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# (54) Hydraulic clutch release device

(57) A release bearing 8 presses against the center of a diaphragm spring 1 as a hydraulic pressure is introduced in a cylinder space 13 on depression of a clutch pedal. A predetermined weak hydraulic pressure set by a control valve 26 remains within the cylinder space 13 after the clutch pedal is released so that the release bearing 8 is lightly pressed against the diaphragm spring 1 even when the clutch pedal is not depressed. The control valve 26 comprises a ball valve 33, which opens when the clutch pedal is depressed, in a housing 29 which moves against spring 31 to open the ball valve by way of pin 36 when the pedal is released. The spring 31 determines the weak residual pressure. A clutch release lever may be acted upon by a slave piston instead of the arrangement shown.

FIG. 1

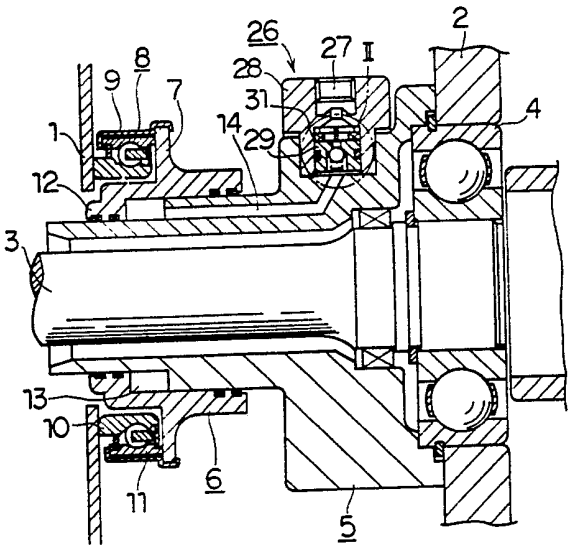
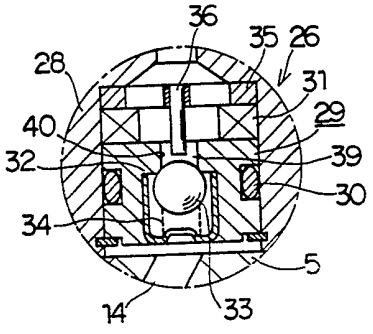



FIG. 2




GB 2 245 329 A

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1990.

