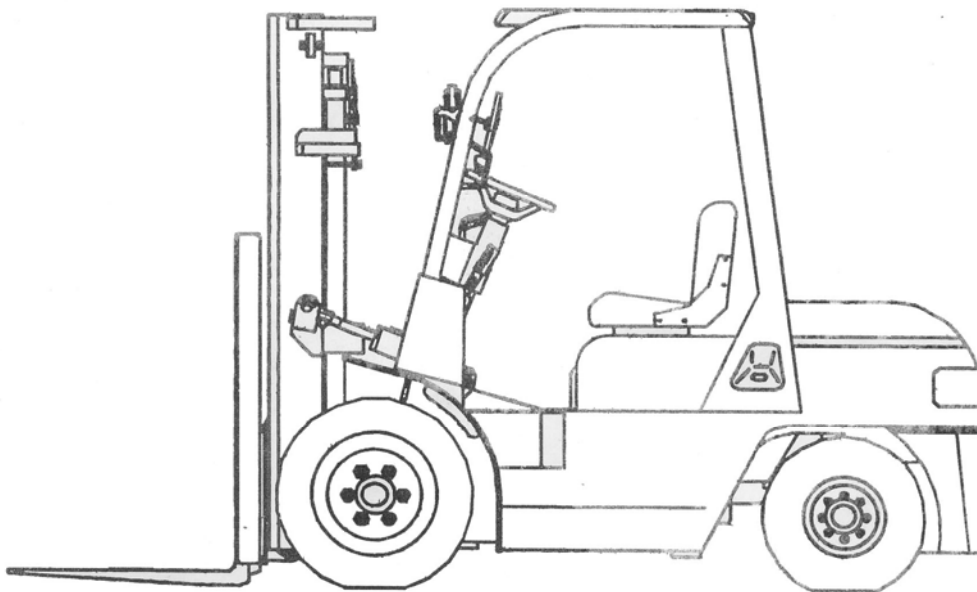


SHANGLI

CPCD 80

CPCD 100 Hydraulic-drive Diesel Forklift

Operation & Service Manual



Shanghai Shangli Forklift Co., Ltd.

Foreword

The instrument mainly specifies the contents about relevant performance, structure, operation and maintenance for 8Ton and 10Ton forklift, so that forklift operators may understand the forklift, use and maintain properly.

Related operators and equipment supervisors shall carefully follow the requirements and regulations of forklift described in the book in use for keeping good technical condition of forklift always.

Because forklifts are constantly improved and modified, the instruction content is subject to the practicality of forklifts. Sorry for inconvenience.

Shanghai Shangli Forklift Co., Ltd.
2004

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I Safety Regulations for Driving and Operating Forklift

- I Forklift operators and supervisors must have “safety foremost” in their mind, safely and normatively operate forklift following Use & Maintenance Instruction of Forklift.

II Transport of Forklift

The followings shall be noted while transporting forklifts by trunk.

1. Brake parking brake;
2. Mast and bob-weight shall be fixed by steel wires fore-and-aft: corresponding positions of front and rear tyres shall be padded with wedge blocks firmly;
3. Lift according to the marked position of “lifting nameplate”.

III Storage of Forklift

1. Discharge fuel completely (coolant shall not be discharged if it is anti-rust and antifreeze liquid);
2. Coat anti-rust grease on the non-painted parts, lift chains for coating grease;
3. Lower the mast to the lowest position;
4. Brake parking brake;
5. Front and rear tyres shall be padded by wedge blocks.

IV Preparation before Use

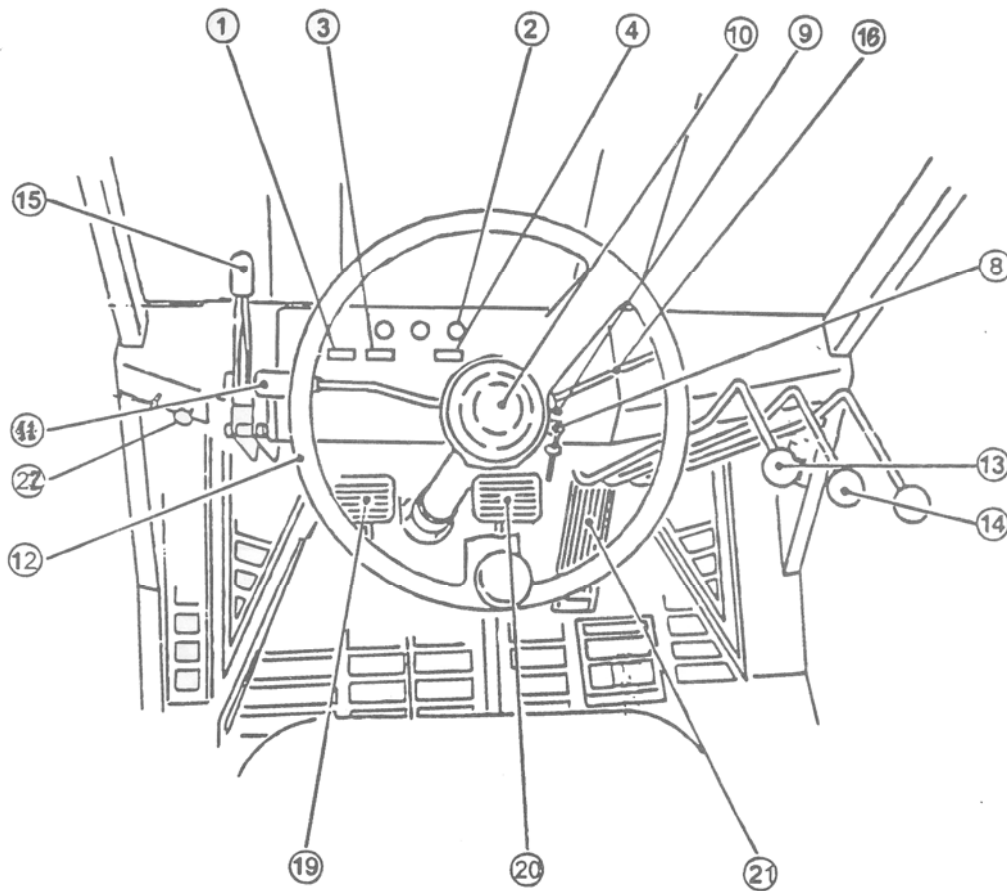
1. Do not check fuel, oil leakage, oil level and electric instruments at open-fire place , do not fill in fuel while running;
2. Check tyre pressure;
3. Forward and reverse handle shall be in neutral position (Zero position);
4. Do not smoke while the fuel system is working and checking battery;
5. Check the conditions of handles and pedals;
6. Well prepare before starting up;
7. Release parking brake;
8. Trial mast lifting, lowering, forward and backward tilt, turning and braking.

V Operation of Forklift

1. Driver shall not operate the forklift until he is trained and got license;
2. Operators shall wear safety protection used shoes, cap, clothes and gloves while operation;
3. Check control and warning devices before operation, repair is required before operation if damage or defect is found;
4. Load shall not exceed the required value, fork shall insert under the goods fully and goods shall be evenly placed on the fork while transport. Forking goods with single fork tip is not allowed.
5. Starting, turning, driving, braking and stopping shall be smoothly made. Speed down is required while turning direction on the wet or smooth road;

6. Goods shall be lowered and mast shall be tilted backward as much as possible while running with load;
7. Carefully drive on the slope, forward running is required upgrade and backward running is required downgrade as running on the slope more than 1/10. Do not turn direction upgrade and downgrade. Loading and unloading operation is not permitted while the forklift is running downgrade;
8. Pay attention to foot passengers, obstacles and chuckholes on the road while driving. Clearance above forklift shall be noted as well;
9. People shall not stand on the fork, the forklift shall not carry people;
10. People shall not stand or walk beneath the fork;
11. Do not operate the forklift and accessorial tools in the position except the driver's seat;
12. Pay attention to goods falling while using the forklift the high lift of which over 3 meters. Countermeasure shall be taken if necessary;
13. Mast shall be tilted backward as much as possible while the high lift forklift is working. Loading and unloading operation shall be carried within the minimum range with forward tilting;
14. Great care and slowly driving are required when the forklift is running on dock or temporary plank;
15. Driver shall not stay in the forklift and the engine shall be stopped as filling fuel. Do not ignite while checking battery or oil level;
16. Forklift with accessorial tools shall be deemed as loaded forklift when it is running unloaded;
17. Do not transport unfixed or loose goods, transport large goods with care;
18. Fork shall be lower to ground, shift shall be in neutral position and engine shall be stopped or switched off while leaving the forklift. The parking brake shall be used while parking on a slope, wheels shall be padded with wedges if parking long time;
19. Do not open the water tank cover when the engine is hot;
20. Pressure of multi-way valve and safety valve of forklift shall be well adjusted before ex-factory. Optional adjustment is not required in use to prevent the whole hydraulic system and hydraulic components damage due to pressure over high;
21. Inflation pressure of tyre shall follow the pressure value described on the nameplate of "tyre pressure";
22. Maximum noise value outside the forklift shall be no more than 89dB (A), test method: JB/T3300;
23. Well knowing and noting various functions of the forklift.

VI Diagram for Forklift Instruments and Control Arrangement



- | | |
|---------------------------|--------------------------------|
| 1 Fuel meter | 13 Lifting handle |
| 2 Indicator lamp | 14 Tilting handle |
| 3 Water temperature gauge | 15 Parking brake handle |
| 4 Timer | 16 Forward and backward handle |
| 8 Ignition switch | 19 Inching pedal |
| 9 Lamp switch | 20 Braking pedal |
| 10 Horn button | 21 Accelerator pedal |
| 11 Turning lamp switch | 22 Chock cable |
| 12 Steering wheel | |

VII Daily Maintenance of Forklift

1. Startup description

- 1) Hydraulic oil level: oil level shall be in the middle position of oil level gauge scale.
- 2) Check pipes, joints, pumps and valves whether leakage or damage;
- 3) Check driving brake;
 - a) Empty travel of braking pedal shall be 40mm;
 - b) Clearance between front base plate and pedal shall be more than 20mm.
- 4) Check the hand brake function: the forklift shall brake on the 20% slope (unload) when the hand brake is pulled to the bottom.
- 5) Instruments and lights: check instruments, lighting, connections, switches and electrical lines whether work normally.

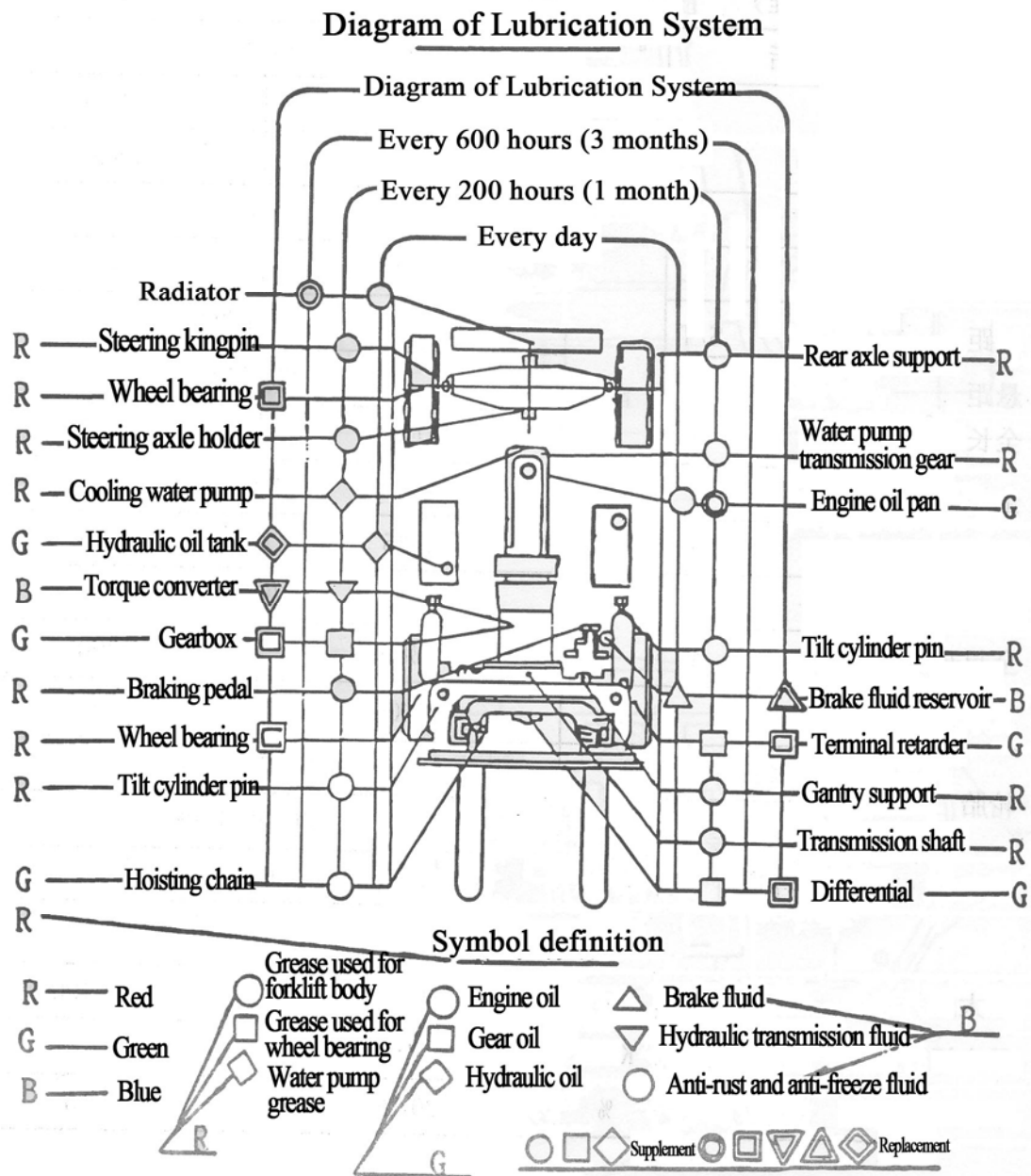
2. Fuel, grease and coolant used for forklift:

Name	Trademark/ code (domestic)	Trademark/ code (foreign)
Diesel	Selection according to Use and Maintenance Instruction of Diesel Engine or light diesel of Gb252-81: Winter: -10 ~ 35#, summer: 0#	JISK2204, 2# (general area)
		JISK2204, 3# (cold area)
Grease	Selection according to Use and Maintenance Instruction of Engine (or select CC30# diesel engine grease)	SAE10W (winter)
		SAE30 (summer)
Hydraulic oil	N32# or N46#	ISOVG30
Hydraulic transmission oil	8# transmission oil	SAE10w
Gear oil	85W/ 90	SAE90/ SAE80w
Grease	3# Lithium Base Grease dropping point 170	JISK-2220, 1#, 2#
Coolant	FD-2-35oC long-term effect antirust coolant	

3. Use notes for cooling system

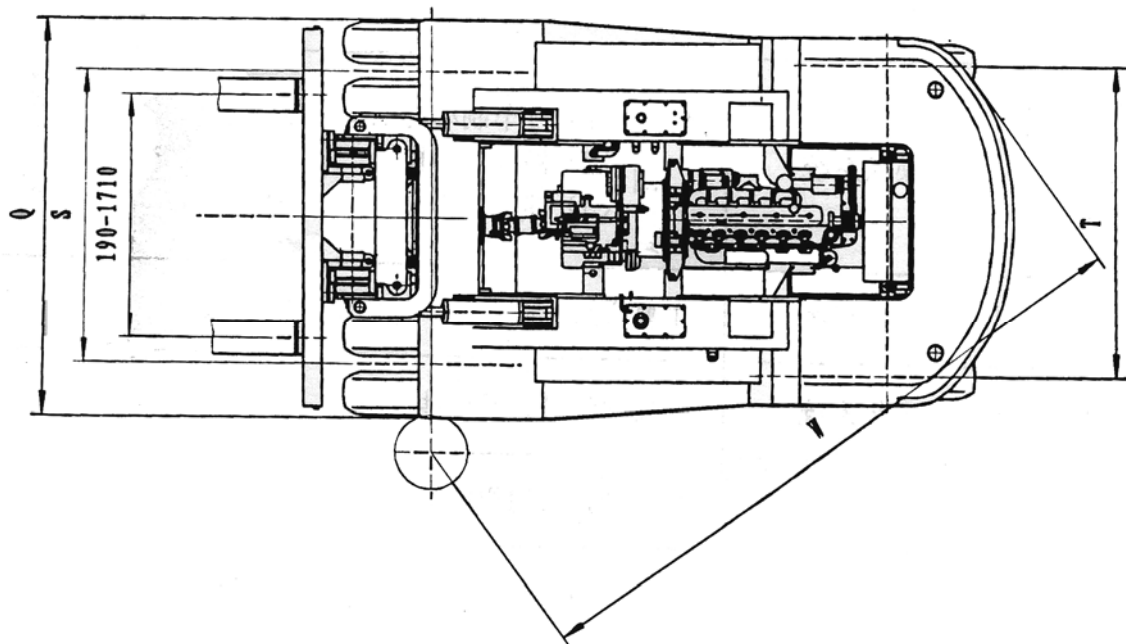
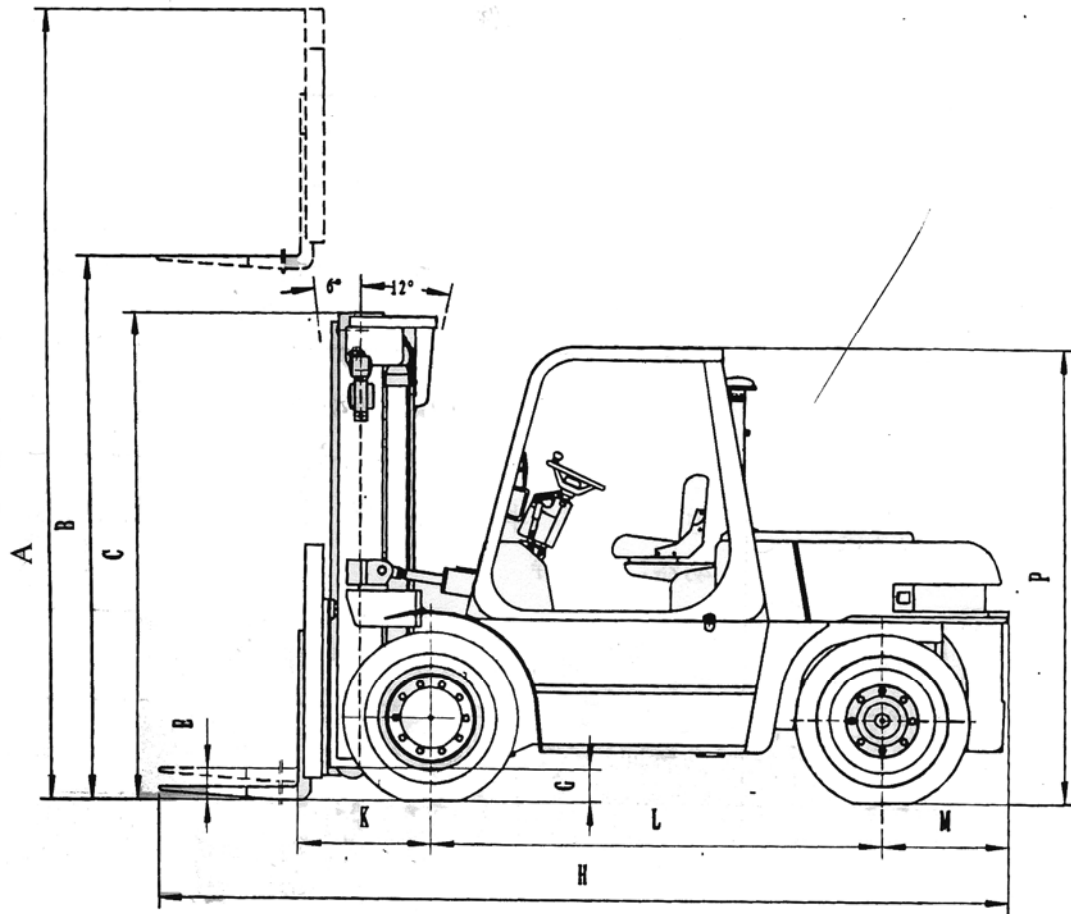
- 1) In use of forklift, if the radiator is boiling or the coolant temperature is too high, do not open the radiator cover immediately. If the cover must be opened for finding boiling reason, the engine speed shall be down to medium speed, then slowly turn the radiator cover, remove the cover after a while to prevent the injury from coolant jetting and splashing. The cover must be tightened properly. Otherwise, required pressure system shall not be established.
- 2) According to different working condition, dirt on the radiator outer surface shall be cleaned regularly. It may use cleaner, compressed air or high pressure water (pressure $\leq 4\text{kg/cm}^2$) either.

4. Diagram of lubrication system



II. Main Technical Parameters of Forklift

Lift Weight of Forklift				8t	10t
Parameter					
Rated life weight			kg	8000	10000
Load centre distance			mm	600	
Maximum lift height (normative) B				3000	
Free lift height (normative) E				200	210
Mast inclination falling front/ rear			° / °	6/22	
Minimum turning radius W			mm	3700	3900
Minimum right angle aisle width X				3310	3540
Minimum ground clearance G				250	
Track L				2500	2800
Wheel base front/ rear S/T				1600/1700	
Fork overhang front/ rear K/M				725/700	
Full length H				5125	5425
Full width Q				2165	
Total height	Mast C			2735	2885
	Overhead guard P			2530	
Total height of fully lift A				4380	4300
Forklift dead weight			kg	12000	13100
Tyre	Front wheel 2X2			9.00-20-16PR	
	Rear wheel 2X1			9.00-20-16PR	
Battery voltage/ capacity			V/Ah	24/135	
Maximum lift speed load/ unload			Mm/s	400/500	320/400
Maximum running speed load/unload			Km/h	26/30	
Max. climbing capacity load/unload			%	20/20	20/15



III Introduction for Main Parts of Forklift

Main parts of forklift are shown in the table below:

SN	Name	Content
1	Power system	Mainly including engine installation, fuel, exhaust and cooling (including oil cooling of torque converter) systems, etc.
2	Transmission system	Mainly including torque converter, gearbox, transmission shaft and transmission control
3	Drive axle	Mainly including axle housing, axle shaft, differential, wheel retarder, brake and front wheels, etc.
4	Steering system	Mainly including steering wheel, full hydraulic redirector
5	Steering axle	Including steering axle, steering oil tank and rear wheels
6	Lifting system	Mainly including mast, fork, fork bracket, goods baffle, tilt cylinder, lift cylinder, lifting chain, mast chain gear and roller, etc.
7	Body system	Mainly including body frame, instrument frame, internal-combustion engine housing, water tank cover, counterweight, base plate and seat, etc.
8	Control system	Including: (1) Driving brake and inching control (2) Parking brake control (3) Accelerator control
9	Hydraulic system	Mainly including pump, valve, high and low pressure oil pipe, joints
10	Electric system	Mainly including lights, battery, instruments, wiring harness, etc.
11	Overhead guard	Overhead guard, (driver's cabin is optional)

IV Structure, Principle, Adjustment & Maintenance of Forklift

1. Power System

1.1 General

Power system mainly includes engine installation, fuel system, cooling system and exhaust system. The engine is mounted on the frame with rubber cushion to reduce vibration. Engine, torque converter, transmission shaft of gearbox and driving axle are integrated, see Fig 1.1 as below:

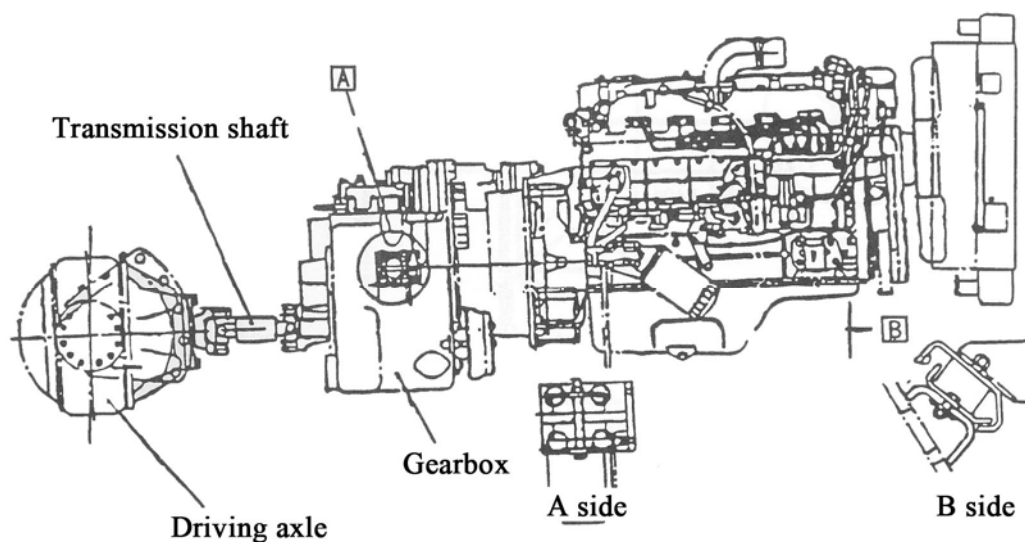


Fig 1.1 Diagram of Engine Installation

1.2 Engine Configuration

Currently, 8-10t forklift is equipped with home-made Dongfeng Chaoyang 6120BG diesel engine. According to various demands, it may be mounted with other type diesel engine in the future. Main performance, parameters and structure of engine are shown in Use Instruction of Engine.

1.3 Fuel System

Fuel system consists of fuel tank, filter and fuel sensor.

1.3.1 Fuel Tank

Fuel tank is welded structure, which is integrated in the left side of the frame, with fuel tank cover in the upper part. The fuel sensor is mounted on the cover, see Fig 1.2.

1.3.2 Fuel Sensor

Function of fuel sensor is to transform the left oil amount to electric current through up and down movement of floater, then reflect it in the fuel meter of the dashboard, so people may directly know how much oil left in the fuel tank, see Fig 1.3.

