ABSTRACT: A sliding plate-type directional control valve which is so designed that none of the ports in communication with respective operating elements in a fluid circuit become communicated with the valve bore during the transitional period of fluid supply changing-over operation of a sliding member in the valve bore, and which can be converted into directional control valves of various functions by merely modifying the sliding member, said sliding plate-type directional control valve comprising a port member having the ports P, T, A, B bored therethrough, the sliding member, a floating plate interposed between said port member and said sliding member, and sets of a sealing member and a spring mounted in said floating plate or said port member or between said floating plate and said port member in such a manner that said sealing member be urged against said floating plate or said port member, whereby a fluid leakage through the gap between said port member and said floating plate is prevented and simultaneously said floating plate and said sliding member are held in plane contact preventing a fluid leakage through the gap therebetween.
SLIDING PLATE-TYPE DIRECTIONAL CONTROL VALVE

BACKGROUND OF THE INVENTION

1. Field of the Invention
The present invention relates to a directional control valve adapted to be used in a fluid circuit comprising a fluid pressure operative element, e.g., a fluid pressure operative pump or cylinder, and more particularly to a sliding plate-type directional control valve so constructed that the fluid supply is shifted from one line to another by the sliding movement of a sliding member disposed in the valve chest.

2. Description of the Prior Arts
 Consequently, a sliding spool-type directional control valve and a sliding plate-type directional control valve have been used as means to shift the supply of a pressure fluid from one line to another but such conventional directional control valves have the following defects.

First of all, the sliding spool-type directional control valve comprises a valve body having a port P, port T, port A and port B communicating with the fluid pressure operative elements in a fluid circuit, such as a fluid pump, a fluid tank, a fluid cylinder, etc., through respective conduits, and a cylindrical spool slidably disposed in the bore of the valve and having a plurality of annular grooves formed in the peripheral surface thereof for communication with said respective ports, said spool making a reciprocating sliding movement in the valve bore, communicating the port P with the port A and the port T with the port B, or the port P with the port B and the port T with the port A and thus changing the flowing direction of fluid. This type of directional control valve has the merit that various types of directional control valve, such as the type wherein all ports are open and the type wherein all ports are closed, can be obtained by suitably selecting the configuration of the spool; but on the other hand there are the disadvantages that the spool sticks or the fluid leaks between the spool and the valve body as a result of a foreign material, present in the fluid, being caught between the spool and the valve body, and that the outer surface of the spool and the inner surface of the valve body become worn out during an extended period of operation, causing an increasing leakage through the gap therebetween, with the result that the volumetric efficiency is lowered markedly.

In order to eliminate the foregoing drawbacks of the spool-type directional control valve, a sliding plate-type directional control valve has been proposed but such a conventional sliding plate-type directional control valve has not been entirely satisfactory as will be described in detail hereinafter.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a changeover valve which is so designed that all ports are not communicated with the valve chest at once during the transitional period of the directional control operation and therefore a pressure fluid is not allowed to flow into the low-pressure side or the pressure of the fluid is not lowered, which can be used for any and all purposes, which can be modified into various types of directional control valve by selectively changing the configuration of the sliding plate, and which is adapted for mass production.

It is another object of the present invention to provide a directional control valve which is free of fluid leakage, operable with a minimum sliding resistance, easy to operate and operable with high pressure.

