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DE FR GB IT(30) Priority: **03.04.1996 JP 106308/96**(71) Applicant: **SMC CORPORATION**
Minato-ku Tokyo 105 (JP)

(72) Inventors:

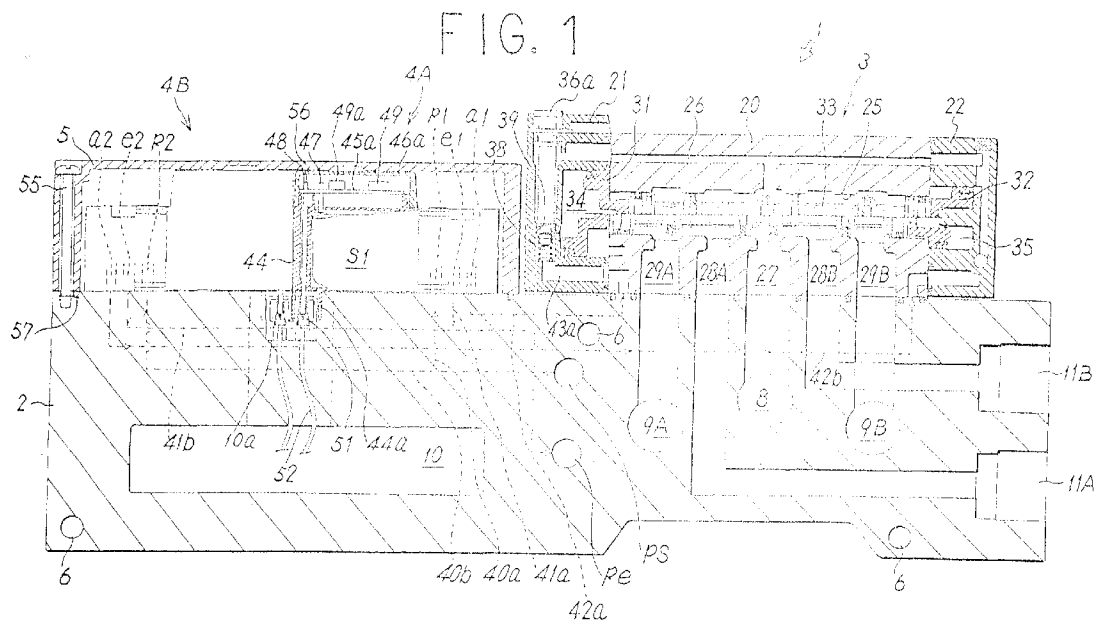
- **Sato, Hideharu, c/o SMC Corporation**
Yawara-mura, Tsukuba-gun, Ibaraki (JP)

- **Miyazoe, Shinji, c/o SMC Corporation**
Yawara-mura, Tsukuba-gun, Ibaraki (JP)
- **Ishikawa, Makoto, c/o SMC Corporation**
Yawara-mura, Tsukuba-gun, Ibaraki (JP)

(74) Representative: **Findlay, Alice Rosemary**
Lloyd Wise, Tregear & Co.,
Commonwealth House,
1-19 New Oxford Street
London WC1A 1LW (GB)(54) **Solenoid pilot valve**

(57) A main valve 3 and solenoid-driven pilot valves 4A and 4B are independently installed on a manifold base 2, separate from each other. The manifold base houses a feeding line passage, through which feeding

lines to the pilot valves pass. The manifold base includes a waterproof cover 5 that covers the pilot valves and the energization system, extending from the feeding line to the pilot valve. The main valve 3 may be a single or double solenoid.

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Description

The present invention relates to a pilot solenoid valve, in particular to a pilot solenoid valve that is installed on a manifold base to drive the valve body of a main valve using pilot fluid supplied or ejected through pilot valves driven by a solenoid, and that switches the output opening of the main valve between a supply opening and an ejection opening for communication.

Pilot solenoid valves that include a main valve installed on a manifold base and pilot valves attached to the main valve to drive the valve body of the main valve using a pilot fluid which is supplied or ejected through the pilot valves, and that switches the output opening of the main valve between a supply opening and an ejection opening for communication are well known and need not be illustrated here.

If such well-known pilot solenoid valves are used in a very humid working environment, pilot valves that have an electrical section and the energization system must be protected to prevent accidents that could be caused by water. It is difficult and expensive, however, to make only the pilot valves attached to the main valve and the energization system water proof or moisture-proof. Therefore, so it is simpler and more effective to cover all the valves including a large number of the main valves arranged on manifold bases to protect them from water.

When, however, the pilot solenoid valve is waterproof, the cover must be removed to disable the overall waterproof function each time maintenance or inspection of the main or pilot valves is carried out or a defective part is replaced even if said maintenance or inspection involves parts other than the pilot valves, which do not require a waterproof function. This might cause some troubles and is also a problem that makes maintenance and inspection cumbersome. In addition, the pilot solenoid valve normally includes a manual operation section that allows the main or pilot valves to be manually opened and closed when power supply is interrupted or the valves becomes defective. In such a case, the cover must also be removed to disable the overall waterproof function.

It is an object of this invention to provide a pilot solenoid valve that has a simple structure protecting only the pilot valves and the energizaion system from water.

It is another object of this invention to provide a pilot solenoid valve that enables the maintenance, inspection, and replacement of parts other than the pilot valves and the energization system without disabling the waterproof function, and that allows the above work to be carried out independently of the above waterproofed section.

It is yet another object of this invention to provide a pilot solenoid valve that allows a common cover to be used for a pilot solenoid valve with one or two pilot valves.

It is still another object of this invention to provide a

pilot solenoid valve that allows the manual operation section provided therein to be operated easily without disabling the waterproof function of the pilot valves.

This invention provides a pilot solenoid valve comprising on a manifold base, a main valve for switching the output opening between a supply opening and an ejection opening for communication, and pilot valves driven by a solenoid to drive the valve body of the main valve, the pilot solenoid valve axially driving the valve body of the main valve using a pilot fluid which is supplied or ejected through the pilot valves in order to switch the channel between the openings for communication, wherein the main and pilot valves are independently installed on the manifold base so as to be separated from each other and arranged parallel to the axial direction of the valve body of the main valve, and the manifold base includes a feeding line housing passage through which pass feeding lines for feeding the pilot valves, and wherein a waterproof cover covering the pilot valves and the energization system extends from the feeding line to the pilot valve.

Preferably, an installation surface for the two solenoid-driven pilot valves that drive the valve body of the main body in its axial direction either forward or backward is provided on the manifold base in the axial direction of the valve body of the main body or in an orthogonal direction to the axial direction.

In addition, suitably for a pilot valve with a pilot manual operation button that switches the communication between the channels to the pilot valve when pressed, a manual press section that can press and operate the pilot manual operation button when externally pressed is provided at the position of the waterproof cover section corresponding to the pilot manual operation button.

In the pilot solenoid valve with the above configuration, since the main valve and the solenoid-driven pilot valves are independently installed on the manifold base so as to be separated from each other, the pilot solenoid valve can be provided with a waterproof function using a simple structure by covering with a waterproof cover only the pilot valves that have an electrical section and the energization system.

Furthermore, it is unnecessary to remove the waterproof cover to disable the waterproof function even when conducting maintenance or inspection of those parts which do not require a waterproof function as in the case where the overall solenoid valve, including a large number of main valves arranged on the manifold bases, is covered to make it waterproof, and the maintenance or inspection of these parts can be carried out independently of the waterproofed section. At the same time, the maintenance and inspection of the waterproofed section can be conducted without affecting the other waterproofed sections by removing the waterproof cover for the desired section.

Furthermore, since the installation surface for the two solenoid-driven pilot valves that drive the valve body of the main body forward or backward is provided on the

manifold base, and the pilot valves installed on the installation surface and the energization system are covered with a waterproof cover, the common waterproof cover can be used for both a single solenoid valve with one pilot valve and a double solenoid valve with two pilot valves. In addition, since the manifold base includes the feeding line housing passage to the pilot valves, the energization system can be simultaneously protected from water.

In addition, in this pilot solenoid valve, since the installation surface for the two solenoid-driven pilot valves that drive the valve body of the main body either forward or backward is provided on the manifold base in the axial direction of the valve body of the main body or in a direction orthogonal to the axial direction, the pilot solenoid valve can be made compact so that it can be installed at small installation sites.