FIG. 1

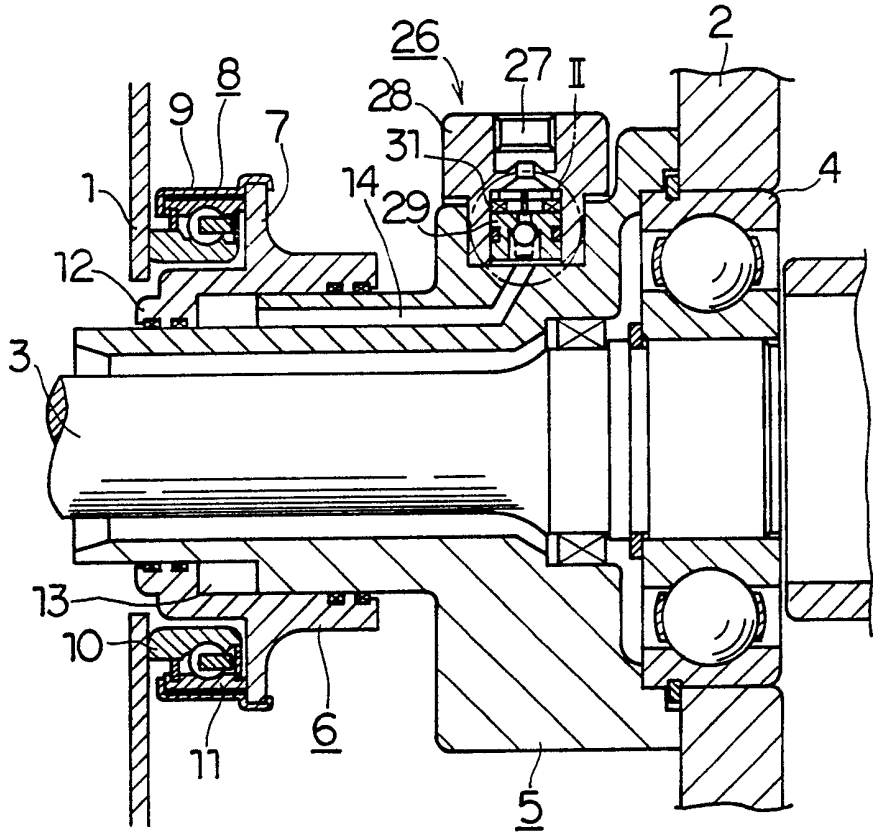

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FIG. 2

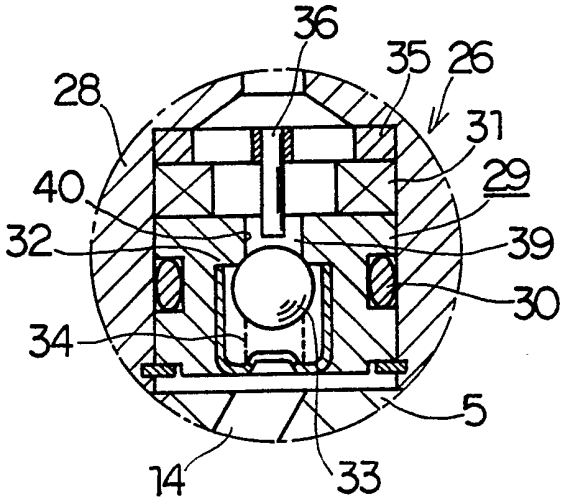

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FIG. 3

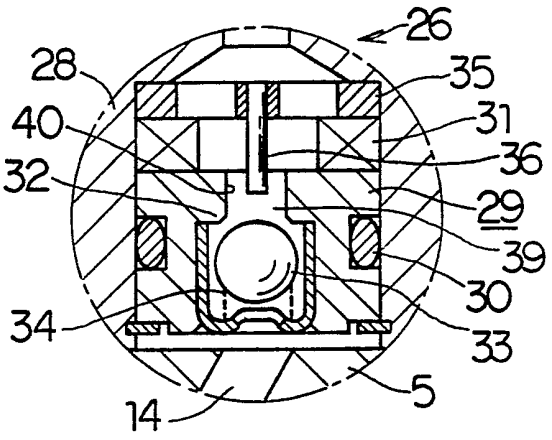



FIG. 4

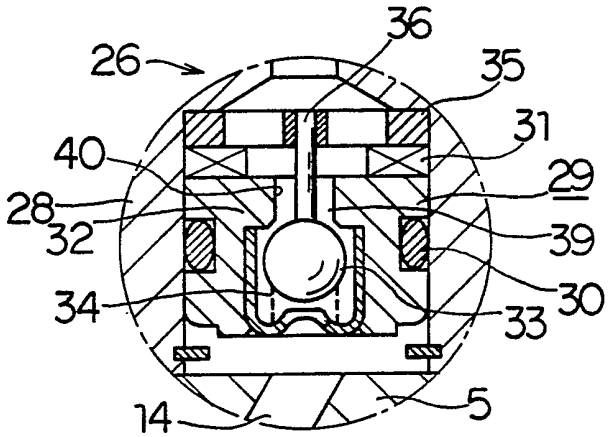



