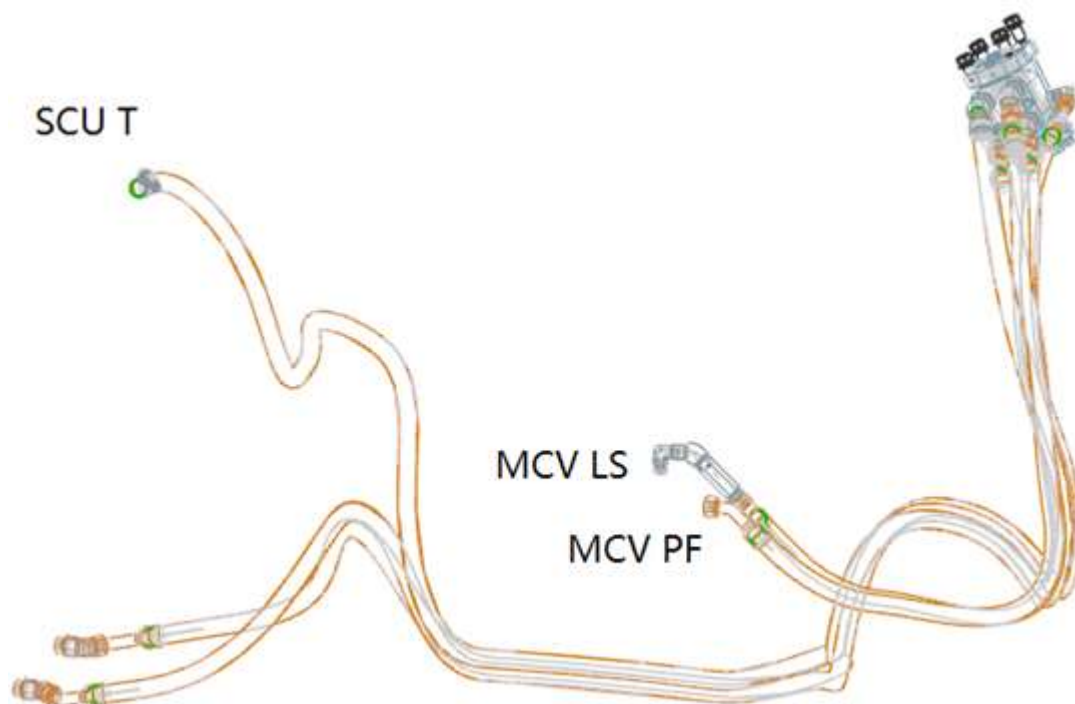


## SECTION 5 STEERING SYSTEM

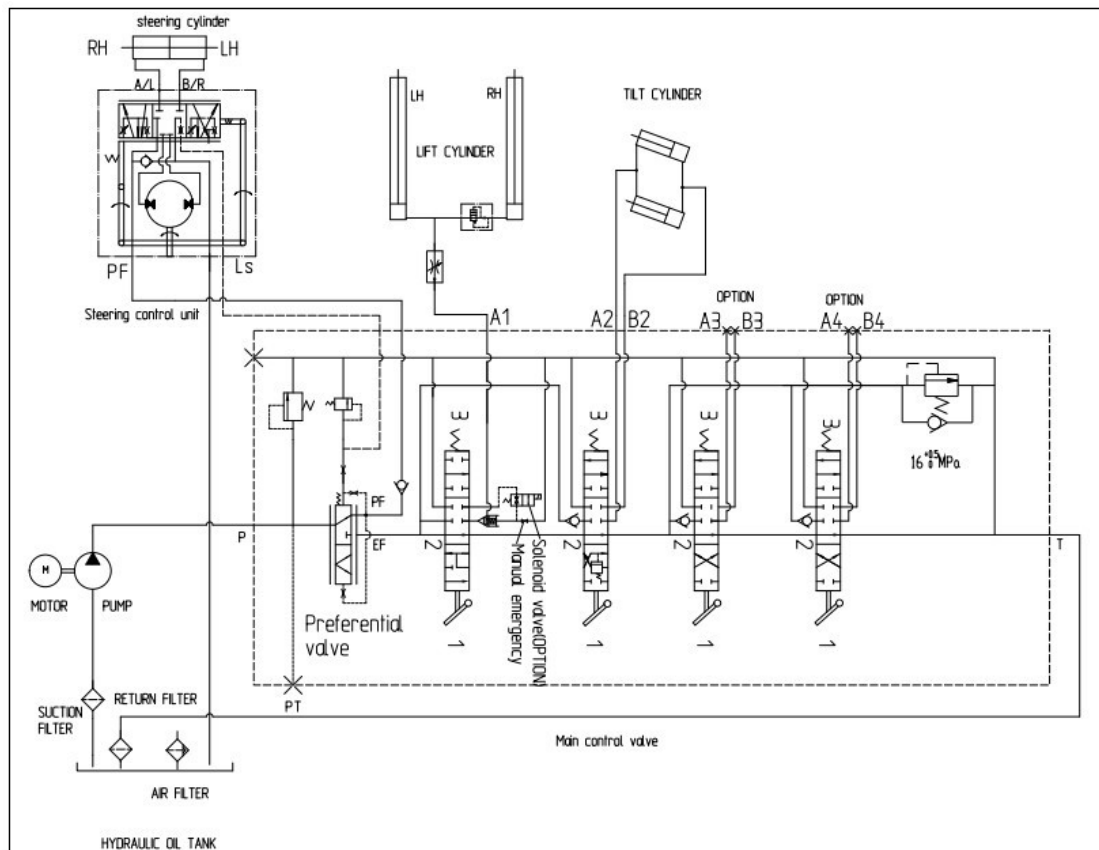
### GROUP 1 STRUCTURE AND FUNCTIONS

#### 1. INTRODUCTION



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 truck 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 oil excessively 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) TURNING LEFT OR RIGHT

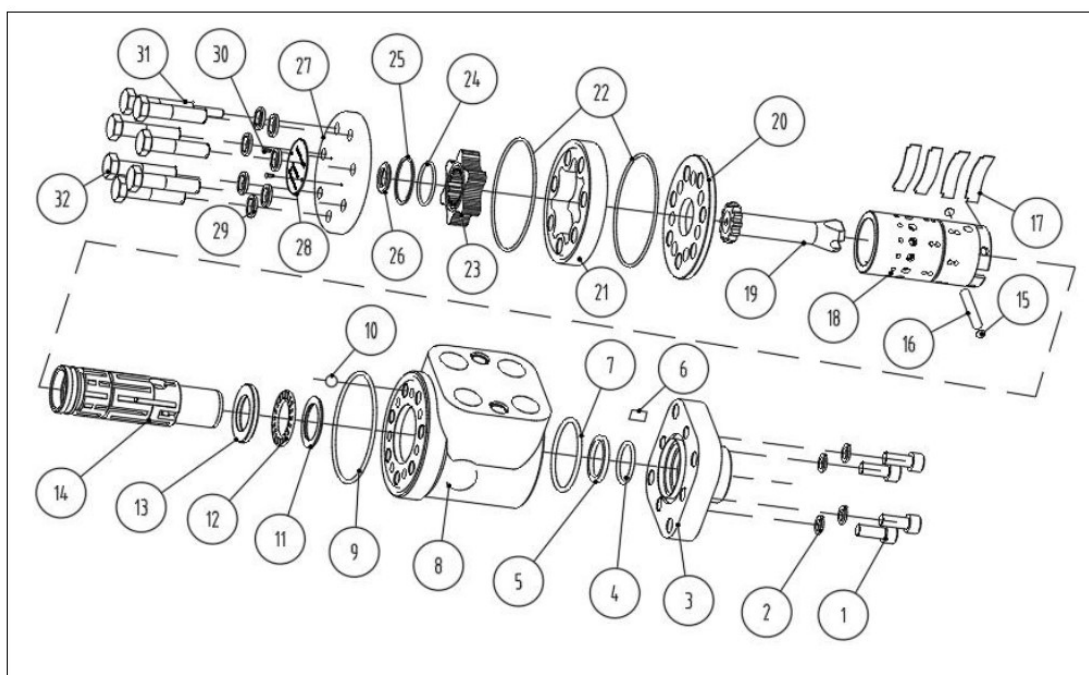
When hydraulic motor starts operating, and steering wheel is turned, steering unit spool and sleeve rotate. Path opens to allow supply of hydraulic oil to gear inside steering unit. Hydraulic oil causes rotation of pump. Hydraulic oil returns to steering valve spool and sleeve, and is supplied to left 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

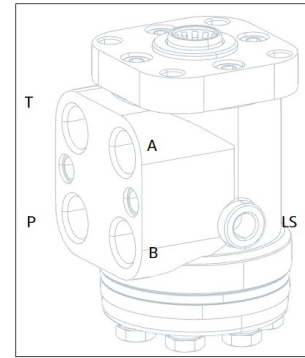


1	Screw	12	Bearing	23	Rotor
2	Washer-Spring	13	Washer	24	O-Ring
3	Cover-Front	14	Element-Valve	25	Ring-Slide
4	O-Ring	15	Washer	26	Pin
5	X-ring	16	Pin	27	Cover-Rear
6	Sleeve-Thread	17	Plate-Spring	28	Nameplate
7	O-Ring	18	Sleeve-Valve	29	Washer
8	Body-Valve	19	Shaft	30	Rivet
9	O-Ring	20	Plate-Separate	31	Bolt-Retain
10	Steel Ball	21	Stator	32	Bolt
11	Ring-Retain	22	O-Ring		

