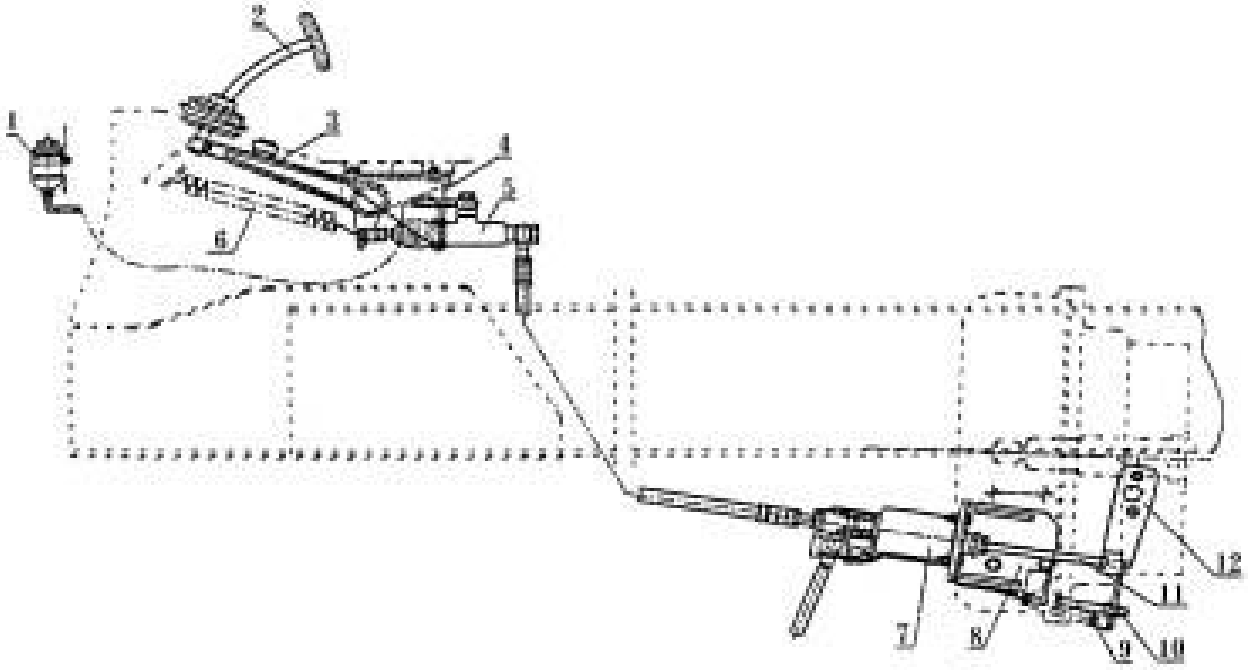
SECTION 4 AIR-ASSISTED AND HYDRAULICALLY OPERATED CONTROL MECHANISM

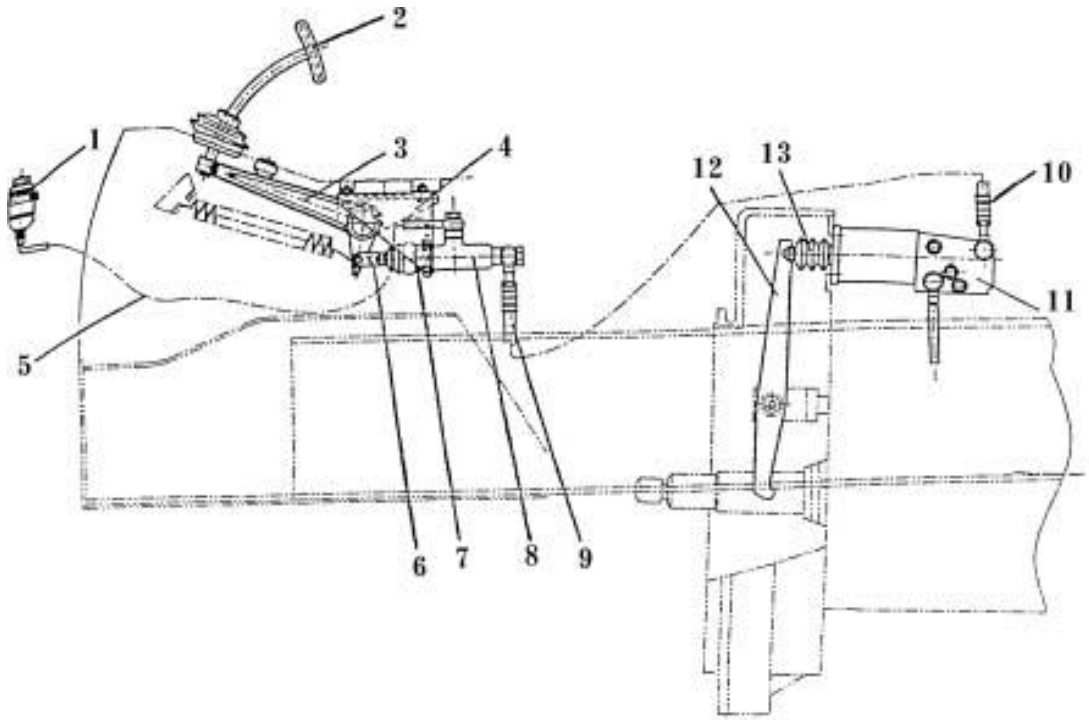
The control mechanism is mainly composed of the boost cylinder, oil reservoir, pedal device, clutch fork device, etc. Fig. 3-8 and Fig. 3-9 show the operating principle of two configurations. Fig. 3-8 is for push-type clutch and Fig. 3-9 for the pull-type clutch.



1. Oil reservoir 2. Clutch pedal 3. Pedal arm 4. Master pump bracket 5. Master pump 6. Return spring 7. Boost cylinder 8. Boost cylinder bracket 9. Stop spring 10.Stop bolt 11. Thrust rod 12. Release rocker

Fig. 3-8 The clutch control mechanism