Furthermore, with this pilot solenoid valve, if a manual press section that can operate the pilot manual operation button is provided at the position on the waterproof cover corresponding to the manual operation button, the pilot manual operation button can be operated easily without disabling the waterproof function for the pilot valves when an accident such as service interruption prevents the main valve from being operated by using the pilot valves.

The invention will now be further described by way of example with reference to the accompanying drawings in which:

Figure 1 is a vertical cross sectional side view showing the configuration of a first embodiment of this invention taken along line I-I in Figure 2.

Figure 2 is a plan view showing an implementation in which pilot solenoid valves are connected together according to this invention.

Figure 3 is a front view of Figure 2.

Figure 4 is a side view of Figure 2.

Figure 5 is a vertical cross sectional side view showing a second embodiment of this invention.

Figure 6 is a vertical cross sectional side view showing a third embodiment.

Figure 7 is a vertical cross sectional side view showing a variation of the third embodiment.

Figure 8 is a vertical cross sectional side view showing a fourth embodiment.

Figure 9 is a plan view of Figure 8.

Figure 10 is a vertical cross sectional side view showing a fifth embodiment.

Figures 1 to 4 show a first embodiment of this invention, and a manifold base 2 of a pilot solenoid valve 1 has an installation surface for a main valve 3 and an installation surface for a first and second pilot valves 4A and 4B, the surfaces being separated longitudinally of the manifold base 2. In Figure 1, a single solenoid main valve 3 is mounted on the installation surface of the manifold base 2 and a first solenoid-driven pilot valve

4A is mounted on its installation surface of the manifold base 2 (the I-I cross section in Figure 2). Although, in Figure 1, the second pilot valve 4B is expressed on the second pilot valve 4B installation surface by a chain line, this shows how the second pilot valve 4B is mounted when a double solenoid pilot valve 1A (see Figure 2) is used, and the pilot valve 4B is not mounted when the single solenoid main valve 3 is used. The manifold base includes a waterproof cover 5 capable of covering both pilot valves 4A and 4B.

Many manifold bases 2, each including main and pilot valves, are generally connected together as shown in Figures 2 and 3. The manifold base 2 has a pressure fluid supply channel 8; first and second ejection channels 9A and 9B; a pilot supply channel ps; and a pilot ejection channel pe; all penetrating the manifold base in the direction in which the manifold bases are connected together. It also has a wiring housing passage 10 for an energization system; and a first and second output ports 11A and 11B that open to a front end surface, as shown in Figures 1. The supply channel 8, the ejection channels 9A and 9B, and the output ports 11A and 11B open to the main valve installation surface within the top surface of the manifold bases 2. In addition, the pilot supply and ejection channels ps and pe open to the installation positions of the first and second pilot valves 4A and 4B in the pilot valve installation surface within the top surface of the manifold bases 2, and the wiring housing passage 10 is in communication with a socket-mounting section 10a that opens to the pilot valve installation surface via a passage.

The channels 8, 9A, and 9B that open to the main valve installation surface of the manifold base 2 are formed under the main valve installation surface, and the pilot supply and ejection channel ps and pe are formed under the main valve installation position or under the installation surface between the main valve installation position and the pilot valve installation position. Furthermore, the wiring housing passage 10 is formed under the installation surface of the pilot valves 4A and 4B. Since the manifold base 2 has few large channels under the pilot valve installation surface, a sufficient space can be obtained for the feeding line housing passage 10.

This pilot solenoid valve 1 is used so that a required number of manifold bases 2 are connected together. The manifold bases are connected together by inserting connecting bolts 14 (see Figure 4) into the various connecting holes 6 (see Figure 1) formed in the manifold base 2 and the connecting holes formed in the corresponding positions in a first side plate 12 at one end of the set of manifold bases and a second side plate 13 at the other end thereof.

The first side plate 12 includes on its front surface a pressure fluid supply and ejection ports P and R and in a connector mounting hole formed on the outer surface, a multi-pole connector 16 that electrically connects to the solenoids of the pilot valves 4A and 4B (see Fig-

ures 2 to 4). The supply port P opens to the positions corresponding to the supply channel 8 and pilot supply channel ps in the manifold base 2 through the passages in the first side plate 12, and the ejection port R opens to the positions corresponding to the ejection channels 9A and 9B and pilot ejection channel pe. On the other hand, the second side plate 13 closes the other ends of these channels in the manifold base 2. Although not shown, a gasket is mounted in the connecting surfaces between the manifold base 2 and the first and second side plates 12 and 13 to allow the channels to communicate with one another in an airtight manner.

The manifold base 2 allows the single solenoid main valve 3, as shown in Figure 1, to be installed on the main valve installation surface, and also allows a double solenoid main valve 3A (Figure 2) to be installed. Thus, various main valves 3 and 3A can be selectively mounted when various of manifold bases 2 are connected together, as shown in Figure 2. Of course, when the single solenoid main valve 3 is installed, only the first pilot valve 4A is installed on the pilot valve mounting surface of the manifold base 2, whereas when the double solenoid main valve 3A is installed, both the first and second pilot valves 4A and 4B are installed thereon.

A one-touch pipe joint 17 is attached to the supply and ejection ports P and R of the first side plate 12 and to the output ports 11A and 11B of the manifold base 2. When a flexible pressure fluid supply tube (not shown) is inserted into any port, the one-touch pipe joint 17 can engage the outer surface of the tube, and pressing a release bush enables the tube to be disengaged and removed.

Reference numeral 18 designates a fixation hole formed in the side plates 12 and 13, which is used to mount the pilot solenoid valve 1 on the selected members.

The single solenoid main valve 3, which is shown in detail, in Figure 1, includes a valve body 20 and first and second piston boxes 21 and 22 located at both axial ends of the valve body 20. The piston boxes are connected to the valve body 20 with connecting screws (not shown), and these members are connected together using connecting screws (not shown) and mounted on the main valve installation surface within the top surface of the manifold base 2 via the gasket in an airtight manner, using various of mounting screws 23 (see Figure 2).

The valve body 20 includes a valve hole 25 and a pilot passage 26 that axially penetrate the body; and a pressure fluid supply opening 27, first and second openings 28A and 28B, and first and second ejection openings 29A and 29B that are all open in the orthogonal direction to the valve hole 25. When the main valve 3 is mounted on the installation surface of the manifold base 2, these openings communicate with the corresponding channels and ports. The pilot passage 26 is in communication with the supply opening 27.

A first piston 31 is inserted into a first piston box 21 that is coaxial with the valve hole 25, a second piston

32 having a smaller diameter than the first piston (the pressure-receiving area is approximately half of the first piston) is inserted into a second piston box 22, and a valve body 33 is inserted into the valve hole 25 in such a way that these pistons and valve body can axially slide. A first pressure chamber 34 in which the first piston 31 slides is in communication with the first pilot output passage 42a described below, and a second pressure chamber 35 in which the first piston 32 slides is in communication with the pilot passage 26.

When pilot fluid is output to the first pressure chamber 34, the valve body 33 moves to right in the figure, and the supply opening 27 communicates with the output opening 28A, while the output opening 28B communicates with the ejection opening 29B (see the upper half of the valve body in Figure 1). When pilot fluid is ejected from the first pressure chamber 34, the fluid that has been supplied to the second pressure chamber 35 through the pilot passage 26 moves the valve body 33 to left in the figure, and the supply opening 27 communicates with the output opening 28B, while the output opening 28A communicates with the ejection opening 29A (see the lower half of the valve body in Figure 1). In this manner, the main valve 3 comprises five ports.

A manual operation button 36a capable of sliding inserted into the first piston box 21 is normally moved upward by the force of a coil spring 38, and allows the first pilot output passage 42a to communicate with the first pressure chamber 34. When the button is pressed against the force of the coil spring 38, the first pressure chamber 34 communicates with the pilot channel 26, and a seal packing 39 blocks the communication between the first pressure chamber 34 and the first pilot output passage 42a. Thus, when an accident such as a service interruption prevents fluid from being output from the pilot valve 4A to the first pressure chamber 34, the manual operation button 36a can be pressed to supply pressure fluid from the pilot passage 26 to the first pressure chamber 34, thereby driving the valve body 33 to make use of the difference in diameter between the piston 31 and the piston 32.

The first pilot valve 4A includes a first pilot supply opening p1, a first pilot output opening a1, and a first pilot ejection opening e1, and also has a first solenoid s1 for driving the valve body of the pilot valve. If a second pilot valve 4B is provided, it includes second pilot supply, output, and ejection openings p2, a2, and e2, and a second solenoid s2.