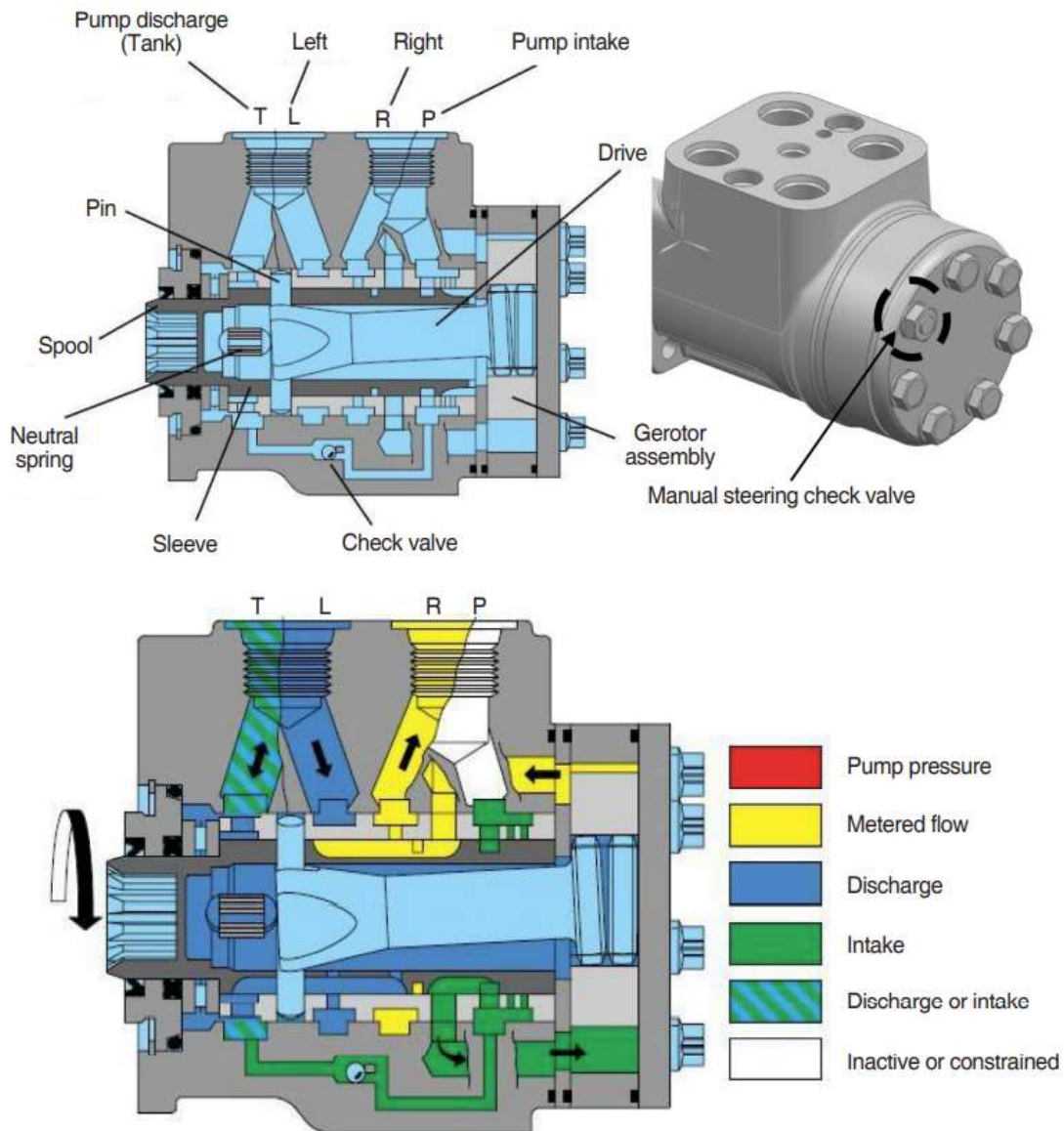
※ Seal kit: 5,7,9,22, 29

## 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.



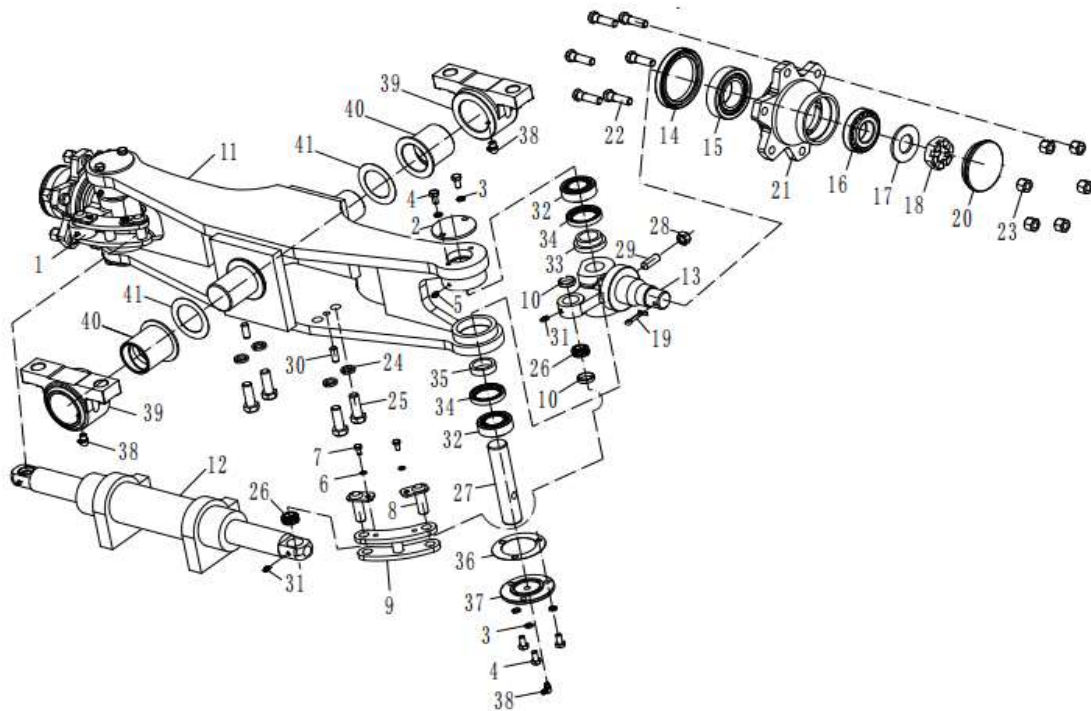
## 3) MANUAL STEERING IN EMERGENCY



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. Turning 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.

