United States Patent [19]

Chang

[11] **3,881,513**

[45] **May 6, 1975**

[54] **THREE-COORDINATE FLUID MANIFOLD**

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[73] Assignee: **Sun Oil Company of Pennsylvania**, Philadelphia, Pa.

[22] Filed: **Jan. 25, 1974**

[21] Appl. No.: **436,819**

[52] **U.S. Cl.** ..... **137/608**; 137/271; 137/367; 235/201 ME

[51] **Int. Cl.** **F15c 3/06**

[58] **Field of Search** ..... 137/608, 271, 367, 833; 235/201 ME, 201 PF

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Primary Examiner—Charles J. Myhre
Assistant Examiner—Ira S. Lazarus
Attorney, Agent, or Firm—George L. Church; Donald R. Johnson; Frank A. Rechif

[57] **ABSTRACT**

An X-coordinate manifold, having a plurality of parallel channels extending in the X direction, is mated with a Y-coordinate manifold, having a plurality of parallel channels extending in the Y direction, to form a XY plane manifold. A preselected arrangement of ports, communicating with certain channels, is provided in each manifold, to thereby provide, when the manifolds are so mated, a matrix of paired, aligned ports which are located at the crossing points of certain channels in the X and Y coordinate manifolds. Also, a vertical or Z-channel is made available at the crossing points of certain channels in the X and Y coordinate manifolds. Two or more XY plane manifolds are stacked on top of one another to form a three-coordinate manifold. Gaskets used between the mated coordinate manifolds, and also between the stacked plane manifolds, act as programming devices and also serve as ball retainers for shuttle balls functioning as check valves.

11 Claims, 21 Drawing Figures

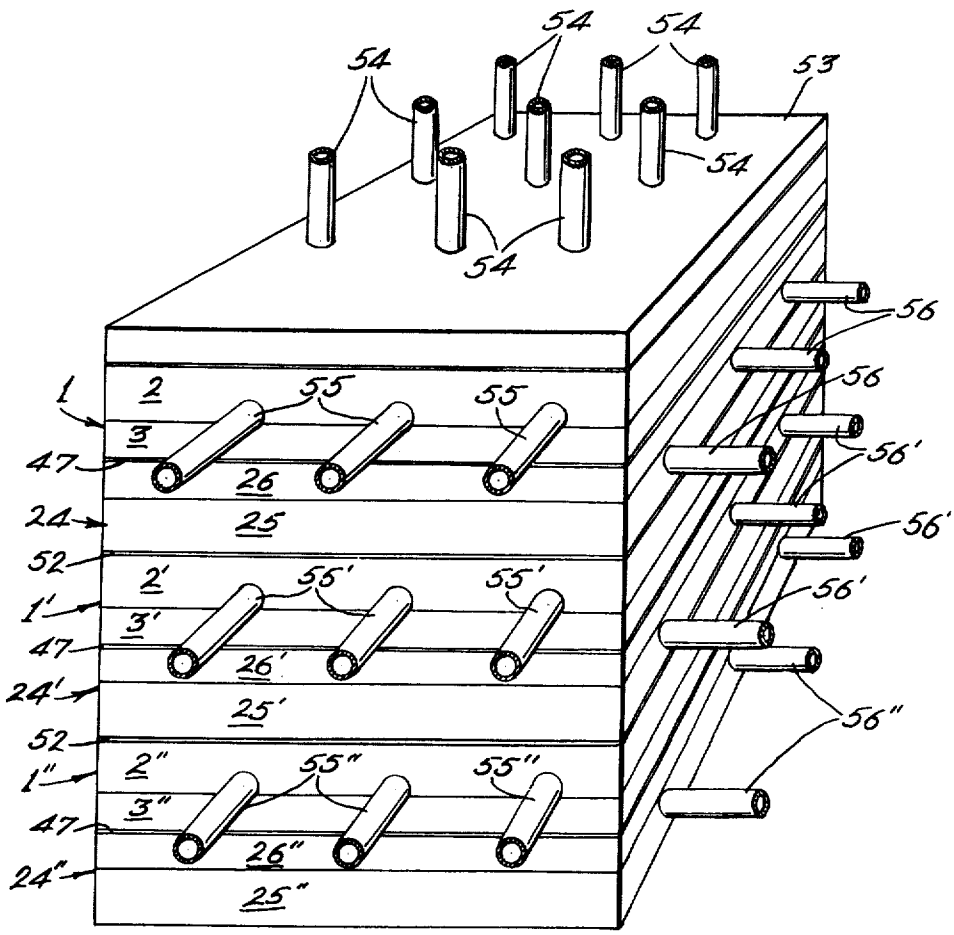


FIG. 1.

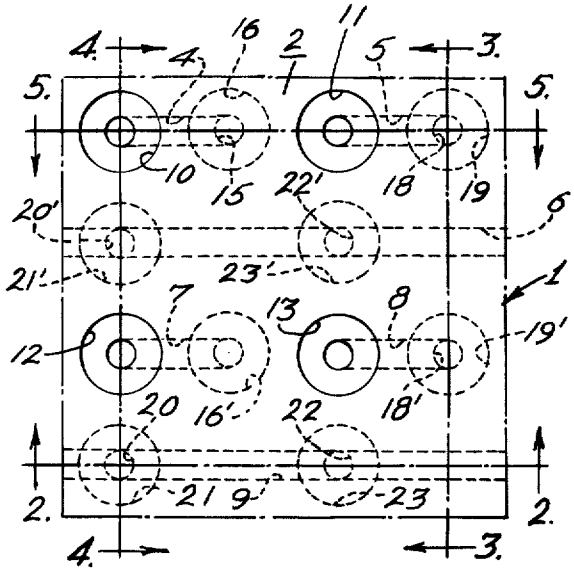


FIG. 2.

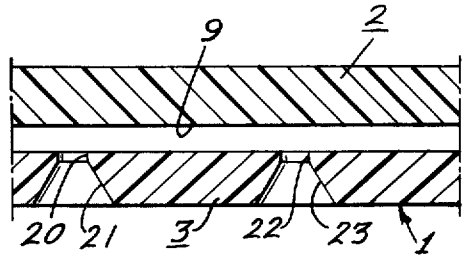


FIG. 5.

