United States Patent

Klee

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[54] DUCT SYSTEM FOR FLUID PRESSURE MEDIUM OPERATED REGULATING, CONTROL AND MEASURING APPARATUS

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[30] **Foreign Application Priority Data**

Apr. 5, 1969 Germany ..... P 19 17 727.6

[52] **U.S. Cl.** **137/608**, 137/81.5

[51] **Int. Cl.** **F17d 1/00**

[58] **Field of Search** 137/81.5, 608

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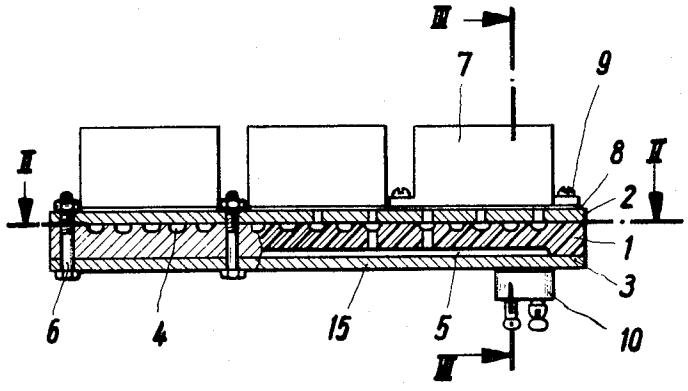
Attorney—McGlew and Toren

[57] **ABSTRACT**

A duct system for fluid pressure medium operated apparatus comprises plural substantially flat superposable plates. At least one plate is formed with channel-type recesses separated from each other by separating walls. The recesses are arranged in regular groups, and all recesses in each group extend in the same direction. The recesses in adjacent groups extend in respective different directions, such as at right angles to each other. The separating walls are pierceable to interconnect channels at selected locations to form a fluid pressure medium flow circuit. In one embodiment of the invention, the plate has channel-type recesses on both surfaces, with the recesses on one surface extending substantially perpendicularly to the recesses on the other surface and with interconnection being effected by aperturing the portion of the plate separating the recesses on the opposite surfaces. In another embodiment of the invention, the recesses are formed on only one surface of the plate, and the separating walls comprise webs of the channel-type recesses.

5 Claims, 13 Drawing Figures



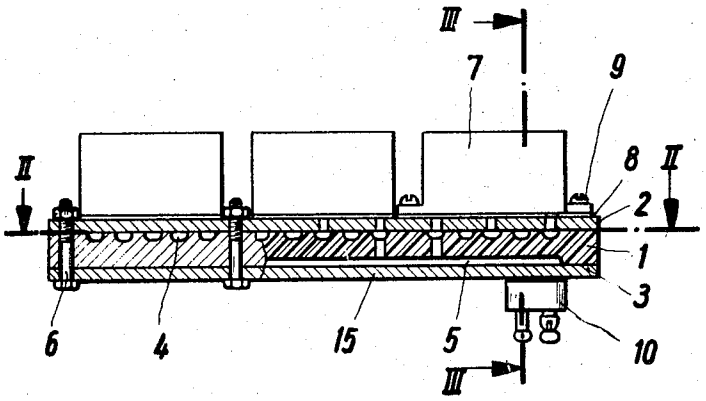


Fig. 1

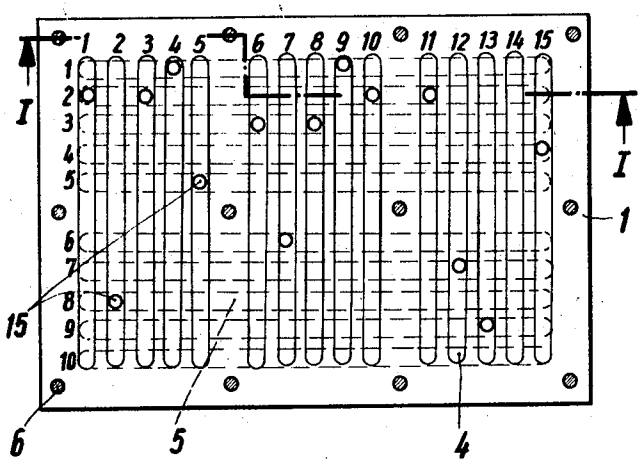


Fig. 2

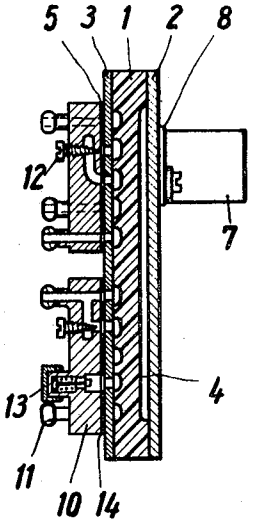


Fig. 3

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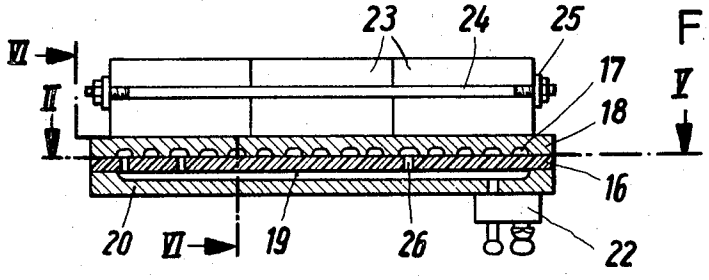