FIG. 5

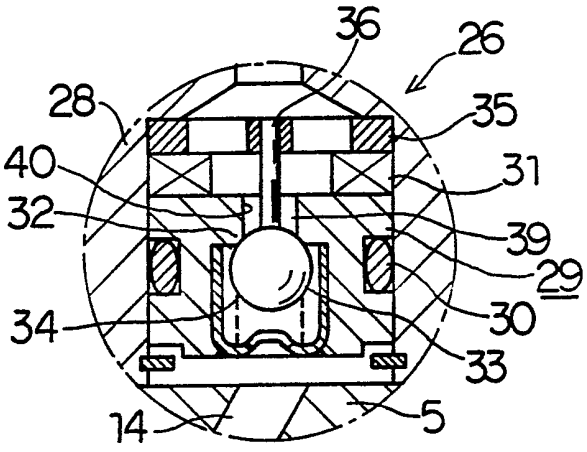


FIG. 6

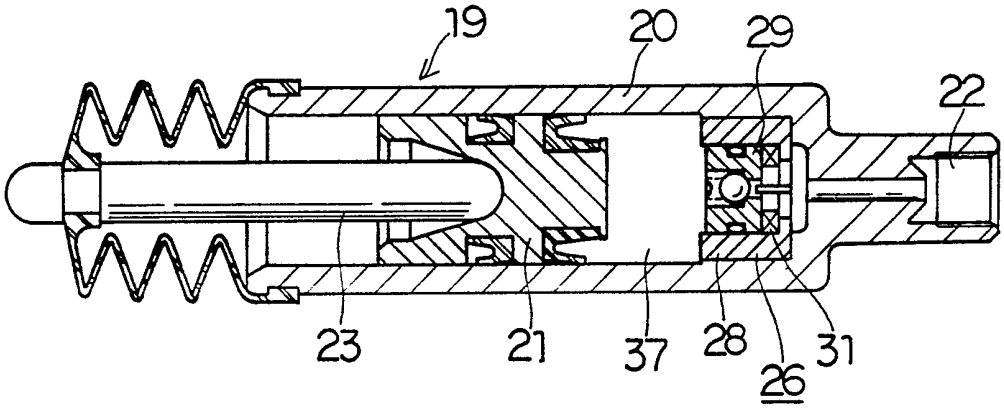



FIG. 7

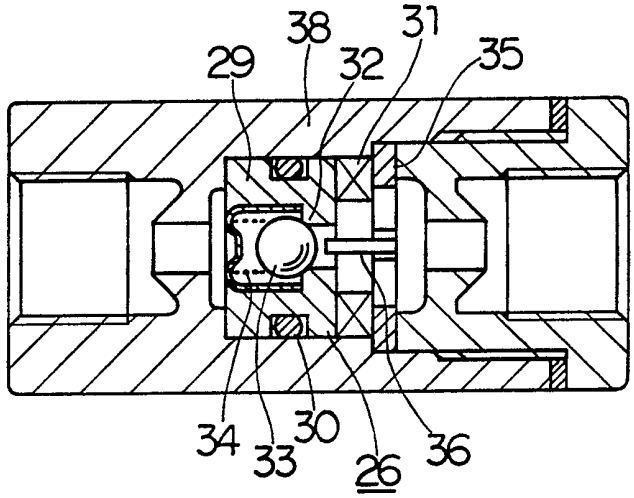



FIG. 8

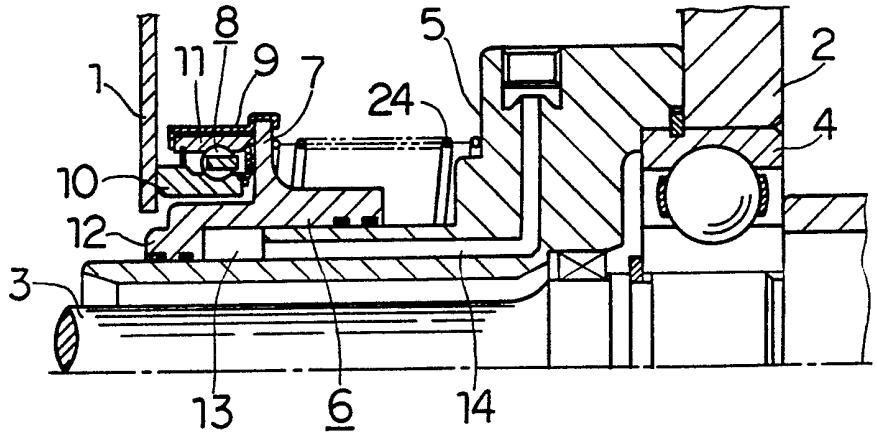


FIG. 9

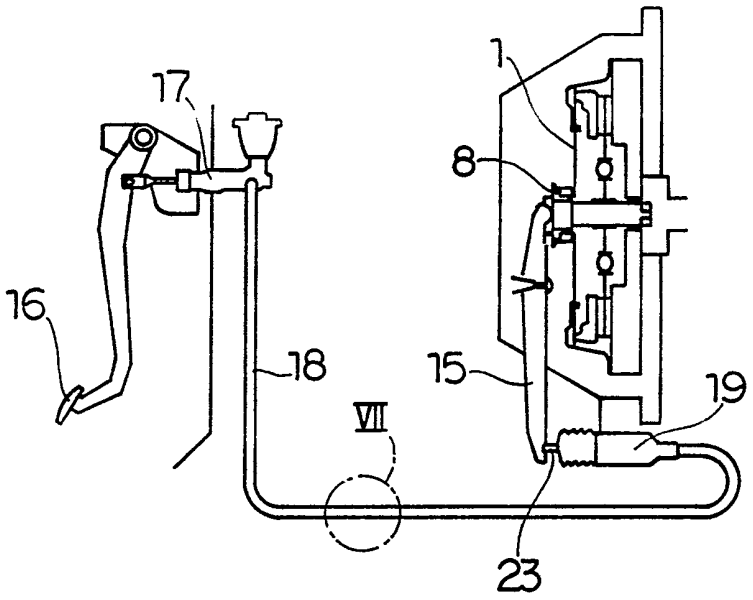
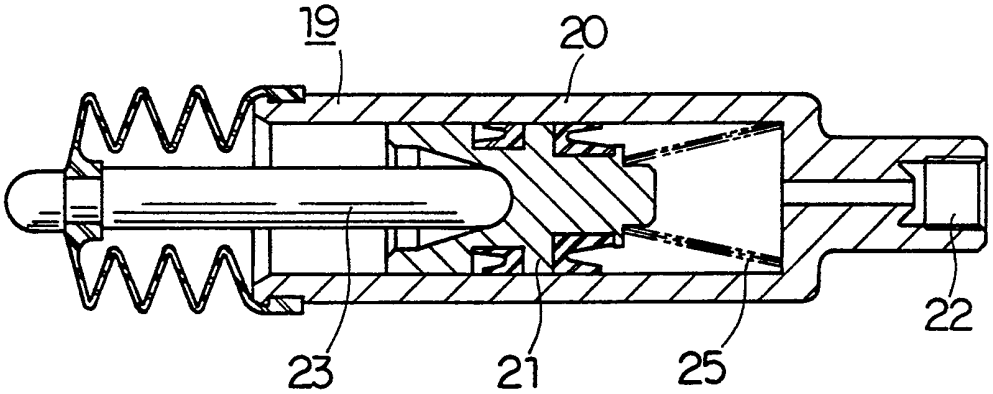



