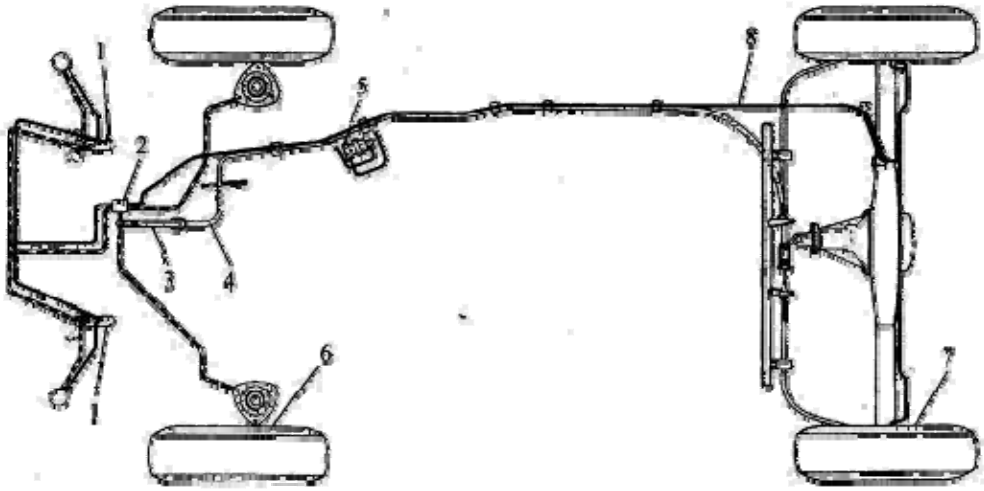


Fig. 8 - 1 Layout diagram of braking system

1- brake master cylinder；2- five-way valves；3- parking brake handle；4- parking brake cable；5- proportioning valve；6- front wheel brake；7- rear wheel brake；8- oil pipe

Service brake is dual circuit hydraulic brake system, and uses H-shape circuit, which means that one brake circuit is used for two front wheels and another brake circuit is used for two rear wheels. Working medium of these two brake circuits is mutually independent, when one brake circuit can't be run, another brake circuit can still retain the certain braking energy to improve the safety of vehicle driving. For brake circuit of rear wheel, can choose proportioning valve, so that braking force of rear wheel brake can be distributed at the ideal proportion, and favorable to improve directional stability when the wheel is braking. Parking brake is mechanical flexible shaft drive, and rear wheel brake is concurrently worked as parking brake.

8.1.2 Structure of brake device

1 . Structure of brake pedal

For structural components of brake pedal, see Fig. 8-2:

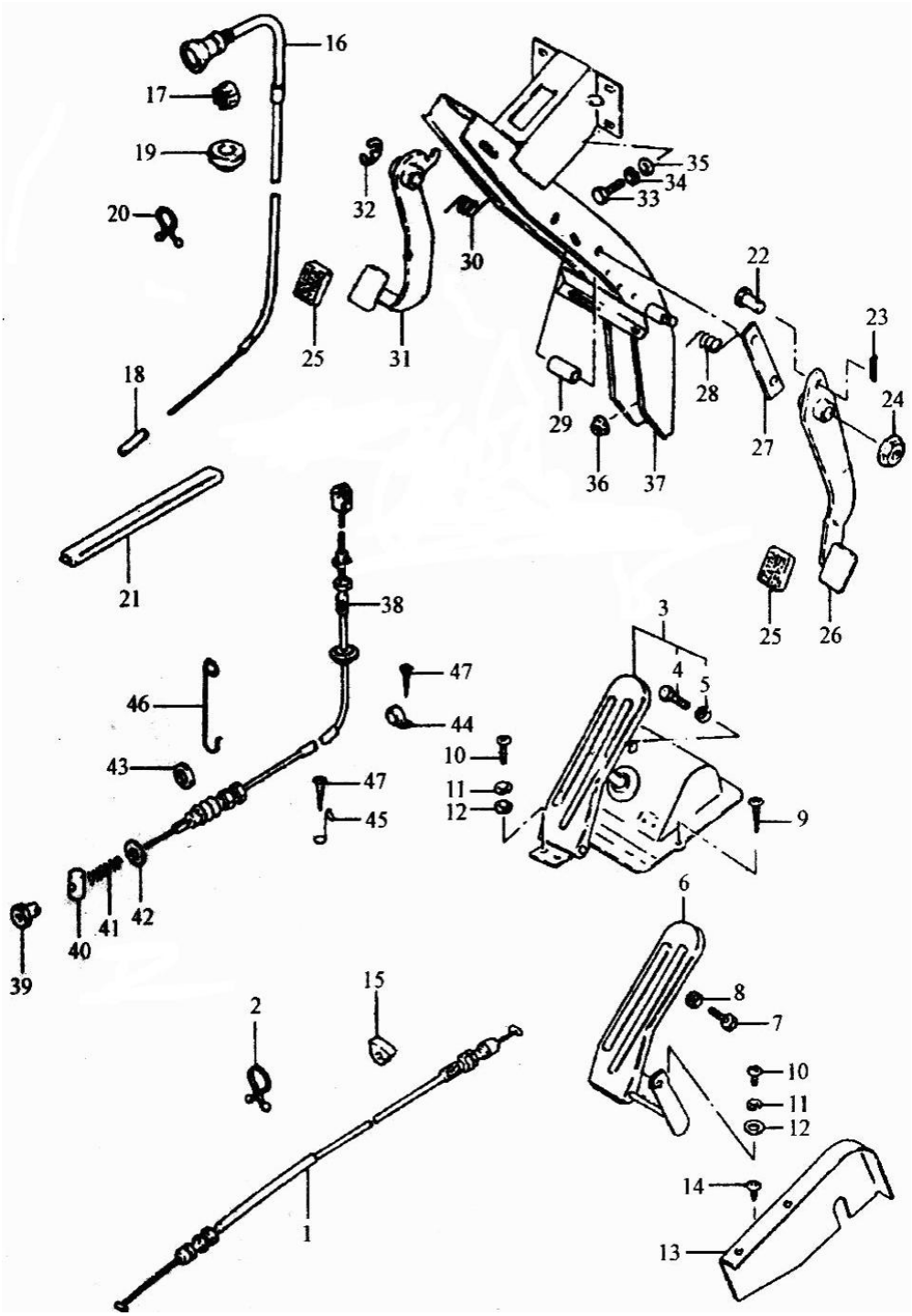


Fig. 8 - 2 Structural components of brake pedal

1- accel pedal cable ; 2-clip ; 3- accel pedal assembly ; 4-bolt ; 5-nut ; 6- accel pedal ; 7-bolt ; 8-nut ; 9-bolt ; 10-bolt ; 11- lock washer ; 12- washer ; 13-cable cover ; 14-bolt ; 15- sealing ; 16- throttle cable ; 17-nut ; 18-shield ; 19-sealing ; 20-clip ; 21-protection device of cable ; 22-pin ; 23-Opeing pin ; 24-nut ; 25- pedal pad ; 26-brake pedal ;27- pedal axial plate ;28- spring of brake pedal ;29- spacer ;30- pedal spring of clutch ;31- clutch pedal ; 32-E-shape ring ; 33-bolt ; 34-lock washer ; 35-washer ; 36-nut ; 37-bracket ; 38- clutch cable ; 39-nut ; 40-pin ; 41-spring ; 42-washer ; 43- cushion ; 44-clip ; 45-clip ; 46-clip ; 47-bolt

2 . Structural components of brake master cylinder and brake circuit

（1）Brake master cylinder

For structural components of brake master cylinder, see Fig. 8-3:

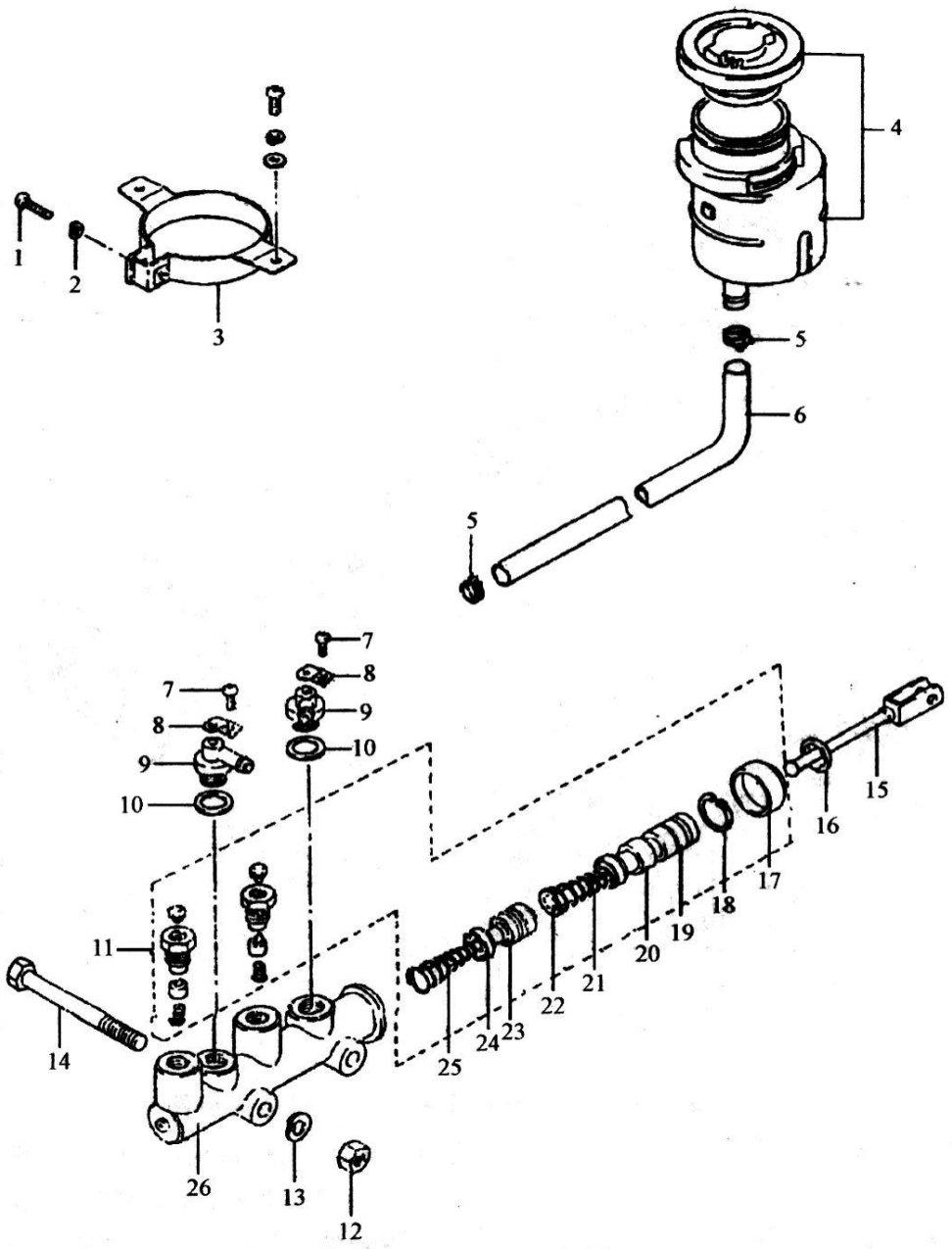


Fig. 8 - 3 Structural components of brake master cylinder

1-bolt；2- lock washer；3- holt hoop iron；4-fluid reservoir；5- holt hoop iron；6-hose；7-bolt；8-clip；9- inlet connector；10-O-shape ring；11- outlet connector；12-nut；13- lock washer；14-bolt；15-push rod；16-buckle；17-shied；18- clip ring；19-A piston；20-cup；21- stop bolt of A piston；22-return spring；23-B piston；24-cup；25- return spring；26-chief pump shell （2）Vacuum booster

Vacuum booster is located in the middle of brake master cylinder and brake pedal, and adopts the engine vacuum to mechanically increase the force caused by brake pedal when it is stepped for the purpose of braking save labor. For structural components of vacuum booster, see Fig. 8-4.

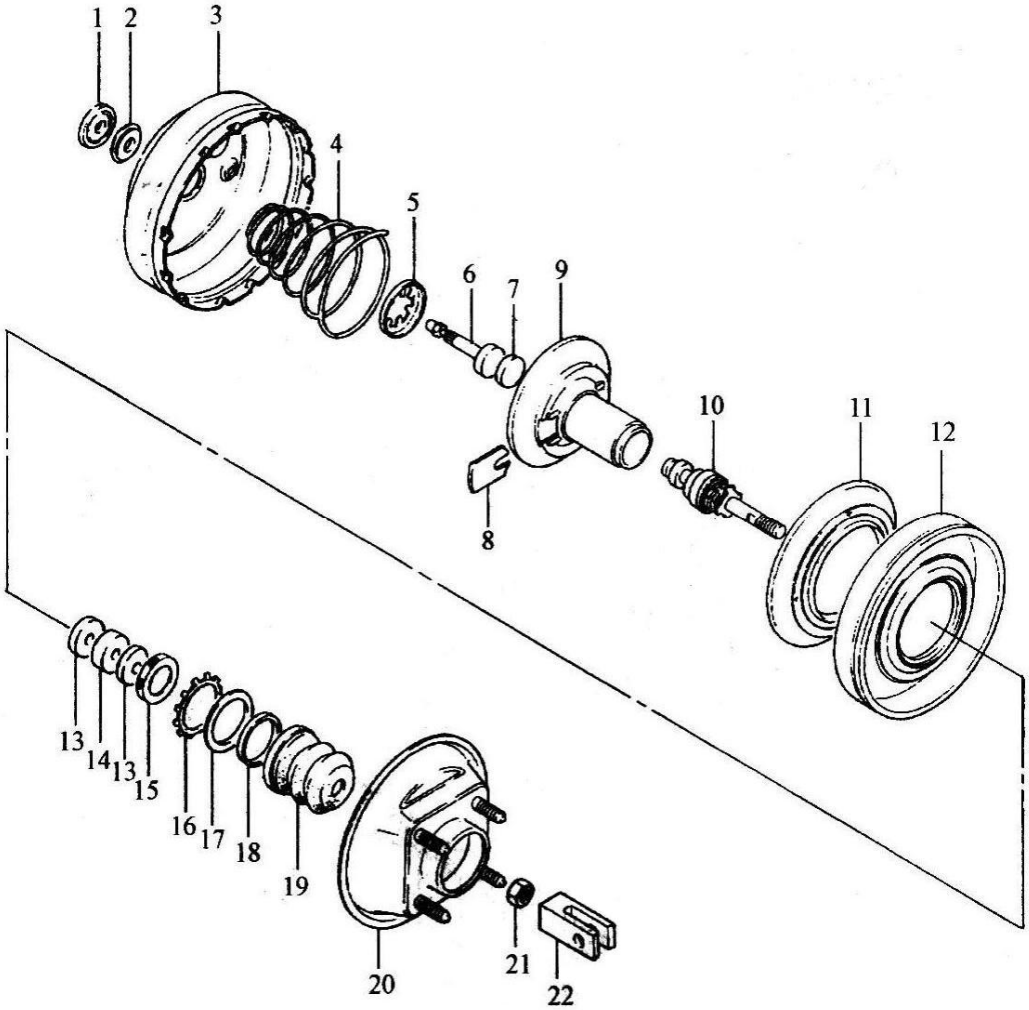


Fig. 8 - 4 Structural components of vacuum booster

1-front gas seal；2-front gas seal plate；3- shell of 1# booster；4- return spring of booster piston；5- return ring of piston rod；6- piston rod；7- reaction disc；8- valve guard 0；9- booster piston；10- booster valve assembly；11-piston plate；12- booster diaphragm；13- air filter spacer；14- air filter core；15-shield liner；16-piston ring；17- piston pivot ring；18- gas seal of 2# shell；19- booster shield；20- 2# shell of booster；21-nut；22- clevis pin of push rod

（3）Brake piping

For structural components of brake piping, see Fig. 8-5:

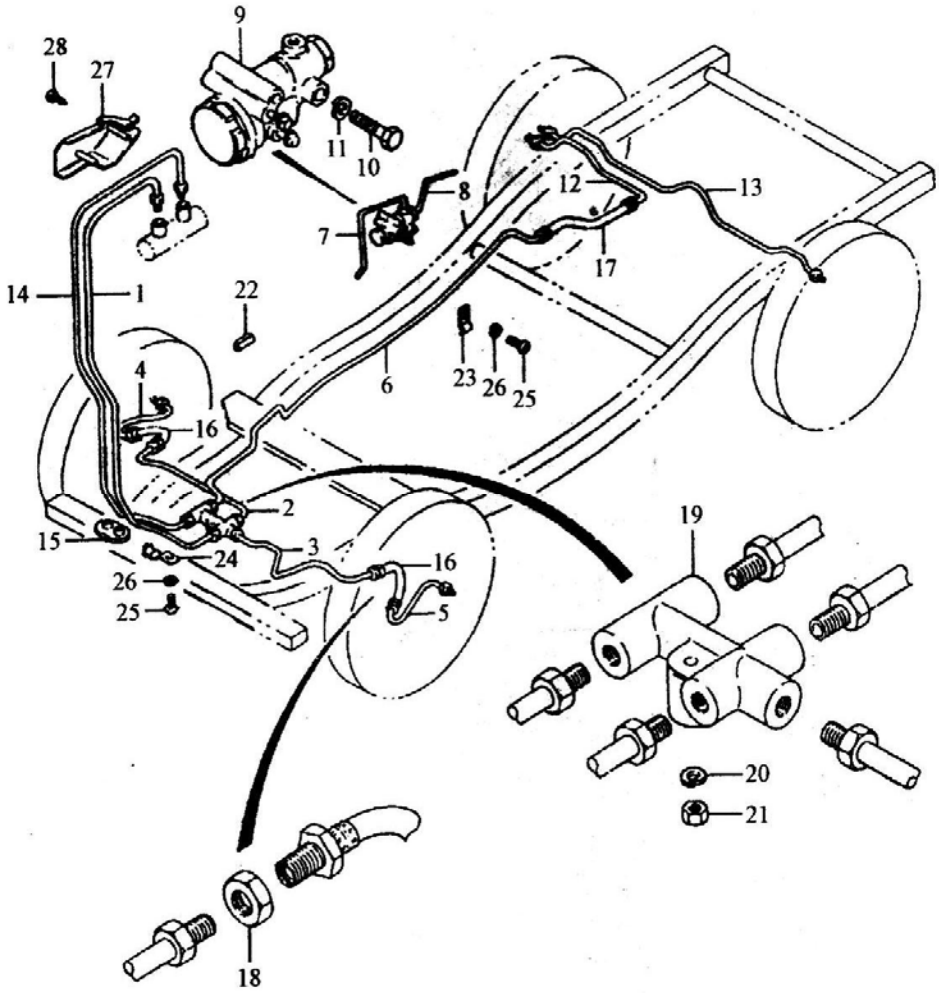


Fig. 8 - 5 Structural components of brake piping

1- brake master cylinder to five-way valve tubing (front) ; 2- five-way valve to front braking tubing (right) ; 3- five-way valve to front braking tubing (left) ; 4- front brake lock tubing (right) ; 5- front brake lock tubing (left) ;6- five-way valve to rear braking tubing ;7- proportioning valve inlet tube (optional) ;8- proportioning valve outlet tube (optional) ; 9- proportioning valve (optional) ; 10-bolt ; 11-washer ; 12- connecting tubing of brake hose ;13- rear brake tubing ;14- chief pump to five-way valve tubing (rear) ;15- rubber gasket ;16- front brake hose ; 17-rear brake hose ; 18-nut ; 19- five-way valve ; 20-washer ; 21-nut ; 22-shield ; 23-clip ; 24-clip ; 25-bolt ; 26-washer ; 27-chief pump cover ; 28-bolt

3 . Structure of wheel brake

Front and rear wheel brake of SC series truck of Changan uses leading trailing shoe brake, and the structure can refer to Fig. 8-6:

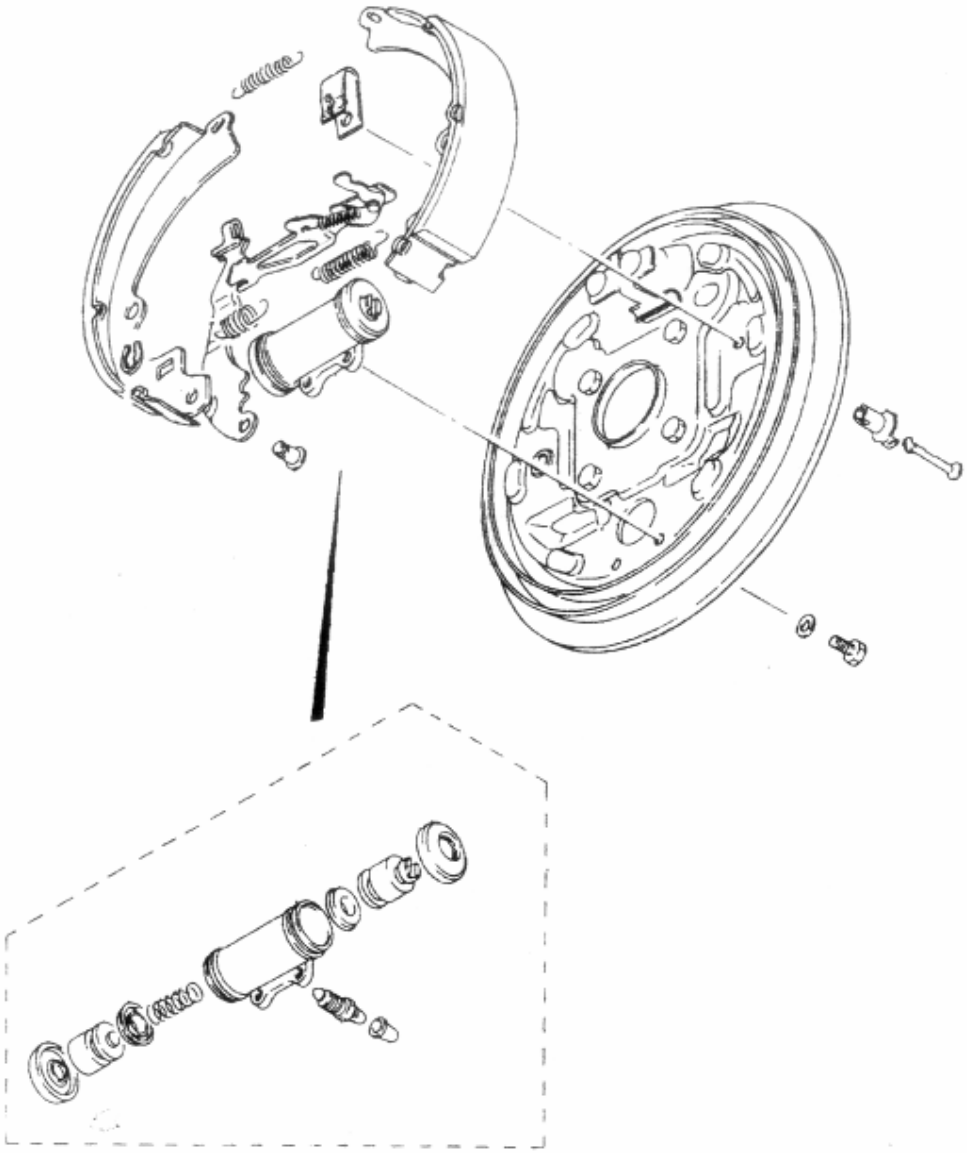


Fig. 8 - 6 Structural components of leading trailing shoe brake

4 . Structure of parking brake device

For structural components of parking brake device, see Fig. 8-4.

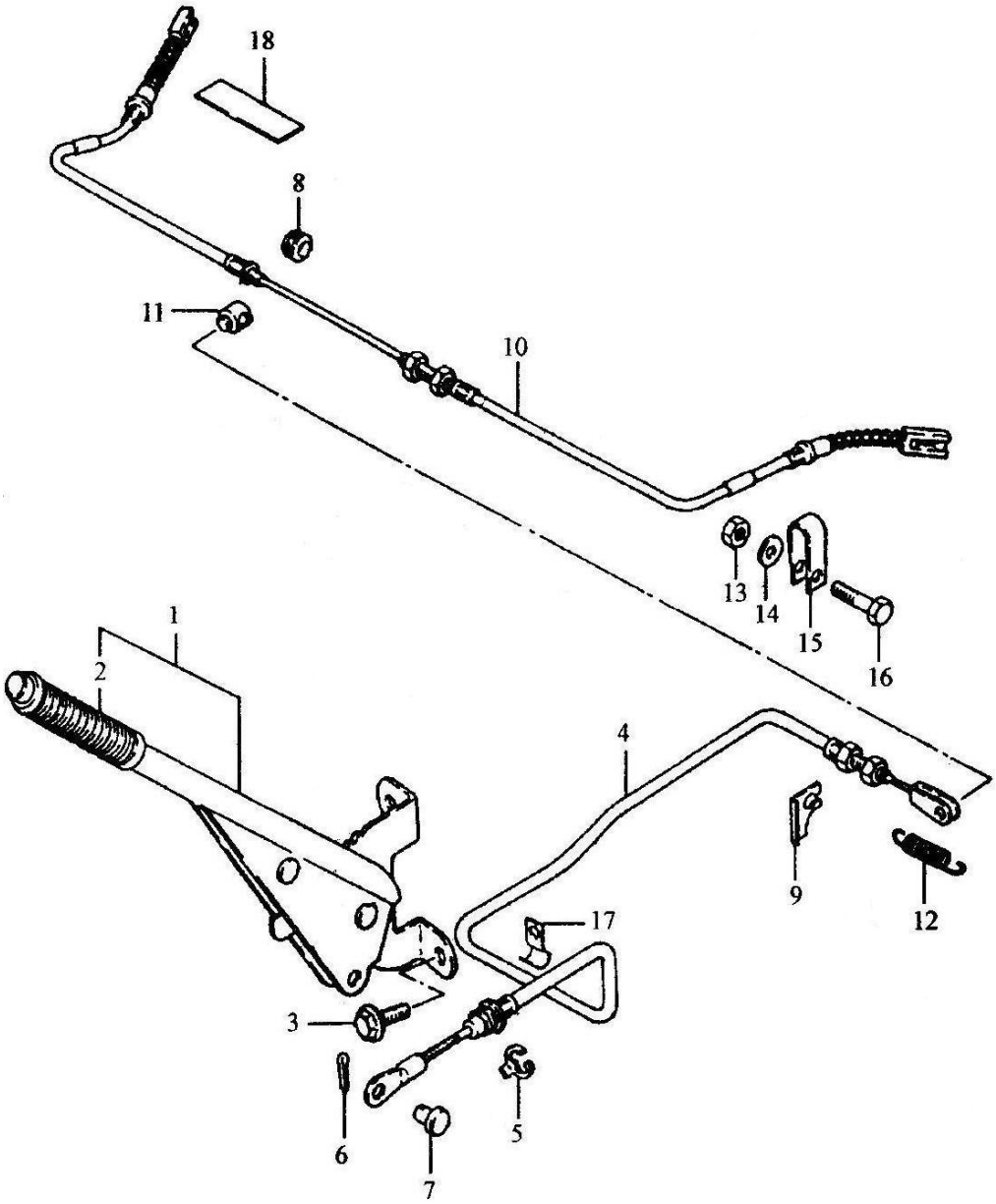


Fig. 8 - 7 Structural components of parking brake device

1- joystick ;2-handle ;3-bolt ;4-cable ;5-E-shape ring ;6- split pin ;7-pin ;8- rubber ring ;9- baffle plate ;10-cable ;

11-pin ; 12-spring ; 13-nut ; 14-washer ; 15- bending plate ; 16-bolt ; 17-clip ; 18-plate

8.2 Analysis of main component wear

The performance of auto brake mainly depends on the braking torque produced by brake friction pairs and the road adhesive conditions required by wheel. Therefore, mail component wear of the

wheel brake is below:

8.2.1 Wear analysis of friction lining

Friction lining is the main component produces braking force, therefore, friction lining wear becomes the main reason that affects brake performance, and then main performance parameter of friction lining - friction coefficient, becomes main parameter affects brake performance. So, the change of friction coefficient becomes the leading factor of friction lining wear.

Followings are main reasons affects the friction coefficient:

（1）Lining material

Lining material is the main factor affects friction coefficient. When friction lining is changed, should choose the lining recommended by the manufacturer to guarantee braking performance of the original auto. Meanwhile, should notice that all brakes of the same auto must use the material of the same brand, which is the important factor to make sure brake balance coordination of each wheel.

（2）Working temperature of friction lining and brake drum

When working temperature of the brake is too high, friction lining can lead to heat fade and make friction coefficient reduced obviously. Lining heat fade means material polymers of lining will decompose to some gases and liquids at the high temperature, and gases and liquids will be acted as the lubrication among friction surfaces to reduce friction coefficient and deteriorate braking performance.

When the brake is maintained, many factors will destroy heat dissipation conditions of the brake to make working temperature of the brake higher. Thereinto, conjoint status of friction lining and horseshoe is the key factor affects lining heat dissipation. If there is foreign body or spacing, heat dissipation efficiency of the lining will be reduced. So, when the lining is re-riveted, must ensure the joint surfaces is flat and clean and must be riveted, and forbid adding the gasket between them to adjust the radius of curvature of brake shoe. Otherwise, if it is too long, friction lining can lead to smaller clearance between two ends of brake shoe and brake drum to cause mutual friction between shoe and drum during normal driving, so that working temperature of the brake can be increased.

（3）Surface quality of friction lining

Surface oil pollution and ablation of friction lining can make friction coefficient reduce.

8.2.2 Brake analysis of shoe and drum

（1）Form and position error of brake shoe and brake drum

Brake shoe and brake drum have round and taper and can cause the connivent area of shoe and drum to reduce and decrease the braking performance. Otherwise, when the phenomena of ellipse or the different axle is existed, the contact of shoe and drum is unstable during braking and can create the vibration and impact to make hydraulic braking performance reduce.

（2）Rigidity of brake drum

The rigidity of brake drum is deficient, and can produce the bigger deformation during braking to decrease pressed force of shoe and drum, so that braking performance will be reduced. Main factors affect the rigidity of brake drum include working temperature and wall thickness of brake drum. If working temperature is too high and wall thickness is reduced, both of them can reduce the rigidity. So, should control the inner diameter in the permissible range in the course of repairing to make sure that wall thickness of braking drum meets the standard.

（3）Surface roughness of brake shoe and brake drum

Too high surface roughness of brake shoe and brake drum will make actual contact area small, and if the load is concentrated on the emboss, it will make the contact temperature too high to be ablated, so as to reduce braking performance and accelerate the part damage. Currently, processing methods of brake shoe include the boring and the grinding. The grinded brake shoe has the lower surface roughness but braking performance is better.

（4）Clearance between shoe and drum

The clearance between shoe and drum is too small, and they can’t be completely separated, not only create braking error, but also make the brake temperature too high to reduce braking performance; If the clearance is too big, it will make the braking force reduce, even can’t be braked. Therefore, when the brake

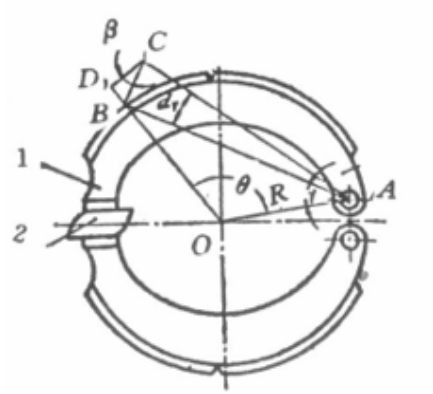


Fig. 8 - 8 Displacement when brake shoe is opened

is maintained, the brake clearance must be 1 - brake shoe ; 2 - brake camshaft

carefully checked and adjusted to meet the standard, and the clearance of left and right wheel of the same axle must be consistent.

（5）Anastomosis of brake shoe and brake drum

If other conditions are the same, the anastomosis of brake shoe and brake drum has great effect on braking performance.

Anastomosis of shoe and drum includes three instances: synchronously comprehensive anastomosis of shoe and drum, anastomosis of the middle of shoe and drum, and anastomosis of two ends of shoe and drum.

1）Synchronously comprehensive anastomosis of shoe and drum

When the shoe is opened, shoe and drum will be anastomosed completely at the same time, friction area is large and load distribution is uniform; the deformation of shoe and drum is small, working temperature is low, the change of friction coefficient is small but braking performance is good. It is difficult to realize, even impossible to come true because of following reasons.