It is still another object of the present invention to provide a directional control valve which is so designed that all of the ports are not communicated with the valve chest at once during the transitional period of the changing-over operation, and therefore the port T is subjected to a back pressure and which is capable of inching action or any other functions.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a cross-sectional view taken along the line I-I of FIG. 3 of a conventional rotary plate-type directional control valve which is a kind of conventional sliding plate-type directional control valve;
FIG. 2 is an enlarged view of a portion of the rotary plate-type directional control valve shown in FIG. 1;
FIG. 3 is a cross-sectional view taken along the line III-III of FIG. 1;
FIG. 4 is a bottom view of the rotary plate shown in FIG. 1;
FIG. 5 is an enlarged view showing the position of the portion of the directional control valve shown in FIG. 2 during the transitional period of the changing-over operation;
FIG. 6 is a cross-sectional view of a rotary plate-type directional control valve based upon this invention which is a kind of the sliding plate-type directional control valve according to the present invention;
FIG. 7 is a cross-sectional view taken along the line VII-VII of FIG. 6;
FIG. 8 is a cross-sectional view taken along the line VIII-VIII of FIG. 6;
FIG. 9 is a bottom view of an all-port open-type rotary plate; FIG. 9b is a view for explaining the operation of the rotary plate and FIG. 9c is a symbol diagram thereof;
FIG. 10a is a bottom view of a center by-pass-type rotary plate FIG. 10b is a view for explaining the operation of the rotary plate and FIG. 10c is a symbol diagram thereof;
FIG. 11a is a bottom view of a rotary plate capable of inching operation and FIG. 11b is a symbol diagram thereof;
FIG. 12 is a cross-sectional view of a modification of the rotary plate-type directional control valve shown in FIGS. 6, 7 and 8 wherein a device is made for more easy rotation of the rotary plate;
FIG. 13 is a cross-sectional view taken along the line XIII-XIII of FIG. 12;
FIG. 14 is a cross-sectional view taken along the line I-XIV of FIG. 12;
FIG. 15 is a fragmentary cross-sectional view, in enlargement, of the directional control valve wherein a sealing member and a spring are mounted in a floating plate;
FIG. 16 is a fragmentary cross-sectional view, in enlargement, of the directional control valve wherein the sealing member and the spring are mounted in the floating plate and a port member; and
FIG. 17 is a cross-sectional view of a reciprocating sliding plate-type directional control valve which is a kind of the directional control valve of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

First of all, the conventional sliding plate-type manual directional control valve will be described with reference to FIG. 1. The valve is a four-way valve as indicated by the symbol denoted in the upper corner of the FIG.

In this valve, a rotary member 7 for changing over the flowing direction of a fluid and a bearing 15 supporting said rotary member 7 are disposed in a bore 5 of a valve housing 2 and the open end of the valve housing 2 is scalably closed by a cover 3 through sealing members 11 and springs 12. As shown in FIG. 3, the cover 3 is provided with a port P, a port T and ports A and B which are communicating with a fluid pump, a tank and hydraulic cylinders in a fluid circuit respectively through respective conduits. The inner open ends of the respective ports are located radially in equally spaced relation. On the other hand, the rotary member 7 has fluid passages 6a, 6b wherein which are open in the lower face of the rotary member 7 as shown in FIG. 4. The open ends E, F, G and H of the respective fluid passages 6a, 6b are also located radially on the same circumference in equally spaced relation for communication with the aforesaid ports.
The rotary member 7 is operated by a handle 8 which is fixed to a rotary shaft 1 extending through the wall of the housing 2, and thereby a pressure fluid introduced through the port P is shifted into the port A or B through the fluid passages 6a, 6b. Each of the ports P, T, A and B is provided in the inner open end thereof a hollow sealing member 11 and a spring 12 as shown in FIG. 2, said sealing member 11 being always urged against the rotary member 7 by said spring 12.

In the conventional directional control valve having a construction as described above, a fluid leakage between the rotary member 7 and the cover 3 is prevented by the sealing members 11 pressed at one end face against the rotary member 7 by a force which are the combination of the biasing force of the spring and the fluid pressure, that is, the differential between the effective pressure-receiving areas of the opposite end faces of the sealing member 11 multiplied by the fluid pressure. Namely, even when the rotary member 7 or the sealing member 11 is worn out, a fluid leakage through the gap t between can be prevented by the so-called wear compensation and thus the valve is durable to be serviceable for a prolonged period. However, with such a directional control valve, it is impossible, because of its fatal defect, to produce various types of directional control valves by simply selecting the configuration of the sliding member. This is because, when the fluid circuit is operated with a pressure fluid, the pressure fluid acting in the fluid passages 6a, 6b develops a force f urging the rotary member 7 upwardly against the bearing 15, as shown FIG. 1, with the result that a gap t is formed between the cover 3 and the rotary member 7 as shown in FIG. 2. When the respective ports are in communication with the inner open ends of the fluid passages 6a, 6b, a fluid leakage through said gap t is prevented by the inner end portions 11a of the respective sealing members 11 in pressure contact with the rotary member 7 under the aforesaid combined force, but the following phenomena will occur during the transitional period of the changing-over operation.