FIG. 10



TITLE OF THE INVENTION

# HYDRAULIC CLUTCH RELEASE DEVICE

## BACKGROUND OF THE INVENTION

### Field of the Invention

The present invention relates to a hydraulic clutch release device, and, in particular, to a hydraulic clutch release device incorporated in a clutch mechanism for an automobile equipped with a manual gear shift by which pressure is applied to the center of a diaphragm spring during a gear shifting operation.

### Description of the Prior Art

A clutch mechanism for an automobile equipped with a manual gear shift is provided with a clutch pedal and a combination of clutch plate and flywheel. The driver depresses this clutch pedal with his foot to cut the transmission of the driving power from the engine to the gear shift mechanism in order to perform the gear shift operation. The center section of a cone-shaped diaphragm spring is depressed by the operation of the clutch pedal so that the angle of the diaphragm spring changes. As a result, the clutch plate releases the power which applies pressure to the flywheel, and the rotation of the flywheel is no longer transmitted to the shaft of the gear shift mechanism. The driver then performs the necessary gear changing operation.

After the driver has completed the gear change, he removes his foot from the clutch pedal. This causes the diaphragm spring to press the clutch plate against the flywheel to engage the clutch. The driving power of the engine is then transmitted once more to the wheels.

A hydraulic clutch release device is incorporated in the clutch release mechanism and the movement of the clutch pedal is transmitted to the diaphragm spring by hydraulic pressure. This hydraulic clutch release device presses against the center of the diaphragm spring when the gears are being shifted. Figs. 8 to 10 show examples of conventional structures for a hydraulic clutch release device.

A first example of a conventional structure for a hydraulic clutch release device illustrated in Fig.8 comprises a diaphragm spring 1, a transmission housing 2, and a rotatable shaft 3. The rotatable shaft 3 penetrating the transmission housing 2 is supported in a freely rotatable manner by a roller bearing 4 mounted to the transmission housing 2.

A cylindrical stationary sleeve 5 is provided around the rotating shaft 3, and the axially rear end (the right end in Fig.8) of the cylindrical stationary sleeve 5 is linkingly secured to the transmission housing 2. A short cylindrical movable sleeve 6 is supported on the axially front end (the left end in Fig.8) of the stationary sleeve 5 in a manner permitting free

displacement of the sleeve 6 in the axial direction (the left-right direction in Fig.8).

A release bearing 8, which is a deep groove ball bearing, is supported through a short cylindrical casing 9 on a mounting flange 7 formed on the outer peripheral surface of the movable sleeve 6. An inner race 10 of the release bearing 8 axially protrudes further than an outer race 11 which is maintained in the casing 9. The end surface of the inner race 10 (the left end surface in Fig.8) abutts against the center section of the diaphragm spring 1.

A collar section 12 is formed at the axially front end (the left end in Fig.8) of the movable sleeve 6 by bending the axially front end of the movable sleeve 6 in the radially inward direction. The inner peripheral surface of the collar section 12 is in sliding contact in an oiltight manner with the outer peripheral surface of the stationary sleeve 5. A cylinder space 13 is defined substantially by the outer peripheral surface of the stationary sleeve 5 and the inner peripheral surface of the movable sleeve 6. The cylinder space 13 is effective for the stationary sleeve 5 and the movable sleeve 6 to function as a release cylinder.

An oil supply channel 14 is provided through the stationary sleeve 5. One end of the oil supply channel 14 is communicated with the cylinder space 13 and the other end is communicated with a master cylinder through the

hydraulic piping, respectively. The master cylinder is pressurized whenever the clutch pedal is depressed.

