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**Kyoto-fu, Japan**  
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 [33] **Japan**  
 [31] **42-65781**

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[54] **FLUID SWITCHING DEVICE**  
 2 Claims, 12 Drawing Figs.

[52] U.S. Cl. .... 137/625.68,  
 251/75, 251/367  
 [51] Int. Cl. .... F16k 31/56  
 [50] Field of Search ..... 251/75,  
 367; 137/625.68

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**ABSTRACT:** A fluid switching device in which first and second passageways of a sleeve arranged in a case are switched by a third passageway of a spool movable in the sleeve and controlled by a snap-action device which is operated quickly at dead center point and is movable so as to intersect by its direction of movement the third passageway whereby, producing no influence of fluid pressure in the passageways in the operating directions upon the spool, the first and second passageways are switched quickly by the spool; all passageways are made gastight or fluidtight with the result that the snap-action device is protected from corrosion and ensuing erroneous operation.

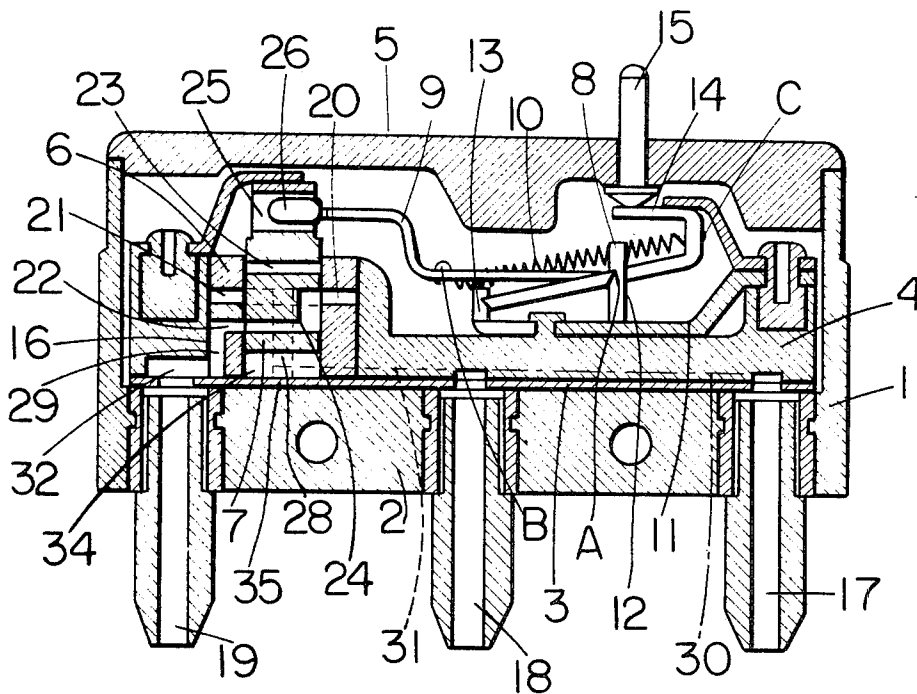


Fig. 1

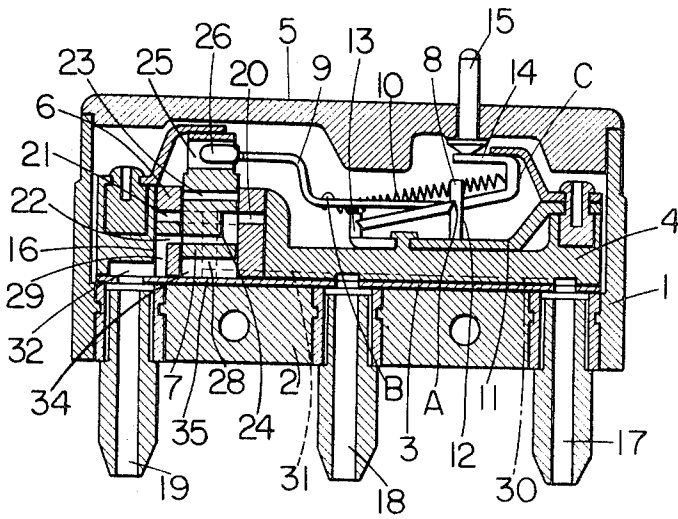


Fig. 2

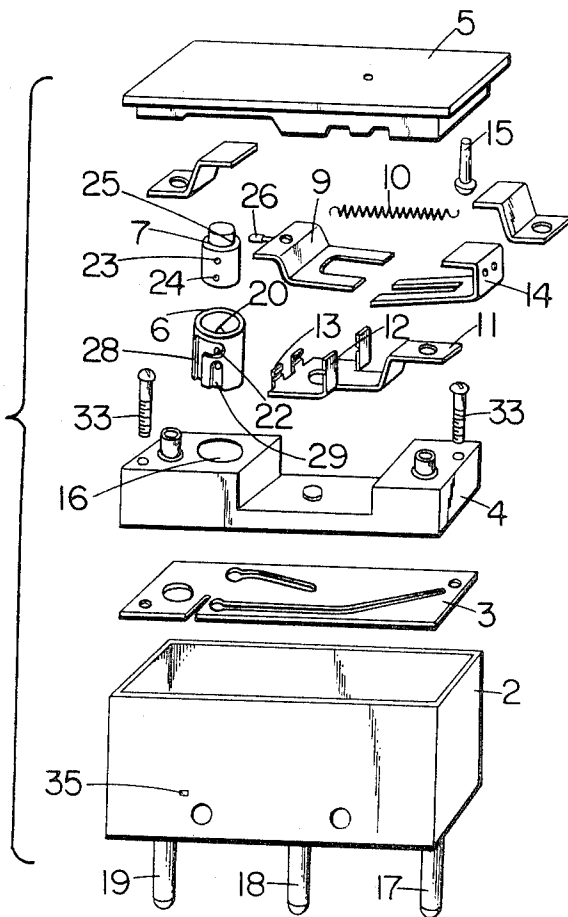


Fig. 4

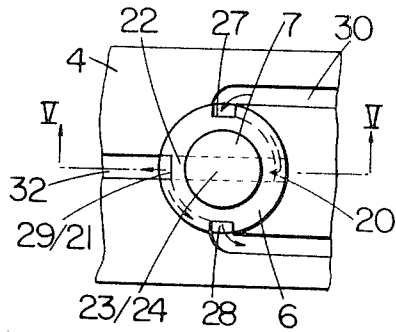


Fig. 5

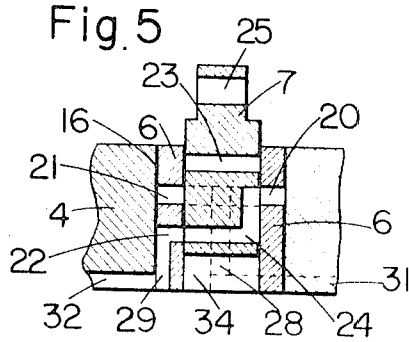


Fig. 6

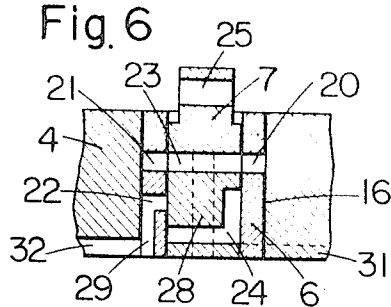


Fig. 3

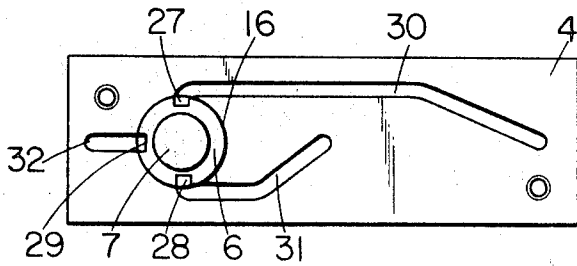


Fig. 7

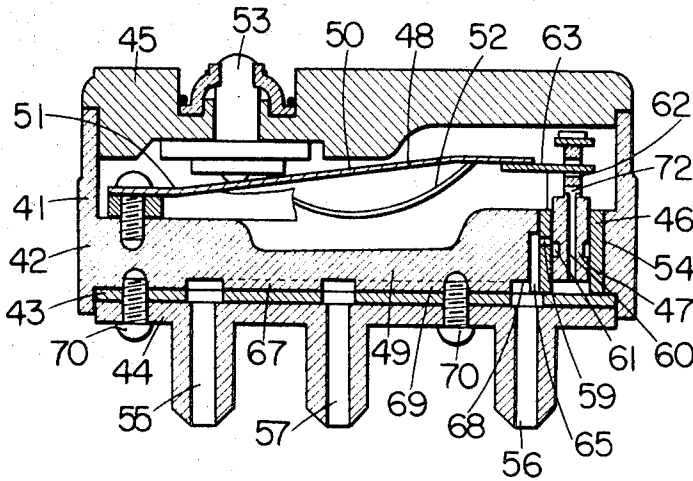


Fig. 9

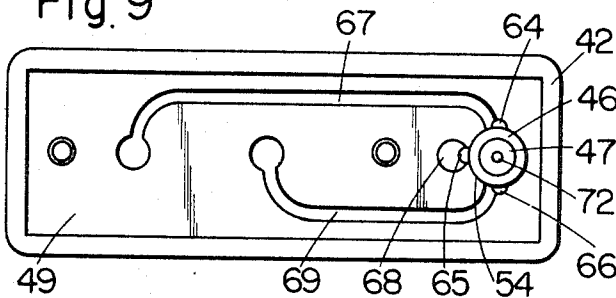


Fig. 8

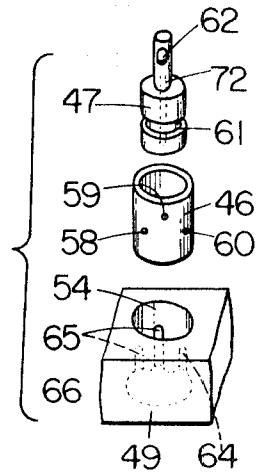


Fig. 10

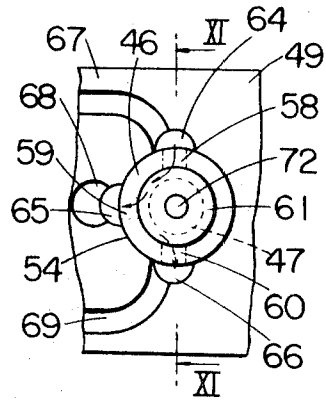


Fig. 11

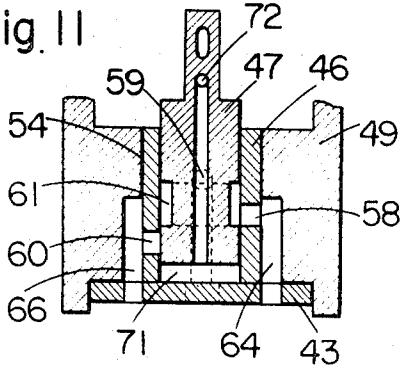
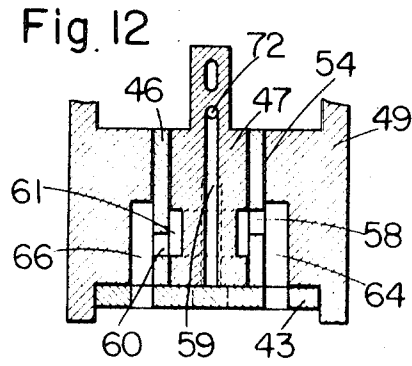


Fig. 12



## FLUID SWITCHING DEVICE

The present invention relates to a fluid switching device and more particularly to a switching arrangement which is used for diverting a flow in fluid control systems. The recent development of fluid logic elements is remarkable and with this progress, fluid control systems which correspond to electric circuits are successively developed and put to practical use. Especially it is a specific feature of the fluid control systems that they are not influenced by electric noise and it is unnecessary to take care of a gas proof construction, and further it uses, not a electric source, but a fluid source such as air, water and so on, so that it is most suitable for control devices of a machine tool or machines that handle an object requiring a gas proof construction, such as gasoline, for example a gasoline selling machine and so on. By the way a fluid switching device for diverting flow like a fluid logic element for controlling input and output is indispensable to a fluid control system and exhibits more remarkably the essential feature of the system in the case of containing no electric elements.

