United States Patent

[11] 3,584,651

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[21] Appl. No. **868,426**
[22] Filed **Oct. 22, 1969**
[45] Patented **June 15, 1971**
[32] Priority **Oct. 25, 1968**
[33] **Germany**
[31] **P 18 05 175.7**

[54] **FLUID SWITCHING DEVICE**
14 Claims, 4 Drawing Figs.

[52] **U.S. Cl.** **137/625.66,** 137/608, 137/625.27, 251/367
[51] **Int. Cl.** **F16k 11/04**
[50] **Field of Search** 137/625.66, 608, 271, 81.5; 251/172, 175, 367

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ABSTRACT: A hydraulic or pneumatic fluid-switching device comprising a stack of thin plates located between two spaced cover plates, the intermediate plates being formed with apertures or slots to accommodate individual switching elements of the plate-valve type each having a control pressure passage and supply-and-discharge passages, and including a pressure chamber at one end of the stack, connected to the main pressure supply so as to exert an end pressure on the stack to provide effective sealing between the individual plates. The effective area of the plate exposed to the fluid in the pressure chamber is greater than the effective pressure areas of the intermediate plates.

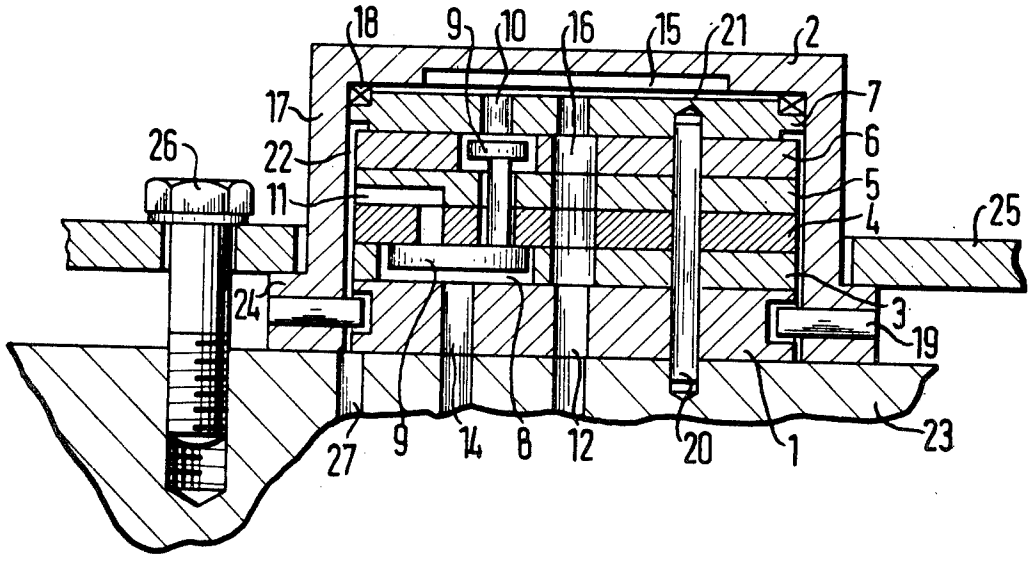


Fig. 1

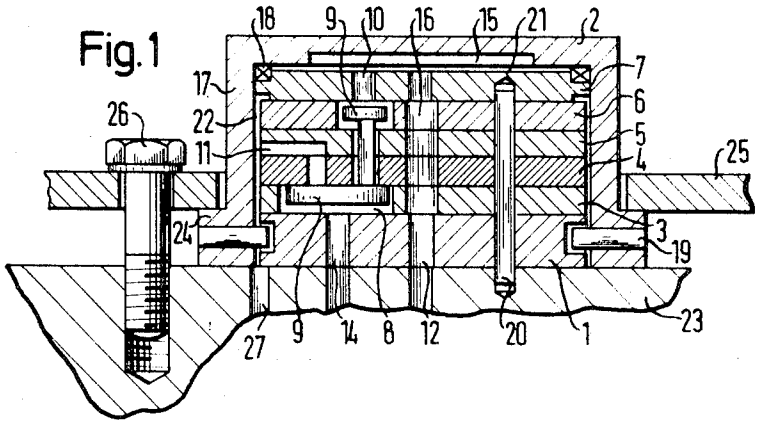


Fig. 3

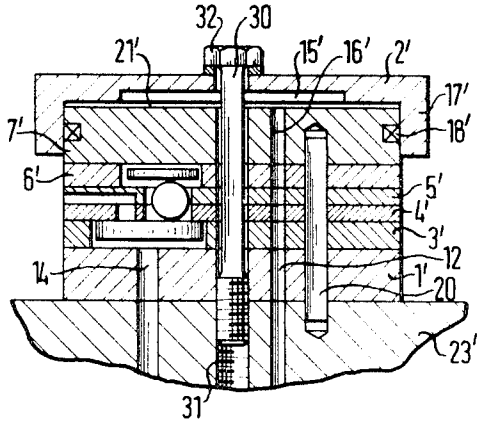


Fig. 2

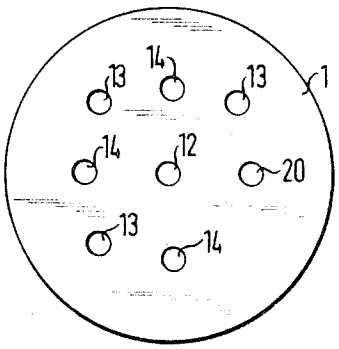
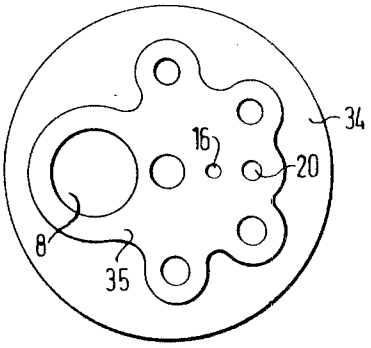


Fig. 4



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FLUID SWITCHING DEVICE

CROSS-REFERENCE TO RELATED APPLICATION

The invention is preferably but not exclusively intended for use with integrated fluid logic circuits having switching elements as described in U.S. Pat. application No. 758,512.

BACKGROUND OF THE INVENTION

This invention relates to an hydraulic or pneumatic switching device comprising a pair of generally parallel spaced end members, and a plurality of parallel platelike intermediate members positioned between the end members, some of the said intermediate members being formed with bores, slots or apertures to provide fluid connections respectively between one or more individual fluid-switching elements and main fluid supply, relief, and control pressure passages, and some of said intermediate members being formed with apertures or cavities to accommodate parts of said fluid-switching elements.