Open speed (radial displacement) of each point on the shoe is different. According to Fig. 8-8, when brake shoe of simple non-balance brake is opened, radial displacement of each point on the shoe is introduced as follows:

Choose randomly point B on the brake shoe, when brake shoe turns to the angle of dr around pinhole center A, point B will move to point C and the displacement is BC. Displacement BC is decomposed to radial displacement BD and tangential displacement DC. Radial displacement BD is the efficient displacement to cancel the clearance between shoe and drum. According to the figure, for it is small, dr can be regarded as CBA≈90°

therefore: $BD=BC\cdot\sin\beta$ $BC\approx AB\cdot dr$

then $BD\approx AB\cdot dr — \sin\beta$ （8 - 1）

According to sine theorem: $AB=\dfrac{R\bullet\sin\theta}{\sin\beta}$ （8 - 2）

formula（8 — 1）will be replaced by formula（8 — 2）, so

$$BD \approx R \bullet \sin\theta \, dr \qquad (8-3)$$

According to formula (8 — 3), when θ is 90° (the middle of frictional plate of brake shoe), radial displacement of friction lining of the shoe is largest and gradually reduces to two ends. When θ is 0° and 180°, radial displacement becomes zero.

For Fig. 14-2, it is radial displacement of each point on the frictional plate when brake shoe of certain auto brake conquers clearance opening 18′ between shoe and drum. From this figure, radial displacement of frictional plate middle is larger 60% than two ends.

Otherwise, for different opening value-dr, its difference is changed. For brake drum creates min. deformation and the braking force is not the same during braking, it is different between actual displacement and theoretic displacement. It is obvious that the shape and the size of brake shoe are taken measures, so that it is almost impossible to synchronously cancel the clearance between each point and brake drum during the shoe is opened to realize synchronously comprehensive anastomosis.

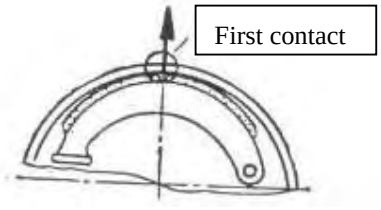
② Brake shoe and brake drum have processing error. Only curvature radius of shoe and drum is the completely same, and then maybe realize synchronously comprehensive anastomosis. But, there is the error of size, shape and orientation while processing, and add the influence of equipment precision, it is difficult to make sure curvature radius of them is the same.

③ Assembly and adjustment have errors. During assembly, wheel brake can create the deformation of brake carrier, knuckle spindle deformation or axle tube deformation, wrong mounting position of brake carrier or hub bearing; When adjusting, the clearance between shoe and drum is adjusted improperly to cause relative position error of shoe and drum. It is difficult to make brake shoe and brake drum comprehensive anastomosis in the course of the shoe opening.

2) Anastomosis of the middle of shoe and drum

When the shoe isn’t opened, the clearance between frictional plate of brake shoe and brake drum is not less than two-end clearance. When the shoe is opened, the shoe middle will first contact with brake drum (Fig. 8-9) because of the big displacement of the shoe middle. So, there is only one contact for each shoe and brake drum, and the pressure of two shoes has been concentrated on two points of the drum. The stress is 10 times bigger than comprehensive anastomosis, and the

deformation of brake drum is big, and the abrasion of the lining middle is strengthened which is easy to create the scorch and obviously reduce the braking performance.



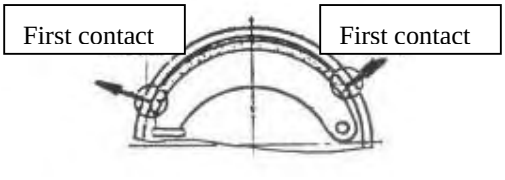
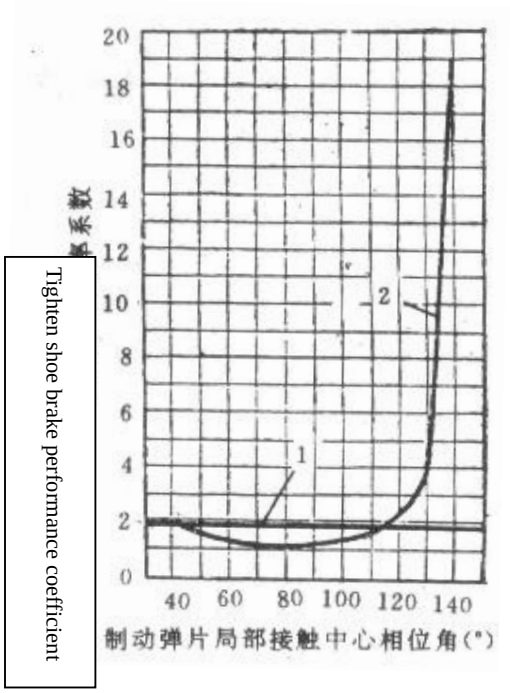


Fig. 8 - 9 Contact of brake shoe middle and brake drum

Fig. 8 - 10 Contact of two-end brake shoe and brake drum



3）Anastomosis of two ends of shoe and drum

When the shoe isn't opened, the two-end clearance between friction lining and brake drum is less than the middle clearance. If proper adjustment, when the shoe is opened, maybe first realize the anastomosis of two ends of friction lining and brake drum, and then realize the anastomosis the middle after two ends (Fig. 8-10). So, there are two contacts for each shoe and brake drum, the contact surface near to the middle will be increased and pressure distribution is uniform. The deformation of brake drum is smaller, working temperature of the brake is lower, but th Otherwise, by the effects of friction force of friction lining end, the shoe creates the bend and the deformation to rapidly realize the anastomosis with the drum, and trend to the comprehensive anastomosis based on the abrasion and the brake increase.

Fig. 8-11 is braking performance change curve of brake friction pair of certain auto brake leading shoe calculated when contacting on each position. From this figure, when two ends of frictional plate of brake shoe are contacted, the braking performance is better than the middle contact and the braking torque is big.

From above analysis, it is impossible to make synchronously comprehensive anastomosis, and the braking performance of first two-end anastomosis is better than first the middle anastomosis. And

for their abrasion during use, the contact area of them is gradually increased and trend to realize comprehensive anastomosis, and improve the braking performance and the life of shoe and drum is longer. When the brake is repaired, the anastomosis between shoe and drum should realize the middle after two ends. Measure: when friction lining is added, the brake shoe radius is larger than the radius of brake drum, that is to say, R shoe is more than R drum.

8.2.3 Unbalance of wheel brake at two sides of the same axle

Wheel brake at two sides of the same axle should be equal to ensure the braking stability. If wheel brake at two sides of the same axle is unequal and two-wheel braking deceleration is unequal, the auto can create running deviation. Reasons cause

the unequal brake of left and right wheel are followed:

（1）The friction coefficient at two sides of wheel brake is different. As mentioned above, the material and surface quality of friction pair is different and working temperature of the brake is not the same, etc., and all can create the difference of friction coefficient.

Fig. 8 - 11 Braking performance coefficient curve of certain auto brake

1 - Uniform contact of frictional plate brake shoe

2 - Partial contact of frictional plate brake shoe

（2）The pressure of two-wheel brake shoe to the drum is unequal. The pressure between shoe and drum is one of mail factors determine the braking torque. Reasons cause the unequal pressure of left and right wheel shoe and drum mainly include the different two-wheel brake piping resistance, the different technology of left and right brake chamber or wheel cylinder, the unequal elasticity of return spring of shoe plate or the unequal clearance between shoe and drum. Otherwise, above factors affect not only the braking torque, but also the starting time of the braking action.

（3）Inner diameter of brake drum is different. If the inner diameter of two brake drums, connivent area of shoe and drum and the rigidity of brake drum is different, all can lead to the difference of braking torque. Therefore, when brake drum is processed, should guarantee the inner diameter of brake drum at two sides of the same axle is the same, and the tolerance should not be more than 1mm.

Besides above reasons, if the tire technology of left and right wheel (abrasion and air pressure, etc.) is different, the load quality is uneven and the suspension is different, all can destroy brake balance of left and right wheel to create running deviation when the auto brakes.

8.3 Disassembly and maintenance of brake device

8.3.1 Disassembly of brake device

(1) Disassembly of brake

1) Release brake handle and remove parking brake
2) Unscrew the nut of back wheel, and then peak the auto supported by the bracket, disassemble the wheel nut and take off the back wheel;
3) Loosen the drain plug and clean up gear oil of rear axle house;
4) Pull out the brake drum by two bolts;
5) Turn the brake shoe by nipper pliers to impact the pin, and remove the brake shoe to press the spring;
6) Take off the parking brake cable from pull rod of parking brake shoe, and dismantle brake shoe;
7) Take apart the fixed clip of parking brake cable, and disassemble parking brake cable from brake carrier;
8) Draw out the brake fluid in brake oil pipe by absorbing cylinder, and then unscrew the connecting nut of brake pipe from wheel brake pump to remove brake pipe;
9) Immediately install the tubing plug to all brake oil pipes and brake pumps to avoid spill the brake fluid out;
10) Unscrew the erection bolt of wheel brake pump and remove the brake pump;
11) Disassemble the fitting nut of brake carrier from rear axle housing;
12) Pull out brake carrier and half axle from axle housing by special tooling;
13) Thin bearing shield ring by grinding machine, and remove bearing shield ring by chisel;
14) Remove the bearing from half axle by special tooling, and then remove brake carrier.

（2） Disassembly of brake chief-pump

1) Cut off the lead of fluid cylinder;

2) Clean the cover of the fluid reservoir casing and clean out brake fluid in the casing by sucker;

3) Dismantle brake hose on the fluid reservoir casing, and remove the bracket nut of the fluid reservoir casing to take off the fluid reservoir casing;

4) Disassemble the connecting nut between brake oil pipe and brake master cylinder to cut brake oil pipe from chief pump;

5) Remove two fixed nuts of brake master cylinder, and dismantle brake master cylinder from vacuum booster;

6) Disconnect dust shield of chief pump, and remove the spring shield ring from the pump piston cylinder;

7) Blow out back-cavity piston by compressed air;

8) Loosen off the locking screw of the piston;

9) Blow compressed air into the locking screw hole to blow out front-cavity piston;

(3) Disassembly of vacuum booster

1) Disconnect vacuum hose and booster;

2) Remove the connecting pin between U-shape yoke of push rod of vacuum booster and brake pedal arm;

3) Unscrew the fixed nut of vacuum booster, and remove vacuum booster from pedal bracket;

8.3.2 Maintenance of brake device

(1) Maintenance of drum brake

1) Check whether the drum brake is clean and there is any crack. Scrape the deep groove and measure the inner diameter of brake drum and check the abrasion of the working surface. If the abrasion of the working surface is serious or there is the right crack, etc., the brake drum should be changed.

2) Check the abrasion of friction lining of brake shoe. If the abrasion of any friction lining exceeds use limit, all friction linings of brake shoe should be changed.

3) Clean brake pump components of brake pump by brake fluid and check whether each component of the pump is worn, cracked, corrupted or damaged. If there is any badness,

the components should be changed.

4) Check whether each spring of brake supporting rod is damaged, corrupted or the spring is bad. If there is any badness, the spring should be changed.

(2) Maintenance of brake master cylinder

1) Check whether fluid reservoir casing of brake master cylinder is leaked and distorted, and the cover of fluid reservoir casing is damaged and distorted, and brake hose is damaged. If there is any badness, all should be changed;

2) Check whether the shell and hole of brake master cylinder is corrupted, damaged or cracked on the right, etc. If there is any badness, brake master cylinder should be changed;

3) Check whether the inlet connector of brake master cylinder has any aging, cracking or oil leakage, O-shape seal ring is reliable, outlet valve is bad and the spring is softened. If there is any badness, all should be changed;

4) Check whether the piston of brake master cylinder is seriously damaged, return spring is softened, and piston cup has any aging and cracking. If there is any badness, all should be changed.

(3) Maintenance of vacuum booster

1) Check whether vacuum booster has any effect as booster. If it has any aging and dilapidation, the vacuum tube should be changed; If it has any badness, vacuum booster should be changed to the vacuum booster assembly;

2) Check the length of U-shape yoke of push rod of vacuum booster. If the length from the pin hole of U-shape yoke of push rod to the installation surface doesn't meet the required value, the length of the yoke should be adjusted, ant then the nut will be screwed to the prescribed torque;

3) Check the clearance between the piston rod of the booster and the piston of brake master cylinder. If it doesn't meet the regulation, the clearance should be adjusted. Below is the adjustment method of the clearance between push rod of the booster and the piston of chief pump:

① Before it is measured or adjusted, the piston rod should be pushed repeatedly to ensure that the plate can be positioned; Inside pressure of the booster should be kept under the atmospheric pressure;

② Special tooling-measuring tool of the piston rod is installed on brake master cylinder, and push the guide pin of piston rod until piston plane A is level with end face B of chief pump.

③ Reverse the special tooling and install the tooling on the booster, and check the clearance between push rod of booster piston and the pin head of special tooling. If the clearance doesn't meet the described range, the adjustable bolt of push rod of booster piston should be reversed in order that the clearance will be adjusted the defined value.

（4）Maintenance of parking brake device

1）Clean the surface of brake cable, and check whether the outer layer of the cable is cracked and the joint is damaged, and the core wire is broken. If there is any badness, the cable should be changed to the cable assembly;

2）Check whether the lockup toothed plate of parking brake handle and the ratchet are distorted or damaged, the lockup is reliable and released flexibly. If there is any badness, the handle should be changed to the assembly of brake handle;

3）Check whether return spring hook of brake cable is installed correctly, the spring is broken or distorted, and the elasticity is reduced. If there is any badness, all should be changed.

8.4 Assembly and adjustment of brake device

8.4.1 Installation of brake device

1． Assembly of drum brake

When drum brake is installed, following items should be paid attention to:

1) Wipe the waterproof glue on the contact surface of brake carrier and rear axle;

2) Install brake carrier and half axle on the rear axle, and screw the fitting bolt of brake carrier up to the defined torque;

3) According to the prescription, screw the torque to install brake pump on brake carrier;

4) Connect brake oil pump to brake pump, and the connecting nut of brake oil pump is screwed to the defined torque;

5) When parking brake cable is installed, wipe the waterproof glue on the contact surface of brake carrier and brake cable, and then parking brake cable will cross the brake carrier to be fixed by clip;

6) When the brake shoe is installed, press hold-down spring of brake shoe to the installation position, and hold-down pin is turned over 90° by needle nose pliers to make pressure spring positioned;

7) Before brake drum is installed, the right-angled screwdriver head is plugged between the supporting rod and the ratchet, and then press the ratchet down to gain the max. clearance between brake shoe and brake drum, and subsequently install brake drum.

8) Install the rear wheel brake and the wheel, and after general air of brake system is eliminated, step the brake pedal for 4-5 times at the force of 30KG so that the clearance between brake drum and brake shoe can reach the regulated value.

2 . Installation of brake master cylinder and vacuum booster

When brake master cylinder and vacuum booster are installed, following items should be paid attention to:

1) When brake master cylinder is assembled, clean the components of chief pump by brake fluid. Change the new piston cup, and then the piston and the cup will be assembled together, and pay attention to the assembly direction of the cup;

2) When the piston components are assembled, according to the opposite order of the disassembly, firstly, install components of front-cavity piston to the cylinder body of

chief pump, and secondly, assemble components of back -cavity piston and adjust the size of piston components, and finally, enclose the cylinder body of chief pump;

3) When locking bolt of the piston is installed, slowly push the piston inside, and then mount seal ring and locking bolt of the piston to screw down to the regulated torque;

4) When the pipe joint of brake master cylinder is installed, the locking bolt of the pipe joint is screwed to the regulated torque;

5) Install the booster on the pedal bracket, and then mount U-shape yoke of the booster on brake pedal arm by pin and split pin, and the booster nut is screwed down to the regulated torque;

6) Install brake master cylinder on the booster, and the connecting nut is screwed down to the regulated torque;

7) Connect the vacuum hose to vacuum tube of the booster. Notice when connecting, the arrowhead on the hose should be faced to the side of intake manifold, and fix the hose by the clip.

8.4.2 Adjustment of brake device

1 . Checkup and adjustment of free pedal travel

Check free pedal travel, if free pedal travel doesn't satisfy the standard value, should check whether the bolt of pedal arm axle and the pin of brake master cylinder are loosened. If there is any badness, should be changed.

Standard value of brake free pedal travel: 8~15mm (oil brake), 25 ~ 35mm (gas brake)

2 . Checkup and adjustment of brake pedal height

Step down the brake pedal at the force of 30KG, measure the distance from brake pedal arm to cab arm and this distance should not less than the specified value. If the distance is too short, should check whether there is any air in brake tube or brake lining is worn, and should get rid of the air in the system or change brake shoe. For the auto with the booster, should check and adjust the length of push rod of the booster.

Standard distance from brake pedal to cab wall: ≧95mm

3． Adjustment of the switch of brake light

When the brake pedal is stepped down, the switch of brake light should be connected, if there is any failure, the position of brake light switch should be adjusted. While adjusting, put up the brake pedal towards the driver and retain this position, and loosen the fixing nut of brake light switch and adjust the clearance between the contact of brake light switch and the contact surface of brake pedal to the standard value, and then locking nut is screwed to the standard value.

Clearance between the contact of brake light switch and the contact surface of brake pedal 0.5～1.0mm

Standard torque of locking nut 10～15N.m

4． Checkup and adjustment of parking brake handle travel

（1）Checkup of parking brake handle travel

Hold the middle of parking brake handle, and slowly lift up parking brake handle at the force of 20KG until the booster is completely braked, and its ratchet travel should be 5~7 teeth.

（2）If parking brake handle travel is not included in the range of 5~7 teeth, the length of brake cable should be adjusted. While adjusting, unscrew the adjusting nut of brake cable and, and adjust parking brake handle travel to the specified range, and then screw the adjusting nut.

5． Exhaust of brake system

After brake device is maintained and re-assembled and the piping of brake system is input the air or the brake fluid is changed, the piping of brake system should be exhausted. Exhaust methods of brake system are below:

1） First mount the brake pump of left rear wheel far to brake master cylinder, and then mount the brake pump of right rear wheel, left-right front wheel in turn;

2） Pour brake fluid to fluid reservoir of brake master cylinder to make sure that at least brake fluid volume is half during exhaust;

3） Remove the bleeding plug, and connect the transparent plastic catheter to bleeding plug

of wheel brake pump, and another end of the catheter is inset the vessel;

4) Step down brake pedal several times so that brake fluid in fluid reservoir casing can enter chief pump and brake piping, and then when brake pedal is stepped, unscrew 1/3 ~ 1/2 cycles of bleeding plug;

5) Step brake pedal again and again until there is no bubble in the transparent catheter, and then hold brake pedal by foot and screw the bleeding plug. Notice that brake fluid will be filled at any moment in course of exhaust, in order that brake fluid in fluid reservoir casing keeps above “MIN” scale mark to prevent the air from entering brake master cylinder;

6) Remove the catheter, and re-assemble the bleeding plug of brake pump. And then press the piping to check whether brake fluid is leaked;

7) Fill brake fluid to fluid reservoir casing to specified “MAX” scale mark, but it had better not exceed this scale mark to avoid brake fluid pouring out to corrupt the body.

8.5 Maintenance of air brake device

8.5.1 Structure introduction

Wheel brake is the simple balance-type air brake. Upper and down brake shoe is tightly pulled by return spring so that platform of brake shoe is tightly pressed on brake cam, when it is turned, the cam opens the platform of brake shoe to stretch brake shoe, and the shoe clings to brake drum to realize the brake of the wheel.

8.5.2 Adjustment of the brake

(1) After changing brake shoe lining and re-work the friction surface of brake drum, or turning cam position of the supporting pin of brake shoe is changed because brake carrier is disassembled, so as to destroy the right contact status of brake shoe lining and brake drum, must do the overall adjustment, and the order is as below:

① Loosen the fixing nut of the supporting pin of brake shoe and the nut of the fastening bolt of the camshaft bracket.

② Rotate brake shoe so that the marks of two shaft ends is faced towards inside oppositely.

③ Through repeatedly screwing the supporting pin of brake shoe and worn shaft of adjusting arm, brake shoe lining and brake drum can be completely attached, at this adjusted position, carefully screw the fixing nut of the bracket and the locking nut of the supporting pin. (Now, keep the position of the supporting pin and bracket of brake shoe invariable)

④ Worm shaft is unscrewed 1/2～2/3 cycles, and brake drum should be automatically rotated and not crash with brake shoe lining or other parts. Check by feeler gauge that the clearance range between brake shoe lining and brake drum should be:

Supporting pin end of brake drum	0.25～0.4mm
Camshaft	0.4～0.6mm
Difference of two shoes at the same end	<0.1mm

⑤ Push rod travel after brake chamber is input compressed air should be 25 ± 5mm.

（2）After brake shoe is worn, push rod travel of brake chamber is beyond 40mm, in order to reduce the clearance between brake shoe lining and brake drum, only need do partial adjustment. Methods are below:

① Don’t rotate the supporting pin of brake shoe lining to prevent damaging the original good contact status.

② When it is adjusted, the front wheel faces the adjusting worm. For rear wheels, the worm is screwed at the counterclockwise direction (the clearance between brake shoe lining and brake drum is reduced) and is unscrewed at the clockwise direction.

Notice: it is wrong that the clearance is adjusted by screwing the push rod clevis of brake chamber to change the length and direction of push rod.

（3）When the auto brake is trouble by running deviation of front wheel (during braking, obvious turning and catch on the steering wheel), it can be removed by the method of increase running deviation lining clearance of front wheel at another side. (or reduce one-side clearance of running deviation) If running deviation to the left, increase the lining clearance of right front

wheel (adjust brake adjusting arm and increase push rod travel of brake chamber), or reduce the lining clearance of left front wheel (shorten push rod travel). When the worm shaft of brake adjusting arm is turned 1/4 cycle, push rod travel is changed about 6mm.

Reasons of adjustment: when brake chamber is input at the low pressure, the efficient area of brake chamber diaphragm is extended according to pushing surface of push rod. Since the increase of the efficient area of the diaphragm leads to increase the brake, it is larger than the brake reduce caused by the increase of the clearance between brake drum and brake lining, so that when the lining clearance is increased and push rod travel is extended, the efficient area of the diaphragm will be extended and the brake will be increased, on the contrary, when the lining clearance is reduced and push rod travel is shortened, the diaphragm distortion is small, the efficient area is small so that the brake is small.

Notice: this adjusting method is only used for running deviation of front wheel brake caused by the limited difference of the lining clearance of left and right front wheel (in the range of 1/3～1 cycles of worm shaft of brake adjusting arm). All running deviations of front wheel caused by too large lining abrasion, inconsistent performance of left and right lining, oil pollution of the lining, inconsistent adjustment of left and right hub bearing, inconsistent pendulum difference of left and right brake drum, etc., belong to the failure category, should separately removed based on the related reason.

（4）When axial movement value of brake camshaft is not less than 1mm, can suitably add adjusting washer.

（5）If the rear camshaft doesn’t return, can loosen three bolts of rear bracket and adjust the concentricity of camshaft hole of two brackets. After the camshaft can rotate freely, screw the bracket bolt.

8.6 Maintenance of front and rear brake

1 Check whether the fixing bolt of brake carrier is loosened.

2 Brake shoe should be rotated flexibly on the supporting pin of brake shoe, in case of clip and corrosion, etc., brake shoe should be disassembled to clean and remove rust, and smear the suitable lubricating grease. If the supporting pin of brake shoe is loose, the bushing should be changed.

3 The brake camshaft should be added lubricating grease when the maintenance at 3000Km, in order that the camshaft can be turned over freely on the bracket hole, in case of clip and corrosion, etc., the camshaft should be disassembled to clean and remove rust, and smear the suitable lubricating grease.

4 When the distance from the surface of brake shoe lining to the rivet head is less than 0.5mm, the brake shoe lining should be changed. Or for the crack and chip shell of the lining surface, etc., the lining should be changed.

5 During running, if the clearance between brake shoe lining and brake drum of certain auto is changed often, should check:

① Whether brake adjusting arm is locked up worm shaft.

② Whether the locking nut of the supporting pin of brake shoe is screwed tightly.

6 Out-of-round of brake drum abrasion is permitted cutting, when cutting, must be positioned by the conical surface of bearing cups of wheel hub, and total trip of the friction surface in the brake drum to the bearing axis is less than 0.2mm. The difference of the Inner diameter of left and right brake drum of the same auto is less than 1mm.

7 For the return spring of brake shoe, carefully check two-end hook and make sure there is no crack. If it is rusted or failed, return spring should be changed.

8 The diaphragm of brake chamber should be good without any crack and aging; and different diaphragms with rubber compound recipes are forbidden installing on the left and right brake chamber of the same auto.

8.7 Analysis of common fault and experience diagnosis

Common faults of auto brake system include ineffective braking, braking failure, braking deflection and braking lag, etc.

8.7.1 Hydraulic braking system

1 . Ineffective braking

1) Phenomenon: when the auto was braked, the driver felt the deceleration wasn’t enough; when the auto was braked emergently, the braking distance is too long.

2) Reasons:

(1) Oil leakage of chief pump, pump, piping or pipe joint;

(2) Lack of oil or no oil for fluid reservoir casing of chief pump;

(3) The brake fluid is metamorphic (thinning or thickening) or the deposit of the inner wall of the piping is too thick;

(4) There is the air in the brake fluid;

(5) The abrasion of the chief pump cup, the piston or the cylinder is too more;

(6) The abrasion of the pump cup, the piston or the cylinder is too more;

(7) The gasoline inlet of the chief pump, compensated hole or the vent hole of fluid reservoir casing is blocked;

(8)The outlet valve and oil returning value of chief pump is not sealed or the pre-tightening force of return spring of the piston is too small;

(9)The front transfixion hole of the chief pump piston is blocked or the chief pump cup has the pastiness and the swell;

(10) The pump cup has the pastiness and the swell;

(11) The turbocharger or the booster is inefficient or has the failure;

(12) The oil pipe is collapsed or the inner hole of the hose is blocked;

(13) The free brake pedal travel is too large;

(14) The connivent surface of the brake shoe lining and brake drum (tray) is bad or the brake clearance is adjusted improperly;

(15)The quality of the brake shoe lining is not good or during using, the surface is hardened, scorched, oil polluted and the rivet head is exposed;

(16) The abrasion of brake drum is too more or during braking, it is distorted.

3) Diagnostic method: refer to below flow chart (Fig. 8 - 12) to diagnose.

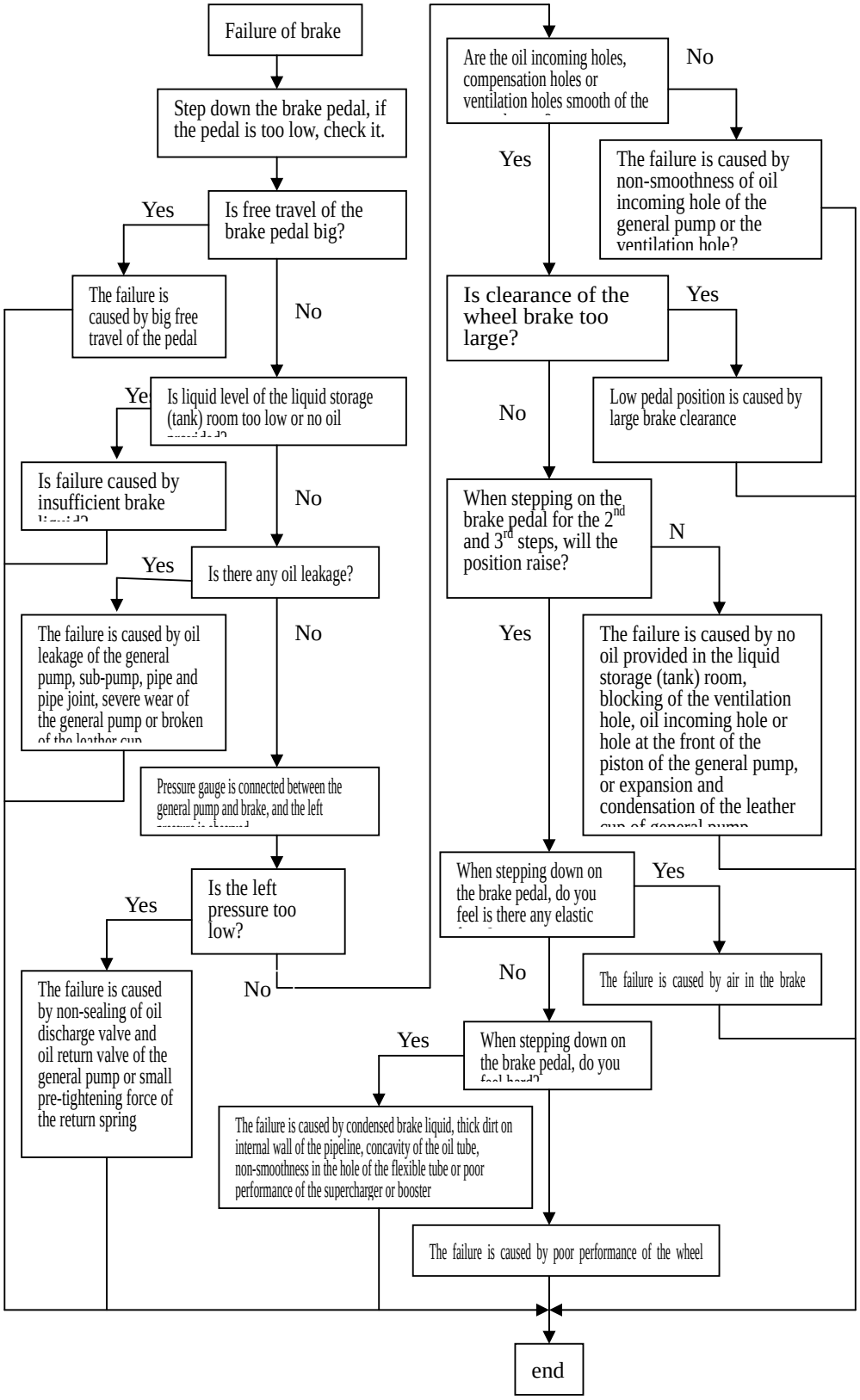


Fig. 8 - 12 Diagnostic flow chart of Ineffective braking

2．Braking failure

1）Phenomenon: when the brake pedal was stepped, the auto was not decelerated, even if continuous several steps, there was no obvious deceleration.

2）Reasons：

（1）There is no brake fluid in chief pump;

（2）The chief pump cup is seriously broken or the brake system is seriously leaked;

（3）The brake hose or the metal pipe is ruptured;

（4）The connection is cut from the brake pedal to chief pump.

3）Diagnostic method: refer to below flow chart (Fig. 8 - 13) to diagnose.

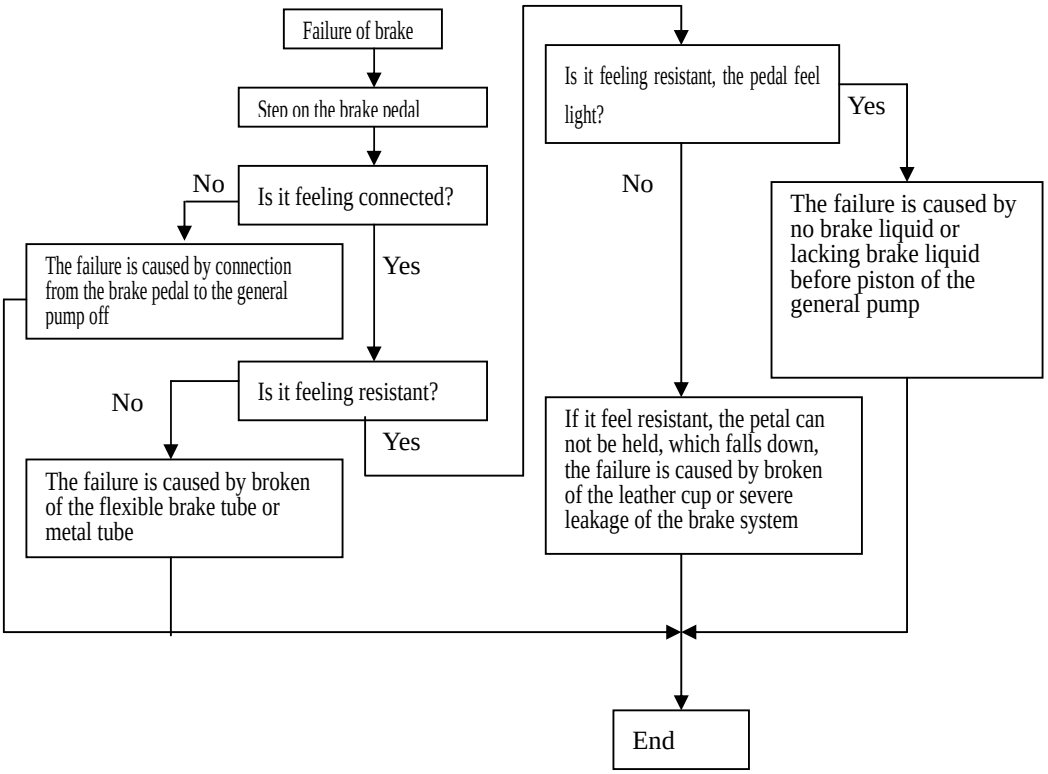


Fig. 8 - 13 Diagnostic flow chart of braking failure

３．Braking deflection

１）Phenomenon: when the auto was braked, the driving direction was deflected; when the emergent braking, the auto happened the plunging into head and tail-flick.

