SECTION 2 MAJOR COMPONENT STRUCTURE AND PRINCIPLE OF THE STEERING SYSTEM

- **1.Power Steering Gear**

  Integral hydraulic power steering gear is adopted with rotary spool valve type control valve. The models ZF8095, ZF8098 are power steering gears manufactured by ZF Group in Germany with the same structure and principle, but with different torque output, both applicable for steering axles under 6.5 tons, while for steering axles over 7.5 tons only the 8098 steering gear is suitable. Parameters for the steering gears are shown in Table 11-1.

Table 11-1

Model Parameters	ZF8098		ZF8095
Suitable front axle load (Kg)	6500	8000	6000—7000
Maximum torque output (Nm)	4954--5829	5717--6726	4356--5146
Maximum pressure (MPa)	13	15	17
Pump flow (L/min)	16--20	16--20	16
Transmission ratio	22.2—26.2	22.2—26.2	15.7—18.5
Round number of the steering wheel	6.2	6.2	4.4
Rock arm swing angle	94°	94°	94°
Mass (Kg)	41	41	86
Model Number of the Original manufacturer	8098955654	8098955709	8095955204
Drawing number of SINOTRUCK	AZ9100470228	AZ9719470228	AZ9100470225

- Steering gears model ZF8095 and ZF8098 are mainly composed of two parts: the mechanical part and the hydraulic booster.
- As shown in Fig. 11-5，the steering wheel, through the steering column, is linked with the input shaft C via the direction shaft. The input shaft is inserted in the worm D, and they enforce the hydraulic oil flow of the rotating valve and the sleeve to control the steering operation. The input shaft C is connected to the worm via the drive pin at the front end, while there is certain angular space (left and right) in the connection of the drive pin and the worm. In other words, when the drive shaft is turned round, only after turning a certain angle in relation to the worm valve bush D, can it drive the worm valve bush to rotate together. The input shaft C is also connected at the end with the torsion bar E, which is an elastic bar. The other end of the torsion bar is connected with the other end of the worm valve D. The worm valve D, together with piston B and via a circulation ball, forms a worm nut movement pair. The aim of the circulation ball is to reduce the moving resistance to the worm nut pair. Piston B is installed in steering gear housing A. It divides the steering gear housing into front and rear chambers. Strait teeth on piston A are engaged with the sector teeth of the sector shaft F.

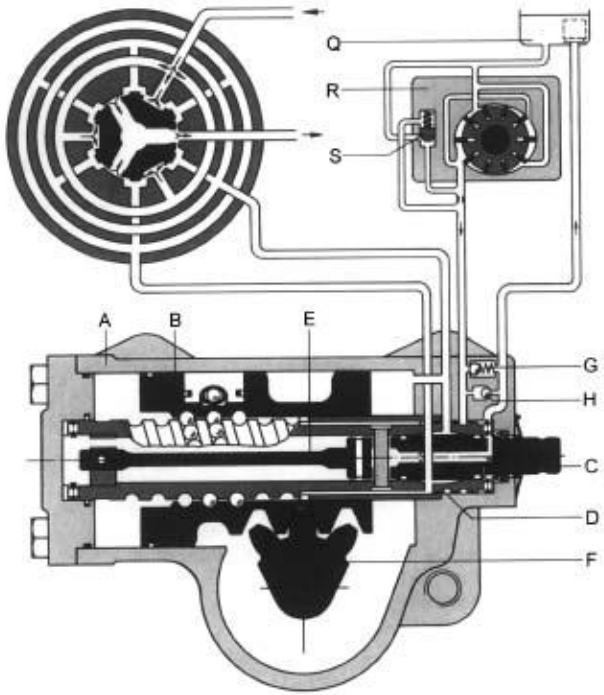


Fig. 11-5 Working principle diagram of the ZF8095 and ZF8098 steering gear（in case of straight-line running） A-Steering gear housing B-Piston C-Rotating valve core of the input shaft D-Worm valve bush E-Torsion barF-Sector gear shaft H-Oil supplementary valve Q-Oil storage tank R- Booster pump S-Flow control valve