The detailed construction of the fluid-switching elements themselves is not an essential part of the present invention. The invention is particularly applicable, however, to switching elements comprising plate-type valves which are subject to the fluid pressure in a control passage and arranged to interconnect or isolate at least two other main fluid passages, for example, pressure supply and relief passages, in dependence upon the value of the control pressure.

With such switching device, fluid logic circuits can be accommodated in the minimum of space, but for satisfactory operation of the individual switching elements, it is important that the switching elements and the associated main supply pressure and control passages should be effectively sealed with respect to one another, to avoid interference. Effective sealing presents considerable problems where high pressures are involved, such as are necessary, for example, if the switching elements are to be used not only as fluid logic components but also as power switches.

Accordingly, it is an object of the invention to provide an improved fluid-switching device of the type referred to, which will permit effective sealing between the various different elements and passages.

The invention consists broadly in a fluid-switching device comprising a pair of generally parallel spaced end members, and a plurality of parallel platelike intermediate members positioned between the end members so as to be capable of movement in a direction perpendicular to the planes of said intermediate members, some of the said intermediate members being formed with bores, slots or apertures to provide fluid connections respectively between one or more individual fluid-switching elements and main fluid supply, relief, and control pressure passages, and some of said intermediate members being formed with apertures or cavities to accommodate parts of said fluid-switching elements, means for applying opposed reaction forces between the two end members towards each other, means providing a sealed pressure chamber between one of said end members and the adjacent intermediate member and means for connecting this pressure chamber to a source of fluid under pressure, so as to exert a pressure force against the said intermediate member in a direction to compress all the intermediate members against each other, the arrangement being such that the separating forces generated by fluid pressure between any adjacent intermediate members are less than the said compressive force exerted by the pressure fluid in the pressure chamber.