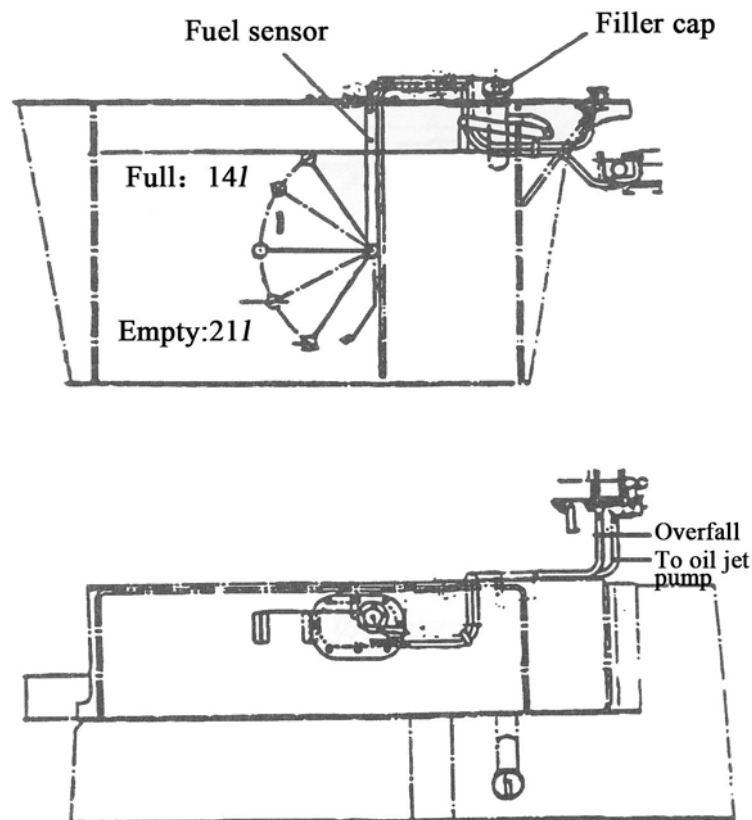


Fig 1.2 Fuel Tank

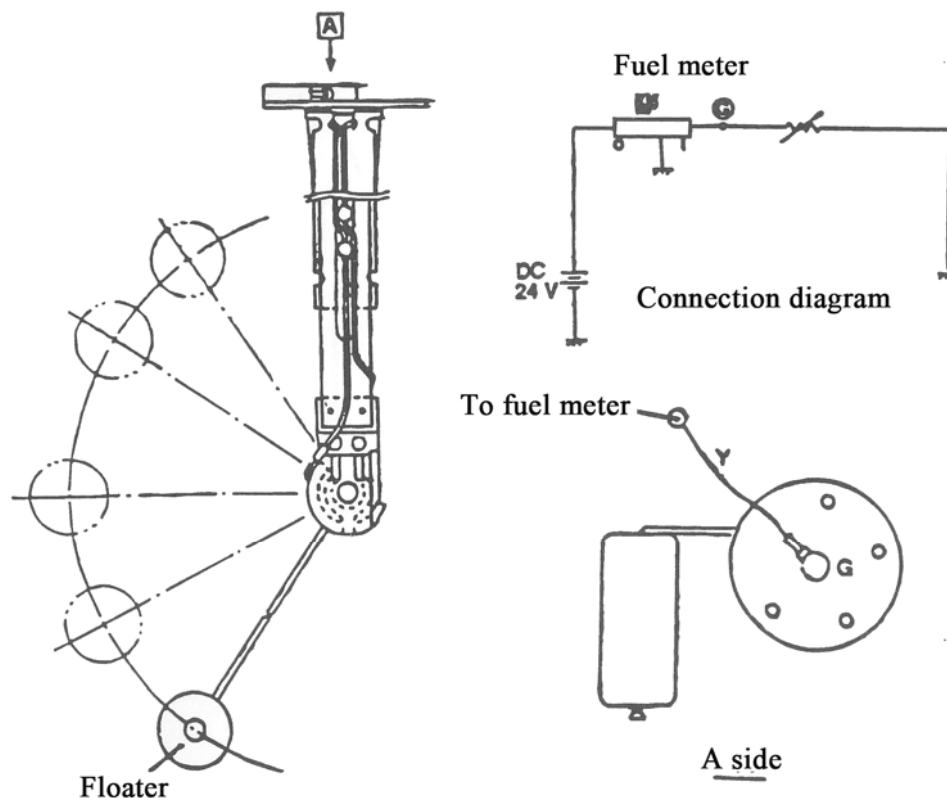


Fig 1.3 Fuel Sensor

1.3.3 Fuel Filter

Fuel filter is mounted on the oil inlet manifold of engine and used for filtering the fuel supplied to the engine. There is a bypass valve, which may feed oil to the engine in case of filter blocked.

1.4 Cooling System

Cooling system consists of water pump, fan and water tank. The pump is mounted on the engine. The crankshaft drives the water pump to work through V-shaped rubber strip.

1.5 Inspection and Adjustment

In order to keep good working condition of engine, the engine shall be inspected and adjusted regularly. Main points are as below:

1.5.1 Air Filter (see Fig 1.4)

- (1) Take out the filter;
- (2) Check the dirt and damage condition of filter, use low pressure air to blow from inside to outside first for cleaning. The filter shall be replaced if it is seriously blocked or damaged;
- (3) Clean up the dirt inside the cover.

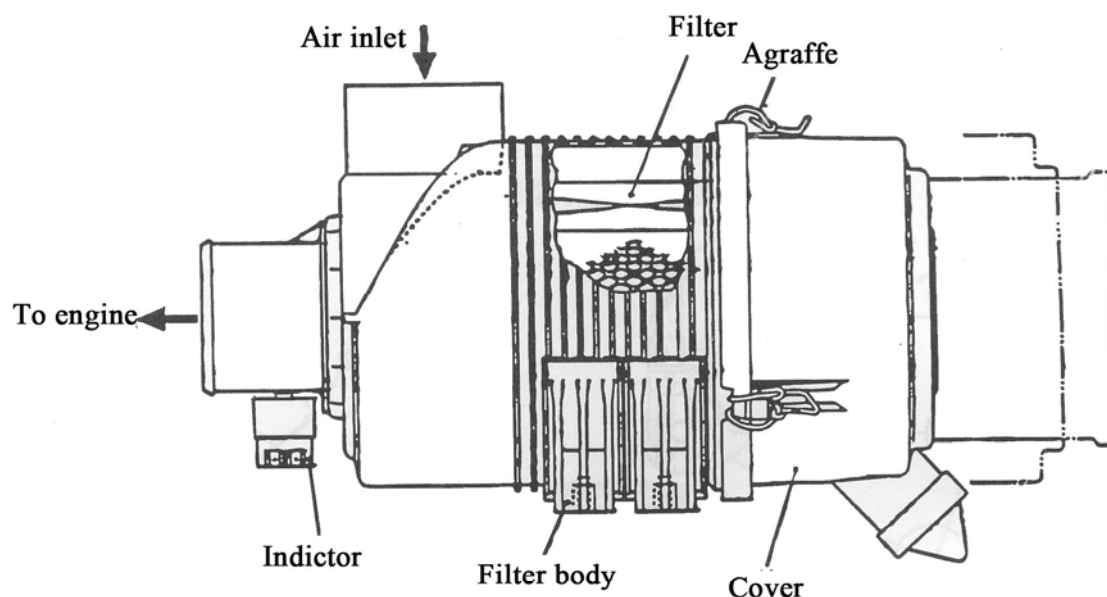


Fig 1.4 Air Filter

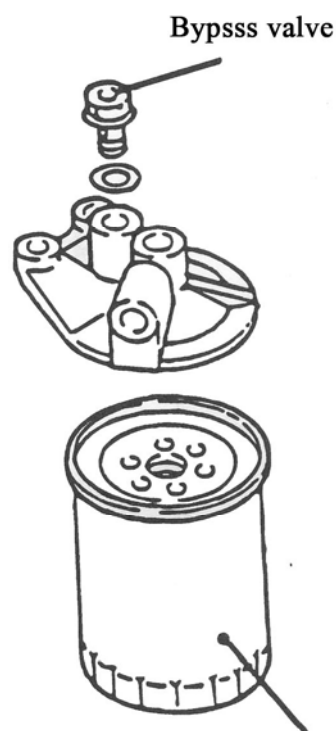


Fig 1.5 Block-in filter

1.5.2 Fuel Filter (see Fig 1.5)

- (1) Remove the filter with special filter wrench, replace it if damaged or blocked.
- (2) Add several drops of grease along the new filter seal ring, then mount it, tighten it 2/3 circle when the seal ring contacts the filter body.

1.5.3 Engine Oil Filter (see Fig 1.6)

- (1) Remove the filter with special filter wrench and replace it.
- (2) Add several drops of grease along the new filter seal ring, then mount it, tighten it 2/3 circle when the seal ring contacts the filter body.

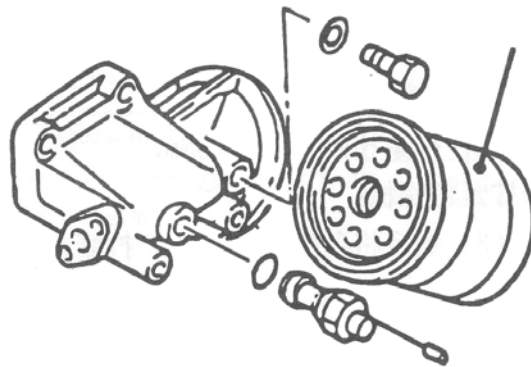


Fig 1.6

1.5.4 Cooling System

(1) Replace coolant

- A. Stop the engine at least for half hour, open the water tank cover after cooling and loosen the water discharge valve under the water tank;
- B. Loosen the engine discharge valve and discharge the coolant completely;
- C. Tighten the above two valves after discharge.

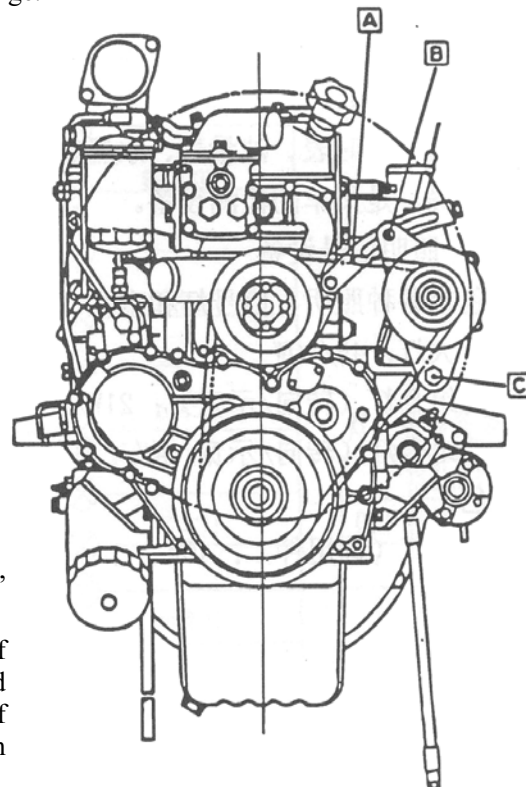


Fig 1.7

(2) Adjusting fan belt

The fan belt shall be tensioned if it is loose, see Fig 1.7.

Step: Loosen the mounting bolts B and C of generator, outward move the generator and press the belt at A by finger with a force of 10kg, its flexibility is about 10mm, then tighten bolts B and C in turn.

1.5.5 Tightening of engine cylinder head bolts

- (1) According to the order shown in Fig 1.8, tighten the engine cylinder head bolts with 68Nm torque one by one;
- (2) Increase the tightening torque to 93Nm and tighten the bolts one by one;
- (3) Then turn the bolts 90°, and screw down.

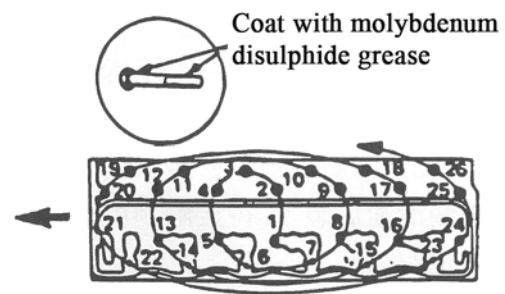


Fig 1.8

2. Electric System

2.1 General

Electric system is cathode earthed single wire circuit, it is like the nerve system of forklift. The system mainly contains the following systems (see Fig 2.1 for Diagram of Electric Principle):

1) Charging system

It contains generator, battery and charging indicator lamp and supplies power for electric equipment of forklift, voltage: DC24V.

2) Starting system

It contains starting switch, starting protection circuit and starter, etc. and is used for starting engine.

3) Stop control system

It mainly includes chock cable and so on.

4) Instrument system

It mainly includes engine hour meter, fuel meter, water temperature gauge and charging indicator lamp, oil pressure indicator lamp, neutral indicator lamp, braking oil pressure, warning lamp and so on. It is the check and inspection equipment of forklift.

5) Lighting and signal equipment

It includes various lights, signal lights, horn and buzzer and so on.

Front headlight: 45/40W

Front combination light (turn signal lamp/ width lamp): 21W/8W

Rear combination light (turn signal/ width/ reverse/ brake lamps): 21W (yellow)/ 8W (yellow)/ 10W (white) /21W (red)

Rear headlight (optional): 45W

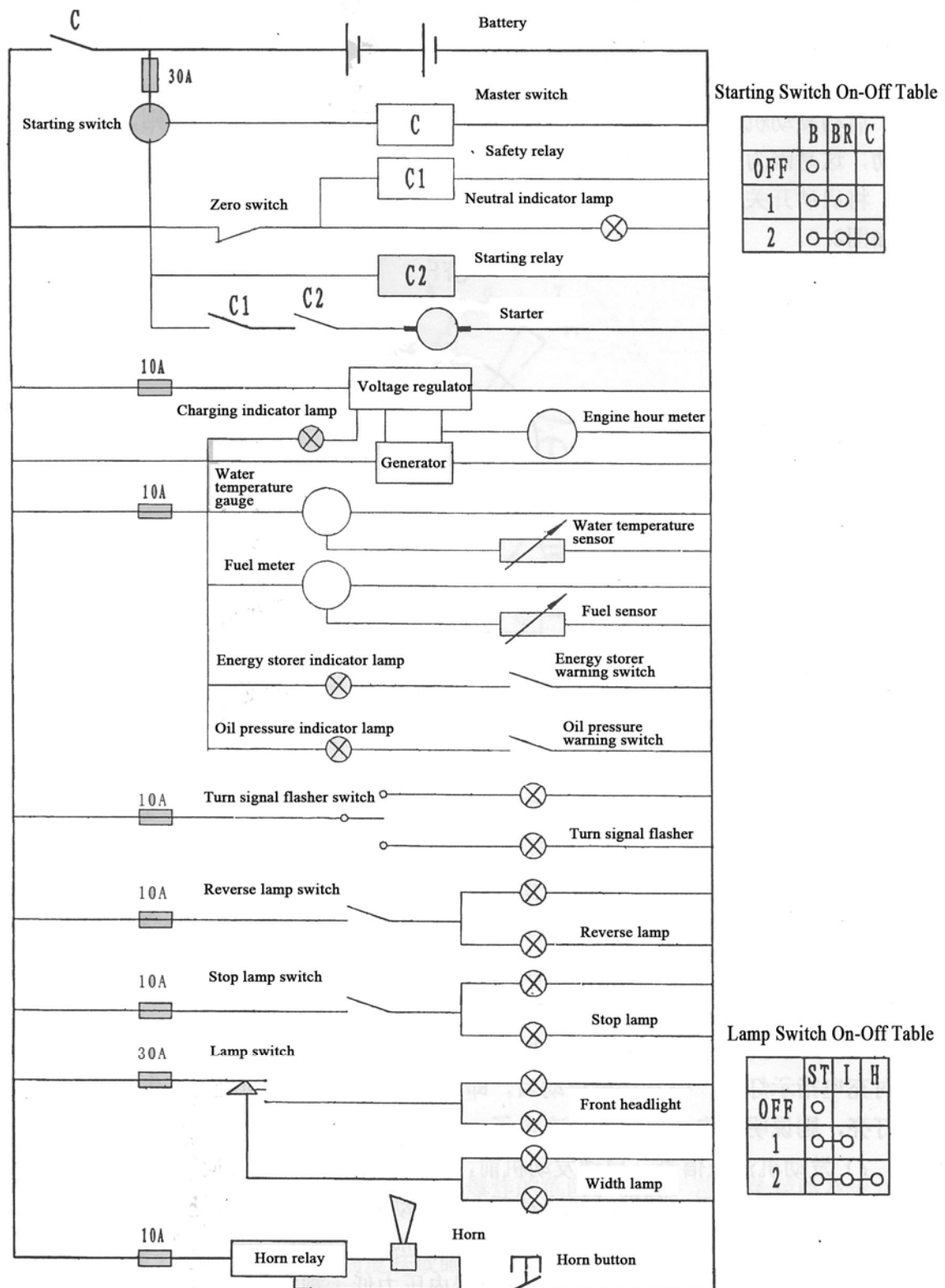


Fig 2.1 Electric Principle

2.2 Brief Instruction for Operation

1) Starting

Before starting engine, transmission lever shall be placed at zero position (neutral indicator lamp on). Otherwise the engine will not be started, because the starting protection circuit has been designed the safety starting protection function for forklift.

Clockwise turn the starting switch to Position 1 (electrifying), the power supply of instrument system shall be switched on. Positions of starting switch are shown in Fig 2.2 as below.

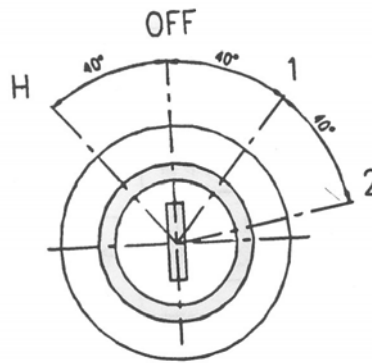


Fig 2.2 Diagram of Starting Switch Position

Clockwise turn the starting switch to Position 2 (starting) and start the engine.

Push forward the transmission lever after engine started, namely the forward position. Increase the accelerator and the forklift shall run or work in rapid speed. If pull the transmission lever backward, the reverse shift, the reverse lamp shall be on and the reverse buzzer is buzzing.

- 2) Light switch: pull to Position 1, front and rear width lamps shall be on, pull to Position 2, front headlight shall be on and the width lamps are still on.
- 3) Turn signal: backward pull the turn signal flasher switch, the turn signal lamps of front combination lights and rear combination lights at the left side of forklift shall be flashing. Forward push the turn signal light switch, the turn signal lamps of front combination lights and rear combination lights at the right side of forklift shall be flashing.
- 4) Stop signal: step the braking pedal when stopping the forklift, braking lamp (red) of rear combination lights shall be on.
- 5) Reverse signal: backward pull the transmission lever when reverse the forklift. The gearbox shall be at reverse position and the reverse lamp (white) of rear combination lights shall be on, the reverse buzzer is buzzing.
- 6) No-charging signal indicator: before starting the engine, clockwise turn the starting switch to Position 1 (electrifying), the charging indicator lamp is on. After the engine started, it will be off automatically. If the lamp is on while the engine is working, which means the charging circuit fails and no charge any more, the engine shall be stopped for check.
- 7) Engine oil pressure signal: before starting engine, clockwise turn the starting switch to Position 1 (electrifying), the oil pressure lamp will be on and it will be off automatically after the engine started. If the lamp is on while the engine is working, which means the engine oil pressure is too low to lubricate well, the engine shall be stopped for check.
- 8) Automatic energy storer pressure signal: the pressure signal lamp will be on if the inside pressure of automatic energy storer is lower than required value. It will be off automatically when the pressure reaches to required value.
- 9) Fuel meter: it indicates the remained amount of fuel in the fuel tank.

- 10) Water temperature gauge: it indicates the temperature of engine coolant.
- 11) Engine hour meter: it indicates the accumulated working hours of engine.

See Fig 2.3 for Diagram of Instruments.

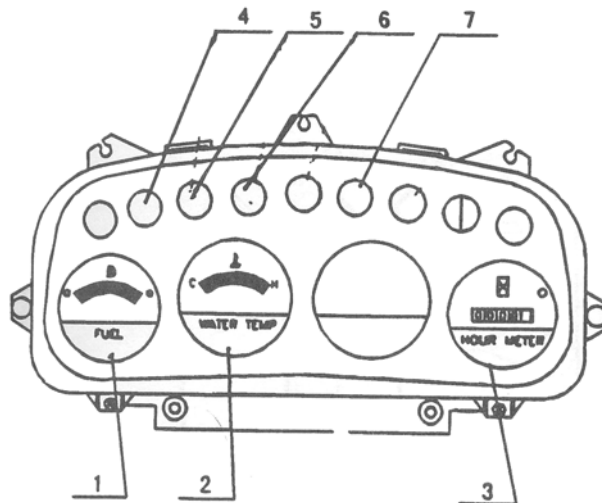


Fig 2.3 Combination Instruments

1. Fuel meter 2. Water temperature gauge 3. Engine hour meter 4. Charging indicator lamp
5. Engine oil indicator lamp 6. Pressure indicator lamp of brake energy storer
7. Neutral position indicator lamp

2.3 Battery

▲! Notes for battery use:

- (1) Battery may produce flammable gas and has explosive risk. Therefore, the occurrence of short circuit and spark shall be prevented and no smoke and fire.
- (2) The electrolyte is dilute vitriol, it is very dangerous if it contacts with eyes or skin (burn or ablepsia). It shall use clean water to wash immediately if the electrolyte contacts with skin. It shall use clean water to wash and see doctor in time if the electrolyte splashes in eyes.

2.4 Wiring harness

See Fig 2.4 -2.8 for wiring harnesses.