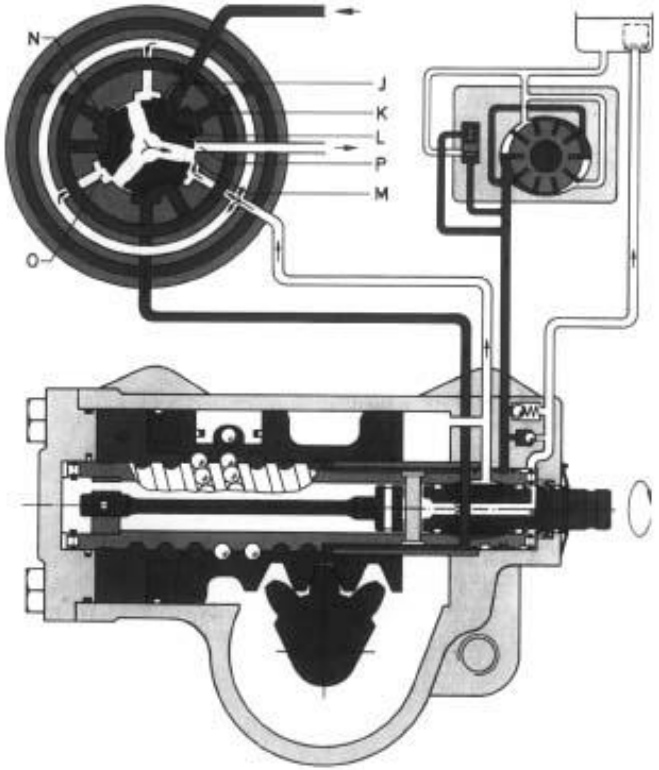


Fig. 11-6 Working principle diagram of ZF8095 and ZF8098 steering gear（In case of right turn）J-Oil inlet and Oil return closed K-Connected oil inlet L-Oil inlet and Oil return closed M-Connected oil return N-Connected oil inlet O-Connected oil return P-Oil return port

- When the automobile runs straight forward, the input shaft C is kept standing still, and torsion bar E, worm valve bush D and import C all are kept relatively standing still, and the steering valve core on the input shaft is in a position corresponding to the valve bush in neutral position. This pair of valve bush and core is actually a three-position and four-way hydraulic valve. When the valve is in a position that the valve bush is in neutral, high-pressure oil from the steering booster pump R passing this valve is directly connected to the oil chambers on the piston's both sides and the oil return pipe. At this time, the piston remains still, and the steering sector shaft also remains still. So the vehicle is kept in a state of straight-line running.
- As shown in Fig. 11-5, when the automobile turns to the right, input shaft C turns right, thus drives the torsion bar E shaft end turning right together, and the other end of the torsion bar is in connection with the worm valve bush. Therefore，the torsion deformation force from the torsion bar acts upon the worm valve bush D，and forces the worm turning right in the same way. At the same time, after the input shaft C rotates to a certain angle related to worm D, the drive pin connected with the input shaft removes the rotating clearance worn with the worm. The input shaft keeps turning right, and the input shaft directly drives the worm turning right via the drive pin. The result is, the worm, through the re-circulating ball，pushes the piston right in a direction as shown in the diagram; Thus the sector gear shaft turns right, and forces the vehicle turn right through steering crank and tie rod and draglink. That is part of the steering mechanism function.

- Concurrent with that, when the input shaft C turns right, due to torsion bar E's elastic deformation and the drive pin's rotating clearance，the input shaft rotation valve core C is forced to rotate in relation to the worm sleeve D thus to stagger an angle, and opens the booster pump high pressure oil and the passage from the piston B's right chamber (shown in the diagram) to the oil return pipe. As shown in the diagram, the difference of oil pressures between the two sides of the piston forces the piston to move to the right. In the same way, such action forces the sector gear shaft F to turn right, so the vehicle turns right. That is part of the steering hydraulic pressure booster's function.
- Owning to the above mechanism and hydraulic pressure concurrent functions, the steering operation is not only swift, but also easy and convenient.