Namely, the port P isimmovable, whereas the fluid passage 6a is gradually displaced incident to the rotation of the rotary member 7. Therefore, when the centers of the port P and the fluid 6a are displaced relative to each other during the transitional period of the changing-over operation, as shown in FIG. 5, the pressure fluid being circulated under pressure by the pump flows into the gap t as indicated by the arrow and drained into the tank through the drain channel and the fluid pressure is reduced to zero at once. This phenomena also occurs at the other ports. Namely, all of the ports are communicated with the tank and the fluid pressure is reduced to zero temporarily during the transitional period of the changing-over operation. Such a phenomenon extremely restricts the scope of application of the directional control valve and at the same time makes it impossible to provide various types of directional control valves by the suitable selection of the sliding member. Such undesirable phenomena can only be avoided by the incorporation of additional accessories in the fluid circuit, which is in no way desirable. For instance when the flowing direction of a fluid in one operating element is desired to be changed in a fluid circuit comprising a plurality of operating elements to be operated by one pump, the fluid pressure operating said operating element is released at the port P and simultaneously the fluid pressure for the other operating elements which is desired to be maintained on a certain level is also released from said port P. In other words, the fluid pressure in the entire system drops at once, so that the operations of the other operating elements are adversely affected.

Further, when the directional control valve of the type described is used in a fluid circuit wherein a back pressure is acted on the port T or, in a circuit wherein a plurality, for example, of tandem center-type directional control valves is connected with each other in series (by connecting the port T of one directional control valve with the port P of the following directional control valve), it is possible that the preceding valve becomes inoperative due to the pressure fluid entrapped in the valve chest or becomes broken, since the port T is opened during the transitional period of the changing-over operation as stated previously. Thus, the directional control valve is not adapted for use with such fluid circuits. Still further, the directional control valve cannot be used in a fluid circuit simultaneously with an accumulator which is provided for the purpose of obtaining a high flow rate of fluid instantaneously by accumulating a predetermined small quantity of fluid continuously supplied by a pump or storing therein spare oil to supplement an oil leakage, because all of the ports of the directional control valve are opened into a tank instantaneously during the transitional period of the changing-over operation. For the same reason, the directional control valve cannot be used simultaneously with an inching mechanism which causes an inching motion of an operating element to a predetermined position.

As described above, the conventional rotary plate-type directional control valve has an extremely limited scope of application and does not enable the user to obtain various types of directional control valves by merely suitably selecting the configuration of the sliding plate. Now, a rotary plate-type directional control valve which is an embodiment of the sliding plate-type directional control valve of this invention will be described in detail hereinafter with reference to FIGS. 6, 7 and 8.

FIG. 6 is a cross-sectional view of a rotary plate-type directional control valve. As shown, the directional control valve comprises a housing 15 having a bore 18 formed therein, a rotary member 32 adapted to change the flowing direction of fluid disposed in said bore 18, a floating plate 36 disposed in said bore 18 in plane contact with said rotary member 32, and a port member 16 closing the open end of the housing 15 liquid tight through sealing members 45 and springs 46. Describing in more detail, the housing 15 and the port member 16 are fixedly connected with each other by means of bolts 17a, 17b, 17c and 17d to form a valve body and an O-ring is interposed between two members for preventing a fluid leakage therethrough. The port member 16 is provided with ports P, T, A and B for communication with operating elements, such as a pump, a tank and a cylinder, provided in a fluid circuit, through respective conduits. The outer open end of each port is provided with a port joint 20P, 20T, 20A or 20B to facilitate the connection of the conduit with said port, said port joint being fixed to the port member by bolts 21, 22, 23 or 24. The inner open end of the respective ports are located in such a manner that the centers thereof are positioned on the same circumference radially in equally spaced relation. Further, the inner ends of the respective ports are slightly enlarged in diameter so as to receive a hollow sealing member 45 and a spring 46 to be described later therein.