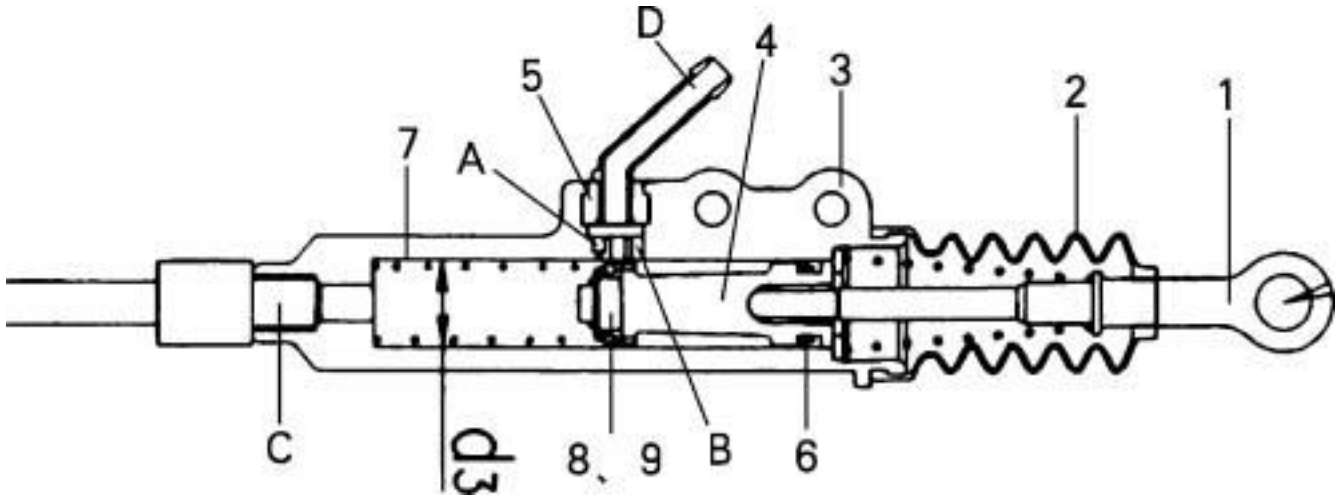
- **Ⅱ. Operating principle**
- When the clutch pedal is stepped, the piston of the master hydraulic cylinder moves backward. The brake fluid in the hydraulic chamber enters the hydraulic chamber of the boost cylinder through oil pipe. The brake fluid on the one hand acts upon the working air chamber and on the other hand, acting as control fluid, acts upon the air pressure control valve to open the valve, allowing the compressed air to enter the air chamber of the boost cylinder. They together push the working piston to act upon the rocker arm, which pushes the release bearing via the release fork 2, causing the clutch to disengage.