- During steering, once the steering wheel stops rotating, the input shaft C stops rotating immediately, and valve bush staggered angle at the beginning, high-pressure oil continues supplying the piston left chamber, and the right chamber of the piston opens to the oil return pipe. Such function allows the hydraulic pressure boosting of the piston continuously moves to the right, as shown in the diagram. However, now the input shaft has stopped rotating, so the piston's right movement via the re-circulating ball forces the worm right rotating in relation to input shaft, and enables the valve bush to return to the related neutral position，thus the high pressure oil opens, the both sides of the piston chambers immediately open to the oil return pipe, and the high pressure is released, the steering boosting vanishes immediately. In this process，elastic force of the torsion bar also forces the worm valve bush to return to the initial position aligned with the input shaft valve core.

- The other function of the torsion bar is to play a role as a centering spring，that is, in a case without turning the steering wheel, the torsion bar is always kept at a position that the worm valve bush and the input shaft rotation valve core are in neutral position，thus keeping the vehicle running straight forward. Therefore，the installation and adjustment of the torsion bar is very important. In case the torsion bar is in a badly regulated initial state, it will result in a constant function to the steering booster and cause the vehicle in severe off tracking malfunction. Nevertheless, the installation and adjustment of the torsion bar has been finished on the test stand prior to shipment from the factory. These operations are not permitted for service on site.
- For the automobile to turn left, the working principle is the same. When left turning, the high-pressure oil will flow to the right chamber of the piston, as shown in the diagram, to push the piston to move to the left, thus to generate hydraulic pressure boosting, as shown in Fig. 11-7.
- On purpose to avoid possible damage by the sudden up-rise of oil pressure in the high-pressure chamber when the steering wheel is turned to the limit position (at the moment the front wheels have been turned to the limit), two limit valves have been installed in the steering gear piston.

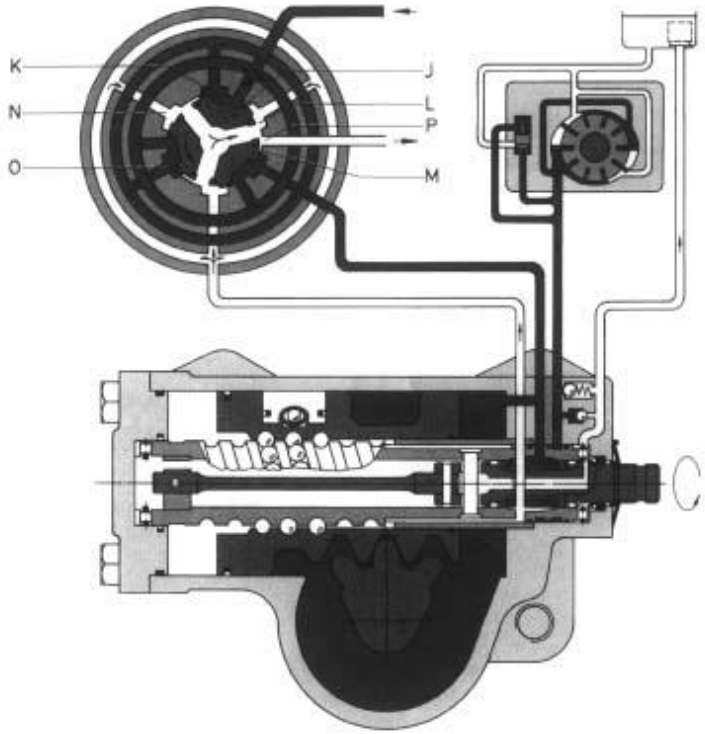


Fig. 11-7 Steering gear models ZF8095 and ZF8098 left turning working principle sketch J-Oil Inlet and oil return line closed K-Connected oil inlet L-Connected oil return M-Oil inlet and oil return closed N-Connected oil return O-Connected oil inlet P-Oil return port

- As shown in Fig. 11-8，the left and right limit valves are installed in the piston B. They are actually two check valves composed of the left and right valve stems.
- When the vehicle is running normally or before reaching the limit positions, as shown in Fig. 11-8, both the limit valves are closed. When it turns right and reaches the preset limit position, as shown in Fig. 11-9, piston B moves to the right regulating bolts and pushes the limit valve stem into the piston, the right limit valve is turned open. High-pressure oil from the left piston chamber passes through the left limit valve and the open right limit valve to the right chamber, which is at lower pressure at the moment. The pressure is thus relieved and the boosting vanished. Thus damage will not occur from steering wheel turning to the limit position. Working principle of the left position limit valve is the same as the right limit valve. The limit valve must be adjusted after the steering gear is installed onto the automobile.