２）Reasons：

（１）The material of brake shoe lining of left and right wheel is different or the new and old material is different;

（２）The connivent area and the connivent position of between brake lining and brake drum (tray) of left and right wheel is different or brake clearance is different;

（３）The technology of left and right wheel pump is different, so that the acting time is different or the tension is different;

（４）The return spring pull of brake shoe of left and right wheel is different;

（５）The tyre pressure of left and right wheel is different, the diameter or the pattern is different, or the pattern depth is different;

（６）The thickness, diameter, distortion and roughness of working surface of brake drum of left and right wheel is different;

（７）Single-side brake piping is collapsed, blocked or oil leaked;

（８）There is the vapor lock in single-side brake piping or the pump;

（９）The connection between single-side brake shoe and the supporting pin is tight or rusted;

（10）The vehicle frame and axle are bent in the horizontal plane, the axle base at two sides of the frame is unequal or the rigidity of front steel plate spring is unequal, etc.

３）Diagnostic method:　refer to below flow chart (Fig. 8 - 14) to diagnose.

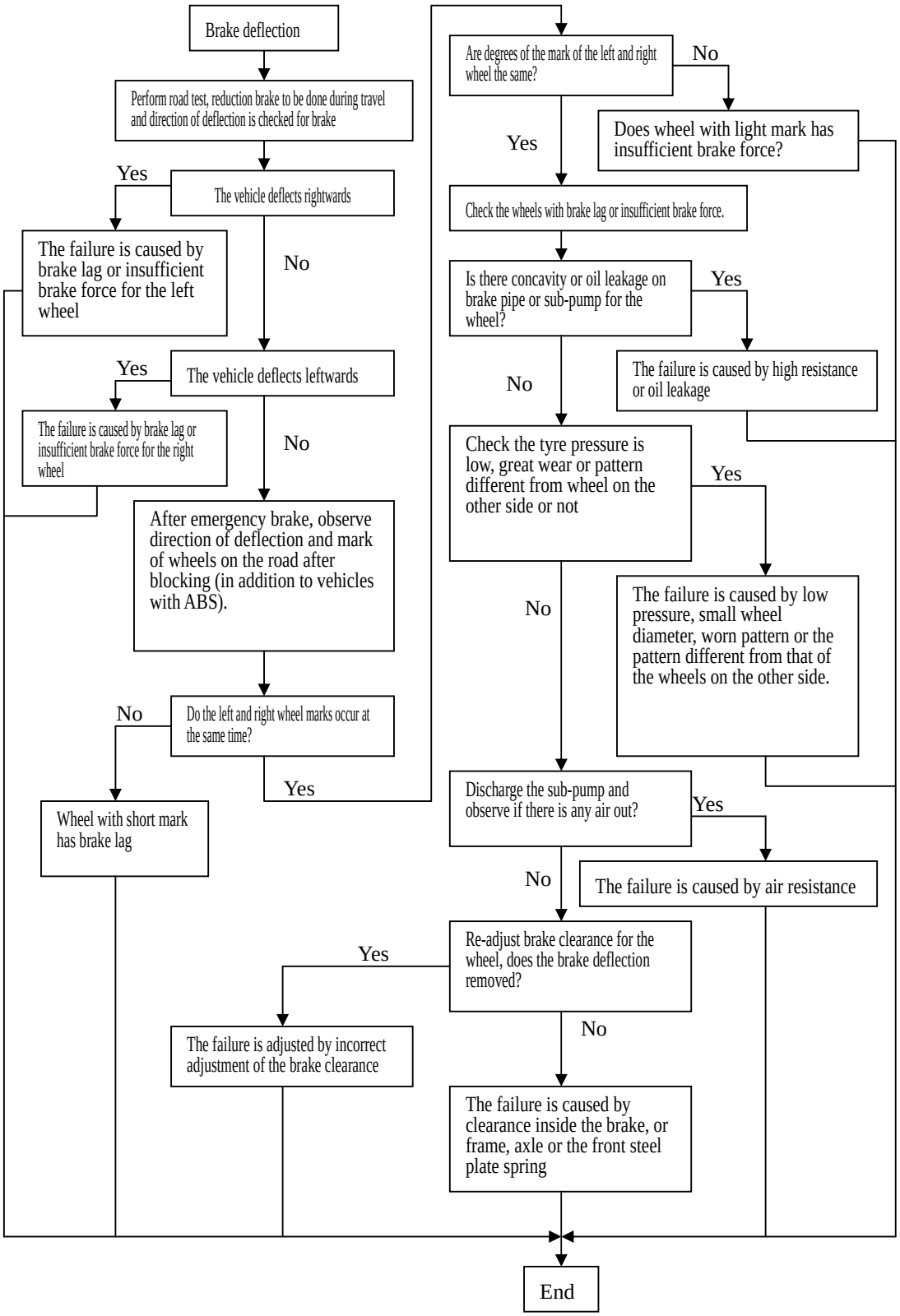


Fig. 8 - 14 Diagnostic flow chart of braking deflection

4．Braking lag

1）Phenomenon: after brake pedal is lifted, braking action of all or separate wheels can not be cancelled immediately, so as to affect re-starting, acceleration running or skidding.

2）Reasons：

（1）The brake pedal has no free travel;

（2）The connection of brake pedal and its axle is lake of oil, rusted or the return spring of the pedal is taken off and broken, and the pull is too small, etc.;

（3）The return spring of the chief pump piston is broken or pre-tightening forcing is too small;

（4）The length of chief pump piston and the cup is too large, or the cup has the swell and the pastiness;

（5）The compensated hole of chief pump is jammed by filth;

（6）The pump cup has the swell and the pastiness or the piston is caught;

（7）The return spring of brake shoe is taken off, broken or its pull is too small;

（8）The brake shoe and the supporting pin is rusted;

（9）The clearance between brake shoe and brake drum (tray) is adjusted improperly, and after the bake is loosened, the attrition is still existed partially;

（10）The oil pipe through the pump is collapsed or blocked;

（11）When no braking, the piston center hole of auxiliary cylinder of the turbocharger can not be opened;

（12）The hub bearing is loosened.

3）Diagnostic method: refer to below flow chart (Fig. 8 - 15) to diagnose.

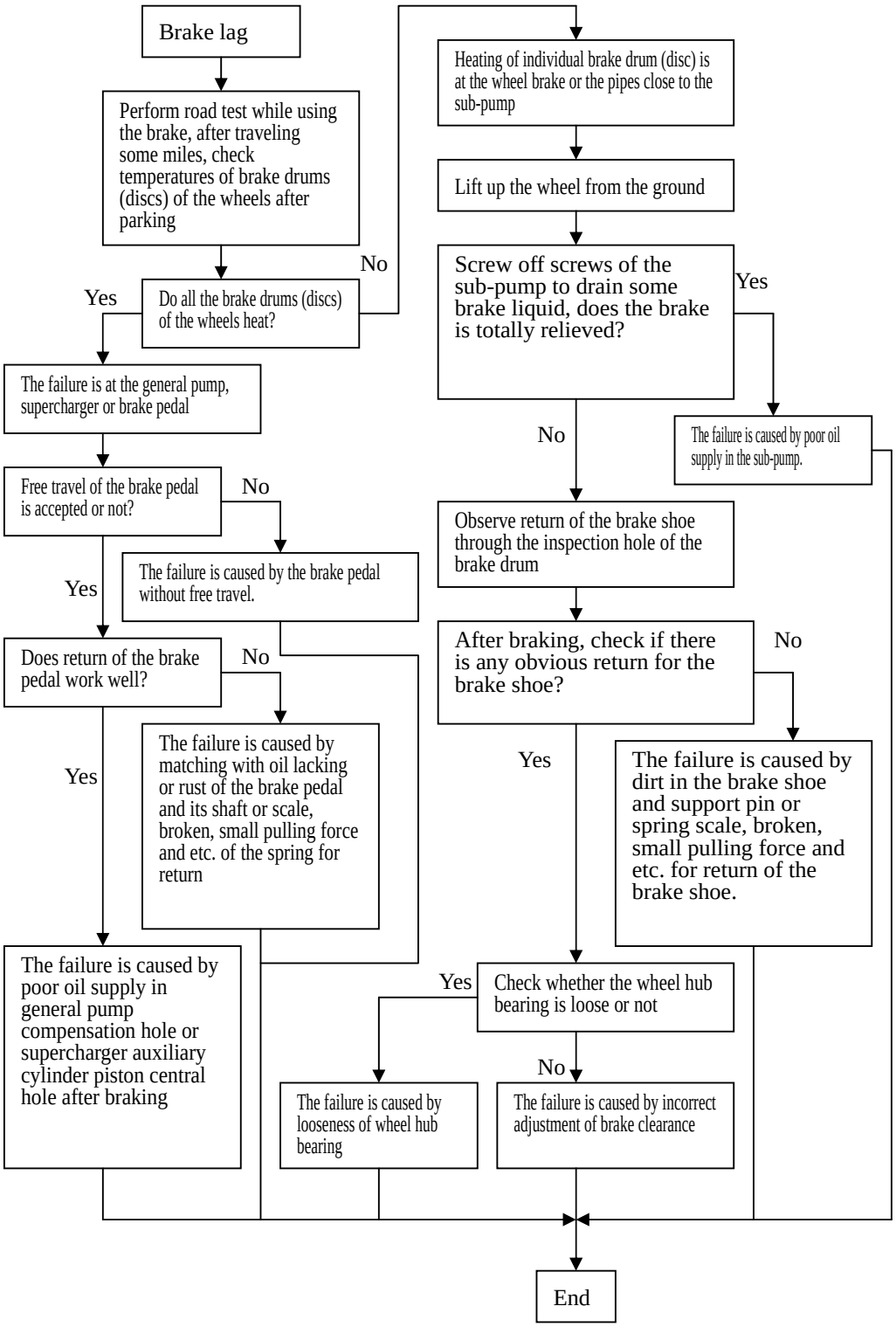


Fig. 8 - 15 Diagnostic flow chart of braking lag

8.7.2 Air braking system

1 . Ineffective braking

1) Phenomenon: the same to ineffective braking of hydraulic braking system.

2) Reasons：

(1) The free travel of brake pedal is too large;

(2) The air-reserve tank can not reach the specified air pressure;

(3) Max. air adjusting bolt of brake valve is improper to make brake air pressure lower;

(4) Pre-tightening force of the balance spring of brake valve is too small, and the keeping brake is earlier;

(5) The diaphragm of brake valve is broken or exhaust valve is closed imprecisely;

(6) The diaphragm of brake chamber is broken or brake piping is leaked;

(7) The brake piping is collapsed or the inner hole of the hose is blocked;

(8) The connivent area between brake shoe lining and brake drum is not good or brake clearance is adjusted improperly;

(9) The quality of the brake shoe lining is not good or during using, the surface is hardened, scorched, oil polluted and the rivet head is exposed;

(10) The abrasion of brake drum is too more or during braking, it is distorted.

(11) The brake camshaft is rusted in the supporting sleeve;

(12) The deposit of the inner wall of the brake piping is too serious;

3) Diagnostic method: refer to below flow chart (Fig. 8 - 16) to diagnose.

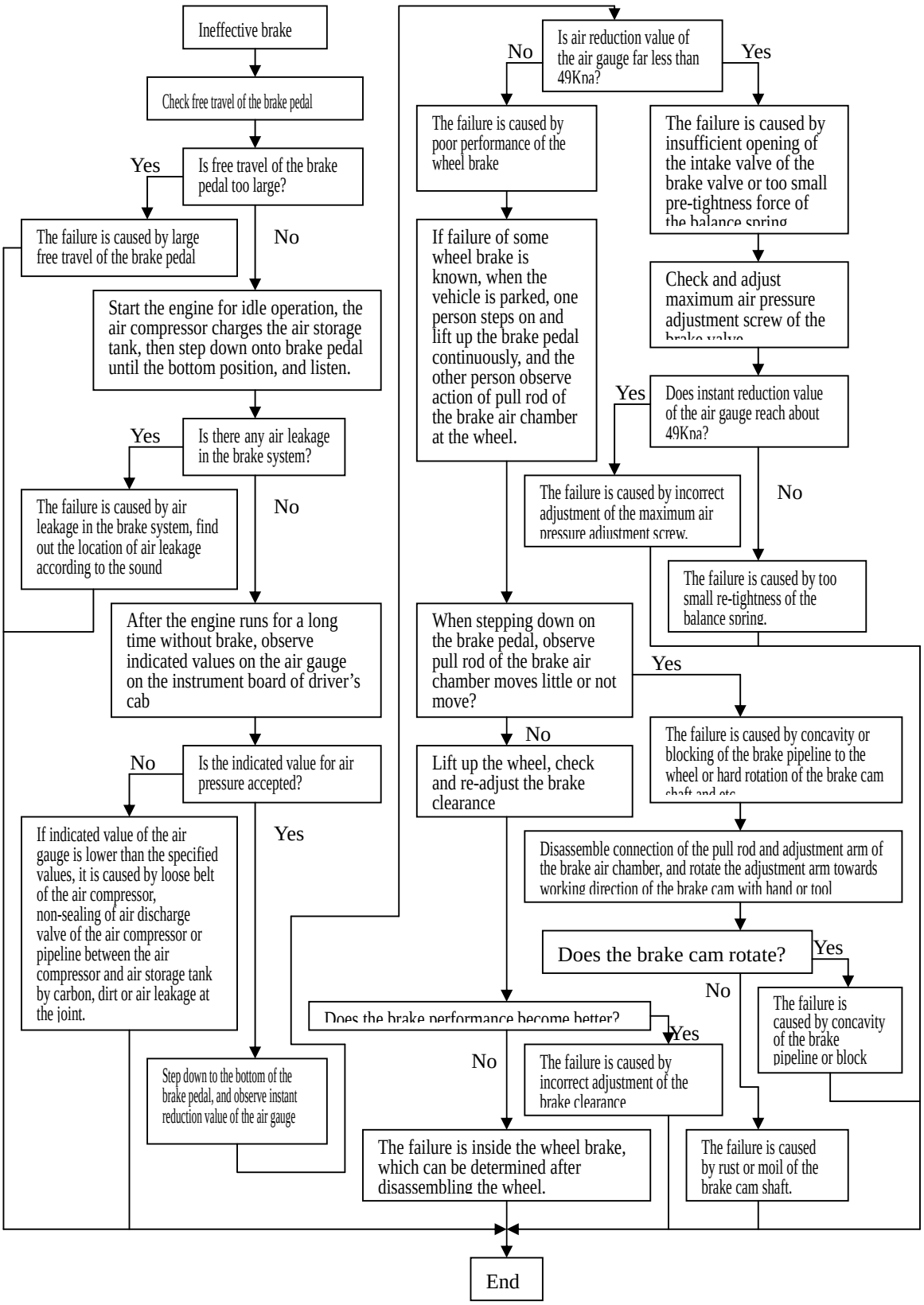


Fig. 8 - 16 Diagnostic flow chart of ineffective braking

2．Braking failure

1）Phenomenon: the same to braking failure of hydraulic braking system.

2）Reasons：

（1）The connection from brake pedal to brake valve is taken off;

（2）There is no compressed air in air-reserve tank;

（3）The air inlet valve of brake valve can not be opened or exhaust valve is closed imprecisely;

（4）The diaphragm of brake valve and brake chamber is seriously broken or the brake hose is ruptured;

（5）The brake piping is frozen or blocked by oil contamination.

3）Diagnostic method: refer to below flow chart (Fig. 8 - 17) to diagnose.

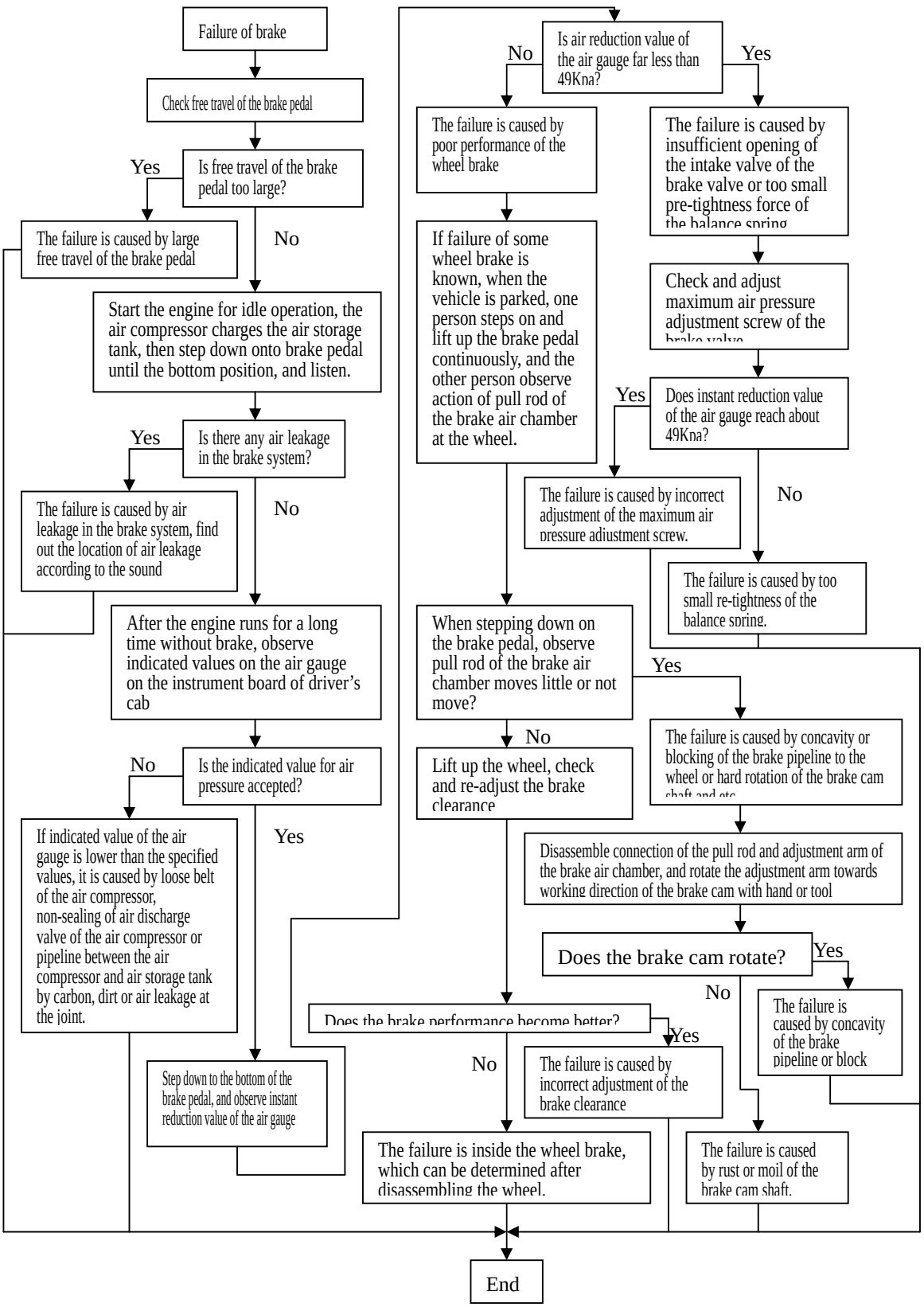


Fig. 8 - 17 Diagnostic flow chart of braking failure

3．Braking lag

1）Phenomenon: the same to braking lag of hydraulic braking system.

2）Reasons：

（1）The small free travel of brake pedal causes the start degree of exhaust valve of brake valve is too small;

（2）The exhaust valve spring of brake valve or the spring causes exhaust valve to open is tired, broken or its elasticity is too small;

（3）The rubber valve surface of exhaust valve of brake valve has the swell and the pastiness, or the more oil contaminations and the colloids are piled at the valve port;

（4）The return spring of brake pedal is tired, broken and lost or its pull is too small;

（5）The return spring of brake chamber diaphragm (piston) is tired, broken or its pull is too small;

（6）The return spring of brake shoe is tired, broken and taken off or its pull is too small;

（7）The brake camshaft is lack of oil, rusted or blocked in its sleeve;

（8）The brake shoe and the supporting pin are rusted;

（9）The brake clearance is adjusted improperly, and after the bake is loosened, the attrition between brake lining and brake drum is still existed partially;

（10）The hub bearing is loosened.

3）Diagnostic method: refer to below flow chart (Fig. 8 - 18) to diagnose.

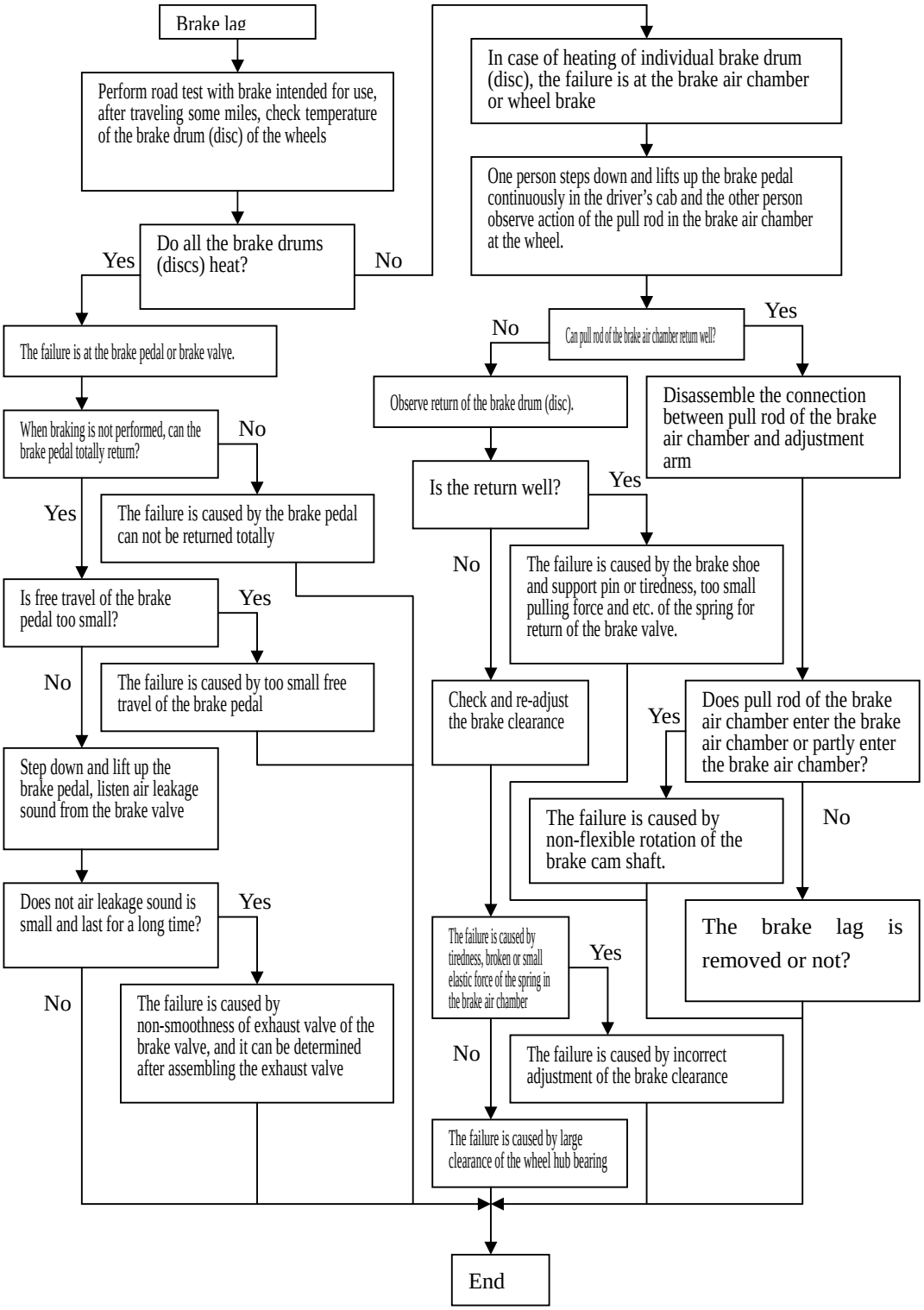


Fig. 8 - 18 Diagnostic flow chart of braking lag

Chapter 8 Braking System

8.1 Layout diagram and structure of braking system

8.1.1 Layout diagram of braking system

Braking system of Changan Automobile includes two systems of service brake and parking brake. Refer to the layout diagram (Fig. 8-1).

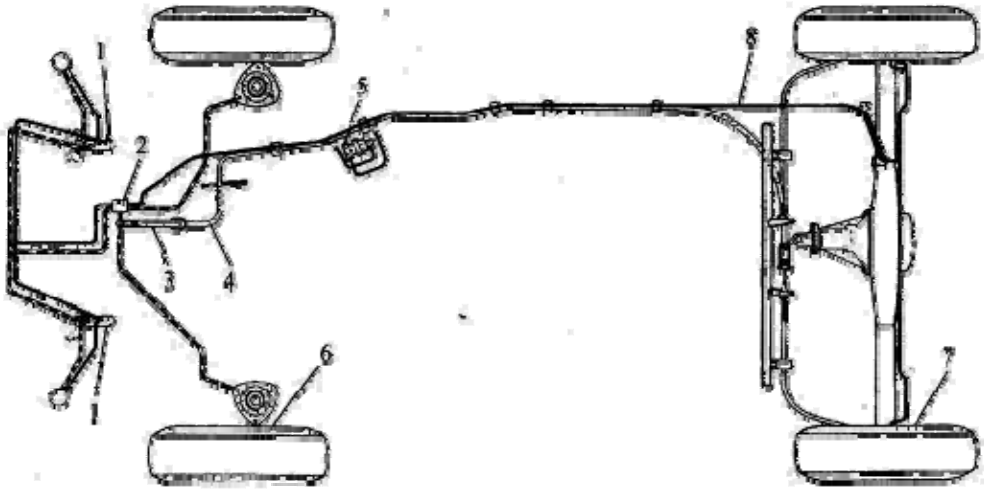


Fig. 8 - 1 Layout diagram of braking system

1- brake master cylinder；2- five-way valves；3- parking brake handle；4- parking brake cable；5- proportioning valve；6- front wheel brake；7- rear wheel brake；8- oil pipe

Service brake is dual circuit hydraulic brake system, and uses H-shape circuit, which means that one brake circuit is used for two front wheels and another brake circuit is used for two rear wheels. Working medium of these two brake circuits is mutually independent, when one brake circuit can't be run, another brake circuit can still retain the certain braking energy to improve the safety of vehicle driving. For brake circuit of rear wheel, can choose proportioning valve, so that braking force of rear wheel brake can be distributed at the ideal proportion, and favorable to improve directional stability when the wheel is braking. Parking brake is mechanical flexible shaft drive, and rear wheel brake is concurrently worked as parking brake.