A rotary shaft 28 is rotatably extending through the end wall of the housing 15 through an O-ring 29. That end of the rotary shaft 28 which is located inside of the housing 15 is provided with projections 26, 27, while the other end 28e projecting to the outside is provided with means for operatively connecting said rotary shaft with driving means such as a motor. The rotary member 32 has formed therein fluid passages 30, 31 and axially slidely engages the aforesaid projections 26, 27 of the rotary shaft 28, so that said rotary member 32 may be readily brought into a position perpendicular to the rotary shaft 28 and the rotational force of the rotary shaft only is transmitted to the rotary member 32. Between the housing 15 and the rotary member 32, there is interposed a thrust bearing 33 so as to facilitate the rotation of said rotary member even under the action of a pressure fluid. As stated previously, the hollow sealing member 45 of a known type and the spring 46 are disposed in the enlarged diameter portion at the inner end of each port bored through the port member 16. The floating plate 36 defines a flow passage 37 under a combined force which will be described later. An O-ring 47 is disposed between the outer surface of the sealing member and the inner wall surface of the inner end of the port for sealing.
The construction so far described is not of substantial difference from that of the conventional directional control valve. The characteristic feature of the present invention resides in the fact that the floating plate 36 is interposed between the sealing members 45 and the rotary member 32. Namely, the floating plate 36 is disposed on the right-hand side of the rotary member 32. Thus, the floating plate 36 having four passage holes 35P, 35T, 35A and 35B bored therethrough in such a manner that the centers of the respective passage holes are located radially on the same circumference in equally spaced relation so that said passage holes are always in communication with the ports P, T, A and B respectively. Further, the floating plate 36 is provided adjacent the peripheral edge thereof with two small-diameter through-holes 41A, 41B, in which pins 42A, 42B, extending outwardly from the port member 16, are disengagably received. Thus, it will be understood that the floating plate 36 is slidable axially but not rotatable. The relative position of the rotary member 32 and the floating plate 36 is maintained by means of a positioning pin 39 which is loosely received in a central hole 37 in the rotary member 32 at one end and in the central hole 38 in the floating plate 36 at the other end. Furthermore, stepped through-holes 35 are bored through the floating plate 36, the openings of said through-holes facing the port member 16 being circular in shape and the openings of the same facing the rotary member 32 being arcuate in shape. In general, when a pressure fluid acts in a passage the cross-sectional area of which varies between the opposite open ends thereof, a pressing force of a value which is the difference between the cross-sectional areas at the opposite ends multiplied by the fluid pressure is developed in a direction from the open end of the larger cross-sectional area to the open end of the smaller cross-sectional area. Based upon this principle, the floating plate 36 slides axially in one direction when a pressure fluid is caused to act in the passage holes 35. Namely, when the pressure fluid flows through the passage holes 35, the floating plate 36 is pressed against the rotary member 32 to be in intimate contact therewith under the fluid pressure, permitting no fluid to leak through the contacting surfaces of both members. It is for this reason that the cross-sectional area of the open ends of the passage holes 35 on that side of the floating plate facing the port member is made slightly greater than that of the opposite open ends thereof. On the other hand, the sealing member 45 has one end surface 45A in contact with the floating plate 36 and the other end surface 45B being mate with the abutment against the spring 46. Therefore, when the pressure fluid flows through the passage 44, the sealing member 45 is pressed against the floating plate 36 by the fluid pressure acting on the end surface 45A. Namely, the floating plate 36 is subjected to the combined force of the pressure fluid acting on the sealing member 45 and the biasing force of the spring 46, and is pressed against the rotary member 32 by said combined force. In this view, it may be possible to make the cross-sectional area of the open ends of the passage holes 35 on that side of the floating plate 36 facing the port member 16 equal to or slightly smaller than that of the other end surfaces 45B so that even during the transitional period of the changing-over operation, and the fact that the openings of the through-holes 35 in the floating plate 36, facing the rotary member, are shaped in an arcuate configuration to increase the area of said openings. This advantage of the present invention will be described more specifically with reference to FIGS. 9, 10 and 11. By employing the rotary member 32 having the passages 30, 31 as shown in FIG. 8 the so-called all-port block-type directional control valve can be obtained wherein all ports become closed in a neutral position of the valve. However, the passage holes 35 which are disposed in the floating plate 36 are radially longer than the passages 30, 31 shown in FIG. 8, formed in a sliding surface 50 as shown in FIG. 9a, the so-called all-port open-type directional control valve of a symbol shown in FIG. 9b. The floating plate 36 is further provided with a drain channel 40 communicating with a fluid tank through a drain port 52, through which drain channel a very small amount of the fluid leaking through the gap between the floating plate 36 and the rotary member 32 is returned to said fluid tank.
The so-called tandem center-type directional control valve wherein the port P is communicated with the port T but the port A is not communicated with the port B in a neutral position of the valve as shown in FIG. 10b, can be obtained by the use of a rotary member 32 as shown in FIG. 10a wherein independent openings 30, 31 are formed through channels 56 and 57, extending through the valve, respectively to constitute fluid passages. Further, since none of the ports become communicated with the valve bore or the fluid pressure is not released to the outside of the system during the transitional period of the changing-over operation, it is possible to obtain an external drain-type rotary end changeover valve can be obtained by eliminating the sealing member 45T so as to allow the fluid pressure to be released from the valve bore 18 into the port T.