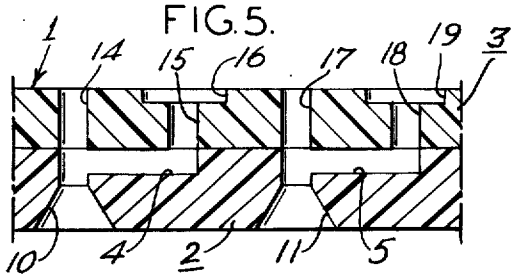


FIG. 3.

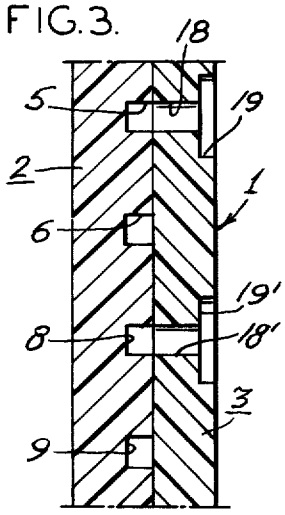


FIG. 4.

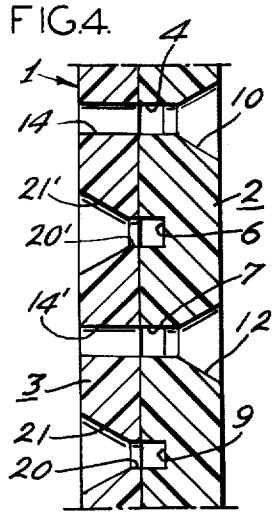


FIG. 6.

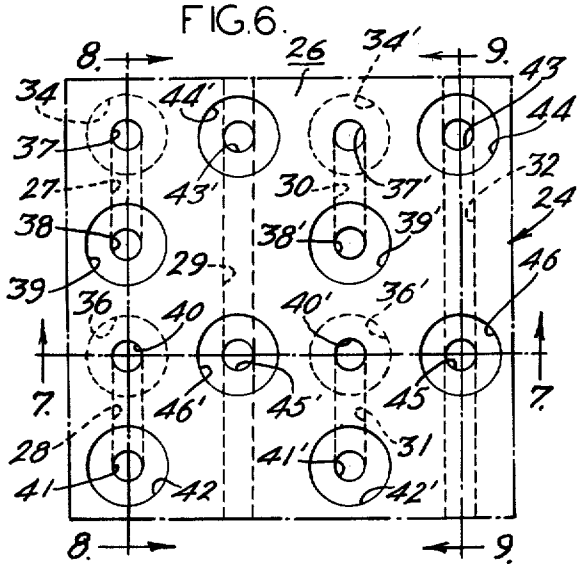


FIG. 7.

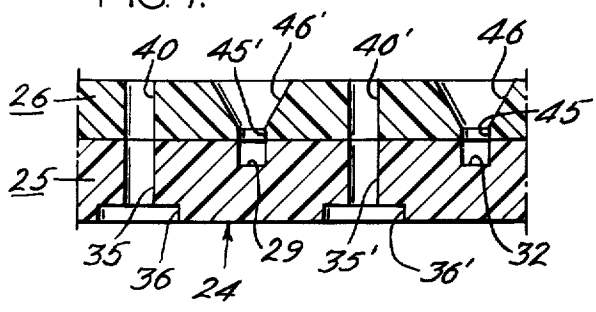


FIG. 8.

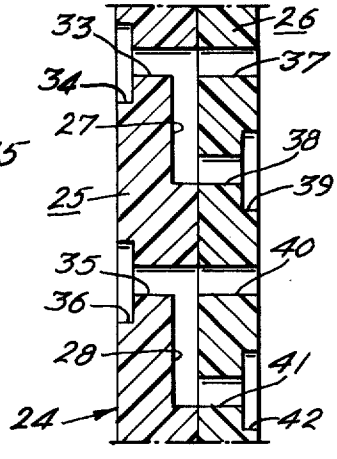


FIG. 9.

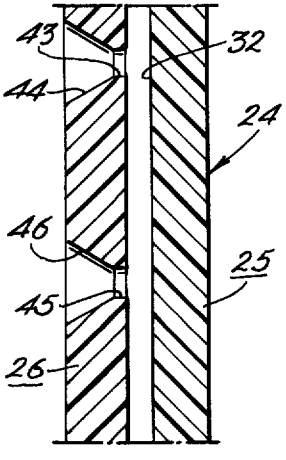


FIG. 10.

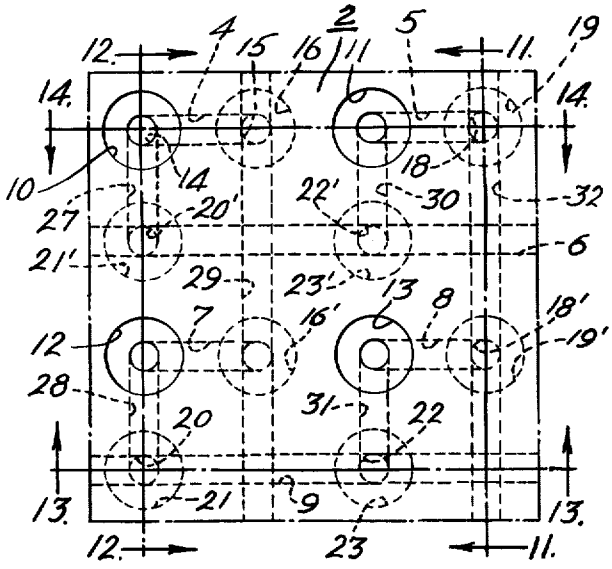


FIG. 11.