Fig. 4

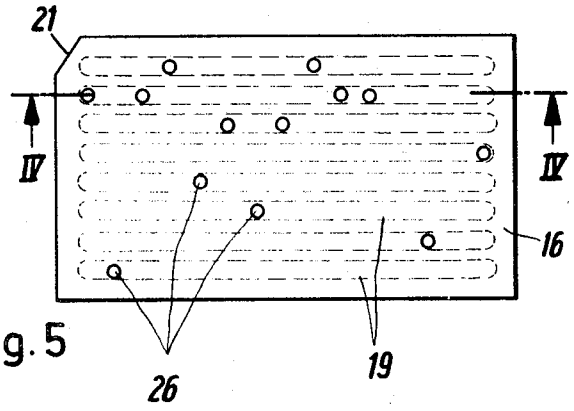

Fig. 5

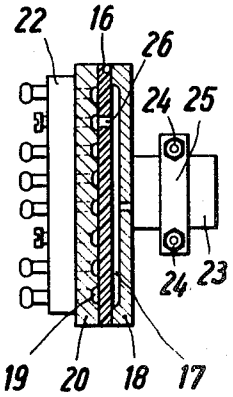

Fig. 6

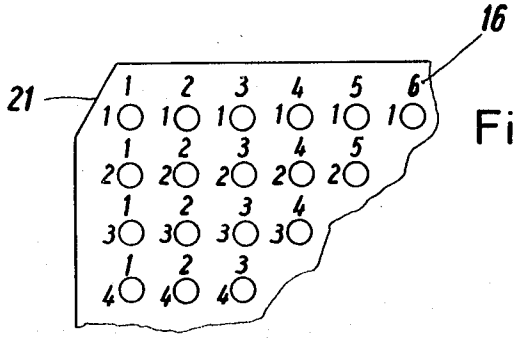

Fig. 7

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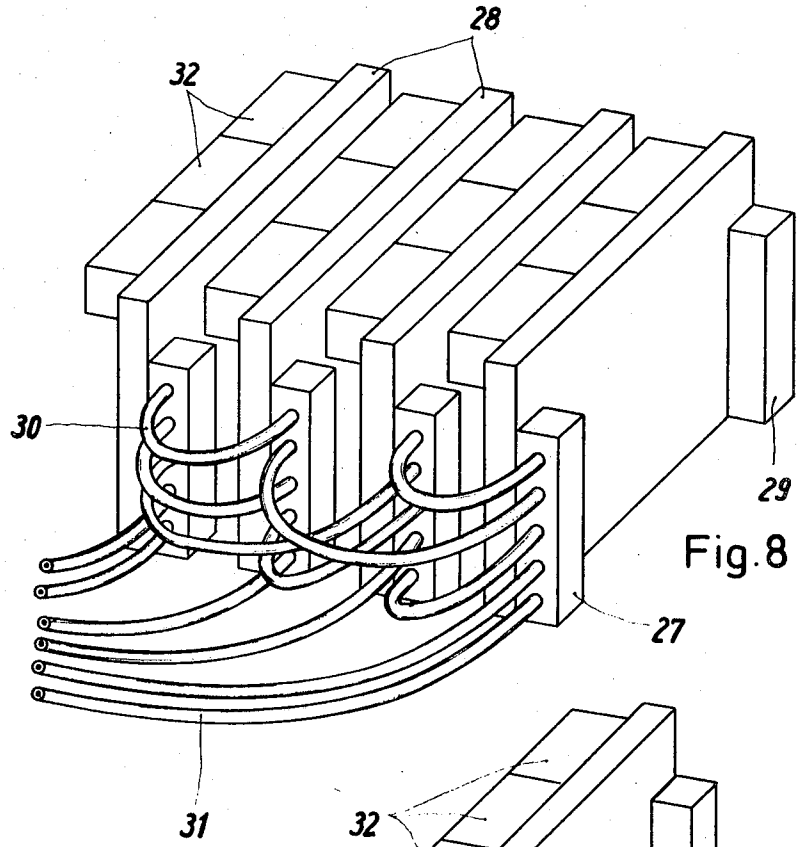

