SECTION 5 STEERING SYSTEM



Steering system consists of hydraulic pump, steering wheel assembly, steering unit, preferential valve, steering cylinder, and piping. Steering axle with integrated rear wheel tire and cylinder supports the weight of forklift truck. Steering axle is of structure with steering knuckles installed on the both sides of king pin. Hubs and wheels are fastened on spindles of knuckles. When turning steering wheel to move forklift struck to the left or right, rotational torque is transferred to steering unit, and hydraulic oil in steering unit flows to steering axle hydraulic cylinder through hose. Force generated from steering cylinder moves knuckle of rear wheel through intermediate link. See the figure for locations of steering system components.

2. HYDRAULIC CIRCUIT



Hydraulic oil is supplied from hydraulic pump to preferential valve. When driver turns steering wheel, hydraulic oil is supplied first to steering unit by working circuit inside preferential valve. Hydraulic oil inside steering unit is expanded or shrunk, and then supplied to steering cylinder of forklift truck. hydraulic oilexcessively discharged from hydraulic pump flows to hydraulic oil tank along main control valve and preferential valve EF port.

1) NEUTRAL

When hydraulic motor starts operating, and steering wheel is kept in neutral position, steering unit spool and sleeve are kept in neutral position. Flow of hydraulic oil through valve is blocked to the left and right steering ports. Pressure on pilot of preferential valve spool controls spool to move it to the opposite direction. Hydraulic oil flows to main control valve through EF port with this type of control. Small quantity of hydraulic oil in neutral position is continuously discharged through orifice. Hydraulic oil flows in through LS hose piping, and then is discharged to hydraulic oil tank through steering unit spool and sleeve. Upon sudden steering, dynamic flow of hydraulic oil prevents initial hard spot.

2) TURING LEFT OR RIGHT

When hydraulic motor starts operating, and steering wheel is turned, steering unit spool and sleeve rotate. Path opens to allow supply of hydraulic oil to gear inside steering unit. Hydraulic oil causes rotation of pump. Hydraulic oil returns to steering valve spool and sleeve, and is supplied to left or right steering port by turning of steering wheel. LS port circuit is connected to PF port, which blocks return of hydraulic oil to hydraulic oil tank, and senses pressure required for turning of steering

wheel. When pressure required for LS circuit increases or decreases, preferential valve spool moves to satisfy conditions of hydraulic oil and pressure required for rotating tires. Once steering cylinder reaches the maximum stroke, relief valve supplies hydraulic oil to hydraulic oil tank to adjust pressure. Preferential valve spool moves to supply hydraulic oil to main control valve through EF port.

When the vehicle turns right (R), the steering wheel rotates clockwise, the steering gear works right, the B port is under high pressure, and the steering cylinder is connected to the left chamber (LH). The same is true for vehicles turning left.

3. STEERING UNIT

1) STRUCTURE



1 Screw

3

4

5

6

7

8

9

10

11

2 Washer-Spring

O-Ring

X-ring

O-Ring

O-Ring

Steel Ball

Body-Valve

Cover-Front

Sleeve-Thread

13 Washer

12

14 Element-Valve

Bearing

- 15 Washer
- 16 Pin
- 17 Plate-Spring
- 18 Sleeve-Valve
- 19 Shaft
- 20 Plate-Separate
- 21 Stator
- 22 O-Ring

- 23 Rotor
- 24 O-Ring
- 25 Ring-Slide
- 26 Pin
- 27 Cover-Rear
- 28 Nameplate
- 29 Washer
- 30 Rivet
- 31 Bolt-Retain
- 32 Bolt

* Seal kit: 5,7,9,22, 29

Ring-Retain

2) OPERATION

Steering unit is a closed neural circuit and a gauging gear set consisted of rotation valve (spool + sleeve set). Steering unit mitigates impact of sudden rotation or kickback of tire on steering wheel together with LS (load sensing) dynamic circuit to ensure smooth movement of steering wheel without interference when oil viscosity is low in winter season. LS circuit inside valve is used for control of operation of preferential valve spool.







Hydraulic motor stops, and preferential valve spool is pushed to the end by spring force when turning steering wheel. In such a case, hydraulic oil flows to spool and sleeve set, and EF port is closed. Turing steering wheel forms vacuum in supply line between preferential valve and steering unit spool and sleeve set. Path is opened for allowing flow of hydraulic oil to gerotor gear inside steering unit to rotate spool and sleeve set. Hydraulic oil entrapped in steering port flows through manual steering check valve, and is supplied to opposite steering cylinder through gerotor gear.