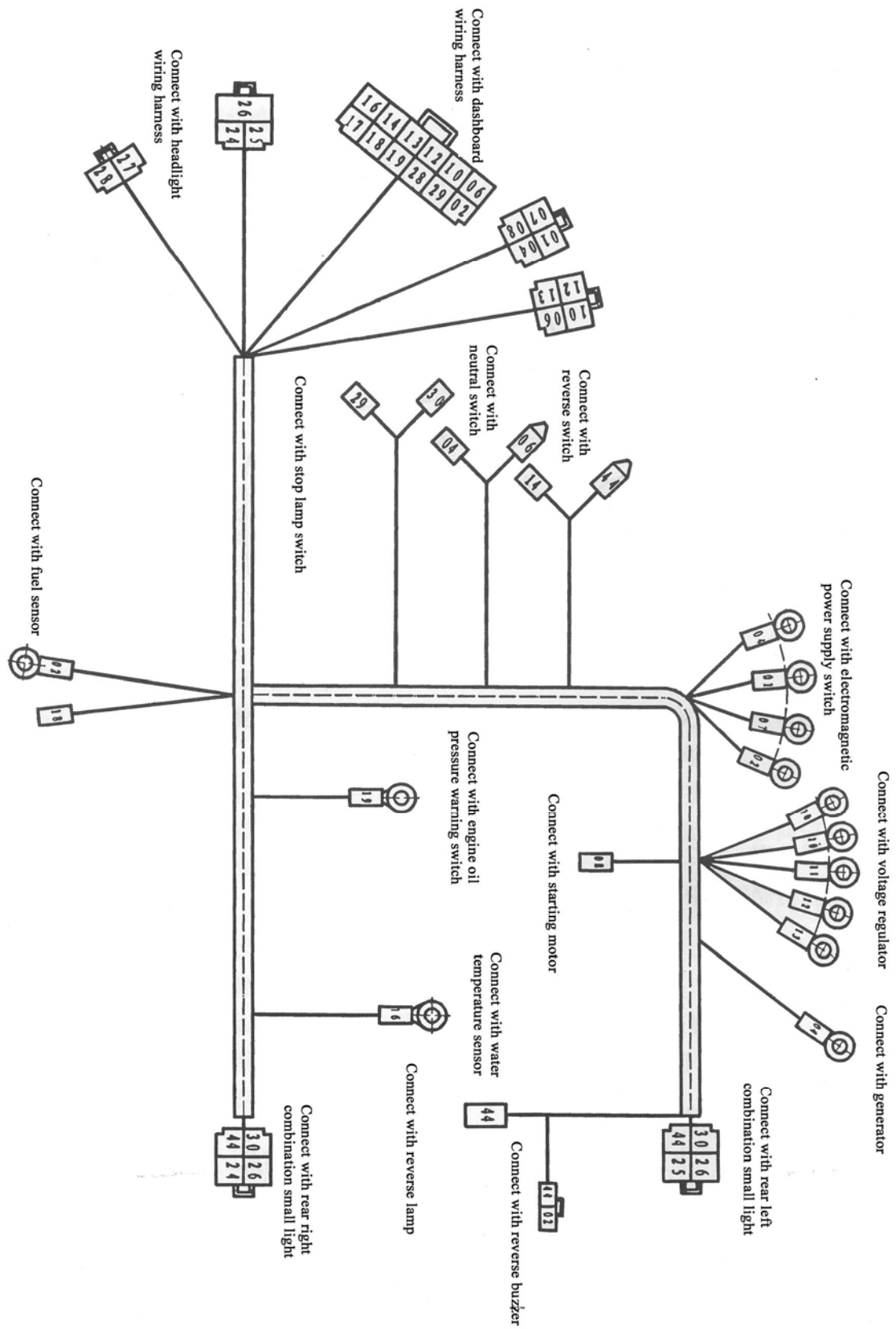


Fig 2.4 Bus Bar Diagram

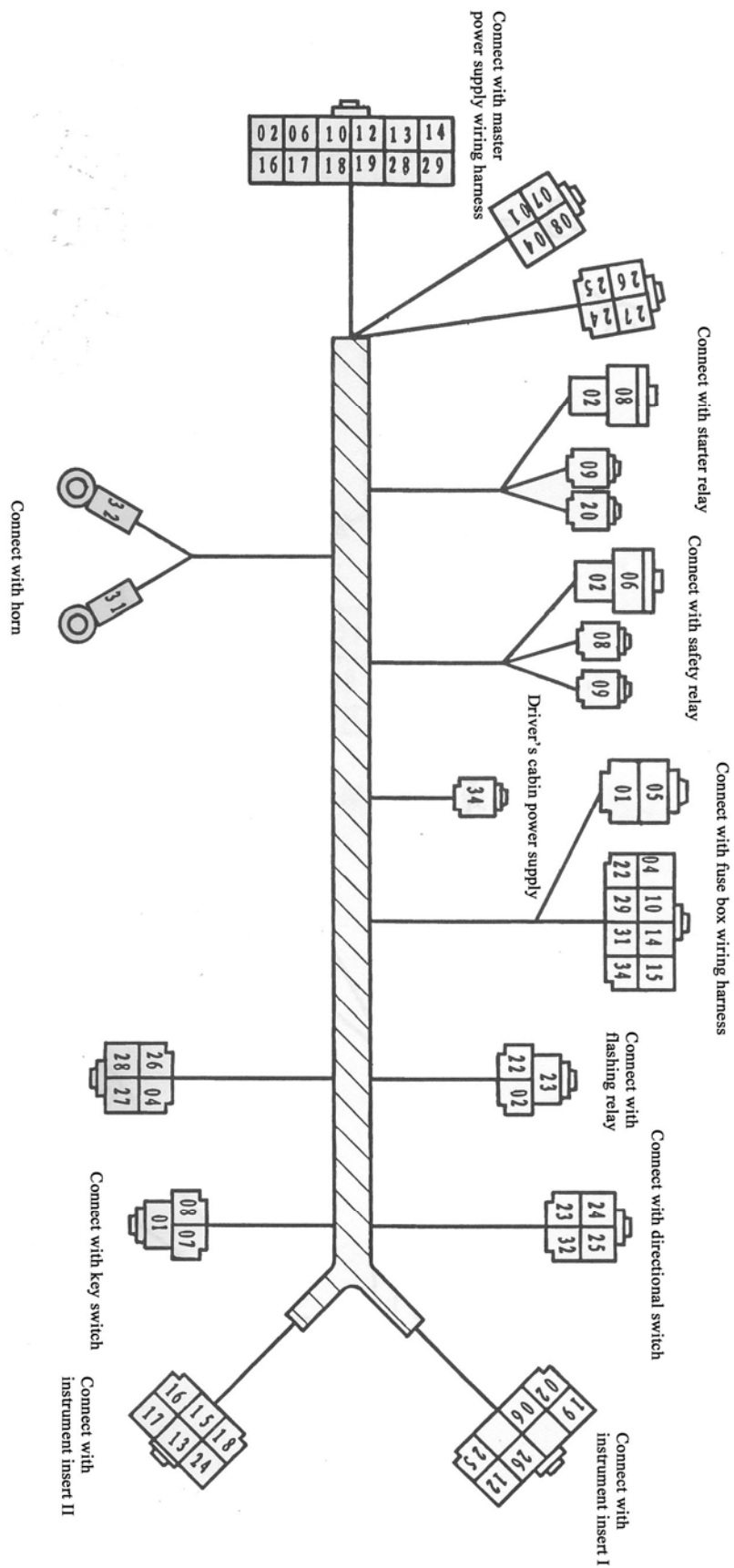


Fig 2.5 Diagram of Instrument Wiring Harness

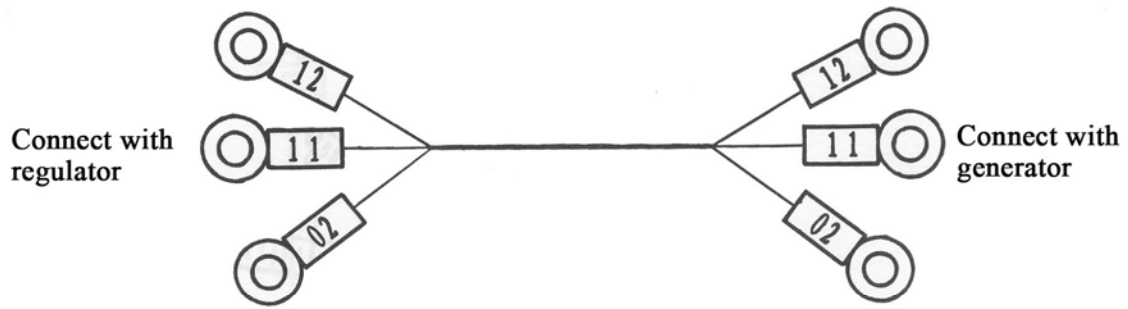


Fig 2.6 Generator Wiring Harness

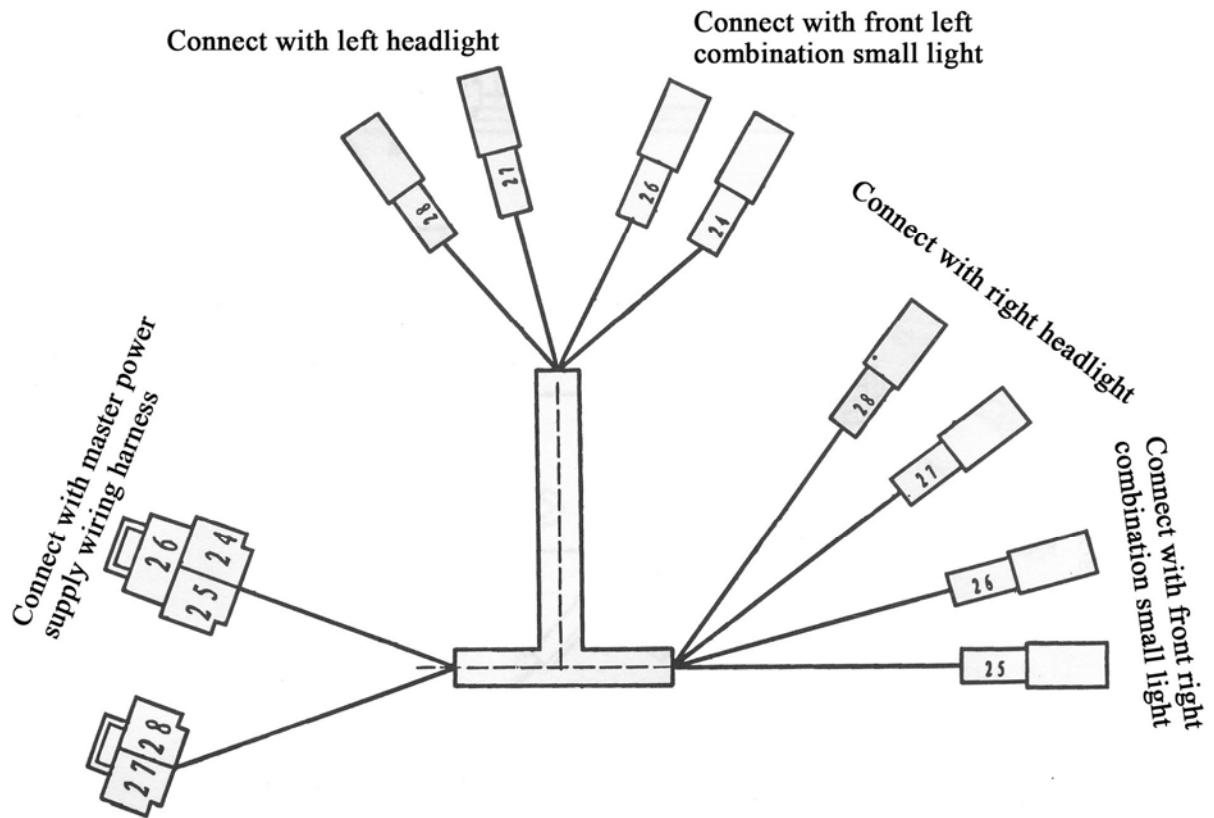


Fig 2.7 Headlight Wiring Harness

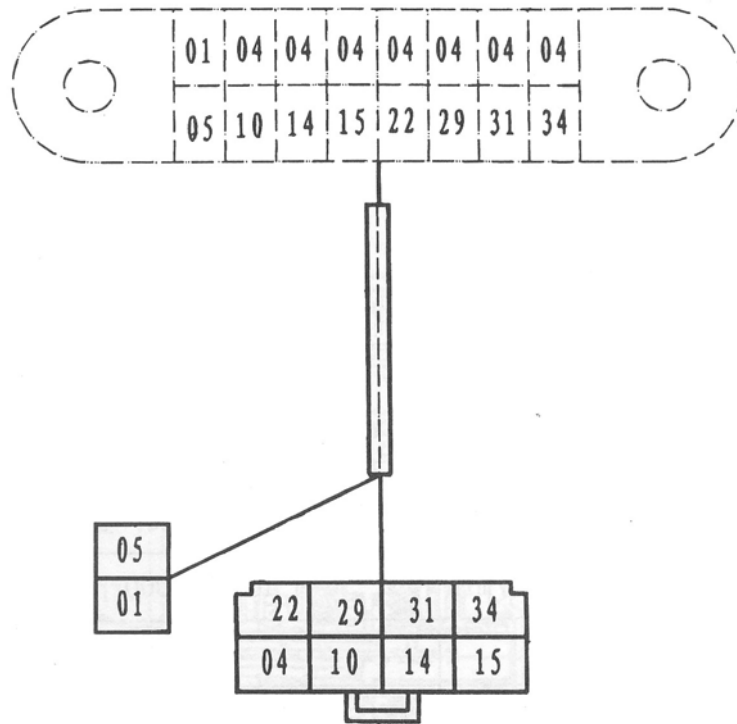


Fig 2.8 Fuse Box Wiring Harness

3. Transmission device

Transmission device mainly contains torque converter and gearbox two parts.

See Table 3.1 for main parameters; see Fig 3.1 for transmission device structure.

Table 3.1

Item			Unit	Structural Property, parameter
Torque converter	Model			Three-component, single pole, two phase
	Circulatory circle diameter/torque ratio			12.5” (Φ315)/ 3.1
	Setting oil feed pressure		Mpa	0.5 ~ 0.7
Oil feed pump	Model			Internal meshing gear pump: gearbox power output
	Flow		l/min	40 (at 2000rpm, 2Mpa)
Gearbox	Model			Power shift
	Shift number			2 shifts for front and rear
	Speed ratio (front and rear the same)			I:1.621/ II:0.526
	Hydraulic clutch	Friction disc	mm	Outer Φ134/ inner Φ90/ thickness 2.8
		Friction surface area	cm ²	77.4
		Setting pressure	Mpa	1.2 ~ 1.5
Mass			kg	About 295
Oil volume			l	About 20
Oil code				8# hydraulic transmission oil

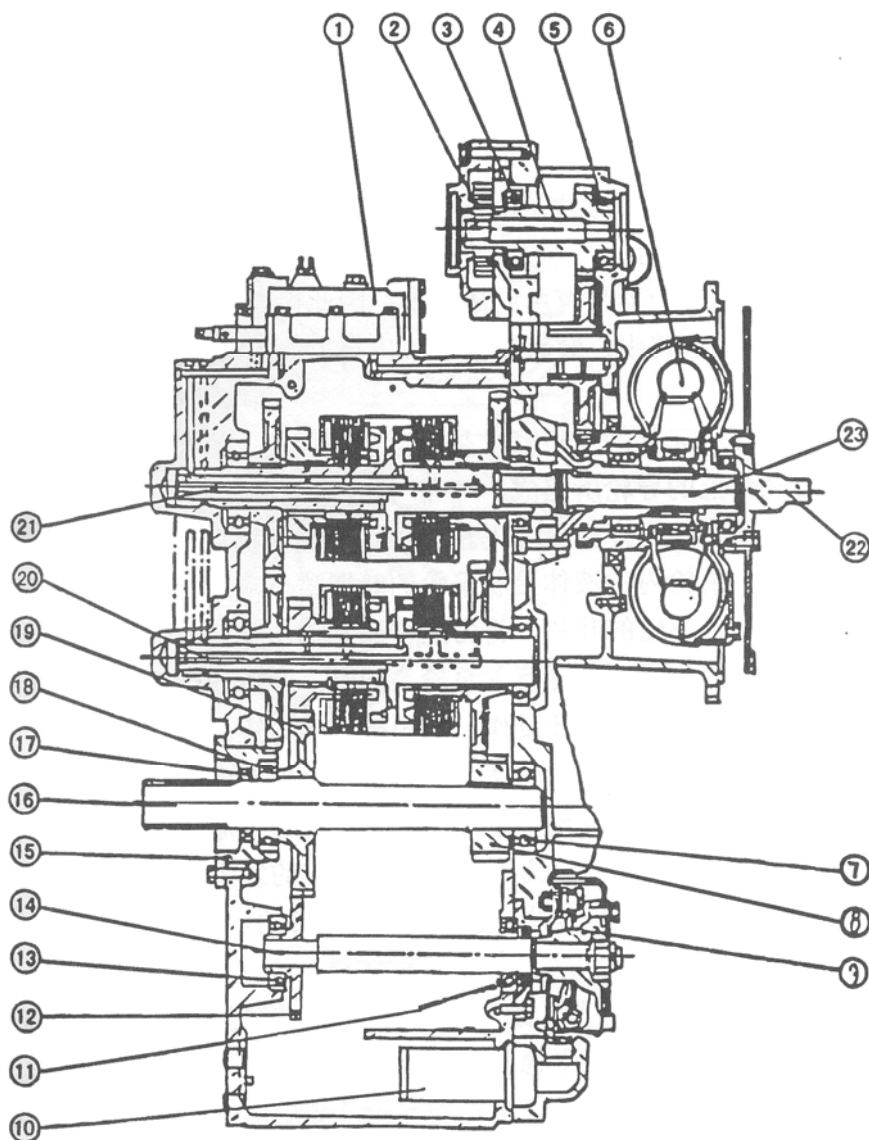


Fig 3.1 Hydraulic Gearbox

- | | | |
|---------------------|-------------------|---------------------------------|
| 1. Control valve | 9. Parking brake | 17. Oil seal |
| 2. Oil feed pump | 10. Oil filter | 18. Ball bearing |
| 3. Ball bearing | 11. Oil seal | 19. Gear |
| 4. Shaft | 12. Gear | 20. Reverse clutch unit |
| 5. Ball bearing | 13. Ball bearing | 21. Forward clutch unit |
| 6. Torque converter | 14. Shaft | 22. Elastic plate (input plate) |
| 7. Ball bearing | 15. Bearing cover | 23. Gearbox input shaft |
| 8. Gear | 16. Output shaft | |

3.1 General

The hydraulic gearbox of the forklift consists of torque converter and power shift gearbox, which has the following characteristics:

- (1) Equipped with inching valve, which improves inching function. Therefore, the forklift may keep inching function when it is starting or operating in any rotation speed.
- (2) Friction disc of hydraulic clutch is composed of 7 steel discs and 7 copper-based discs with special treatment, so it has better durability.
- (3) Torque converter has single-way clutch, which improves the transmission effect.
- (4) There is an oil filter in the torque converter oil way, which increases the oil cleanness and extends the use life of torque converter.

3.2 Torque Converter

For single-pole three-component torque converter, it is usually composed of impeller that is mounted on the input shaft, turbine that is mounted on the output shaft and reactor that is fixed on the torque converter housing.

The impeller is driven by elastic plate, which is connected with fly wheel. When the engine is rotating, the impeller starts to turn, the liquid inside the impeller shall jet out along its grid (the mechanic energy is converted to hydraulic energy) due to the action of centrifugal force.

Therefore, the liquid flows in the blades of turbine and transfers the moment to the output shaft, the liquid will change under the reactor action leaving the turbine's direction, so it shall flow in the impeller in the best angle. Meanwhile, it creates a counterforce that pulls reactor, which leads to the output torque is a moment that equals the counterforce moment larger than the input torque.

When the turbine rotation increases and approaches to input rotation, the angle change of liquid flow is reducing, the output shaft torque shall decrease along with, and finally the liquid shall flow in the reactor grid right-about. Under this case, the torque on the output shaft is smaller than the one on the input shaft. In order to prevent this happened, a single-way clutch is mounted in the reactor. The reactor will rotate freely when the above counterforce acts right about. In the case, the input torque equals the output torque, so it ensures the high efficiency of work.

The torque converter changes torque transfer by mechanical method (clutch) and it acts as coupler and torque converter, so it is called two-phase, which is stable in operation and increase the efficiency.

Torque converter is mounted with single-way clutch turbine, impeller and reactor inside, and full of torque converter oil.

There is a gear that meshes with the drive gear of oil feed pump and drives the pump at the impeller top.

The turbine is connected with input shaft (gearbox) by spline, which functions on transferring power to hydraulic clutch.

See Fig 3.2 for Diagram of Torque Converter Structure.

3.3 Oil Feed Pump

See Fig 3.3 for Diagram of Oil Feed Pump Structure.

Oil feed pump is composed of drive gear, internal gear (spur gear), housing and cover, and mounted on the upper part of torque converter housing. The drive gear is driven by torque converter impeller, neutral gear and oil pump drive gear. Oil feed pump supplies the oil in the gearbox bottom to every part of the gearbox.

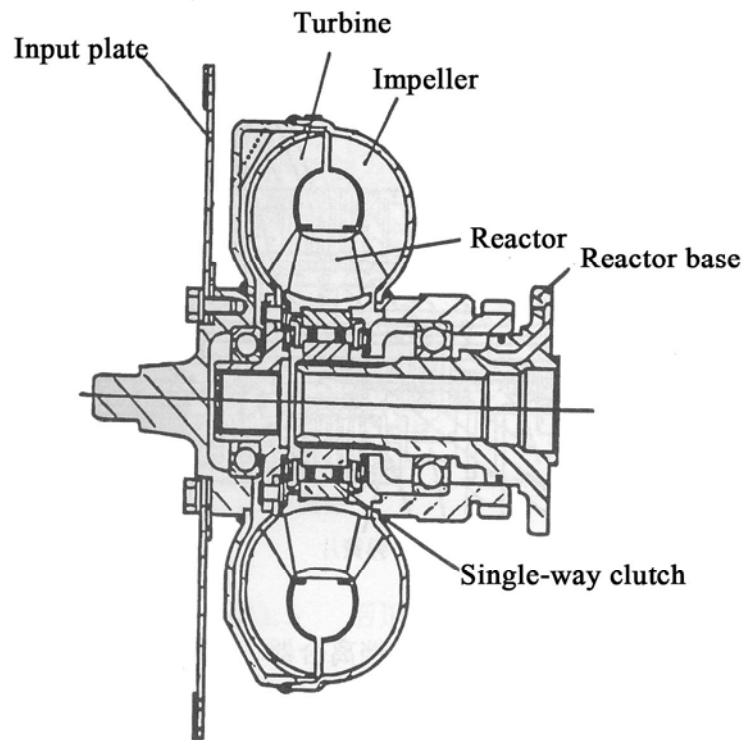


Fig 3.2 Torque Converter

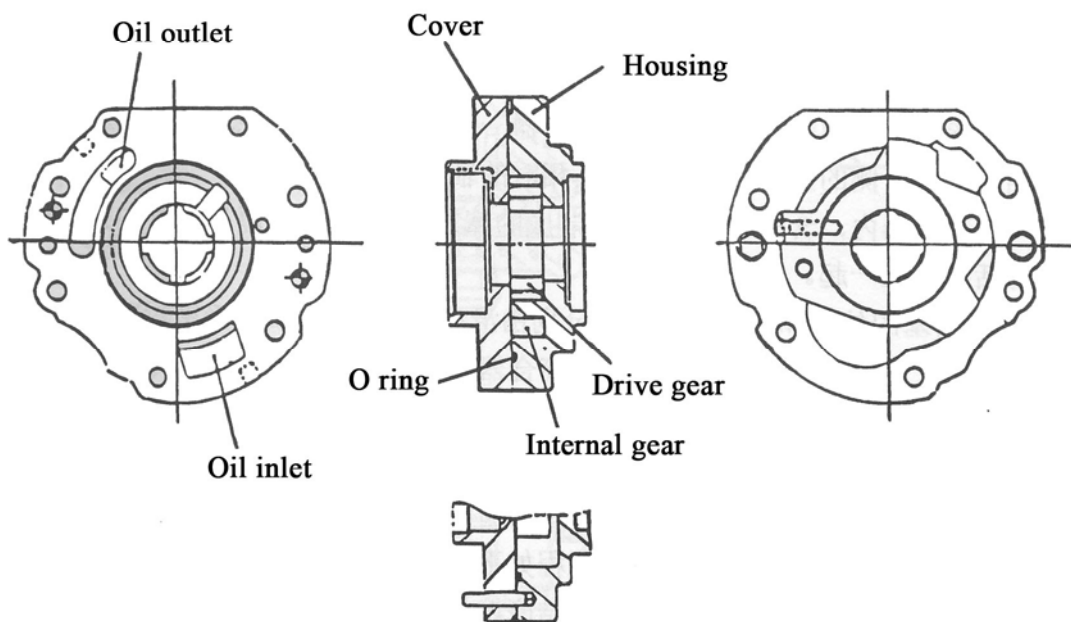


Fig 3.3 Oil Feed Pump

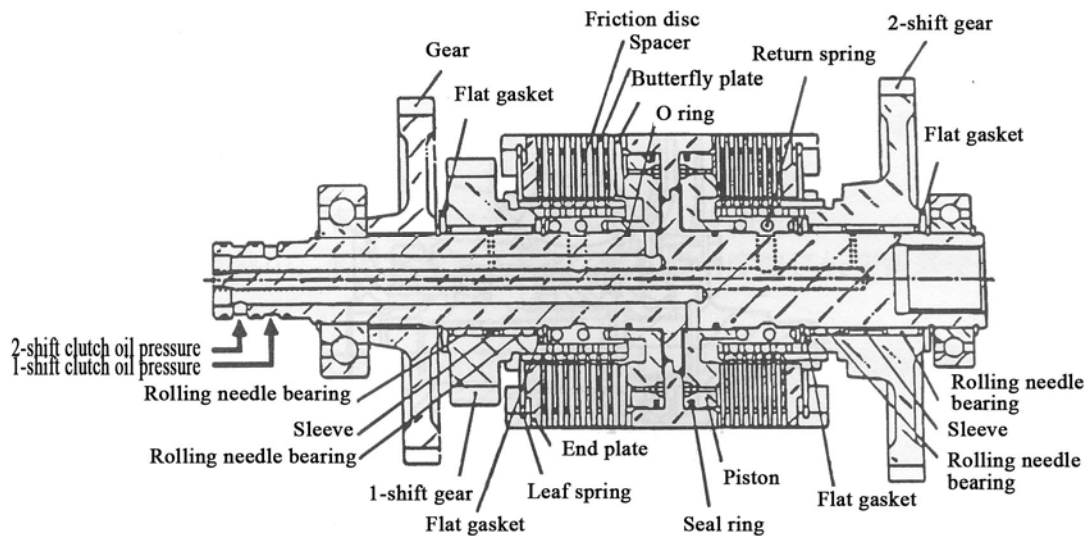


Fig 3.4 Forward Clutch

3.4 Hydraulic Clutch

See Fig 3.4 for Forward Clutch and see Fig 3.5 for Backward Clutch.

There is a hydraulic clutch mounted in the gearbox, the drive gear that is in the side of wet multi-disc clutch meshes with the corresponding spur gear. The drive gear mounted in the side of backward clutch meshes with its opposite shaft gear.

A unit of clutch includes 6 friction discs made of sintered material and 7 steel spacers. They are alternately assembled together with a piston.

The air-tightness of outer circle and inner circle of piston are guaranteed by sliding oil seal and O seal ring respectively in operation. Under non-working condition, disc-typed return spring is off the hydraulic clutch friction discs, surfaces of which are lubricated by the oil returned from the oil cooler to prevent the clutch surface adhesion and wear out.

When pressure oil acts on the piston, alternately mounted sintered friction disc and steel spacer is pressurized, so the integrated clutch unit will transfer the power from torque converter to the drive gear.

Thus, the power transfer flow of torque converter—gearbox is as below:

Turbine – input shaft – clutch drum – steel spacer – sintered friction disc – forward or backward gear – output shaft.

3.5 Control Valve and Inching Valve

See Fig 3.6 for Control Valve

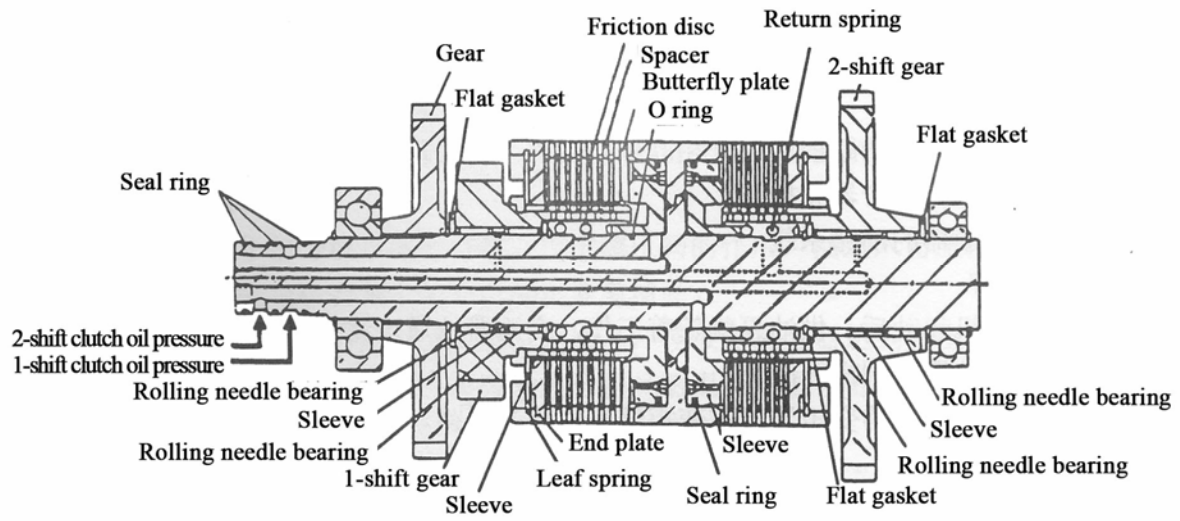


Fig 3.5 Backward Clutch

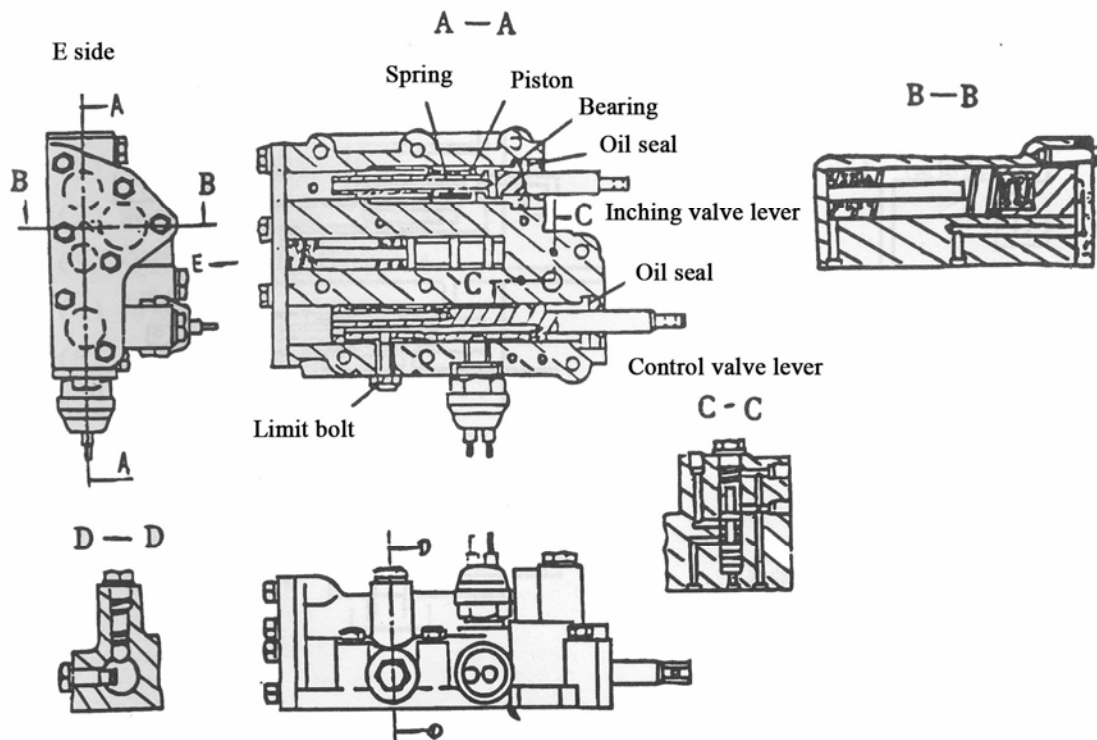


Fig 3.6 Control Valve

Control valve is mounted in the upper part of gearbox housing; shift sliding valve and inching valve are mounted inside the valve body.

Overflow valve of hydraulic clutch is used for regulating the clutch oil pressure inside the gearbox, and the overflow valve of torque converter is used for regulating the oil pressure that flows in the converter.

Inching valve lever is connected with the connection rod of inching pedal. When step down the inching pedal, the valve lever presses in. So the oil pressure of clutch is temporarily decreases and the clutch is released.

3.6 Oil Way System of Torque Converter

See Fig 3.7.

When the engine is starting, the oil feed pump begins to work with it. Torque converter oil will be pressurized in the control valve from oil reservoir (gearbox bottom) by oil feed pump.

The oil from the pump is divided into two ways in the torque converter housing, one is used for torque converter and another is used for gearbox.