Fig.8

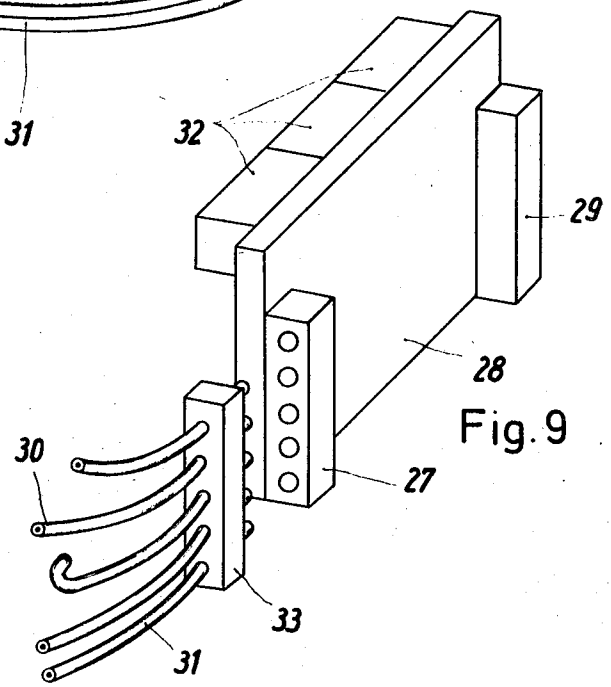

Fig.9

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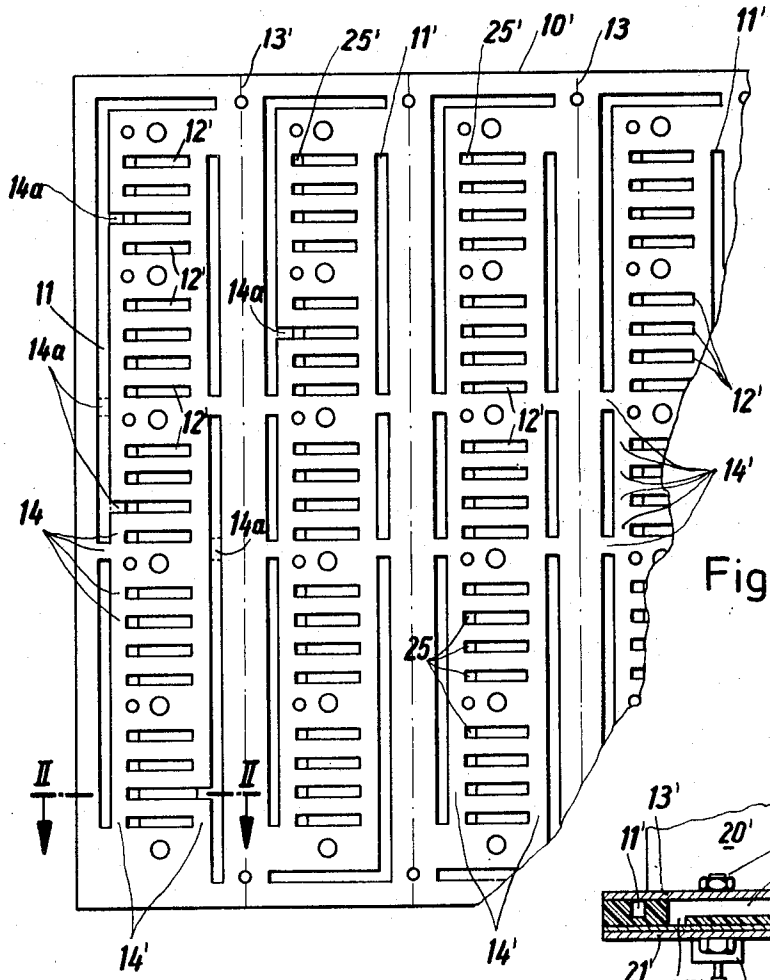