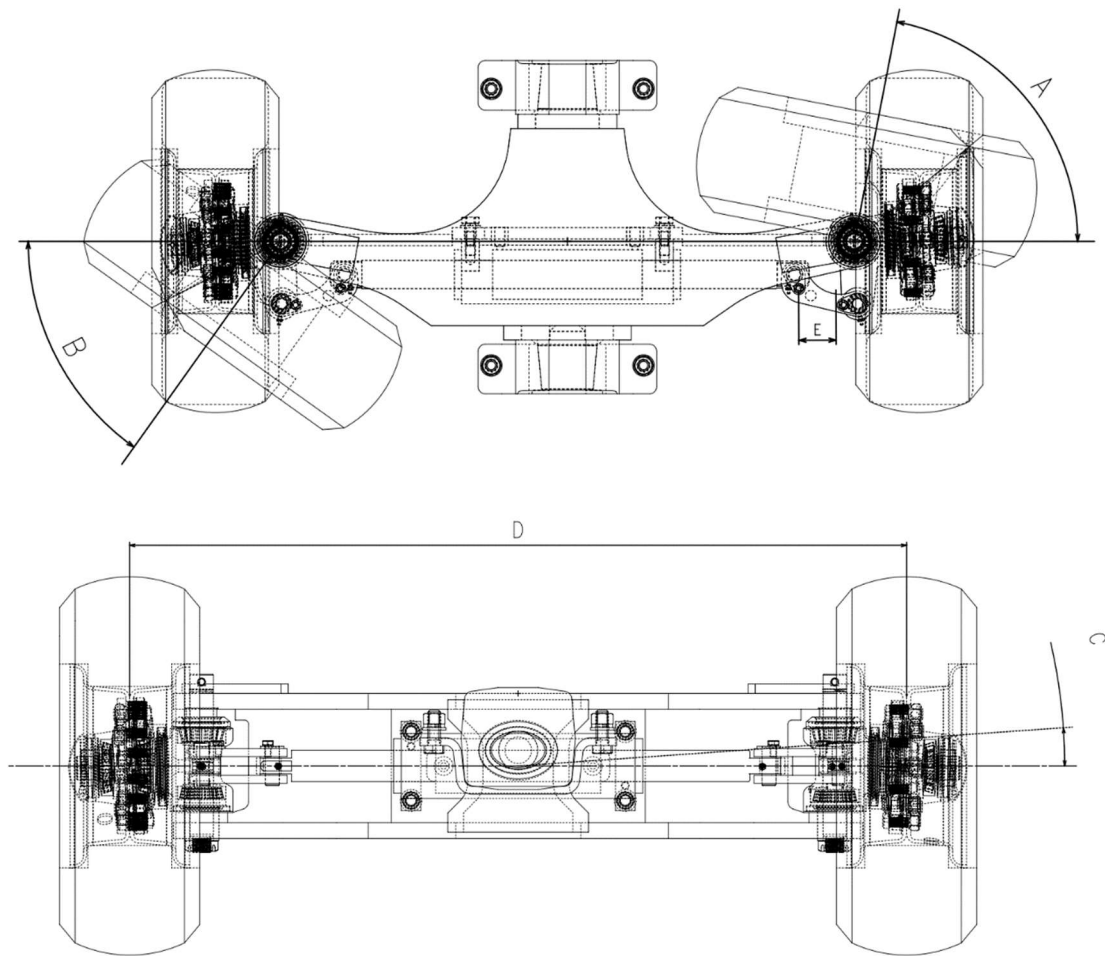
#### 4. STEERING AXLE

##### 1) Structure



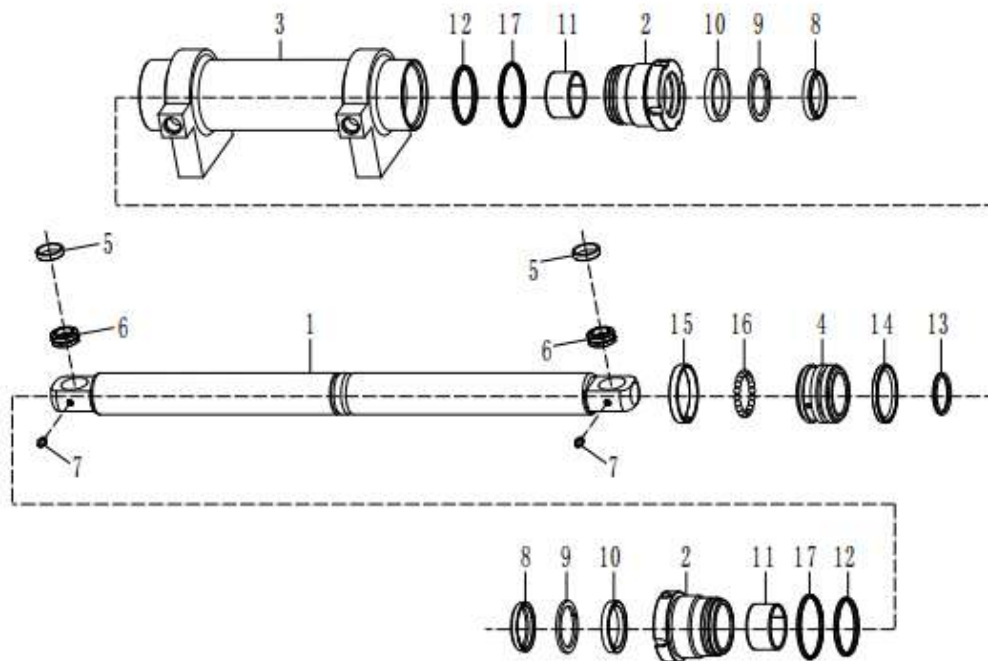
1	KNUCKLE-LH	15	BEARING	29	SCREW-HEX SOCKET
2	COVER- KING PIN	16	BEARING	30	PIN
3	WAHSER-SPRING	17	WASHER-PLAIN	31	GREASE FITTING
4	BOLT	18	NUT-SLOTTED	32	BEARING
5	GREASE FITTING	19	SPLIT PIN	33	CIRCLIP
6	WAHSER-SPRING	20	CAP	34	SEAL
7	BOLT	21	HUB	35	CIRCLIP
8	PIN-STEER LINK	22	BOLT-HUB	36	SHIM
9	LINK	23	NUT-HUB	37	PLATE
10	BUSHING	24	WAHSER-SPRING	38	GREASE FITTING
11	BODY	25	BOLT	39	SUPPORT
12	STEERING CYLASS'Y	26	BEARING-SPH PLAIN	40	BUSHING
13	KNUCKLE-RH	27	KING PIN	41	SHIM-SUPPORT
14	SEAL	28	NUT		

## 2) SPECIFICATION TABLE



Item			Unit	Specifications
Max. steering angle	Inner side	A	Degree	78.54
	Outer side	B		53.74
Reciprocating angle		C		1
Distance between wheels		D	mm	945
Stroke		E		72.5

## 5. STEERING CYLINDER



1	ROD	7	GREASE FITTING	13	O-RING
2	ROD COVER	8	DUST WIPER	14	GLEN CIRCLE
3	TUBE ASS'Y	9	RETAINING RING	15	RING
4	PISTON	10	SEAL	16	Steel Ball
5	CIRCLIP	11	DU-BUSH	17	O-RING
6	BEARING-SPH PLAIN	12	O-RING		

※ Seal kit: 5,8,9,10,12,13,14,15,17

## GROUP 2 OPERATIONAL CHECKS AND TROUBLESHOOTING

### 1. OPERATIONAL CHECK

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

### 2. TROUBLESHOOTING

#### 1) STEERING UNIT

Trouble	Possible cause	Troubleshooting
Oil leak	· Bolts loose	· Tighten
	· Oil seal broken	· Replace
	· Washer broken	· Replace
Turn steering wheel need bigger force	· Pump supply insufficient oil	· Check oil pump and the oil hose connected to pump/repair or replace
	· Air in system	· Check/repair connection and exhaust air
	· Oil level in tank is lower than designed	· Add oil
	· 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