4. STEERING AXLE

1) Structure



| 1 | Body | 13 | BEARING |
|----|--------------------|----|-------------|
| 2 | Steering Cyl.Ass'y | 14 | WASHER |
| 3 | KNUCKLE-RH | 15 | CAP |
| 4 | COVER | 16 | NUT-SLOTTED |
| 5 | SPACER | 17 | Split Pin |
| 6 | O-RING | 18 | BOLT-HUB |
| 7 | King Pin | 19 | NUT-HUB |
| 8 | PIN | 20 | SEAL |
| 9 | BEARING | 21 | Collar |
| 10 | SEAL | 22 | NUT-SLOTTED |
| 11 | BEARING | 23 | Split Pin |
| | | | |

12 HUB

- В
- rted
- - 24 BEARING

- 25 KNUCKLE-LH
- 26 CIRCLIP
- 27 BEARING-SPH PLAIN
- 28 BUSHING
- 29 PIN-STEER LINK
- 30 LINK
- **GREASE FITTING** 31
- 32 PIN
- 33 WASHER
- 34 SPRING WASHER
- 35 BOLT-PATCH
- 36 **GREASE FITTING**

2) SPECIFICATION TABLE





| Item | | Unit | Specifications | |
|-------------------------|------------|------|----------------|------|
| Max, standing angle | Inner side | А | | 79 |
| Max. Steering angle | Outer side | В | Degree | 54.5 |
| Reciprocating angle | | C | | 1 |
| Distance between wheels | | D | mm | 810 |
| Stroke | | Е | | 81 |

5. STEERING CYLINDER



- 1 ROD
- 2 DUST WIPER
- 3 CIRCLIPS FOR SHAFT
- 4 RING-RETAINING
- 5 U-PACKING
- 6 RETAINING RING
- * Seal kit: 2,5,6,7,13,15,16

- 7 O-RING
- 8 BACK UP RING
- 9 TUBE ASS'Y
- 10 PISTON
- 11 Steel Ball
- 12 DU-BUSH

- 13 GLEN CIRCLE
- 14 ROD COVER
- 15 O-RING
- 16 O-RING
- 17 BEARING-SPH PLAIN

GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

| I. OPERALIONAL CHECK | | |
|-------------------------|--|--|
| Inspection items | Inspection procedures | |
| Knuckle | \cdot Inspect knuckle with visual checking, or crack inspection method. Bent | |
| | knuckle indicates non-uniform abrasion of tires. Check abrasion of tires. | |
| Steering axle | \cdot Make request to assistant to drive the truck in the min. turning radius. | |
| | \cdot Affix chalk on outer edge of counterweight for drawing turning radius. | |
| | · Min. turning radium (outside): see Section1 Group2 'specifications.' | |
| Power steering pressure | Install hydraulic pressure gauge on bidirectional pump. | |
| | \cdot Turn steering wheel as far as possible, and check hydraulic pressure. | |
| | Hydraulic pressure: 100 bar | |

1. OPERATIONAL CHECK

2. TROUBLESHOOTING

1) STEERING UNIT

| Trouble | Possible cause | Troubleshooting | |
|----------------------|---|---|--|
| Oil leak | · Bolts loose | ·Tighten | |
| | · Oil seal broken | ·Replace | |
| | · Washer broken | · Replace | |
| Turn steering wheel | · Pump supply insufficient oil | \cdot Check oil pump and the oil hose | |
| need bigger force | | connected to pump/repair or replace | |
| | · Air in system | \cdot Check/repair connection and exhaust air | |
| | $\cdot \operatorname{Oil}$ level in tank is lower than designed | · Add oil | |
| | \cdot Check valve (steel ball) disabled | · Clean the steel ball | |
| | · The pressure is too low | · Check all system | |
| Steering not allowed | · Spring broken | · Replace | |
| | · Pin or shaft broken | ·Replace | |
| | · Incorrect installation in rotor and shaft | ·Remount | |
| | · Rotor or stator's gap is too big | ·Replace | |