Fig. 10

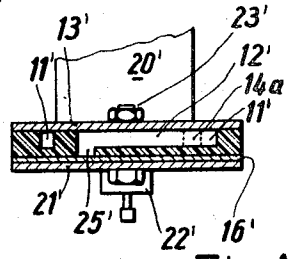

Fig. 11

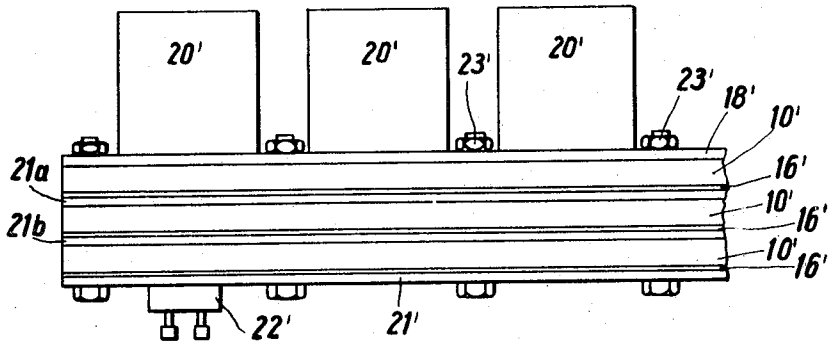

Fig. 12

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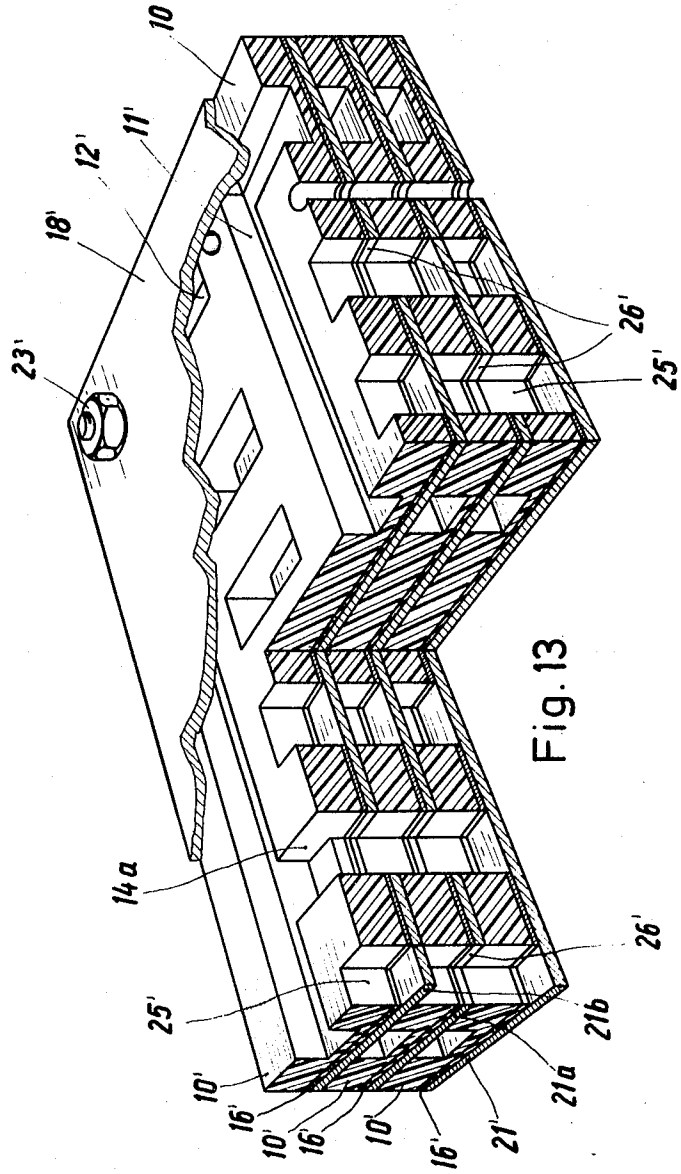

Fig. 13

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DUCT SYSTEM FOR FLUID PRESSURE MEDIUM OPERATED REGULATING, CONTROL AND MEASURING APPARATUS

BACKGROUND OF THE INVENTION

Circuit plates or circuit members used to form duct systems for pressure medium operated apparatus have, up to the present, been relatively expensive because they must be produced specially for each particular application. Thus, they are not adaptable to other conditions or requirements, and hence must usually be replaced by new circuit plates or circuit members when the operating conditions change. Similar disadvantages result with circuit blocks having bores arranged in several planes, the circuit arrangement of which is difficult and, when once established, can no longer be changed.

When flat plates, such as known, for example, from German DAS 1,093,625, are used for such a duct system, they are made of rubber or plastic and channels are pressed thereinto by means of press molds which are produced by the method, known from printing, for producing metal-rubber printing plates.

With this type of production, new press molds must be provided for each application, in order to produce the required channeled plates. Such channeled plates therefore are comparatively expensive and are applicable only for installations which are produced in relatively large quantities.

Additionally, when the plates are arranged in superposed relation to form a duct system including ducts in several planes, the duct layout becomes complicated and leads to errors. Also, such channeled plates are not adaptable to other conditions or requirements. When circuit requirements or regulating parameters change, therefore, new press molds must be prepared to make the channeled plates, and this is very complicated and expensive.

There have also been used so-called circuit blocks with transverse and longitudinal channels crossing in four planes and separated by partitions. By removal of the partitions from the longitudinal and transverse channels, any desired duct connections can be produced. Aside from the fact that such circuit blocks are difficult to produce because of the blind bores, the removal of the partitions involves further difficulties, and the circuit course is not visible. Thus, circuit errors may occur very easily, and become evident only when the installation is placed in operation. Additionally, the construction of a duct system utilizing such circuit blocks is very voluminous.

Finally, the construction of an extensive duct system with several planes one above the other is possible only with great difficulty if at all.

SUMMARY OF THE INVENTION

This invention relates to duct systems for pressure medium operated apparatus and, more particularly, to such a system including superposed plates at least one of which is formed with pressure medium channels, and which is more versatile than known duct systems and which provides greater safety in designing a flow circuit, greater reliability in operation with a small overall volume, low cost of production, easy adaptation to new problems or new conditions and providing for planning of a circuit arrangement in one plane as far as possible.

In accordance with one embodiment of the invention, the preferably plate-shaped circuit member contains rows of pressure medium channels on both surfaces, the rows thus being separated by a separating wall, and the rows on each surface extending in a different direction from the rows on the other surface. The rows are interconnectable by forming apertures in the separating walls at intersections selectable according to the desired circuit diagram. An especially advantageous feature is that the duct system comprises an assembly of this circuit member with plates which are superposed in flat relation, at least one of these plates being formed with open pressure medium channels which are coverable by a respective adjacent plate.