The conventional fluid switching devices are divided roughly into two types; one type in which the valve for diverting the flow is moved with use of an electromagnetic solenoid and another type in which the valve is moved by hand or fluid pressure. But the former cannot exclude electric elements and the latter could not divert the flow quickly from one path to another path, though it is important to divert the flow quickly as a switching arrangement. The present invention, in the consideration of this point belongs to the latter and may be controlled to divert the flow quickly, and so one object of the present invention is to provide a fluid switching device having a sleeve with first and second passageways connected to an inlet and an outlet of a case and a spool operated by snap acting means with a third passageway switching said first and second passageways, and said third passageway being formed to intersect the moving direction of the spool so that fluid pressure has no influence on said spool and on said snap acting means which controls said spool, and the flow of fluid from said first passageway to said second passageway may be switched quickly.

And a dead point device, namely a device which is moved quickly so as to pass a dead point, making use of compression and tension members, is provided in the snap acting means which switch the flow of fluid passageways quickly, for making this fluid switching device small on the whole.

Generally it is necessary for the changeover force of snap acting means not to be influenced by other force particularly by the force acting in an opposite direction so that such snap action means with a so-called dead point may exhibit thoroughly the effect of the quick snap action. For this purpose in this invention no fluid pressure acts in the moving direction of the valve or the spool which is moved by the snap acting means and switches the fluid passageways, so that the snap action means fulfills its function sufficiently and may switch the flow of fluid with a completely quick operation.

Another object of the invention is to provide a fluid switching device, having a sleeve with first and second passageways, a spool which is movable in the sleeve and a third passageway for switching the passageways of the above-mentioned sleeve in the direction intersecting the moving direction, and a snap acting means which moves the spool, and providing a fluid course which leads the pressure fluid entering through one of the passageways of the sleeve to the rear of said spool on the opposite side of the passageway, so that the frictional resistance between the sleeve and the spool particularly in the rear of the spool may not increase with fluid pressure acting on the spool from the passageway of the sleeve, so that the motion of the spool against the sleeve may be smooth and both passageways of the sleeve are switched by the spool quickly in accordance with the action of the snap acting means.

Still another object of the invention is to provide a fluid switching device, having a sleeve with first and second passageways connected to an inlet and an outlet and a spool operated by snap acting means with a third passageway switching the first and said second passageways, and the third passageway being formed to intersect the moving direction of the spool, and a connecting hole being provided in the spool which accepts a moving end of the snap acting means with some clearances in its moving direction, the means not being connected directly to the spool so that during the initial operation the spool may respond quickly without resistance and the switching operation of the spool may be done by only a small switching force of the means.

A further object of this invention is to provide a fluid switching device having a sleeve put in a hole of a case with first and a second passageways, a spool with a third passageway switching the first and second passageways which is movable in the direction intersecting the third passageway and fourth and fifth passageways which connect an inlet and an outlet of a case to the first and second passageways of the sleeve respectively, and all the passageways, i.e. first to fifth passageways, being constituted gas or fluid proof so as not to connect with the inside of the case containing the snap acting means by which said spool is quickly movable in its moving direction.

And in this way the gas proof liquid-tight feature of the fluid courses is realized and the snap acting means can not touch fluid directly which would corrode and shorten the useful life of the means.

Generally in the fluid switching device it is of course necessary to maintain gas proof or liquid tight the fluid course and further it is necessary that the snap acting means is not exposed to the flow of fluid.

Probably shortening of the useful life of the means may be unavoidable if this means is corroded by moisture which stems from the fluid. For this purpose in the present invention the fluid courses are not connected to the snap acting means and are constituted themselves gastight or fluidtight in order to be sufficiently gas proof, and by making gas proof the inside of the case which contains the snap acting means by means of a packing, it is protected from corrosion and erroneous operation.

A still further object of the invention is to provide a fluid device having a sleeve with first and second passageways, a spool which is movable in the sleeve and which has a third passageway for switching the passageways of the above-mentioned sleeve in the direction intersecting the moving direction, and fourth and fifth passageways which connect an inlet and an outlet of a case to the first and the second passageways of the sleeve respectively, and the spool being movable by snap acting means put in the case, the fourth and the fifth passageways consisting of grooves provided in the hole of the case, and sixth and seventh passageways which connect said fourth and fifth passageway to the inlet and the outlet of the case respectively being formed in the back of the case so that assembly of the case may be possible as a unit and manufacture and assembling of whole devices may be easy in order to promote productivity.