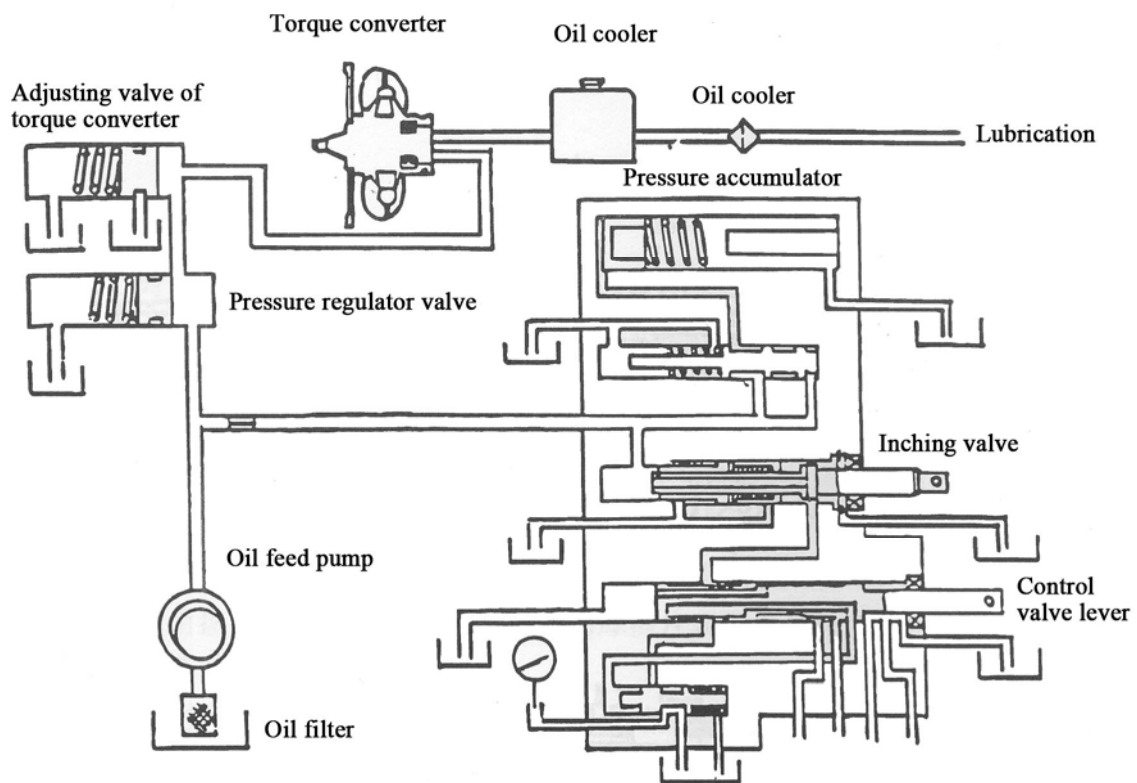


Fig 3.7 Oil Way System of Torque Converter

Oil pressure of clutch inside the gearbox may be adjusted to 1.2 -1.5MPa by its pressure regulator valve. The oil pressure of torque converter shall be adjusted to 0.5 -0.7 MPa by its adjusting valve, then the pressurized oil can reach to the converter grid. Through oil cooler, the oil is cooled down and lubricates the clutch unit, then return to oil reservoir through oil filter, and repeat the circulation.

When the shift valve lever is at the middle position (neutral), the oil way from shift sliding valve to clutch shall be shut off. Here, the liquid will flow in the torque converter fully.

When the shift valve lever is at forward or backward position, the oil enters into the pressure accumulator due to the action of pressure regulator valve. Thus, the oil pressure is gradually increasing in the period of the clutch acts to completely press together.

When the pressure accumulator is full of pressurized oil, the oil pressure severely increases and makes the hydraulic clutch completely meshed. When the forward or backward clutch is working, non-working clutch (backward or forward) shall be in separate state. Oil from oil cooler shall lubricate it to prevent discs conglutination and also have cooling function.

When step down the inching pedal, the inching valve acts, most oil inside the clutch shall return to the gearbox bottom (oil reservoir) through inching valve. The oil way is the same as the neutral.

3.7 Notes for Forklift Failure

When the forklift fails and cannot operate, it must be towed by other equipment, the following requirements must be noted:

- (1) Remove the transmission shaft between gearbox and differential.
- (2) Shift lever shall be in the middle position (neutral).

Because the oil feed pump will not carry the normal lubrication when it does not work. If the rotation of drive gear is transferred to gearbox, the conglutination between gear and clutch may be happened (so the transmission shaft shall be removed).

3.8 Trouble Shooting

- (1) Power shortage, see Table 3.2;
- (2) Oil temperature raises abnormally, see Table 3.3;
- (3) Loud noise of gearbox, see Table 3.4
- (4) Low transmission efficiency, see Table 3.5;
- (5) Oil leakage, see Table 3.6.

Table 3.2 Power Shortage

Part	Malfunction Reason	Inspection Method	Removal Method
Torque Converter	A. Oil pressure too low		
	(1) Oil level low	Check oil level	Fill in oil
	(2) Oil suction side sucking in air	Check joints and oil pipes	Retighten joints and replace sealing
	(3) Oil filter blocked	Remove and check	Clean or replace
	(4) Oil feed pump emission shortage	Remove and check	Replace
	(5) Spring distortion of master overflow valve disc	Check spring tension	
	(6) Seal ring or O ring damage or wear out	Remove and check	Replace
	B. Fly wheel damage or other parts contacted	Draw out a few oil and check whether have impurities	Replace
Gearbox	A. Improper oil or bubble	Check	
	(1) Oil suction side sucking in air	Check joints and oil pipes	Retighten joints or replace
	(2) Oil pressure of torque converter is too low or bubbles	Measure the pressure	Adjust pressure
	B. Clutch sliding		
	(1) Oil pressure too low	Measure the pressure	Adjust pressure
	(2) Seal ring damaged	Remove, check and measure	Replace
	(3) Clutch piston ring worn out	Remove and check	
	(4) Friction disc worn out or steel disc distorted	Remove and check engine starter, place the shift in forward, backward and neutral position respectively, the forklift operates in neutral position, and it does not work at forward and backward position.	Replace
	C. Positions of inching lever and shift valve lever position are not correct.	Check and measure	Adjust
Engine	Engine power decrease	Check the rotation speed at stall	Adjust or repair engine

Table 3.3 Oil Temperature Raises Abnormally

Part	Malfunction Reason	Inspection Method	Removal Method
Torque Converter	(1) Oil level low	Check oil level	Fill in oil
	(2) Oil filter blocked	Remove and check	Clean or replace
	(3) Fly wheel contacts with other parts	Discharge the oil filter or oil wall of oil reservoir and check whether have impurity	Replace
	(4) Sucking in air	Check joints and oil pipes at the air suction side	Tighten joints or replace gaskets
	(5) Oil mixed with water	Discharge oil and check	Replace oil
	(6) Oil flow too low	Check pipeline whether damaged or bended	Repair or replace
	(7) Bearing worn out or blocked	Remove and check	Repair or replace
Gearbox	(1) Clutch sliding	Place shift lever at neutral position and check the forklift whether operate	Replace clutch friction disc
	(2) Bearing worn out or blocked	Remove and check	Replace

Table 3.4 Loud Noise of Gearbox

Part	Malfunction Reason	Inspection Method	Removal Method
Torque Converter	(1) Elastic plate broken	Check rotation sound under low speed	Replace the elastic plate
	(2) Bearing damaged or worn out	Remove and check	Replace
	(3) Gear broken	Remove and check	Replace
	(4) Spline worn out	Remove and check	Replace
	(5) Oil feed pump has loud noise	Remove and check	Repair or replace
	(6) Bolt loose	Remove and check	Tighten or replace
Gearbox	(1) Bearing worn out or blocked	Remove and check	Replace
	(2) Gear broken	Remove and check	Replace
	(3) Spline worn out	Remove and check	Replace
	(4) Bolt loose	Remove and check	Tighten or replace

4. Drive Axle

Main parameters of drive axle see Table 4.1

Table 4.1

Forklift Tonnage		8-10T
Item		
Drive axle type		Fully floating type, cast steel axle
Master retarder	Model	Spiral bevel gear
	Reduction ratio	6.33
Wheel retarder	Model	Planetary gear
	Reduction ratio	3.67
Total reduction ratio		23.23
Oil volume	Master retarder, differential	10 L
	Wheel retarder	Total 10L for left and right
Wheel	Tyre (two for each side, left and right)	9.00-20-16PR
	Hub	7.0-20
	Air pressure Kpa	750

4.1 General

Drive axle is composed of master retarder, differential, wheel retarder and driving brake (see Fig 4.1). The drive axle is connected with the sector plate at the front frame by bolts, and the mast is mounted on the drive axle casing.

4.2 Master retarder and differential

Master retarder and differential are mainly composed of left and right different housing, ring gear(spiral bevel gear) and spur gear and so on. They are mounted in the master retarder housing (see Fig 4.2) and raise to drive axle housing through gasket.

The differential is split type, the left and right differential housings are connected by bolts, axle shaft gear and planetary gear (fixed on the cross shaft) are built in. The two kinds of gears mesh mutually.

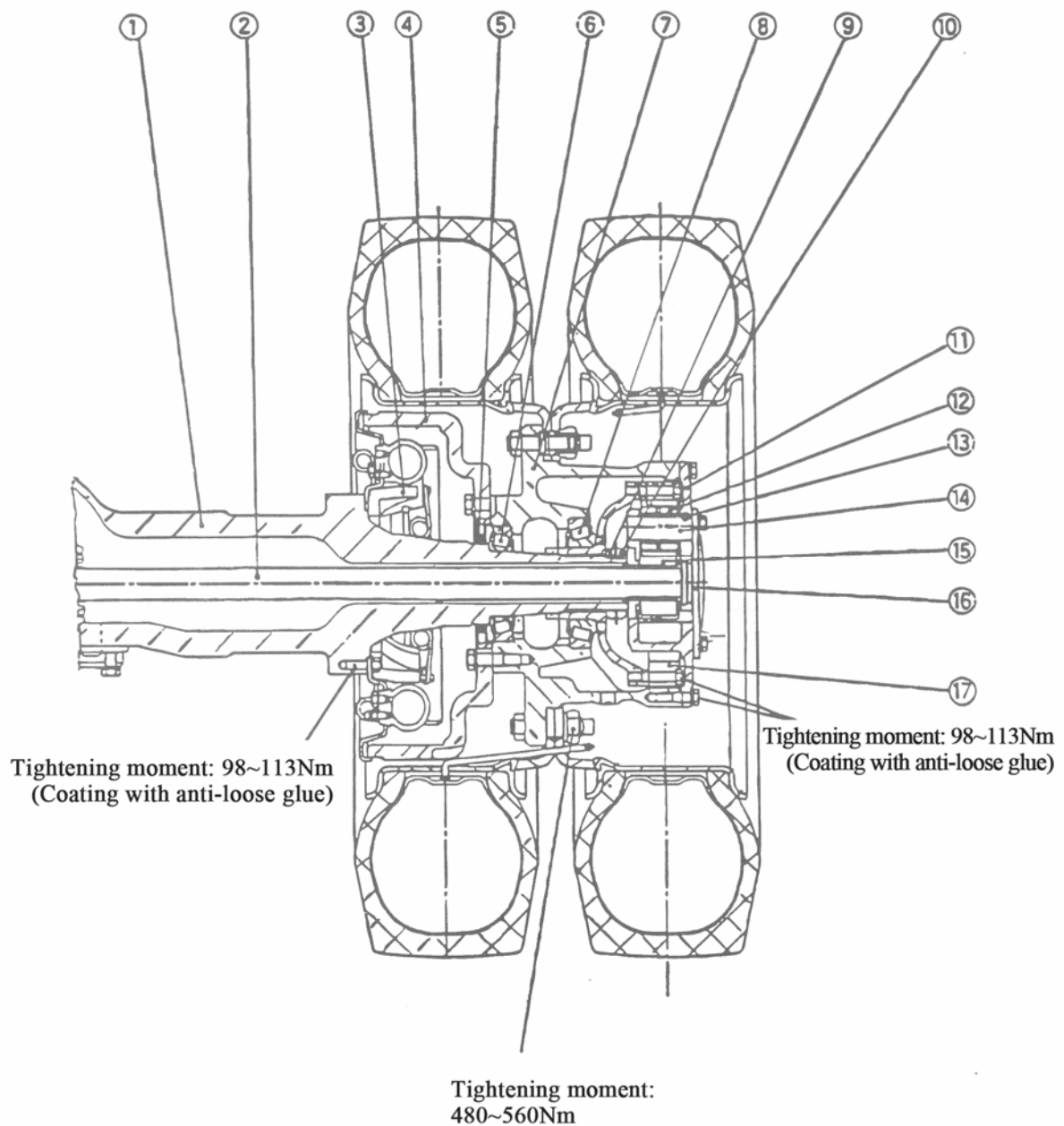
Drive gear shaft is supported by two taper roller bearings that are mounted in the bearing holder. Through gasket and fillings, the bearing holder is fixed on the master retarder housing. The ring gear is spiral bevel gear type, which is raised on the right differential housing by bolt. The power transferred from the gearbox reduces through the pinion (shaft) and gear ring.

Table 3.5 Low Transmission Efficiency

Part	Malfunction Reason	Inspection Method	Removal Method
Torque Converter	(1) Elastic plate broken	Check rotation sound under low speed and check the front cover whether rotate	Replace
	(2) Oil shortage	Check oil level	Fill in oil
	(3) Drive system of oil feed pump fails	Remove and check	Replace
	(4) Shaft broken	Remove and check	Replace
	(5) Oil pressure too low	Check the oil inlet side of oil feed pump whether formed suction pressure	Replace
Gearbox	(1) Oil shortage	Check oil level	Fill in oil
	(2) Seal ring damaged	Remove and check	Replace
	(3) Clutch disc sliding	Check clutch oil pressure	Replace
	(4) Shaft broken	Remove and check	Replace
	(5) Clutch cover broken	Remove and check	Replace
	(6) Spring ring of clutch cover broken	Remove and check	Replace
	(7) Clutch oil tank has impurities	Remove and check	Clean or replace
	(8) Spline of shaft worn out	Remove and check	Replace

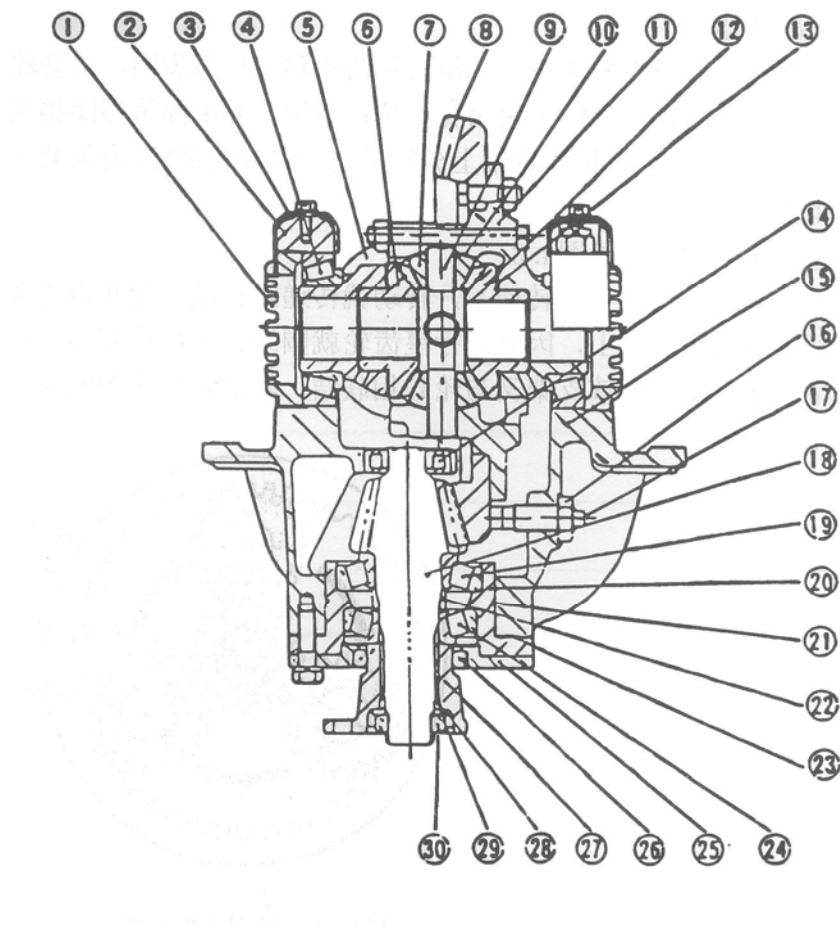
Table 3.6 Oil Leakage

Part	Malfunction Reason	Inspection Method	Removal Method
Torque Converter & Gearbox	(1) Oil seal damaged	Remove and check, oil seal lip or other sliding parts whether worn out	Replace oil seal
	(2) Housing connection incorrect	Check	Tighten or replace gasket
	(3) Joints and oil pipes loose	Check	Tighten or replace pipe
	(4) Oil release plug loose	Check	Tighten or replace
	(5) Oil jetting out from the vent hole	Discharge the oil and check the oil whether mixed with water, check the oil suction joint whether sucked in air, check the vent hole	Replace oil Tighten or replace seal Repair
	(6) Oil too much	Check oil level	Discharge extra oil



- | | | | |
|-----------------|-------------------------|----------------------------|---------------|
| 1. Axle housing | 6. Taper roller bearing | 11. Planetary gear support | 16. End cover |
| 2. Axle shaft | 7. Hub | 12. Planetary gear | 17. Ring gear |
| 3. Brake | 8. Taper roller bearing | 13. Steel ball | |
| 4. Brake drum | 9. Adjusting nut | 14. Shaft | |
| 5. Oil seal | 10. Locking nut | 15. Sun gear | |

Fig 4.1 Drive Axle



- | | | |
|--------------------------------|-----------------------------|--------------------------|
| 1. Adjusting nut | (right) | 22. Sleeve |
| 2. End cover | 12. Axle shaft gear | 23. Adjusting pad |
| 3. Locking plate | 13. Thrust gasket | 24. Taper roller bearing |
| 4. Taper roller bearing | 14. Roller bearing | 25. Oil seal bracket |
| 5. Differential housing (left) | 15. Master retarder housing | 26. Oil seal |
| 6. Axle shaft gear | 16. Locking nut | 27. Flange |
| 7. Planetary gear | 17. Adjusting bolt | 28. O ring |
| 8. Spiral bevel gear | 18. Drive gear shaft | 29. Gasket |
| 9. Cross shaft | 19. Taper roller bearing | 30. Locking nut |
| 10. Thrust gasket | 20. Bearing holder | |
| 11. Differential housing | 21. O ring | |

Fig 4.2 Master Retarder & Differential

4.3 Wheel Retarder

Wheel retarder includes a sun gear, a unit of planetary gears and an internal ring gear. Two sets of wheel retarder gears are mounted on the two sides of drive axle housing respectively. The sun gear is mounted on the axle shaft with spline and baffled by spring ring. Planetary bracket is mounted in the wheel house; a unit of planetary gear shafts that built in the bracket is equipped with a unit of planetary gears. Internal ring gear (or through internal ring gear holder) is mounted on the drive axle housing by spline.

Principle of power transfer is as following, see Fig 4.3.

When the sun gear is rotating (i.e. the axle shaft rotating), the rotation is transferred to the planetary gear and internal ring gear. Because the internal ring gear is fixed in the both sides of the drive axle housing, the planetary is rotating around the sun gear and self-rotating synchronously. Planetary gear is mounted on the planetary gear bracket, which is connected with the hub, and the spoke is also connected with the hub, so that, the power of axle shaft drives the wheels to rotate.

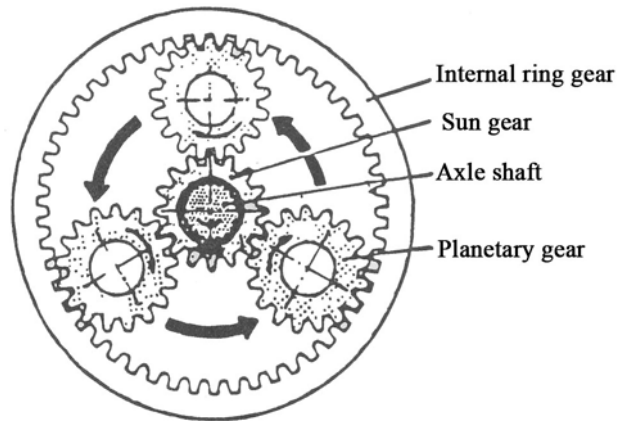


Fig 4.3 Wheel Retarder

4.4 Trouble Shooting

See Table 4.2.

Table 4.2

Malfunction	Reason of Failure	Removal Method
1. Oil leaking from master retarder housing	Connecting bolt of master retarder loose or gasket damaged	Tighten or replace
	Vent hole blocked	Clean or replace
	Oil seal worn out or damaged	Replace
2. Differential with loud noise	Gear worn, damaged or broken	Replace
	Bearing worn, damaged or broken	Replace
	Gear clearance improper	Adjust
	Spline connecting axle shaft gear with axle shaft loose	Replace parts
	Gear oil shortage	Fill in oil as per demand

4.5 Maintenance Data

See Table 4.3

Table 4.3

Part	Item	Standard Value (mm)
Differential	Thickness of bearing holder gasket	0.1,0.2,0.5
	Matching diameter of flange and oil seal	69,95-70
	Spline clearance of flange and driving pinion (shaft)	0.036-0.067
	Clearance between driving pinion and ring gear	0.20-0.30
	Preload of driving pinion	2.5-3.5 (N. m)
	Swing back of ring gear	0.25-0.38
	Tightening moment of ring gear mounting bolt	100-150 (N. m)
	Tightening moment of differential housing mounting bolt	100-150 (N. m)
	Thickness of planetary gear gasket	1.562-1.613
	Clearance of spline connecting axle shaft gear with axle shaft	0.038-0.130
Axle Housing	Tightening moment of bolts mounting axle house and master retarder house	150-175 (N. m)
	Matching diameter of small bearings at both sides of axle house (No. 6 in Fig 4.1 and No. 6 in Fig 4.2) with axle house	89.66-89.88
	Matching diameter of oil seals at both sides of axle house with axle house	109.913-110
	Tightening moment of bolts mounting axle house and frame	630-946 (N. m)
	Tightening moment of bolts mounting brake base plate and axle house	280-330 (N. m)
	Matching diameter of axle house and mast	189.2-190
Wheel Hub	Matching diameter of hub and small bearing	159.32-159.72
	Matching diameter of hub and big bearing	179.32-179.72
	Matching diameter of hub and oil seal	164.6-165
	Tightening moment of bolts mounting brake drum and wheel hub	280-330 (N. m)
	Tightening moment of bolts mounting hub and planetary gear bracket	98-113 (N. m)
	Tightening moment of hub nut	480-560 (N. m)

5. Braking System (See Table 5.1 for main parameters)

Table 5.1

Driving brake	Braking type	Power braking
	Brake type	Disc type brake
	Braking disc diameter mm	430
	Number of brake	3 for left/ right
Parking brake	Braking type	Mounted on the gearbox middle shaft, internal expansion
	Braking drum diameter mm	160
	Shoe size (length X width X thickness) mm	140X36X3.5
	Surface area of shoe cm ²	50.4
Braking valve	Nominal pressure MPa	16
	Rated flow L/min	25
	Braking pressure Mpa	10
	Power braking valve travel mm	12.5
Energy storer	Relief valve setting pressure Mpa	13
	Open and close pressure of warning switch Mpa	5±0.5
	Storer capacity ml	70

5.1 General

Braking system is composed of driving brake and parking brake two parts. The driving brake is mounted at the inner side of drive gear, and the parking brake is mounted on the middle shaft in the rear part of gearbox.

5.2 Power braking (Systemic diagram is shown in Fig 5.1)

Power braking typed driving brake system is made up of brake pedal, brake valve, energy storer and brake.

Power brake utilizes the pressure oil distributed from the multi-way valve of hydraulic system. It provides required oil pressure to steering wheel as well as the required oil pressure of brake. Meanwhile, it may supply oil to energy storer for storing energy for standby.

5.2.1 Braking pedal device (see Fig 5.2) braking pedal and inching pedal are mounted on the left side of frame by bracket. The inching pedal in the left and the braking pedal in the right have linkage function. After the inching travel, the inching pedal drives the brake valve to brake. The brake pedal directly drives brake valve.

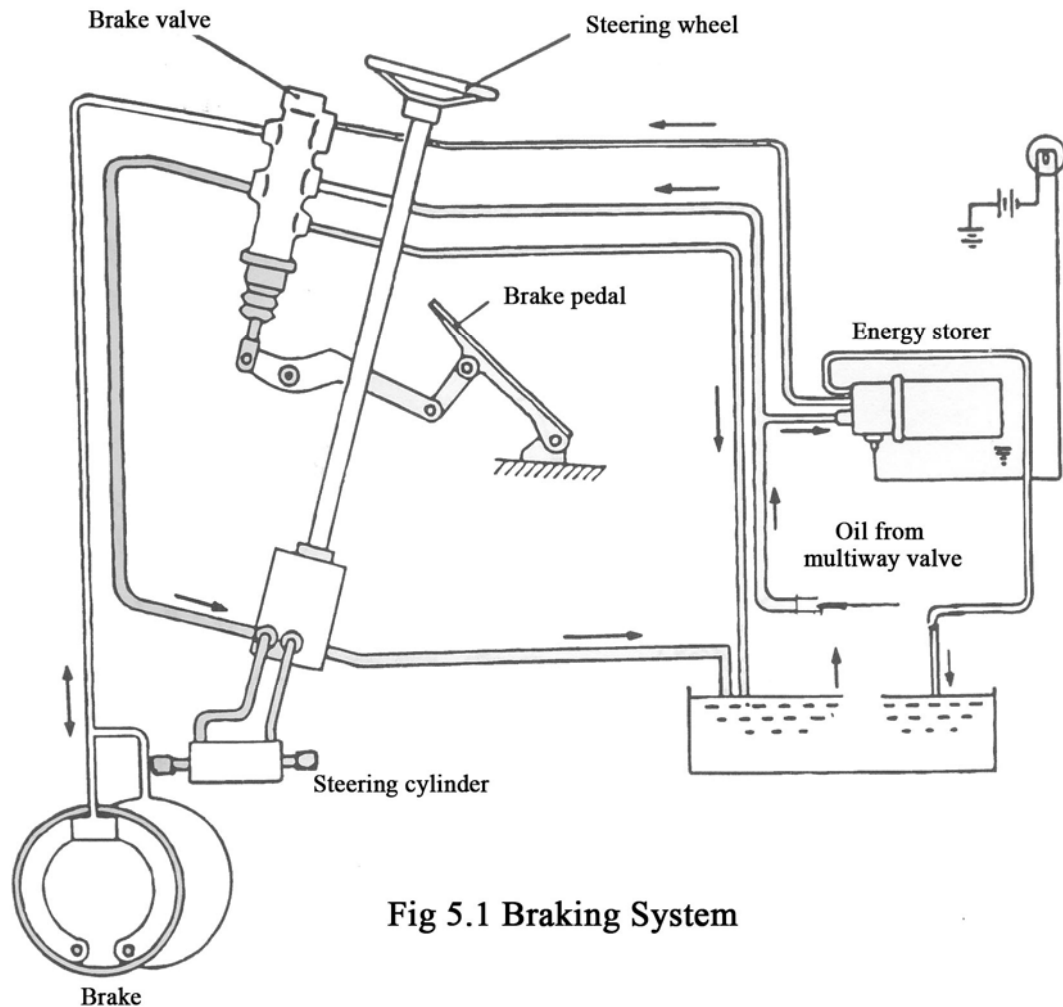


Fig 5.1 Braking System

5.2.2 Brake valve (see Fig 5.3)

(1) Non-braking state

Under non-braking case, because the brake valve Opening A open, coming oil communicates with the redirector joint, and the redirector works normally. When the brake pedal is not stepped down, the brake won't be created even the steering operation. Here the Opening B is closed, and the oil pressure in the control oil chamber shall not rise.