In the hydraulic clutch release device of the first example, the hydraulic pressure produced when the clutch pedal is depressed is imparted through the oil supply channel 14 into the cylinder space 13.

As a result, the movable sleeve 6 moves to the left side in Fig.8. Then, the end surface of the inner race 10 of the release bearing 8 applies pressure axially to the center section of the diaphragm spring 1. This causes the angle of inclination of the diaphragm spring 1 to change so that the clutch is disengaged.

When the driver removes his foot from the clutch pedal on completion of the gearshift operation, the movable sleeve 6 is moved to the right side in Fig.8 by the elastic force of the diaphragm spring 1. As a result, the clutch plate is pressed against the flywheel and the clutch is engaged. The driving power of the engine is then freely transmitted to the wheels of the vehicle.

A compression spring 24 is provided between a frontward facing surface of the stationary sleeve 5 (the leftward facing surface in Fig.8) and the rearward facing surface of the movable sleeve 6 (the rightward facing surface in Fig.8). The elastic force of the compression spring 24 is much smaller than the elastic force of the diaphragm spring 1. But, the compression spring 24 causes the end surface of the inner race 10 to apply pressure

elastically to the center of the diaphragm spring 1, even in the case where the driver removes his foot from the clutch pedal. Accordingly the compression spring 24 prevents the production of slippage between the end surface of the inner race 10 and the diaphragm spring 1. In addition, the compression spring 24 causes the inner race 10 to begin to directly press against the diaphragm spring 1 immediately after the pressure in the cylinder space is removed as the clutch pedal is depressed.

Fig.9 and Fig.10 illustrate a second example of a conventional hydraulic clutch release device. As shown in Fig.9, the release bearing 8 is pressed against the center of the diaphragm spring 1 by a release fork 15.

In Fig.9, a master cylinder 17 is provided for producing hydraulic pressure when a clutch pedal 16 is depressed. One end of a hydraulic piping 18 is connected to the master cylinder 17. The other end of the hydraulic piping 18 is connected to a release cylinder 19.

As shown in Fig.10, the release cylinder 19 comprises a piston 21 enclosed in an oil tight state in a cylindrical cylinder casing 20. A pressurized oil supply and discharge port 22 is provided in one end of the cylinder casing 20 (the right end in Figs. 9 and 10). The pressurized oil discharged from the master cylinder 17 passes through the supply/discharge port 22 and is fed into the cylinder casing 20.

One end of a rod 23 abutts against one end surface

of the piston 21. The other end of the rod 23 abutts against one end of the release fork 15. The release fork 15 is pivotably supported at its middle section, and the other end of the release fork 15 opposes the center section of the diaphragm spring 1.

In the hydraulic clutch relase device of the second example, when the driver depresses the clutch pedal 16, the oil pressurized in the master cylinder 17 passes through the hydraulic piping 18 and is supplied to the release cylinder 19.

As a result, the piston 21 moves in the left direction in Fig.9 and Fig.10 inside the cylinder casing 20 of the release cylinder 19, and the rod 23 substantially protrudes from the cylinder casing 20. The release fork 15 then swings in the clockwise direction in Fig.9. This causes the end of the release fork 15 to press against the center section of the diaphragm spring 1 so that the angle of inclination of the diaphragm spring 1 changes to place the clutch in a disengaged state.

When the driver removes his foot from the clutch pedal on completion of the gearshift operation, the piston 21 is moved by the elastic force of the diaphragm spring 1 (to the right side in Figs.9 and 10). As a result, the clutch plate is pressed against the flywheel and the clutch becomes engaged. The driving power of the engine is then freely transmitted to the wheels of the vehicle.

A compression spring 25 is provided between the

inner surface of one end of the release cylinder 19 and one end surface of the piston 21. The compression spring 25 has an elastic force which is much smaller than the elastic force of the diaphragm spring 1. The action of the compression spring 25 is substantially the same as the action of the compression spring 24 in the first example. Specifically, the compression spring 25 causes the end surface of the inner race 10 (see Fig.8) to apply pressure elastically to the center of the diaphragm spring 1, even in the case where the hydraulic pressure through the supply/discharge port 22 is reminded as the driver removes his foot from the clutch pedal 16.

However, the pressure applied to the movable sleeve 6 from the compression spring 24 (in the case of the first example shown in Fig.8), and also the pressure applied to the piston 21 from the compression spring 25 (in the case of the second example shown in Fig.9 and Fig.10) are inclined to change according to the amount of wear on the clutch plate.