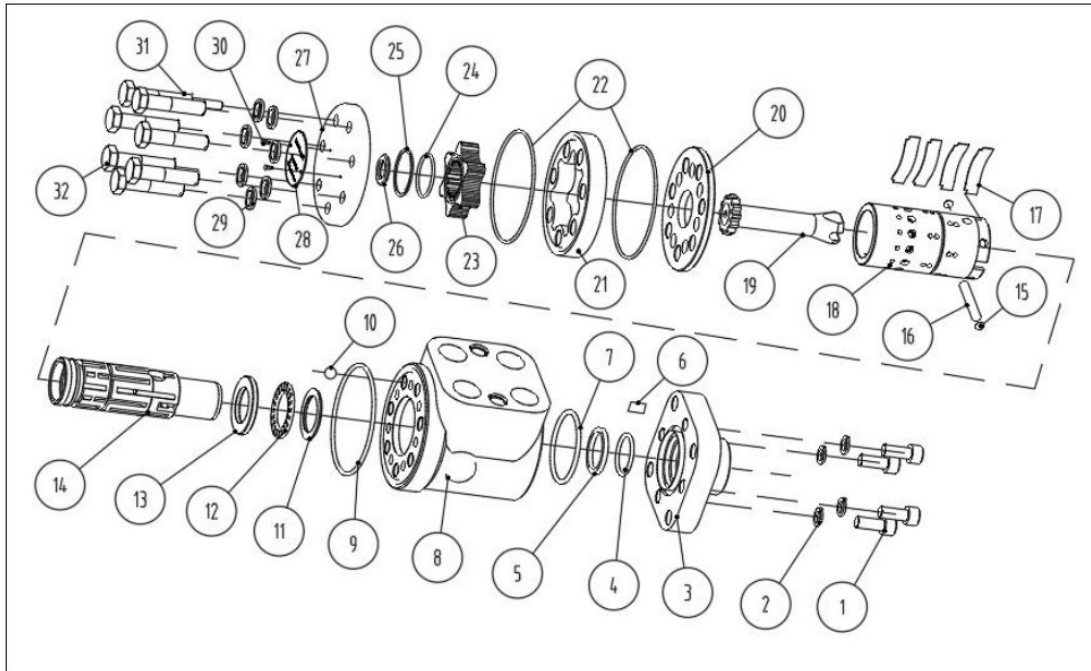


## 2) Steering axle

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 · U-Packing broken · O-Ring broken · Piston rod surface is scratched	· Replace · Replace · Replace · Replace
	Cylinder body connector	· O-Ring broken	· Replace
Noise	Hub	· Hub bearing's gap is too big · Hub bearing broken	· Adjust · Replace
	King pin	· King pin bearing's gap is too big · Hub bearing broken · King pin is abrasive	· Adjust · Replace · Replace
	Pin-Steer link	· Bearing-SPH plain is abrasive · Pin-Steer link bearing is abrasive	· Replace · Replace
	Cylinder	· Connect bolts loosen · Ring-Back up broken · Steel ball position is abrasive · DU-Bush inner is abrasive	· Tighten · Replace · Replace · Replace

## GROUP 3 DISASSEMBLY AND ASSEMBLY

### 1. STEERING UNIT

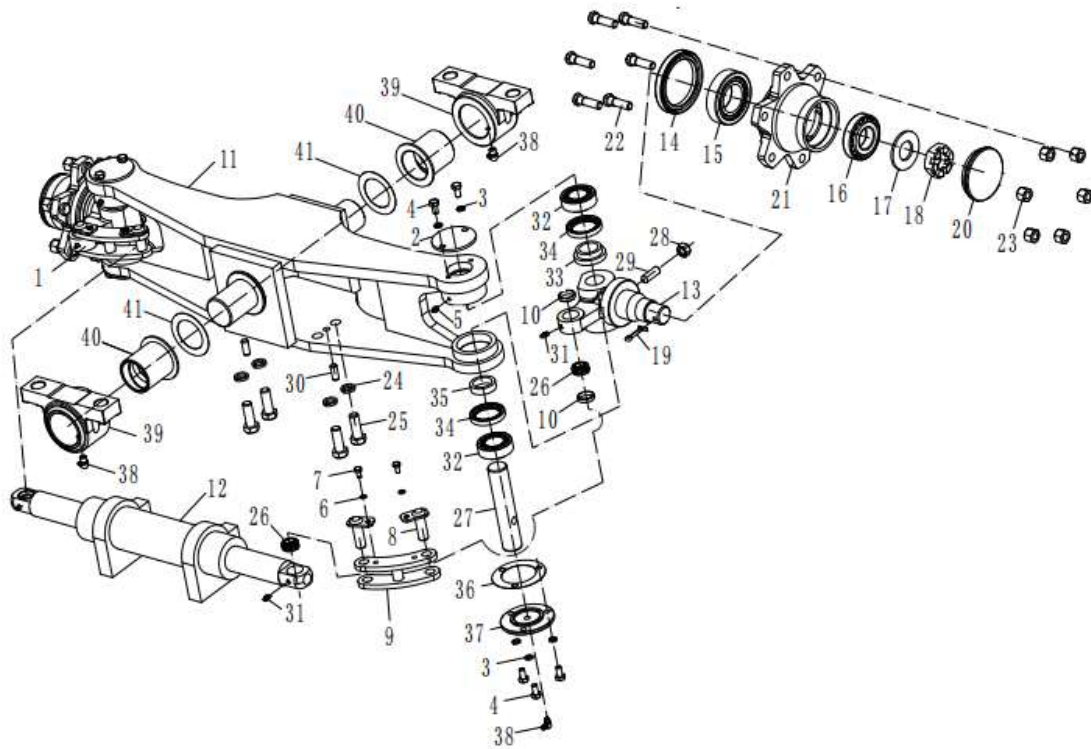


#### Disassemble

- 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 pin-steer link (8#) to remove links (9#).
  - 2) Remove bolt (25#) to remove steering cylinder (12#).
  - 3) Remove king pin (27#) to remove hubs (21#) and knuckles (1#/13#)
  - 4) Remove cap (20#) and nut (18#) to remove hub (21#) from knuckle (1#/13#).
- ※ 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 (16#) into hub (21#) with a fixture.