1. Oil cylinder 2. Pedal 3. Pedal arm 4. Shaft sleeve bracket 5. Oil delivery pipe 6. Push rod 7. Master pump bracket 8. Master pump 9. Pressure oil pipe 10. Pressure oil pipe 11. Bracket 12. Rocker arm 13. Push rod 14. Boost cylinder

Fig. 3-9 The diaphragm pull-type clutch control mechanism

- ## Ⅲ.Master pump
- Master pumps provided by different suppliers are slightly different in structure. The structure of a sample master pump and a sample boost cylinder will be explained as follows:
- The structure of the master pump is shown in Fig. 3-10. The master pump is mainly composed of push rod (1), dust cover (2), oil cylinder block (3), piston (4), rubber cup (6), oil inlet adapter (5), spring (7), non-return valve (8), rubber seal (9), etc.
- When the clutch pedal is released, rubber cup (6) and piston (4) are pressed to the right end under the action of the spring. The rubber seal is clear of the orifices A and B, as shown in Fig. 3-10. Now the inner chamber of the oil cylinder block is fully filled with hydraulic oil.

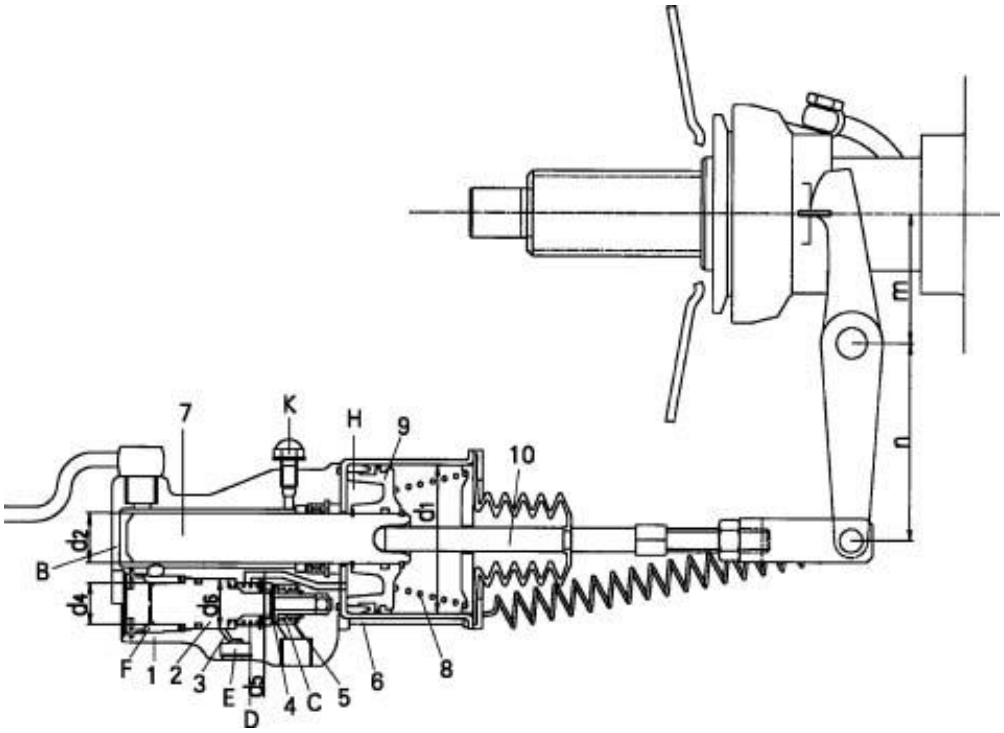


1. Push rod 2. Dust cover 3. Oil cylinder block 4. Piston 5. Oil inlet adapter 6. Rubber seal 7. Spring8. Check valve 9. Rubber seal A- Oil orifice B- Oil orifice C- To clutch booster oil orifice D- To oil reservoir oil orifice