These pilot valves comprise a well-known direct operated 3-port solenoid valve wherein a movable iron core (not shown) is attracted when the solenoids s1 and s2 are energized, thereby allowing the pilot supply opening to communicate with the pilot output opening, whereas the movable iron core is returned by the force of a return spring (not shown) when the solenoids s1 and s2 are de energized, thereby allowing the pilot output opening to communicate with the pilot ejection opening.

The pilot supply openings p1 and p2 and the pilot

ejection openings e1 and e2 are in communication with the pilot supply and ejection channels ps and pe, respectively, through the pilot supply passages 40a and 40b and the pilot ejection passages 41a and 41b, respectively, formed in the manifold base 2.

The first pilot output opening a1 is in communication with the first pressure chamber 34 through the first pilot output channel 42a formed in the manifold base 2 and through the passage 43a formed in the valvebody 20 of the main body and the first piston box 21. On the other hand, the second pilot output opening a2 opens to the top surface of the manifold base 2 near the second piston box 22 of the valve body 20 through the second pilot output passage 42b. In the single solenoid main valve 3, however, the communication between the second pilot output passage 42b and the second pressure chamber 35 is blocked in the second piston box 22.

The solenoids s1 and s2 each have a solenoid cover 44, on which substrates 45a and 45b and protective covers 46a and 46b covering those substrates are mounted. Coil terminals 47 and 47 protruding upward from the solenoids s1 and s2; and feeding terminals 48 and 48 penetrating the solenoid cover 44 downward are electrically connected to an electric circuit printed and wired in the substrates 45a and 45b, and lamps 49a and 49a mounted on the substrates 45a and 45b and indicating the energization of the solenoids s1 and s2; and electronic parts 49 required to energize the solenoids are also electrically connected to the electric circuit. Windows 56 and 56 that allow the energization of the solenoid valves s1 and s2 to be externally viewed are provided at those positions on the waterproof cover 5, which are opposed to the lamps 49a and 49a, and may be formed of a thin wall if the waterproof cover 5 is formed of a transparent or semi-transparent synthetic resin. If the waterproof cover 5 is formed of metal, a transparent material that allows the lamp 49a to be viewed must be attached to the window 56 in an airtight manner.

Sockets 51 to which the feeding terminals 48 and 48 of the first and second pilot valves 4A and 4B are connected are loaded on the socket mounting section 10a that opens to the pilot valve installation surface within the top surface of the manifold base 2, and the other end of a feeding terminal 52 connected to one end of the terminal connected to the socket is electrically connected to a pin in the multi-pole connector 16 through the wiring housing passage 10. The solenoid cover 44 has a positioning section 44a that is externally fitted to the socket 51 to allow the pilot valve to be positioned on the manifold base 2.

When the pilot valves 4A and 4B are installed on the manifold base 2 using the positioning section 44a, each pilot opening communicates with the corresponding pilot channel formed in the manifold base 2, and the feeding terminal 48 is inserted into the socket 51. Thus, the multi-connector 16 can feed the solenoids s1 and s2 of the pilot valves 4A and 4B together. In addition, the

pilot valves 4A and 4B are mounted on the top surface of the manifold base 2 in an airtight manner by using mounting screws 53 (see Figure 2). This prevents the feeding line 52 from being exposed through the wiring housing passage 10 formed in the manifold base 2.

The waterproof cover 5 covers the pilot valves 4A and 4B and is mounted on the top surface of the manifold base 2 via frame-like packing 57 in an air-tight manner by using mounting screws 55. Thus, if the pilot solenoid valve is used in an operation environment in which liquid such as water may splash or where humidity is high, the pilot valves 4A and 4B and the energization system extending from the feeding line 52 to the pilot valve are completely protected, thereby preventing accidents that could be caused by water. The waterproof structure consists of only the waterproof cover 5 and is very simple. Furthermore, since only the pilot valves and the energization system which require a waterproof function can be protected from water, maintenance, inspection, and replacement of the other sections can be conducted independently without disabling the waterproof function. Furthermore, a common cover can be used for a pilot solenoid valve with one or two pilot valves to allow this part to be shared by the single and double solenoid pilot valves. In addition, since the feeding line housing passage to the pilot valves is formed in the manifold base, the energization system can also be protected from water.

Although the manifold base 2 includes a supply channel 8 and ejection channels 9A and 9B, and pilot supply and ejection channels ps and pe, while are separate from the channels 8, 9A, and 9B, these pilot channels can be omitted and the pilot supply passages 40a and 40b can communicate with the supply channel 8, while the pilot ejection passages 41a and 41b can communicate with the ejection channel 9A or 9B.

In the pilot solenoid valves 1 having the above configuration, when the main valves 3 and the pilot valve 4A (and the pilot valve 4B as required) are installed on the manifold base 2, the openings of these valves communicate with the corresponding channels and ports, and the solenoids s1 and s2 of the pilot valves are electrically connected to pins in the multi-pole connector 16. In addition, when the manifold base 2 includes a waterproof cover 5, the electrical sections of the pilot valves 4A and 4B and the energization system are protected from water from the external environment.

If the single solenoid pilot valve 1 is used and the pilot valve 4B is not installed, the openings of the pilot channels 40b and 41b on the pilot valve installation surface must be closed with an appropriate means such as plugs (not shown) to prevent the flow of pilot fluid. This is also true of the following embodiments.

Although a detailed description is omitted to avoid redundancy, valve body 20 can include the double pilot type main valve 3A (see Figure 2), having a second piston box 21A (with the same configuration as a first piston box 21) instead of a second piston box 22. In this case,

the second piston box 21A includes a second pressure chamber 34A and a second piston 31A, both of which have diameters identical to first pressure chamber 34 and first piston 31. The second piston box 21A has a manual operation button 36b similar to manual operation button 36a, with the same effects.

In addition, this configuration requires mounting pilot a second valve 4B. A second pilot output passage 42b communicates with a second pressure chamber 35 through the same passage in a second piston box 21A as passage 43a in a first piston box 21, thereby providing pilot solenoid valve 1A with double pilot type main valve 3A (see Figures 2 to 4).

Figure 5 shows a second embodiment of this invention. In pilot solenoid valve 61, manifold base 62 has an installation surface for main valve 73 and a different installation surface for pilot valves 4A and 4B (as in the first embodiment). Cover 5 covers all solenoid-driven pilot valves 4A and 4B separate from main valve 61. Since in the first embodiment a pilot passage 64 is added to the manifold base 2, the manifold base here can be used with a main valve of a different structure.

Specifically, in the second embodiment, manifold base 62 of solenoid valve 61 allows for the mounting of an external pilot type main valve 63. Thus, an external pilot fluid flows through the pilot supply channel ps from a side plate similar to the first side plate 12 shown in Figures 2 and 3. The side plate does not allow the pilot supply channel ps to communicate with supply port P.

Manifold base 62 has a configuration similar to that of the first embodiment, but in addition includes external pilot channel 64, one end of which communicates with pilot supply channel ps.

Main valve 63 includes valve body 65 and has piston boxes 66 and 67 at either axial end, and the other end of the external passage 64, one end of which communicates with the pilot supply channel ps, communicates with the second pressure chamber 35 in which the second piston 32 slides, through a passage 68 formed in the valve body 65 and the second piston box 67, and is also in communication with a pilot passage 69 formed in the valve body 65, via the second pressure chamber 35. But communication between second pilot output passage 42b and second pressure chamber 35 is blocked in second piston box 67.

Since manifold base 62 of the pilot solenoid valve 61 in the above configuration is identical to manifold base 2 in the first embodiment, except for the external pilot passage 64 (one end of which communicates with the pilot supply channel ps), it can be made of the same material as manifold base 2, permitting it to be used interchangeably in piston boxes 66 and 67. This is also true of pilot valve 4A and the water-proof cover 5 covering it. Therefore, this facilitates the specification change from an internal pilot type to an external pilot type, and reduces costs by sharing the parts.

Figure 5 shows the installation position of the second pilot valve 4B using a chain line, but it need not be

mounted, since pilot solenoid valve 61 enables a pilot fluid to be supplied continuously from pilot supply channel ps to second pressure chamber 35.

The other configuration of the above pilot solenoid valve 61 is almost the same as that of the pilot solenoid valve 1 in the first embodiments. Thus, a detailed description is omitted. Main components have the same reference numerals.