Preferably the pressure chamber is connected to fluid at the same pressure as the main supply pressure and the effective area of the first-mentioned intermediate member which is exposed to the pressure in the pressure chamber is greater than the effective area exposed to fluid pressure of each one of the remaining intermediate members.

Thus, the main supply pressure also acts to produce the required seal, so ensuring that as the pressure rises, the force

with which the plates are pressed against one another, and hence the sealing action, also increases. Since the pressurized faces of the other intermediate members are smaller than the pressurized face of the intermediate plate adjacent the pressure chamber, the intermediate plates are compressed against one another to provide effective seals whenever pressure fluid is admitted to the device.

The main pressure supply and control passages are preferably disposed in the cover member at the opposite end from the pressure chamber, and a supply conduit extends from the supply passage through all the intermediate plates to the pressure chamber. Thus, the main supply and control passages in the first cover member are sealed with respect to one another.

One method of obtaining the surface area relationship mentioned above is to form pressure relieved areas between adjacent intermediate plates. This surface area relationship can also be achieved by making the diameters of the other intermediate plates smaller than the diameter of the intermediate plate adjacent to the pressure chamber.

The end member adjacent to the pressure chamber may have an upstanding peripheral wall enclosing at least the adjacent intermediate plate, with a packing ring located between the peripheral surface of the enclosed intermediate plate and the peripheral wall, so that the pressure chamber is sealed off from the surrounding space. The peripheral wall may also extend as far as the other end member, which may be secured to the peripheral wall. In such constructions it is of advantage to provide an annular space between the peripheral surfaces of the other intermediate plates and the peripheral wall, and to connect this annular space to relief (tank pressure or atmosphere), so that the aforesaid surface area relationship is achieved and, in addition, the peripheral wall is relieved of stresses generated by the pressure of the working medium. If pressure relieved areas are formed between the intermediate plates, these areas may also communicate with the annular space.

The connection between the end members may be provided by means of a tension member or bolt extending from one end member through the intermediate plates to the other end member, and fixed in position, for example, by a screw thread or by means of an abutment to which the other end member is clamped. This construction is particularly advantageous if the switching device is built into a container, since then the pressure relieved ares between the intermediate plates can be arranged to communicate directly with the container. The tension member may be provided with a longitudinal passage communicating at one end with the supply passage and at the other with the pressure chamber.

The intermediate plates are preferably ground flat and secured against rotation with respect to each other by means of keys or the like.

For manufacturing reasons, it is preferred that the intermediate plates should be circular, and owing to the pressurized areas being relieved, the plates may be made from synthetic plastics material. In fact, it is possible to produce the intermediate plates by stamping, and photochemically etching the necessary cutouts or apertures for the flow paths, so that a very simple and inexpensive process of manufacture is provided with high precision.

The invention may be performed in various different ways and two specific embodiments will now be described by way of example with reference to the accompanying drawings in which:

FIG. 1 is a cross section through a first embodiment of switching device according to the invention;

FIG. 2 is a plan view of the top cover plate of the switching device shown in FIG. 1;

FIG. 3 is a cross section through a second embodiment; and

FIG. 4 is a plan view of an intermediate plate of the type shown in FIG. 3.

Referring first to the embodiment illustrated in FIGS. 1 and 2, this switching unit comprises two end members or cover

plates 1 and 2, arranged parallel with each other and accommodating between them a series of intermediate members in the form of circular plates 3, 4, 5, 6 and 7. Some of these plates are provided with apertures 8 to accommodate plate valves 9, and some of the plates have bores 10 and/or cutouts 11 which connect the apertures 8 to a supply passage 12, a discharge passage 13 and/or a control pressure passage 14 in the cover plate 1. Together with the associated lines, spacer, etc., the plate valves 9 form switching elements which act to interconnect or separate the supply passage 12 and discharge passage 13 in dependence on the pressure in the control pressure passage 14.