Still further, by employing a rotary member 32 as shown in FIG. 11, wherein notches 30a, 31b are formed at the opposite ends of the individual fluid passages 30, 31 to provide for communication between said respective fluid passages and the passage holes 35 therethrough during the transitional period of changing-over operation, a valve capable of inching operation during said transitional period, as shown in FIG. 11b can be obtained.

As described and illustrated above, it is possible according to the present invention to obtain a directional control valve of any symbol as desired by providing a selected form of fluid passages in the rotary member 32, owing to the fact that the openings of the through-holes 35 facing the rotary member are made arcuate in shape to increase the area of said openings and furthermore none of the ports become communicated with the valve bore in any position of the rotary member. In other words, various types of directional control valve can be obtained only by providing a variety of rotary members, without necessitating any design change of the other parts and such advantageous feature of the present invention enables the directional control valve to be produced in a large quantity at extremely low costs.

Another form of the directional control valve according to the present invention, wherein a device is made to minimize the sliding resistance between the sliding surfaces 50, 51 of the floating plate 36 and the rotary member 32, is shown in FIGS. 12, 13 and 14. The structure of this directional control valve is essentially the same as that of the directional control valve shown in FIGS. 6, 7 and 8, as will be seen in FIG. 12. Namely, the housing 15, port member 16, bearing 33, rotary shaft 28, rotary member 32, sealing members 45 and springs 46, etc. are exactly identical with those of the preceding embodiment.

In this embodiment, however, a sealing plate 102 and a thrust bearing 103 are interposed between the floating plate 36 and the rotary member 32. As shown in FIG. 14, the sealing plate 102 is provided therein with fluid passages 130, 131 which are identical in shape with the open ends of the fluid passages 30, 31 formed in the rotary member 32, and is made smaller in diameter than the floating plate 36 and the rotary member 32.

The floating plate 36 is secured to the rotary member 32 by means of bolts 120, 121 as shown but may alternately be secured to the floating plate 36 by boring therethrough passage holes of the same cross-sectional shape as that of the open ends of the passage holes in the floating plate 36 which are open toward the rotary member 32. The thrust bearing 103 can be produced with a thickness error of several microns, owing to the recent progress of machine tools. Therefore, the sealing plate may be conveniently produced by first shaping a blank sealing plate in a predetermined thickness and thereafter reducing the thickness of the blank sealing plate to about 10 microns smaller than the thickness of the thrust bearing in the finishing stage. The sealing plate 102 thus produced is interposed between the floating plate 36 and the rotary member 32 and then the thrust bearing 103 is arranged peripherally of said sealing plate. Consequently, the floating plate 36 is urged against the rotary member 32 through the intermediary of the thrust bearing 103 and the gap formed between said floating plate and said rotary member, which is equal to the thickness of the thrust bearing 103, is filled by the sealing plate 102 whose thickness is smaller by about 10 microns than that of said gap. Therefore, a fluid leakage through said gap is practically negligible. However, in order to lead an extremely small quantity of fluid leaking through the gaps between the floating plate 36 and the sealing plate 102 and between the sealing plate 102 and the rotary member 32 to the outside of the valve, drain channels 122, 123 are formed through said sealing plate and said floating plate respectively for communication with the valve bore 18 and the drain port 52. By constructing the directional control valve as described above, it will be obvious that the rotary member 32 rotates more smoothly with no fluid leakage, as the floating plate 36 engages the rotary member 32 through the thrust bearing 103.

Although in the embodiments described and illustrated herein, the sealing members 45 disposed between the port member 16 and the floating plate 32 are fitted in the inner open ends of the respective ports, it is to be understood that the sealing members may be positioned as shown in FIGS. 15 and 16 with no change in the resulting effect.