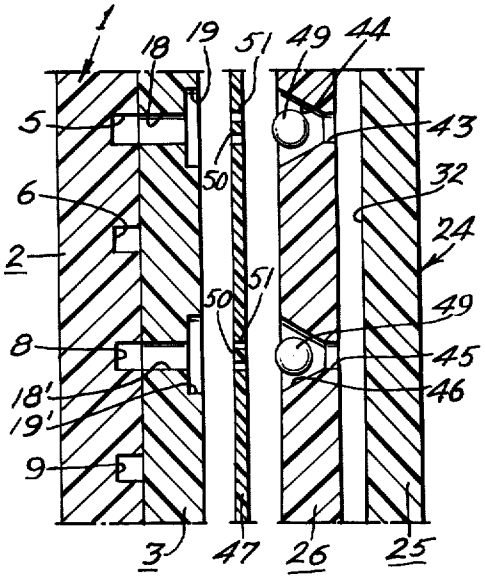


FIG. 12.

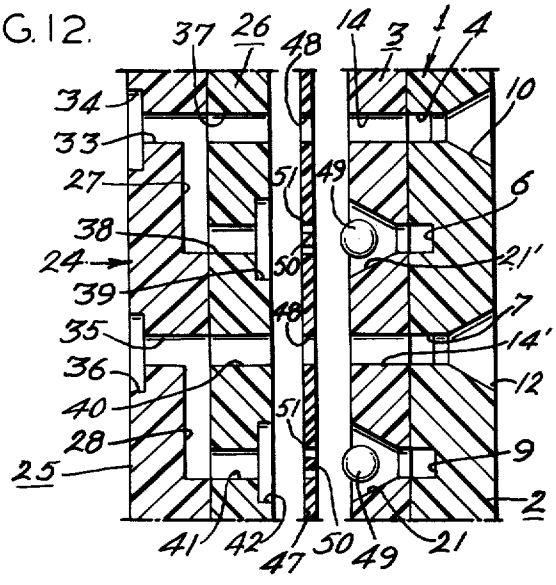


FIG. 13.

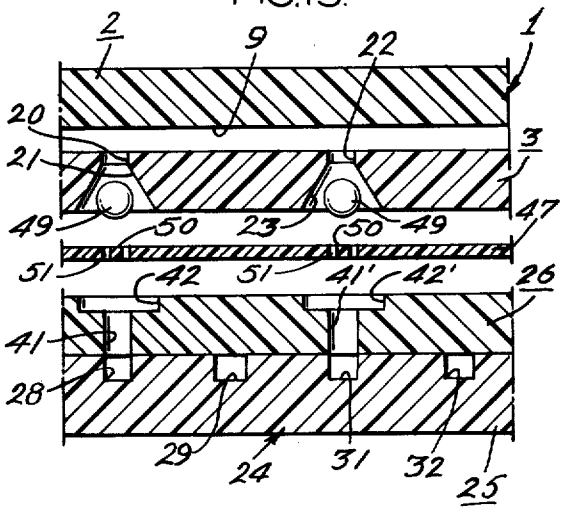


FIG. 14.

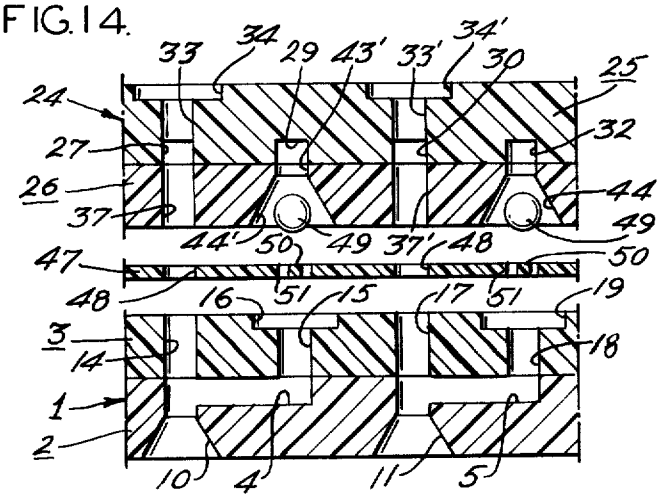


FIG. 15.

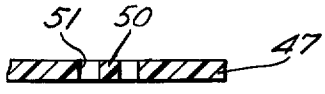


FIG. 16.

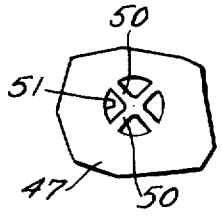


FIG. 17.

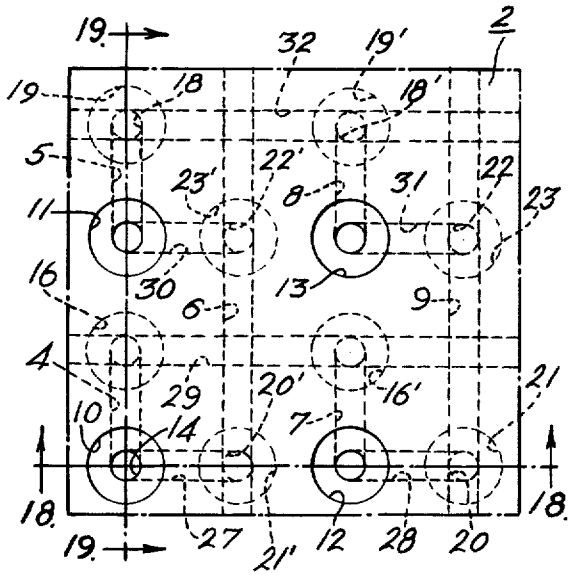


FIG. 18.