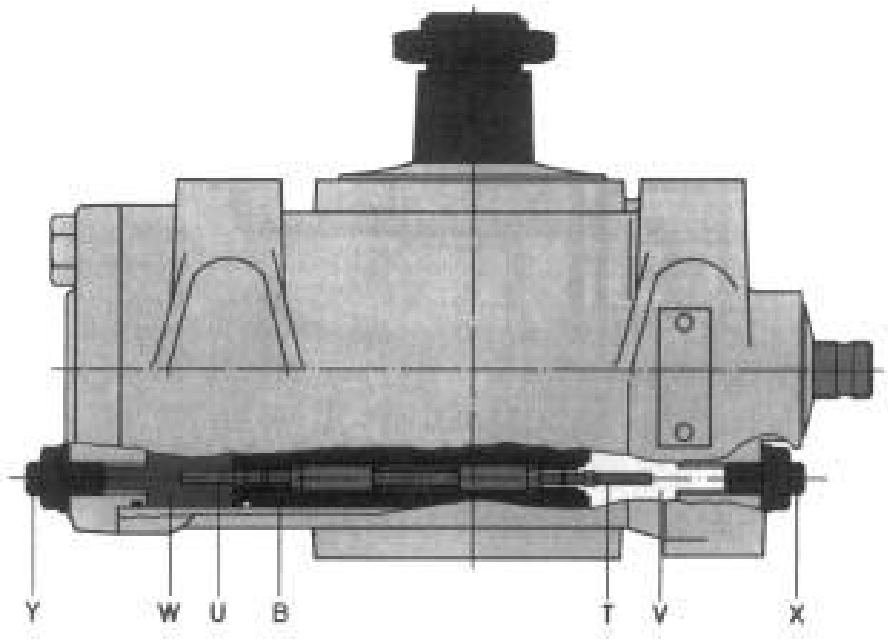


Fig. 11-8 Working principle of the limit valve
B.-Piston T-Right limit valve stem U-Left limit valve stem W-Left piston chamber V-Piston right chamber X-Right limit valve regulating bolt Y-Left limit valve regulating bolt

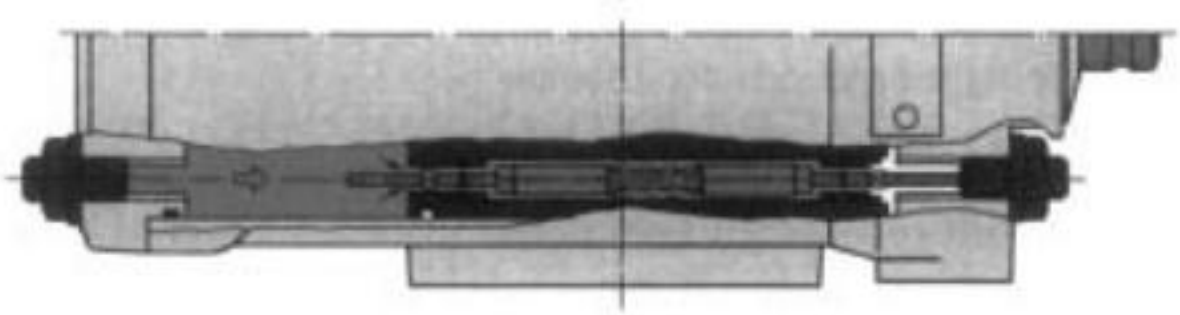


Fig. 11-9 Right limit valve open position

2. Steering Booster Pump

The steer booster pump is installed on the timing gear of the diesel engine. The timing gear drives the booster pump drive gear to rotate. Model VOP306_A168/160H1 vane pump of a certain type of booster is shown in Fig. 11-10, with fundamental performance parameters in Table 11-2.