In practice, such a circuit device can be constructed in various ways. In a very simple form of construction, the circuit member consists of an inner plate, formed on both surfaces with rows of open pressure medium channels and, at the same time, forming the separating wall, and two other plates covering the pressure medium channels. In another, and also very simple, form of construction, the circuit member consists of two outer plates formed, on their inner surfaces, with a row of open pressure medium channels, and an inner plate covering the pressure medium channels and forming the separating wall.

The pressure medium channels in each row of channels extend preferably parallel to one another, but obliquely to preferably perpendicularly to the pressure medium channels of the other row of channels. In the case of such a circuit device, where the longitudinal and transverse channels cross, one may speak of a circuit member having cross channel plates. At the points where the channels cross, the plate forming the separating wall is provided with markings or, at these points, holes are marked and are, advantageously, specially designated or numbered. These marked holes then can be punched or pierced according to the desired circuit diagram, in order to interconnect the respective longitudinal and transverse channels. To one side of the central plate, the outer plates carry those elements which are to be connected with the transverse channels and, to the other side of the central plate, the outer plates carry those elements which are to be connected with the longitudinal channels.

The central or inner plate advantageously may be produced from an elastic material, so that the pressure medium channels are sealed hermetically by the compressive pressure of the outer plates against the elastic inner plate. The plates of the circuit member advantageously are pressed firmly together by bolts or other securing means.

However, instead of bolts for holding the plates pressed together, the plates of the circuit members simply may be glued together. The surfaces to be glued together then may be treated so that they vulcanize themselves and thereby gain adhesive strength. When the plates are glued together, with the aid of such activated surfaces, the outer plates also may consist of elastic or soft material.

Circuit members embodying the invention or, respectively, the individual channel plates or separating plates, actually may be produced in any desired size and form but, for the purpose of rational production, they are preferably formed with a uniform size which should be so dimensioned that the circuit members suffice for the circuiting of the control and regulating units most frequently used. It also may be an advantage to provide a smaller number of longitudinal channels and a larger number of transverse channels, and to connect the logic or circuit elements with the transverse channels while connecting the junctions for the supply of air and the input and output signals with the longitudinal channels. The logic elements, in fact, usually must be connected together in multiple ways, besides being connected with the input and output signal passages, so that generally fewer longitudinal channels than transverse channels are needed.

For forming the circuit of larger and more complicated regulating or control installations, two or more plate-shaped circuit members may, in accordance with the invention, be interconnected selectively to form one larger circuit installation.

In another embodiment of the invention, there is utilized, as a basis, a duct system consisting of open channels arranged in one surface of a flat plate and covered by another plate. Instead of these channels, channel sections, separated from each other by pierceable webs are provided, and these are arranged in the flat plate according to a regularly recurring pattern.

With this embodiment of the invention, it is possible, for the first time, to create, from one type of channel plates, and merely by piercing or breaking away of webs between the individual channel sections, any desired duct connections within the given possibilities, namely in one circuit plane. The resulting duct system therefore is clear at a glance. Since only one type of channel plate must be produced, for example by

pressing, large quantities and, accordingly, low prices result. Since, in establishing the ducts system, the duct connections, represented properly in a drawing, or transferable directly onto the channel plate, as by breaking away of the selected webs between the channel sections, errors in laying out the flow circuit are practically excluded. The breaking away of the webs is relatively easy, and can be effected, for example, by cutting or breaking out with a suitable tool. The expense for establishing a duct system therefore is extremely low, and this is reflected also in the adaptation of an established installation to new tasks, since the channel plate, with the old duct layout, can be replaced easily and quickly by a channel plate with a new duct layout. New pressing tools, such as required for the exchange of channel plates used up till the present, are no longer necessary.

Establishment of duct systems is made especially inexpensive if the plate having the channel sections is provided with division lines with relation to which the regularly recurring patterns are arranged in symmetry. A so-called norm plate (standard plate) then can be used, in accordance with the requirements to be fulfilled, as a whole plate for the establishment of a desired duct system, or else only parts of this plate, provided by division of the plate along the symmetry or division lines, can be used. This results in a further saving of production costs and stock-keeping costs.

In a preferred form of construction, the pattern, which repeats on both sides of the divisional lines, is in the form of a ladder, but alternatively it may be in comb or meander form. To facilitate handling of the plate formed with the channel sections, it is connected with a firm or rigid, and preferably metallic, support.

For particularly extensive duct systems it may, under certain spatial conditions, be desirable to subdivide the duct system into several superposed planes instead of arranging the duct system in a single plane. A channel plate embodying the invention is suitable for this construction also, and without losing its advantageous properties. Such a plate, with channel sections separated from each other by frangible webs, and whose channel sections are arranged according to a regularly recurring pattern has, in accordance with another feature of the invention, channel sections which present apertures passing through the plate. In this manner, a pressure potential of one circuit plane can be transferred easily and reliably to another circuit plane, such as the one below. In accordance with the preferred former construction, the channel sections having the apertures are arranged side by side at a spacing such that they match the junctions of pneumatic or hydraulic components to be interconnected by the duct system.