In solenoid valve 61, according to the second embodiment, when the manual operation button 36a is pressed, the pilot fluid in external pilot passage 64 flows to first pressure chamber 34 in the first piston box 66 through passage 68 and pilot passage 69. The seal packing 39 blocks communications between the first pressure chamber 34 and the first pilot output passage 42a, thereby moving the valve body 33 to the right in the figure, due to the difference in diameter between piston 31 in the first piston box 66 and piston 32 in the second piston box 67, as shown in the upper half of valve body 33 in Figure 5. When manual operation button 36a is released, the pilot fluid in the first pressure chamber 34 flows outside, forcing the external pilot fluid supplied to second pressure chamber 35 to move valve body 33 left in the figure (see the lower half of valve body 33 in Figure 5).

The other effects of the second embodiment are almost the same as those of solenoid valve 1 in the first embodiment, so a detailed description is omitted.

Figure 6 shows a third embodiment of this invention. In pilot solenoid valve 71, the pilot passages in a manifold base 72 collectively open to a first piston box 76 in a valve body 75. The manifold base to this embodiment differs from those in the first and second embodiments and requires a compatible main valve 73. Nevertheless, since the basic configuration is the same as in the first and second embodiments, the manifold bases 2, 62, and 72 can be formed of the same material and differentiated through slight modifications for the locations and number of pilot passages. In addition, when manifold bases are joined as shown in Figures 2 and 3, all types can be mixed as appropriate.

The third embodiment includes the manifold base 72, the double pilot type main valve 73 and pilot valves 4A and 4B, all mounted on the installation surfaces individually provided on base 72. The pilot valves 4A and 4B are covered with waterproof cover 5.

Main valve 73 includes a valve body 75 and first and second piston boxes 76 and 77 at either end. Valve hole 25 and first and second pilot passages 78a and 78b are axially formed in valve body 75. First piston box 76 includes first piston 31, first pressure chamber 34 and first manual operation button 79a. Second piston box 77 includes second piston 82 (with the same diameter as first piston 31), second pressure chamber 83 and second manual operation button 79b, which has the same configuration as first manual operation button 79a.

For the sake of illustration, pilot channels 78a and 78b in Figure 6 are arranged vertically above valve hole

25, but these pilot channels may be formed in the dead space diagonally above the valve hole 25, parallel to a perpendicular to the plane of the figure.

Formed in manifold base 72, external pilot channel 84 and first and second pilot output channels 42a and 42b all open to the first piston box in main valve 73. As in the first embodiment, pilot output channel 42a communicates with the first pressure chamber 34, while second pilot output channel 42b communicates with second pilot channel 78b in valve body 75 through a passage 80a, formed in first piston box 76. In addition, external pilot passage 84 communicates with first pilot passage 78a through a passage to insertion hole 85a of first manual operation button 79a and the gap in the insertion hole 85a. But when the first manual operation button is not pressed, the seal packing 39 in the first manual operation button 79a blocks communication with first pressure chamber 34.

The other end of second pilot passage 78b, which communicates with the second pilot output passage 42b, also communicates with second pressure chamber 83 through a passage 87 formed in second piston box 77. The other end of first pilot passage 78a communicates with the gap in the insertion hole 85b of second manual operation button 79b, but under the illustrated conditions, the seal packing 39 in second manual operation button 79b blocks communication with second pressure chamber 83.

The other configuration of the third embodiment resembles the first embodiment, except for second pilot valve 4B, so a detailed description is omitted. Main components have the same reference numerals.

In the pilot solenoid valve, according to the third embodiment, when pilot valve 4A is operated to supply pilot fluid to first pressure chamber 34, valve body 33 moves to the right of the figure, switching the channel (see the upper half of the valve body in Figure 6). When operation of the first pilot valve 4A is stopped to eject pilot fluid from the first pressure chamber 34, and second pilot valve 4B is operated to supply pilot fluid to second pressure chamber 83, valve body 33 moves to the left of the figure (see the lower half of the valve body in Figure 6).

If an accident occurs, such as a service interruption, while first manual operation button 79a is pressed, external pilot passage 84 communicates with first pressure chamber 34, and seal packing 39 blocks communication between first pressure chamber 34 and the first pilot output passage 42a, causing the external pilot fluid to flow into the first pressure chamber 34. This in turn moves valve body 33 to the right of the figure. When first manual operation button 79a is released and second manual operation button 79b is pressed, pilot fluid in first pressure chamber 34 flows outside. External pilot passage 84 and the first pilot passage 78a then communicate with second pressure chamber 83 through the gap in insertion hole 85 in second manual operation button 79b, outputting pilot fluid to the second pressure chamber 83 and moving valve body 33 to the left of the figure. In this

case, seal packing 39 blocks communication between second pressure chamber 83 and passage 87.

Figure 7 illustrates a case in which single solenoid pilot valve 91 is mounted instead of pilot solenoid valve 71, according to the third embodiment.

Although second piston box 94 in a main valve 93 of pilot solenoid valve 91 has a second piston 95 and a second pressure chamber 96 with smaller diameters than first piston 31 and first pressure chamber 34, and although valve body 75 is the same as in the third embodiment, the first pilot passage 78a communicates with second piston chamber 96 through passage 97, and the end of the second pilot passage 78b close to the second piston box 94 is closed by second piston box 94.

The other configuration of pilot solenoid valve 91 resembles the third embodiment except for second pilot valve 4B. Pilot solenoid valve 91 has the same effects as pilot solenoid valve 1 in the third embodiment, except for constant application of external pilot fluid pressure to pressure chamber 96. Main components have the same reference numerals, A description is omitted.

Each of the embodiments described above shows a case in which the main valve and two pilot valves are positioned on the installation surface of the manifold base in series. Figures 8 and 9 show a fourth embodiment in which the two pilot valves are positioned in parallel. A pilot solenoid valve 101 in Figure 8 includes a single pilot type main valve 103 and pilot valve 4A, whereas pilot solenoid valve 101A in Figure 9 includes a double pilot type main valve 103A and pilot valves 4A and 4B. In pilot solenoid valves 101 and 101A, pilot valves 4A and 4B are placed on the installation surface of manifold base 102 in the direction in which the manifolds bases connect, as shown in Figure 9.

Main valve 103 shown in Figures 8 and 9 has the same configuration as main valves 3 in the first embodiment, but may be of the single pilot type described in the other embodiments. The main valve 103A may be configured as the double solenoid type described in any of the above embodiments. Solenoid valves 101 and/or 101A can be joined, as shown in Figure 9. In this case, if the main valve shown in Figure 6 or 7 is used, manifold base 102 must include pilot passages compatible with the main valve.

In the pilot solenoid valve according to the fourth embodiment, the pilot valves 4A and 4B are installed on the installation surface in parallel in the direction of the width of the main valve. Nevertheless, this configuration permits increasing the diameters of valve hole 25 and valve body 33 of the main valve and consequently the flow through these valves. This configuration reduces the longitudinal length of the manifold base, despite somewhat wider width in the direction in which the manifold bases join.

The other configuration and effects of the fourth embodiment are the same as in either the first or third embodiment. A description is omitted.

Figure 10 shows a fifth embodiment of this inven-

tion. In this embodiment, manifold base 2 of pilot solenoid valve 108 includes an installation surface for main valve 3, and as in each of the above embodiments, a different installation surface for pilot valves 110A and 110B. It also includes a waterproof cover 109 that covers both pilot valves. Figure 10 shows the pilot valve 110B, but this is only intended to show its installation position. The main valve 3 shown in this figure does not require pilot valve 110B.

The pilot valves 110A and 110B used in this embodiment include a pilot manual operation button 111. This is a well-known operation button, pressed when an accident prevents the main valve from being operated by pilot valves 110A and 110B to move the iron core in the pilot valve and to allow pilot supply openings p1 and p2 to communicate with pilot output openings a1 and a2. This action outputs pilot fluid to the pilot output passage. When the operation button is released, it is returned by a return spring to allow pilot output openings a1 and a2 to communicate with pilot ejection openings e1 and e2.

At the position corresponding to pilot manual operation button 111, the waterproof cover 109 has a manual operation section 112a or 112b that presses and operates pilot manual operation button 111. Manual operation section 112a or 112b is made up of a push button that penetrates waterproof cover 109. On its outer circumference, a seal member 113 is mounted to form a seal against the button insertion space in waterproof cover 109. This prevents moisture from entering the waterproof cover and enables the pilot manual operation button to be operated without disabling the waterproof function for the pilot valves, even when an accident prevents the main valve from being operated by the pilot valves.