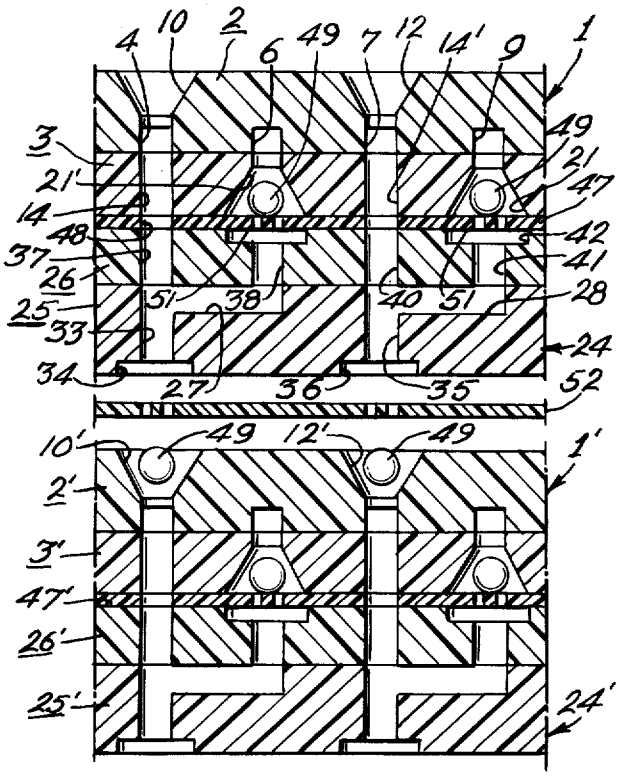


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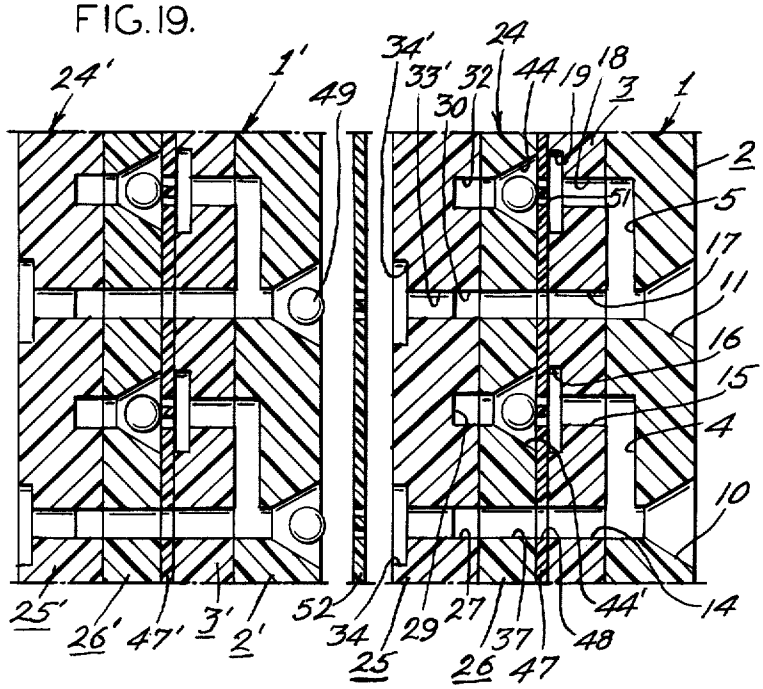


FIG. 20.

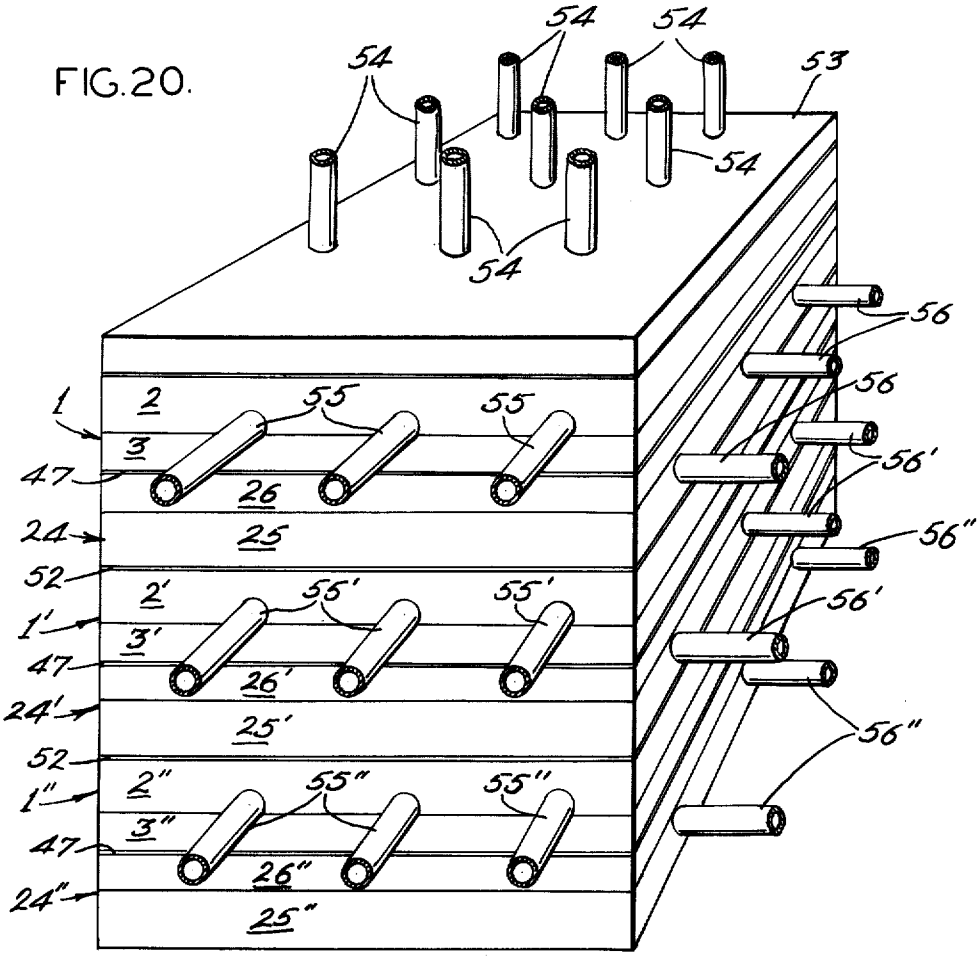
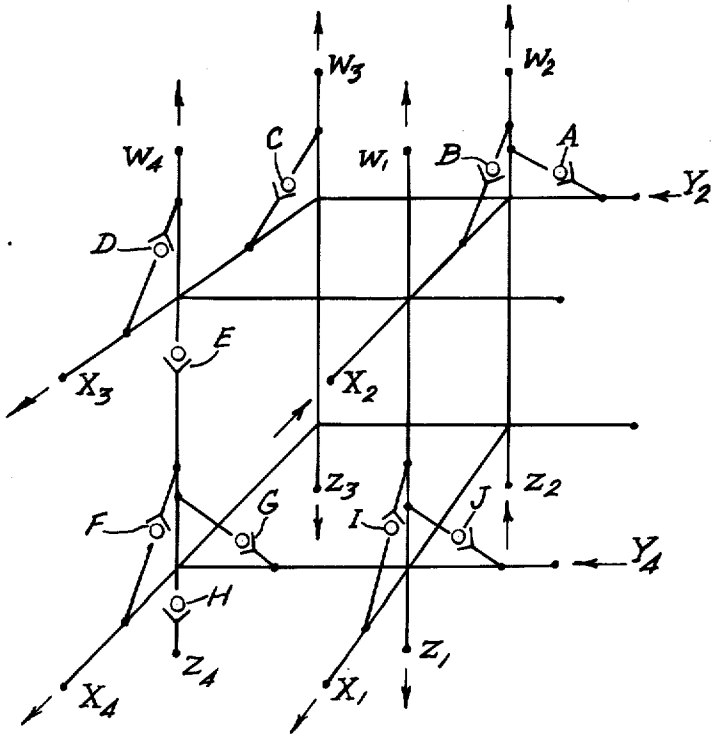