Still another and further object of this invention is to provide a fluid switching device, which does not include an electric element and whose form is small, and in which diverting the flow of fluid is controlled sufficiently quickly.

The fluid switching device of this invention does satisfy the above-mentioned various objects, and its kind of structure and operation are not limited to the details shown and described herein. And various preferred embodiments of this invention illustrated in the following figures are explained concretely in order to make apparent other objects, characters and merits of this invention.

FIG. 1 is a vertical sectional front view showing a preferred embodiment of this invention.

FIG. 2 is a segmental exploded isometric view of FIG. 1.

FIG. 3 is a bottom plan view of the base of FIG. 1.

FIG. 4 is partly enlarged plan view of FIG. 3.

FIG. 5 is a section taken along the line V-V of FIG. 4 and shows the relation between a sleeve and a spool. FIG. 6 is a section showing the operating condition of FIG. 5.

FIG. 7 is a vertical sectional front view showing another embodiment of the invention.

FIG. 8 is a segmental exploded isometric view of a part of FIG. 7.

FIG. 9 is a bottom plan view of the case body of which the lower cover is removed in FIG. 7.

FIG. 10 is a partly enlarged plan view of FIG. 9.

FIG. 11 is a section taken along the line XI-XI of FIG. 10 and shows the relation between a sleeve and a spool.

FIG. 12 is a section showing the operating condition of FIG. 11.

In the first place one preferred embodiment of the invention illustrated in FIG. 1 to FIG. 6 is explained hereinafter.

As is illustrated in FIG. 1, a case 1 is composed of the case body 2, of a base 4 which is installed in the case body 2 through packing 3, and of an upper cover 5 which is installed in the upper opening of the case body 2. In the case 1 are accommodated a sleeve 6, a spool 7 and snap acting means 8. The snap acting means 8 is composed of a compression member 9 and of a tension member 10 so as to provide a dead point position. More particularly, one end of the compression member 9 is jointed at A (FIG. 1) to the first foot pieces 12 of a check plate 11 which is fixed on the upper side of the base 4 and the other end pivots freely around its jointing point A. And one end of the tension member 10 is connected at B (FIG. 1) to the compression member 9 and the other end is connected at C to an extreme part of a lever 14 which is jointed to the second foot pieces 13 of the check plate 11.

When the connecting point (C) reaches the line which links the jointing point A with the connecting point (B), namely the dead center position line, a dead point position is reached, and when the extreme part of the lever 14 is pushed down by the push button 15 which is arranged to move freely upwardly and downwardly, in the upper cover 5, then as the connecting point (C) passes through the dead point position, the compression member 9 goes down or moves downwardly quickly.

The cylindrical sleeve 6 is fitted and fixed in a hole 16 which is bored vertically into the base 4 and as is explained in the following, the sleeve 6 has a first passageway 20, a second passageway 21 and a passageway 22 opening to the atmosphere, all of circular cross sections which are connected respectively to an inlet 17, an outlet 18 and an atmospheric opening 19 provided in the case body 2 (FIG. 1).

Furthermore, the spool 7 in the form of a round bar is movable in the sleeve 6 and has a third passageway 23 which switches the first and second passageways 20, 21 of said sleeve 6 and the atmospheric changeover fluid course 24 of the sleeve 6, and the third passageway 23 is formed in the direction intersecting the moving direction of the spool 7.

The connecting rod 26 extending from the free end of the compression member 9 engages in a connecting hole 25 provided in the upper end of the spool 7 and is fitted with some clearances in the moving direction of the spool 7 so that the spool 7 is controlled by the snap acting means 8.

In the outside circumference of the sleeve 6 are arranged a fourth passageway 27, a fifth passageway 28 with grooves and a second fluid course 29 opening into the atmosphere which are connected respectively to the first and second passageways 20, 21 and to the atmospheric opening fluid course 22. In the back of the base 4 are arranged a sixth passageway 30, a seventh passageway 31 and a third fluid course 32 opening to the atmosphere which are connected respectively to the fourth and fifth passageways 27, 28 and to the second atmospheric opening fluid course 29, and these passageway 30, 31 and course 32 are connected respectively to the inlet 17, the outlet 18 and the atmospheric opening 19 of the case body 2. In the case body 2 the base 4 is covered with packing 3 and is installed by screws 33 (FIG. 2) to the case body 2.