(2) Start and end of braking state

- A. When stepping down the brake pedal, the piston assembly 10 will move leftward, the valve sleeve 7 and bounce-back piston 5 will be pressed to the left side by spring unit 8, meanwhile, the return spring 6 will compress to the left side.
- B. The part 7 moves and closes position A, and disconnects D with return oil tank joint. B will open correspondingly and connect the D with the pump joint.
- C. Then the valve sleeve 7 shall move to the left again, C is compressed and the oil pressure of coming oil joint and chamber D shall rise, namely, the oil pressure to the brake sub0pump rises with, in addition, the higher oil pressure in chamber D shall push the bounce-back piston 5 rightward, the push force is balanced with the pedal force.
- D. When the right side of piston inputs the maximum pedal force, in order to make the oil pressure in chamber D no higher than the maximum adjustment oil pressure, the bolt and pedal bracket shall be limited.

- E. Release the pedal, the counterforce of bounce-back piston and the spring counterforce of part 6 and 8 will apply on valve sleeve 7 to return. The braking process is end.

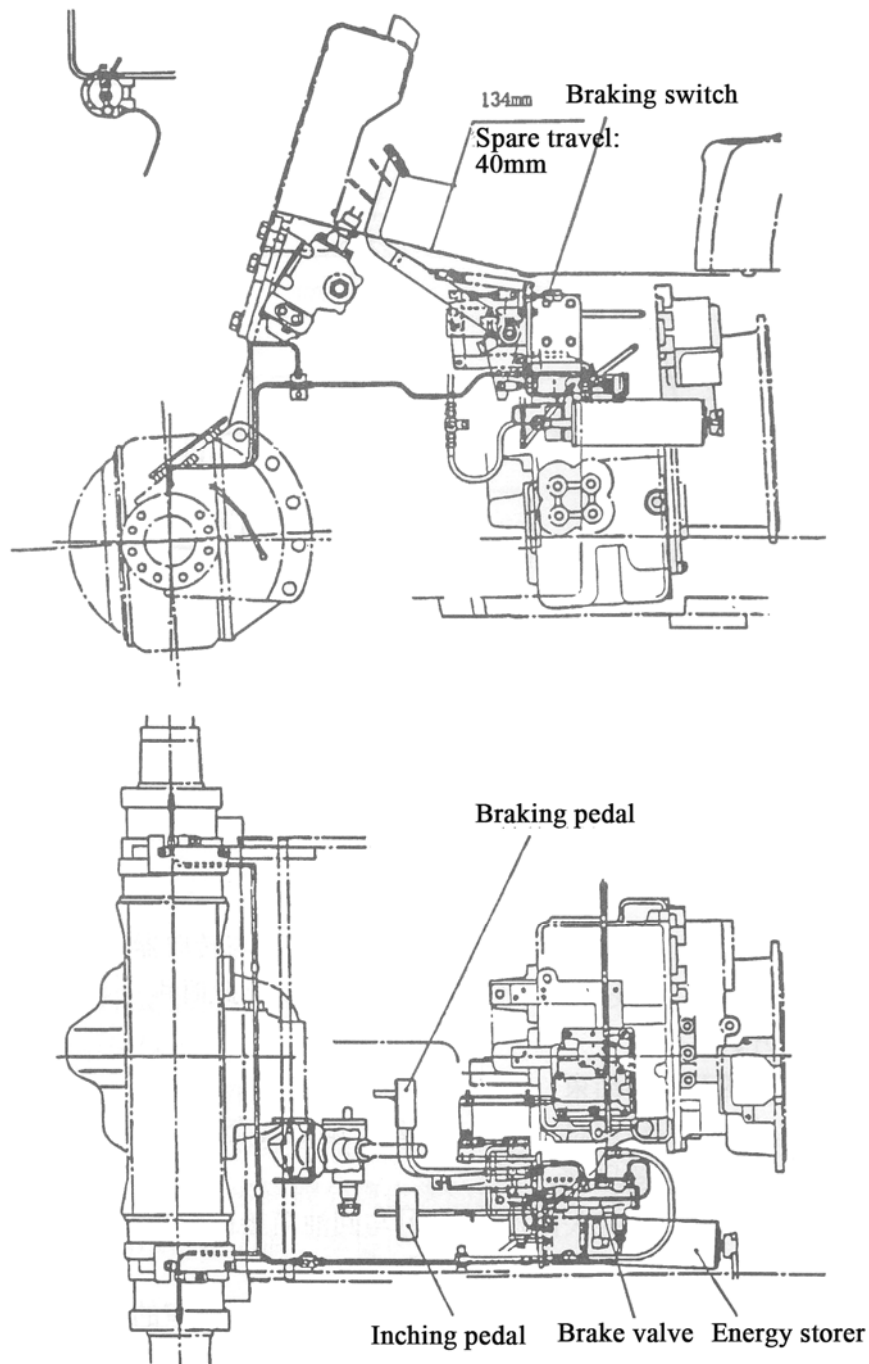


Fig 5.2 Braking Pedal Device

(3) Working process of energy storer

When the oil pump stops working (due to engine stop) or damages, the energy storer shall enter into working state.

- A. Step down the brake pedal further, valve sleeve 7, bounce-back piston 5 and single-way valve pin will move leftward together, the pin moves the ball and connects chamber D with energy storer joint, through the pressure oil of energy storer, the brake sub-pump brakes.
- B. Release the pedal, valve sleeve 7, bounce-back piston 5 and pin move rightward together, the ball of single-way valve recovers connection with the valve holder under the action of spring force (single-way valve close), the pin stops at the position correspondingly.

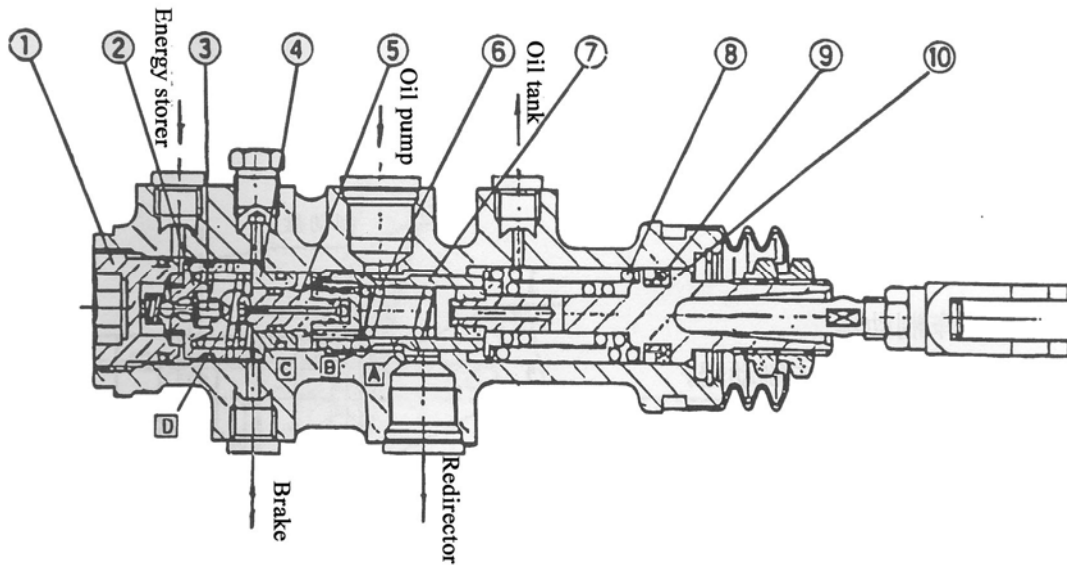


Fig 5.3 Brake Valve

- C. The bounce-back piston moves rightward and position C opens, the oil of braking sub-pump returns to oil tank through Chamber D.

5.2.3 Energy Storer(see Fig 5.4)

When the engine stops work or oil pump fails, the energy storer may be used as unusual energy to meet with the braking demand. The energy storing method is spring type.

The figure shows the non-energy storing state, and the buzzer of warning switch is at the to-ring state.

When operating the brake pedal and the oil pressure reaches above 3.9 MPa, single-way valve will open the energy storer and feeds in oil to push the piston moving leftward and compressing the combination spring, the oil pressure will be set.

In addition, piston moving leftward makes the warning switch control lever moving to left under the action of spring pressure, so that the switch valve core falls in the groove of switch control lever; here the warning switch is at non-ring state.

With the oil pressure of pump increase, the left-moving travel of piston shall be limited by the thrust pipe in the middle of combination spring, here, the energy storer stores the maximum energy and the oil pressure is 13 MPa. The value is controlled by relief valve.

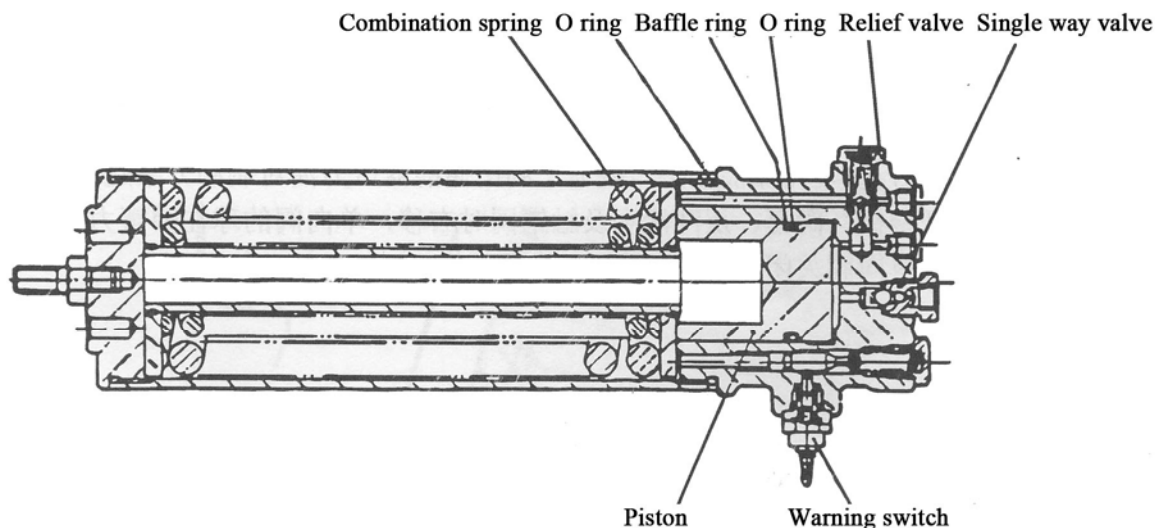


Fig 5.4 Energy Storer

5.3 Driving Brake

Driving brake adopts disc-typed brake, its structure is shown in Fig 5.5.

The brake body is mounted on the forcipate bracket of drive axle house, both of its inter and outer housings are the pump body of hydraulic brake sub-pump. It pushes two friction discs to press the braking disc to realize the forklift braking.

The brake friction disc shall be replaced when it is worn to 5mm. the friction disc shall be replaced in pair.

Replacement method of disc: set up the drive axle and pad it stably, remove the tyre and then remove the brake from the axle housing, replace new friction discs, and then assemble in the contrary order.

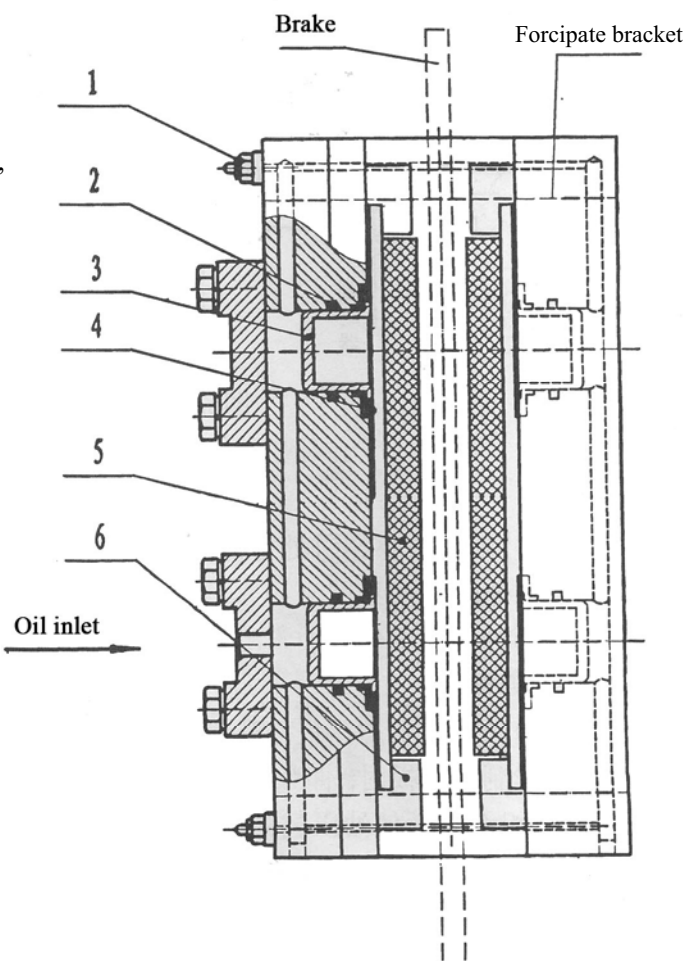


Fig 5.5 Driving Brake

1. Exhaust bolt 2. seal ring 3. piston 4. anti-dust ring
5. friction disc 6. guide hinge pin

5.4 Parking Brake

Parking brake includes internal expansion and shoe disc types, which are mounted in the output side of the middle shaft in the rear part of gearbox (see No. 9 in Fig 3.1), see Fig 5.7 for detailed structure.

See Fig 5.6 for the operation of parking brake. A forklift carries parking brake in a slope under standard loading and running state, the operation force shall be no more than 300 N. Pulling force shall be adjusted according to the direction shown in the figure, B is the force measure point.

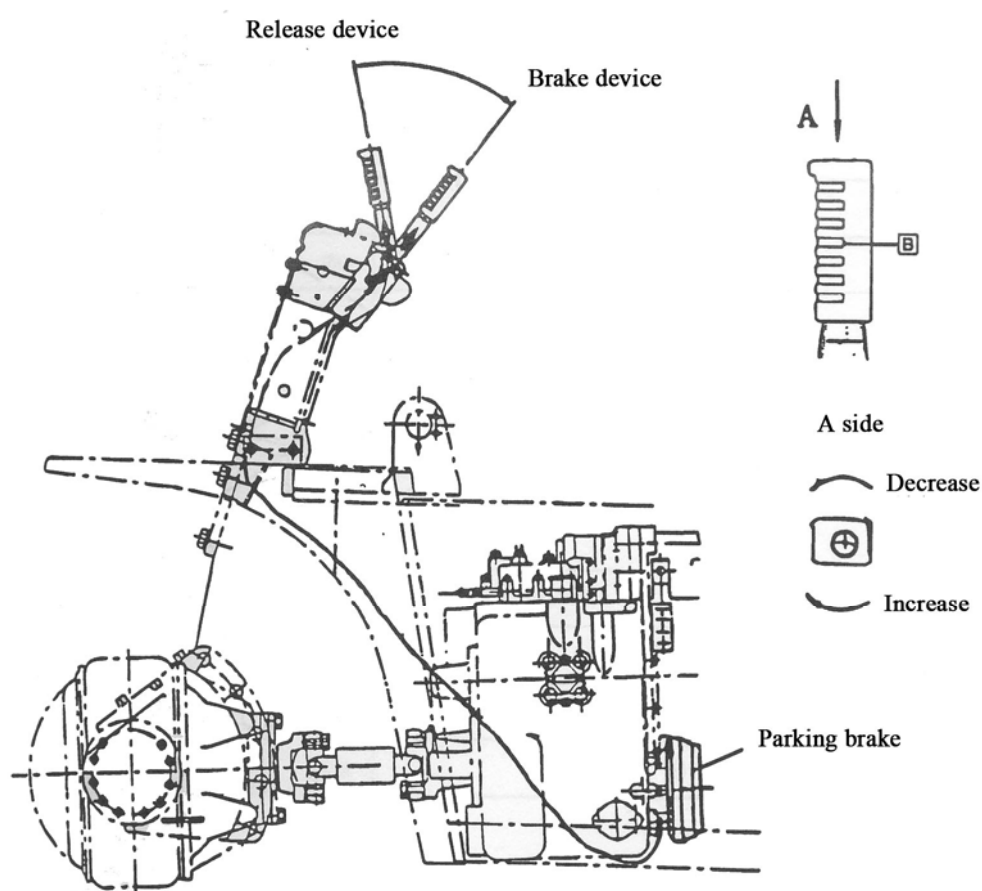
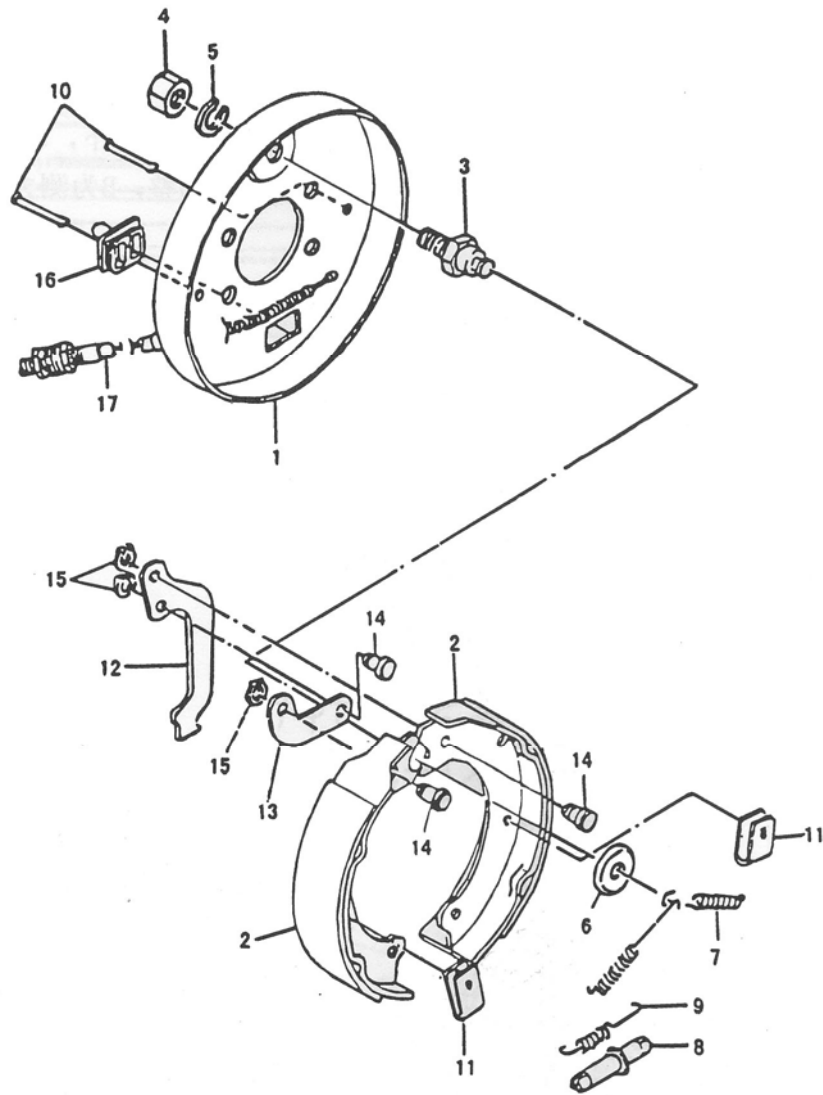


Fig 5.6 Control Device of Parking Brake



- | | | |
|------------------|-----------------------------|----------------------------|
| 1. Base plate | 7. Return spring | 13. Support plate |
| 2. Brake shoe | 8. Regulator | 14. Pin |
| 3. Mounting bolt | 9. Regulator spring | 15. U holding ring |
| 4. Nut | 11. Spring mounting bracket | 16. Plug |
| 5. Spring washer | 12. Lever | 17. Braking flexible cable |
| 6. Washer | | |

Fig 5.7 Parking Brake

6. Steering System (see Table 6.1 for main parameters)

Table 6.1

Steering system type		Rear wheel steering with power steering
Diameter of steering wheel		mm 350
Redirector	Type	BZZ1-E315B
	Emission	ml/r 315
	Rated pressure	Mpa 16
Steering cylinder	Type	Horizontal, double-action type
	Cylinder dia./ lever dia.	mm 115/ 85
	Travel	mm 2X260
By-pass valve	Setting pressure	Mpa 16
	Rated flow	L/min 25
Steering axle	Type	Mid-support shaft, horizontal cylinder
	Steering angle	outer/inner 79°/ 50°
	Rear wheel base	mm 1700
	Kingpin distance	mm 1500
Wheel	Tyre	9.00-20-16PR
	Hub	7.0-20
	Air pressure	Mpa 0.7

Steering system is made up of steering wheel, steering column, universal joint assembly, redirector, steering axle and steering cylinder. See Fig 6.1 for steering control device.

The steering shaft and redirector are connected by universal joint. The steering wheel drives the steering shaft and universal joint to act the redirector and realize the hydraulic turning. The steering column that supports the steering shaft may tilt a certain angle forward and backward for adjusting to a proper position and satisfying the demand of various drivers.

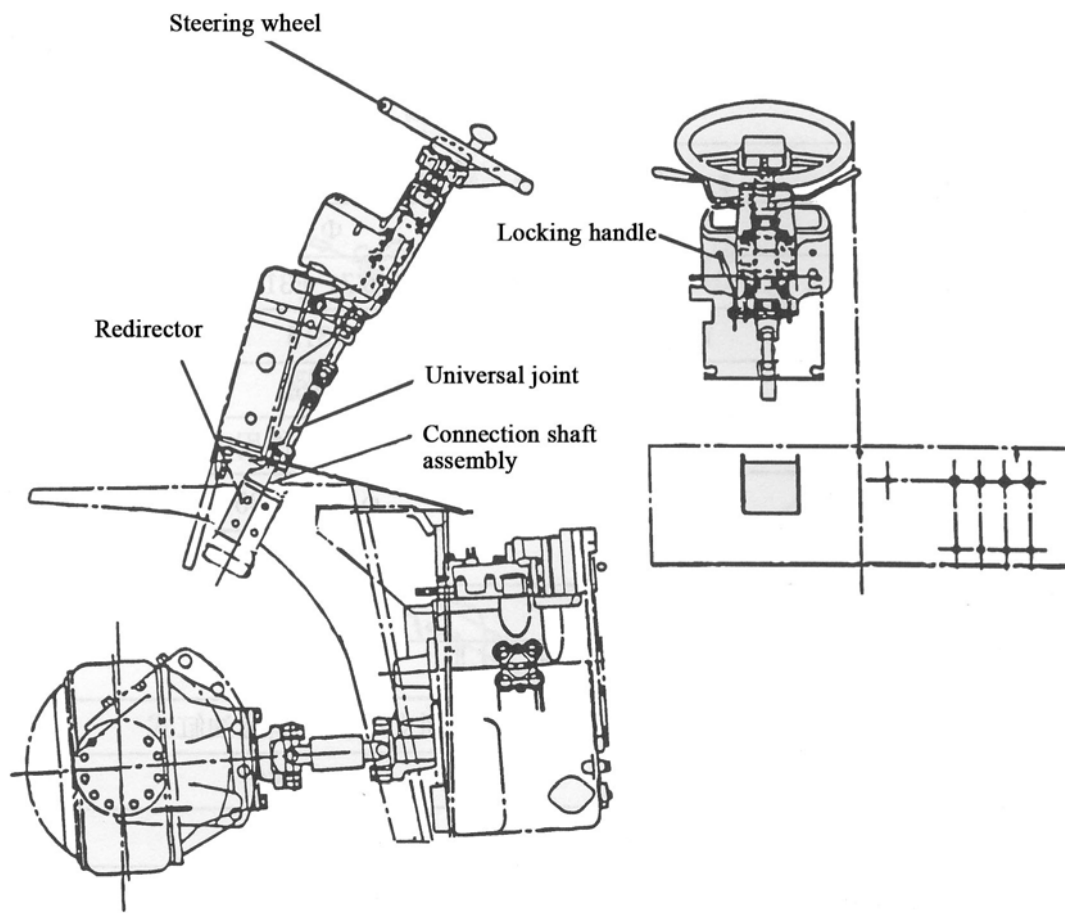


Fig 6.1 Steering Control Device

6.1 Redirector

6.1.1 General

Redirector is swing type full-hydraulic redirector, it may transfer the pressure oil flowing from the by-pass valve to the steering cylinder through oil pipe according to the steering angle of steering wheel to realize the rear wheel direction turning. When the engine stops, oil pump shall not feed oil, the direction turning may be carried manually. Full-hydraulic steering system is shown in Fig 6.2. The redirector structure is shown in Fig 6.3.