8.1.2 Structure of brake device

1 . Structure of brake pedal

For structural components of brake pedal, see Fig. 8-2:

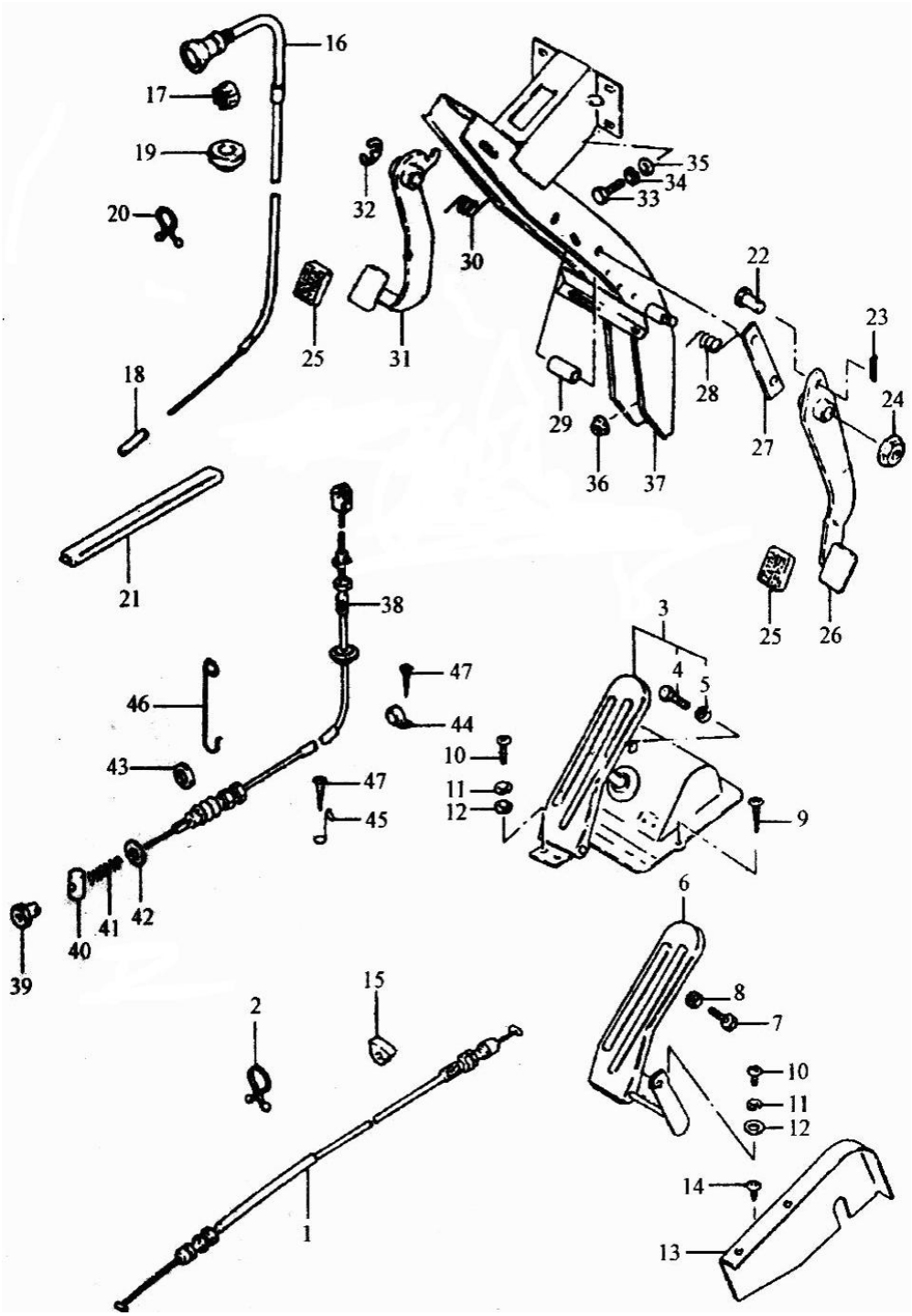


Fig. 8 - 2 Structural components of brake pedal

1- accel pedal cable ; 2-clip ; 3- accel pedal assembly ; 4-bolt ; 5-nut ; 6- accel pedal ; 7-bolt ; 8-nut ; 9-bolt ; 10-bolt ; 11- lock washer ; 12- washer ; 13-cable cover ; 14-bolt ; 15- sealing ; 16- throttle cable ; 17-nut ; 18-shield ; 19-sealing ; 20-clip ; 21-protection device of cable ; 22-pin ; 23-Opeing pin ; 24-nut ; 25- pedal pad ; 26-brake pedal ;27- pedal axial plate ;28- spring of brake pedal ;29- spacer ;30- pedal spring of clutch ;31- clutch pedal ; 32-E-shape ring ; 33-bolt ; 34-lock washer ; 35-washer ; 36-nut ; 37-bracket ; 38- clutch cable ; 39-nut ; 40-pin ; 41-spring ; 42-washer ; 43- cushion ; 44-clip ; 45-clip ; 46-clip ; 47-bolt

2 . Structural components of brake master cylinder and brake circuit

（1）Brake master cylinder

For structural components of brake master cylinder, see Fig. 8-3:

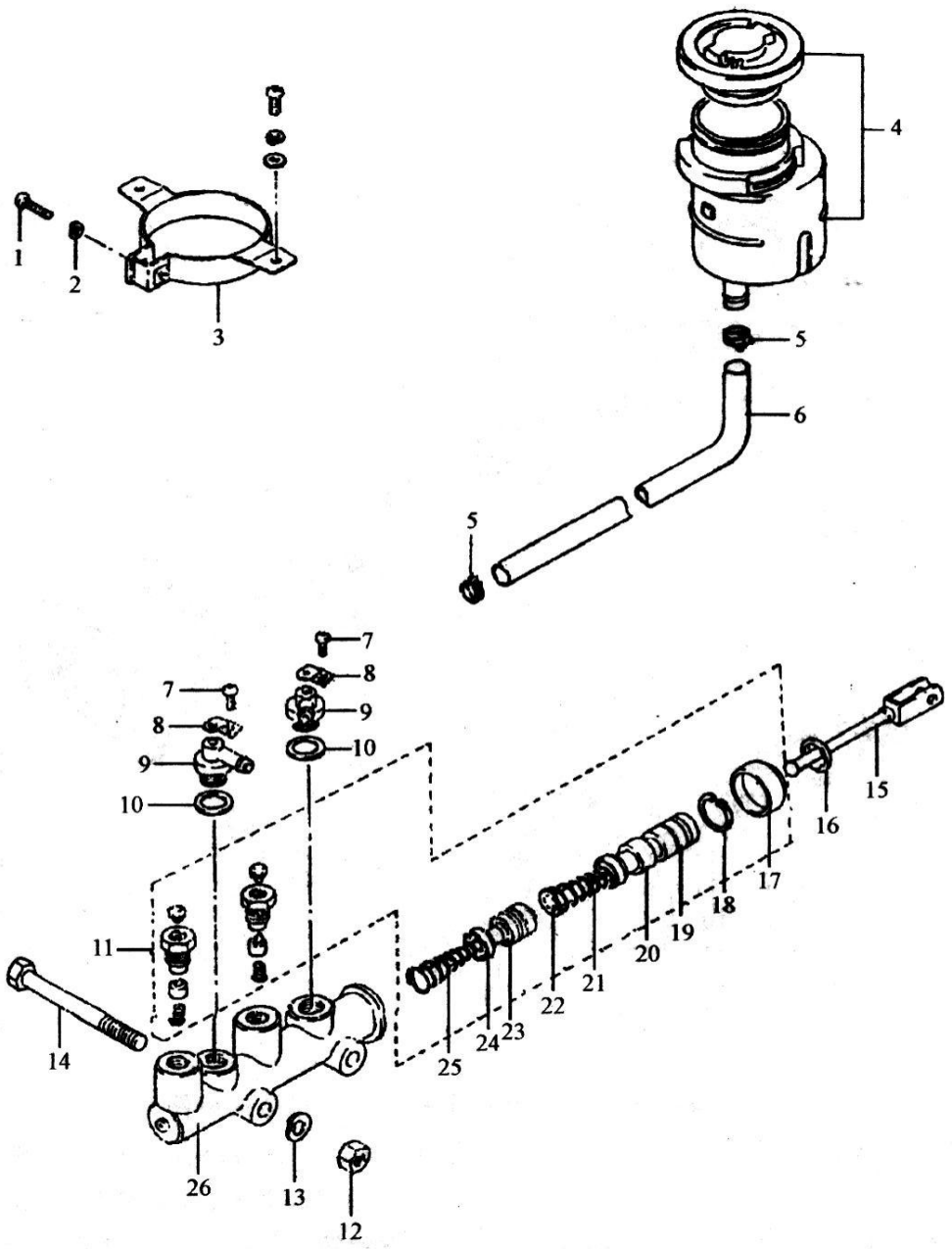


Fig. 8 - 3 Structural components of brake master cylinder

1-bolt；2- lock washer；3- holt hoop iron；4-fluid reservoir；5- holt hoop iron；6-hose；7-bolt；8-clip；9- inlet connector；10-O-shape ring；11- outlet connector；12-nut；13- lock washer；14-bolt；15-push rod；16-buckle；17-shied；18- clip ring；19-A piston；20-cup；21- stop bolt of A piston；22-return spring；23-B piston；24-cup；25- return spring；26-chief pump shell （2）Vacuum booster

Vacuum booster is located in the middle of brake master cylinder and brake pedal, and adopts the engine vacuum to mechanically increase the force caused by brake pedal when it is stepped for the purpose of braking save labor. For structural components of vacuum booster, see Fig. 8-4.

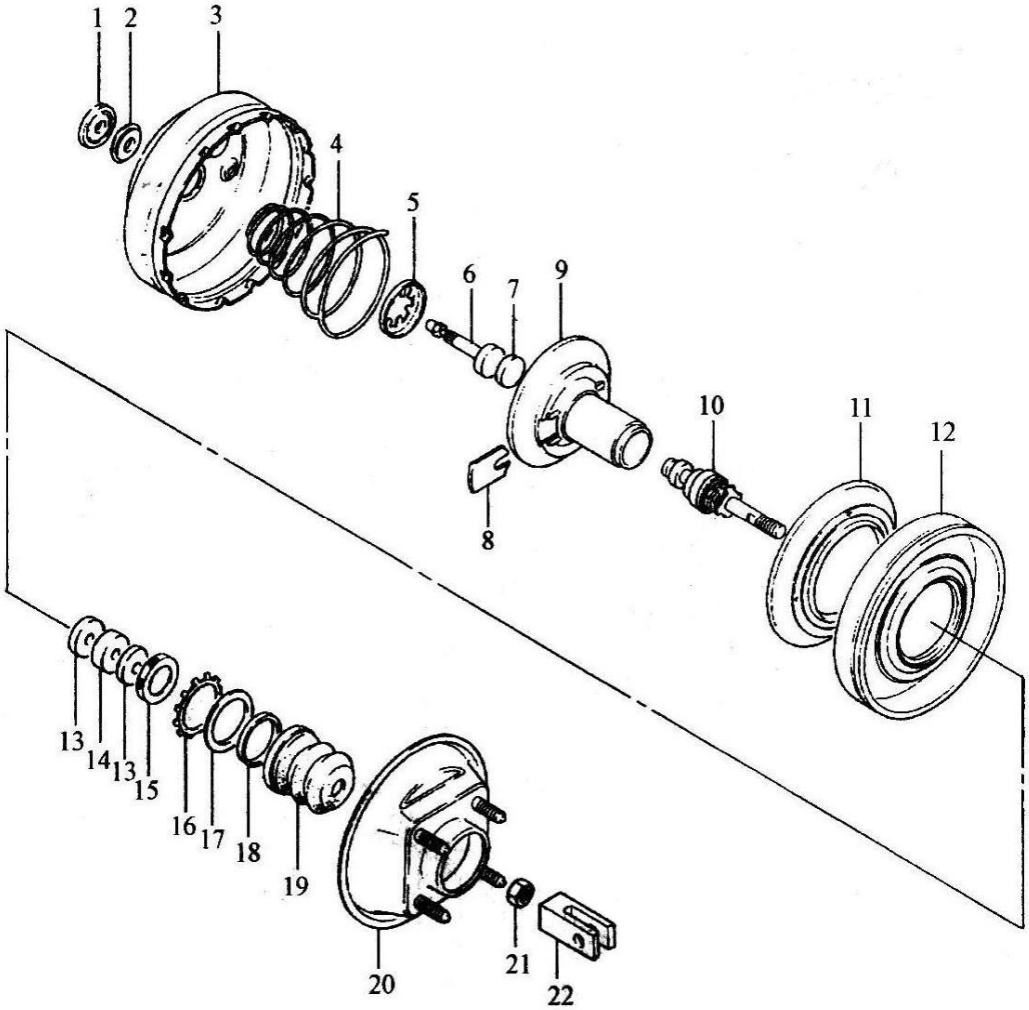


Fig. 8 - 4 Structural components of vacuum booster

1-front gas seal；2-front gas seal plate；3- shell of 1# booster；4- return spring of booster piston；5- return ring of piston rod；6- piston rod；7- reaction disc；8- valve guard 0；9- booster piston；10- booster valve assembly；11-piston plate；12- booster diaphragm；13- air filter spacer；14- air filter core；15-shield liner；16-piston ring；17- piston pivot ring；18- gas seal of 2# shell；19- booster shield；20- 2# shell of booster；21-nut；22- clevis pin of push rod

（3）Brake piping

For structural components of brake piping, see Fig. 8-5:

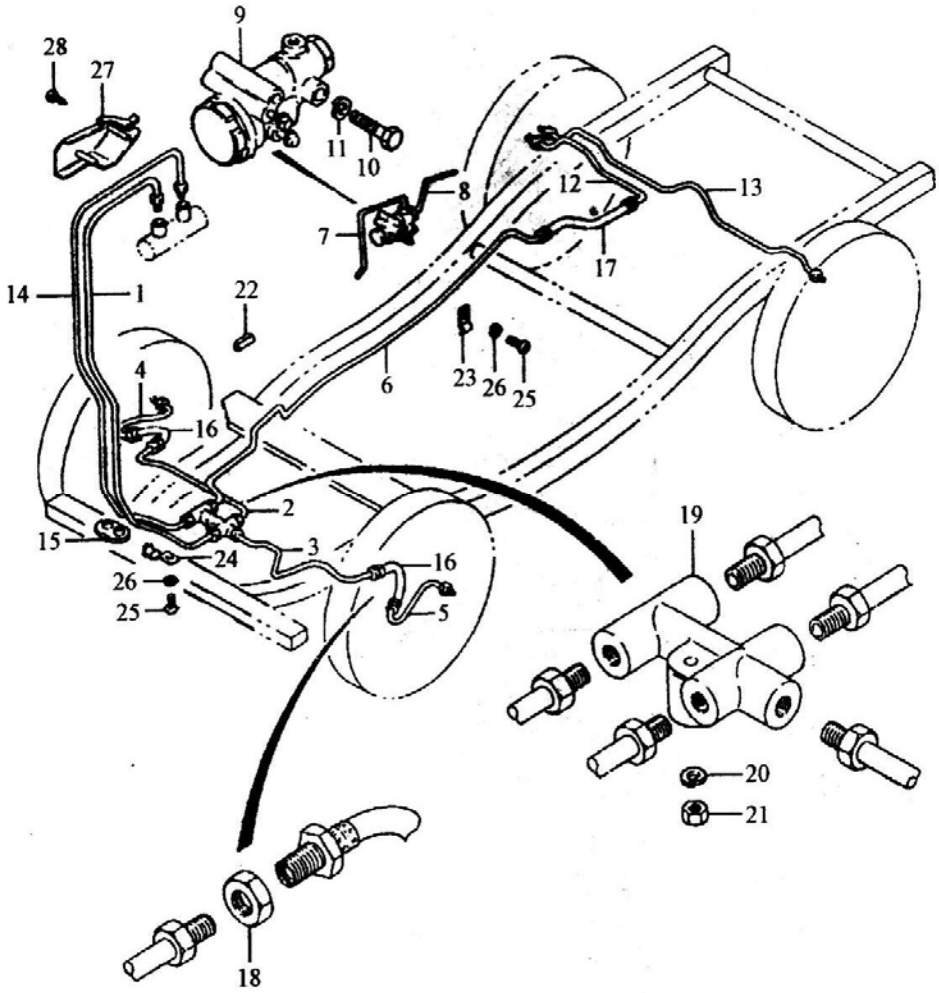


Fig. 8 - 5 Structural components of brake piping

1- brake master cylinder to five-way valve tubing (front) ; 2- five-way valve to front braking tubing (right) ; 3- five-way valve to front braking tubing (left) ; 4- front brake lock tubing (right) ; 5- front brake lock tubing (left) ;6- five-way valve to rear braking tubing ;7- proportioning valve inlet tube (optional) ;8- proportioning valve outlet tube (optional) ; 9- proportioning valve (optional) ; 10-bolt ; 11-washer ; 12- connecting tubing of brake hose ;13- rear brake tubing ;14- chief pump to five-way valve tubing (rear) ;15- rubber gasket ;16- front brake hose ; 17-rear brake hose ; 18-nut ; 19- five-way valve ; 20-washer ; 21-nut ; 22-shield ; 23-clip ; 24-clip ; 25-bolt ; 26-washer ; 27-chief pump cover ; 28-bolt

3 . Structure of wheel brake

Front and rear wheel brake of SC series truck of Changan uses leading trailing shoe brake, and the structure can refer to Fig. 8-6:

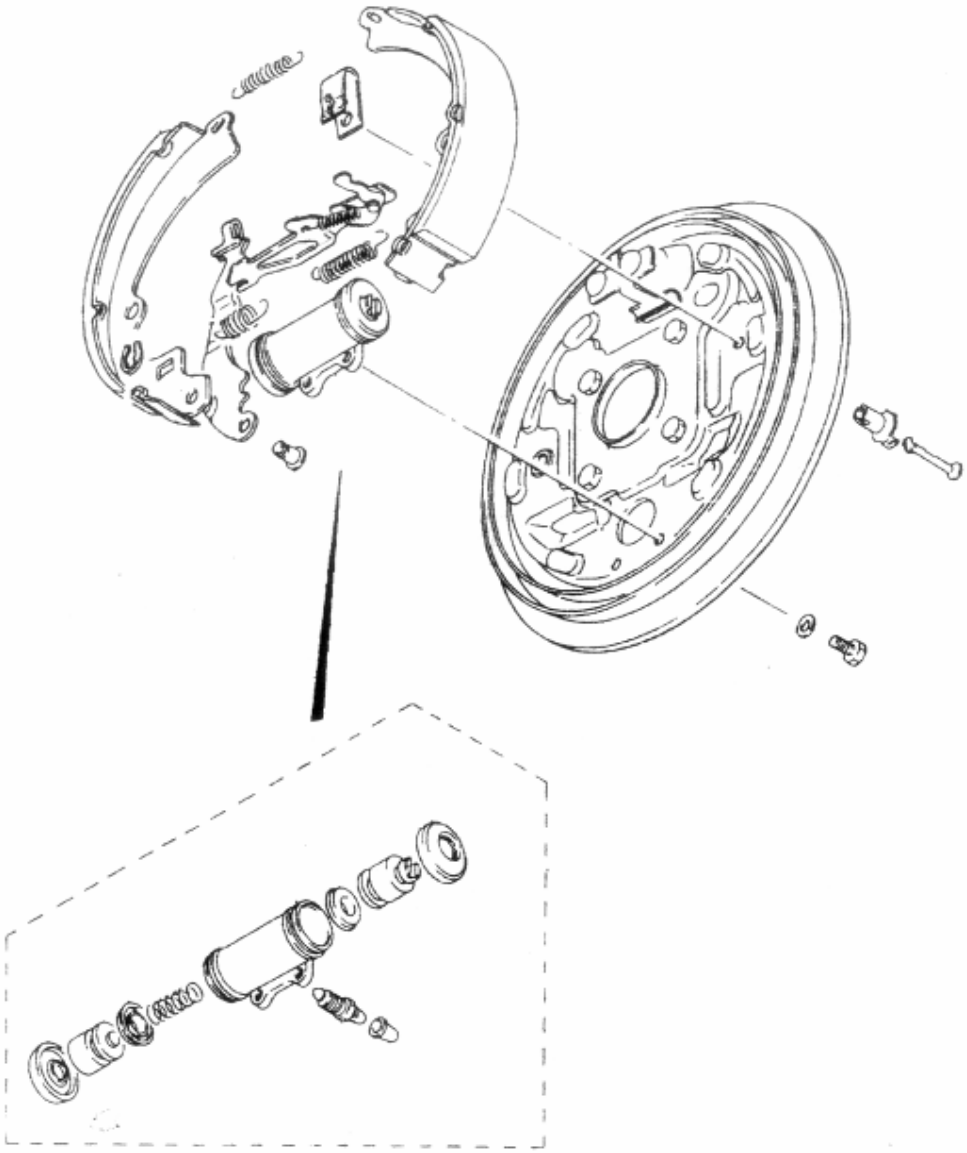


Fig. 8 - 6 Structural components of leading trailing shoe brake

4 . Structure of parking brake device

For structural components of parking brake device, see Fig. 8-4.

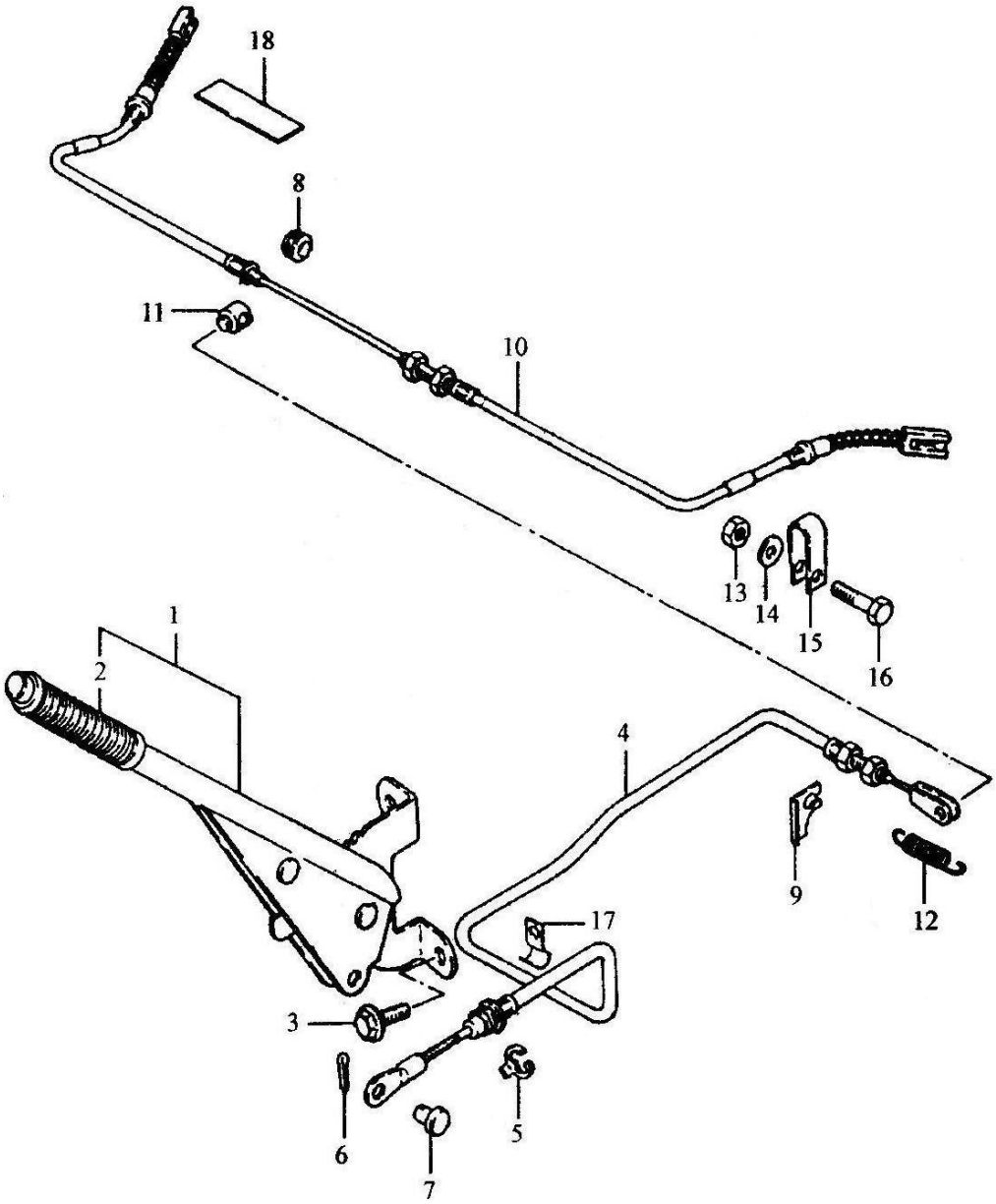


Fig. 8 - 7 Structural components of parking brake device

1- joystick ;2-handle ;3-bolt ;4-cable ;5-E-shape ring ;6- split pin ;7-pin ;8- rubber ring ;9- baffle plate ;10-cable ;

11-pin ; 12-spring ; 13-nut ; 14-washer ; 15- bending plate ; 16-bolt ; 17-clip ; 18-plate

8.2 Analysis of main component wear

The performance of auto brake mainly depends on the braking torque produced by brake friction pairs and the road adhesive conditions required by wheel. Therefore, mail component wear of the

wheel brake is below:

8.2.1 Wear analysis of friction lining

Friction lining is the main component produces braking force, therefore, friction lining wear becomes the main reason that affects brake performance, and then main performance parameter of friction lining - friction coefficient, becomes main parameter affects brake performance. So, the change of friction coefficient becomes the leading factor of friction lining wear.

Followings are main reasons affects the friction coefficient:

（1）Lining material

Lining material is the main factor affects friction coefficient. When friction lining is changed, should choose the lining recommended by the manufacturer to guarantee braking performance of the original auto. Meanwhile, should notice that all brakes of the same auto must use the material of the same brand, which is the important factor to make sure brake balance coordination of each wheel.

（2）Working temperature of friction lining and brake drum

When working temperature of the brake is too high, friction lining can lead to heat fade and make friction coefficient reduced obviously. Lining heat fade means material polymers of lining will decompose to some gases and liquids at the high temperature, and gases and liquids will be acted as the lubrication among friction surfaces to reduce friction coefficient and deteriorate braking performance.

When the brake is maintained, many factors will destroy heat dissipation conditions of the brake to make working temperature of the brake higher. Thereinto, conjoint status of friction lining and horseshoe is the key factor affects lining heat dissipation. If there is foreign body or spacing, heat dissipation efficiency of the lining will be reduced. So, when the lining is re-riveted, must ensure the joint surfaces is flat and clean and must be riveted, and forbid adding the gasket between them to adjust the radius of curvature of brake shoe. Otherwise, if it is too long, friction lining can lead to smaller clearance between two ends of brake shoe and brake drum to cause mutual friction between shoe and drum during normal driving, so that working temperature of the brake can be increased.

（3）Surface quality of friction lining

Surface oil pollution and ablation of friction lining can make friction coefficient reduce.

8.2.2 Brake analysis of shoe and drum

（1）Form and position error of brake shoe and brake drum

Brake shoe and brake drum have round and taper and can cause the connivent area of shoe and drum to reduce and decrease the braking performance. Otherwise, when the phenomena of ellipse or the different axle is existed, the contact of shoe and drum is unstable during braking and can create the vibration and impact to make hydraulic braking performance reduce.

（2）Rigidity of brake drum

The rigidity of brake drum is deficient, and can produce the bigger deformation during braking to decrease pressed force of shoe and drum, so that braking performance will be reduced. Main factors affect the rigidity of brake drum include working temperature and wall thickness of brake drum. If working temperature is too high and wall thickness is reduced, both of them can reduce the rigidity. So, should control the inner diameter in the permissible range in the course of repairing to make sure that wall thickness of braking drum meets the standard.

（3）Surface roughness of brake shoe and brake drum

Too high surface roughness of brake shoe and brake drum will make actual contact area small, and if the load is concentrated on the emboss, it will make the contact temperature too high to be ablated, so as to reduce braking performance and accelerate the part damage. Currently, processing methods of brake shoe include the boring and the grinding. The grinded brake shoe has the lower surface roughness but braking performance is better.

（4）Clearance between shoe and drum

The clearance between shoe and drum is too small, and they can’t be completely separated, not only create braking error, but also make the brake temperature too high to reduce braking performance; If the clearance is too big, it will make the braking force reduce, even can’t be braked. Therefore, when the brake

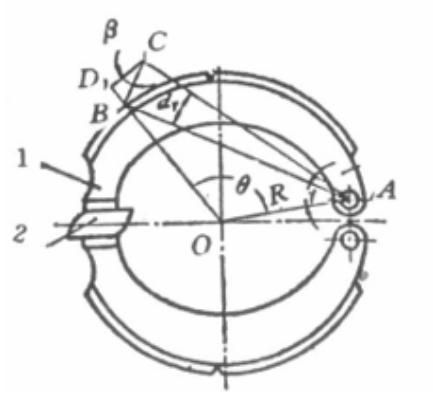


Fig. 8 - 8 Displacement when brake shoe is opened

is maintained, the brake clearance must be 1 - brake shoe ; 2 - brake camshaft

carefully checked and adjusted to meet the standard, and the clearance of left and right wheel of the same axle must be consistent.

（5）Anastomosis of brake shoe and brake drum

If other conditions are the same, the anastomosis of brake shoe and brake drum has great effect on braking performance.

Anastomosis of shoe and drum includes three instances: synchronously comprehensive anastomosis of shoe and drum, anastomosis of the middle of shoe and drum, and anastomosis of two ends of shoe and drum.

1）Synchronously comprehensive anastomosis of shoe and drum

When the shoe is opened, shoe and drum will be anastomosed completely at the same time, friction area is large and load distribution is uniform; the deformation of shoe and drum is small, working temperature is low, the change of friction coefficient is small but braking performance is good. It is difficult to realize, even impossible to come true because of following reasons.

Open speed (radial displacement) of each point on the shoe is different. According to Fig. 8-8, when brake shoe of simple non-balance brake is opened, radial displacement of each point on the shoe is introduced as follows:

Choose randomly point B on the brake shoe, when brake shoe turns to the angle of dr around pinhole center A, point B will move to point C and the displacement is BC. Displacement BC is decomposed to radial displacement BD and tangential displacement DC. Radial displacement BD is the efficient displacement to cancel the clearance between shoe and drum. According to the figure, for it is small, dr can be regarded as CBA≈90°

therefore: $BD=BC\cdot\sin\beta$ $BC\approx AB\cdot dr$

then $BD\approx AB\cdot dr — \sin\beta$ （8 - 1）

According to sine theorem: $AB=\dfrac{R\bullet\sin\theta}{\sin\beta}$ （8 - 2）

formula（8 — 1）will be replaced by formula（8 — 2）, so

$$BD \approx R \bullet \sin\theta \, dr \qquad (8-3)$$

According to formula (8 — 3), when θ is 90° (the middle of frictional plate of brake shoe), radial displacement of friction lining of the shoe is largest and gradually reduces to two ends. When θ is 0° and 180°, radial displacement becomes zero.

For Fig. 14-2, it is radial displacement of each point on the frictional plate when brake shoe of certain auto brake conquers clearance opening 18′ between shoe and drum. From this figure, radial displacement of frictional plate middle is larger 60% than two ends.

Otherwise, for different opening value-dr, its difference is changed. For brake drum creates min. deformation and the braking force is not the same during braking, it is different between actual displacement and theoretic displacement. It is obvious that the shape and the size of brake shoe are taken measures, so that it is almost impossible to synchronously cancel the clearance between each point and brake drum during the shoe is opened to realize synchronously comprehensive anastomosis.

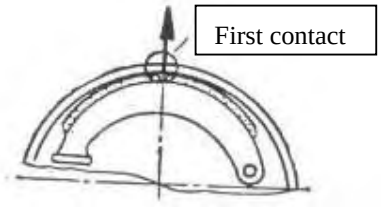
② Brake shoe and brake drum have processing error. Only curvature radius of shoe and drum is the completely same, and then maybe realize synchronously comprehensive anastomosis. But, there is the error of size, shape and orientation while processing, and add the influence of equipment precision, it is difficult to make sure curvature radius of them is the same.

③ Assembly and adjustment have errors. During assembly, wheel brake can create the deformation of brake carrier, knuckle spindle deformation or axle tube deformation, wrong mounting position of brake carrier or hub bearing; When adjusting, the clearance between shoe and drum is adjusted improperly to cause relative position error of shoe and drum. It is difficult to make brake shoe and brake drum comprehensive anastomosis in the course of the shoe opening.

2) Anastomosis of the middle of shoe and drum

When the shoe isn’t opened, the clearance between frictional plate of brake shoe and brake drum is not less than two-end clearance. When the shoe is opened, the shoe middle will first contact with brake drum (Fig. 8-9) because of the big displacement of the shoe middle. So, there is only one contact for each shoe and brake drum, and the pressure of two shoes has been concentrated on two points of the drum. The stress is 10 times bigger than comprehensive anastomosis, and the

deformation of brake drum is big, and the abrasion of the lining middle is strengthened which is easy to create the scorch and obviously reduce the braking performance.



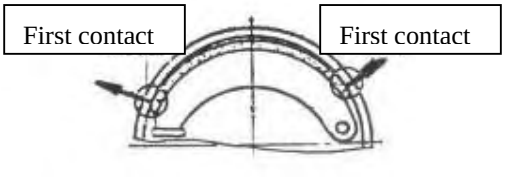
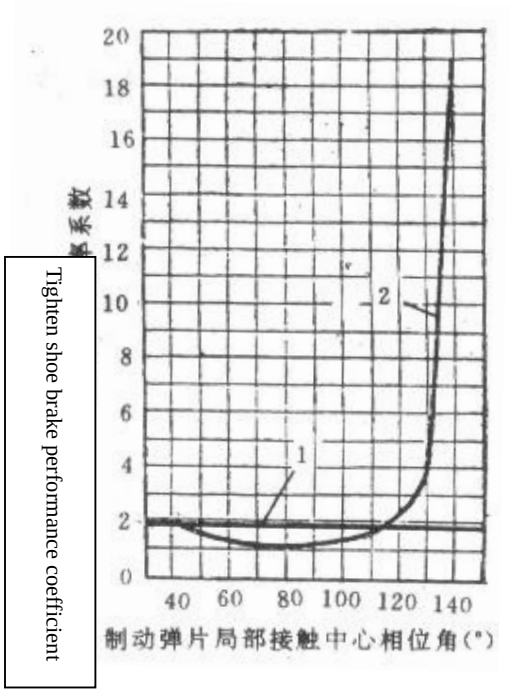


Fig. 8 - 9 Contact of brake shoe middle and brake drum

Fig. 8 - 10 Contact of two-end brake shoe and brake drum



3）Anastomosis of two ends of shoe and drum

When the shoe isn't opened, the two-end clearance between friction lining and brake drum is less than the middle clearance. If proper adjustment, when the shoe is opened, maybe first realize the anastomosis of two ends of friction lining and brake drum, and then realize the anastomosis the middle after two ends (Fig. 8-10). So, there are two contacts for each shoe and brake drum, the contact surface near to the middle will be increased and pressure distribution is uniform. The deformation of brake drum is smaller, working temperature of the brake is lower, but th Otherwise, by the effects of friction force of friction lining end, the shoe creates the bend and the deformation to rapidly realize the anastomosis with the drum, and trend to the comprehensive anastomosis based on the abrasion and the brake increase.

Fig. 8-11 is braking performance change curve of brake friction pair of certain auto brake leading shoe calculated when contacting on each position. From this figure, when two ends of frictional plate of brake shoe are contacted, the braking performance is better than the middle contact and the braking torque is big.

From above analysis, it is impossible to make synchronously comprehensive anastomosis, and the braking performance of first two-end anastomosis is better than first the middle anastomosis. And

for their abrasion during use, the contact area of them is gradually increased and trend to realize comprehensive anastomosis, and improve the braking performance and the life of shoe and drum is longer. When the brake is repaired, the anastomosis between shoe and drum should realize the middle after two ends. Measure: when friction lining is added, the brake shoe radius is larger than the radius of brake drum, that is to say, R shoe is more than R drum.

8.2.3 Unbalance of wheel brake at two sides of the same axle

Wheel brake at two sides of the same axle should be equal to ensure the braking stability. If wheel brake at two sides of the same axle is unequal and two-wheel braking deceleration is unequal, the auto can create running deviation. Reasons cause

the unequal brake of left and right wheel are followed:

（1）The friction coefficient at two sides of wheel brake is different. As mentioned above, the material and surface quality of friction pair is different and working temperature of the brake is not the same, etc., and all can create the difference of friction coefficient.