According to the fifth embodiment, the main valve and manifold base may be any of the main valves and manifold bases shown in the first through fourth embodiments. The other configuration and effects of the fifth embodiment are the same as in the first embodiment. The main components have the same reference numerals, and a description is omitted.

Through the design of the pilot solenoid valve, since the main and solenoid-driven pilot valves are installed to be separate from each other and the pilot solenoid valve includes a water-proof cover that covers the pilot valves and the energization system, extending from the feeding line to the pilot valve, only the pilot valves and the energization system can be protected from water with a simple waterproof cover. Since only the pilot valves and the energization system are protected, maintenance, inspection, and replacement of other sections can be done without disabling waterproofing for that section. In addition, the common cover can be used for a pilot solenoid valve with one or two pilot valves.

At the position corresponding to the pilot manual operation button for the pilot valve, when the waterproof cover has a manual operation section that presses and operates the operation button, the operation button can

be operated without disabling the waterproofing for the pilot valves.

5 Claims

1. A pilot solenoid valve comprising a manifold base, a main valve for switching an output opening between a supply opening and an ejection opening, and pilot valves driven by a solenoid to drive the valve body of the main valve, the pilot solenoid valve axially driving the valve body of the main valve using pilot fluid supplied or ejected through the pilot valves in order to switch the channel between openings, wherein

the main valve and the pilot valves are independently installed on the manifold base, separate from each other and arranged in parallel in the axial direction of the valve body of the main valve, wherein the manifold base includes a feed line housing passage through which feed lines for feeding the pilot valves pass, and wherein a water-proof cover is provided for protecting the pilot valves and the energization system, extending from the feed line to the pilot valve.

2. A pilot solenoid valve as claimed in Claim 1, wherein an installation surface for two solenoid-driven pilot valves which drive the valve body of the main valve in its axial direction either forward or back is provided on the manifold base, in the axial direction of the valve body of the main valve.

3. A pilot solenoid valve as claimed in Claim 1, wherein an installation surface for two solenoid-driven pilot valves which drive the valve body of the main body in its axial direction either forward or back is provided on the manifold base, in a direction orthogonal to the axial direction of the valve body of the main valve.

4. A pilot solenoid valve as claimed in any preceding Claim wherein the pilot valve has a manual operation button that switches communication between the channels to the pilot valve when pressed, and wherein a manual press section which, when externally pressed, is capable of pressing and operating the pilot manual operation button, is provided at a position in the waterproof cover corresponding to the location of the pilot manual operation button.