54
54
54
53
54
54
56
56
56'
56"
56'
56"
1
2
3
47
26
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55
55
24
52
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3'
26'
25'
55'
55'
1'
47
24'
52
2"
3"
26"
25"
55"
55"
1"
47
24"

FIG. 21.


W3
W2
W4
C
W1
B
A
Y2
D
E
X3
X2
Z3
Z2
F
G
I
J
Y4
H
Z4
Z1
X4
X1

THREE-COORDINATE FLUID MANIFOLD

This invention relates to a device useful in fluidic (fluid logic) circuits, for performing such functions as decoding and sequencing of events. More particularly, it relates to a fluid manifolding arrangement for providing a large number of interconnections between fluid input and output signals.

The present invention may be thought of as an improvement over that disclosed in my prior U.S. Pat. No. 3,765,441, issued October 16, 1973. In such prior application, an X-coordinate manifold is mated with a Y-coordinate manifold to form a matrix of paired, aligned ports (e.g., at the crossing points of channels in the respective manifolds); such a matrix is in two coordinates, and may be termed a two-coordinate matrix fluid manifold.

Whereas a matrix or two-coordinate manifold provides MN possible interconnections by means of a program gasket between M input and N output signals (where M and N are positive integers in general greater than one), a three-coordinate manifold can provide MNL possible interconnections, where M and N are, respectively, the number of input and/or output connections on the X and Y axes, and L (also a positive integer) is the number of output connections on the Z axis. Consequently, the three-coordinate manifold, when compared to its two-coordinate counterpart, has increased the interconnection capacity by a factor of L, thereby making it a more versatile logic device in performing such functions as decoding and sequencing of events.

The present application describes a means for implementing a third coordinate to the (prior) two-coordinate matrix fluid manifold, resulting in a three-dimensional manifold.

A detailed description of the invention follows, taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a face view of a typical X-coordinate manifold according to this invention;

FIG. **2** is a sectional view taken on line **2—2** in FIG. **1**;

FIG. **3** is a cross-section taken along line **3—3** in FIG. **1**;

FIG. **4** is a cross-section taken on line **4—4** in FIG. **1**;

FIG. **5** is a sectional view taken on line **5—5** in FIG. **1**;

FIG. **6** is a face view of a typical Y-coordinate manifold according to this invention;

FIG. **7** is a sectional view taken on line **7—7** in FIG. **6**;

FIG. **8** is a cross-section on line **8—8** in FIG. **6**;

FIG. **9** is a cross-section taken along line **9—9** in FIG. **6**;

FIG. **10** is a face view of a typical XY plane manifold according to this invention;

FIG. **11** is a section taken on line **11—11** in FIG. **10**;

FIG. **12** is a cross-section taken along line **12—12** in FIG. **10**;

FIG. **13** is a cross-section on line **13—13** in FIG. **10**;

FIG. **14** is a sectional view taken on line **14—14** in FIG. **10**;

FIG. **15** is a fragmentary sectional view illustrating a detail;

FIG. **16** is a plan view illustrating a detail;

FIG. **17** is a face view illustrating stacked XY plane manifolds;

FIG. **18** is a cross-section taken along line **18—18** in FIG. **17**;

FIG. **19** is a section taken on line **19—19** in FIG. **17**;

FIG. **20** is a perspective view of a three-coordinate manfold; and

FIG. **21** is a functional schematic representation of a three-coordinate manifold according to the invention.

Refer first to FIGS. **1–5**. An X-coordinate manifold, denoted generally by numeral **1**, is illustrated in fragmentary fashion in thse figures. It comprises a block member **2** to which is secured, in face-to-face relation, a plate member **3**, the members **2** and **3**, when assembled together, constituting the manifold **1**. For ease of illustration, in the fragmentary illustration of FIGS. **1–5**, the block **2** and the plate **3** are of square configuration, seen in face view as in FIG. **1**. The portion of block member **2** shown has formed in one of its surfaces (to wit, the surface thereof which abuts the plate **3** when the manifold **1** is assembled) a plurality of grooves or channels which are disposed generally in uniformly-spaced parallel rows extending horizontally in FIG. **1** (which may be considered to be the X-direction). By way of illustration, the two channels **4** and **5** are located in the uppermost (in FIG. **1**) row, and each of these channels has a length equal to the spacing between adjacent rows; the single channel or groove **6** is located in the second row, and is continuous throughout the illustrated fragmentary portion of block **2**; the two grooves **7** and **8** are located in the third row, and each of these grooves has a length equal to the spacing between adjacent rows; the single channel or groove **9** is located in the bottom or fourth row, and is continuous throughout the illustrated fragmentary portion of block **2**.