In the above-mentioned fluid switching device, as is indicated by the full line arrow of FIG. 4 and FIG. 5, during the

normal state, working fluid which flows to the fourth passageway 27 of the sleeve 6 through the sixth passageway 30 from the inlet 17 is conducted into the atmospheric changeover fluid course 24 of the spool 7 through the first passageway 20 of the sleeve 6 and is exhausted through the atmospheric opening 19 by way of the first and second fluid courses 22, 29 and the third atmospheric opening fluid course 32. At this time, the third passageway 23 of the spool 7 is closed by the sleeve 6 and the first passageway 20 is not connected to the second passageway 21 and so the working fluid is not conducted to the outlet 18.

Now, when the pushbutton 15 is pushed, the spool 7 falls down immediately. At first the snap acting means 8 linked with the pushbutton 15 is not connected directly to the spool 7, and has some clearances in the moving direction of its connecting rod 26 within the connecting hole 25, and therefore, the snap-acting means 8 responds quickly to a small operating power of the pushbutton 15 without resistance in the initial movement. Next, the spool 7 which is moved quickly by the snap acting means 8 is not under the influence of fluid pressure in the first passageway 20 of the sleeve 6, because the third passageway 23 intersects the moving direction of the spool 7. And atmospheric air in the space 34 underneath the falling spool 7 is exhausted to the outside of the case 1 through a hole 35 (FIGS. 1 and 2) drilled in the side of the case body 2, so that the spool 7 may be moved quickly downwards without reaction. In this manner the spool 7 connects the second passageway 21 of the sleeve 6, which conducts the working fluid on to the outlet 18, by way of the third passageway 23 with the first passageway 20 of the sleeve 6, and so as is illustrated by the dotted line arrow of FIG. 4 and FIG. 6, the working fluid which flows into the first passageway 21 of the sleeve 6 from the inlet 17 is introduced to the second passageway 21 of the sleeve 6 through the third passageway 23 of the spool 7. And the working fluid is exhausted from the outlet 18 through the fifth passageway 28 of the sleeve 6 and the seventh passageway 31 of the base 4. At this time the fluid is not exhausted by way of the atmospheric opening 19 because the atmospheric changeover fluid course 24 of the spool 7 is closed by the sleeve 6 and the first passageway 20 of the sleeve 6 is not connected to the atmospheric opening fluid course 22.

The snap acting means 8 is restored again to the former situation when the pushdown force is removed from the pushbutton 15 since the lever 14 supported by the second foot pieces 13 is always urged upwardly by the spring 10.

In the fluid switching device which operates in the above-mentioned way, the inlet 17 and the outlet 18 are arranged on the bottom side of the case body 2, and the spool 7 and the sleeve 6 which switch the working fluid are placed into the hole 16 of the base 4, and further all passageways 20, 21, 23, 27, 28, 30, 31, 32, in which the working fluid flows are arranged and are constituted gas proof, whence the working fluid does not leak into the inside of the case 1 containing the snap acting means 8 so that fluid proof condition of all passageways is maintained and the snap acting means 8 is not corroded by moisture from the fluid with the result that its useful life is improved.

In the fluid switching device which is constituted in the above-mentioned way, by reason of the possibility of a selection of a suitable number of the passageways of the spool and the sleeve, the passageways of the base may be designed easily and adequately. For instance, the above-mentioned practical example is a fluid switching device representing a three-way valve, but it is also easy to design another fluid switching devices which constitutes a two-way valve or four-way valve.

Another preferred embodiment of a fluid switching device is explained hereinafter by reference to FIGS. 7-12. As is shown in FIG. 7, a case 41 is composed of a case body 42, of a lower cover 44 which is installed in the case body 2 through packing 43, and of an upper cover 45 which is installed in the upper opening of the case body 42.

In the case 41 are accommodated a sleeve 46, a spool 47 and snap acting means 48. The snap acting means 48 is com-

posed of a tension member 50 of which one end is fixed on the upper side of a base plate 49 of the case body 42 and another end is free, and of a compression member 52 of which one end is jointed to a check plate 51 arranged on the base plate 49 and another end is connected securely to the tension member 50 to form a unitary body so as to provide a dead point position. When the tension member 50 is pushed by the pushbutton 53 which is arranged to move freely upwards and downwards in the upper cover 45, the free end of the tension member 50 falls down quickly.