Between the cover plate 2 and the intermediate plate 7 adjacent thereto, there is a pressure chamber 15 which is sealed from the surrounding space and which communicates with the supply passage 12 through bores 16 in the individual intermediate plates 3 to 7. The cover plate 2 has an upstanding peripheral wall 17 bounding the pressure chamber 15 and extending as far as the other cover plate 1. Disposed between this peripheral wall 17 and the intermediate plate 7 is a packing ring 18. The cover plate 1 is loosely located in the peripheral wall 17 by pin members 19 to prevent its falling out. A fitting key 20 passes through all the intermediate plates 3 to 7 as well as the cover plate 1 and ensures that these plates remain in their correct positions of alignment with respect to one another.

When a pressure medium, such as hydraulic oil, is supplied to the switching unit, it passes through the bore 16 to the pressure chamber 15. The pressure in this pressure chamber 15 acts on the top surface 21 of the upper intermediate plate 7 and presses all the intermediate plates against one another and against the cover plate 1. Since the same pressure medium also passes into at least some of the apertures 8, then to ensure tight sealing engagement between the intermediate plates and the cover plate 1, it is arranged that the surface area of the intermediate plate 7 which is subject to the pressure in the pressure chamber 15 shall be larger than the effective pressurized surface of any other intermediate plate. This is achieved by arranging for the diameters of the other intermediate plates 3 to 6 to be smaller than the diameter of the intermediate plate 7.

As seen in FIG. 1, the plates 3 to 6 are of smaller diameter than the wall 17 and an annular gap 22 is formed between the peripheral surfaces of the intermediate plates 3 to 6 and the peripheral wall 17. This gap is connected to relief or return pressure, in other words communicates with the atmosphere or, in the case of hydraulic equipment, with the oil reservoir. At the same time, this construction avoids subjecting the peripheral wall 17 to the relatively high inlet pressure of the pressure medium.

The switching unit shown in FIG. 1 is designed to be mounted on the wall 23 of an appliance which is to be controlled. For this purpose, the peripheral wall 17 has a flange 24 engaged by a bracket or plate 25 which is bolted to the wall 23 by bolts 26. With this method of mounting the switching unit, the pin members 19 in themselves serve only as a means for mounting and transporting the switching unit as a whole. From the functional operating point of view, they could be eliminated, since the wall 23 accommodates the pressure in the pressure chamber 15 which acts on the intermediate plates 3 to 7 and on the cover plate 1. Since in this case the passages 12, 13 and 14 continue in the wall 23, it is necessary, in order to seal these connections from one another, for the cover plate 1 to bear in sealing tight manner on the wall 23. As shown in FIG. 1, this is achieved by providing between the cover plate 1 and the pin members 19 a sufficient axial clearance to allow this applied pressure to react on the wall 23. Also provided in the wall 23 is a channel 27 which communicates at one end with the gap 22 and at the other with relief or tank pressure.

The construction shown in FIGS. 3 and 4 is intended particularly to be fitted in a nonpressurized container, from which oil, for example, is being extracted by a pump and into which the oil is returned after use. The peripheral wall 17' of the cover plate 2' in this case only surrounds the adjacent topmost intermediate plate 7', and a pressure chamber 15' is again provided and sealed from the surrounding space by a packing ring 18'. The switching device is secured to the wall 23' of the container by a bolt 30 which passes through all the plates 1' to 7', and is screwed into a threaded hole 31 in the wall 23'. The cover plate 2' is externally clamped by the head 32 of the bolt 30.

As in the previous example, the pressure medium is supplied to the pressure chamber 15' through a bore 16' which passes through the cover plate 1' and all the intermediate plates 3' to 7'.

The pressure in the pressure chamber 15' acts on the adjacent face 21' of the intermediate plate 7', so that all the intermediate plates and the cover plate 1' are pressed against the housing wall 23'. In this arrangement, where the diameters of all the intermediate plates are the same, in order to ensure that the area of surface 21' of the intermediate plate 7' which is exposed to the pressure in the pressure chamber 15' is greater than the pressurized areas of the faces of every other intermediate plate 3' to 6', pressure relieved areas 34 (FIG. 4) are provided between adjacent intermediate plates and also on both side faces of the cover plate 1', these pressure relieved areas being formed by the provision of a raised land 35 around the apertures, cutouts or bores. As can be seen, the pressure relieved areas 34 extend out to the outer periphery of each of these plates, so that they communicate with the interior of the container. These relieved areas 34 may be produced by etching.