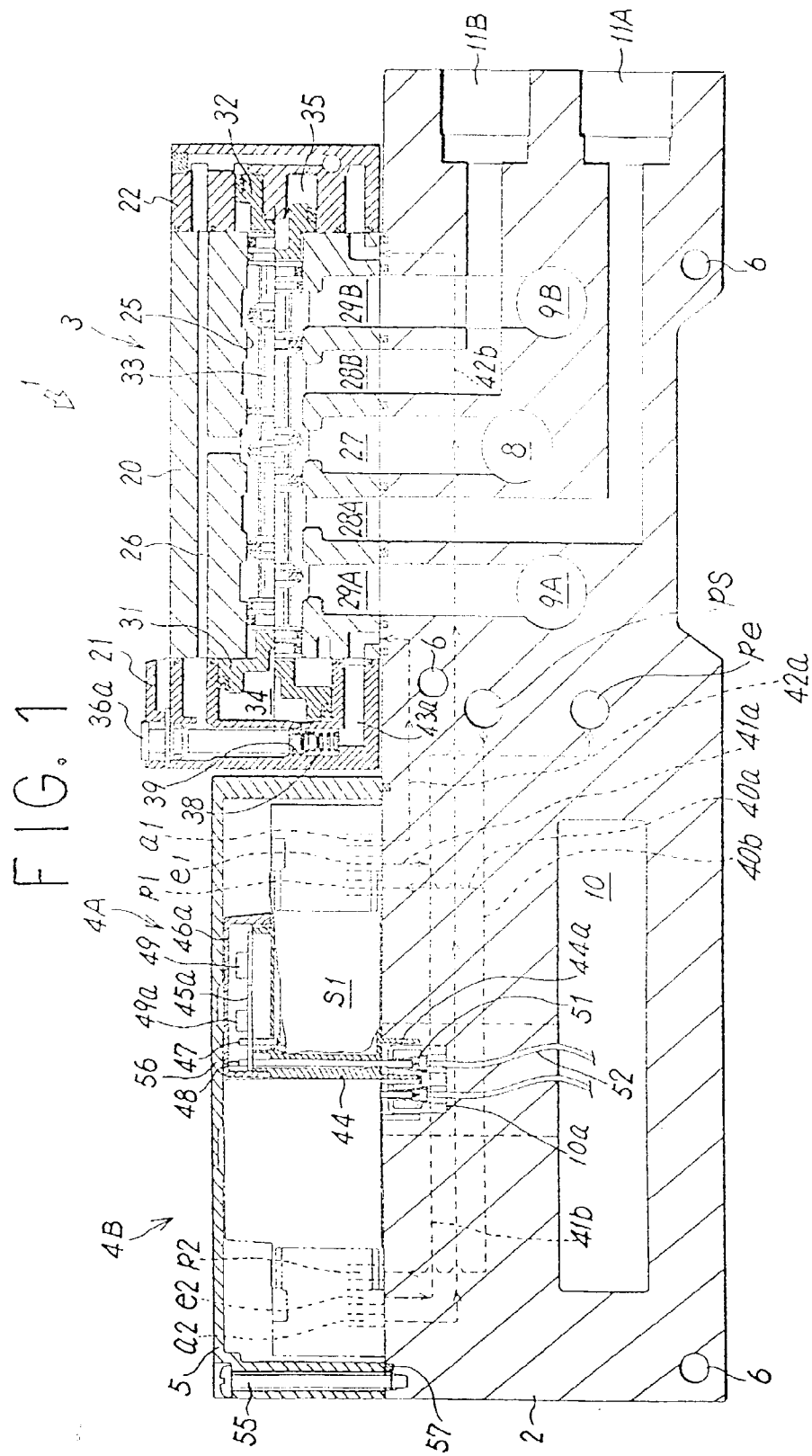


FIG. 2

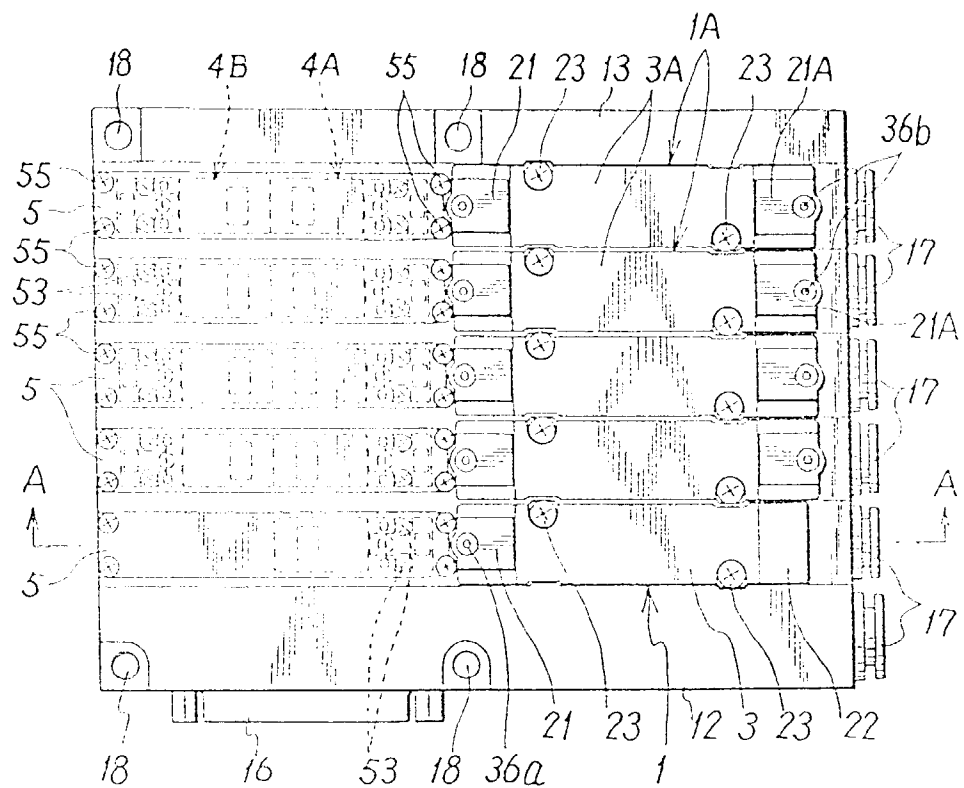


FIG. 3

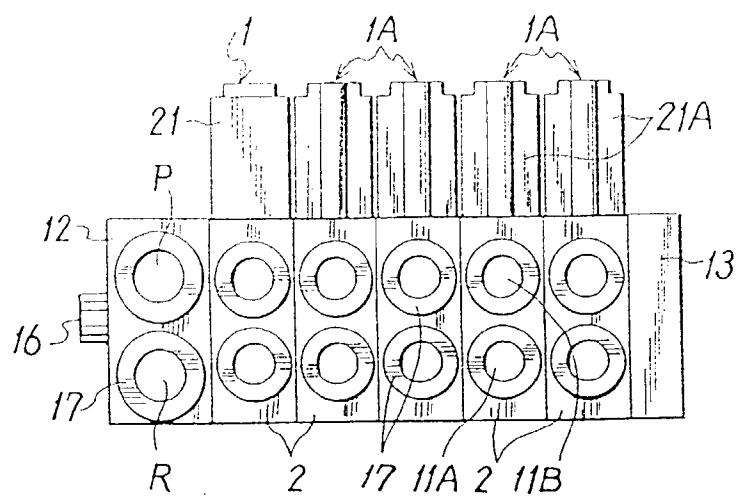
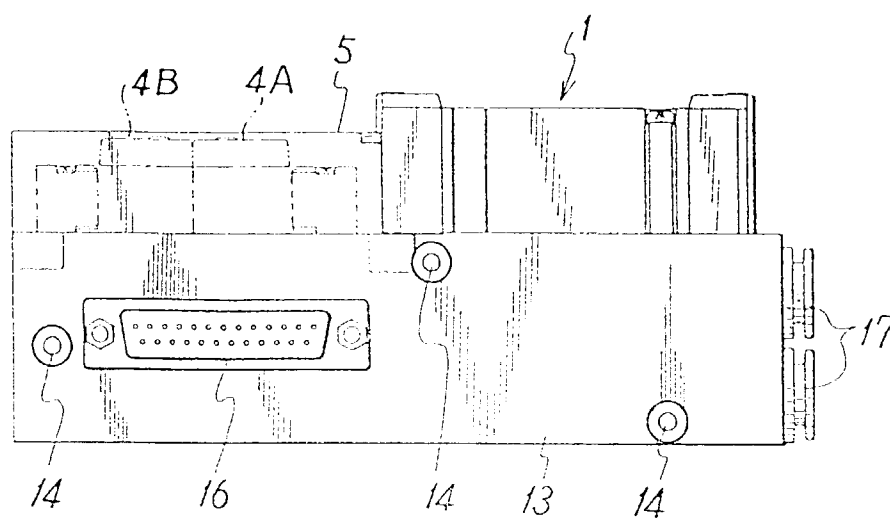