At one end, channel **4** is extended outwardly to the opposite surface of block **2**, and is provided at such opposite surface with a conical valve seat **10** for a shuttle ball (to be later referred to) operating as a check valve. Similarly, at one end, channel **5** is extended outwardly to the opposite surface of block **2**, and is provided at such opposite surface with a conical valve seat **11**. Channel **7** has a similar extension and conical valve seat **12**, which latter is in line (vertically in FIG. **1**) with the seat **10**. Channel **8** has a similar extension and conical valve seat **13**, which latter is in line (vertically in FIG. **1**) with the seat **11**.

Plate member **3** has extending therethrough a bore **14** which is concentric with seat **10**, and which communicates with this seat and with channel **4**. At the opposite end of channel **4**, plate **3** has therein a bore **15** which communicates with this channel and which extends outwardly to the outer surface of the plate, and a counterbore **16** of increased diameter is provided at the outer surface of plate **3**. A bore **17** extends through plate **3**, concentric with seat **11**, this bore communicating with seat **11** and with channel **5**. At the opposite end of channel **5**, plate **3** has therein a bore **18** which communicates with this channel and which extends outwardly to the outer surface of the plate, with a counterbore **19** at such outer surface.

For channels **7** and **8**, in association with valve seats **12** and **13**, the plate member **3** preferably has a construction which exactly duplicates that at **14—'9** (previously described, for channels **4** and **5**, in association with valve seats **10** and **11**). For channels **7** and **8**, ele-

ments similar to those previously described are denoted by the same reference numerals, but carrying prime designations.

Plate 3 has therein, at a location vertically aligned (in FIG. 1) with seats 10 and 12, a bore 20 which communicates at its inner end with groove 9 and at its outer end with a conical valve seat 21 which is provided at theh outer end with a conical valve seat 21 which is provided at the outer surface of plate member 3. Plate 3 also has therein, at a location vertically aligned (in FIG. 1) with seats 11 and 13, a bore 22 which communicates at its inner end with groove 9 and at its outer end with a conical valve seat 23 which is provided at the outer surface of plate 3.

For channel 6, the plate member 3 preferably has a construction which exactly duplicates that at 20–23 (previously described, for channel 9). For channel 6, elements similar to those previously described are denoted by the same reference numerals, but carrying prime designations.

Refer now to FIGS. 6–9. A Y-coordinate manifold, denoted generally by numeral 24, is illustrated in fragmentary fashion in these figures. It comprises a block member 25 to which is secured, in face-to-face relation, a plate member 26, the members 25 and 26, when assembled together, constituting the manifold 24. Again, for ease of illustration, in the fragmentary illustration of FIGS. 6–9, the block 25 and the plate 26 are of square configuration, seen in face view as in FIG. 6. The portion of block member 25 shown has formed in one of its surfaces (to wit, the surface thereof which abuts the plate 26 when the manifold 24 is assembled) a plurality of grooves or channels which are disposed generally in uniformly-spaced parallel columns extending vertically in FIG. 6 (which may be considered to be the Y-direction). By way of illustration, the two channels 27 and 28 are located in the left-hand (in FIG. 6) column, and each of these channels has a length equal to the spacing between adjacent columns; the single channel or groove 29 is located in the second column, and is continuous throughout the illustrated fragmentary portion of block 25; the two grooves 30 and 31 are located in the third column, and each of these grooves has a length equal to the spacing between adjacent columns; the single channel or groove 32 is located in the right-hand column, and is continuous throughout the illustrated fragmentary portion of block 25.

At one end of channel 27, block 25 has therein a bore 33 which communicates with this channel and which extends outwardly to the outer surface of this block, and a counterbore 34 of increased diameter is provided at the outer surface of block 25. At one end of channel 28, block 25 has therein a bore 35 which communicates with this latter channel and which extends outwardly to the outer surface of the block, and a counterbore 36 of increased diameter is formed at the outer surface of block 25.

For channels 30 and 31, The block member 25 preferably has a construction which exactly duplicates that at 33–36 (previously described, for channels 27 and 28). For channels 30 and 31, elements similar to those previously described are denoted by the same reference numerals, but carrying prime designations.

Plate member 26 has extending therethrough a bore 37 which is concentric with bore 33 and of the same diameter, and which communicates with bore 33 and with channel 27. At the opposite end of channel 27, plate 26 has therein a bore 38 which communicates with this channel and which extends outwardly to the outer surface of the plate, and a counterbore 39 of increased diameter is provided at the outer surface of plate 26. A bore 40 extends through plate 26, concentric with bore 35, bore 40 communicating with bore 35 and with channel 28. At the opposite end of channel 28, plate 26 has therein a bore 41 which communicates with this channel and which extends outwardly to the outer surface of the plate, and a counterbore 42 of increased diameter is provided at the outer surface of plate 26.

For channels 30 and 31, the plate member 26 preferably has a construction which exactly duplicates that at 37–42 (previously described, for channels 27 and 28). For channels 30 and 31, elements similar to those previously described are denoted by the same reference numerals, but carrying prime designations.

Plate 26 has therein, at a location horizontally aligned (in FIG. 6) with counterbores 34 and 34', a bore 43 which communicates at its inner end with groove 32 and at its outer end with a conical valve seat 44 which is provided at the outer surface of plate member 26. Plate 26 also has therein, at a location horizontally aligned (in FIG. 6) with counterbores 36 and 36', a bore 45 which communicates at its inner end with groove 32 and at its outer end with a conical valve seat 46 which is provided at the outer surface of plate member 26.

For channel 29, the plate member 26 preferably has a construction which exactly duplicates that at 43–46 (previously described, for channel 32). For channel 29, elements similar to those previously described are denoted by the same reference numerals, but carrying prime designations.

The three-coordinate manifold of this invention is made up of two basic building blocks: the X-coordinate manifold 1 (FIGS. 1–5) and the Y-coordinate manifold 24 (FIGS. 6–9). These two coordinate manifolds are mated together (as will now be described) to form an XY plane manifold which is functionally similar to the matrix manifold described in my copending application above mentioned, except that a vertical or Z-channel is made available at the crossing points of the channels in the X-coordinate and Y-coordinate manifolds.