Fig.3-10 Master pump

- When the clutch pedal is stepped, piston (4) moves leftward under the action of the push rod (1), The spring (7) is compressed, the oil in the oil cylinder flows to the boost cylinder through hole C after the oil orifice A is blocked under rubber seal (9), and the clutch disengages. When the clutch pedal is released, push rod (1) exerts no pushing force upon the piston and the rubber seal. The piston and rubber seal move rapidly to the right under the action of the spring, and the oil pressure inside the oil cylinder quickly decreases. In the same time, the oil in oil cup D flows into the left cylinder chamber through oil orifice B .check valve 8 and rubber seal under the oil pressure difference between the left and cylinder chamber. Now, as the oil pressure inside the boost cylinder is much higher than that inside the control oil cylinder, the pressure from the boost cylinder returns to the control oil cylinder suddenly and the pressure oil flows into the oil cylinder of the master pump. The pressure difference between the two sides rapidly decreases. As the oil pressure inside the left chamber is higher than that inside the right chamber, spring(7)again presses the check valve together the rubber seal (9). The piston moves back under the action of the pressure oil and spring 7. When the oil in the oil cylinder is insufficient, oil is replenished through the orifice A oil also enters the space in front of the rubber seal through the orifice B.

- **Ⅳ. Boost cylinder**
- The clutch booster is composed of the two major parts: the hydraulic control and the booster air chamber. Its structure is shown in Fig. 3-11.
- The hydraulic control mechanism consists of the controller body (6), air valve (4), air valve spring (5), oil piston (2), oil piston spring (3), piston guide shaft (7), etc.



1、 cylinder block 2、oil piston 3、 spring 4、 air valve 5、 air valve spring 6、 controller body 7、 piston guide shaft 8、 spring 9、 air piston 10、 piston rod A- bleed hole B- oil chamber C- air chamber D- air chamber E- air chamber F- oil chamber H- air chamber K- discharge plug

Fig.3-11 Boost cylinder

- The booster air chamber is mainly composed of cylinder block (1), air piston (9), piton rod (10), piston guide shaft (7), air piston spring (8), etc.
- When stepping the pedal to disengage the clutch, the clutch master pump presses the hydraulic oil into the hydraulic control system. The hydraulic oil in the hydraulic chamber pushes the oil piston to compress the oil piston spring (3). The spring moves to the right. The hollow pipe of oil piston (2) pushes air valve (4) open. The compressed air in chamber C at the rear end of the air valve enters chamber D before the air valve. There is a vent passage connecting chamber D with the chamber H. The pressure air enters chamber H through air valve, and pushes the air piston to move to the right. The piston rod drives the clutch fork and makes the clutch disengage. The pressure oil enters chamber F through a radial bypass hole, and at the same time enters chamber B behind the air piston guide shaft (7) . The pressure oil in chamber B and the compressed air in chamber H together push the piston to move rightward.

- When the clutch pedal is released, the oil pressure in the master pump decreases, the pressure oil in chamber F returns to the master pump, and its oil pressure also decreases. Oil piston spring (5) pushes the piston to move to the left, and air valve (4) is closed under the action of spring (5). Now, the central pipe of the oil piston separates from the air valve (4) and gap is formed between the two. The compressed air in chamber H returns to the chamber D and from chamber D flows to chamber E through the central pipe of the oil piston, and is finally discharged to the atmosphere from chamber E. Under the action of the spring, the air valve will push the air piston to move to the right to its original position via the release shaft, the release fork and the piston rod. Now, the oil in chamber B will no longer exert any pressure on the piston shaft, the extra oil will be pressed back into the master pump, and a complete working cycle is ended.
- K is the discharge plug, which is used to discharge the air in the hydraulic system. The actual products supplied by the manufacturers might be slightly different from that shown in the Figure, but their operating principle will be the same.