FIG. 4



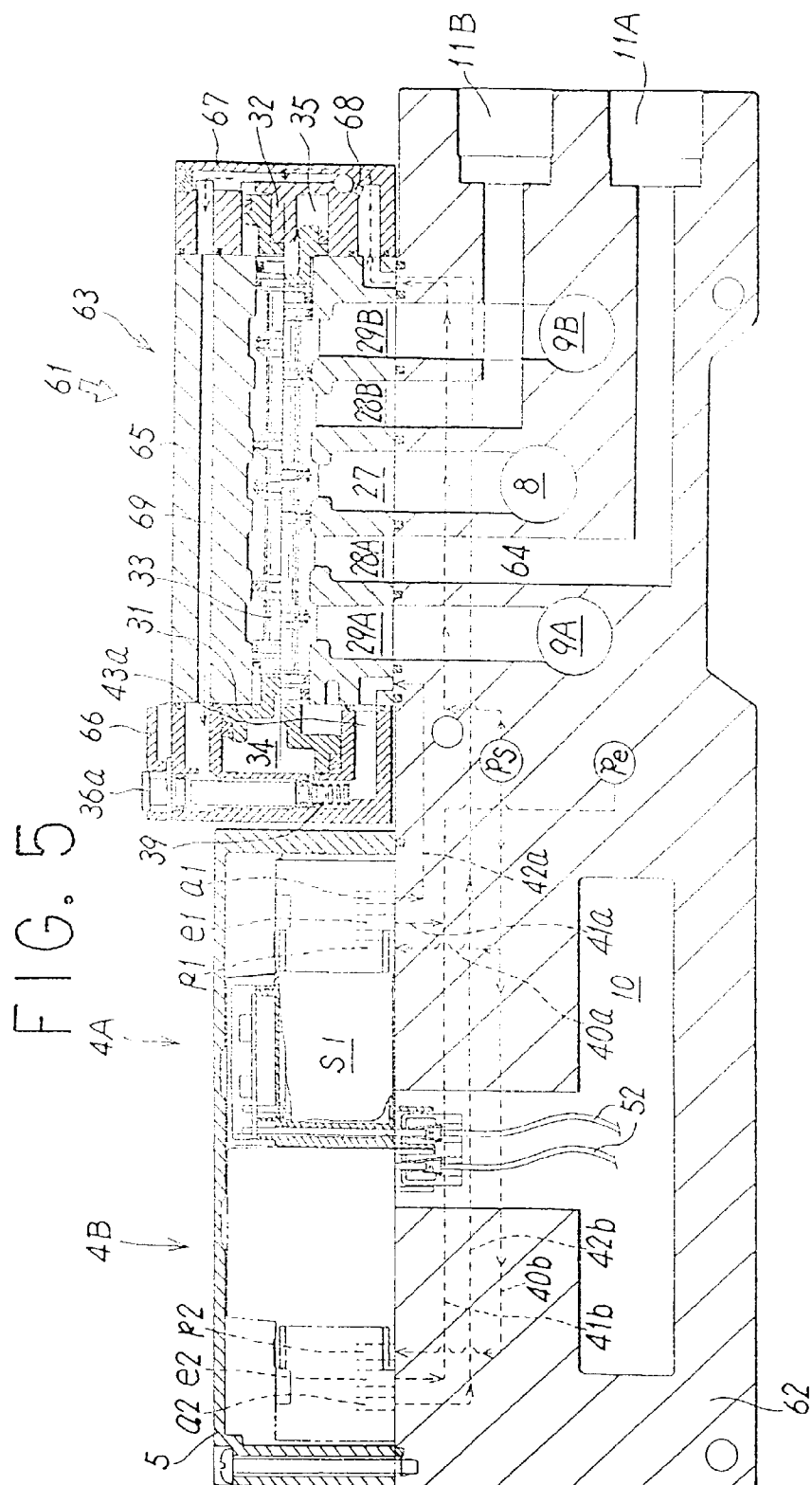
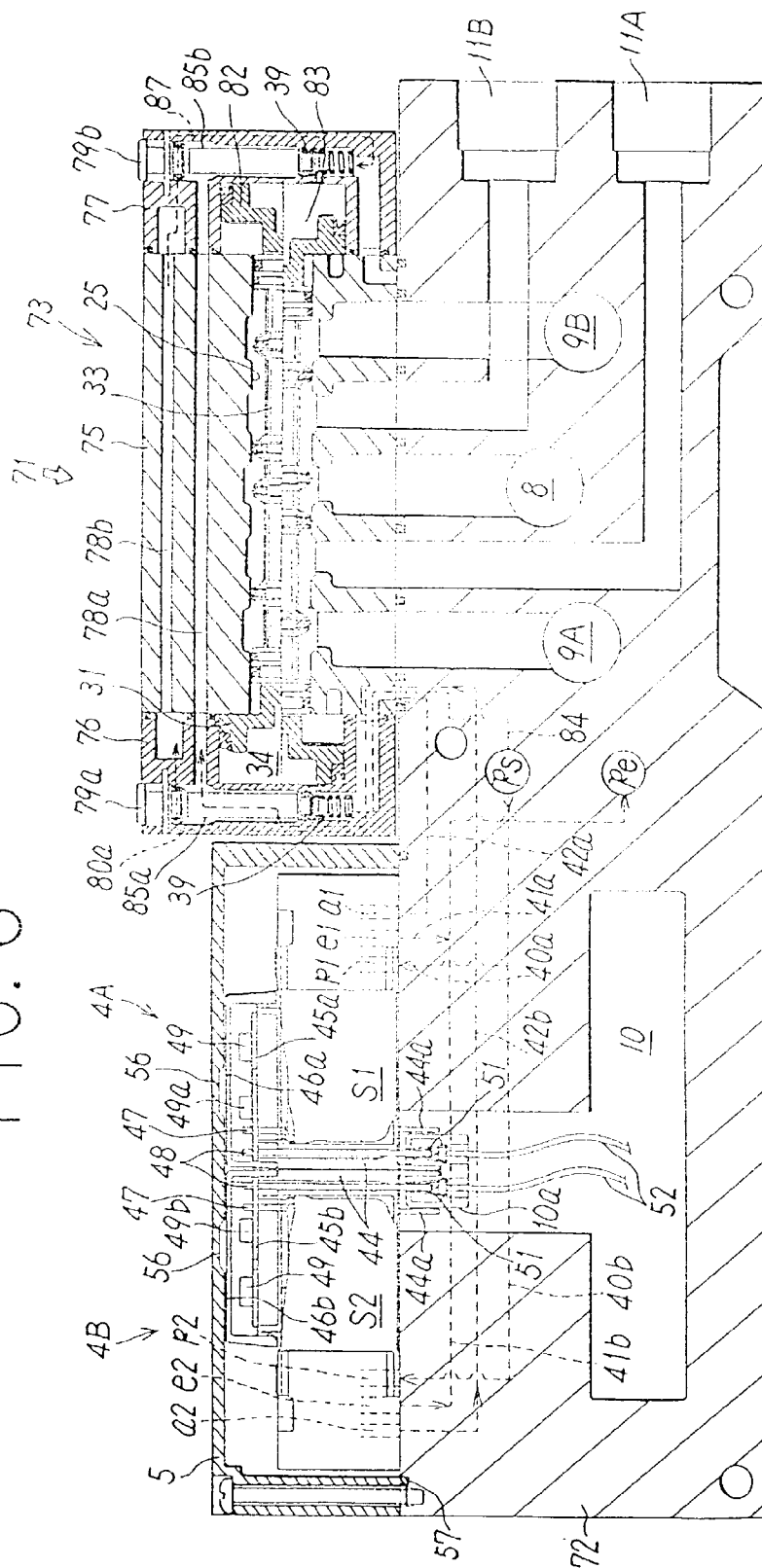
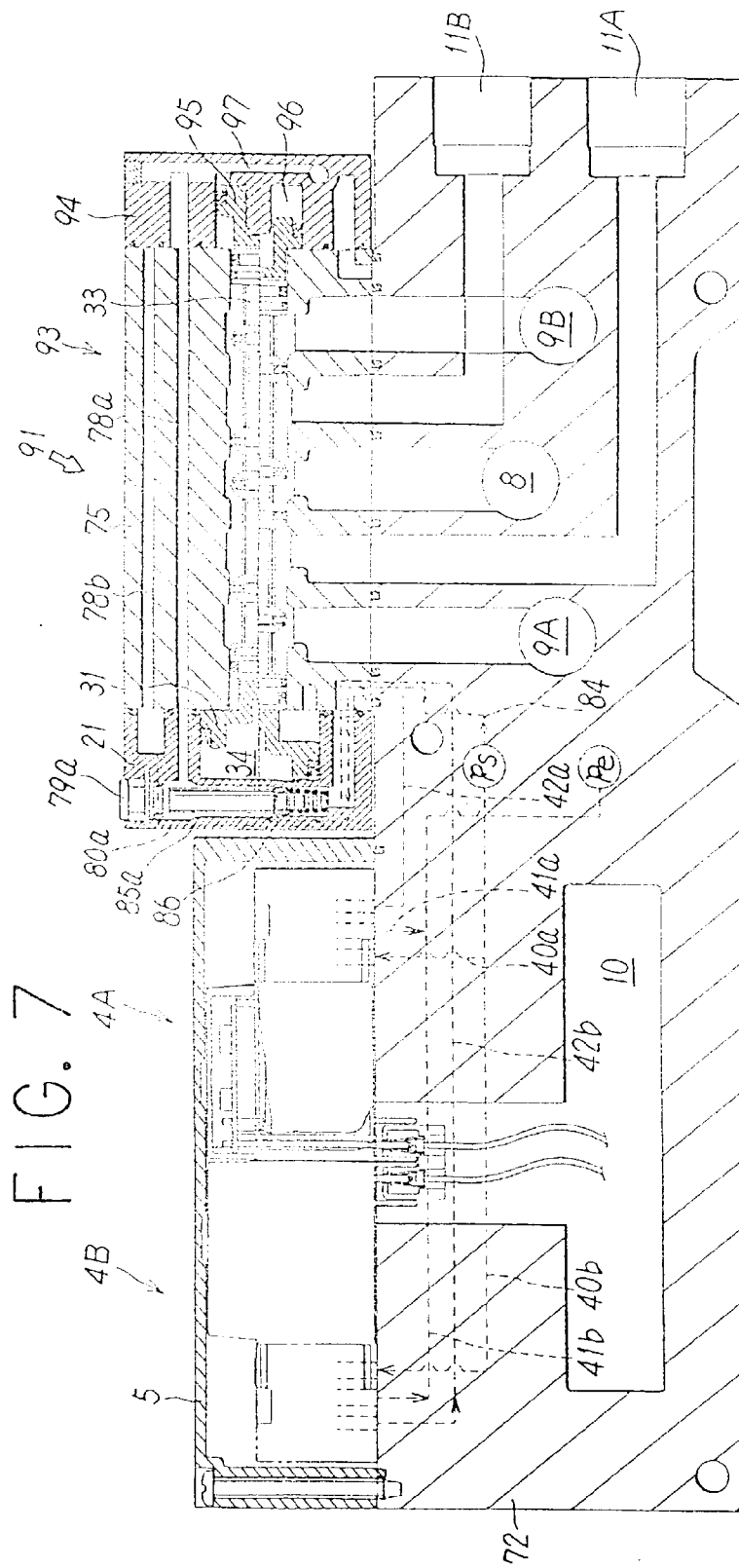