With a stacked arrangement of several plates formed with channel sections, in accordance with the invention, the additional plates of the duct system, arranged between these plates and covering the open channels, have the passages (break throughs) establishing the connection between the individual channel planes. The property of the plates formed with the channel sections, as norm plates, is thus preserved, since, when the duct system to be established is arranged in a single plane, the plate is clamped in a manner known per se between two metal plates, with one metal plate carrying the circuit elements and the other metal plate the inlet and discharge lines. The passages provided in the plate formed with the channel sections therefore are closed pressuretight by the plates carrying the inlet and discharge lines. Something similar applies for stacked arrangements of plates formed with the channel sections, and here again the passages not needed in the plates are covered in a pressuretight manner by additional metal plates.

To facilitate establishing of the passages, another feature of the invention involves the additional plates having a network of lines indicating all possible locations for passages to be established.

An object of the invention is to provide an improved duct system including circuit members and which is more versatile than known duct systems.

Another object of the invention is to provide such a duct system which is easily adapted to a variety of circuit diagrams.

A further object of the invention is to provide such a duct system which fulfills, to a higher degree than heretofore, the requirements of greater safety in circuiting.

Another object of the invention is to provide such a duct system providing great reliability in operation with a small overall volume and a low cost of production.

For an understanding of the principles of the invention, reference is made to the following description of typical embodiments thereof as illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIGS. **1**, **2** and **3** are, respectively, longitudinal sectional, plan and transverse sectional views of a circuit device in accordance with a first embodiment of the invention;

FIGS. **4**, **5** and **6** are, respectively, longitudinal sectional, plan and transverse sectional views of a circuit device in accordance with a second embodiment of the invention;

FIG. **7** is a partial plan view of a separating plate provided with markings;

FIG. **8** is a perspective view of a combined circuit installation;

FIG. **9** is a perspective view of a part of a combined circuit installation;

FIG. **10** is a partial plan view of a channeled plate used in the formation of a duct system embodying the invention;

FIG. **11** is a sectional view on the line II—II of FIG. **10**;

FIG. **12** is a side elevation view of a duct system, embodying the invention, and consisting of several superposed channel plates such as shown in FIG. **10**; and

FIG. **13** is a perspective view, partly in section, of a duct system such as shown in FIG. **12**.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIGS. **1**, **2** and **3**, in the therein illustrated embodiment of the invention, the circuit member comprises an inner plate **1**, of elastic material, having its opposite surfaces formed with respective rows of open pressure medium channels **4** and **5**, respectively, and two firm outer plates **2** and **3**. FIG. **2** illustrates inner plate **1** with the upper outer plate **2** removed. Transverse channels **4** are arranged in groups of **5**, to leave space for bolts **6** which secure the three plates together in tightly sealed relation. The longitudinal channels **5**, which are not directly visible in the plan view of FIG. **2**, are illustrated in broken lines. A part of the longitudinal sectional view constituting FIG. **1** is offset to illustrate a longitudinal channel **5**.

The logic elements **7** are secured on upper outer plate **2** through the medium of screws or bolts **9** and with the interposition of packings **8**. The distributor pieces **10**, which carry the connections for the input and output signals, for the air supply, and possibly for time elements or volumes to be connected, as well as the adjustable chokes **12** and testing valves **13**, are secured in a similar manner on lower outer plate **3**, with the interposition of packings **14**. As best seen in FIG. **2**, inner plate **1** is formed with apertures **15**, drilled therethrough at selected locations in accordance with the circuit diagram.

FIGS. **4**, **5** and **6** illustrate another example of the construction of the invention, wherein the individual plates of the circuit member are adhered or glued together and to the logic elements **23** and connecting pieces **22**. In this embodiment of the invention, inner plate **16** is flat and smooth, with transverse channels **17** being formed in one surface of outer plate **18**, and longitudinal channels **19** in one surface of outer plate **20**, the surfaces of plates **18** and **20** formed with the respective channels **17** and **19** facing inner plate **16**. Inner plate **16** is formed with bores **26** at points corresponding to the circuit diagram, to selectively interconnect channels **17** and **19** to form the flow circuits. said logic and circuit elements, and said longitudinal channels being connected with said

FIG. **7** illustrates a portion of inner plate **16** carrying designations, solely by way of example, of the marked aper-

tures or bores therein. One corner **21** of all three plates of the circuitry device is beveled, to insure the correct relative positions of the individual plates when they are cemented or glued together. In the embodiment of FIGS. **4**, **5** and **6**, connecting pieces **22** are made in one piece. Logic elements **23** are firmly connected together, so that they act as a single piece, this being indicated schematically by bolts **24** anchored through crosspieces **25**.