The cylindrical sleeve 46 is fitted and fixed in a hole 54 which is provided vertically in the base plate 49 of the case body 42 and as is explained in the following, the sleeve 46 has a first passageway 58, a second passageway 59 and a fluid course 60 opening into the atmosphere, all with circular cross sections which are connected respectively to an inlet 55, an outlet 56 and an atmospheric opening 57 provided in the lower cover 44.

And further the spool 47 in the form of a round bar is movable in the sleeve 46 and as is mentioned in the following, the spool 47 has a third passageway 61 with a concave circular groove which connects the first passageway 58 of sleeve 46 to the second passageway 59 or to the atmospheric opening fluid course 60, and the third passageway 61 is formed in the direction intersecting the moving direction of the spool 47. At the same time the third passageway 61 forms a connecting fluid course which leads the pressure fluid entering from the first passageway 58 of the sleeve 46 all ranges of the movement of the spool 47 to the rear of the spool 47 which is on the opposite side of the first passageway 58.

The connecting rod 63 extending from the free end of the tension member 50 engages in a connecting hole 62 provided in the upper end of spool 47 and is fitted with some clearance in the moving direction of the spool 47, and the spool 47 is thus controlled quickly by the snap acting means 48.

Along the inside circumference of the hole 54 of the base plate 49 in which is fitted the sleeve 46, are arranged by means of straight grooves, a fourth passageway 64, a fifth passageway 65 and a second atmospheric opening fluid course 66 which are connected respectively to the first and second passageways 58, 59 and the first atmospheric opening fluid course 60. And in the back of the case plate 49 are provided a sixth passageway 67, a seventh passageway 68 and a third atmospheric opening fluid course 69 which are connected respectively to the fourth and fifth passageways 64, 65 and the second atmospheric opening fluid course 66, and these passageways 67, 68 and the course 69 are connected respectively to the inlet 55 and the outlet 56 and the atmospheric opening 57 of the lower cover 44.

In the case body 42 the base plate 49 is covered through packing 43 by the cover 44 which is securely assembled by screws 70 to the case body 42 to form one body therewith.

In the above-mentioned fluid switching device, as illustrated by the full line arrow of FIG. 10 and FIG. 11, during the normal state, working fluid which flows to the fourth passageway 64 forming a straight groove provided in the hole 54 of the base plate 49 by way of the inlet 55 and the sixth fluid passageway 67, is conducted to the third passageway 61 of the spool 47 by way of the first passageway 58 of the sleeve 46.

At this time the third passageway 61 is situated in the upper portion of the sleeve 46 and is connected to only the second passageway 59 of the sleeve 46, so that the working fluid is exhausted through the outlet 56 by way of the second, fifth and seventh passageways 59, 65, 68.

Now, when the pushbutton 53 is depressed, the spool 47 falls down immediately. At first as the snap acting means 48 linked with the pushbutton 53 is not connected directly to the spool 47 and has some clearances in the moving direction of its connecting rod 63 within the connecting hole 62, no resistance acts upon the initial response and therefore the snap-acting means 48 responds quickly to a small operating power of the pushbutton 53 without resistance in the initial movement.

Next, the spool 47 which is moved quickly by the snap acting means 48 is not under the influence of fluid pressure in the first passageway 58 of the sleeve 46, because the third passageway 61 intersects the moving direction of the spool 47.

As the pressure fluid flowing from the first passageway 58 of the sleeve 46 is connected to all sides of the spool 47 through the third passageway 61, regardless of the motion of the spool 47, towards the opposite direction of the first passageway 58 by the pressure of fluid with the result that the frictional resistance of the contact surface between the spool 47 and the sleeve 46 does not increase. And atmospheric air in the space 71 of the spool 47 is exhausted to the inside of the case body 42 through a hole 72 provided in the axial center of the spool 47, so that the spool 47 may be moved quickly downwards without reaction. In this manner the spool 47 closes the passageway 59 of the sleeve 46 so that the working fluid is disconnected from the outlet 56. But as is illustrated by the dotted line arrow of FIG. 10 and FIG. 12, the third passageway 61 of the spool 47 is now situated on the lower side and connects the first passageway 58 to the first atmospheric opening fluid course 60, and so now the working fluid is exhausted through the atmospheric opening 57. And the snap acting means 48 is restored again to the former situation when the pushdown force of is removed from the pushbutton 53 since the tension member 50 is always urged upwardly by the compression member 52.