- 2) Mount outer ring of bearing (15#) into hub (21#) with a fixture.



- 3) Mount bolt (22#) × 8 into hub (21#) with a fixture.



- 4) Apply lithium base grease on inside of hub (21#) until 1/3-1/2 of inside surface is applied.



5) Mount oil seal (14#) into hub (21#).



6) Mount bearing-SPH plain (26#) and bushing (10#)  
× 2 into knuckle (1#/13#)



7) Mount the hub assy (21#) and knuckle (1#/13#)  
together.



8) Mount inner ring of bearing (16#) into knuckle  
(1#/13#).

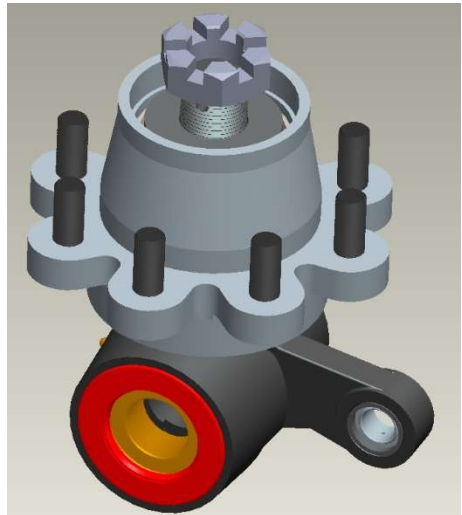


9) Mount washer (17#) into hub (21#).



10) Mount the nut-slotted (18#) into hub (21#). 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 (18#)





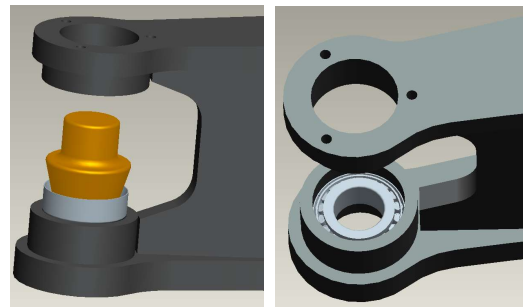
- 11) Mount the split pin (19#) into knuckle (1#/13#) after adjust the nut-slotted (18#).



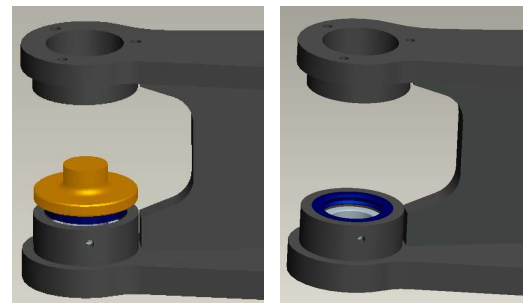
- 12) Mount the cap (20#) on hub (21#) with a rubber hammer.



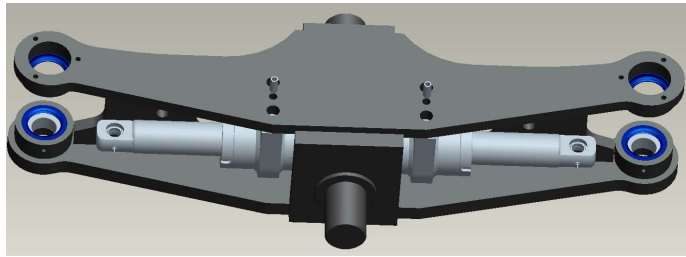
- 13) Mount the bearing (32#)  $\times$  2 into body (11#).



- 14) Mount seal (34#) into the bearing (32#) until the upper surface flush with the body (11#).

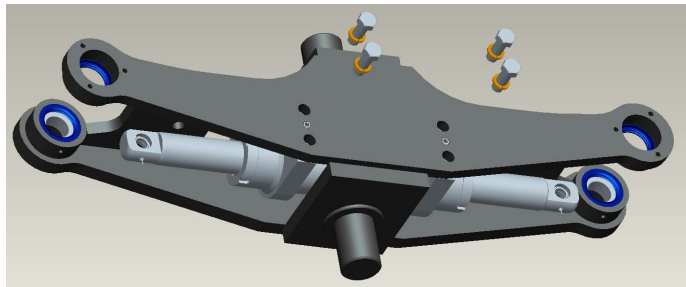


15) Mount the pin (30#)  $\times$  2 in body (11#).