2) Steering axle

| Trouble | | Possible cause | Troubleshooting |
|----------|-------------------------|--------------------------------------|-----------------|
| Oil leak | Hub oil seal | ·Broken | · Replace |
| | Cover-knuckle | ·Broken | · Replace |
| | Knuckle oil seal | ·Broken | · Replace |
| | Piston rod oily | • Dusty wiper broken | · Replace |
| | | · U-Packing broken | · Replace |
| | | · O-Ring broken | · Replace |
| | | · Piston rod surface is scratched | · Replace |
| | Cylinder body connector | · O-Ring broken | · Replace |
| Noise | Hub | · Hub bearing's gap is too big | · Adjust |
| | | · Hub bearing broken | · Replace |
| | King pin | · King pin bearing's gap is too big | · Adjust |
| | | · Hub bearing broken | · Replace |
| | | · King pin is abrasive | · Replace |
| | Pin-Steer link | · Bearing-SPH plain is abrasive | · Replace |
| | | · Pin-Steer link bearing is abrasive | · Replace |
| | Cylinder | · Connect bolts loosen | · Tighten |
| | | · Ring-Back up broken | · Replace |
| | | · Steel ball position is abrasive | · Replace· |
| | | · DU-Bush inner is abrasive | · Replace |

GROUP 3 DISASSEMBLY AND ASSEMBLY

1. STEERING UNIT



Disassemble

- 1) Remove bolt (32#) and rear cove (27#).
- 2) Remove sleeve-valve (18#) and shaft (19#) from body-valve (8#).
- 3) Remove O-Rings (9#/24#).
- 4) Remove bolts (1#) and front cover (3#).
- 5) Remove X-Ring (5#) and O-Ring (7#).

2. STEERING AXLE

Disassemble



- 1) Remove circlips (26#) to remove links (30#).
- 2) Remove pins (32#) and bolts (35#) to remove steering cylinder (2#).
- 3) Remove king pin (7#) to remove hubs (12#) and knuckles (3#/25#)
- 4) Remove cap (15#) and nut (16#) to remove hub (12#) from knuckle (3#/25#).
- * Care should be exercised to protect O-ring and bearings.
- * Store LH and RH knuckles respectively.

Assembling is the reverse order of removal and for more details please refer disassemble in next page.

Assemble

1) Mount outer ring of bearing (13#) into hub (12#) with a fixture.

2) Mount outer ring of bearing (11#) into hub (12#) with a fixture.

3) Mount bolt (19#) \times 8 into hub (12#) with a fixture.

 Apply lithium base grease on inside of hub (12#) until 1/3-1/2 of inside surface is applied.









5) Mount oil sear (10#) into hub (12#).

6) Mount bearing-SPH plain (27#) and bushing (28#)
× 2 into knuckle (3#/25#)

Mount outer ring of bearing (9#) into knuckle
(3#/25#) with a fixture.

 Mount outer ring of bearing (24#) into knuckle (3#/25#) with a fixture



 Mount inner ring of bearing (24#) into knuckle (3#/25#).

10) Mount seal (20#) into knuckle (3#/25#) with a fixture.

11) Mount the hub assy (12#) and knuckle (3#/25#) together.

12) Mount inner ring of bearing (13#) into knuckle (3#/25#).



13) Mount washer (14#) into hub (12#).

14) Mount the nut-slotted (16#) into hub (12#). After tightening the nut with torque in 15 kgf·m, then return the nut 1/5 circle.

Check if the start torque of hub is 4.5-9 kgf • m. If not, adjust the nut-slotted (16#)



15) Mount the split pin (17#) into knuckle (3#/25#).

16) Mount the cap (15#) on hub (12#) with a rubber hammer.

17) Mount inner ring of bearing (9#) into knuckle (3#/25#).

 Mount cover (4#) and space (5#) together, then mount it on hub (3#/25#).









19) Mount O-Ring (6#) on king pin (7#), then mount it and hub (3#/25#) in body (1#).

20) Mount collar (21#) in body (1#)

21) Mount the nut-slotted (22#) on king pin (7#). After tightening the nut with torque in 12 kgf·m, then return the nut 1/5 circle.

Check if the start torque of hub is 2.5-4.5 kgf • m. If not, adjust the nut-slotted (22#)



22) Mount split pin (23#) into king pin (7#).



23) Put steering CYL.Assy (2#) into body (1#).



24) Mount bolt-patch (35#) \times 4, spring washer (34#) \times 4 and washer (33#) \times 4 in body (1#) to lock steering CYL.Assy.

25) Mount pin (32#) \times 2 into body (1#).

- 26) Mount link (30#) \times 2 with pin-steer link (29#) \times 4 to link knuckle (3#/25#) and steering CYL.Assy (2#).
- 27) Mount circlip (26#) $\,\times\,$ 4 to lock the links.







28) Mount grease fitting (31#) × 4 into pin-steer link (29#).



29) Mount grease fitting (36#) \times 2 into knuckle (3#/25#).