- **Ⅴ. The assembly and adjustment of the control system**
- ① Check and adjust the clearance between the master pump push rod and the piston. There should be a 0.7mm~1mm clearance between the master pump push rod and the piston, in order to prevent the oil entering the oil inlet compensation orifice in the oil cylinder from being blocked by the piston cup. During assembly, use hand to turn the push rod gently to adjust its length until you feel that the push rod reaches the piston, then loosen the push rod by one full turn, and tighten the fastening nut. This clearance must not exceed 1mm, or the effective stroke of the master pump would be shortened and affect the disengagement of the clutch.
- ② Check and adjust the free travel of the push rod of the boost cylinder. The clutch release bearing should have a 2~3mm free travel so as to prevent the bearing from being premature damaged under sustained load. Therefore, push rod of the boost cylinder should have a 6~8mm free travel. As shown in Fig. 3-9, when assembling and adjusting, do not install the return spring, just use the pretension spring inside the boost cylinder to push the piston and the push rod and allow them to hold the clutch release rocker arm. Now, adjust the stop bolt until the clearance between the end of the bolt and the bracket is 6~8mm, tighten the fastening nut, and then install the return spring.
- ③ Discharge all the air in the hydraulic system. If there is air in the hydraulic system, the effective travel of the push rod of the boost cylinder piston would be shortened, the clutch could not be disengaged completely, and the engagement of the gear would be difficult.

- When connecting or disconnecting oil pipes, be sure to loosen the discharge valve of the boost cylinder, fill oil into the oil reservoir while pulsating the clutch pedal until there is oil overflowing through the discharge valve, and then tighten the valve. In order to discharge air in the system quickly and thoroughly, the system can be discharged section by section. First discharge the air in the front end of the oil pipeline. Pulsate the pedal 2~3 times, then step and keep the pedal fully to its bottom, and loosen the nut of the connecting tube of the master pump. Air in the front section will be discharged from this point. Tighten the nut and release the pedal. Repeat the above procedure for 4~6 times, and the air can be discharged completely. As the mid section of the oil pipe is located at a higher position, air is likely to be accumulated in this section. Air in this section can also be discharged by the above-mentioned method. Now, the oil pipeline is basically filled with oil. By stepping the pedal, the push rod of the boost cylinder piston might move slightly. You can start the engine to pump air, and shutdown the engine after sufficient air is pumped. To pump air is to utilize the function of air pressure boosting of the boost cylinder to reduce the pedal load. Use the above-mentioned method to discharge air in the aft section of the pipeline through the discharge plug of the boost cylinder.

- Special attentions should be paid to the following:
- a. When discharging air, make sure to release the pedal after the discharge valve or the connecting tube nut are tightened, so as to prevent sucking air into the system. The pedal must be released to its highest position, so as to allow the oil in the oil reservoir to be filled into the pressure chamber of the master pump. With the pedal stepped, if the effective travel of the boost cylinder push rod can reach 30~34mm, it means that the air in the hydraulic system of the clutch has been discharged completely; if the travel is less than 30mm, it means that there is still some air in the system which should be discharged further.
- b. During the first maintenance of a new vehicle, the clearance should be readjusted. For a vehicle in service, the clearance should be readjusted once every 12,000km (level 2 maintenance) and rechecked once every 4,000km (level 1 maintenance). To check, manually pull the clutch release rocker arm with force, and there should be a clearance at the end of the stop bolt.
- c. The working medium of the hydraulic system must be DOT3 brake fluid. When the oil pipes are connected, Loctite 572 sealant can be used to seal the connecting tube nut and the pipe union.
- d. When replacing the brake fluid, the residual fluid in the hydraulic system must be drained completely. New brake fluid must be of the specified brand in the same lot.