Namely, as shown in FIG. 15 in an enlarged scale, the sealing member 67 may be loosely mounted in the passage hole 35 in the floating plate 36 with the inner end thereof resting on one end of a spring 66 and having the other end of which is bearing against a shoulder 65 formed on the inner wall of said passage hole 35. In this way, the sealing member 67 pressed against the port member 16 at the other end under the combined force defined earlier, whereby a fluid leakage occurring between the port member 16 and the floating plate 36 can be prevented.

Another arrangement of the sealing member is shown in FIG. 16. According to this arrangement, a combination of a spring 72 and a sealing member 73 is disposed in a cavity defined by the inner open end of the individual ports in the port member 16 and the open end of the individual passage holes in the floating plate 36 adjacent said port member, with the free end of said spring bearing against a shoulder 70 formed on the inner wall of said open end of the port and the free end of said sealing member resting on a shoulder 71 formed on the inner wall of said open end of the passage hole. Such an arrangement is also satisfactory for preventing a fluid leakage occurring between the port member 16 and the floating plate 36.

At any rate, all that is necessary is to provide the sealing members 45, each defining a passage 44 therein, in the port member 16 or the floating plate 36 or there between in such a manner that said sealing members are pressed against the floating plate 36 or the port member 16 under the aforesaid combined force to prevent a fluid leakage occurring between said port member and said floating plate.

To this point, the present invention has been described in detail with reference to a rotary plate-type, changeover valve which constitutes one aspect of the present invention. According to another aspect of the invention, there is provided a reciprocating sliding plate-type changeover valve wherein a member corresponding to the rotary member in the rotary plate-type directional control valves described and illustrated hereinabove makes a reciprocatory motion to shift the fluid supply from one line to another. Such a reciprocating sliding plate-type directional control valve according to the present invention will be described in detail hereunder with reference to FIG. 17.

FIG. 17 is a cross-sectional view of an all-port, block-type detent-type directional control valve which is an embodiment of the reciprocating sliding plate-type directional control valve of the instant invention.

As shown, the directional control valve of this type comprises a housing 142 having a bore 141 therein, a cover member 143 sealably enclosing said housing, a port member 145 sealably mounted on said cover member and having ports A, P, B and T formed therein, a reciprocation-type thrust bearing 145 disposed in said valve bore, a reciprocating member 146 disposed in said valve bore for reciprocatory
movement therein, a floating plate 147 disposed in said valve bore to be located between said reciprocating member 146 and said port member and having passage holes 151A, 151B, 151P and 151T bored therethrough, and sets of a sealing member 148 and a spring 149 disposed in respective passage holes 155A, 155B, 155P and 155T formed in said cover member in communication with the respective ports A, B, P and T in said port member, said reciprocating member 146 being caused to make a reciprocatory movement in said valve bore by a reciprocating shaft 150 having one end connected to said reciprocating member and the other end extending outwardly through said cover member, whereby fluid supply is shifted from one line to another. As may be seen from the foregoing description, the directional control valve of this type is the same in basic structure as the previously described rotary plate-type directional control valve but is greatly different from the latter in its shape because of the fact that the rotary member 32 in the latter is caused to make a reciprocatory movement in the form of the reciprocating member 146.

Namely, the ports P, T, A and B in the port member 144 are arranged in a straight line, and the passage holes 151P, 151T, 151A and 151B in the floating plate 147 are also arranged in a straight line for communication with said respective ports. The reciprocating member 146 is provided therein with three fluid passages 152, 153 and 154 in such a manner that all ports become open when the reciprocating member 146 is in the position shown in FIG. 17, that is, a neutral position. The port P is communicated with the port A through the fluid passage 152 and the port T is communicated with the port B through the fluid passage 154 when the reciprocating member 146 is in the left-side end of its stroke, and the port P is communicated with the port B through the fluid passage 152 and the port T is communicated with the port A through the fluid passage 153 when the reciprocating member is in the right-side end of its stroke.

However, an arrangement wherein the floating plate 147 is interposed between the port member 144 and the reciprocating member 146 and the sealing members 148 are provided in the port member 144 or the floating plate 147 or between said port member and said floating plate to be pressed against said floating plate or said port member under the bias of the respective springs 149 for thereby preventing a fluid leakage occurring between said two members, is of no difference from the rotary plate-type directional control valves described previously.