Refer now to FIGS. 10–16. The manifolds 1 and 24 are positioned in face-to-face relation, with the plate member 3 of manifold 1 facing the plate member 26 of manifold 24. A gasket 47, which functions as a ball retainer and also as a programming means, is sandwiched between the two manifolds, which are brought into tight engagement with the gasket to form a sealed coupling between the two manifolds 1 and 24. In this connection, it is pointed out that the device (XY plane manifold) is illustrated in somewhat exploded form in FIGS. 11–14, merely for convenience of illustration.

The heart of the device of this invention is the node junction, which is the junction where the X, Y, and Z channels meet. In the fragmentary illustration of the XY plane manifold, there are 4 × 4, or sixteen, such node junctions. Through passages, check valves, or no passage (depending on the applications) can be implemented by gasket 47 at the interface of the X and Y coordinate manifolds 1 and 24.

A through passage is illustrated at the left-hand end of FIG. 14, where X-channel 4 and Y-channel 27 meet. Thus, one end of channel 4, bore 14, and aligned open-

ing 48 provided in gasket 47, bore 37, and bore 33 together form a through passage between the valve seat 10 at the outer surface of X-coordinate manifold 1 and the counterbore 34 at the outer surface of Y-coordinate manifold 24. It may be noted that the gasket 47, by means of hole 48, implements the described through passage, which extends in the Z-direction (vertically in FIG. 14).

A check valve coupling or interconnection is illustrated at the next adjacent node junction in FIG. 14, where X-channel 4 and Y-channel 29 meet. At this node junction location, the counterbore 16 of manifold 1 and the conical valve seat 44' of manifold 24 are aligned with each other. Illustrated is a shuttle-type of check valve, in which the gasket 47 serves as a shuttle ball retainer for a light-weight shuttle ball 49 which is adapted to form a seal in, and thus block, its conical valve seat 44'. Refer also to FIGS. 15 and 16. The ball 49 is retained on gasket 47 by means of a pair of integral supporting struts 50 (at 90° to each other) which extend across an aperture 51 (of circular configuration) in gasket 47. The area of aperture 51 not taken up by the struts 50 provides a passage allowing fluid to flow from the manifold 24 to the manifold 1. Fluid can flow in this direction (which is to say, from the Y-channel 29 to the X-channel 4, via bore 43', aperture 51 in gasket 47, and bore 15) because such fluid flow urges ball 49 away from its seat 44'. However, reverse flow (flow in the opposite direction) is disallowed (not permitted, or blocked) by virtue of the natural tendency of the shuttle ball 49 to move toward, and seal against, its conical valve seat 44' when fluid tends to flow in this latter direction.

It will be observed that ball 49 is retained by the upper surface (in FIG. 14) of gasket 47, so that the ball is adjacent its seat 44'. The larger-diameter counterbore 16 enhances or eases the flow of fluid in the "permitted direction" (downwardly in FIG. 14).

At the node junction where X-channel 5 and Y-channel 32 meet (see FIG. 11), a ball 49 cooperates with the valve seat 44. Fluid can flow from the Y-channel 32 to the X-channel 5 (via bore 43, an aperture similar to aperture 51 in gasket 47, and bore 18, but cannot flow in the opposite direction.

A "no passage" is illustrated in FIG. 11, at the node junction where X-channel 6 and Y-channel 32 "meet". At this node junction, there is no hole in gasket 47, and there are no bores in plate member 3 of manifold 1, or in plate member 26 of manifold 24. Thus, the channels 6 and 32 are entirely isolated from each other at this latter node junction.

In FIG. 10, out of a total of sixteen node junctions, there are twelve which are arranged as either "through passages" or "check valves," while the remaining four are arranged as "no passages."

As previously mentioned, FIGS. 10–14 illustrate an XY plane manifold. Two or more XY plane manifolds are stacked on top of one another to form a three-coordinate manifold.

FIGs. 17–19 illustrate an arrangement according to this invention, wherein two XY plane manifolds are stacked together. Referring now to these latter figures, a first X-coordinate manifold 1 and a first Y-coordinate manifold 24 are mated together as disclosed in FIGS. 10–14 to form or constitute a first XY plane manifold, with a ball retainer program gasket 47 between the X-coordinate and Y-coordinate manifolds. The node junctions illustrated in FIGS. 18 and 19 for these two manifolds include both "through passages" and "check valves."

Similarly, a second X-coordinate manifold 1' and a second Y-coordinate manifold 24' are mated together as previously disclosed to form or constitute a second XY plane manifold, with a ball retainer program gasket 47' between the X-coordinate and Y-coordinate manifolds.

The first XY plane manifold 1, 24 and the second XY plane manifold 1', 24' are positioned in stacked relation in proper alignment, such that, for example, the counterbores 34 and 36 of the first plane manifold face the are aligned respectively with the valve seats 10' and 12' of the second plane manifold. A ball retainer program gasket 52 is sandwiched between the two XY plane manifolds, and the two manifolds are brought into tight engagement with the gasket to form a stacked or three-coordinate fluid manifold. The two stacked X–Y plane manifolds are illustrated in somewhat exploded form in FIGS. 18 and 19, for convenience of illustration.

Through passages, check valves, or no passage can be implemented by gasket 52, at the interface of the XY plane manifolds 1, 24 and 1', 24'. As illustrated in FIGS. 18 and 19, check valves are implemented by the gasket 52, at the interface of the two XY plane manifolds. Referring to FIG. 18, a ball 49, cooperating with valve seat 10' (and with the apertured ball retainer gasket 52 and the counterbore 34), serves as a check valve which permits fluid flow only in one direction—namely, upwardly in FIG. 18. Similarly, another ball 49, cooperating with valve seat 12' (and with the apertured ball retainer gasket 52 and the counterbore 36), also serves as a check valve, which permits fluid flow only upwardly in FIG. 18.