Specifically, the angle of inclination of the diaphragm spring 1 changes according to the amount of wear on the clutch plate, and the position of the center section of the diaphragm spring 1 also changes as the angle of inclination changes (moving to the right side in Fig.8 and to the left side in Fig.9). The compression springs 24 and 25 then tend to be more compressed according to the changes in the position of the

abovementioned center section. Accordingly, the pressure applied to the movable sleeve 6 and the release fork 15 by the compression springs 24 and 25 changes, specifically becomes larger. For this reason, even if the elastic force of the compression springs 24 and 25 is regulated in a suitable range originally, it becomes larger because of the wear of the clutch plate.

Accordingly, it has been proposed that the elastic force of the compression springs 24 and 25 be set lower. In this case, the clutch plate is made sufficiently thick and the pressure is set to be smaller when the clutch plate is new, so that even when the clutch plate is worn, the force applied on the release bearing 8 by the compression springs 24 and 25 is not excessive.

However, when the clutch plate is new and the initial force is small, slippage is produced between the front surface of the inner race 10 and the diaphragm spring 1 which make up the release bearing 8 so that there is some concern that an abnormal noise will be produced by those parts. For this reason, it is difficult to design for the proper elastic force on the compression springs 24 and 25.

## Summary of the Invention

The hydraulic clutch release device for a clutch mechanism of this invention always keeps a constant hydraulic pressure in the cylinder space in a release

cylinder having a release bearing by placing a control valve in between the master cylinder and the release cylinder such that the control valve only opens when the release cylinder pressure is lower than the master cylinder pressure and when the release cylinder pressure is higher by a predetermined amount or more than the master cylinder pressure, so as to keep constant the pushing force to press the release bearing on the diaphragm spring of the clutch mechanism.

## Brief Description of the Drawings

Fig.1 is a cross-sectional view of the entire construction of a first embodiment of this invention;

Fig.2 is an enlarged cross-sectional view corresponding to section II of Fig.1 and shows the first stage of control valve operation;

Fig.3 is substantially the same cross-sectional view as Fig.2 and shows the second stage of control valve operation;

Fig.4 is substantially the same cross-sectional view as Fig.2 and shows the third stage of control valve operation;

Fig.5 is substantially the same cross-sectional view as Fig.2 and shows the fourth stage of control valve operation;

Fig.6 is a cross-sectional view of the release cylinder of a second embodiment of this invention;

Fig.7 is a cross-sectional view of the control valve housing which houses the control valve of a third embodiment of this invention;

Fig.8 is a cross-sectional view of a half part of a first example of a prior device;

Fig.9 is a schematic vertical cross-sectional view of a second example of a prior art device;

Fig.10 is a cross-sectional view of the release cylinder used in prior art devices.

Detailed Description of the Prefferred Embodiments

In Fig.1, the hydraulic clutch release device of a first embodiment of this invention is substantially the same as that of Fig.8 in construction except that a control valve 26 is provided therein instead of the spring member 24 of Fig.8. The rotating shaft 3 is support by the ball-and-roller bearing or rolling bearing 4 so that it freely rotates inside the transmission housing 2. The cylindrical stationary sleeve 5 is placed around the transmission shaft 3. The movable sleeve 6 is supported on the outer periphery of the front end (the left end in Fig.1) of the stationary sleeve 5 so that it is shifted or displaced freely in the axial direction of the shaft. The release bearing 8 is supported on the mounting flange 7 formed around the movable sleeve 6.

The cylinder space 13 is defined substantially between the outer peripheral surface of the above

stationary sleeve 5 and the inner peripheral surface of the movable sleeve 6. The supply oil path 14 is located through the stationary sleeve 5. One end of this oil supply path 14 is communicated with the cylinder space 13 and the other end with the master cylinder 17 (see Fig.9).

A control valve 26 is located at the base section of the stationary sleeve 5 on the outer periphery thereof and adjacent to the mouth of the oil supply path 14. This control valve 26 is connected in series with the oil supply path 14.

This control valve 26 only opens when the pressure in the cylinder space 13 is lower than the pressure at the port 27 communicated with the master cylinder, and when the pressure in the cylinder space 13 is higher by a predetermined amount or more than the pressure of the port 27.

This control valve 26 is detailed in Fig.2. A short cylindrical check-ball housing 29 is located inside a stationary housing 28, which is fixed to the outer periphery of the stationary sleeve 5 and can freely shifted or displaced by a small amount in the direction of the shaft (the up-down direction in Fig.2). An O-ring 30 keeps the space between the outer peripheral surface of the check-ball housing 29 and the inner peripheral surface of the housing 28 oiltight. The check-ball housing 29 is elastically pushed by a plate spring 31, which is provided to produce an elastic pressure force in the direction to

the cylinder space 13 (bottom side of Figs.1 to 2).