Fig. 8 - 11 Braking performance coefficient curve of certain auto brake

1 - Uniform contact of frictional plate brake shoe

2 - Partial contact of frictional plate brake shoe

（2）The pressure of two-wheel brake shoe to the drum is unequal. The pressure between shoe and drum is one of mail factors determine the braking torque. Reasons cause the unequal pressure of left and right wheel shoe and drum mainly include the different two-wheel brake piping resistance, the different technology of left and right brake chamber or wheel cylinder, the unequal elasticity of return spring of shoe plate or the unequal clearance between shoe and drum. Otherwise, above factors affect not only the braking torque, but also the starting time of the braking action.

（3）Inner diameter of brake drum is different. If the inner diameter of two brake drums, connivent area of shoe and drum and the rigidity of brake drum is different, all can lead to the difference of braking torque. Therefore, when brake drum is processed, should guarantee the inner diameter of brake drum at two sides of the same axle is the same, and the tolerance should not be more than 1mm.

Besides above reasons, if the tire technology of left and right wheel (abrasion and air pressure, etc.) is different, the load quality is uneven and the suspension is different, all can destroy brake balance of left and right wheel to create running deviation when the auto brakes.

8.3 Disassembly and maintenance of brake device

8.3.1 Disassembly of brake device

(1) Disassembly of brake

1) Release brake handle and remove parking brake
2) Unscrew the nut of back wheel, and then peak the auto supported by the bracket, disassemble the wheel nut and take off the back wheel;
3) Loosen the drain plug and clean up gear oil of rear axle house;
4) Pull out the brake drum by two bolts;
5) Turn the brake shoe by nipper pliers to impact the pin, and remove the brake shoe to press the spring;
6) Take off the parking brake cable from pull rod of parking brake shoe, and dismantle brake shoe;
7) Take apart the fixed clip of parking brake cable, and disassemble parking brake cable from brake carrier;
8) Draw out the brake fluid in brake oil pipe by absorbing cylinder, and then unscrew the connecting nut of brake pipe from wheel brake pump to remove brake pipe;
9) Immediately install the tubing plug to all brake oil pipes and brake pumps to avoid spill the brake fluid out;
10) Unscrew the erection bolt of wheel brake pump and remove the brake pump;
11) Disassemble the fitting nut of brake carrier from rear axle housing;
12) Pull out brake carrier and half axle from axle housing by special tooling;
13) Thin bearing shield ring by grinding machine, and remove bearing shield ring by chisel;
14) Remove the bearing from half axle by special tooling, and then remove brake carrier.

（2） Disassembly of brake chief-pump

1) Cut off the lead of fluid cylinder;

2) Clean the cover of the fluid reservoir casing and clean out brake fluid in the casing by sucker;

3) Dismantle brake hose on the fluid reservoir casing, and remove the bracket nut of the fluid reservoir casing to take off the fluid reservoir casing;

4) Disassemble the connecting nut between brake oil pipe and brake master cylinder to cut brake oil pipe from chief pump;

5) Remove two fixed nuts of brake master cylinder, and dismantle brake master cylinder from vacuum booster;

6) Disconnect dust shield of chief pump, and remove the spring shield ring from the pump piston cylinder;

7) Blow out back-cavity piston by compressed air;

8) Loosen off the locking screw of the piston;

9) Blow compressed air into the locking screw hole to blow out front-cavity piston;

(3) Disassembly of vacuum booster

1) Disconnect vacuum hose and booster;

2) Remove the connecting pin between U-shape yoke of push rod of vacuum booster and brake pedal arm;

3) Unscrew the fixed nut of vacuum booster, and remove vacuum booster from pedal bracket;

8.3.2 Maintenance of brake device

(1) Maintenance of drum brake

1) Check whether the drum brake is clean and there is any crack. Scrape the deep groove and measure the inner diameter of brake drum and check the abrasion of the working surface. If the abrasion of the working surface is serious or there is the right crack, etc., the brake drum should be changed.

2) Check the abrasion of friction lining of brake shoe. If the abrasion of any friction lining exceeds use limit, all friction linings of brake shoe should be changed.

3) Clean brake pump components of brake pump by brake fluid and check whether each component of the pump is worn, cracked, corrupted or damaged. If there is any badness,

the components should be changed.

4) Check whether each spring of brake supporting rod is damaged, corrupted or the spring is bad. If there is any badness, the spring should be changed.

(2) Maintenance of brake master cylinder

1) Check whether fluid reservoir casing of brake master cylinder is leaked and distorted, and the cover of fluid reservoir casing is damaged and distorted, and brake hose is damaged. If there is any badness, all should be changed;

2) Check whether the shell and hole of brake master cylinder is corrupted, damaged or cracked on the right, etc. If there is any badness, brake master cylinder should be changed;

3) Check whether the inlet connector of brake master cylinder has any aging, cracking or oil leakage, O-shape seal ring is reliable, outlet valve is bad and the spring is softened. If there is any badness, all should be changed;

4) Check whether the piston of brake master cylinder is seriously damaged, return spring is softened, and piston cup has any aging and cracking. If there is any badness, all should be changed.

(3) Maintenance of vacuum booster

1) Check whether vacuum booster has any effect as booster. If it has any aging and dilapidation, the vacuum tube should be changed; If it has any badness, vacuum booster should be changed to the vacuum booster assembly;

2) Check the length of U-shape yoke of push rod of vacuum booster. If the length from the pin hole of U-shape yoke of push rod to the installation surface doesn't meet the required value, the length of the yoke should be adjusted, ant then the nut will be screwed to the prescribed torque;

3) Check the clearance between the piston rod of the booster and the piston of brake master cylinder. If it doesn't meet the regulation, the clearance should be adjusted. Below is the adjustment method of the clearance between push rod of the booster and the piston of chief pump:

① Before it is measured or adjusted, the piston rod should be pushed repeatedly to ensure that the plate can be positioned; Inside pressure of the booster should be kept under the atmospheric pressure;

② Special tooling-measuring tool of the piston rod is installed on brake master cylinder, and push the guide pin of piston rod until piston plane A is level with end face B of chief pump.

③ Reverse the special tooling and install the tooling on the booster, and check the clearance between push rod of booster piston and the pin head of special tooling. If the clearance doesn't meet the described range, the adjustable bolt of push rod of booster piston should be reversed in order that the clearance will be adjusted the defined value.

（4）Maintenance of parking brake device

1）Clean the surface of brake cable, and check whether the outer layer of the cable is cracked and the joint is damaged, and the core wire is broken. If there is any badness, the cable should be changed to the cable assembly;

2）Check whether the lockup toothed plate of parking brake handle and the ratchet are distorted or damaged, the lockup is reliable and released flexibly. If there is any badness, the handle should be changed to the assembly of brake handle;

3）Check whether return spring hook of brake cable is installed correctly, the spring is broken or distorted, and the elasticity is reduced. If there is any badness, all should be changed.

8.4 Assembly and adjustment of brake device

8.4.1 Installation of brake device

1． Assembly of drum brake

When drum brake is installed, following items should be paid attention to:

1) Wipe the waterproof glue on the contact surface of brake carrier and rear axle;

2) Install brake carrier and half axle on the rear axle, and screw the fitting bolt of brake carrier up to the defined torque;

3) According to the prescription, screw the torque to install brake pump on brake carrier;

4) Connect brake oil pump to brake pump, and the connecting nut of brake oil pump is screwed to the defined torque;

5) When parking brake cable is installed, wipe the waterproof glue on the contact surface of brake carrier and brake cable, and then parking brake cable will cross the brake carrier to be fixed by clip;

6) When the brake shoe is installed, press hold-down spring of brake shoe to the installation position, and hold-down pin is turned over 90° by needle nose pliers to make pressure spring positioned;

7) Before brake drum is installed, the right-angled screwdriver head is plugged between the supporting rod and the ratchet, and then press the ratchet down to gain the max. clearance between brake shoe and brake drum, and subsequently install brake drum.

8) Install the rear wheel brake and the wheel, and after general air of brake system is eliminated, step the brake pedal for 4-5 times at the force of 30KG so that the clearance between brake drum and brake shoe can reach the regulated value.

2 . Installation of brake master cylinder and vacuum booster

When brake master cylinder and vacuum booster are installed, following items should be paid attention to:

1) When brake master cylinder is assembled, clean the components of chief pump by brake fluid. Change the new piston cup, and then the piston and the cup will be assembled together, and pay attention to the assembly direction of the cup;

2) When the piston components are assembled, according to the opposite order of the disassembly, firstly, install components of front-cavity piston to the cylinder body of

chief pump, and secondly, assemble components of back -cavity piston and adjust the size of piston components, and finally, enclose the cylinder body of chief pump;

3) When locking bolt of the piston is installed, slowly push the piston inside, and then mount seal ring and locking bolt of the piston to screw down to the regulated torque;

4) When the pipe joint of brake master cylinder is installed, the locking bolt of the pipe joint is screwed to the regulated torque;

5) Install the booster on the pedal bracket, and then mount U-shape yoke of the booster on brake pedal arm by pin and split pin, and the booster nut is screwed down to the regulated torque;

6) Install brake master cylinder on the booster, and the connecting nut is screwed down to the regulated torque;

7) Connect the vacuum hose to vacuum tube of the booster. Notice when connecting, the arrowhead on the hose should be faced to the side of intake manifold, and fix the hose by the clip.

8.4.2 Adjustment of brake device

1 . Checkup and adjustment of free pedal travel

Check free pedal travel, if free pedal travel doesn't satisfy the standard value, should check whether the bolt of pedal arm axle and the pin of brake master cylinder are loosened. If there is any badness, should be changed.

Standard value of brake free pedal travel: 8~15mm (oil brake), 25 ~ 35mm (gas brake)

2 . Checkup and adjustment of brake pedal height

Step down the brake pedal at the force of 30KG, measure the distance from brake pedal arm to cab arm and this distance should not less than the specified value. If the distance is too short, should check whether there is any air in brake tube or brake lining is worn, and should get rid of the air in the system or change brake shoe. For the auto with the booster, should check and adjust the length of push rod of the booster.

Standard distance from brake pedal to cab wall: ≧95mm

3． Adjustment of the switch of brake light

When the brake pedal is stepped down, the switch of brake light should be connected, if there is any failure, the position of brake light switch should be adjusted. While adjusting, put up the brake pedal towards the driver and retain this position, and loosen the fixing nut of brake light switch and adjust the clearance between the contact of brake light switch and the contact surface of brake pedal to the standard value, and then locking nut is screwed to the standard value.

Clearance between the contact of brake light switch and the contact surface of brake pedal 0.5～1.0mm

Standard torque of locking nut 10～15N.m

4． Checkup and adjustment of parking brake handle travel

（1）Checkup of parking brake handle travel

Hold the middle of parking brake handle, and slowly lift up parking brake handle at the force of 20KG until the booster is completely braked, and its ratchet travel should be 5~7 teeth.

（2）If parking brake handle travel is not included in the range of 5~7 teeth, the length of brake cable should be adjusted. While adjusting, unscrew the adjusting nut of brake cable and, and adjust parking brake handle travel to the specified range, and then screw the adjusting nut.

5． Exhaust of brake system

After brake device is maintained and re-assembled and the piping of brake system is input the air or the brake fluid is changed, the piping of brake system should be exhausted. Exhaust methods of brake system are below:

1） First mount the brake pump of left rear wheel far to brake master cylinder, and then mount the brake pump of right rear wheel, left-right front wheel in turn;

2） Pour brake fluid to fluid reservoir of brake master cylinder to make sure that at least brake fluid volume is half during exhaust;

3） Remove the bleeding plug, and connect the transparent plastic catheter to bleeding plug

of wheel brake pump, and another end of the catheter is inset the vessel;

4) Step down brake pedal several times so that brake fluid in fluid reservoir casing can enter chief pump and brake piping, and then when brake pedal is stepped, unscrew 1/3 ~ 1/2 cycles of bleeding plug;

5) Step brake pedal again and again until there is no bubble in the transparent catheter, and then hold brake pedal by foot and screw the bleeding plug. Notice that brake fluid will be filled at any moment in course of exhaust, in order that brake fluid in fluid reservoir casing keeps above “MIN” scale mark to prevent the air from entering brake master cylinder;

6) Remove the catheter, and re-assemble the bleeding plug of brake pump. And then press the piping to check whether brake fluid is leaked;

7) Fill brake fluid to fluid reservoir casing to specified “MAX” scale mark, but it had better not exceed this scale mark to avoid brake fluid pouring out to corrupt the body.

8.5 Maintenance of air brake device

8.5.1 Structure introduction

Wheel brake is the simple balance-type air brake. Upper and down brake shoe is tightly pulled by return spring so that platform of brake shoe is tightly pressed on brake cam, when it is turned, the cam opens the platform of brake shoe to stretch brake shoe, and the shoe clings to brake drum to realize the brake of the wheel.

8.5.2 Adjustment of the brake

(1) After changing brake shoe lining and re-work the friction surface of brake drum, or turning cam position of the supporting pin of brake shoe is changed because brake carrier is disassembled, so as to destroy the right contact status of brake shoe lining and brake drum, must do the overall adjustment, and the order is as below:

① Loosen the fixing nut of the supporting pin of brake shoe and the nut of the fastening bolt of the camshaft bracket.

② Rotate brake shoe so that the marks of two shaft ends is faced towards inside oppositely.

③ Through repeatedly screwing the supporting pin of brake shoe and worn shaft of adjusting arm, brake shoe lining and brake drum can be completely attached, at this adjusted position, carefully screw the fixing nut of the bracket and the locking nut of the supporting pin. (Now, keep the position of the supporting pin and bracket of brake shoe invariable)

④ Worm shaft is unscrewed 1/2～2/3 cycles, and brake drum should be automatically rotated and not crash with brake shoe lining or other parts. Check by feeler gauge that the clearance range between brake shoe lining and brake drum should be:

Supporting pin end of brake drum	0.25～0.4mm
Camshaft	0.4～0.6mm
Difference of two shoes at the same end	<0.1mm

⑤ Push rod travel after brake chamber is input compressed air should be 25 ± 5mm.

（2）After brake shoe is worn, push rod travel of brake chamber is beyond 40mm, in order to reduce the clearance between brake shoe lining and brake drum, only need do partial adjustment. Methods are below:

① Don’t rotate the supporting pin of brake shoe lining to prevent damaging the original good contact status.

② When it is adjusted, the front wheel faces the adjusting worm. For rear wheels, the worm is screwed at the counterclockwise direction (the clearance between brake shoe lining and brake drum is reduced) and is unscrewed at the clockwise direction.

Notice: it is wrong that the clearance is adjusted by screwing the push rod clevis of brake chamber to change the length and direction of push rod.

（3）When the auto brake is trouble by running deviation of front wheel (during braking, obvious turning and catch on the steering wheel), it can be removed by the method of increase running deviation lining clearance of front wheel at another side. (or reduce one-side clearance of running deviation) If running deviation to the left, increase the lining clearance of right front

wheel (adjust brake adjusting arm and increase push rod travel of brake chamber), or reduce the lining clearance of left front wheel (shorten push rod travel). When the worm shaft of brake adjusting arm is turned 1/4 cycle, push rod travel is changed about 6mm.

Reasons of adjustment: when brake chamber is input at the low pressure, the efficient area of brake chamber diaphragm is extended according to pushing surface of push rod. Since the increase of the efficient area of the diaphragm leads to increase the brake, it is larger than the brake reduce caused by the increase of the clearance between brake drum and brake lining, so that when the lining clearance is increased and push rod travel is extended, the efficient area of the diaphragm will be extended and the brake will be increased, on the contrary, when the lining clearance is reduced and push rod travel is shortened, the diaphragm distortion is small, the efficient area is small so that the brake is small.

Notice: this adjusting method is only used for running deviation of front wheel brake caused by the limited difference of the lining clearance of left and right front wheel (in the range of 1/3～1 cycles of worm shaft of brake adjusting arm). All running deviations of front wheel caused by too large lining abrasion, inconsistent performance of left and right lining, oil pollution of the lining, inconsistent adjustment of left and right hub bearing, inconsistent pendulum difference of left and right brake drum, etc., belong to the failure category, should separately removed based on the related reason.

（4）When axial movement value of brake camshaft is not less than 1mm, can suitably add adjusting washer.

（5）If the rear camshaft doesn’t return, can loosen three bolts of rear bracket and adjust the concentricity of camshaft hole of two brackets. After the camshaft can rotate freely, screw the bracket bolt.

8.6 Maintenance of front and rear brake

1 Check whether the fixing bolt of brake carrier is loosened.

2 Brake shoe should be rotated flexibly on the supporting pin of brake shoe, in case of clip and corrosion, etc., brake shoe should be disassembled to clean and remove rust, and smear the suitable lubricating grease. If the supporting pin of brake shoe is loose, the bushing should be changed.

3 The brake camshaft should be added lubricating grease when the maintenance at 3000Km, in order that the camshaft can be turned over freely on the bracket hole, in case of clip and corrosion, etc., the camshaft should be disassembled to clean and remove rust, and smear the suitable lubricating grease.

4 When the distance from the surface of brake shoe lining to the rivet head is less than 0.5mm, the brake shoe lining should be changed. Or for the crack and chip shell of the lining surface, etc., the lining should be changed.

5 During running, if the clearance between brake shoe lining and brake drum of certain auto is changed often, should check:

① Whether brake adjusting arm is locked up worm shaft.

② Whether the locking nut of the supporting pin of brake shoe is screwed tightly.

6 Out-of-round of brake drum abrasion is permitted cutting, when cutting, must be positioned by the conical surface of bearing cups of wheel hub, and total trip of the friction surface in the brake drum to the bearing axis is less than 0.2mm. The difference of the Inner diameter of left and right brake drum of the same auto is less than 1mm.

7 For the return spring of brake shoe, carefully check two-end hook and make sure there is no crack. If it is rusted or failed, return spring should be changed.

8 The diaphragm of brake chamber should be good without any crack and aging; and different diaphragms with rubber compound recipes are forbidden installing on the left and right brake chamber of the same auto.

8.7 Analysis of common fault and experience diagnosis

Common faults of auto brake system include ineffective braking, braking failure, braking deflection and braking lag, etc.

8.7.1 Hydraulic braking system

1 . Ineffective braking

1) Phenomenon: when the auto was braked, the driver felt the deceleration wasn’t enough; when the auto was braked emergently, the braking distance is too long.

2) Reasons:

(1) Oil leakage of chief pump, pump, piping or pipe joint;

(2) Lack of oil or no oil for fluid reservoir casing of chief pump;

(3) The brake fluid is metamorphic (thinning or thickening) or the deposit of the inner wall of the piping is too thick;

(4) There is the air in the brake fluid;

(5) The abrasion of the chief pump cup, the piston or the cylinder is too more;

(6) The abrasion of the pump cup, the piston or the cylinder is too more;

(7) The gasoline inlet of the chief pump, compensated hole or the vent hole of fluid reservoir casing is blocked;

(8)The outlet valve and oil returning value of chief pump is not sealed or the pre-tightening force of return spring of the piston is too small;

(9)The front transfixion hole of the chief pump piston is blocked or the chief pump cup has the pastiness and the swell;

(10) The pump cup has the pastiness and the swell;

(11) The turbocharger or the booster is inefficient or has the failure;

(12) The oil pipe is collapsed or the inner hole of the hose is blocked;

(13) The free brake pedal travel is too large;

(14) The connivent surface of the brake shoe lining and brake drum (tray) is bad or the brake clearance is adjusted improperly;

(15)The quality of the brake shoe lining is not good or during using, the surface is hardened, scorched, oil polluted and the rivet head is exposed;

(16) The abrasion of brake drum is too more or during braking, it is distorted.

3) Diagnostic method: refer to below flow chart (Fig. 8 - 12) to diagnose.

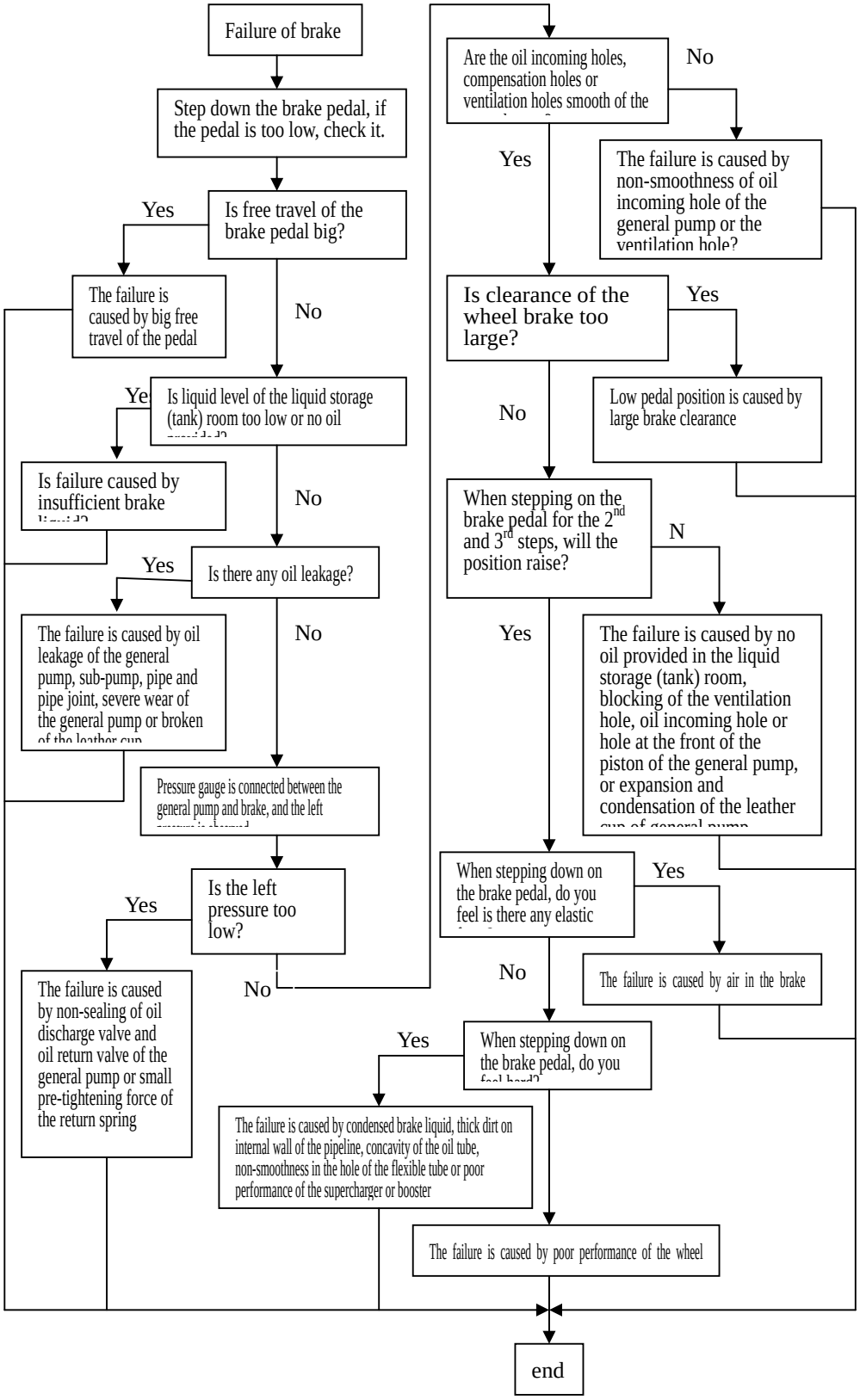


Fig. 8 - 12 Diagnostic flow chart of Ineffective braking

2．Braking failure

1）Phenomenon: when the brake pedal was stepped, the auto was not decelerated, even if continuous several steps, there was no obvious deceleration.

2）Reasons：

（1）There is no brake fluid in chief pump;

（2）The chief pump cup is seriously broken or the brake system is seriously leaked;

（3）The brake hose or the metal pipe is ruptured;

（4）The connection is cut from the brake pedal to chief pump.

3）Diagnostic method: refer to below flow chart (Fig. 8 - 13) to diagnose.

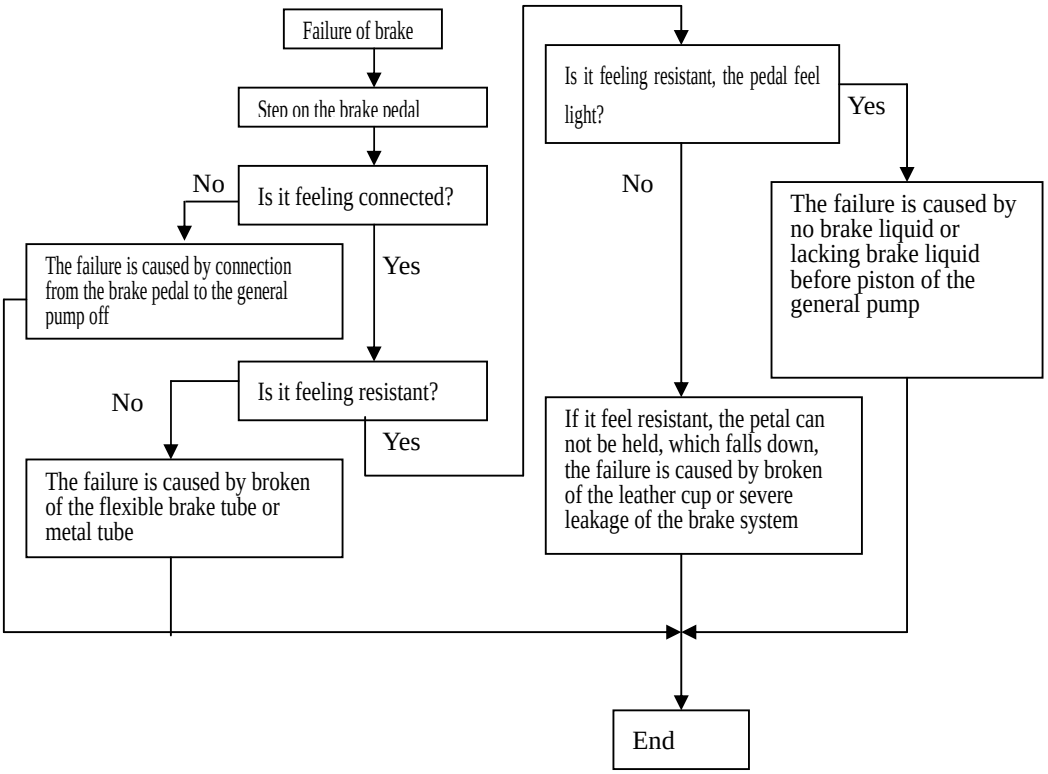


Fig. 8 - 13 Diagnostic flow chart of braking failure

３．Braking deflection

１）Phenomenon: when the auto was braked, the driving direction was deflected; when the emergent braking, the auto happened the plunging into head and tail-flick.

２）Reasons：

（１）The material of brake shoe lining of left and right wheel is different or the new and old material is different;

（２）The connivent area and the connivent position of between brake lining and brake drum (tray) of left and right wheel is different or brake clearance is different;

（３）The technology of left and right wheel pump is different, so that the acting time is different or the tension is different;

（４）The return spring pull of brake shoe of left and right wheel is different;

（５）The tyre pressure of left and right wheel is different, the diameter or the pattern is different, or the pattern depth is different;

（６）The thickness, diameter, distortion and roughness of working surface of brake drum of left and right wheel is different;

（７）Single-side brake piping is collapsed, blocked or oil leaked;

（８）There is the vapor lock in single-side brake piping or the pump;

（９）The connection between single-side brake shoe and the supporting pin is tight or rusted;

（10）The vehicle frame and axle are bent in the horizontal plane, the axle base at two sides of the frame is unequal or the rigidity of front steel plate spring is unequal, etc.

３）Diagnostic method:　refer to below flow chart (Fig. 8 - 14) to diagnose.

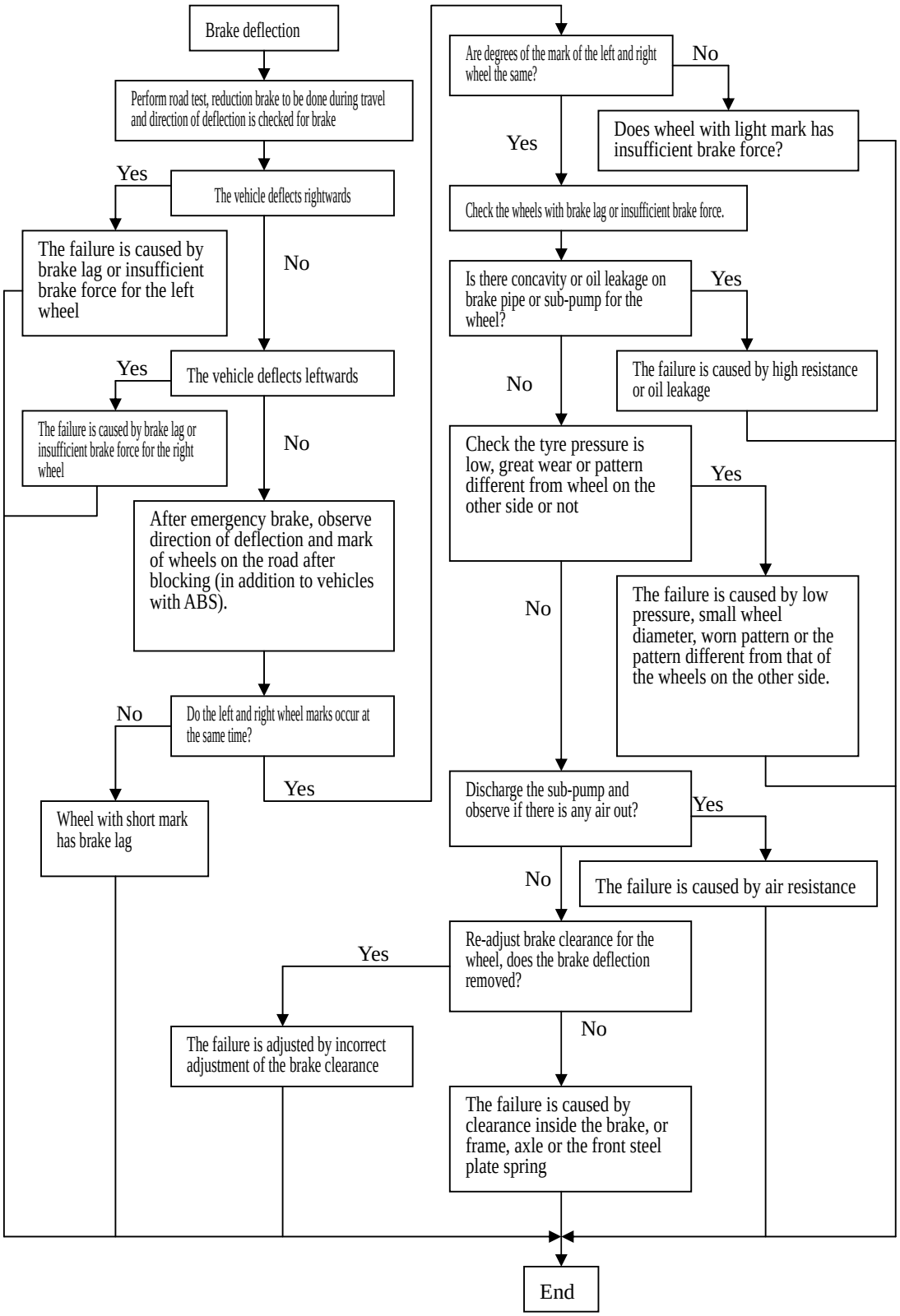


Fig. 8 - 14 Diagnostic flow chart of braking deflection

4．Braking lag

1）Phenomenon: after brake pedal is lifted, braking action of all or separate wheels can not be cancelled immediately, so as to affect re-starting, acceleration running or skidding.