In the fluid switching device which operates in the above-mentioned way, the inlet 55 and the outlet 56 are arranged in the lower cover 44 and the spool 47 and the sleeve 46 which switch the working fluid are placed into the hole 54 drilled into the base plate 49 of the case body 42. As all passageways 58, 59, 61, 64, 65, 67, 68 in which the working fluid flows are arranged in a fluidtight manner, the working fluid does not leak into the inside of the case 41 containing the snap acting means 48 so that the fluid proof feature of all passageways is maintained and the snap acting means 48 is not corroded by moisture from the fluid with the result that its useful life is improved.

If the fluid switching device is constituted in the above-mentioned way, the case 41 is composed of the case body 42, the lower and there are arranged covers 44, 45, and in the case body 42, the fourth and fifth passageways 64, 65 with straight grooves provided in the hole 54 which is provided in the base plate 49, the second atmospheric opening fluid course 69, the sixth and seventh passageways 67, 68 located in the back of the base plate 49 and the third atmospheric opening fluid course 69 and these are formed in one body as a unit. And also the upper and lower covers 45, 44 may be formed in one body as a unit. The sleeve 46 which is fitted and fixed in the hole 54 of the base plate 49 is like a kind of cylinder which is provided with the first and second passageways 58, 59, and the atmospheric opening fluid course 60 with circular section.

And the spool 47 fitted to the sleeve 46 is like a kind of round bar which is provided with a concave circular groove on its side as the third fluid passageway 61 and also with two holes 72, 62 in its axial center and in its extreme part. Therefore manufacture of both sleeve 46 and spool 47 is easy, so that all the systems of the fluid switching device are manufactured and assembled easily and improvement of its productivity is obtained.

The above-mentioned preferred embodiments explain this invention in detail and are easy to understand, but of course the special structures illustrated in the figures and the explanation thereof of a detailed description may be transformed and changed in difference ways, and these changes are within the technical scope of this invention so far as they are the scope of the principal point of this invention.

What I claim is:

1. A fluid switching device, comprising
  - a snap acting means having a dead point position with compression and tension members,
  - a sleeve having first and second passageways connected to an inlet and an outlet of a case respectively,

a spool having a third passageway extending from a front portion to a rear portion thereof, which third passageway selectively connects said first and second passageways of the sleeve, and

said spool being movably received in said sleeve and providing a fluid course which leads the pressure fluid entering from one of the passageways of said sleeve from the front portion to the rear portion of said spool in a direction opposite to the fluid course in said one of said passageways, said third passageway being formed in a direction intersecting the moving direction of said spool, and said spool being moved quickly in its moving direction by said snap acting means which includes a check plate having first and second footpieces, a lever operatively jointed at the second footpiece, pushbutton means operatively associated with said lever and freely movable upwardly and downwardly, and said tension member being operatively connected with said compression member and said lever, wherein said spool provides a connecting aperture which accepts a movable end of said snap acting means with clearances in the moving direction.

2. A fluid switching device comprising

snap acting means having a dead point position with compression and tension members,

a sleeve having first and second passageways,

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a spool movably received in said sleeve and having a third passageway which selectively connects said first and second passageways of the sleeve in a direction intersecting the moving direction of said spool,

a case having a front, a back, an inlet, an outlet and a hole in which is put said sleeve,

fourth and fifth passageways formed by grooves provided in said sleeve, and connecting said inlet and outlet of the case to said first and second passageways of said sleeve respectively,

sixth and seventh passageways formed on the back of the case to connect said fourth and fifth passageways to said inlet and said outlet, respectively, and

said snap acting means including a check plate having first and second footpieces, a lever operatively jointed at the second footpiece, pushbutton means operatively associated with said lever and freely movable upwardly and downwardly, and said tension member being operatively connected with said compression member and said lever, said spool being moved quickly in its moving direction by said snap acting means, and all said passageways being devoid of any connection with the inside of the case containing said snap acting means.

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