Also a valve seat 32 is located inside of the check-ball housing 29 opposite from the cylinder space 13 with reference to the check-ball 33. A compression spring 34 elastically pushes the check-ball 33 in the direction of the valve seat 32. In other words, this compression spring 34 pushes the check-ball 33 in the opposite direction from the direction that the plate spring 31 pushes the check-ball housing 29.

Finally, a support ring 35 is fixed inside of the housing 28 in the section between the check-ball housing 29 and the port 27. As a means to stop shifting, the base portion of a pin 36 is supported in the center of the support ring 35.

The tip end of this pin 36 extends through the hole 40 of the check-ball housing 29 and comes in contact with the check-ball 33, as shown in Fig.4, when the check-ball housing 29 moves up opposing the elastic force of the plate spring 31. In other words, when the check-ball housing 33 moves, the pin 36 prevents the check-ball 33 from moving and separates the check-ball 33 from the valve seat 32.

The function hydraulic clutch release device of this invention with the construction mentioned above will be explained.

When the clutch is released to perform the gearshift operation or to change speeds, the driver

depresses or steps on the clutch pedal. As a result, the hydraulic pressure generated in the master cylinder is sent along the oil-supply path 14 into the cylinder space 13. When this happens, the check-ball 33 of the control valve 26, as shown in Fig.3, opposes the elastic force of the compression spring 34 and is separated from the valve seat 32. The path 39 partly defined by the valve seat 32 is opened and allows the hydraulic pressure sent from the oil-supply path 14 to pass on its way into the cylinder space 13.

As the result, the movable sleeve 6 moves to the left side of Fig.1 and the tip end of the inner race 10 of the release bearing 8, supported by the movable sleeve 6, pushes the center section of the diaphragm spring 1. Consequently, the inclination angle of the diaphragm spring 1 is changed, so that the clutch plate and flywheel are separated from each other.

Following completion of the change of speed operation or the gearshift operation, the hydraulic pressure of the port 27 lowers as soon as the driver takes his foot off of the clutch pedal. As this happens, the movable sleeve 6 moves to the right side of Fig.1 due to the elastic force of the diaphragm spring 1. As a result, the clutch plate is pressed against the flywheel and the clutch is connected, so that the engine driving force is freely transmitted to the wheels through the transmission.

As soon as the operation force applied to the

clutch pedal is released, the hydraulic pressure in the cylinder space 13 exceeds the pressure of the port 27 by just the amount of pressure that the diaphragm 1 applies to the movable sleeve 6.

As a result, the check-ball housing 29 of the control valve 26 is shifted or displaced, as shown in Fig.4 against the elastic force of the plate spring 31. However, because the check-ball 33 abutts the pin 36, the check-ball 33 is not affected by the elastic force of the compression spring 34 and does not shift as much as the check-ball housing 29.

Therefore, as shown in Fig.4, the check-ball 33 is still separated from the valve seat 32. Accordingly, the pressurized oil within the cylinder space 13 is returned to the master cylinder by way of the port 27.

As a result, when the hydraulic pressure inside the cylinder space 13 decreases some what, the check-ball housing 29 is returned by the elastic force of the plate spring 31. Also, as can be seen in Fig.5, the check-ball 33 is pressed against the valve seat 32 and no more of the pressurized oil from the cylinder space 13 returns to the master cylinder.

In this condition, the hydraulic pressure in the cylinder space 13 remains in correspondence with the elastic force of the plate spring 31. The elastic force of the plate spring 31 is much smaller than the elastic force of the diaphragm spring 1. Therefore, the clutch

connection is securely performed by the diaphragm spring 1.

As explained above, in the hydraulic clutch release device of this invention, a predetermined hydraulic pressure is maintained in the cylinder space 13 by the operation of the control valve 26, in correspondence with the elastic force of the plate spring 31. Also, depending on this predetermined hydraulic pressure, the movable sleeve 6 is pressed against the center of diaphragm spring 1.

As a result, the force pushing the release bearing 8 onto the diaphragm spring 1 is not related to the abrasion or wear amount of the clutch plate, and is always constant. Also, there is no slippage between the tip end of the inner race 10 of the release bearing 8 and the diaphragm spring 1.