2）Reasons：

（1）The brake pedal has no free travel;

（2）The connection of brake pedal and its axle is lake of oil, rusted or the return spring of the pedal is taken off and broken, and the pull is too small, etc.;

（3）The return spring of the chief pump piston is broken or pre-tightening forcing is too small;

（4）The length of chief pump piston and the cup is too large, or the cup has the swell and the pastiness;

（5）The compensated hole of chief pump is jammed by filth;

（6）The pump cup has the swell and the pastiness or the piston is caught;

（7）The return spring of brake shoe is taken off, broken or its pull is too small;

（8）The brake shoe and the supporting pin is rusted;

（9）The clearance between brake shoe and brake drum (tray) is adjusted improperly, and after the bake is loosened, the attrition is still existed partially;

（10）The oil pipe through the pump is collapsed or blocked;

（11）When no braking, the piston center hole of auxiliary cylinder of the turbocharger can not be opened;

（12）The hub bearing is loosened.

3）Diagnostic method: refer to below flow chart (Fig. 8 - 15) to diagnose.

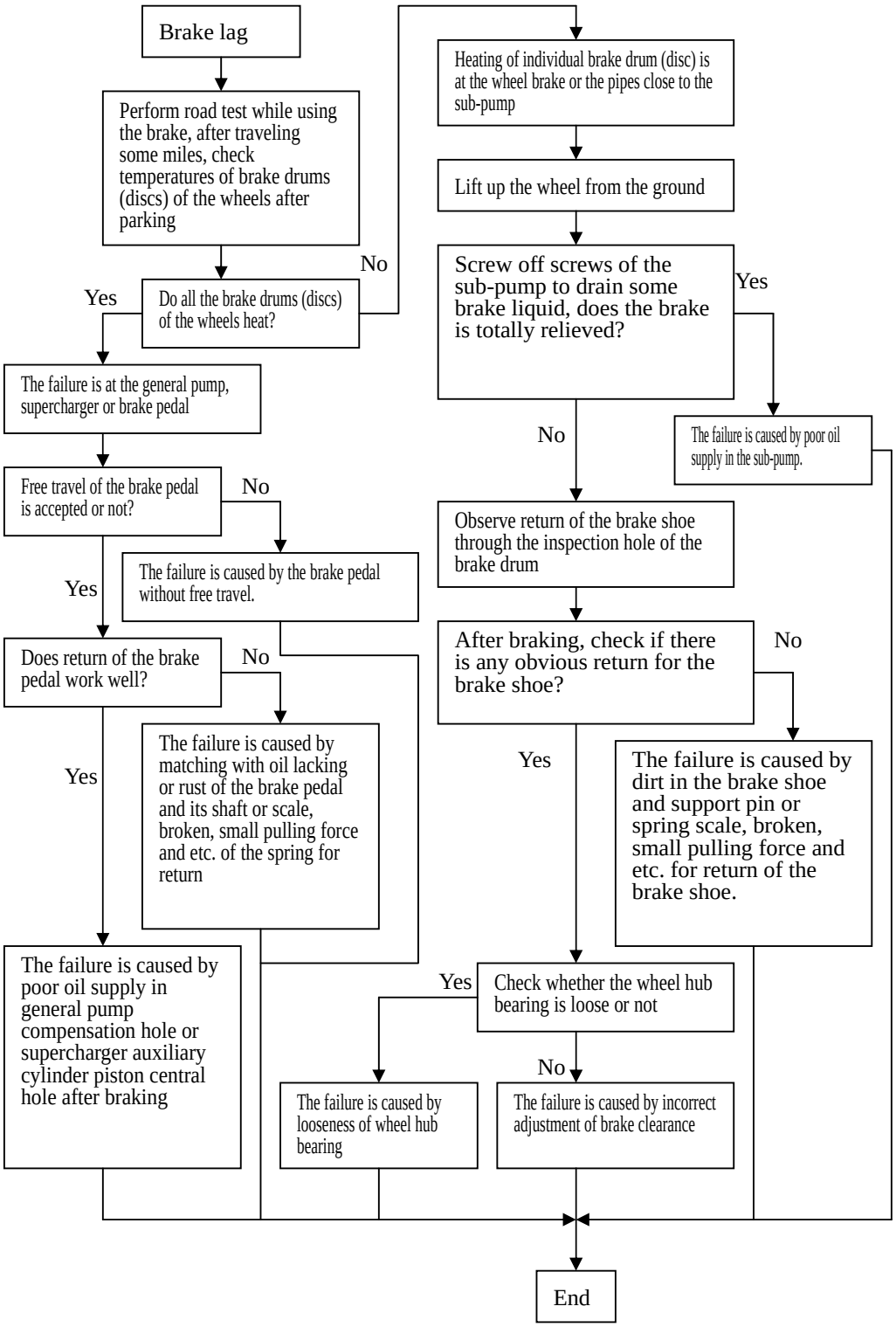


Fig. 8 - 15 Diagnostic flow chart of braking lag

8.7.2 Air braking system

1 . Ineffective braking

1) Phenomenon: the same to ineffective braking of hydraulic braking system.

2) Reasons：

(1) The free travel of brake pedal is too large;

(2) The air-reserve tank can not reach the specified air pressure;

(3) Max. air adjusting bolt of brake valve is improper to make brake air pressure lower;

(4) Pre-tightening force of the balance spring of brake valve is too small, and the keeping brake is earlier;

(5) The diaphragm of brake valve is broken or exhaust valve is closed imprecisely;

(6) The diaphragm of brake chamber is broken or brake piping is leaked;

(7) The brake piping is collapsed or the inner hole of the hose is blocked;

(8) The connivent area between brake shoe lining and brake drum is not good or brake clearance is adjusted improperly;

(9) The quality of the brake shoe lining is not good or during using, the surface is hardened, scorched, oil polluted and the rivet head is exposed;

(10) The abrasion of brake drum is too more or during braking, it is distorted.

(11) The brake camshaft is rusted in the supporting sleeve;

(12) The deposit of the inner wall of the brake piping is too serious;

3) Diagnostic method: refer to below flow chart (Fig. 8 - 16) to diagnose.

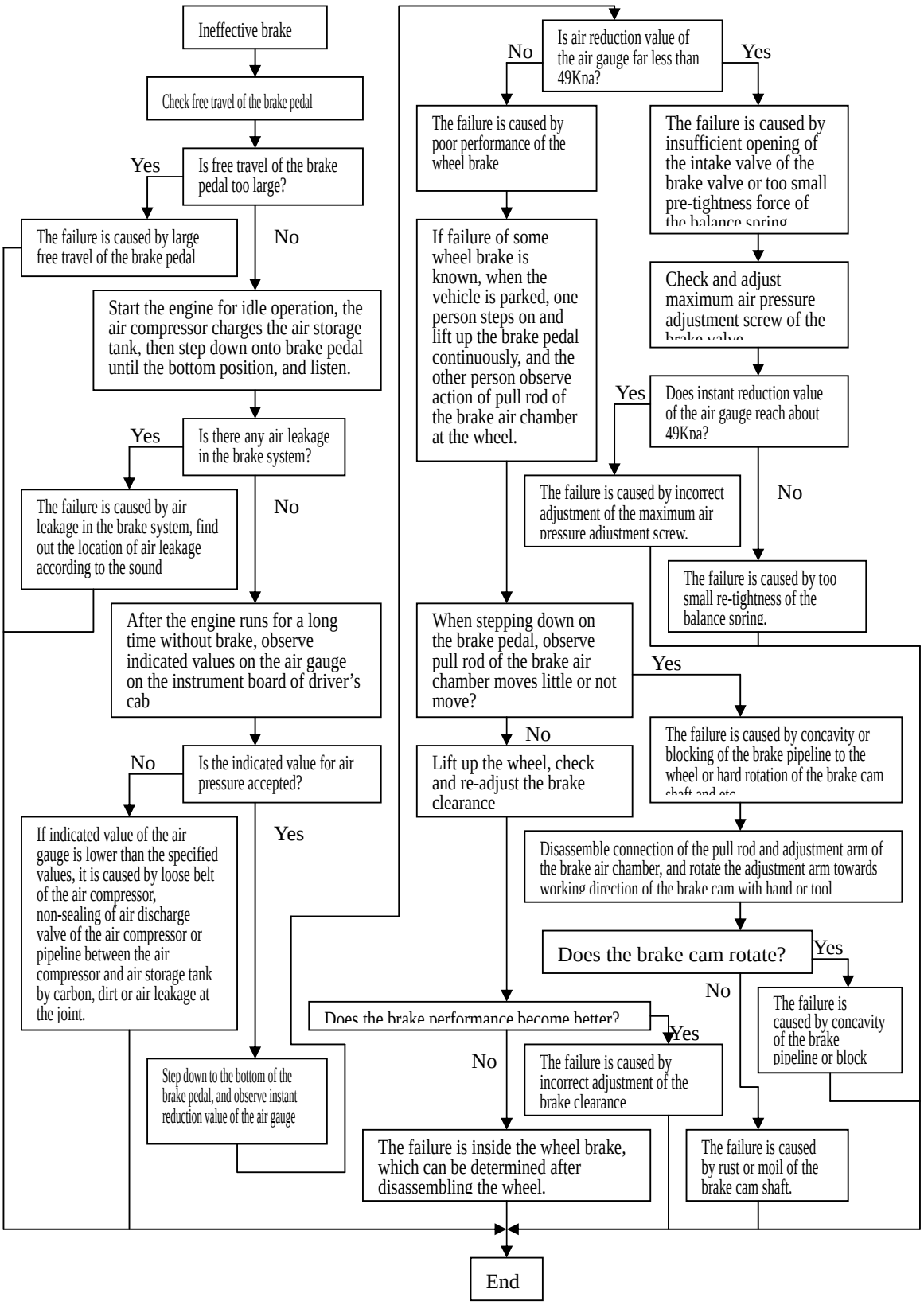


Fig. 8 - 16 Diagnostic flow chart of ineffective braking

2．Braking failure

1）Phenomenon: the same to braking failure of hydraulic braking system.

2）Reasons：

（1）The connection from brake pedal to brake valve is taken off;

（2）There is no compressed air in air-reserve tank;

（3）The air inlet valve of brake valve can not be opened or exhaust valve is closed imprecisely;

（4）The diaphragm of brake valve and brake chamber is seriously broken or the brake hose is ruptured;

（5）The brake piping is frozen or blocked by oil contamination.

3）Diagnostic method: refer to below flow chart (Fig. 8 - 17) to diagnose.

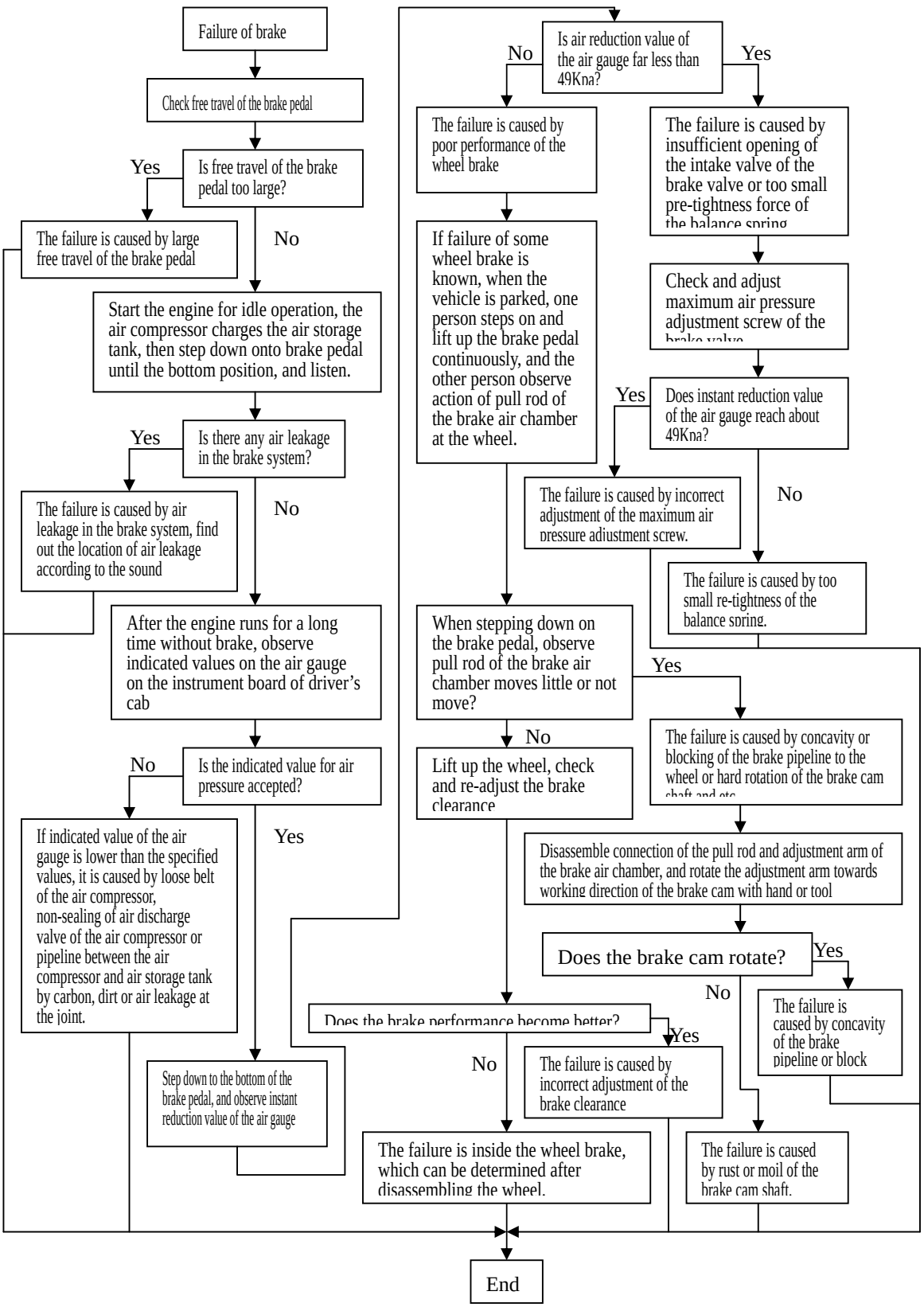


Fig. 8 - 17 Diagnostic flow chart of braking failure

3．Braking lag

1）Phenomenon: the same to braking lag of hydraulic braking system.

2）Reasons：

（1）The small free travel of brake pedal causes the start degree of exhaust valve of brake valve is too small;

（2）The exhaust valve spring of brake valve or the spring causes exhaust valve to open is tired, broken or its elasticity is too small;

（3）The rubber valve surface of exhaust valve of brake valve has the swell and the pastiness, or the more oil contaminations and the colloids are piled at the valve port;

（4）The return spring of brake pedal is tired, broken and lost or its pull is too small;

（5）The return spring of brake chamber diaphragm (piston) is tired, broken or its pull is too small;

（6）The return spring of brake shoe is tired, broken and taken off or its pull is too small;

（7）The brake camshaft is lack of oil, rusted or blocked in its sleeve;

（8）The brake shoe and the supporting pin are rusted;

（9）The brake clearance is adjusted improperly, and after the bake is loosened, the attrition between brake lining and brake drum is still existed partially;

（10）The hub bearing is loosened.

3）Diagnostic method: refer to below flow chart (Fig. 8 - 18) to diagnose.

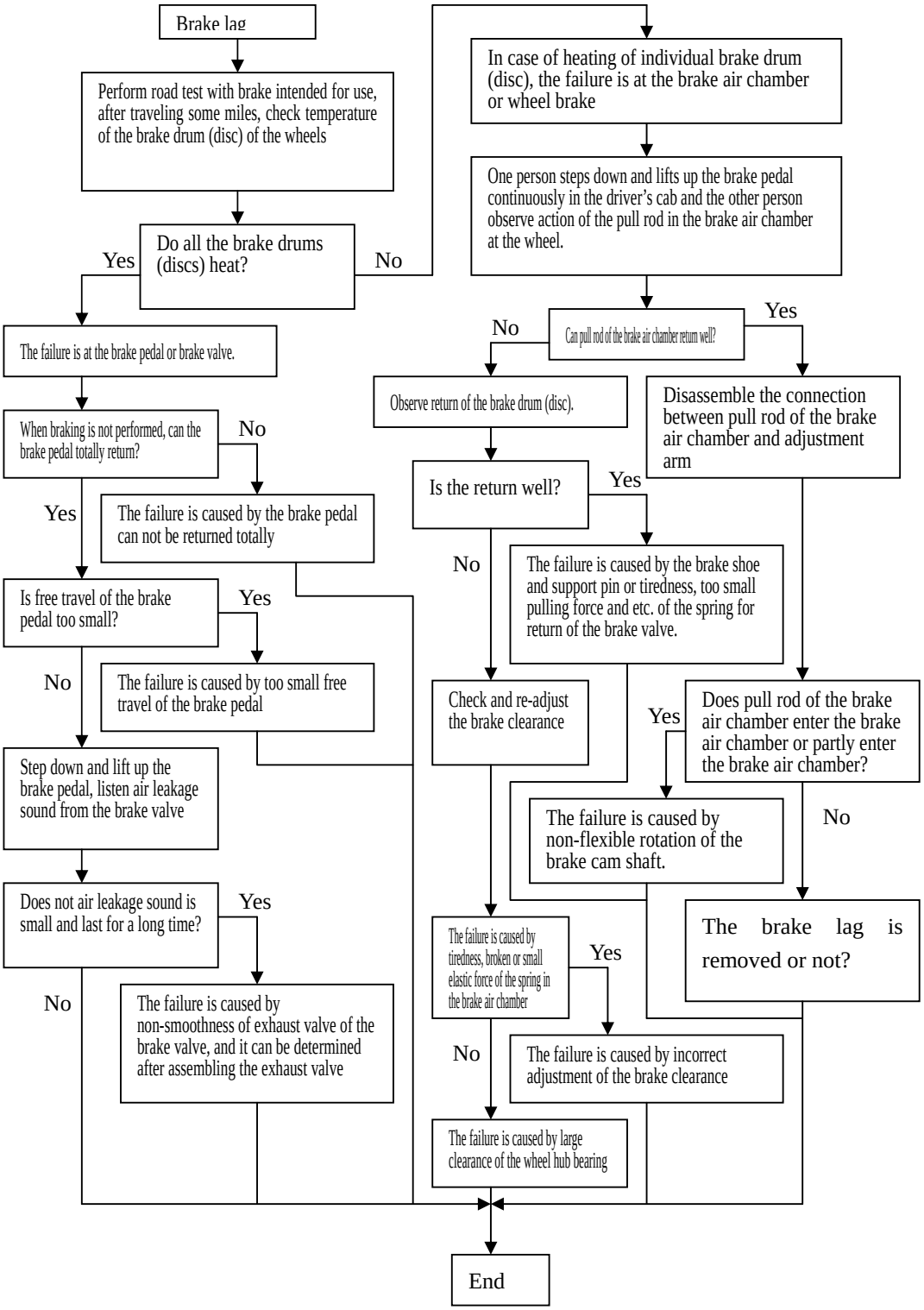


Fig. 8 - 18 Diagnostic flow chart of braking lag

Chapter 9 Frame, Wheel and Tire

9.1 Frame

The frame is the base body the whole vehicle and carrier for the support connecting the parts and bearing varieties of loads inside and outside the vehicle. The cargo carrying vehicle of SC series manufactured by the company employs the frame to fix the engine, transmission system, suspension, steering system and etc. The cargo carrying vehicle frame of SC series employs side-beam frame, owing to structure and use, the frame may be damaged, which affects safe performance of the vehicle. Considering the circumstances, timely and correct repair shall be give.

9.1.1 Wear analysis of the frame

During long-term use of the vehicle, the frame may suffer from deformation, cracking and rust and other losses caused by defects in structural design.

Deformation of the frame may lead to abnormal wear of the tire, the operation stability is poor, the brake performance worsens and oil consumption increases. Meanwhile, relative position of the assemblies of the automobile is changing and it is difficult to install the assemblies leading early damage.

Crack or breaking of the frame is generally on the longitudinal beam of the frame, and cracking or broken of the cross beam of the frame is on the connection to the longitudinal beam and middle of the cross beam. Cracking on the longitudinal beam of the frame is caused by bending stress and collective stress. If it is cracked during use, the result is severe.

Rust of the vehicle frame may reduce tiredness strength of the frame metal greatly to make reduce frame strength and early damage.

9.1.2 Testing of error of geometric of the frame

For the vehicle frame, no matter it is disassembled or not disassembled for repair, integrated testing shall be done before overhaul and after calibration, welding, riveting, reinforcement and assemble to determine degree of deformation of the frame, whether overhaul is required, result after overhaul and etc.

At present, main structure of the frame is side beam. Therefore, testing of geometric takes side beam frame as object. When testing, take location of the suspension as supporting point to avoid

affecting the testing precision caused by the flexibility by its weight.

（1）Check of deflection of the frame

aa'——Axis of pin supporting hole of front frame of the front steel plate;

bb'——Axis of pin supporting hole of back frame of the front steel plate;

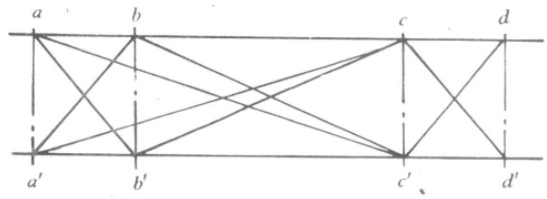


Figure 9-1 Wire-pulling test of frame by section

cc'——Axis of pin supporting hole of front frame of the back steel plate;

dd'——Axis of pin supporting hole of back frame of the back steel plate;

ab', a'b——Diagonal of section I;

bc', b'c——Diagonal of Section II;

cd', c'd——Diagonal of section III;

ac', a'c——Diagonal of section IV.

In general, after deflection of the frame, it can be inspected by wire-pulling of frame by section in Figure 9-1. The general method is that: selection a part with relatively large area on the frame as benchmark plane. Fix middle point of axis of pin support hole of the frame or the symmetrical points which are equidistant to the side of the frame on the steel plate spring, the four projection points on the benchmark plane are drawn to measure length difference of the diagonals among the four points.

For testing of frame by section, length difference of the diagonal may not be more than 5mm.

（2）Linearity inspection of longitudinal beam of the frame

Non-conformed linearity of longitudinal beam of the frame will affect installation of relevant assemblies. Therefore, check and calibration are required. The linearity error testing is divided into longitudinal linearity on the plane and side on the longitudinal beam of the frame. After completion, longitudinal linearity error of plane and side on longitudinal beam of the frame may not be more than 3mm in any length of 1000rnm. In the overall length of the longitudinal beam, the error may not be more than 1/1000 of the length.

Please note that this is the requirement for longitudinal beam under assembly. For length of the longitudinal beam is too long and width is too narrow, requirement of the longitudinal linearity controls the bending and deformation.

Linearity of the longitudinal beam can be tested by the wire-pulling method, see Figure 9-2. Cushion block 1 with the same thickness is on both ends of the testing plane of the longitudinal beam, and pull the wire against external plane of the cushion block. Then the steel ruler is used to measure distance of the points on the plane and wire on the longitudinal beam. The maximum value with thickness of the cushion block is the linearity error.

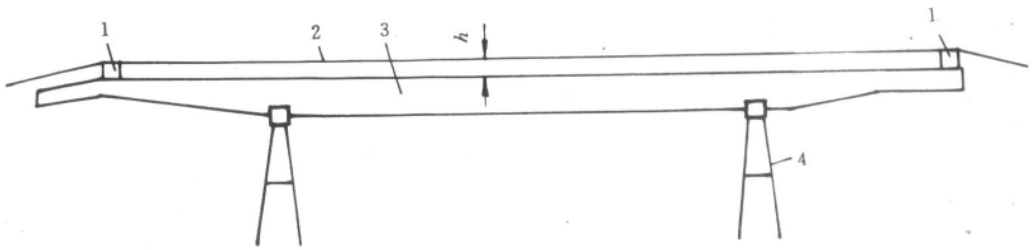


Figure 9-2 Linearity testing of longitudinal beam of the frame

1-Cushion block; 2-Silk line; 3-Longitudinal beam of the frame; 4-Support

（3）Planarity testing on the plane of the frame

If the testing meets the linearity requirement on the plane of the longitudinal beam, when one longitudinal beam bends upwards 1/1000 of the length, and the other longitudinal beam bends downwards 1/1000 of the length, relative error of the two longitudinal beams on the plane reach 2/1000. Or when the frame is distorted, the two longitudinal beams will not be parallel, which can not meet the technical requirements of the driver’s cab, cargo carriage and passenger carriage, affect the vehicle appearance and make gravity center of the vehicle deviated. In case of turning centrifuge force or the road inclination, the operation stability, steering degree and force on the frame and etc. are affected. In addition, verticality error testing of side of longitudinal beam of the frame to plane of the frame in the following is based on the planarity requirement. For common side beam frame, planes on the left and right longitudinal beams on the frame assembly shall be one the same plane, and the planarity error may not be more than 1.5/1000 of the testing length of the plane.

For planarity testing of the planes on the left and right longitudinal beams, it can be tested with method described in Figure 15-3. There are 4 cushion block of the same thickness symmetrically placed on both longitudinal beams of both ends of the tested planes, the diagonals ab′ and a′b. If the two diagonals are not contacted at point c, add gasket of the same thickness for both ends of the lower diagonal to adjust until the two diagonals are crossed (at the point c). At this time, four

points of the two diagonals form the benchmark plane. The wires ab and a′b′ are pulled above the two longitudinal beams and measure the distance from points on the plane of the two longitudinal beams to ab and a′b′. Maximum difference of the distances is the planarity error on the plane of the longitudinal beam.

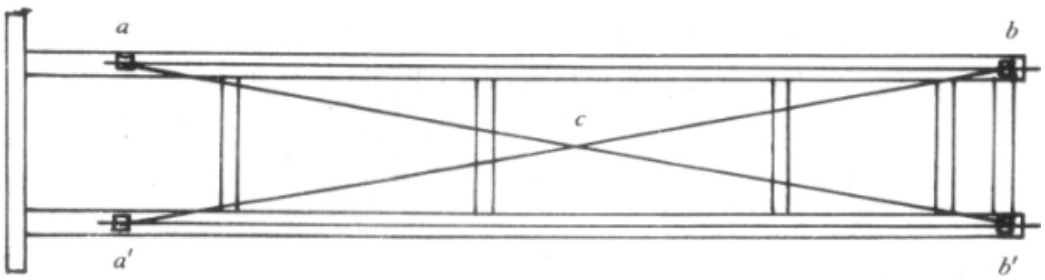


Figure 15 - 3 Planarity testing on longitudinal beam of the frame

（4）Other geometric error testing of the frame assembly

For common side beam frame, the following requirements must be observed after completion of overhaul:

(a) Limit deviation of the frame width is±3mm;

(b) Verticality error of side of the longitudinal beam to the plane on the frame may not be more than 1/100 of height of the longitudinal beam;

(c) Verticality error of main cross beams of the frame to the longitudinal beam may not be more than 2/1000 of length of the cross beam;

(d) Pin hole of fixed support of the left and right steel plate spring shall be co-axial, with coaxiality degree no more than 2.0mm. When the wheel base is no more than 4000mm, the left and right difference of axial of pin hole of the front and back fixing support shall be no more than 2mm; when the wheel base is more than 4000mm, it shall be no more than 3mm

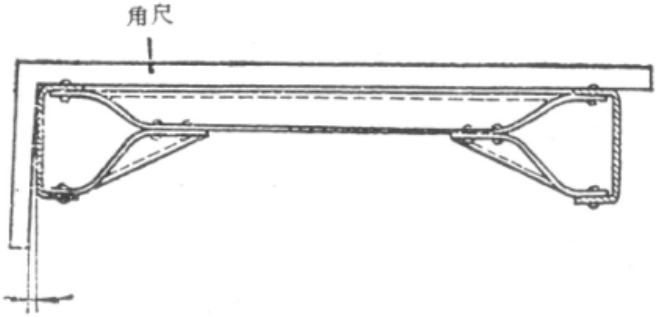


Figure 9 - 4 Verticality testing of frame

Testing of the verticality error can be performed with steel ruler as indicated in Figure 9-4.

Testing of verticality of the cross and longitudinal beams can be conducted by pulling wire in the middle position of the cross and longitudinal beams, then angle ruler is used to measure angle between the two wires.

Testing of coaxiality of pin holes of fixing support of the left and right steel plate springs can be done by using a measuring rod of effective size. According to the actual boundary value, the actual size is the algebra sum of the maximum actual size of the tested element and geometric tolerance.

Actual size = Maximum actual size± geometric tolerance（“+” for shaft, “－” for hole)

Prepare measuring rod of diameter 28.025mm with length little longer than external end surface space of the pin holes of the supports, the measuring rod can pass the left and right holes of the supports simultaneously and it is accepted. See Figure 9-5.

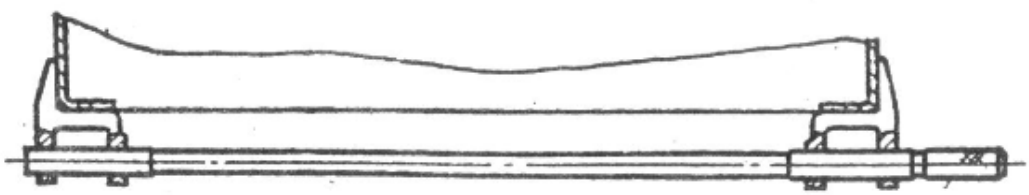


Figure 9-5 Coaxiality testing of support hole of the steel plate

9.1.3 Calibration of the frame

After testing the frame, if geometric error exceeds the permissible value, calibration can be done first. When the frame assembly is sound, there is only individual bending and deformation on the frame, and it can be calibrated on the frame directly. Figure 9-6 indicates common tools for calibrating longitudinal beam of the frame.

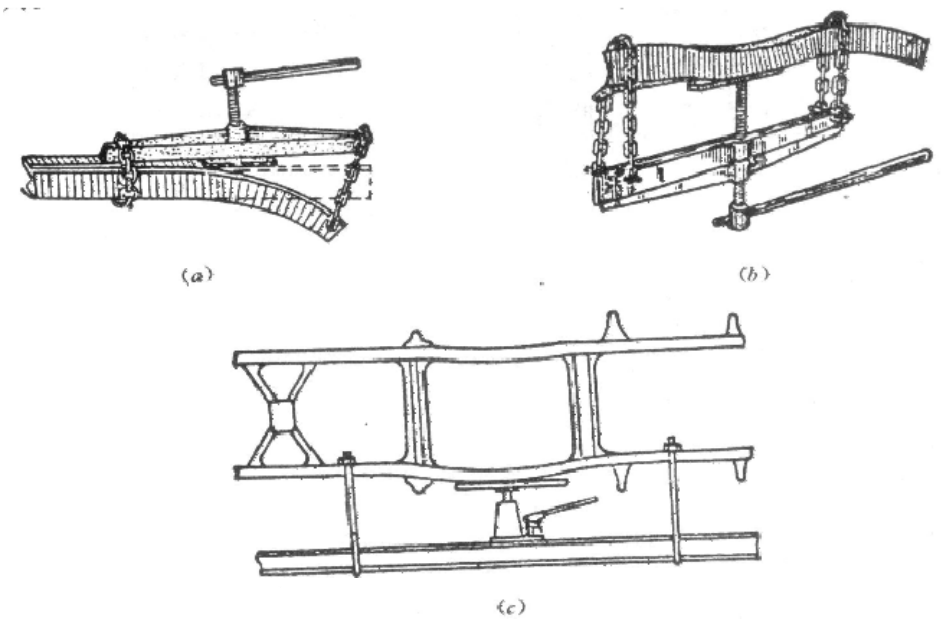


Figure 9-6 Tools for calibrating longitudinal beam of the frame

When the frame deformation is severe or looseness of the rivets is excessive, the frame shall be calibrated after disassembling. The frame is calibrated by cold pressing (drawing). For severe bending, the frame difficult for cold calibration or the service unit without frame calibration equipment, local heating can be used for calibration.

In the past years, according to the condition of more share of car in vehicles, a series of body calibration devices appear in the market. Without disassembling the car, compare the three-dimensional coordinate values on specified points and the standard values, and find out deformation of the body. Then the additional pressing and drawing devices are used to calibrate.

9.1.4 Frame repair and riveting

For longitudinal and cross beams of the frame, if cracking or breaking, displacement of rivet of the cross and longitudinal beams, looseness or breaking and etc. are found, it shall be repaired or riveting. For methods for repairing the cross and longitudinal beams, scarf patch repairing, butt joint, welding and addition welding and etc. are used. If there is defect on the rivet, the used rivet can be removed away and re-riveting.