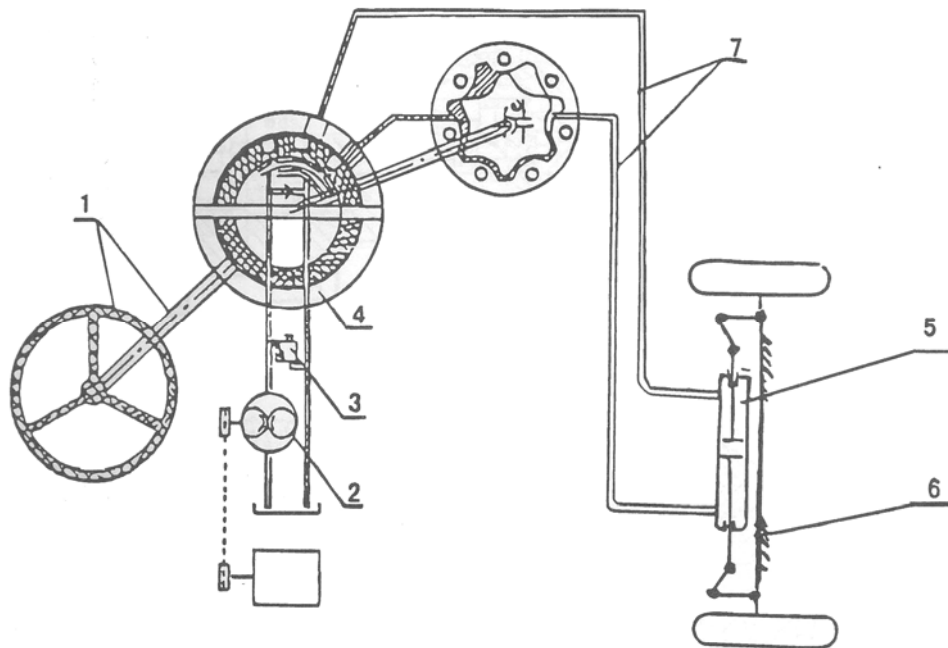


Fig 6.2 Diagram for Full-Hydraulic Steering System

- | | |
|--------------------------------------|----------------------|
| 1. Steering wheel and steering shaft | 5. Steering cylinder |
| 2. Oil pump | 6. Steering axle |
| 3. Flow control valve | 7. Hose |
| 4. Hydraulic redirector | |

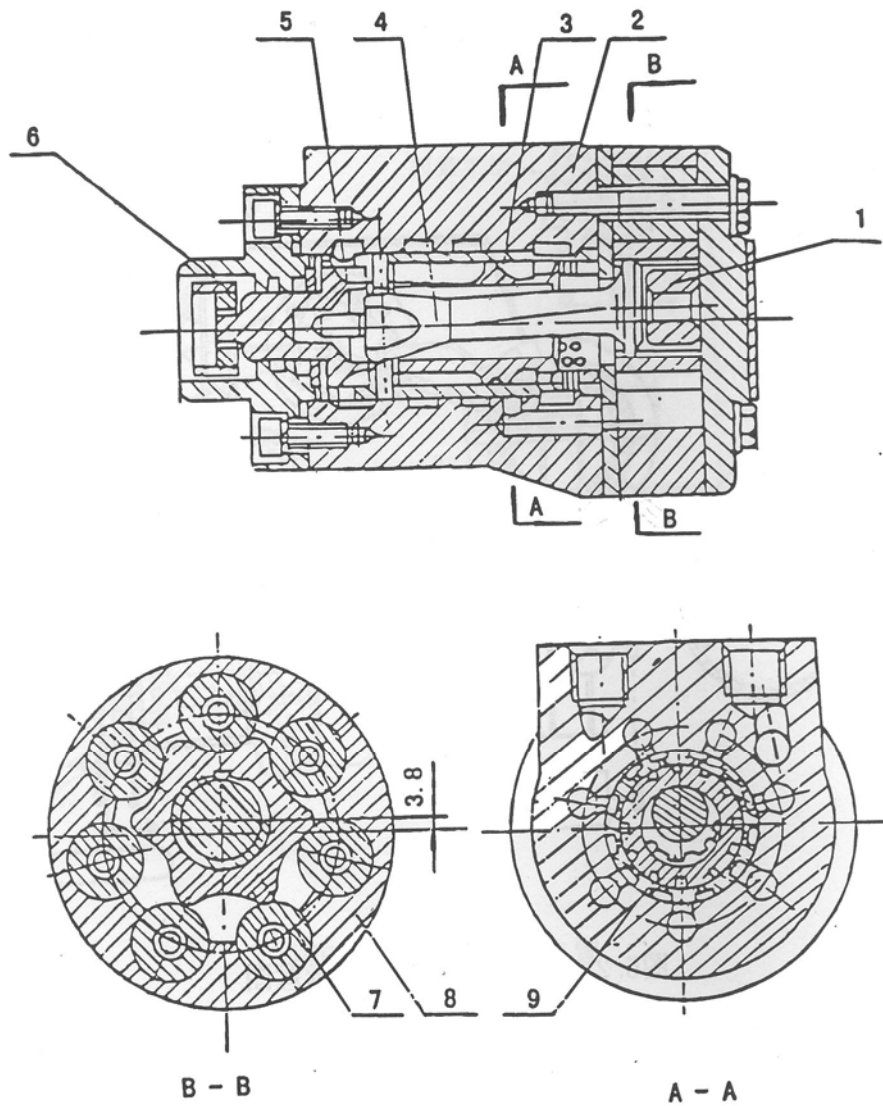


Fig 6.3 Swing Full-Hydraulic Redirector

- | | | |
|-----------------|---------------------|-----------------|
| 1. Limit column | 4. Linkage shaft | 7. Rotator |
| 2. Valve body | 5. Spring leaf | 8. Stator |
| 3. Valve core | 6. Connection block | 9. Valve sleeve |

6.1.2 Working Principle (see Fig 6.4)

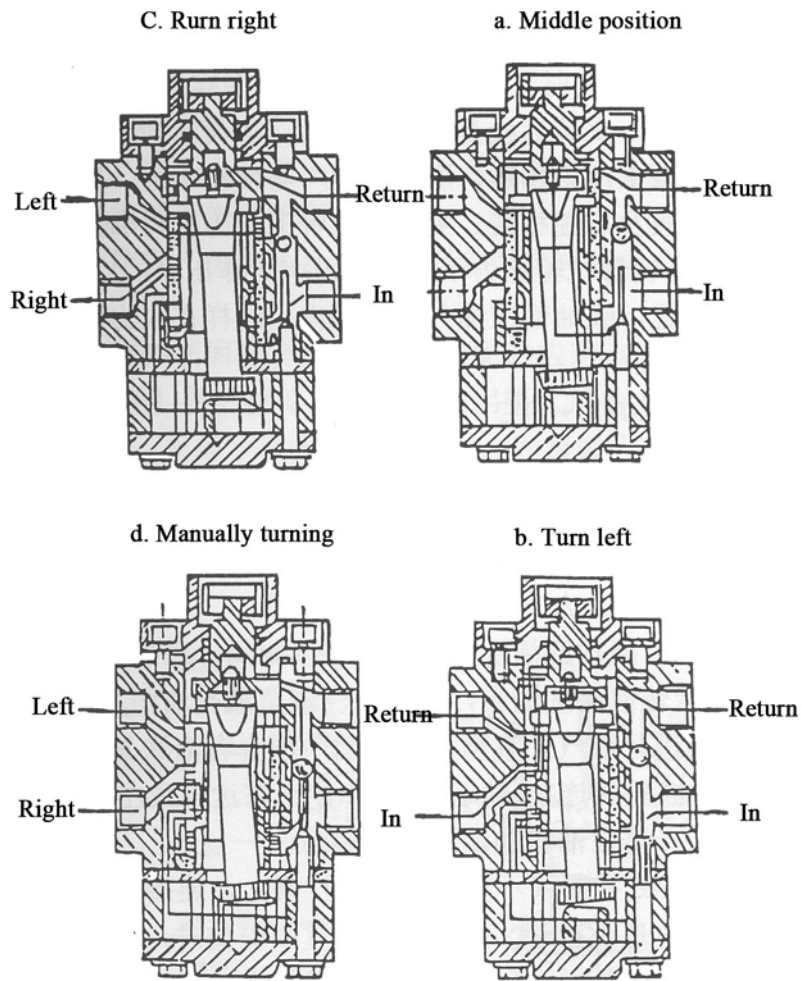


Fig 6.4 Diagram of Redirector Oil Way

The valve core, valve sleeve and valve body inside the redirector compose a follow-up valve, which controls oil flowing direction. Rotator and stator form a swing mesh pair and have measuring function at power steering for ensuring the direct ratio between oil amount flowing in cylinder and steering angle of steering wheel. It is hand oil pump as manual steering. Linkage shaft transfers torque.

In middle position (steering wheel not turn), in the system, the coming oil of oil pump will return to oil tank through internal chamber of valve core (a in Fig 6.4). In power steering, the coming oil of pump enters in the swing gear mesh pair through follow-up valve and pushes rotator turning with the steering wheel, and presses certain amount oil in the left or right chamber of cylinder, to push the steering wheel realizing power steering. The oil in another chamber shall return to the oil tank (b, c in Fig 6.4).

When engine stops, the steering wheel is controlled by human power, through valve core, pull pin, and linkage shaft to drive the rotator to press the oil from one chamber of cylinder to another, and impel the steering wheel to realize manually turning (d in Fig 6.4). The oil tank shall be supplemented with oil through oil supplement single way valve.

BZZ1 redirector used in the forklift is open-core non-reaction type. Namely, the outside force acted on the redirector shall not be transferred to the steering wheel, the driver shall have no road sense.

6.1.3 Requirement of use

- (1) Installation: when assembling a redirector, it shall ensure the connection shaft assembly in the lower part of universal joint homocentric, and axle has clearance to prevent valve core blocking. Check the steering wheel whether return flexibly after assembly. The assembly of pipeline shall follow the mark at the joint of redirector; “in” shall be connected with the oil coming pipe of oil pump. “Return” shall be connected with oil tank. “Left” and “right” shall be connected with left chamber and right chamber of steering cylinder respectively. Allowance velocity of oil suction pipe is 1 -1.5 m/s, and the allowance velocity for oil press pipe and oil return pipe is 4-5 m/s. The test pressure of high pressure hose shall be no less than 1.5 times of maximum working pressure. Section I of oil tank shall be higher than the mounting position of redirector, and the oil suction pipe shall be inserted below the oil level, so that the oil may be supplemented as manually steering. In addition, it may avoid air mixing in the oil.
- (2) Oil temperature range: -20°C ~ +80°C
Normal oil temperature: +30°C ~ +60°C
- (3) Oil type: N46 or N32 hydraulic oil
- (4) Filter: filtering accuracy for oil entered in the redirector is 30μm. Return oil of redirector shall have 0.2-0.3MPa of back pressure to prevent the oil flow in oil tank as manual steering.
- (5) All pipelines in the system shall be cleaned and the oil tank shall be closed to reduce oil pollution.
- (6) Trial operation: clean the oil tank before trial and fill in oil to the upper oil level, loosen the threaded joint of steering cylinder to make the oil pump operating in low speed and releasing air till the released oil contains no foam.

Remove the connection of piston lever and turning wheel, turn the steering wheel to make the piston reaching the left or right limit position (do not remain at the limit position), then fill oil in the oil tank to the upper oil level.

Tighten all thread joints (do not tighten under pressure), connect piston lever, and check steering system whether works normally under various working conditions. It shall carefully find the reasons if steering is heavy or fails. Do not toughly turn the steering wheel or take apart to avoid redirector parts damage.

- (7) Maintenance in use:

Check oil whether leak, oil level of oil tank and working condition everyday. Regularly replace filter and oil as required. The hydraulic oil may be check by dropping a drop of oil on a blotter, the oil will not be used if the oil stain has black center. It shall carefully look for reasons if abnormal conditions are found in use. Two people turning steering wheel at the same time is not allowed.

6.1.4 Check and maintenance of redirector

In order to keep good working condition of redirector and prevent accident, regular check is required:

- (1) Regularly check the water content, mechanical impurities and acidic substance of working oil. The oil shall be replaced if the original code requirements are not met with. Waste oil without filter must not be used again.
- (2) Do not remove the redirector easily when checking steering system. It must follow “Notes of assembly” when it confirmed that the redirector failed.
- (3) All tools used for removal and assembly shall be clean, the site shall be cleaned. It is better to remove and assemble indoor.

(4) Notes of assembly:

- a. Clean all parts with gasoline or kerosene before assembly. It shall use acetone to clean the joint face if it has paint. Do use cotton yarn or cloth to clean parts, but brush or silk cloth. Compressed air may be used if the equipment is available. Do not dip the rubber ring in the gasoline long time. After the redirector assembled, it shall add 50-100ml hydraulic oil in the oil inlet, turn the valve core before assembly the vehicle. It shall not assemble and commission until no any abnormal remains.
- b. The joint faces of valve body, spacer disc, stator and rear cover shall be very clean, impact and scratch are not required.
- c. The screw barrel must be lower than the valve body level.
- d. Baffle ring and sliding ring shall have a chamfer face in one side. The chamfer side of baffle ring shall face to the front cover, and the sliding ring's shall face to the valve core.
- e. The rotator and end face of linkage shaft shall have impact marks, two marks shall be aligned with in assembly.
- f. Limit bolt (with pin) washer shall be copper or aluminum. 7 bolts of rear cover shall be tightened as following: tighten one every two bolts, do not screw down in one time but gradually, tightening moment is 30-40N.
- g. Pay attention to the marks of "in", "return", "left" and "right" on the valve body when assembling oil pipes, it shall connect with the corresponding oil pipe.

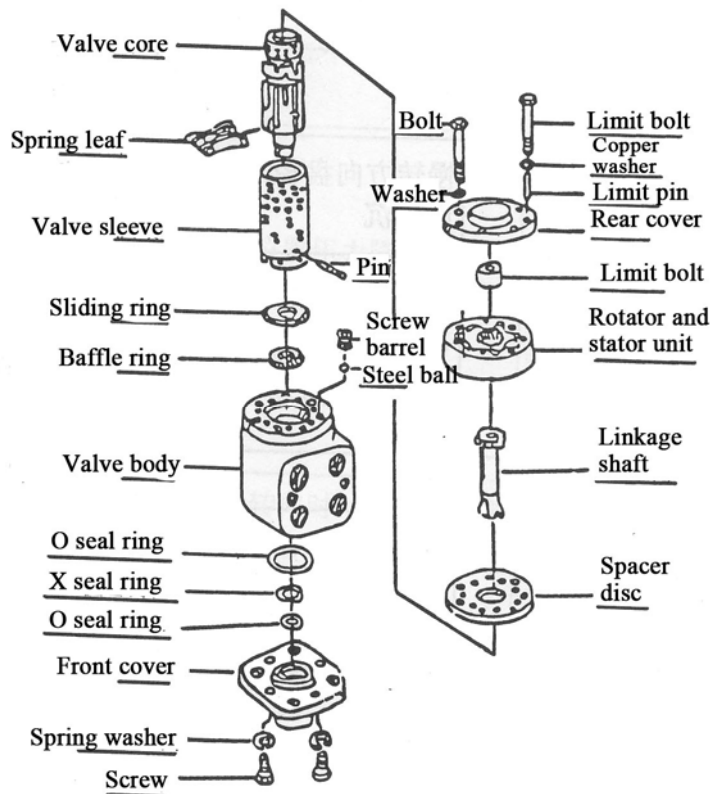


Fig 6.5 Diagram for Removal and Assembly of Redirector

(5) Removal and assembly (see Fig 6.5)

- a. Removal order: front cover – baffle ring – sliding ring – valve sleeve – (gasket – pin – valve core – spring leaf) – rear cover – limit bolt – stator – rotator – linkage shaft – spacer disc – screw barrel – steel ball – valve body.

If it starts removal from rear cover, the steel ball must be taken out before removing the valve core and body and so on. Otherwise the valve body may be damaged. Do not impact or scratch another end of valve body as removing the front cover.

- b. Assembly order: valve core – spring leaf – valve sleeve – pin – gasket – valve body – sliding ring – baffle ring – front cover – steel ball – screw barrel – spacer disc – linkage shaft – rotator – stator – limit bolt – rear cover.

6.1.5 Malfunctions and trouble shooting for redirector are shown in Table 6.2 as below:

Table 6.2

Fault	Reason	Phenomena	Removal method
Oil leakage	Dirt on joint face	Joint faces of valve body, spacer disc, stator and rear cover leak oil	Re-clean
	Rubber ring at shaft diameter damaged and cause oil leakage		Replace rubber ring
	The washer is not flat at limit bolt and causes oil leakage		Grind or replace washer
Steering heavily	Feeding amount of oil pump is not enough	Slowly turning the steering wheel is light and rapidly turning the steering wheel is heavy	Choose proper oil pump or check the bypass valve whether normal.
	Air in steering system	Oil has foam; emit irregular noise; the steering wheel turns and the cylinder sometimes does not turn.	Exhaust the air in the system, and check oil suction pipeline
	Oil tank is not full		Fill in oil to required level.
	Oil is too sticky		Use the oil with proposed viscosity
	Steel ball single way valve inside valve body is invalid	Slowly and rapidly turning is heavy, and no pressure while turning	If the steel ball lost, install a Φ 8 steel ball, clean it if the steel ball is blocked by dirt.
	Pressure of bypass valve is lower than working pressure or the bypass valve is blocked by dirt	Unload (light load) turning is light, turning is heavy when adding load.	Adjust bypass valve pressure or clean bypass valve.

Table 6.2 (Cont.)

Fault	Reason	Phenomena	Removal method
Steering failure	Spring leaf broken	Steering wheel cannot automatically align, pressure in middle position increases	Replace broken spring leaf.
	Pin broken or distorted	Pressure swing increases obviously, even cannot turn	Replace pin
	Opening of linkage shaft broken or distorted	Pressure swing increases obviously, even cannot turn	Replace linkage shaft
	Positions of rotator and linkage shaft assembled wrongly	The oil matching relation is wrong, steering wheel self-rotate or swing right-and-left	Reassemble according to "Notes of assembly"
	Double-way overload valve fails 9steel ball is blocked by dirt or spring is invalid)	Vehicle runs with deflection, or cylinder does not work (or work slowly) while turning steering wheel	Clean double way overload valve
Steering wheel cannot return to middle position automatically	(1) Steering column is not homocentric with valve core (2) Steering column blocks the valve core in axle. (3) Turning resistance of steering column too large (4) Spring leaf broken	The redirector does not unload (vehicle runs with deflection) when the pressure of middle position decreases / increase or the steering wheel stops turning.	Remove troubles according to the malfunction reasons.
Without manual steering	Radius and axle clearance between rotator and stator too big	Driver has no clear end point sense for the limit position of cylinder piston under power steering. The steering wheel turns and the cylinder does not work under manually steering.	Replace rotator and stator

6.2 Inspection after reassembly of steering system

- (1) Check the arrangement of hydraulic pipeline whether proper, left and right steering whether assembled crossly.
- (2) Turn steering wheel right-and-left and to the limit. Check the left and right force whether even and turning whether stable.
- (3) Lift turning wheel after the steering system assembled, start the engine in idle speed, then slowly turn the steering wheel right-and-left and repeat several times, to exhaust the air in the hydraulic pipeline and steering cylinder. Lower the turning wheel and turn the steering wheel several times. Check the turning sound whether proper. If abnormal noise cannot be heard, it means the air has been exhausted fully, then run the engine under idle speed to increase oil temperature.
- (4) Measure steering operation force: park the forklift on a dry and flat road and use parking brake, fix the spring balance device on the wheel edge of steering wheel to measure the steering operation force, the force must be lower than 150N.
- (5) In order to measure the pressure, pressure gauge is required (15-20MPa), stop-off valve and hose shall be connection as shown in Fig 6.6.

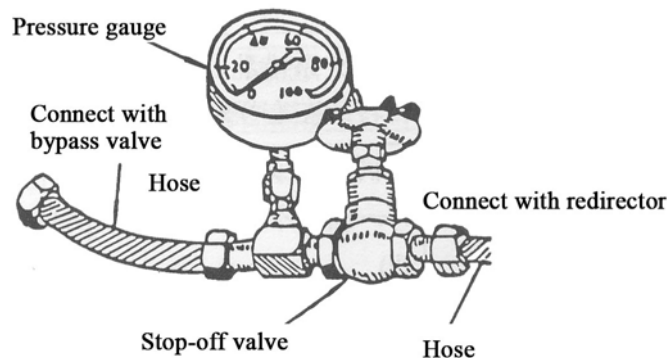


Fig 6.6 Measuring Pressure

Remove the connection hose of bypass valve to redirector, then connect the hose with pressure gauge in the side close to bypass valve, connect the pipe with stop-off valve in the side close to redirector. Start the engine in idle speed, the oil pressure shall be about 0.5-2MPa when the steering wheel is at free state. If the pressure is over the valve, it shall check the bypass valve and pipeline whether blocked. If no abnormality is found, the rotation of engine shall be increase by 1500rpm/min.

Then slowly shut off the stop-off valve and note the pressure up.

Regulate the maximum pressure of bypass valve to 12MPa. Thus, when the stop-off valve is closed completely, reading of pressure gauge is the setting pressure.

If the pressure is over 12MPa, it means the bypass valve failure. If the pressure is too low, it means the oil pump failure or spring of bypass valve broken. In this case, the close time of stop-off valve shall not be over 15 seconds.

Notes: The oil pump provides pressure oil and makes the steering cylinder acting. Its work must be considered from two parts, nominal pressure and rated flow. Even if the pressure is normal and reaches 12MPa, the steering cylinder shall not work normally if the flow is not enough and causes heavy steering. Therefore, when the bypass valve requires removal and reassembly, it shall adjust flow valve and relief valve properly according the capacity and working condition of steering cylinder. Matching marks shall be punched at the setting position for carrying reassembly or measuring and regulating bolt distance.

6.3 Trouble shooting of steering system

Malfunctions caused by bypass valve and removal method are shown in Table 6.3.

Table 6.3

Malfunction	Reason of malfunction	Removal method
Steering wheel locking while rapidly turning	Flow control valve lever blocked	Remove, repair or replace
	Flow control valve lever worn	Replace completely
Oil pressure cannot increase higher	Relief valve always open (cannot be closed)	Replace completely
oil pressure higher than setting pressure of relief valve	Relief valve always close (cannot be opened)	Replace completely
Relief valve has noise	Relief valve vibrated	Replace completely
Oil temperature too high	Relief valve always close (cannot be opened)	Replace completely
Turning operation is difficult under engine idle speed running	Relief valve always close (cannot be opened)	Replace completely
	Flow control valve lever blocked	Remove, repair or replace
	Flow control valve lever worn	Replace completely
Steering force changes	Relief valve vibrated	Replace completely
	Flow control valve lever blocked	Remove, repair or replace
	Flow control valve lever worn	Replace completely
Steering operation is difficult	Relief valve always open (cannot be closed)	Replace completely
	Flow control valve lever blocked	Remove, repair or replace
	Flow control valve lever worn	Replace completely

6.4 Steering Axle

The forklift fully adopts horizontal steering cylinder, which is supported by two support shafts in the steering axle holder through sleeve in the front and rear of the middle. The steering axle holder is fixed on the frame. Two support shafts may swing in certain angle right-and-left. See Fig 6.7 and Fig 6.8 for Diagram of Steering Axle Structure.

Steering axle is mainly composed of steering axle body, left and right steering knuckle assemblies, connection rod assembly, wheel, hub and steering cylinder.

6.4.1 Steering axle body

Steering axle body is the steel plate welded structure, there are upper and lower raised stages (holes) at both sides, which are connected with left and right steering knuckle assemblies by kingpins.

6.4.2 Left and right steering knuckle assemblies

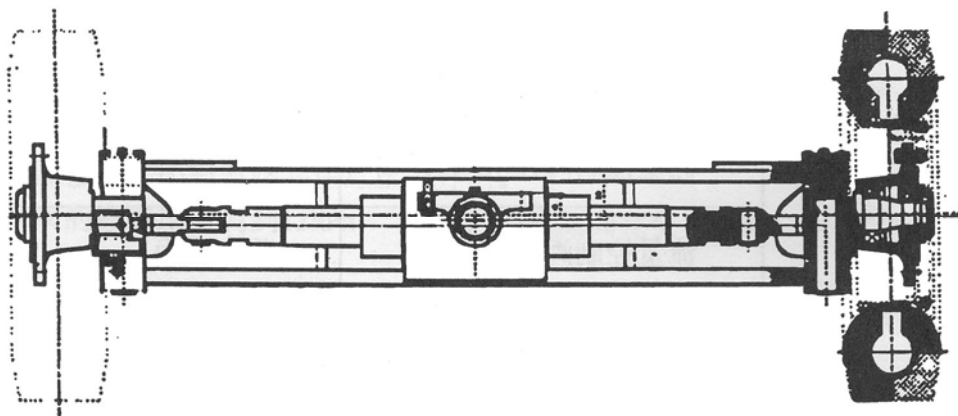
Left and right steering knuckle assemblies are supported on the hub through two thrust bearings. Wheels are mounted on the hub. There is an oil seal in the hub to prevent grease overflow. There is a plane thrust bearing mounted between the steering knuckle and upper and lower raise stages of steering axle body, the steering clearance may be regulated through the gasket at the bottom. Internal holes of upper and lower raised stages are mounted with kingpins and supported by upper and lower rolling needle bearings, and sealed by oil seal in the bottom. There is an oil nozzle in the upper end cover, which lubricates all bearings through the internal hole of kingpin. User shall fill in grease on time. The kingpins of steering knuckle assembly are fixed by locking pin.

6.4.3 Wheel hub

Wheel hub is ball iron parts.

6.4.4 Steering cylinder

Steering cylinder that is horizontally placed in the middle of steering axle body is double-action type. Piston levers at both sides connect with the connection rod assembly, another side of the later may impel the steering knuckle arm to turn the wheel. Both sides of cylinder are guiding sleeve, there are steel-backed bearing, barrier chip, seal ring and anti-dust ring in the holes inside the sleeve that contact with the piston lever. There are support ring and O ring outside the sleeve that contact with the inner wall of cylinder. See Fig 6.9 for Diagram of Cylinder Structure.