In the reciprocating sliding plate-type directional control valve having a construction described above, the floating plate 147, alike in that the previously described rotary plate-type directional control valve, is always pressed against the reciprocating member 146 under the pressing force of fluid developed by the fluid passing through the passage holes 151 or a combined force created in the respective sealing members 148 as will be described later, and thereby a fluid leakage occurring between said floating plate 147 and said reciprocating member 146 is prevented. Namely, each sealing member 148 is always urged against the floating plate 147 under a combined force of the pressing force of fluid created in the sealing member during passage of the pressure fluid through the passage 155 defined by said seating member and the biasing force of the associated spring 149, and consequently the floating plate is pressed against the reciprocating member 146, whereby a fluid leakage therebetween is prevented.

It will be understood therefore that in this directional control valve also, as well as in the previously described rotary plate-type directional control valve, none of the ports become open to the outside of the system in any position of the valve and during the transitional period of the changing-over operation in particular, so that the same function and effect as those obtained by the rotary plate-type changeover valve can be obtained.

I claim:

1. A rotary plate-type directional control valve comprising a housing defining a valve bore therein, a rotary member rotatably disposed in said valve bore and adapted to change over the fluid supply from one line to another, a floating plate disposed in said valve bore in plane contact with said rotary member, and a port member hermetically attached to said housing to seal said valve bore with sealing members and springs interposed therebetween, said rotary member having at least one fluid passage formed therein and being rotated freely by a rotary shaft extending through the wall of said housing, said floating plate being held between said rotary member and said port member in such a manner that it is slideable axially but not rotatable about its axis, the floating plate having at least two through-holes that is, one through-hole which is always communicated with a pressure port in said port member and the other through-hole which is always communicated with a cylinder port and/or a tank port, the openings of said through-holes closer to the rotary member being arcuate in shape and the effective pressure-receiving area thereof being smaller than the area of said ports, said through-holes being brought into and out of communication with the fluid passage in said rotary member after the fluid supply changing-over operation, and said sealing members and said springs biasing said respective sealing members being mounted in said port member in which a fluid leakage through the gap between said floating plate and said port member is prevented simultaneously, said floating plate in plane contact with said rotary member, under which condition said rotary shaft is rotated for effecting the fluid supply changing-over operation.

2. A rotary plate-type directional control valve as claimed in claim 1 wherein said springs biasing said respective sealing members are mounted in said floating plate.

3. A rotary plate-type directional control valve as claimed in claim 1 wherein said springs biasing said respective sealing members are mounted between said port member and said floating plate in such a manner that each of said sealing members is urged toward the floating plate.

4. A rotary plate-type directional control valve as claimed in claim 1 wherein said springs biasing said respective sealing members are mounted by a combined force of the fluid pressure acting on an end face of the sealing member and the biasing force of the spring.

5. A rotary plate-type directional control valve as defined in claim 1, wherein the arcuate openings of said through-holes are located in an annular sliding surface the width of which is slightly larger than the width of said arcuate openings, the exterior of said annular sliding surface serving as a drain communicating with a tank, with the effective pressure-receiving area of the arcuate openings closer to the rotary member being maintained substantially constant.

6. A rotary plate-type directional control valve as claimed in claim 1 wherein a sealing plate having a diameter smaller than the diameter of the floating plate and the diameter of the rotary member is interposed between said floating plate and said rotary member, said sealing plate has a thrust bearing arranged around its periphery, said thrust bearing having a thickness slightly greater than the thickness of said sealing plate with said floating plate and said rotary member being held in plane contact with said thrust bearing.

7. A plate-type directional control valve comprising a housing having a bore defined therein: a cover member secured to said housing and substantially enclosing said bore, said cover member having a plurality of passage apertures therethrough; a port member mounted to said cover member, said port member having a plurality of ports therethrough, said ports being positioned for communication with said cover member passages to form fluid lines; bearing means disposed in said bore; a reciprocating member adjacent said bearing means and positioned in said bore for reciprocating movement therein; a floating plate positioned in said bore between said reciprocating member and said cover member, said float-
ing plate having a plurality of passage apertures therethrough; sealing means seated in at least one of said cover member passage apertures, and

means to reciprocate said reciprocating member in said bore allowing a fluid supply from one fluid line to shift to another fluid line.