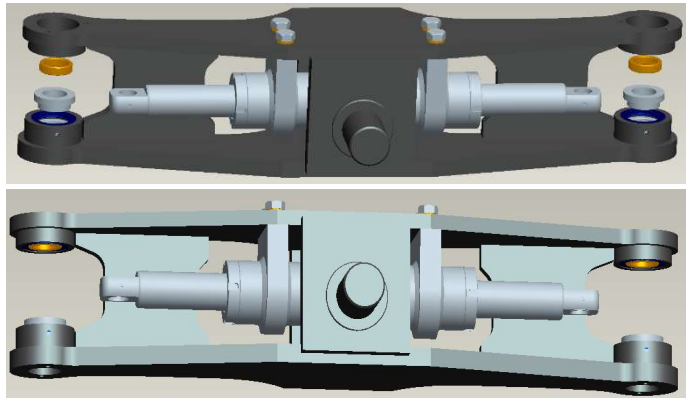


16) Mount washer-spring (24#) and bolt (25#) in body (11#).

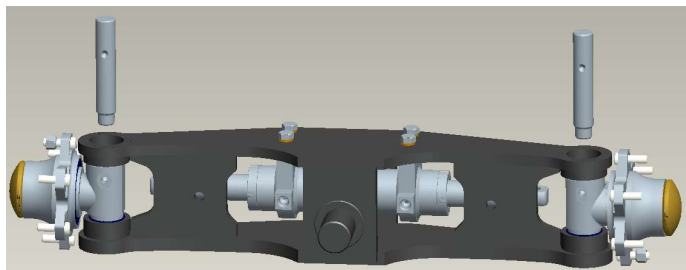
Fastening torque: 11-13 kgf·m



17) Mount the circlip (33#)  $\times$  2 and (35#)  $\times$  2 in the seal (34#).

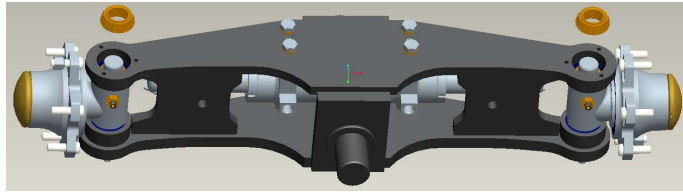


18) Mount the knuckle (1#/13#)  $\times$  2 in body (11#) with king pin (27#)  $\times$  2.



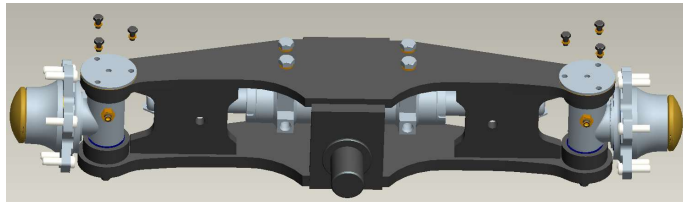
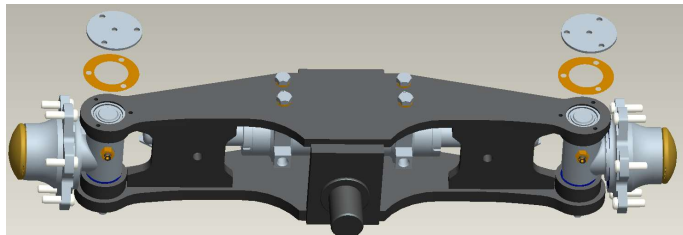


19) Mount the bearing (32#)  $\times$  2 between king pin (27#) and body (11#).



20) Mount the shim (36#)  $\times$  2 and plate (37#)  $\times$  2 with bolt (4#)  $\times$  6 and washer (3#)  $\times$  6 to body (11#).

Fastening torque: 2.5 kgf·m



21) Check if the start torque of rotating is 2.5-4.5 kgf·m.

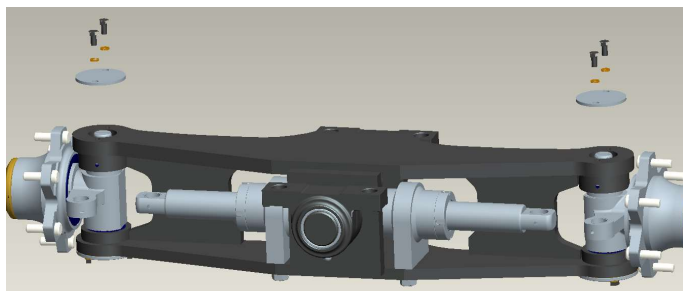
If it is greater than 4.5 kgf·m, add the number of shim (36#).

If it is less than 4.5 kgf·m, reduce the number of shim (36#).



22) Mount the cover-king pin (2#)  $\times$  2 with bolt (4#)  $\times$  4 and washer (3#)  $\times$  4 to body (11#).

Fastening torque: 2.5 kgf·m



23) Mount link (9#)  $\times$  2 with pin-steer link (8#)  $\times$  4 to link knuckle (1#/13#) and steering CYL.Assy (12#).