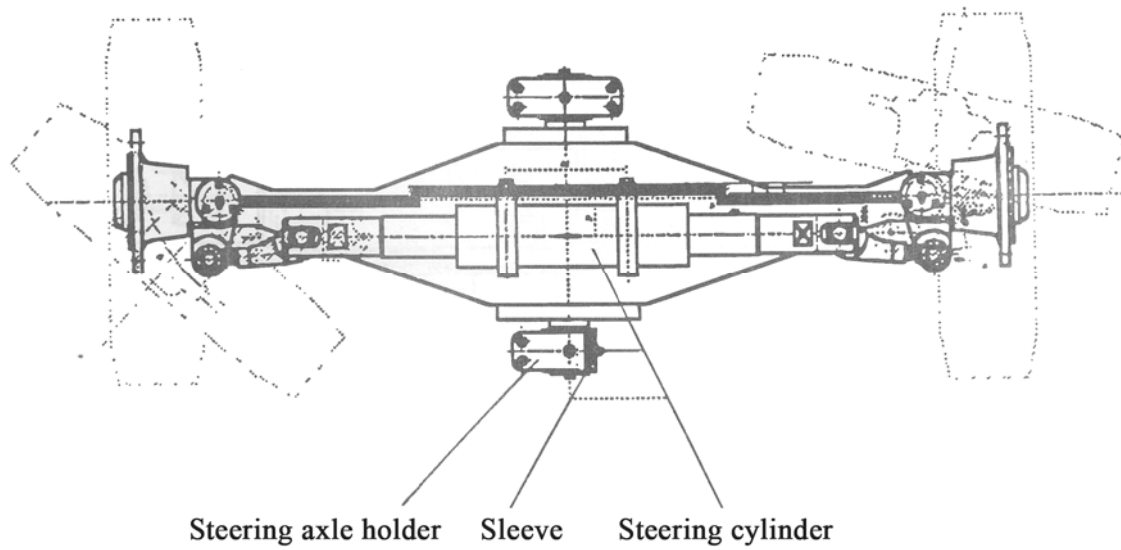


Fig 6.7 Steering Axle

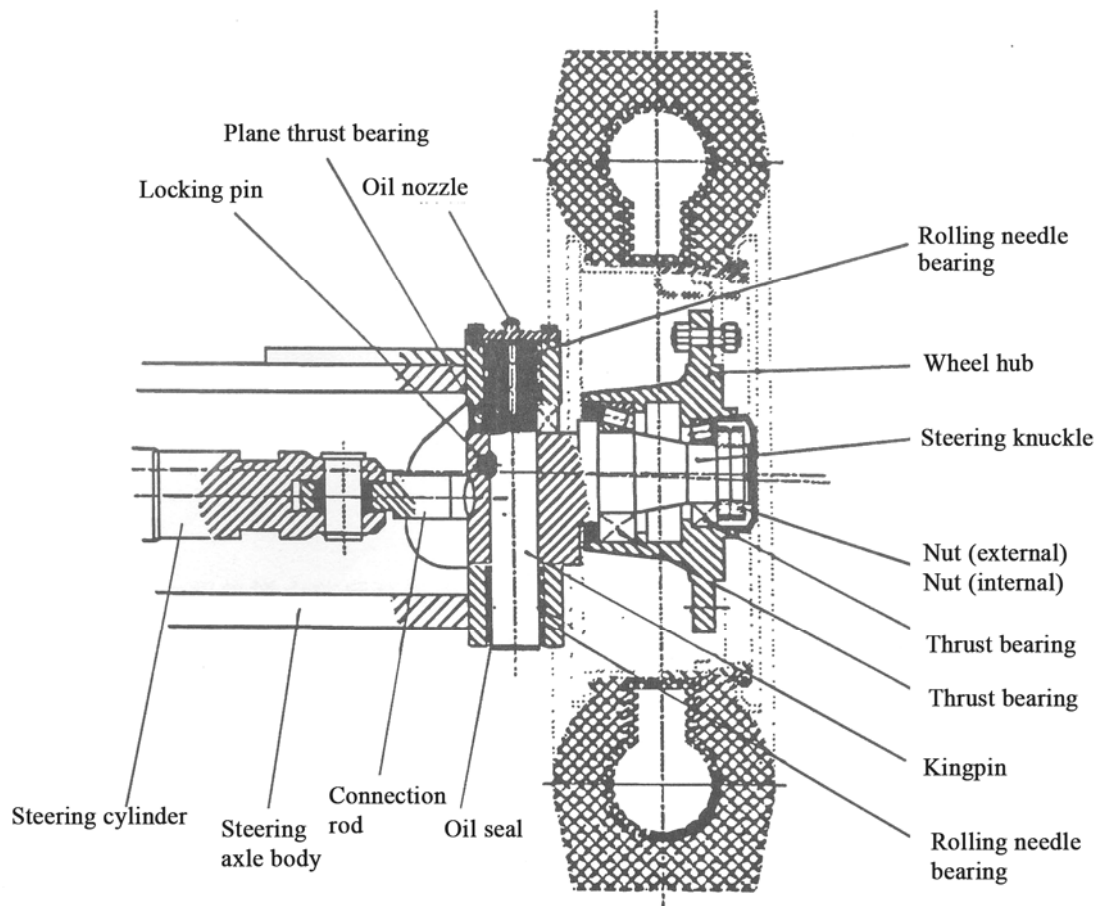


Fig 6.8 Steering Axle

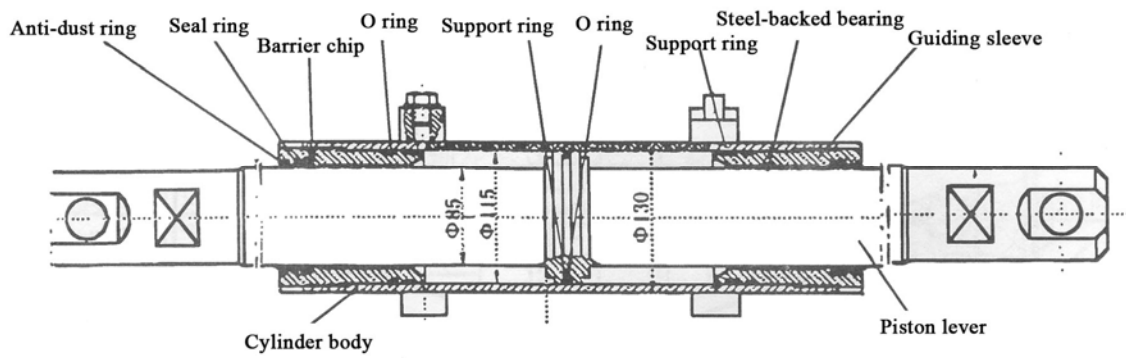


Fig 6.9 Steering Cylinder

7. Hydraulic System (See Table 7.1 for main parameters, see Fig 7.1 for principle)

Table 7.1

Master oil pump	Driving type	Gearbox power output	
	Rated pressure	25MPa	
	Gear pump type	CBK-G436-AFΦ (front pump)	
		CBK-G436-AFΦL (rear pump)	
Multi-way valve	Type	Valve lever sliding type (with relief valve, bypass valve, tilting self-locking valve)	
	Setting pressure	20MPa	

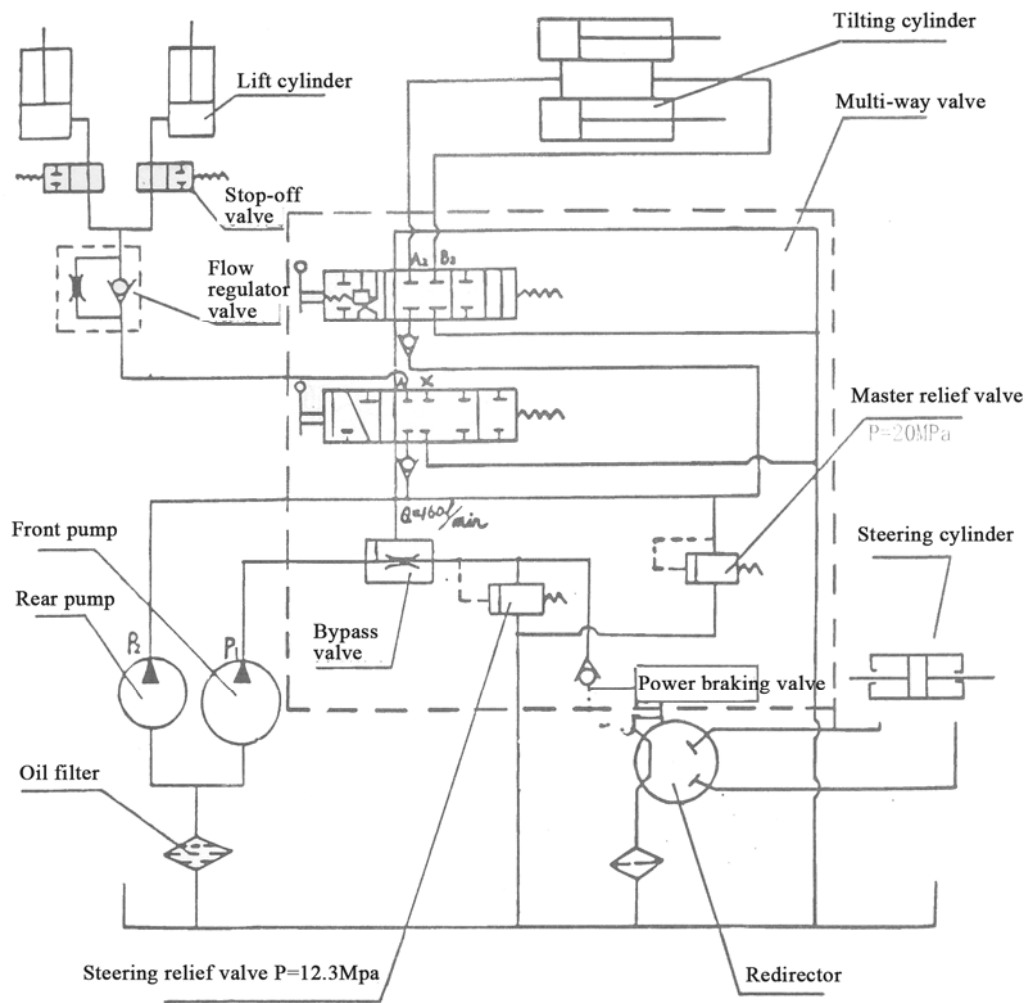


Fig 7.1 Diagram of Hydraulic System Principle

7.1 General

Hydraulic system mainly includes oil pump made up of front pump and rear pump, multi-way valve (bypass valve and multi-way valve are mounted together), high and low pressure oil pipes and joints and so on. Oil pump is gear pump and mounted in the side of gearbox. When the engine is running, it drives oil pump sucking oil from oil tank and transferring to the multi-way valve. The relief valve inside the multi-way valve is used for keeping oil pressure inside oil way within the required range. Through the control of valve lever, it changes the oil way of multi-way valve and then controls the cylinder. Through bypass valve, the oil enters in redirector, which controls the action of steering cylinder.

7.2 Oil Pump

Oil pump is gear pump, mainly composed of drive gear, spur gear and pump body. Namely, oil pump includes two gears and other parts. Drive gear meshes with spur gear.

7.3 Multi-way Valve (See Fig 7.2)

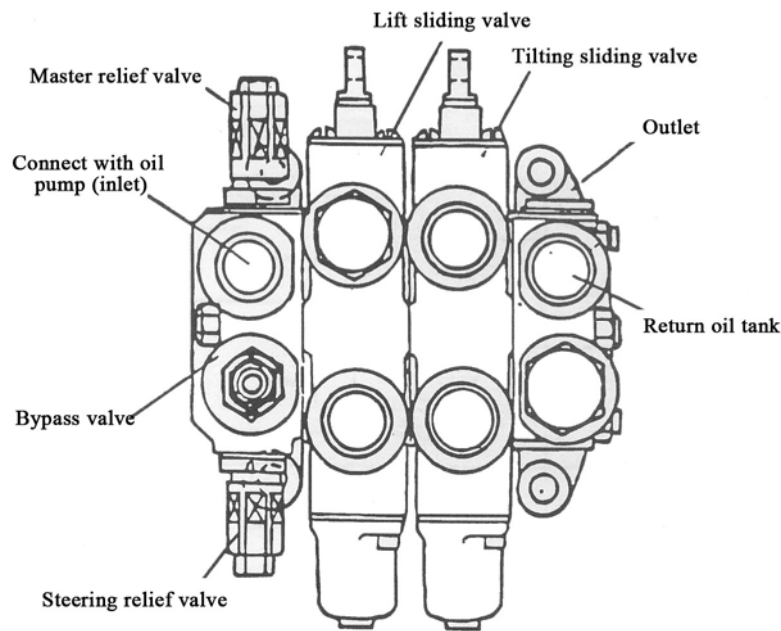


Fig 7.2 Multi-way Valve

Multi-way valve is split type, includes three parts, inlet (bypass valve is mounted in the part), outlet and sliding valve, which are mounted together by three bolts. Bypass valve (outlet) is mounted with multi-way valve, so that the structure is compact and the pipeline is simple.

There is a canister shaped master relief valve at inlet used for regulating the oil pressure in the oil way. The steering relief valve is used for regulating the oil pressure of power steering oil way.

Sliding valve is used for controlling lift and tilting cylinders. Through operating the lift and tilt valve levers, it makes the oil flow change and reach the purpose of control cylinder.

There is a tilting self-lock valve mounted on the tilting sliding valve, return oil coming from cylinder shall return the oil tank through the outlet. Every valve is sealed by O ring. In addition, the oil way is mounted a single-way valve in the high pressure side.

7.4 Operation of multi-way valve

(1) Middle position (See Fig 7.3)

Oil released from master pump will return to oil tank through middle oil way. Here, cylinder joint A and B all are closed.

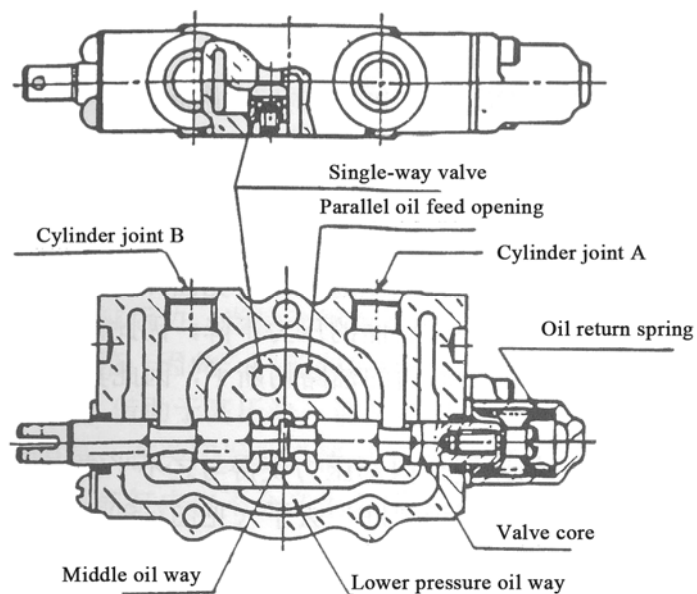


Fig 7.3 Middle Position

(2) Impel sliding valve (see Fig 7.4)

Here, middle oil way is closed (shut off), the oil from inlet pushes out (load) the single way valve, and flows in the cylinder joint B. return oil released by the cylinder joint A will return to the oil tank through the low pressure oil way. By the return spring, the sliding valve may return to the middle position.

(3) Pull sliding valve (see Fig 7.5)

Here, middle oil way is closed. The oil from inlet pushes out (load) single-way valve and flows in the cylinder joint A, the return oil released by the cylinder joint B shall return to the oil tank through low pressure oil way. By the return spring, the sliding valve may return to the middle position.

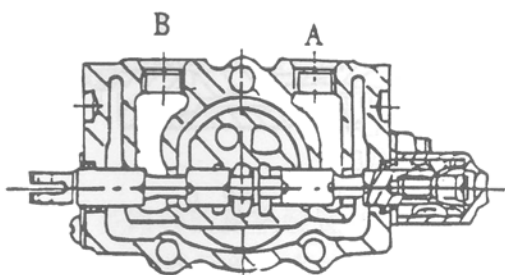


Fig 7.4 Impel Sliding Valve

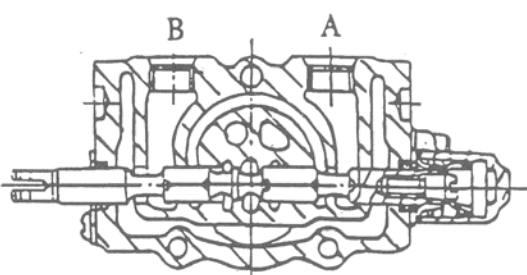


Fig 7.5 Pull Sliding Valve

7.5 Work of Master Relief Valve

- (1) Master relief valve is mounted between the high pressure joint (HP) and low pressure way (LP) of cylinder. Therefore, the valve core of single-way valve and valve core D of master relief valve shall firmly fall in the valve holder (see Fig 7.6).
- (2) When the oil pressure in the high pressure joint of cylinder is over the spring setting pressure, the pilot valve core E will open, oil flows in the hole through the valve core, then enters into the low pressure oil way (See Fig 7.7).
- (3) When pilot valve core E is opened, the pressure after the valve core C decreases, so the valve core C will move rightward and fall on the pilot valve core E, as a result, the oil way behind relief valve core D will be shut off and its internal pressure decreases (see Fig 7.8).
- (4) Comparing with cylinder joint HP, the internal pressure becomes unbalanced, which leads to the relief valve core D opened, so that, the oil in the high pressure side will directly flow in low pressure way LP (see Fig 7.9).

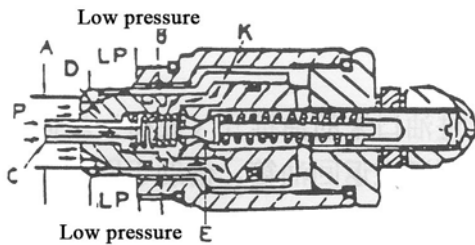


Fig 7.6

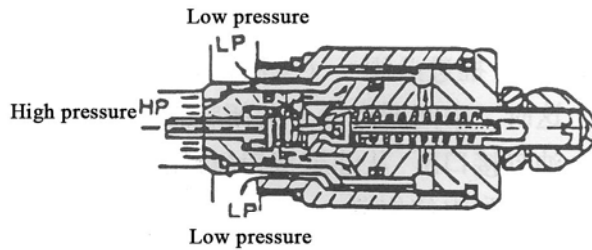


Fig 7.7

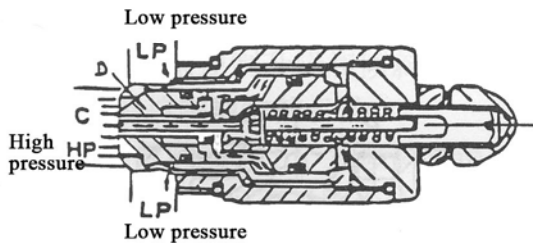


Fig 7.8

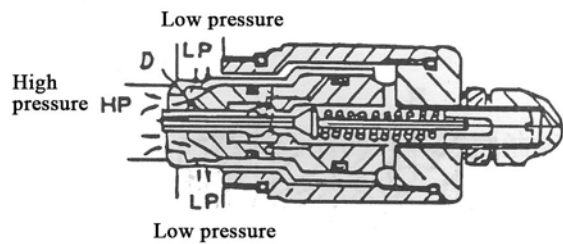


Fig 7.9

7.6 Work of tilting self-locking valve

Tilting self-locking valve is used for preventing the mast vibration (because the tilt cylinder may produce internal negative pressure), as well as the risk of mast inclining caused by accidental misoperation (impact on the tilting control lever) while stopping the engine. In traditional structure, even if the engine stops, mast may tilt forward due to impacting to the tilting control lever. If the modern tilting self-locking valve is used, the mast will not tilt under the above case. Even if hardly push the tilting control lever, the mast won't tilt forward. See Fig 7.10 for the structure of tilting self-locking valve. Joint A is connected in the front part of the tilting cylinder and joint B is connected in the rear part of the cylinder. When pulling the tilting control lever (pull out the sliding valve), the oil from oil pump will flow in A, and oil in B will return to oil tank. Depending on high pressure oil, the self-lock valve in the tilt sliding valve acts, A shall be connected with low pressure and the mast tilt forward. However, A will not be connected with low pressure in case of engine stopped, no high pressure oil makes self-locking valve acting, the mast shall not tilt forward, and the tilting cylinder will not produce negative pressure.

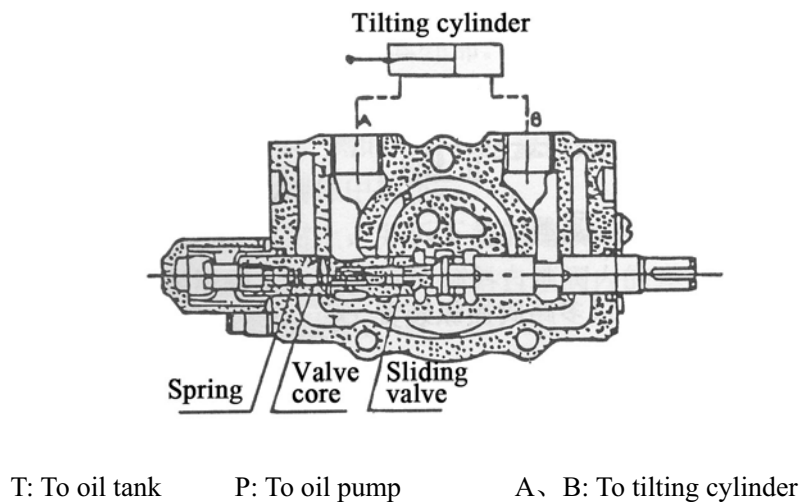


Fig 7.10 Tilting Self-Locking Valve

7.7 Control device of multi-way valve (see Fig 7.11)

Every sliding valve of multi-way valve is controlled by control handles, which are mounted on the same shaft that is installed in the bracket of front instrument panel. Through connection rod, all control handles act on the sliding valves of multi-way valve.

7.8 Oil Tank

Hydraulic oil tank is mounted in the right side of frame, oil suction filters for front and rear oil pumps, oil filler cover with oil level gauge and braking oil pipe used for power braking are mounted on the oil tank. See Fig 7.12.

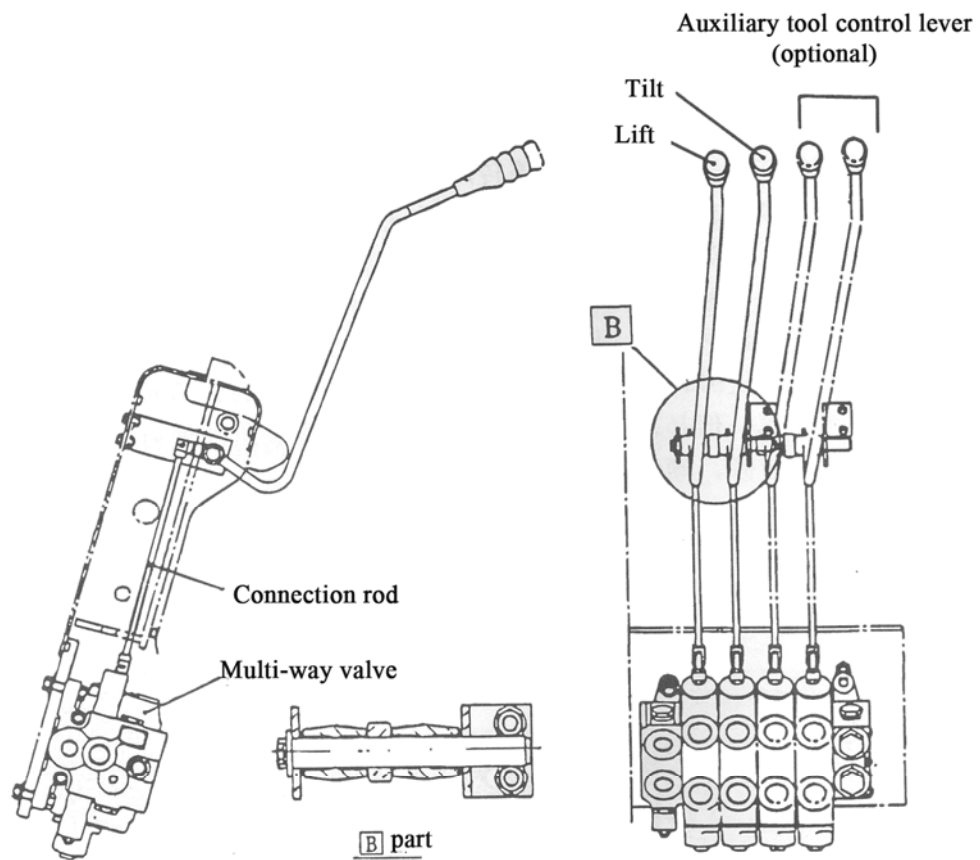


Fig 7.11 Control Device of Multi-Way Valve

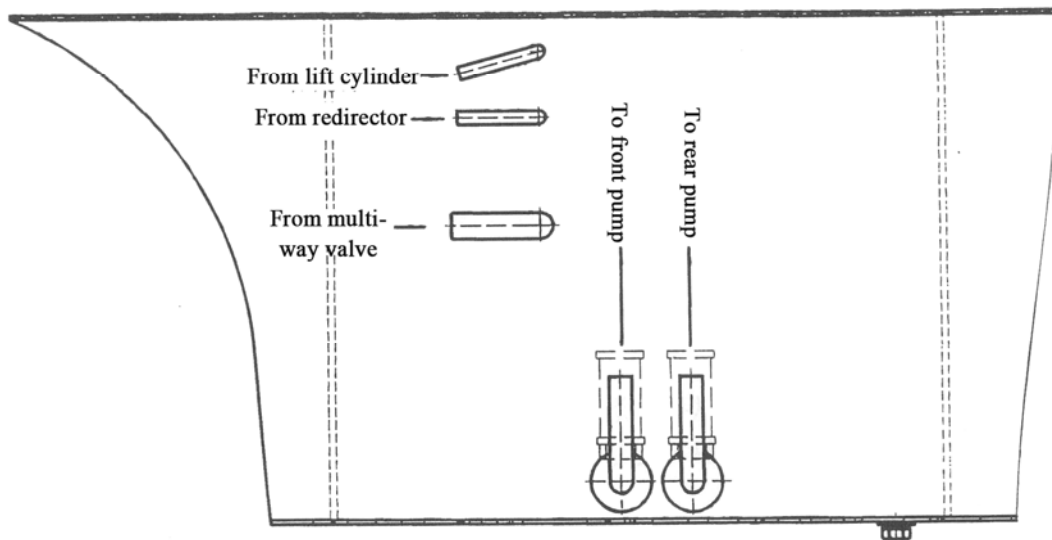


Fig 7.12 Oil Tank

7.9 Oil Way of Hydraulic System

Main oil way of hydraulic system is complex due to using double pump and steering oil way. Oil pipe joints are sealed by O rings, which have good air-tight ability and may ensure seal of oil.

Hydraulic oil released from rear pump shall be transferred directly to multi-way valve. But the oil released from front pump (master pump) is divided into two ways in bypass valve for steering brake and goods loading.

The hydraulic oil used for goods loading flows in multi-way valve and mixes with the oil released from rear pump, together supplied for good lift and tilting. When the multi-way valve is at the middle position, the oil returns to oil tank through multi-way valve.

When pulling the lift control lever, oil released from multi-way flows through the flow control valve and reaches to the bottom of lift cylinder piston, pushes the piston lever. When the lift control lever is impelled, the oil way between the bottom of lift cylinder piston and oil tank is connected, because the self-weight of piston lever, fork bracket and fork, etc. the piston begins down, in the case, oil return speed that from multi-way valve to oil tank shall be regulated by flow control valve.

When operating the tilting lever, hydraulic oil from master pump shall reach to one side of tilt cylinder piston and push the piston acting, oil in another side shall be pushed out by piston and return to oil tank through multi-way valve.

7.10 Maintenance

7.10.1 Removal of Multi-way Valve

Outside of multi-way valve removed from forklift shall be cleaned.

- (1) Remove the connection bolt and take apart the multi-way valve, do not lose the springs of single-way valve and joint face.
- (2) Remove the bolts at the sliding valve head and bolts with hexagonal slot in the cover side, remove the sliding valve with rubber cup, O ring and seal plate from the valve body.
- (3) Place the sliding valve on the bench vice and remove the connection bolts of lower cover, then take out spring and spring holder, for the tilt sliding valve with tilting self-locking valve, the spring and valve core inside the self-locking valve shall be removed as well.

7.10.2 Reassembly of multi-way valve

Clean all removed parts with mineral oil and check whether have burs or scratch. Replace parts if necessary, valve body and sliding valve, sliding valve and valve core shall be well packed after assembly. It shall be replaced integrately if necessary.

- (1) Clip the sliding valve with bench vice, then mount in valve core and spring, pay attention to the direction of valve core.
- (2) Mount in O ring, rubber cup, seal plate, spring holder, spring and spring holder, mount them in the sliding valve end in the turn, then cover after assembly, tighten the connection bolts with a moment of 25-32Nm.
- (3) Insert ready-assembled sliding valve assembly (one-piece valve) in the valve body and cover, connect with hexagonal bolts (tightening moment: 9-11Nm).
- (4) Fix O ring and rubber cup in the sliding valve head, screw down the seal plate with bolts, tightening moment: 4.6-5.8 Nm.
- (5) Mount in single-way valve, spring and O ring in each piece of valve after assembly, then screw down three connection bolts with required moment (one bolt: 103Nm, another bolt: 66Nm).

7.10.3 Notes

Before forklift ex-factory, all pressure of relief valves in multi-way valve shall be well adjusted. Users shall not adjust in use to prevent pressure over high and damage the hydraulic system and components. Pressure of all relief valves shall be regulated correctly according to the instruction after maintenance.

8. Lift cylinder and tilt cylinder (see Table 8.1 for main parameters)

Table 8.1

Forklift Tonnage			8t	10t
Item				
Lift cylinder	Type		Single action piston type	
	Inner Dia. of cylinder	mm	Φ 90	Φ100
	Outer Dia. of piston lever		Φ63	Φ70
	Cylinder travel		1495	
Tilt cylinder	Type		Double action piston type	
	Inner Dia. of cylinder	mm	Φ115	
	Outer Dia. of piston lever		Φ50	
	Cylinder travel		245	

8.1 Lift Cylinder

Two single action lift cylinders are fixed in the rear part of both sides of outer mast respectively. The cylinder bottom is fixed on the cylinder holder of outer mast. The cylinder roof, namely the tail of piston lever is connected with the inter mast upper beam by bolts. The piston travels of two lift cylinders shall be consistent to make two cylinders synchronous. It shall adjust the gaskets if two cylinders are not synchronous (see Fig 8.1).