It may be noted that the two stacked XY plane manifolds provide, in concert, channels or grooves in the X and Y directions (that is, in the two orthogonally-related directions in FIG. 17), and also in the Z direction (the vertical direction in FIG. 18); thus a three-coordinate fluid manifold is formed.

FIG. 20 illustrates an extension of the three-coordinate fluid manifold of FIGS. 17–19. FIG. 20 is a perspective view of a 3 × 3 × 3 three-coordinate manifold. This is formed by the stacking together of three 3 × 3 XY plane manifolds, with the addition of an overlying cover plate 53 for the connection of the nine pipes or tubes (conduits) 54 for the vertically-extending or Z-channels.

The first or uppermost of the three stacked XY plane manifolds comprises the block member 2 and the plate member 3 of an X-coordinate manifold such as 1, and the plate member 26 and block member 25 of a Y-coordinate manifold such as 24; the three pipes or tubes 55 for the X-channels in this first plane are coupled to block member 2, and the three pipes or tubes 56 for the Y-channels in this plane are coupled to block member 25.

The second of the three stacked XY plane manifolds comprises members 2', 3', 26', and 25', and tubes 55' and 56', all similar to those previously described with the same reference numerals, unprimed.

The third of the three stacked XY plane manifolds comprises member 2'', 3'', 26'', and 25'', and tubes 55'' and 56'', all similar to those previously described with the same reference numerals, umprimed.

A typical application of a three-coordinate manifold of this invention is illustrated in FIG. **21**, which is a schematic representation of a 2 × 2 × 2 three-coordinate manifold (eight node junctions). Each of the check valves A through J is represented in this figure by a symbol which includes a circle (for the shuttle ball such as **49**) and a "V" (for the respective valve seat). Flow can take place through each of these check valves in the direction from the "V" toward the circle, but not in the opposite direction. Arrows at the various parts or couplings represent the direction of fluid flow; an arrow pointed toward the arrangement of interconnected conduits and check valves indicates an input port, whereas an arrow pointed in the opposite direction indicates an output port.

An input signal at the X_2 port will give an output signal at the W_2 port, by way of check valve B. An input signal at the Y_2 port will give an output signal at W_2, by way of check valve A. An input signal at the Z_2 port will give an output signal at W_2, by way of the "through passage" depicted between these two ports.

An input signal at the Y_4 port will provide an output signal at the X_1 port, by way of check valves J and I; the Y_4 input will provide output at X_3, by way of check valves G, E, and D; Y_4 input will provide output at X_4, by way of check valves G and F; Y_4 input will provide output at Z_1, by way of check valve J; Y_4 input will provide output at Z_3, by way of check valves G and F; Y_4 input will provide output at W_1, by way of check valve J and a through passage; Y_4 input will provide output at W_3, by way of check valves G, E, and C; Y_4 input will provide output at W_4, by way of check valves G and E and a through passage.

In the foregoing description, there has been described, by way of example, a shuttle-valve type of check valve, employing shuttle balls **49**. However, other types of check valves may be used. One such is a so-called flapper valve type, wherein the holes in the program gasket have hinged flaps which allow fluid to flow in one direction but not the other. In this construction, there is a (manifold) port on one side of the gasket which is of relatively small diameter and is quite close to the gasket, while on the other side of the gasket there is a (manifold) counterbore very similar to counterbores **16, 19**, etc. In this case, the hinged flap can seal against the small-diameter port, to prevent flow in the direction toward this port, while fluid flow can take place in the opposite direction, toward and through the large-diameter counterbore (whose bottom is relatively distant from the gasket and flap).

The invention claimed is:

1. A fluid manifolding arrangement comprising one assembly of first and second stacked manifolds; said first manifold having therein a plurality of spaced, parallel, elongated channels; said second manifold having therein a plurlaity of spaced, parallel, elongated channels which are orthogonally related to the channels of the first manifold, the channels of the first manifold crossing the channels of the second manifold to provide node junctions at the points where the channels meet; and means forming in said manifolds, at certain preselected node junctions, separate parallel channels which are orthogonally related to the channels of both the first and the second manifolds.

2. Arrangement according to claim **1**, wherein at certain preselected node junctions the channels of the first manifold are isolated from the channels of the second manifold.

3. Arrangement recited in claim **1**, including also unidirectional fluid flow devices coupling the channels of the first manifold to the channels of the second manifold, at certain preselected node junctions.

4. Arrangement recited in claim **1**, including also a program gasket sandwiched between the two manifolds, said gasket having therein, at the locations of the last-mentioned channels, holes which provide for such channels.

5. Arrangement recited in claim **1**, including also a program gasket sandwiched between the two manifolds, said gasket having therein, at the locations of the last-mentioned channels, holes which provide for such channels; and unidirectional fluid flow devices coupling the channels of the first manifold to the channels of the second manifold, at certain preselected node junctions; said gasket being constructed and arranged, at the locations of hte last-mentioned node junctions, to function in said unidirectional fluid flow devices.

6. Arrangement defined in claim **1**, including also another assembly of two stacked manifolds, the two manifolds of said other assembly being similar in construction respectively to said first and second manifolds and forming a similar assembly, said other assembly forming a stack with said one assembly.

7. Arrangement recited in claim **6**, including also a program gasket sandwiched between the two assemblies.

8. Arrangement recited in claim **6**, including also unidirectional fluid flow devices coupling the channels of said one assembly to the channels of said other assembly, at the adjacent ends of certain preselected ones of the last-mentioned channels.

9. Arrangement of claim **8**, including also a program gasket sandwiched between the two assemblies; said gasket being constructed and arranged, at the locations of the unidirectional fluid flow devices, to function in such devices.

10. Arrangement recited in claim **6**, including also a program gasket sandwiched between the two stacked manifolds of said one assembly, a program gasket sandwiched between the two stacked manifolds of said other assembly, and a program gasket sandwiched between the two assemblies.

11. Arrangement recited in claim **6**, including also a program gasket sandwiched between the two assemblies; said gasket having holes therein at the locations of the adjacent ends of certain preselected ones of the last-mentioned channels.

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