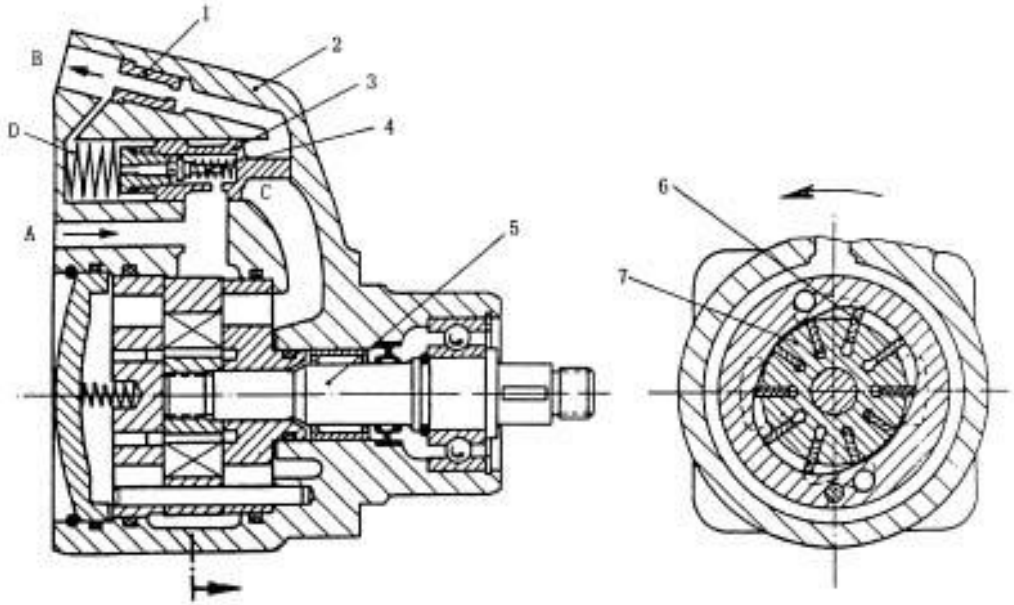


Fig. 11-10 Steering booster pump structure diagram
1.Throttle 2. Pump body 3. Flow control valve 4. Relief valve 5. Pump shaft 6. Vanes 7. Rotor A. Oil inlet port B. Oil outlet port

Table 11-2

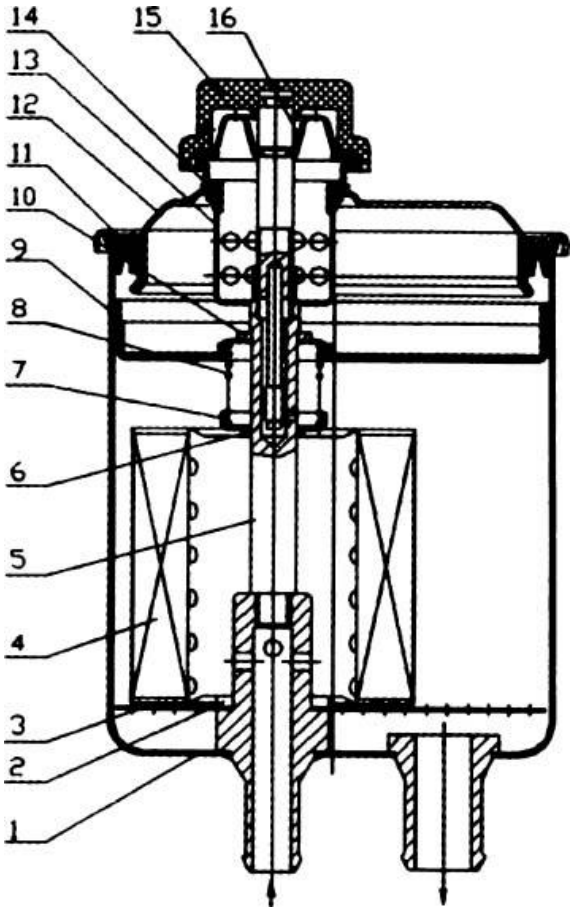
Parameter	Value
Working speed (r/m)	500--3900
Displacement (ml/r)	19.2
Control flow (l/m)	20
Maximum pressure (MPa)	15

- When a diesel engine is working, the vane pump rotates, vanes installed in the rotor slots inside the pump body move clinging to the inner chamber of the pump body under the centrifugal force and oil pressure. Sealed work chambers are formed between the vanes. Areas with sealed working chamber volume diminishing will become pressure oil chamber, while areas with sealed working volume increasing grows into oil suction chamber. With the pump rotating one round, twice of pressing oil and sucking oil passed. As the pressing oil chamber and sucking oil chamber are symmetrically distributed, hydraulic pressure radial force acting on the shaft is balanced. Pump output is determined by the width and rotation speed of the rotor vanes. Delivery pressure of the pump is determined by the steering system resistance. In order to limit the maximum pressure of the pump, relief valve 4 is arranged inside the pump body. When the load outside the steering system increases and it makes the oil pressure reach 50Mpa，