（1）Scarf patch repairing of the frame

Scarf patching repairing of the frame is to remove the cracking of the cross and longitudinal beams away and butt joint welding is used to weld one steel plate of the same material and

thickness with the original frame.

When scarf patch repairing is used, remove old paint layer and rust on the frame, check size and location of the cracking. Then shape and size of the patch are determined according to nature and location of the cracking and manual gas cutting is used.

In vehicle repair, the patch shapes include oval, triangle, diamond, rectangle and etc. See Figure 9-7.

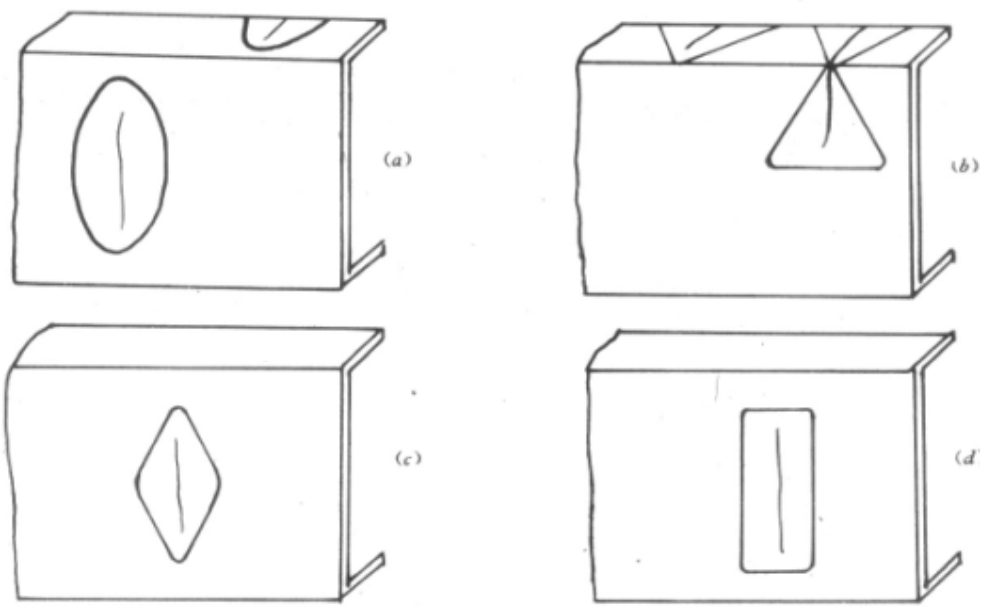


Figure 9 - 7

For cross cracking on the upper and lower planes of the longitudinal and cross beams of the frame and the side frame, longitudinal cracking or broken of the longitudinal beam, oval or triangle patch can be used for repair. Under general conditions, the patch shall remove all the cracks away. For security, for visual crack end, further 7-10mm patch is required. When cross and longitudinal crack on the sides of the longitudinal and cross beams appear, diamond or rectangular patch can be considered for repair.

When the scarf patch repair is used for repairing the frame, the patching cutting edge shall be smooth and clean and the grinding machine or manual chisel is used to open the groove. For forces on the vehicle are complicated, the strict conditions are severe, V or X groove is sued for edge of the cut and embedded plate for patch repair (see Figure 9-8), then double welding is used.

When scarf patch repairing is used, the scarf plates shall be repaired according to the patch size and shape. The scarf plate shall be have the same material quality and thickness with cross or

longitudinal beams of the frame, which shall be drawn from rejected from old frame of the same model and made of new steel plate.

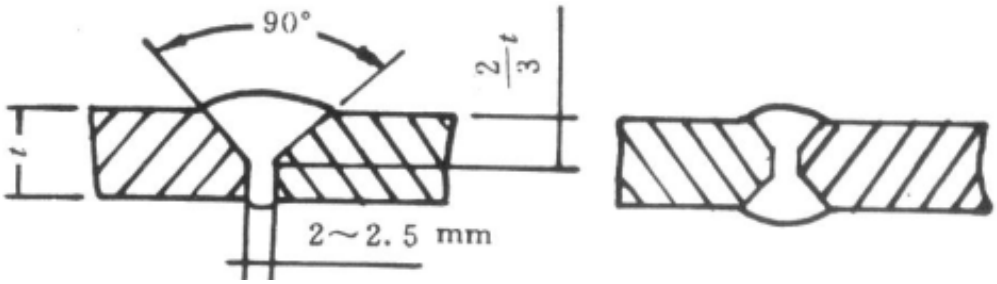


Figure 9-8 Groove shape and size

To ensure welding quality, a clearance of 2-2.5mm shall be preserved between the scarf plate and patch holes. Before welding, clean the groove surface, then the scarf plate is inserted into the patch hole and the scarf plate is fixed according to the weld point, then the flatness is calibrated. For working conditions of the frame has high requirement for the welding strength, correct soldering bar brand, diameter, welding current, number of layer and other welding specifications. In general, 502, 503, 506, 507 and 422 soldering bar can ensure welding quality, with diameter of the soldering bar 3.2-4.0mm. For welding, AC and DC power supply can be used (DC for 507 soldering bar). The welding current from 100-200 A can be selected upon diameter of the soldering bar and thickness of the plate. Surfacing welding can be used, generally 3-4 layers to avoid welding stress.

Short arc shall be used for welding to avoid air hole in melting metal. The seal shall be flat, smooth, without welding beading and crater, and the depth of undercut shall be no more than 0.5mm and the length of undercut shall be no more than 15% of the welding length, without air hole, slag and other defects. When repairing the frame, direction of the welding seam may not be overlapped or vertical with the crest line, except the special frame. There should be no crack on the welding seam or its surroundings.

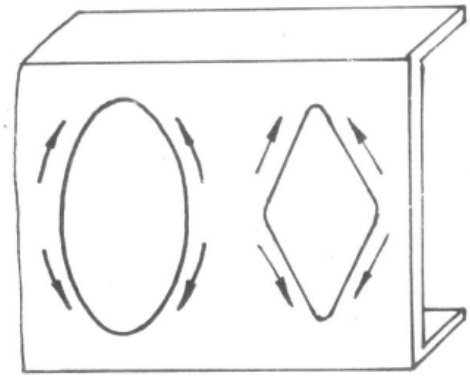


Figure 15-9 Direction of welding

When welding, arrange the direction of welding to reduce welding deformation stress to avoid

broken in use. When conducting welding, it shall be started from the middle of the sides of cross and longitudinal beams and extend along the opposite direction (See Figure 15-9) to lead the welding stress to the edge which becomes loose. After welding, flatten the bead; for the location not affecting the assembling, the bead can be 1-2 higher than the benchmark plane.

（2）Butt joint repair of the frame

For some section of longitudinal beam of the frame, especially within 1.5m of the front and back end of the longitudinal beam, if total broken or crack is collective, the damaged section (end) can be cut, and the butt joint welding can be used to weld a new beam (end) which is the same with the cut one.

For butt joint welding, it is divided into oblique mouth butt joint and flat mouth butt joint welding. For bead length of the oblique mouth welding is longer than that of the flat mount butt joint welding, the former one has more powerful quality guarantee. When cut of the oblique mouth butt joint is connected to the cross beam connected to the longitudinal beam and etc., the cross beam shall be dismounted and the repair becomes complicated, the flat mouth welding can be used. In other word, direction of the welding seam can not be vertical to crest line of longitudinal beam of the frame in general.

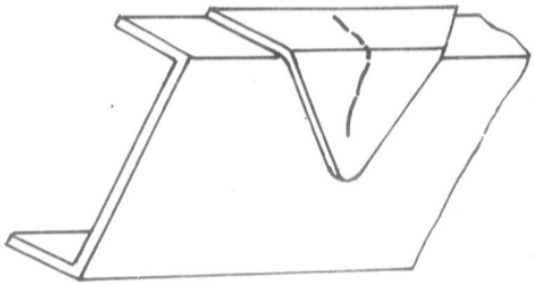


Figure 9-10 Additional welding repairing

When butt joint welding is used, the frame cutting, crater processing, welding specifications and requirements and etc. shall be the same as patch repair of the frame. Please note that, after welding of the butt joint section and the original longitudinal beam, check longitudinal linearity error of the plane and side of the longitudinal plane. After welding, check shall be conducted.

（3）Additional welding repairing of the frame

If regular crack or broken is on the specified part of the vehicle, there must be problem with the vehicle design or use. If it is caused by defect of the frame design, in addition to normal repair of the crack, reinforcement plate shall be used at the point, namely, additional welding repairing (see Figure 9-10).

When additional welding repairing is used, the selected reinforcement plate shall have the same material with the original frame, with thickness a little less than the steel plate of the original frame, which can not be more than. Shape of the reinforcement plate can be triangle, and other shapes and the length shall be 2 times of height of the longitudinal beam. To make smooth toughness transition of local points of the cross and longitudinal beams after repair to avoid collective stress for broken caused by great different of toughness of the reinforcement point and other points of the original frame. In general, sizes of both ends of the reinforcement shall be reduced gradually. Please note that the rear longitudinal beam toughness must be coordinated.

Welding specifications of the reinforcement plate are the same with the patch welding. To avoid excessive increasing of the toughness, sectional welding can be used.

To avoid excessive increasing of weight of the frame and affect its economic use, after completion, the increment may not exceed 10% of the original design weight.

（4）Riveting of the frame

When repairing the vehicle, it most rivets are damaged or deformed caused by accident or severe operation conditions. If calibration of the longitudinal beam is difficult without disassembling, the frame can be repaired by disassembling the frame. By doing so, all the frame rivets will be removed away and re-riveted.

There are so many methods for removing old rivets, such as gas cutting method, drilling method, cutting method, removing method and etc. No matter what method do you use, you may not damage the frame and riveting hole. When wear of the old riveting hole is no more than 0.5mm, it requires no modification; if it exceeds the size but less than 2mm, expand the hole appropriately and employ a larger riveting. Once wear of the old riveting hole is more than 2mm, fill the old holes and drill new ones.

When riveting the frame holes, cold riveting is recommended and hot riveting can also be used. After cold riveting, the rivet is full in the rivet hole without cutting impact during working. For hot riveting, the heat expansion and cold contracting after cooling may generate impact cutting with the radial clearance. When riveting is conducted, fasten the longitudinal and cross beams of the frame, then the total geometric error is in the range of control, and riveting is conducted.

For frame after completion, contacting surface of riveting parts must be strictly contacted. The

rivet must be full in the hole. There should be no crack, deflection and missed on the rivet head. All the rivets can not be replaced with bolt.

Finally, the completed frame shall undergo rustproof treatment. During use, if individual rivet or steel plate for individual rivet is loose and riveting on the vehicle is not easy, it can be fastened with bolt. However, the bolt shall be specially prepared and the material is middle carbon steel, and the rod can be full in the rivet hole.

9.2 Wheel

9.2.1 Wheel structure

Wheel is a rotating assembly bearing load between the tire and axle, which is made up of wheel rib and spoke. The wheel rib is a part mounted on the wheel for supporting the tire and the spoke is a supporting part between the axle and wheel rib. The light-duty truck of SC series manufactured by the factory employs two-part wheel rib (see Figure 9-11). The spoke and wheel rib can not be dismounted permanently.

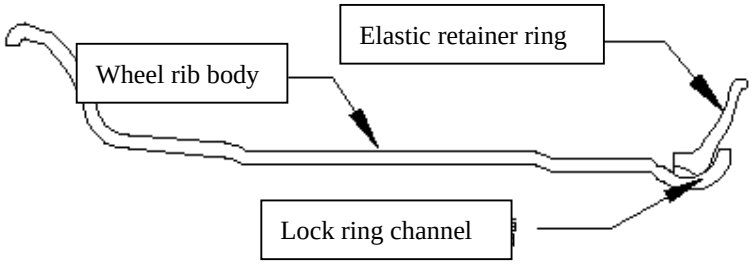


Figure 9-11Sketch map of the wheel rib

9.2.2 Maintenance of the wheel

（1）Dismount the wheel

a) Screw off the wheel bolt about 180°;

b) Lift up the vehicle;

c) Take the wheel off.

Note: Do not screw off the over-tightened wheel by heating, for heat expansion and cold contract may shorten service life of wheel and damage the wheel bearing.

（2）Maintenance

The wheel employs aluminum alloy casting processing, and welding, heating and sand spraying can not be used to repair the wheel. Therefore, all the damaged wheels must be replaced.

（3）Installing wheel

The wheel nut must be tightened to specified torque according to the sequence to avoid bending of the wheel or brake disc. The tightening sequence is the same as that for the engine cover.

Note: before installing wheel, remove rust on the wheel installation surface and brake disc surface or remove it with steel wire brush.

9.3 Tire

9.3.1 Tire structure

The light-truck of SC series employs common bias tire, which is made up of inner tire, external tire and cushion belt and etc. The inner tire is full with compressed air, and the external tire is a elastic shell used to protect the inner tire and prevent it from external impact; the cushion belt is placed between the inner tire and wheel rib to avoid collision and wear of the wheel rib and external tire. See Figure 9-12.

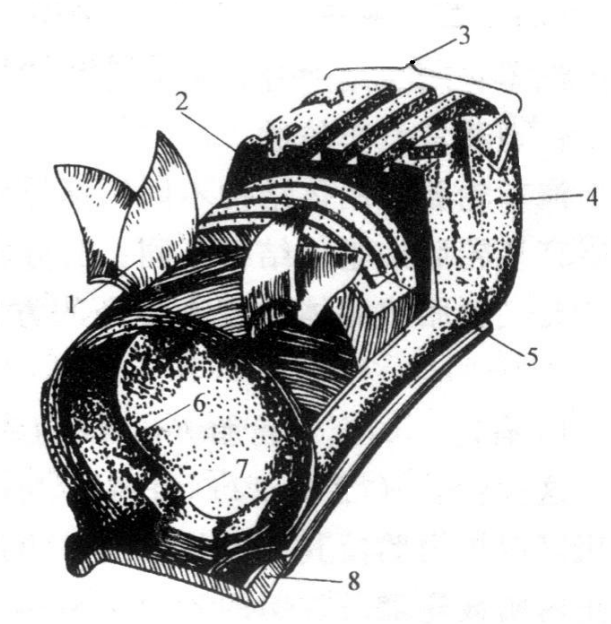


Figure 9-12 Structure of common bias tire with inner tire

1-Cord layer；2-Tire shoulder；3-Crown；4-Tire side; 5-Buffering layer; 6-Inner ring; 7-Cushion belt；8-Tire ring

9.3.2 Maintenance of the tire

（1）Installation and disassembly

Tire replacement machine is used to mount or dismount the tire and the manufacturer's instructions must be observed. Not only the manual tool or tire pry rod is used to replace the tire to avoid damaging the tire edge or wheel rib. Steel wire brush is used to clean external edge fo the wheel rib or the lubricant, old rubber and a small amount of rust is removed. Before mounting or dismounting the wheel, appropriate wheel lubricant is used to lubricate the wheel edge.

（2）Tire maintenance

There are so many materials and methods for repairing the wheel. For not all the materials and methods are applicable for the tire, therefore, the tire manufacturers publish instructions on how to repair the tire timely, which can be obtained from the tire manufacturers.

（3）Tire pressure

For repaired tire, it shall be charged to specified pressure. If it is high, it may lead to: difficult driving, tire cracking or tire body damage; accelerated wear of central tire surface. If it is low, it may lead to: tire sounding for turning; difficult steering; accelerating wear of the tire edge which is uneven; crack or broken on the wheel rib; damage of the tire cord; tire with high temperature; low operation; increased fuel consumption and etc.

9.4 Technical parameters of the wheel tire

Table 9-1

Tire model	4.5J - 15	5.5F - 16
Tire model	6.00 - 16 common pattern 8-layer	6.50 - 16 common pattern, 10-layer
Tire pressure（Kpa）	420	530

Chapter 10 Body and Electrical Equipment

10.1 Body

Automobile body is generally composed of body shell, external parts, internal parts, electrical accessories and packing case.

Body shell is the installing foundation for all components and is welded from longitudinal beam, transverse beam, pillar, stiffener, covering parts, engine hood, door, etc.

External parts refer to those parts that have functions such as protection or decoration for body exterior or external accessories that are used to realize certain function, including bumper, external decorative trims, sealing strips, external back mirror, radiator cowling, skylight and its accessories, door accessories, aerodynamic accessories, etc.

Internal parts are parts that protect human body or decorate inside car as well as ones that are used to realize certain functions, including instrument panel, seat, safety device, sun visor, internal back mirror, internal door decorating parts, internal underbody decorating parts and other internal decorating parts.

Body electrical accessories refer generally to all electrical devices except engine and underbody, including all kinds of instruments and switches, lighting apparatuses, light signal device, audio and video apparatuses, air conditioner, windscreen wiper, windscreen washer, defrosting device, anti-theft device, etc.

The follows are demonstrations for a part of parts.

10.1.1 Door and its accessories

(1) Diagram of door device and components, see Fig. 10-1:

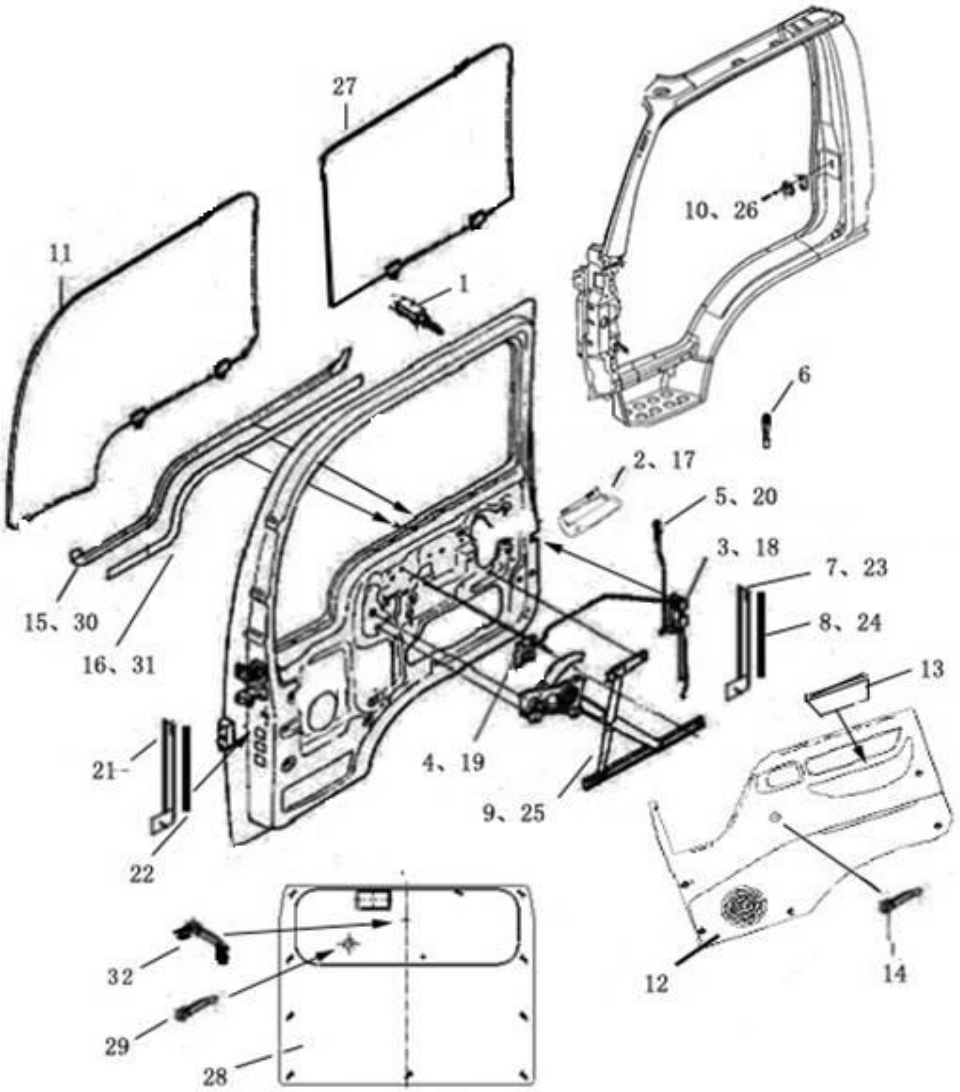


Fig. 10-1 Door device

1-door lock core device; 2, 17-external unlock mechanism assembly of door lock; 3,18-door lock assembly; 4,19-internal unlock mechanism assembly of door lock; 5,20-door locking mechanism assemble; 6-locking button; 7,21,23-window guide assembly; 8,22,24-window guide slot; 9,25-window lifter assembly; 10,26-lock pin assembly; 11,27-door window assembly; 12,28-inner fender; 13-inner fender ; 14-window lifter handle assembly; 15,30-window external batten assembly; 16,31-window internal batten assembly; 29-window lifter handle

(2) Disassembly of door and its accessories

1) Disassemble the fastening screw on internal handle seat using cross screwdriver, then take down internal handle assembly from internal decorating panel by sliding it forward.

2) Lower the window to the lowest position, insert a piece of cloth strip into snap ring

slot of lifter handle, pull the strip to make handle snap ring retract from the slop, take down lifter handle and dust cover.

3) Press the center of the internal decorating panel latch using cross screwdriver, disassemble the latch from its seat, then take down the internal decorating panel and sealing film.

4) Pry off internal and external sealing strips of front window using putty knife or flat screwdriver winded by adhesive tape, then disassemble internal and external sealing strips and their clamps.

Caution: when disassembling sealing strips, apply force evenly to avoid deformation or damage of sealing strips.

5) Loosen the assembling bolt of door slide slot and disassemble the rear part of front window slot, disassemble the fastening bolt of window support, take window together with support from inside door.

6) Unscrew the fastening bolt of window lifter using cross screwdriver, then take window lifter out from door hole.

7) Disassemble locking button, lock installing screw and clamps of lock control lever connectors from door, disassemble external handle and lock assembly from door.

8) Disconnect door wire bundle connector and disassemble bellows from car body.

9) Gently knock out door opening limiter pin upward using hammer.

10) Lift door by lifting jack. Caution: place a piece of wooden plate between jack and door skin to avoid damage of door.

11) Loosen hinge installing bolt and disassemble door assembly.

(3) Check of door and its accessories

1) Check the sliding of window lifter and the moving condition of rotating portions; check whether rack gear is worn or damaged and whether hinges are damaged. If there is any defect, replace lifter assembly.

2) Check whether internal or external sealing strips are damaged or peeled. If any, replace sealing strips.

3) Check whether window felt slot is damaged or deformed or whether the felt is peeled. If any, replace it.

4) Check whether window rubber batten is broken, damaged or aged. Check whether window support is damaged. If any defect, replace it.

(4) Adjusting of door and its accessories

Install door and its accessories in the sequence reverse to disassembly, but pay attention that:

1) Adjusting of lock: move the lock pin up and down to align it with the center slot of the lock; close the door, adjust the lock pin left and right to make the surfaces between the door and the body leveling; increase or decrease the number of gaskets between the body and the lock pin to adjust the longitudinal location so as to ensure that the longitudinal clearance between the lock pin and the body accords with the specified value.

2) When installing door window glass and bracket, apply the bracket slot with soap water, then knock the glass slightly into the bracket slot using wooden or plastic hammer and ensure that the relative location between the glass and the bracket accords with specified value.

3) Before installing the window lifter, apply the sliding portions and rotating portions of the lifter with lubricating grease.

4) After installing window assembly on the lifter, lift the window and check whether the top of the window contacts evenly with the felt slot as well as whether the slipping of the window is flexible. If the contact is not even, adjust the installing position of the lifter to ensure that it accords with the specification and that the window lifts smoothly.

5) Before installing the internal decorative board, apply the internal door panel with adhesive and stick water-proof film. Then install the internal decorative board and

press the buckle in place. If the water-proof film leaks, remove it and reinstall.

6) Lift the window. Under the condition that the window is completely closed, adjust the angle of the lifter handle to 45°, install dust shield and press the buckle in place.

10.1.2 Windshield

(1) Disassembly of windshield

1) Disassemble accessories such as wiper blade, decorative parts, instrument panel, interior roof trims, rearview mirror, sun visor, etc. Clean the outer and inner sides of the windshield and its peripheral.

2) Scratch away the sealing strap around the windshield using knife and expose the peripheral of windshield.

3) Make a small hole in the viscose glue around the windshield using a piercer and pass steel wire through the hole.

4) Attach wooden rods to the two ends of steel wire and draw the steel wire along the windshield to cut the viscose glue.

5) Scratch the residual viscose glue away from the vehicle body using knife smoothly. Caution: the inserting depth of the knife should be 1-2mm.

(2) Installing of windshield

1) If the disassemble windshield is reused. The residual spacing strips and viscose glue on the windshield must be removed entirely.

2) Wash the residual viscose glue on the vehicle body and windshield with cleaning solution. Dry for more than 10min after applying.

3) Coat premier on the vehicle body coating and the exposed metal surface. Don't coat the premier on the residual viscose glue on the body.

4) Insert the windshield into the new fillet and spacing strip.

5) Install trim strip of windshield on front column and install fixing block.

6) Apply the adhesive edge of windshield with premier.

7) Apply the windshield edge with viscose glue.

8) Press the windshield into the vehicle body and knock the windshield surface and the around fillet slightly so as to install the windshield firmly. Fix the fillet on the top.

9) Spray water using hose to check whether the sealing strip of windshield leaks. If any leakage, fill the leaking place with viscose glue.

10.2 Electrical equipment

10.2.1 Lighting equipment

(1) Repair of head lamp

1) Check whether there is any tilt or looseness for the installing of head lamp. If any defect, fasten the installing screw;

2) Check whether the glass cover of head lamp is clean. If any dust or muddiness, clean it. Check the cover glass whether there are any cracks, damages or other defects. If any, replace it with new one;

3) Check the working condition of head lamp switch.

Check the working condition of lighting switch

Turn lighting switch from off position to stop I, head light, back light, license light and light for instrument panel should be turned on; turn lighting switch to stop II, head lamp, head light, back light, license light and light for instrument panel should be turned on.

Check the working condition of head lamp light switching

Turning on head lamp, push the switch handle upward, the head lamp should send far light; set the switch at the medium position, the head lamp should send near light; press the switch handle downward, the head lamp should send far light again.

(2) Adjusting of head lamp beam

1) Preparation before adjusting of head lamp beam: Adjust the pressure of four tires to the specified value, unload the vehicle, and then park the vehicle on the flat load surface. Set a blank screen or wall 10m in the front of the vehicle.

2) Adjusting of vertical beam of head lamp (Fig. 10-2): Turn on the far light switch of head lamp, the illuminating center of main beam of head lamp should be within the range between the center height H of head lamp and H/5D below H. If the position of main beam is not correct, change the position by adjusting the adjusting screw of head lamp so as to ensure that the beam center accords with the specification.

Fig. 10-2 Adjusting of vertical beam of head lamp

3) Adjusting of horizontal beam of head lamp (Fig. 10-3)Turn on the far light switch of head lamp, the horizontal position of the illuminating center of the main beam of head lamp should meet the following requirements: the deviation of the left head lamp beam to the left should not be more than 100mm and the deviation to the right should not be more than 200mm; the deviation of the right head lamp beam to the left or to the right should not be more than 200mm.If the position of the beam is not correct, adjust the adjusting screw of head lamp to ensure that the position of beam in the horizontal direction accords with the specification.

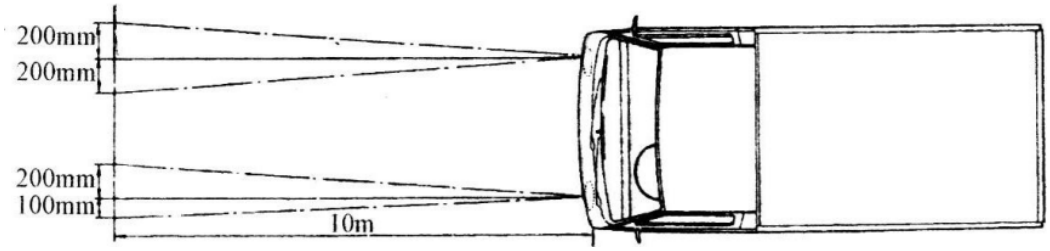


Fig. 10-3 Adjusting of horizontal beam of head lamp

10.2.2 Combined instrument

(1) Repair of fuel indicator and fuel quantity sensor

1) Check of fuel indicator (Fig 10-4)

Disconnect the connecting wire between fuel indicator and fuel quantity sensor, connect a testing bulb (3.4W/V) between the indicator and the sensor; turn on ignition switch, the bulb should be turned off, and the instrument needle should begin to swing in several seconds; if any defect, replace the fuel indicator.

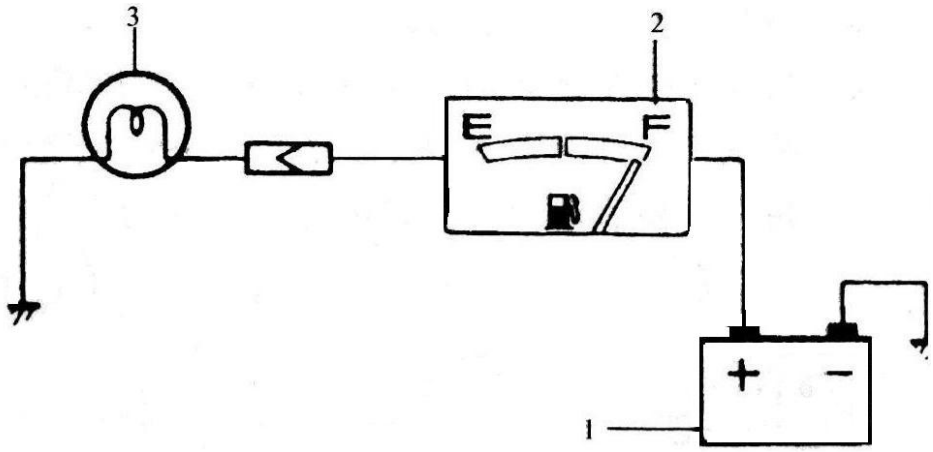


Fig. 10-4 Testing circuit of fuel indicator
1-battery; 2-fuel indicator; 3-testing bulb

2) Check of fuel quantity sensor (Fig. 10-5)

Take down the fuel quantity sensor from the fuel tank. Measure the resistance of fuel quantity sensor float at different heights using multimeter. If the measured resistance doesn't accord with the specified one of the correspondent location, replace the fuel quantity sensor.

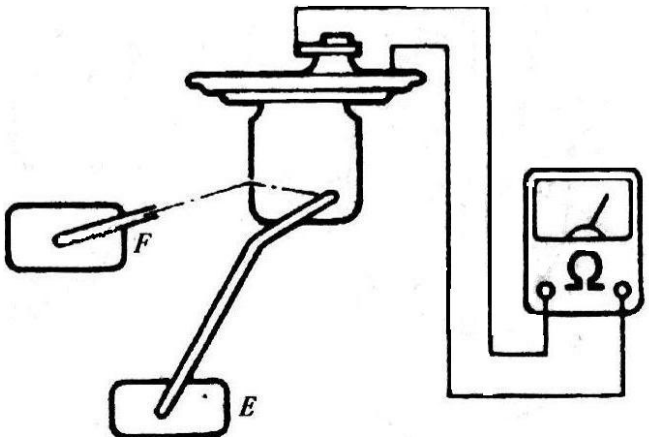


Fig. 10-5 Testing of fuel quantity sensor

Specified value of fuel quantity sensor: E (empty) 110Ω

F (full) 14Ω

1/2 (half) 38Ω

3) Repair of water temperature indicator and sensor

a) Check of water temperature indicator (Fig 10-6)

Disconnect the connecting wire between water temperature sensor, connect a testing bulb between water temperature indicator and the ground wire; turn on ignition switch, the bulb should not be turned on, the instrument needle should swing in several seconds. If any defect, replace the water temperature indicator assembly.