In both of the embodiments of the invention so far described, the number of longitudinal channels and of transverse channels has been assumed as an arbitrary number. Also, the distribution of the logic elements, of the junctions and of the actuating elements over the two outer plates may be effected in any other manner, that is, if necessary, the arrangement of the logic elements, accessories and connecting pieces may, for example, be on one surface only of the circuit device.

For more extensive circuit installations, as required for more complicated control and regulating functions, several channeled plates must be connected together. The channeled plates may be arranged parallel with one another and inserted, for example, in holding racks. A schematic arrangement of this kind is illustrated in FIG. **8**. Referring to FIG. **8**, connection pieces or members **27** for the hose or conduit connections are arranged on one side of each circuit member **28** adjacent one end thereof, and the connecting pieces **29** for the adjustable regulating and testing elements are arranged on the same side of each circuit member **28** but adjacent the opposite end thereof. This results in a clear arrangement, at one end of the circuit members, of the hose or conduit connections **30** between the individual circuit members **28**, as well as of the hose or conduit connections **31** which are connected to external sources while, at the opposite end of the circuit devices **28**, the devices to be manipulated are easily accessible. Logic and circuit elements **32**, which need to be accessible only in case of repair or replacement, are positioned between circuit members **28** and are accessible after detachment of hose connections **30** and **31** and extraction of circuit members **28**.

Disconnection of the hose connections can be further simplified by using plug strips **33**, as illustrated in FIG. **9**. Hoses or conduits **30** and **31** are individually plugged into plug strip **33**. The connecting pieces **27** are so designed as to act as female receptacles for the plug strip **33**. Thus, connection of the hoses with circuit members **28** can be effected with a single manipulation, and the hoses can be disconnected just as easily. With reinsertion of plug strip **33** into junction strip **27**, there results the further advantage, which cannot be underestimated as against insertion of the individual hoses, that mixups in the hose connections are avoided.

This form of construction, where the circuit members are interconnected by hoses, constitutes a very practical combination which affords, besides clarity and accessibility, an extensive adaptability and variability. Other combinations are also possible. Thus, the individual circuit members can be interconnected without the use of hoses by means of plug strips which interconnect all or a part of the longitudinal channels. Also, plug strips can be used in the same manner for connecting the transverse channels of the individual circuit members, thereby multiplying the possibilities for flow circuits in both directions.

In the embodiment of the invention illustrated in FIGS. **10** through **13**, a plate **10'**, of plastic or of natural or artificial rubber, has one surface formed with a plurality of unilaterally open longitudinal channels **11'** and a plurality of unilaterally open transverse channels **12'**, with channels **11'** and **12'** extending at right angles to each other. The longitudinal and transverse channels form regularly recurring ladder-type patterns, which are arranged symmetrically with respect to division lines **13'**.

As clearly illustrated in FIG. **10**, the longitudinal transverse channels are channel sections which are separated from each other by webs **14'**, only some of which have been designated for the purpose of a better illustration. If webs **14'** are divided, pierced or broken away, for example as illustrated at **14***a*, there result duct connections between the individual sections of the longitudinal and transverse channels. In this manner, any desired duct interconnection within the given possibilities can be produced. The division can be effected, for example, by cutting away or by breaking out the webs. To impart sufficient stiffness to plate **10'**, which may also be called the channel plate, and despite the plurality of the channels sections weakening its cross section, as shown in FIGS. **11** and **13**, plate **10'** is connected with a firm, and preferably metallic, support **16'**. This connection may be effected, for example, by gluing or cementing. The unilaterally open channels, of which those where the separating webs have been removed form the actual duct system, are covered in pressuretight relation by an additional flat plate **18'** of metal, which matches plate **10'**. As illustrated in FIG. **12**, plate **18'** carries the pneumatic or hydraulic circuit elements **20'** to be interconnected by the duct system or circuit.

Another metallic plate **21'**, matching plate **18'**, is provided with connection elements **22'** presenting inlet and discharge lines. Plate **21'** faces the underside of channel plate **10'**, and bolts **23'** firmly secure plates **10'**, **16'**, **18'** and **21'** together in such a manner that plate **10'** is interposed between metal plates **18'** and **21'**. The external dimensions of plates **18'** and **21'** always match the external dimensions of the channel plate being used which, for instance, in the construction example shown in FIG. **11**, comprising, in width, simply one ladder-type pattern of channel sections. That is, it has been separated from the full plate shown in FIG. **10** at, for example, the left-most divisional line **13'**.

For the purpose of arranging the duct system in several superposed planes, as shown in FIGS. **12** and **13**, all channel sections **12'**, which are preferably arranged at spacings such that they match the junctions (not shown) of circuit elements **20'** to be interconnected by the duct system, have apertures **25'** formed through plate **10'**.

In the stacking of plates **10'** having the channel sections **11'** and **12'** of the duct system, there are inserted, between pairs of plates **10'**, an additional plate **21***a* and, in the selected example, an additional plate **21***b*. Plates **21***a* and **21***b*, at the points where the pressure level of one circuit is to be transmitted into the other circuit plane, are formed with passages **26'**, so that a direct connection exists between the selected channel section **12'** of an upper plate **10'** with the selected channel section **12'** of a lower plate **10'**. All other apertures **25'** of the channel sections of plate **10'** are blocked or sealed by plates **21***a* and **21***b* interposed between the plates **10'**. Plate **21'** carries the junction elements **22'**, and the entire plate package is secured together, in fluidtight relation, by bolts **23'**.