Lift cylinder mainly includes body, piston, piston lever and cover. There is an oil inlet in the lower part of the body, high pressure oil flows in. there is an oil outlet in the upper part of the body, under Yx seal ring of piston seal, low pressure oil discharges from here. (Outlet is connected with return pipe).

Piston and piston lever are fixed together by groove nut, cotter pin and O seal ring, Yx seal ring, baffle ring and support ring are mounted on the outer circle of piston. The piston shall move upward along the internal surface of cylinder body due to the action of high pressure oil. There are anti-dust ring and steel-backed bearing in the cylinder cover, which is threaded in the body. Steel-backed bearing is used for supporting piston lever and anti-dust ring prevents dust in the cylinder. Tail of piston lever and upper cross sill of inter mast are mounted by bolts on the upper of cylinder.

When lift control lever is pulled backward, high pressure oil shall be input in the cylinder and lift the piston lever and inter mast through the oil inlet of lift cylinder, it lifts the fork by chains. When the inter mast is lift, the distance between ground to the fork is called free lift height, the mast height shall not change in the scope.

When the lift control lever pushes forward, the piston shall fall down due to self-weight of piston lever, fork bracket, goods baffle and fork. It shall release the oil under the piston out of the cylinder. The released oil speed is controlled by flow control valve (throttle) and returns to oil tank through multi-way valve.

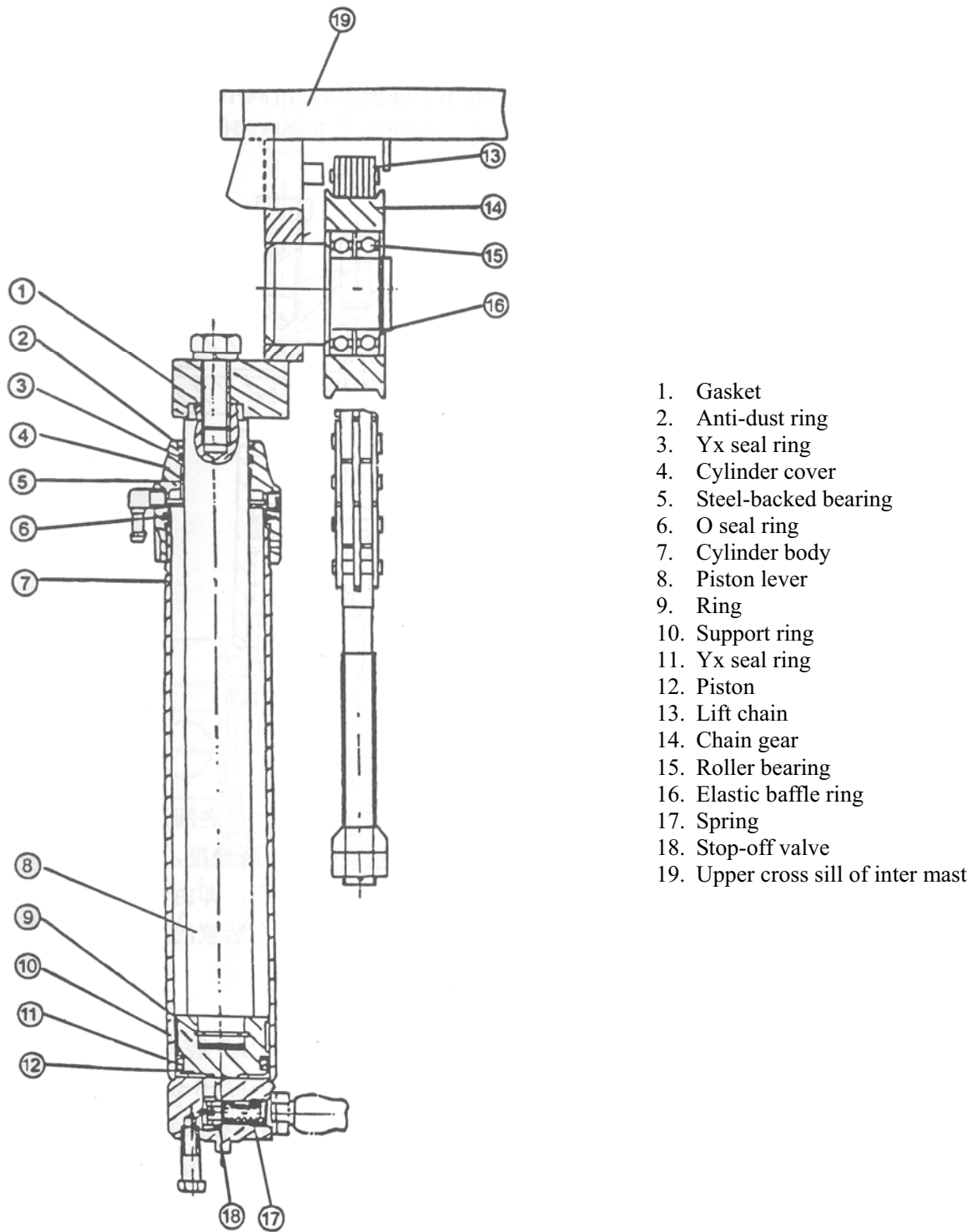


Fig 8.1 Lift Cylinder

8.2 Stop-off Valve

Both lift cylinders are mounted with stop-off valve in the bottom (see No. 18 in Fig 8.1), which may prevent goods sharply falling down when the high pressure pipe suddenly breaks. The structure of stop-off valve is shown in Fig 8.2. Return oil from lift cylinder passes the oil holes of stop-off valve and sliding valve and creates pressure difference of the two chambers. The sliding valve does not act when the difference is lower than spring force. If the high pressure pipe breaks suddenly, only few oil flows through the small hole of end face of sliding valve, the fork shall fall down slowly.

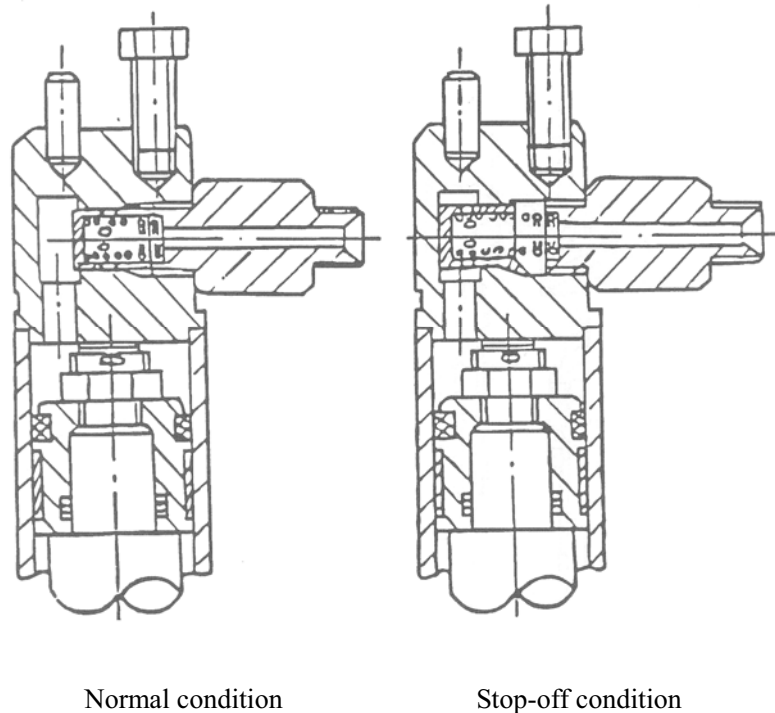


Fig 8.2 Stop-off Valve

8.3 Flow Control Valve

Flow control valve (throttle) is mounted in the oil way between multi-way valve and the high pressure outlet of two lift cylinder close to left lift cylinder (see Fig 8.3). The valve is used for controlling the falling speed of fork with heavy load. Its structure is shown in Fig 8.4.

As well as controlling goods falling speed, the flow control valve is used as a safety device. If the rubber hose between multi-way valve and lift cylinder damaged due to some reasons, the valve shall be a safety device (preventing goods falling suddenly and causing accident).

Work of flow control valve is as below:

See Fig 8.4, when the fork is lifting, high pressure oil from multi-way valve flows in Chamber A and pushes the valve sleeve moving leftward, the opening G will open, high pressure oil shall flow along two routes (A-B-G-D-E and A-B-C-D-E). Both oil of two routes shall flow in lift cylinder. In the case, oil flow is not adjusted and limited. When the fork begins falling, return oil released by lift cylinder enters in chamber E and pushes the valve sleeve moving rightward till the sleeve touching the joint, opening G is closed. Therefore, return oil passes E, D, H, C, A and returns to oil tank must through throttle plate. If return oil released by lift cylinder sharply increases, pressure of Chamber F shall increase and push the valve core (No. 5 in Fig 8.5) overcoming the spring force to move rightward, opening H shall be smaller, as a result, oil flow from Chamber D to Chamber C shall decrease, the falling speed of fork is limited (speed down).

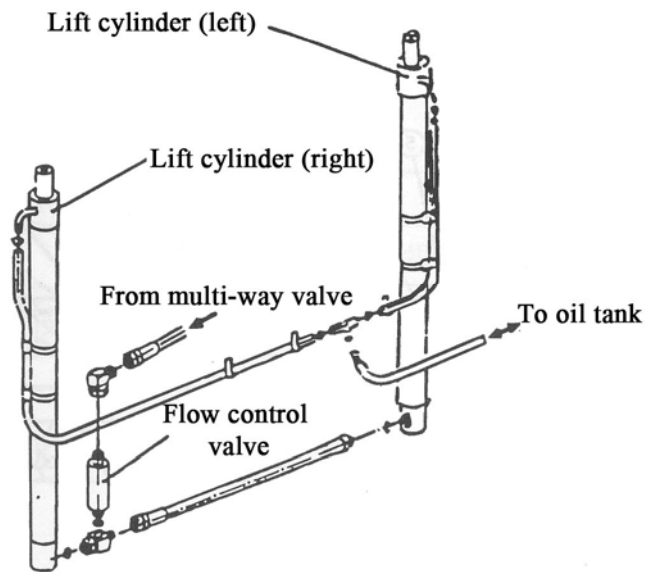
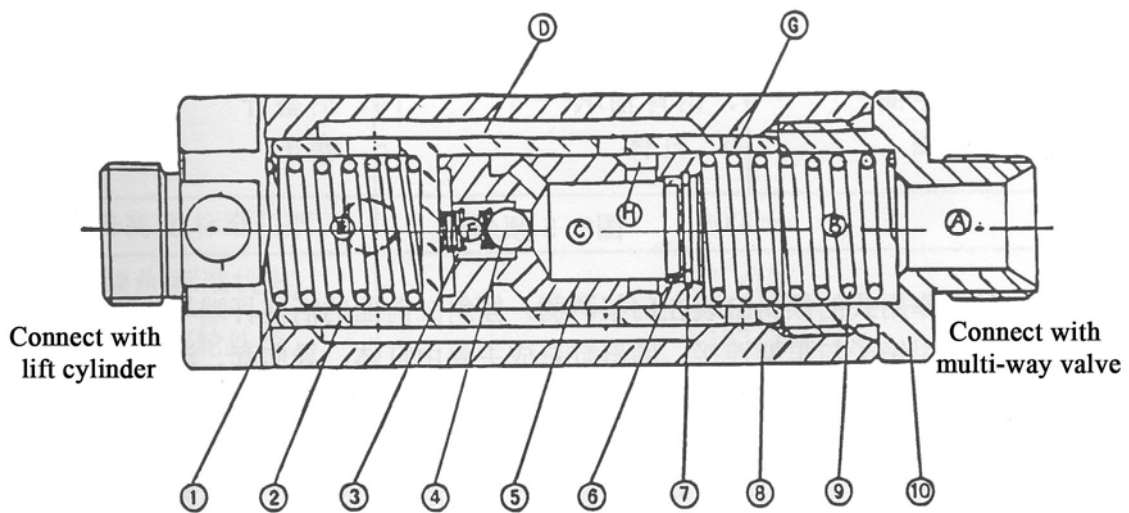


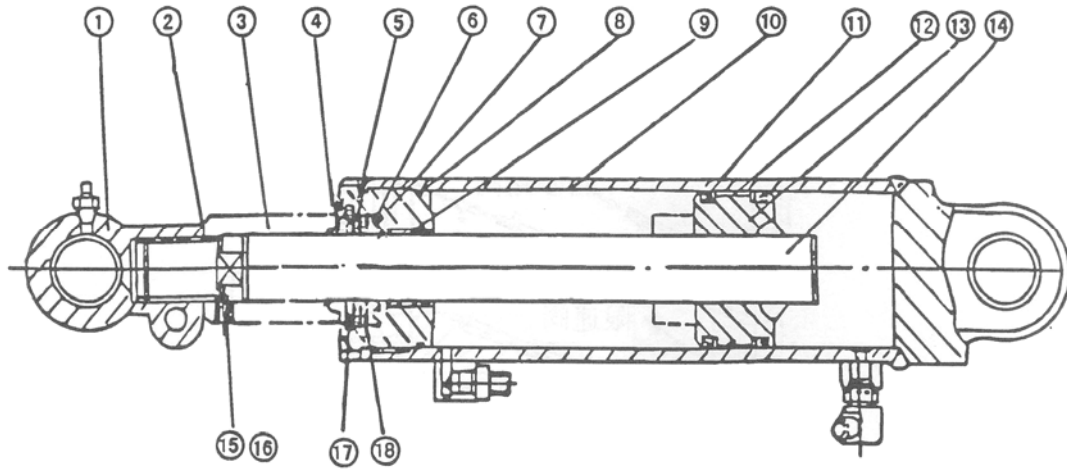
Fig 8.3 Assembly Position of Flow Control Valve



- | | | | |
|-----------------|-------------------|----------------|-----------|
| 1. Spring | 4. Nylon ball | 7. Baffle ring | 10. Joint |
| 2. Valve sleeve | 5. Valve core | 8. Valve body | |
| 3. Spring | 6. Throttle plate | 9. Spring | |

Fig 8.4 Flow Control Valve

8.4 Tilt Cylinder



1. Ring
2. Gasket
3. Adjusting shaft sleeve
4. Anti-dust ring
5. Baffle ring
6. Yx seal ring
7. Guiding sleeve (cylinder cover)
8. O ring
9. Steel-backed bearing
10. Cylinder body
11. Yx seal ring
12. Support ring
13. Piston
14. Piston lever
15. Plug
16. Bolt
17. Baffle ring
18. Baffle ring

Fig 8.5 Tilt Cylinder

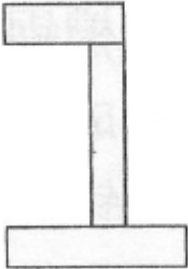
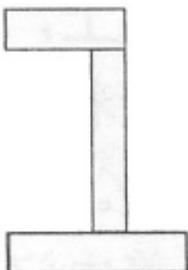
Two double-action tilt cylinders are mounted on the two sides of mast; piston lever in front of tilt cylinder connects with the mast. The cylinder bottom is connected with the frame by pins. Tilt cylinder mainly consists of body, guiding sleeve, piston and piston lever. Piston is welded on the piston lever. There are two Yx seal rings and a support ring mounted on the outer circle surface of piston. The piston shall move in the cylinder body under the action of hydraulic oil pressure. There is a steel-backed bearing, a Yx seal ring and a anti-dust ring mounted in the inter hole of guiding sleeve (cylinder sleeve). Seal ring and anti-dust ring are used for preventing oil leakage (between piston lever and guiding sleeve) and dust.

An O ring is mounted on the outer circle surface of guiding sleeve, and the sleeve is threaded in the cylinder body.

When the tilting control lever is forward, high pressure oil enters in the cylinder from the cylinder bottom and makes piston moving forward. Therefore, the mast tilts forward (about 6°). When the tilting control lever is backward, high pressure oil enters in the cylinder from the front guiding sleeve and makes the piston moving backward, then the mast tilts backward (about 12°).

9. Lifting System (see Table 9.1 for main parameters)

Table 9.1

Forklift		8t	10t
Item			
Mast type		Welded mast with free lift, 2-step trolley extension type	
Section shape of inter mast			
Section shape of outer mast			
Maximum lift height (standard mast)		3000mm	
front and rear tilting angle (standard condition)		6°/ 12°	
Trolley	Outer dia. of master trolley	183.5mm	
	Outer dia. of side trolley	82mm	
	Outer dia. of side trolley (fork bracket)	102	119
Lift chain (leaf chain)		Lh2044	Lh2444
Fork lift type		Hydraulic type	

9.1 General

Lifting system adopts rolling type. Basic type is 2-step extension mast type. Inter mast is J-shaped section. Outer mast is J-shaped section for 10t forklift, and C-shaped section for 8t forklift. Both have free lift.

9.2 Inter and outer mast

Mast assembly is 2-step extension type with free lift, made up of inter mast and outer mast and supported by mast support.

Mast support is welded in the bottom of outer mast, extends to axle housing and connected with it. Namely the self-weight of mast is supported by axle housing. There is a tilt cylinder holder in the outer mast, the front part of tilt cylinder (piston lever side) is connected with the holder by pins. The mast shall tilt under the action of tilt cylinder, forward angle 6° , and backward angle 12° .

Inter mast is composed of left and right mast V-irons, which are connected by upper and lower cross sills. Similarly, outer mast is composed of left and right V-irons, which are connected by upper, middle and lower cross sills. In the upper part of left and right outer mast V-irons, there are trolley shafts welded in the inter side of outer mast V-iron used for mounting master trolley and its spring baffle ring. In addition, side trolley is mounted on the outer mast, in the inter mast of side support. There is trolley shafts welded in the outside of lower part of left and right mast V-irons. Master trolley and its elastic baffle ring are mounted on the trolley shafts. There is side trolley mounted under the master trolley, used for bearing transverse load. Depending on these trolleys, inter mast may work stably.

9.3 Fork bracket

There is a trolley shaft welded on the fork, master trolley that rolls along the inter face of inter mast and its elastic baffle ring are mounted on the shaft. Side trolley that rolls along the inside of inter mast is raised to the inter mast through side trolley shaft by bolts, and adjusted by adjusting gasket. In order to prevent fork beam (fork support plate or upper cross sill) shaking, two limit trolleys are mounted, which rolls along the outer side of inter mast. Master trolley bears the longitudinal load, the master trolley shall expose (a part) from mast top when the fork lifts to the maximum lift height. Transverse load is borne by limit trolley in the upper and side trolley in the lower. It shall consider sufficient rigidity and strength for mast assembly and fork bracket in design. Stable operation shall be also considered.

In addition, upper and lower cross sills of fork bracket are made of high strength steel. The fork bracket shall be integrated structure to ensure its durability.

Two forks are mounted on the bracket, which are made of heat-treated alloy steel.

9.4 Adjustment of Lifting System

9.4.1 Adjustment of lift cylinder head gasket

Lift cylinder travel shall be adjusted when the cylinder, inter mast or outer mast is removed and replaced.

- (1) Mount the piston lever head on the upper cross sill of inter mast without adjustment.
- (2) Slowly lift the mast to the maximum travel of cylinder, check two cylinders whether synchronous.
- (3) Add adjusting gasket between the piston lever head of cylinder that stops moving first and upper cross sill of inter mast.
Thickness of adjusting gasket: 0.2mm – 0.5mm
- (4) Adjust the tension of chain.

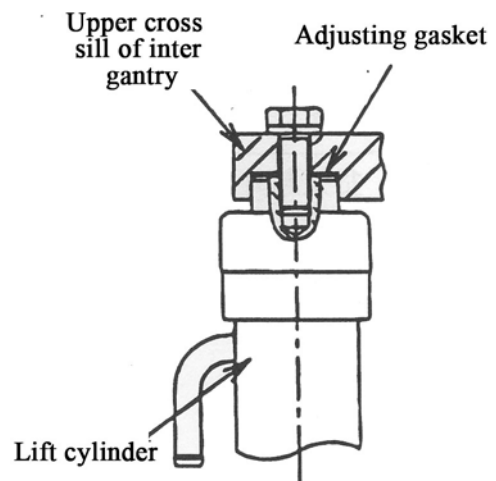


Fig 9.1

9.4.2 Adjustment of fork bracket height

- (1) Park the forklift on the flat ground and make the mast upright.
- (2) Make the fork bottom touching the ground, adjust the adjusting nut of end joint in the upper part of chain to expose the master trolley at the lower part of fork bracket. A is $\frac{1}{4} - \frac{1}{3}$ of the master trolley radius.

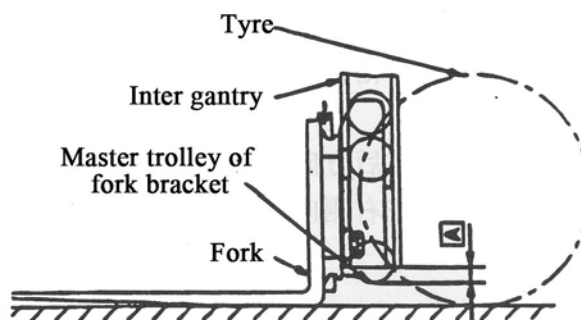


Fig 9.2

- (3) Lift the fork to the upper limit and confirm the clearance B of limit block of fork bracket and limit block of inter mast is 5-10mm.

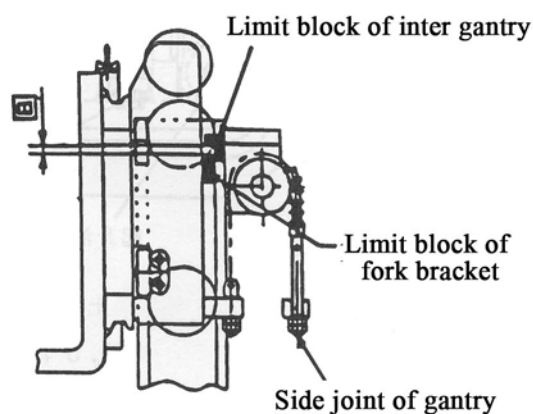


Fig 9.3

- (4) Fall the fork bracket to the ground and tilt properly, adjust the adjusting nut of end joint at the upper part of chain to make the tension of two chains same.

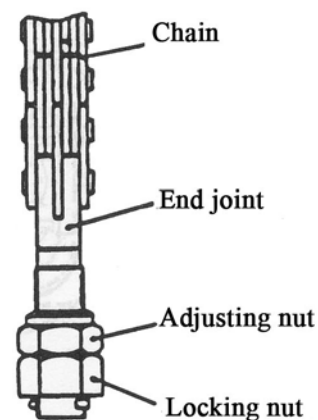


Fig 9.4

9.5 Mounting Position of Trolley

There are three kinds of trolleys in the lifting system, including master trolley, side trolley unit and side trolley, which are mounted on the inter mast, outer mast and fork bracket respectively.

Master trolley bears the main load in the front-to-rear direction of the forklift, generally it cannot be adjusted. Side trolley bears the side load, which may be adjusted by gasket unit in left and right side clearance, and make the inter mast and fork bracket moving freely up and down.

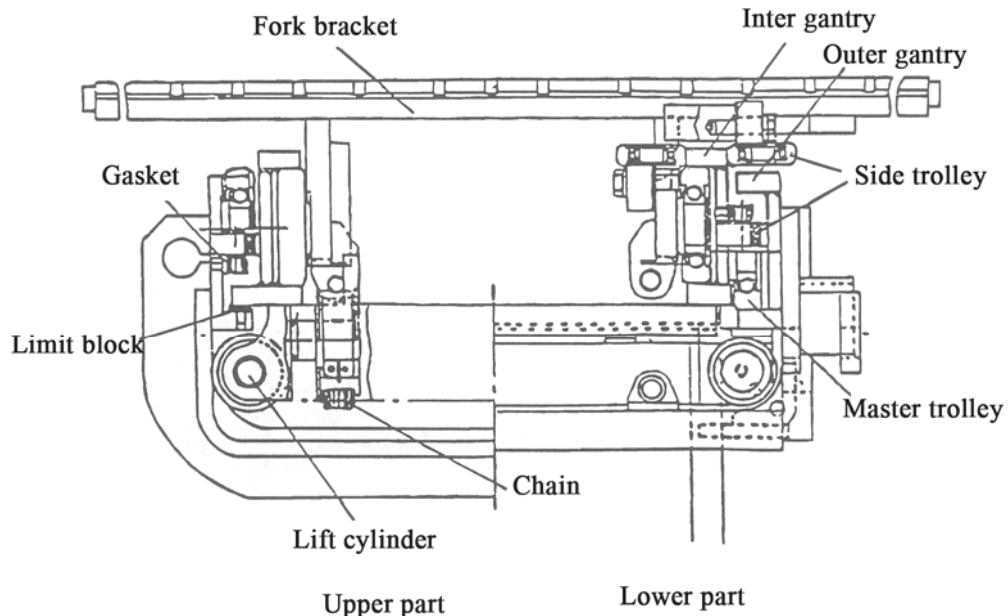


Fig 9.5 Installation of Trolley (8t forklift)

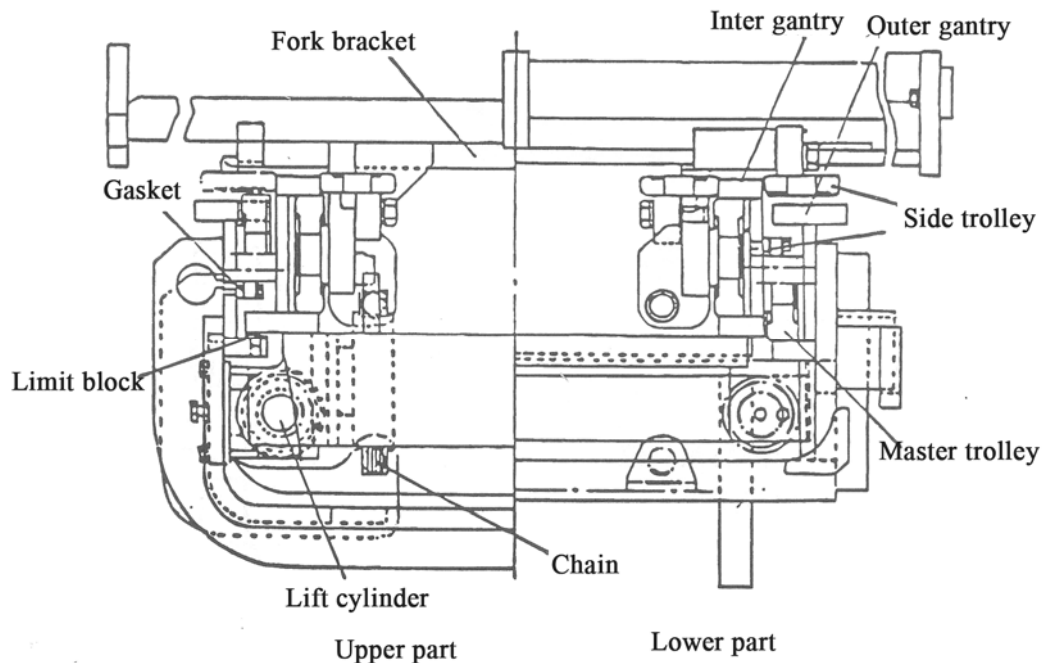


Fig 9.6 Installation of Trolley (10t forklift)