In a modification of the embodiment shown in FIG. 3, the bolt 30 may be provided with a longitudinal bore which serves as a supply channel and communicates through a transverse bore with the pressure chamber 15'.

The opposed flat surfaces or the lands 35 of the adjacently disposed plates are preferably ground flat in order to provide the necessary sealing effectiveness, and it will be understood that similar pressure relieved areas may be provided between the intermediate plates in the embodiment of FIG. 1, and arranged to communicate with the gap 22 which is connected to relief.

In both embodiments, the intermediate plates are displaceable within limits at right angles to their plane faces and between the cover plates in order to achieve effective sealing engagement under the pressure obtaining in the pressure chamber.

Although preferred embodiments of this invention have been described and illustrated herein, it should be understood that this invention is in no sense limited thereby but its scope is to be determined by that of the appended claims.

I claim:

1. A fluid-switching device comprising a pair of generally parallel spaced end members, and a plurality of parallel platelike intermediate members positioned between the end members so as to be capable of movement in a direction perpendicular to the planes of said intermediate members, some of the said intermediate members being formed with bores, slots or apertures to provide fluid connections respectively between one or more individual fluid-switching elements and main fluid supply, relief, and control pressure passages, and some of said intermediate members being formed with apertures or cavities to accommodate parts of said fluid-switching elements, means for applying opposed reaction forces between the two end members towards each other, means providing a sealed pressure chamber between one of said end members and the adjacent intermediate member and means for connecting this pressure chamber to a source of fluid under pressure, so as to exert a pressure force against the said intermediate member in a direction to compress all the intermediate members against each other, the arrangement being such that the separating forces generated by fluid pressure between any adjacent intermediate members are less than the said compressive force exerted by the pressure fluid in the pressure chamber.

2. A fluid-switching device according to claim 1 in which the pressure chamber is connected to fluid at the same pressure as the main supply pressure and the effective area of the first mentioned intermediate member which is exposed to the pressure in the pressure chamber is greater than the effective area exposed to fluid pressure of each one of the remaining intermediate members.

3. A fluid-switching device according to claim 1 in which the main fluid supply pressure passage is formed in the end member remote from that end member which defines the sealed pressure chamber, and the intermediate members are provided with cooperating apertures forming a pressure connection between this main fluid supply passage and the pressure chamber.

4. A fluid-switching device according to claim 1 in which at least some of the intermediate members have relieved surfaces, so as to reduce the effective areas thereof subject to fluid under pressure.

5. A fluid-switching device according to claim 1 in which the intermediate member adjacent to the pressure chamber is of larger transverse dimensions or cross-sectional area than the remaining intermediate members.

6. A fluid-switching device according to claim 1 in which the end member which defines the pressure chamber is provided with a peripheral wall which surrounds at least the adjacent intermediate member, and including a sealing element between this intermediate member and the peripheral wall.

7. A fluid-switching device according to claim 6 in which the peripheral wall extends to the opposite end member, and including means for securing the wall to said opposite end member or to a part connected thereto.

8. A fluid-switching device according to claim 1 in which the intermediate members are enclosed in a surrounding case, arranged to provide a clearance space around the remaining intermediate members, and this clearance space is provided with means for connection to a pressure relief passage.

9. A fluid-switching device according to claim 8 in which at least some of the intermediate members have relieved surfaces, so as to reduce the effective areas thereof subject to fluid under pressure, and the gaps between the intermediate members formed by the relieved surfaces thereof communicate with the said clearance space around the intermediate members.

10. A fluid-switching device according to claim 1 in which the end members are connected together by a tension member passing through the intermediate members.

11. A fluid-switching device according to claim 10 in which the tension member is provided with a longitudinal passage which communicates at one end with the main fluid supply passage, and at the other end with the pressure chamber.

12. A fluid-switching device according to claim 1 in which the end members and intermediate members are interconnected to prevent or limit relative rotation or displacement in directions parallel to the planes of said intermediate members.

13. A fluid-switching device according to claim 1 in which the intermediate members are in the form of circular discs.

14. A fluid-switching device according to claim 1 in which the intermediate members are formed of synthetic plastics material.