Next, Fig.6 shows a second embodiment of this invention the construction of which is substantially the same as that of Fig.10 except that a control valve 26 is provided therein instead of the spring member 25 of Fig.10. In this embodiment, a control valve 26 is located at one end of a cylinder case 20 which makes up a release cylinder 19 which is communicated with a master cylinder 17 (see Fig.9) by way of a hydraulic piping 18, or in other words, is located at the end section with a supply-exhaust opening 22. The construction of the control valve 26 is substantially the same as the control valve 26 of

embodiment 1 located on the oil-supply path 14 (see Fig.1).

A predetermined hydraulic pressure caused by the elastic force of the plate spring 31 in the control valve 26 (for details see Figs.2 to 5) always exists in the cylinder space 37 (this is substantially the same as the cylinder space 13 of Embodiment 1) between the control valve 26 and a piston 21. Also, the other end of a rod 23 which is connected to the piston 21 at one end, is pressed against one end of the release fork 15 (see Fig.9) due to the predetermined hydraulic pressure.

As a result, the elastic force of the other end of the release fork 15 which pushes the release bearing onto the diaphragm 1 is not related to clutch plate abrasion or wear and is always kept constant. Also, there is no slippage between the tip of the inner ring 10 of the release bearing 8 and the diaphragm spring 1.

Next, Fig.7 shows a third embodiment of this invention. In the case of this embodiment, a housing 38 is connected to a hydraulic piping 18 at the midway section thereof (see VII in Fig.9). The hydraulic piping 18 is connected between a master cylinder 17 and a release cylinder 19, such that the master cylinder 17, the housing 38 and the release cylinder 19 are arranged in series. A control valve 26 with substantially the same construction of the control valve in the first and second embodiments is located in this housing 38.

As shown in Fig.7, the opening on the right end of the housing 38 is communicated with the master cylinder 17 and the opening on the left side and is communicated with the release cylinder 19 (see Fig.9). The rest of the construction and operation of the control valve 26 is substantially the same as in the first embodiment.

The control valve as shown in the embodiments does not have to be formed in an integral body. For example, it can also be constructed of a pair of check valve that open due to the difference in pressures of opposite directions. In other words, the control valve can be comprised of a first check valve which opens if the pressure of the master cylinder is higher than the pressure of the release cylinder, and a second check valve which opens if the pressure of the release cylinder is higher by a predetermined amount or more than the pressure of the master cylinder, with these valves being combined in parallel.

The hydraulic clutch release of this invention, is not related to the abrasion or wear amount of the clutch plate, and because the release bearing can be pressed or pushed against the diaphragm spring with proper pressure, generation of abnormal sound due to slippage can always be prevented.

What is claimed is:

1. A hydraulic clutch release device comprising a clutch pedal, a master cylinder for producing a hydraulic pressure as the clutch pedal is depressed, a hydraulic piping having opposite ends, one of which is connected to the master cylinder, a release cylinder connected to the other end of the hydraulic piping, a release bearing adapted to move as a hydraulic pressure is introduced into the release cylinder, and a control valve provided between the master cylinder and the release cylinder and adapted to only open when a pressure of the release cylinder is lower than a pressure of the master cylinder and when a pressure of the release cylinder is at least by a predetermined amount higher than a pressure of the master cylinder.

2. The hydraulic clutch release device of claim 1, wherein the release cylinder is combined with a transmission housing having a rotating shaft therethrough, the transmission housing having a cylindrical stationary sleeve with a peripheral surface secured to the transmission housing to surround the rotating shaft, and a movable sleeve with a peripheral surface supported by the stationary sleeve and adapted to be freely shift in an axial direction, and the release cylinder is comprised of the peripheral surface of the stationary sleeve and the peripheral surface of the movable sleeve.

3. The hydraulic clutch release device of claim 1,

wherein the control valve is comprised of a housing, a check-ball housing axially movable by a small amount within the housing, a valve seat provided within the check ball housing, an elastic bias means for forcing the check-ball housing in a first direction, a check-ball elastically forced in a second direction opposite to the first direction toward the valve seat in the check-ball housing, and a means for preventing the check-ball from moving when the check-ball housing moves against the force of the elastic bias means, so that the check-ball is separated from the valve seat.

4. The hydraulic clutch release device of claim 2, wherein the control valve is comprised of a housing, a check-ball housing axially movable by a small amount within the housing, a valve seat provided within the check-ball housing, an elastic bias means for forcing the check-ball housing in a first direction, a check-ball elastically forced in a second direction opposite to the first direction toward valve seat in the check-ball housing, and a means for preventing the check-ball from moving when the check-ball housing moves against the force of the elastic bias means, so that the check-ball is separated from the valve seat.

5. A hydraulic clutch release device substantially as hereinbefore described with reference to and as shown in Figs. 1 to 5 or Figs. 1 to 5 as modified by Fig. 6 or Fig. 7 of the accompanying drawings.



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