FIG. 6





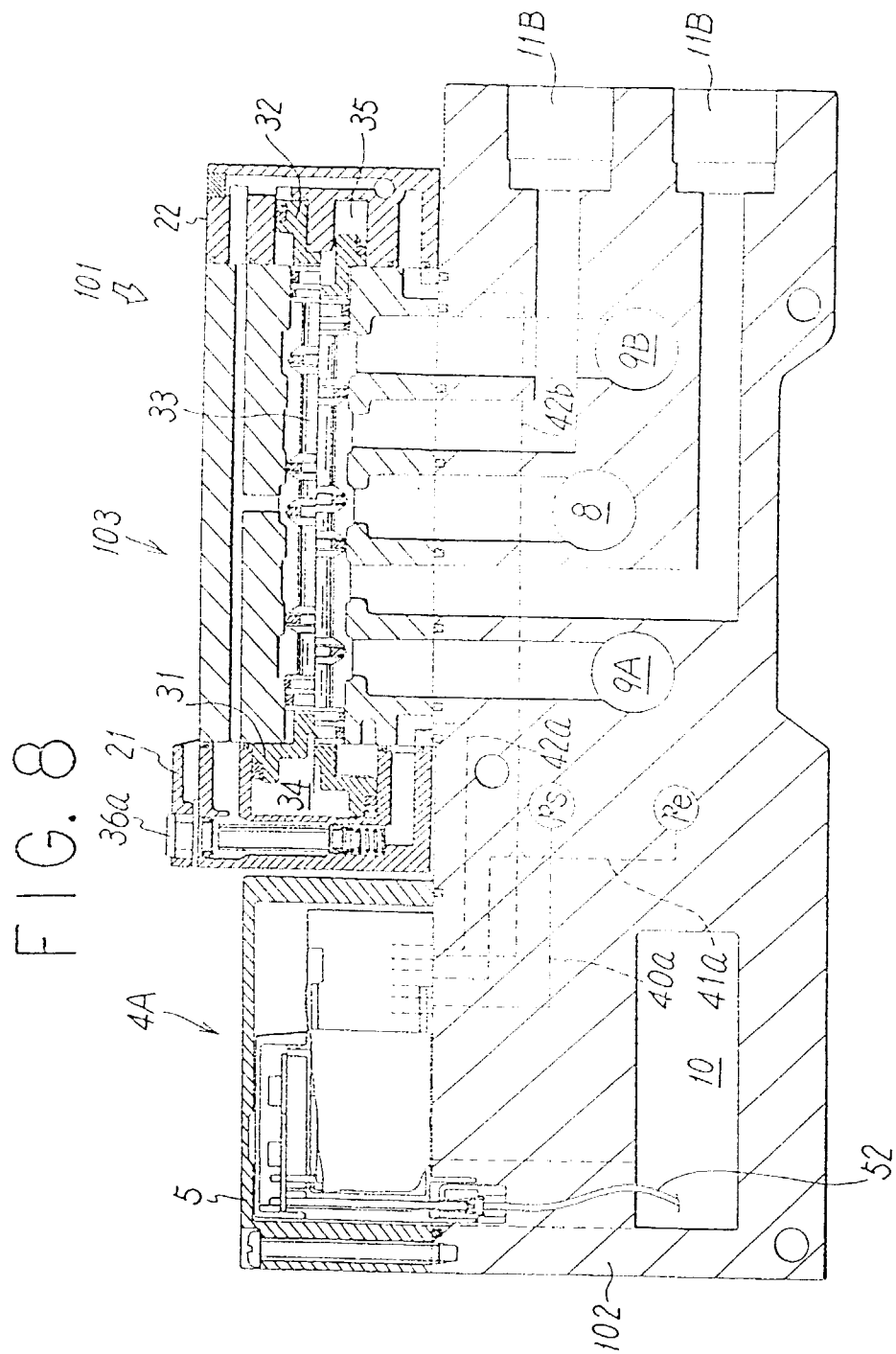
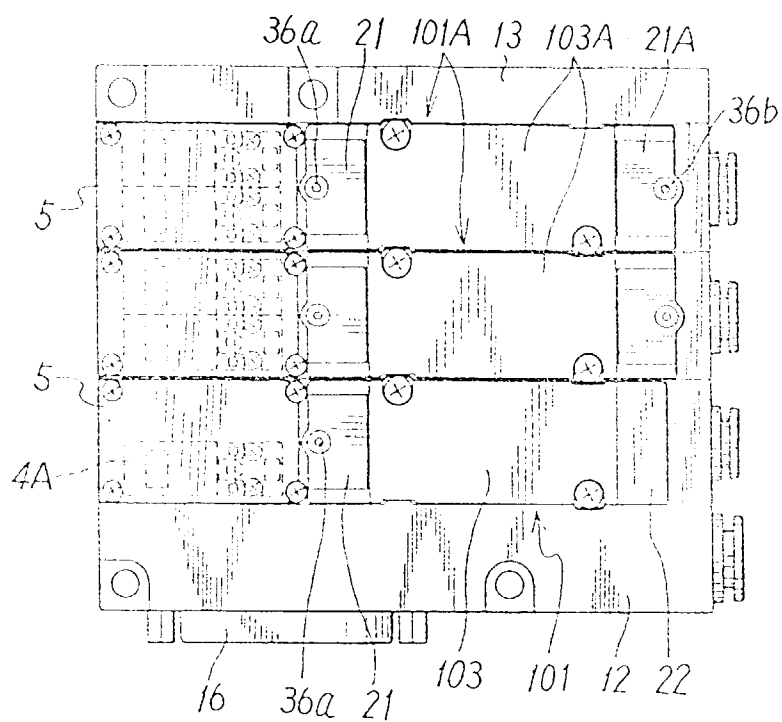
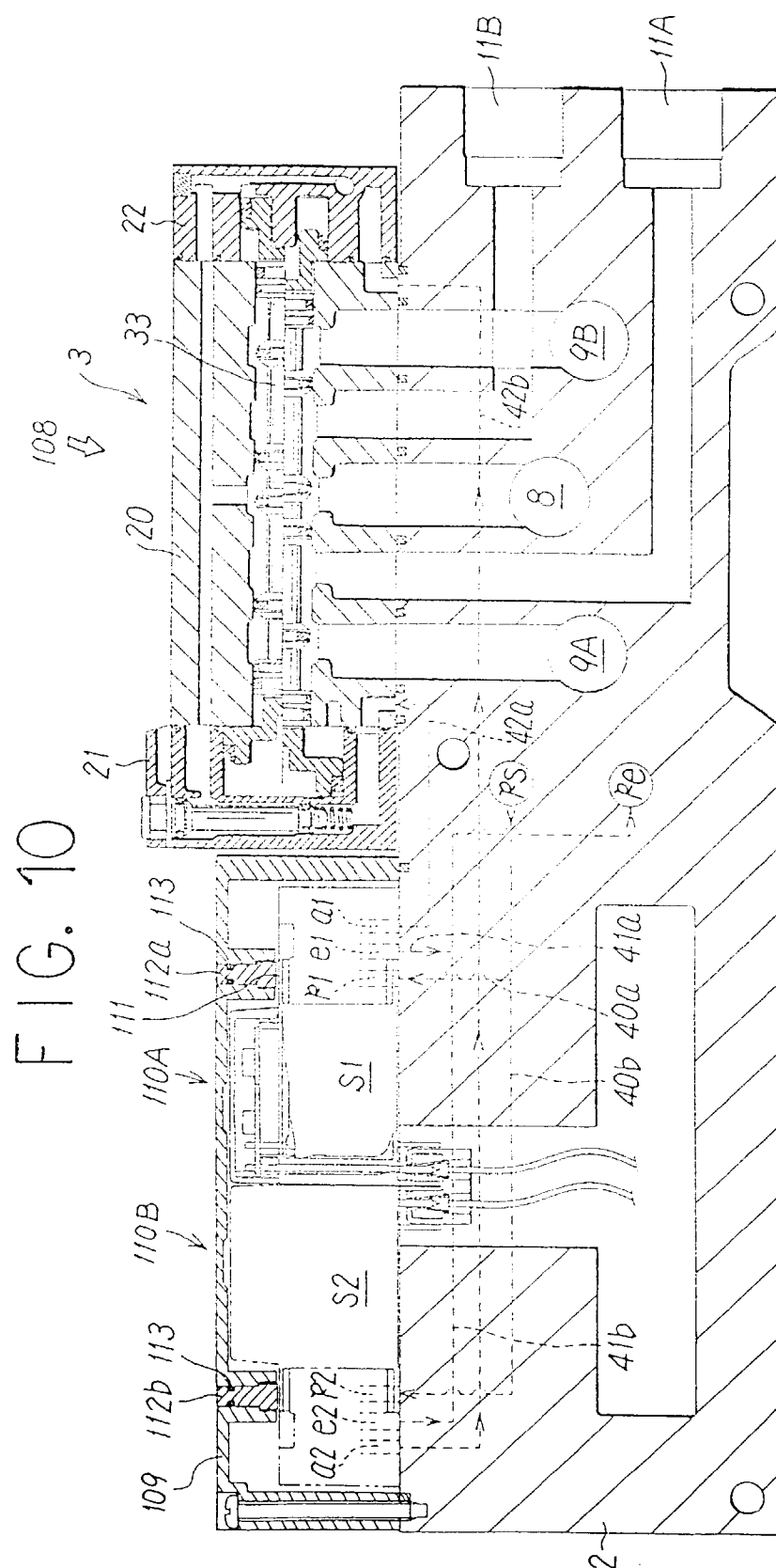


FIG. 9







European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 97 30 2055

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 5 184 648 A (THOMAS R. WALTER ET AL.) * column 2, line 49 - column 4, line 9; figures 1,2,4 *	1,2	F15B13/00
X	DE 43 05 608 A (ROBERT BOSCH GMBH) * the whole document *	1,2	
Y	EP 0 703 369 A (SMC CORPORATION) * column 6, line 51 - line 54; figure 1 *	1,4	
Y	FR 2 686 126 A (MANNESEMANN AKTIENGESELLSCHAFT) * abstract; claims 1-8; figures 1-3,6,7 *	1,4	
A	EP 0 661 484 A (SMC CORPORATION) * column 5, line 3 - line 14 * * column 10, line 12 - line 16; figures 1,4 *	1,3,4	
A	PATENT ABSTRACTS OF JAPAN vol. 18, no. 628 (M-1713), 30 November 1994 & JP 06 241339 A (TOYOOKI KOGYO CO LTD), 30 August 1994, * abstract *	1,2	TECHNICAL FIELDS SEARCHED (Int.Cl.6) F15B
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 9 July 1997	Examiner Cuny, J-M
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