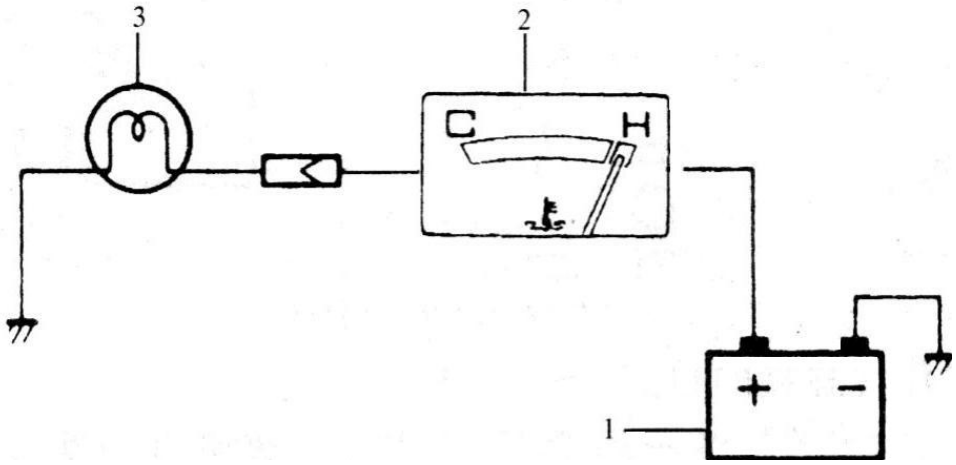


Fig. 10-6 Testing of water temperature indicator
1-battery; 2-water temperature indicator; 3-bulb

b) Check of water temperature sensor (Fig 10-7)

Heat the water temperature sensor, measure the resistance of the sensor using multimeter. If the measured value doesn't accord with the specified one, replace the water temperature sensor.

Specified resistance of water temperature sensor: 40 287Ω

80 69Ω

100 38Ω

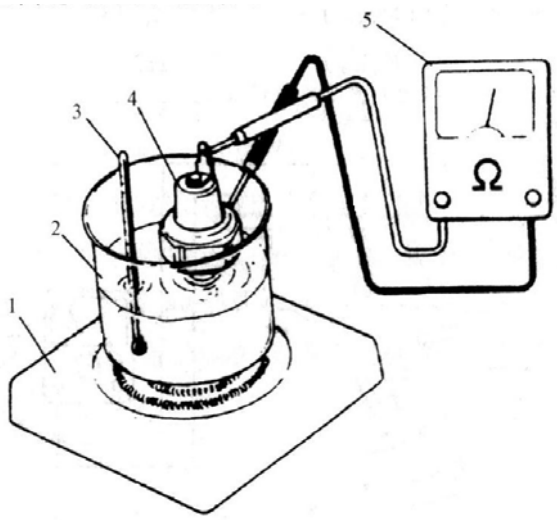


Fig. 10-7 Testing of water temperature sensor

1-electrical furnace; 2-beaker; 3-thermometer; 4-water temperature sensor; 5-multimeter

10.2.3 Windshield cleaner and wiper

(1) Structure of windshield cleaner

The structure and components of windshield cleaner are shown in Fig. 10-8.

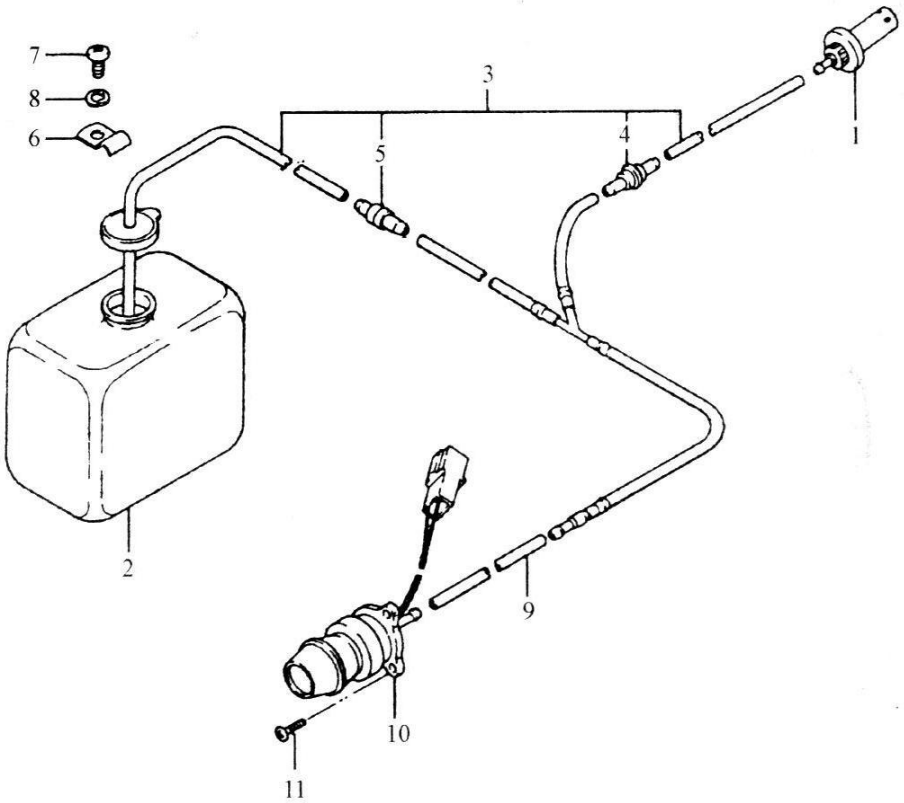


Fig. 10-8 Structure and components of cleaner

1-cleaner nozzle; 2-cleaner tank; 3- cleaner hose group; 4,5-valve; 6-clip; 7-screw; 8-locking

gasket; 9-hose; 10-water pump; 11-screw

(2) Structure of windshield wiper

The structure and components of windshield wiper are shown in Fig. 10-9.

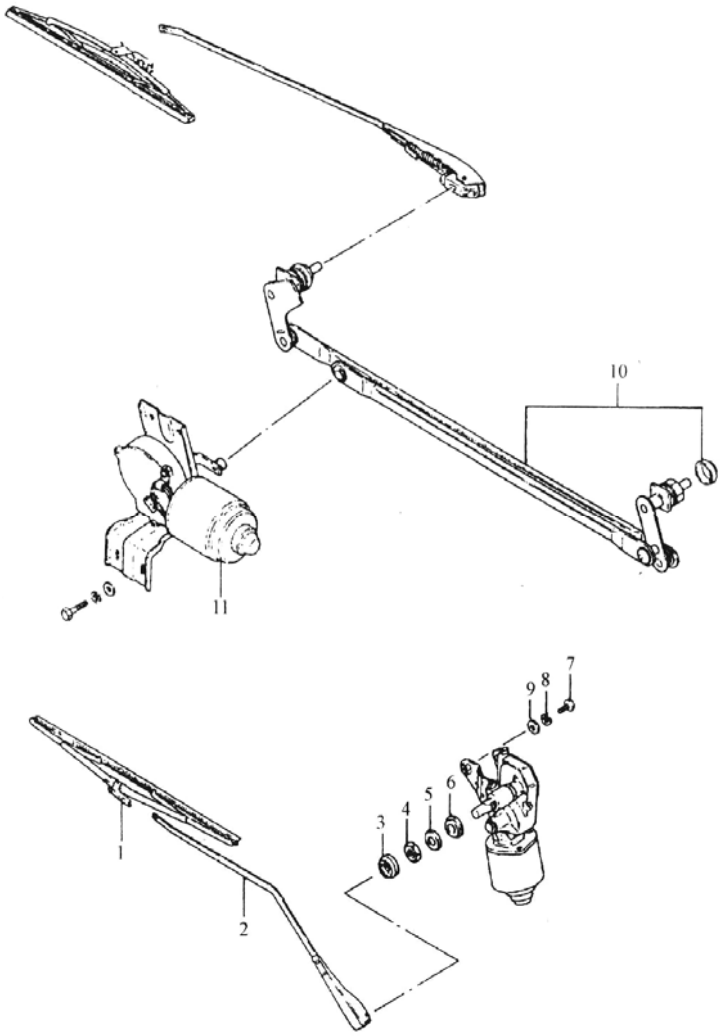


Fig. 10-9 Structure and components of wiper

1-wiper blade; 2-arm; 3-cover; 4-nut; 5-gasket; 6-seal part; 7-screw; 8-locking gasket; 9-gasket; 10-linkage; 11-motor

(3) Repair of windshield wiper

1) Check of working condition of wiper switch

Disconnect switch connector, check the continuity between terminals using multimeter to examine whether the wiper switch and sprayer switch have any defect.

2) Check of wiper motor

a. Idle running test (Fig. 10-10)

Check of low speed: connect the positive pole of battery to the blue wire of switch connector, and the negative pole of battery to the motor gear case, the speed of motor should be 38r/min;

Check of high speed: connect the positive pole of battery to the blue/red wires of switch connector, and the negative pole of battery to the motor gear case, the speed of motor should be 55r/min.

If any defect, replace wiper motor.

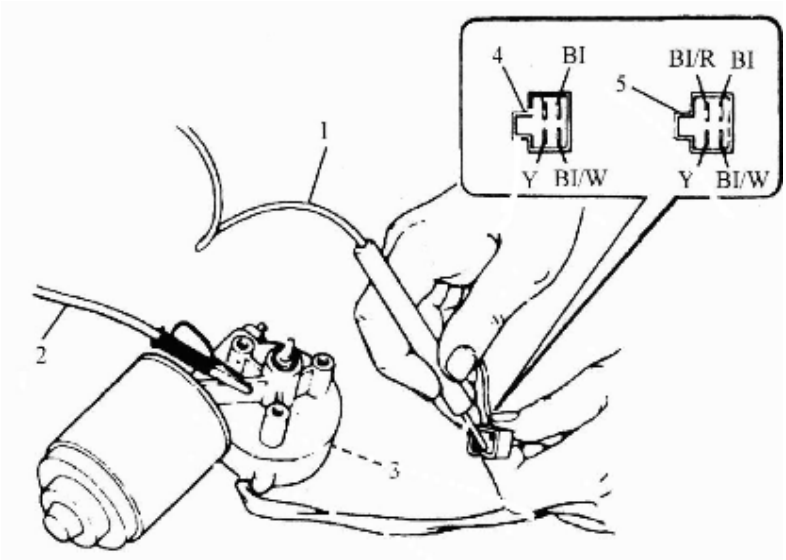


Fig. 10-10 Motor idle test

1-battery positive pole; 2-battery negative pole; 3-gear box; 4-double speed; 5-single speed

BI/R: blue/red; BI/W: blue/white; BI: blue; Y: yellow; Y/BI: yellow/blue

b. Test of automatic stop action (fig. 10-11)

Connect the positive pole to the yellow wire of the motor and the negative pole to the connecting wire of gear case to make the motor work. Then, shortcut the blue/white wire of switch connector and the blue wire using a jumper wire to check whether the position where the motor stops is the same as that it starts. If the position is not correct, repair or replace the motor.

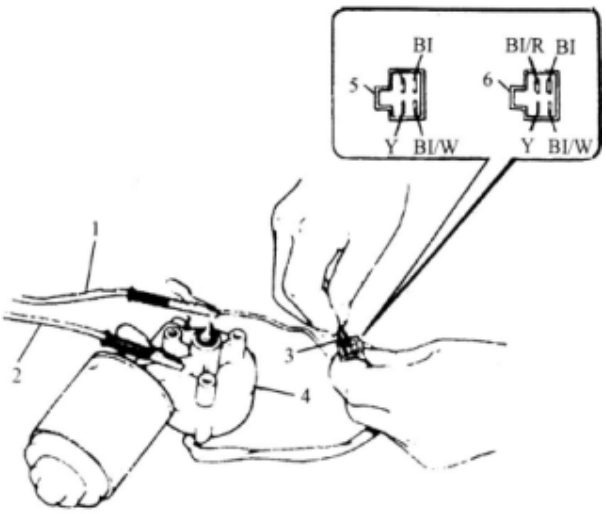


Fig. 10-11 Test of motor automatic stop action

1-battery positive pole; 2-battery negative pole; 3-jumper wire; 4-gear case; 5-double speed; 6-single speed

BI/R: blue/red; BI/W: blue/white; BI: blue; Y: yellow; Y/BI: yellow/blue

10.2.4 Heating device

(1) Structure and components of heating device (Fig. 10-12)

The heating device of chang'an truck is a type of water heating. It heats the air using cooling water of engine and sends the heated air into the truck by blower. Heating device is composed of control lever, blower motor, heater core, air pipes, etc.

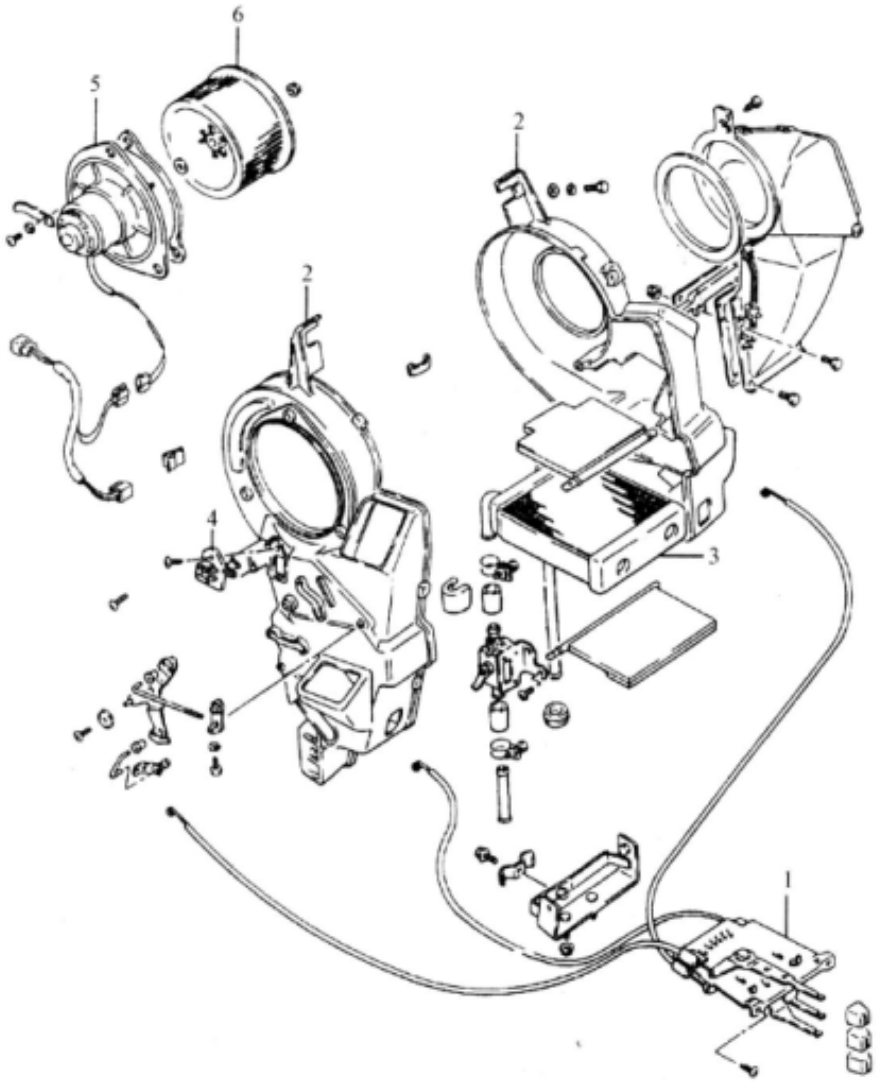
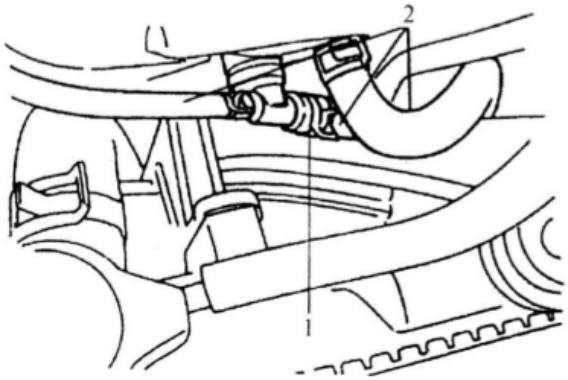


Fig. 10-12 Components of heating device

1-control lever assembly; 2-heater assembly; 3-heater core; 4-resistor; 5-blower motor; 6-blower

(1) Disassembly of heating device

1) Disconnect the negative pole wire of battery, drain engine cooling solution and remove heating hose on heating device (Fig. 10-13);



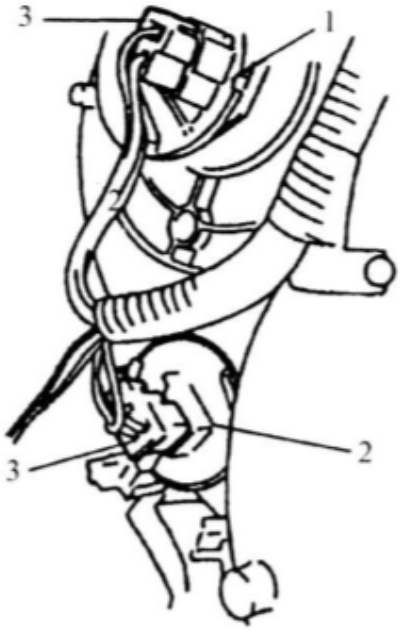


Fig. 10-13 Disassembly of heating hose

1-clamp; 2-hose

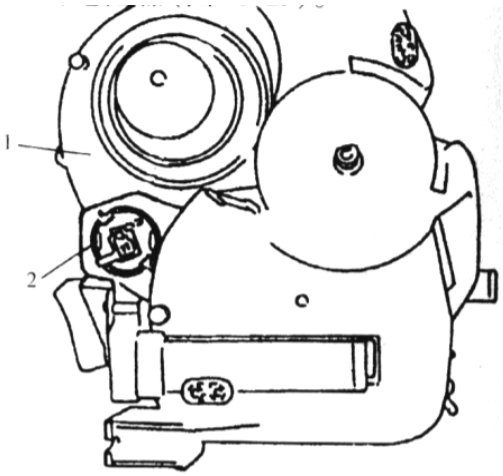
Fig. 10-14 Disassembly of plug connector

1-blower motor; 2-resistor; 3-plug connector

2) Disconnect the plug connector of blower motor and resistor (Fig. 10-14);

3) Remove resistor of blower motor of heater (Fig. 10-15);

4) Remove heater inlet pipe and then remove heating device from the vehicle (Fig. 10-16);



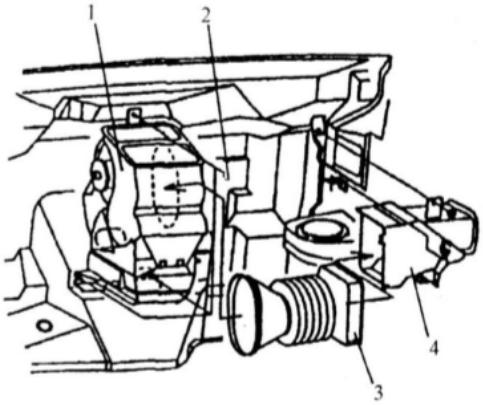


Fig. 10-15 Disassembly of resistor

1-heater; 2-resistor

Fig. 10-16 Disassembly of heater

1-heater; 2-nut; 3-heater inlet pipe; 4-inlet box

5) Pull heater core out from heating device (Fig. 10-17);

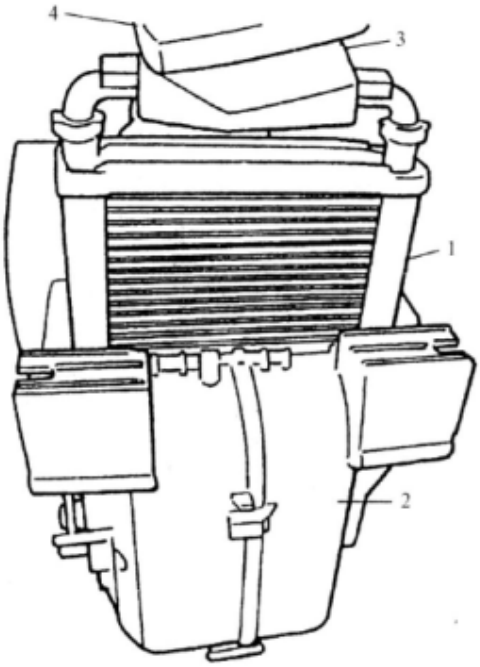


Fig. 10-17 Disassembly of heater core

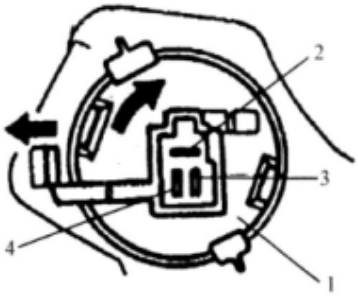
1-heater core; 2-heater case; 3-support; 4-pad

(1) Repair of heating device

1) Check resistor for crack or damage; if any defect, replace it. Measure resistance between terminals; if the measured value is not correct, replace the resistor (Fig. 10-18);

Resistances between terminals:	H-M	3Ω
	H-L	10Ω
	M-L	4Ω

2) Check the continuity condition of blower motor switch circuit using multimeter (Fig. 10-19).



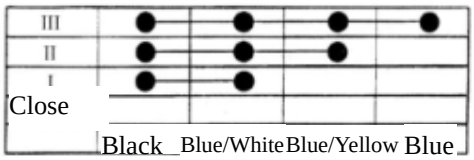
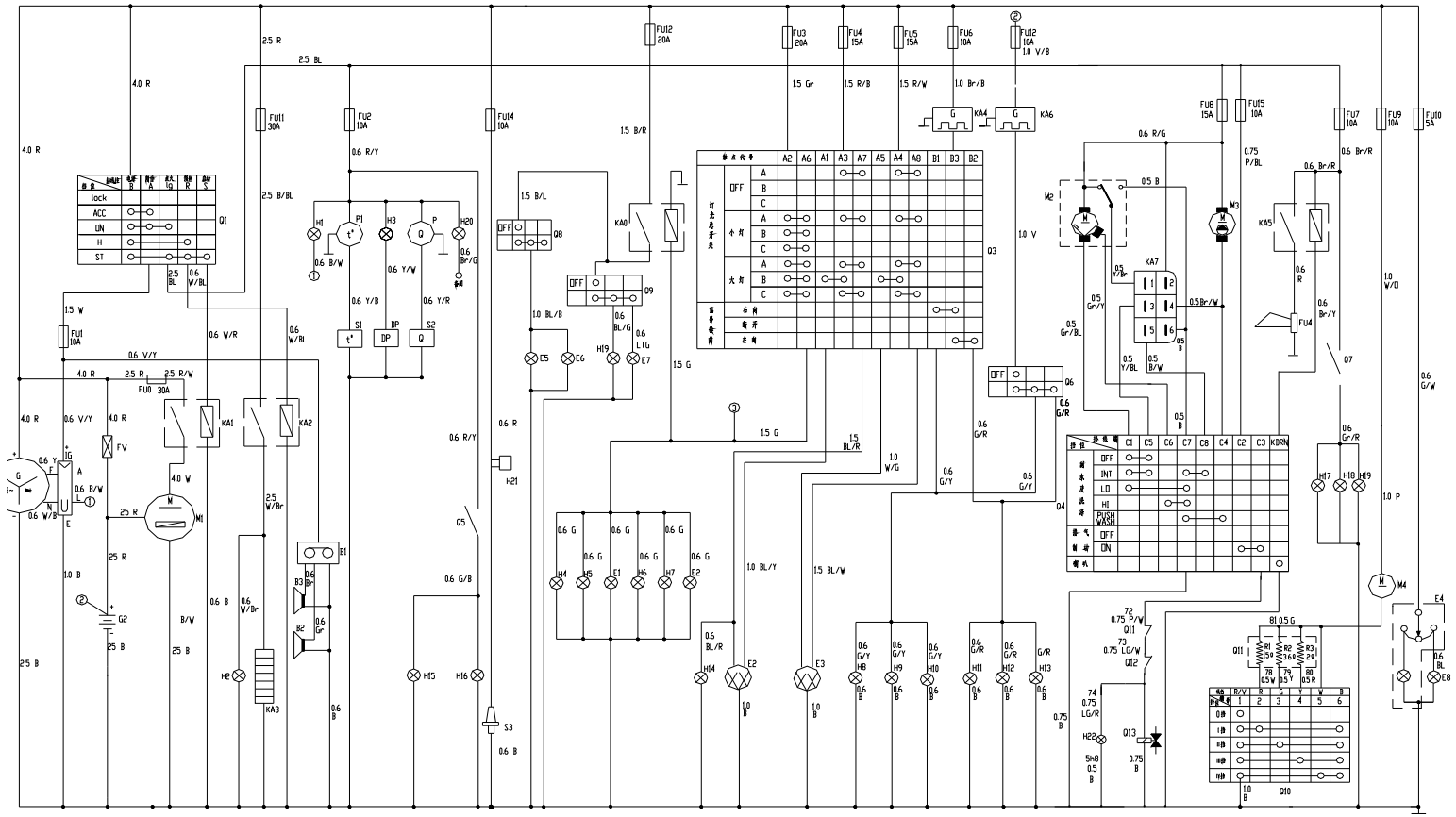


Fig. 10-18 Measurement of resistor Fig. 10-19 Check of blower switch

1-resistor; 2-M terminal; 3-H terminal; 4- L terminal

Annex One: Electrical diagram of KY6 truck

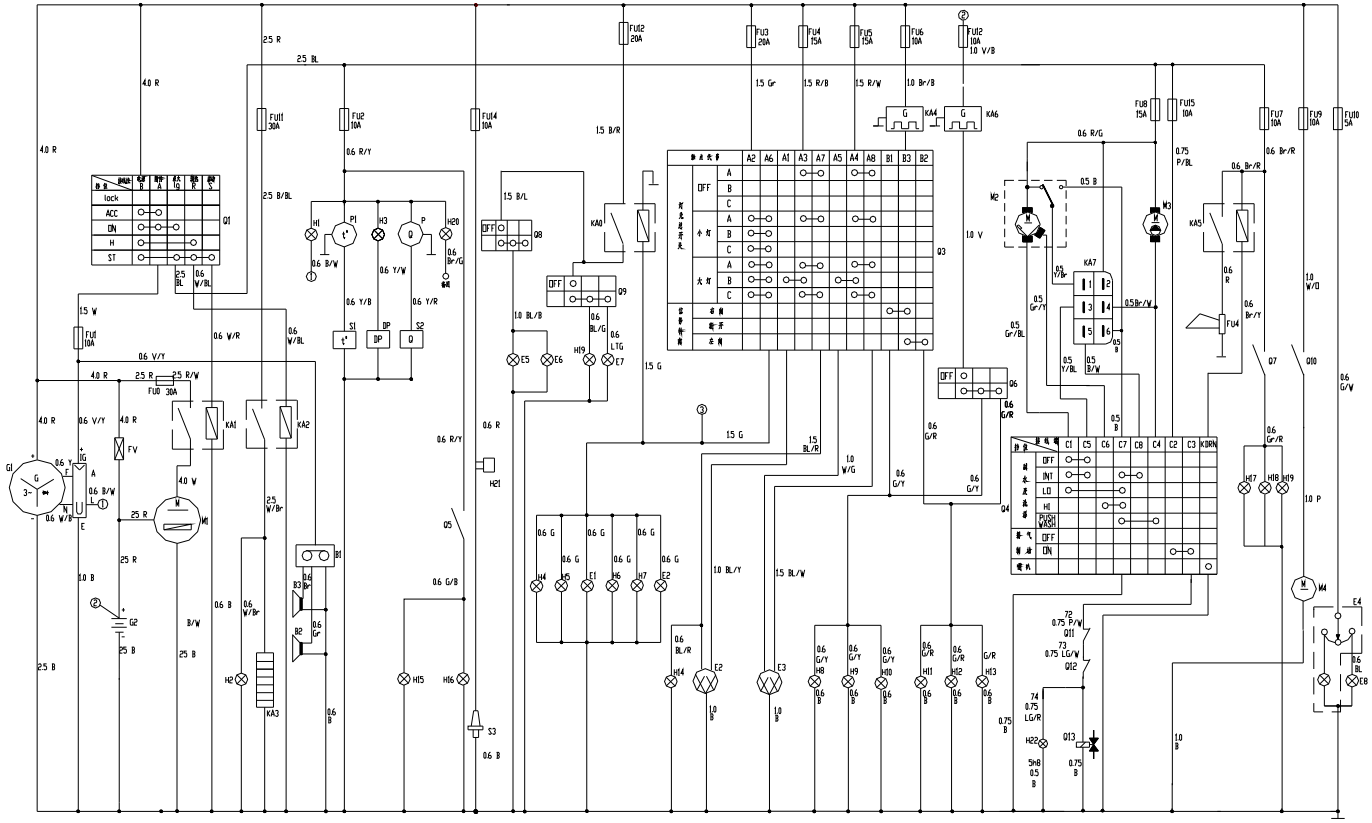


电线颜色	棕	白	红	橙	黄	绿	蓝	灰	紫	黑	粉	Sb	LTG
代 号	B	W	R	G	Y	Br	BL	Gr	V	O	P	Sb	LTG

编 号	G1	Q1	KA0	FV	M1	H1	B1	B2	B3	KA2	KA3	H2	P1	S1	H3	DP	P	Q11	Q12
名 称	发电机	点火开关	紧急继电器	喇叭蜂鸣器	前轮驱动电机	电压调节器	自复灯	左前护栏	右前护栏	喇叭继电器	喇叭器	喇叭按钮	左报警	左报警保险器	机油指示灯	机油压力报警器	机油表	转向开关	闪灯开关
编 号	S2	H4	H5	E1	H6	H7	E2	KA4	Q3	H8	H9	H10	H11	H12	H13	H14	E2	E3	B4
名 称	高油表报警器	左前小灯	右前小灯	前照灯	左后小灯	右后小灯	仪表照明灯	闪光器	灯光组合开关	右前转向灯	左前转向灯	左后转向灯	右后转向灯	左前照灯	右前照灯	电喇叭	喇叭继电器	制动电机	气压表
编 号	M3	Q4	E4	Q5	H15-H16	Q6	Q7	H17-H18	H19	Q8	E5-E6	Q9	E7	H19	Q10	M4	KA6	H20	E8
名 称	洗涤电机	洗涤器电磁分开关	喇叭	喇叭开关	制动灯开关	应急灯开关	转向灯开关	转向指示灯	转向指示灯	前雾灯开关	前雾灯	后雾灯	后雾灯指示灯	喇叭风机组合开关	喇叭风机	洗涤灯泡	洗涤灯继电器	电机灯	报警器

编 号	S3	H21	H22	FU0-FU15
名 称	报警气压表	气压报警器	气压报警器	报警器

Annex Two: Electrical diagram of light truck



					电瓶颜色	黑	白	红	橙	黄	绿	蓝	灰	棕	粉	P	Sb	LTG					
					R 导	B	W	R	G	Y	Br	BL	Gr	V	橙	粉红	天蓝	浅蓝					
电 子	G1	Q1	KA0	Q10	FV	A	G2	KA1	M1	H1	B1	B2	B3	KA2	KA3	H2	P1	S1	H3	DP	P	Q11	Q12
元 器	发电机	点火开关	前照灯继电器	前照灯开关	自动稳压器	电压调节器	蓄电池	远光继电器	雨刷电机	远光指示灯	电喇叭继电器	电喇叭	左前转向灯	右前转向灯	雨刷继电器	雨刷器	雨刷电机开关	远光开关	远光指示灯	远光变光继电器	雨刷器	左前转向	右前转向
电 子	S2	H4	H5	E1	H6	H7	E2	KA4	Q3	H8	H9	H10	H11	H12	H13	H14	E3	E2	E3	B4	KA5	M2	Q13	KA7
元 器	雨刷电机开关	左前小灯	右前小灯	蜂鸣器	左后小灯	右后小灯	左后转向灯	闪光器	闪光器开关	左前转向灯	右前转向灯	右后转向灯	左后转向灯	左后转向灯	右后转向灯	右后转向灯	左前灯	右前灯	电喇叭	喇叭继电器	喇叭开关	气压控制器	雨刷间歇控制器
电 子	M3	Q4	E4	Q5	H15-H16	Q6	Q7	H17-H18	H19	Q8	E5-E6	Q9	E7	H19	M4	KA6	H20	E8	S3	H21	H22	FU0-FU15	
元 器	雨刷电机	雨刷间歇控制器	雨刷电机继电器	制动灯开关	制动灯	左后灯开关	右后灯开关	制动灯	制动器开关	倒车灯开关	倒车灯	倒车灯开关	后雾灯	后雾灯指示灯	暖风机	左后灯继电器	电喇叭	倒车灯开关	电喇叭	气压指示器	气压控制器	熔断器	