The channel sections in plate **10'** may be so arranged that meander-type pattern is formed, as well as other patent patterns. What is essential is only that the patterns repeat regularly on both sides of divisional lines **13'** so that, by means of a single standardized plate **10'** formed with the channel sections, a great variety of duct systems can be established. These systems may be in one or more circuit planes without requiring new pressing tools for the establishment of channel plates. To facilitate production of flow circuits in several planes, plates **21***a* and **21***b* are provided with a network of lines which indicate all possible locations for passages **26'** to be established.

Circuit members embodying the invention are not limited to use with pneumatic logic systems, but can be used to advantage wherever gaseous or drop-forming liquids must be used and distributed.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the principles of the invention, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A duct system, for fluid pressure medium operated regulating control and measuring apparatus, comprising, in combination

plural substantially flat superposable plates arranged in a stack to form a plate-shaped circuit member, at least one plate being formed with channel-type recesses; separating walls which separate said channel-type recesses from each other, said separating walls being perforable to interconnect channels at selected locations to form at least one fluid pressure medium flow circuit; said groups of channel-type recesses defining two rows of pressure medium flow channels, arranged in regular groups and extending in different directions with the channels in each group extending in the same direction parallel to each other, whereby the flow channels in each row extend parallel to each other in the flow channels said two rows extend at an angle to each other, said two rows being defined so that one row comprises transverse channels and the other row comprises longitudinal channels; the number of transverse channels being greater than the number of longitudinal channels; said transverse channels being connected to said logic and circuit elements, and said longitudinal channels being connected with said regulating testing and connection elements; said plate-shaped circuit member carrying, on at least one surface thereof, logic or circuit elements, regulating and testing elements and junction elements to be interconnected by fluid pressure medium flow circuits.

2. A duct system, for fluid pressure medium operated regulating control and measuring apparatus comprising a plurality of substantially flat superposable plates arranged in a stack to form a plate-shaped circuit member, at least one plate being formed with channel-type recesses; separating walls which separate said channel-type recesses from each other, said separating walls being perforable to interconnect channels at selected locations to form at least one fluid pressure medium flow circuit; said groups of channel-type recesses defining two rows of pressure medium flow channels, arranged in regular groups and extending in different directions with the channels in each group extending in the same direction parallel to each other, whereby the flow channels in each row extend parallel to each other and the flow channels in said two rows extend at an angle to each other; said plate-shaped circuit member carrying, on at least one surface thereof, logic or circuit elements, regulating and testing elements and junction elements to be interconnected by fluid pressure medium flow circuits; said duct system including at least two said plate-shaped circuit members interconnected to form a flow medium circulating installation, said plate-shaped circuit members being arranged parallel to each other; first connection means, for conduit means, being arranged on one side of each circuit member; second connection means, for regulating and testing elements and the like arranged on the opposite side of each circuit member; and logic and circuit elements being positioned between said plate-shaped circuit members.

3. A duct system, as claimed in claim 2, in which said conduit means comprise connection hoses terminating at common plug-in strips; said connection means comprising receptacle means mating with said plug-in strips and arranged to have said plug-in strips inserted thereinto.

4. A duct system, for fluid pressure medium operated regulating control and measuring apparatus, comprising, in combination, plural substantially flat superposable plates, at least one plate being formed with channel-type recesses separated from each other by separating walls; said channel-type recesses being arranged in regular groups and extending in respective different directions, with the channels in each group extending in the same direction; said separating walls being perforable to interconnect channels at selected locations to form at least one fluid pressure medium flow circuit; said separating walls constituting webs of channel-type recesses arranged in one surface of said plate in a regularly recurring pattern; said channel-type recesses being interconnectable at intersections, selected according to the desired flow circuit diagram, by removal of selected portions of said webs, said plate being provided with division lines for severing into sections; said regular patterns being arranged symmetrically with respect to said division lines and being a ladder-type pattern repeating on both sides of each division line.

5. A duct system, for fluid pressure medium operated regulating control and measuring apparatus, comprising, in combination, plural substantially flat superposable plates, at least one plate being formed with channel-type recesses separated from each other by separating walls; said channel-type recesses being arranged in regular groups and extending in respective different directions, with the channels in each group extending in the same direction; said separating walls being perforable to interconnect channels at selected locations to form at least one fluid pressure medium flow circuit; said separating walls constituting webs of channel-type recesses arranged in one surface of said plate in a regularly recurring pattern; said channel-type recesses being interconnectable at intersections, selected according to the desired flow circuit diagram, by removal of selected portions of said webs, said plate being provided with division lines for severing into sections; said regular patterns being arranged symmetrically with respect to said division lines and being a meander-type pattern repeating on both sides of each division line.

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