- the relief valve opens for unloading. To ensure the pump output basically constant，flow control mechanism is arranged inside the pump body, composed of throttle 1 and flow control valve 3. In case that the speed of the pump is lower, valve 3 will be kept at the position as shown in Fig. 11-10, at the moment valve 3 closes the oil outlet chamber and the oil inlet chamber. The pump output increases as the pump speed increases, due to the throttling action of throttle 1; pressure difference between the valve 1 front and rear chamber C and D is built up:△P =PC- PD, and the pressure difference will increase with the pump output increase. When the speed of rotation increases to the preset speed, namely, the pump output reaches to a certainty value, the pressure difference △P between the two chambers will overcome the retracing spring's preset force, valve 3 will move to the left under the pressure difference, thus opening the passage of the oil outlet chamber and the inlet chamber; part of the output forms internal recycling; the greater the pump output, the greater the pressure difference △P, and the greater the opening of valve 3, the greater the internal unloading flow, thus ensuring the basically constant output.

- **3. Steering Oil Tank**
- The steering oil tank is equipped with oil inlet filter device, with filtering element inside, which is installed at the oil return port, and with the following features: the tank top and seal ring structure is able to effectively prevent oil seepage; the oil port, breather valve, oil level scale located together on the top of the tank makes the structure more compact, so as to save space, favorable for the entire vehicle arrangement, and the oil level observing can be done at the same time of oil refilling, making it easier to operate. For the specific structure please see Fig. 11-11.

Fig. 11-11



1. Oil tank body assembly 2. Lower seal pad. 3. Grid overlay 4. filter element assembly 5. core fastening plug 6. O-ring seal 7. spring seat 8. compression spring 9. strainer assembly 10. washer 11. tank cap seal ring 12. tank cap assembly 13. oil port holder sleeve 14. holder sleeve seal ring 15. oil port cover with oil level scale assembly 16. oil port seal ring

- **Steering Tie Rod And Draglink**
- The structure of the steering tie rod and draglink is shown in Fig. 11-12. Threads on the two ends of the rods are respectively in left and right direction to facilitate the assembling and the adjustment.

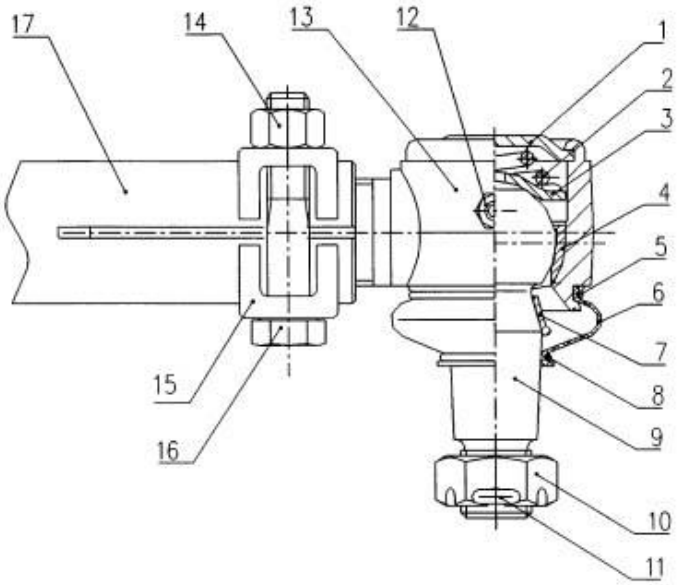


Fig. 11-12 Steering rods and ball head structure

1. Plug 2. Retainer spring 3. Upper ball seat 4. Lower ball seat 5. Steel wire locking collar 6. Protect jacket 7. Plastic taper sleeve 8. Steel wire locking collar 9. Ball lock 10. Hexagonal slotted nut 11. Split pin 12. Steering rod connector 13. Grease nipple 14. Hexagonal nut 15. Pipe clip 16. Hexagonal head bolt 17. Drawbar