# United States Patent

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[32] Priority **Oct. 2, 1968**
[33] **Germany**
[31] **P 18 00 551.1**


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[54] **FLUID-OPERATED LOGIC ELEMENTS**
**8 Claims, 19 Drawing Figs.**


[52] **U.S. Cl.** ..... **137/270,** 137/625.27, 137/608
[51] **Int. Cl.** ..... **F16k 11/10,** F16k 31/12
[50] **Field of Search** ..... 137/270, 269, 270.5, 608; 235/201 ME; 137/112, 625.27



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*Primary Examiner*—M. Cary Nelson
*Assistant Examiner*—Robert J. Miller
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**ABSTRACT:** A fluid logic element which has a base block provided with a plurality of channels and valving means disposed within said block and response to fluid pressure for establishing or interrupting direct communication between channels, a plurality of routing elements each adapted to be secured to one face of said base block in a plurality of angular positions, to connected to selected ones of said channels, thus permitting the conversion of the internal fluid circuit of said logic element to perform any of a plurality of possible fluid logic functions.

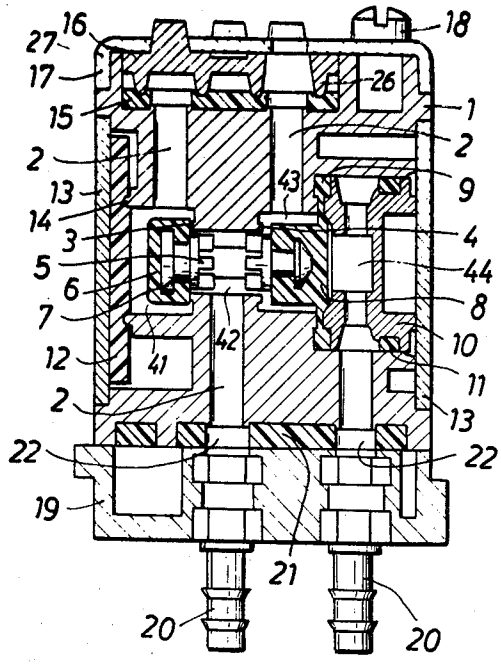



FIG. 1

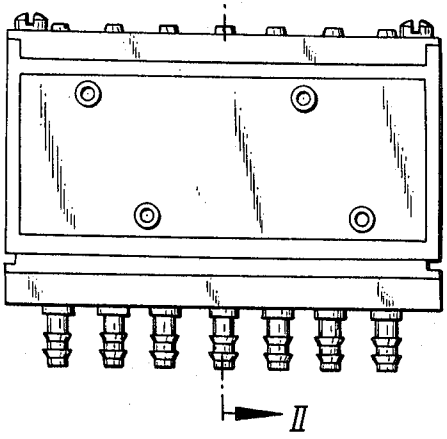



FIG. 2

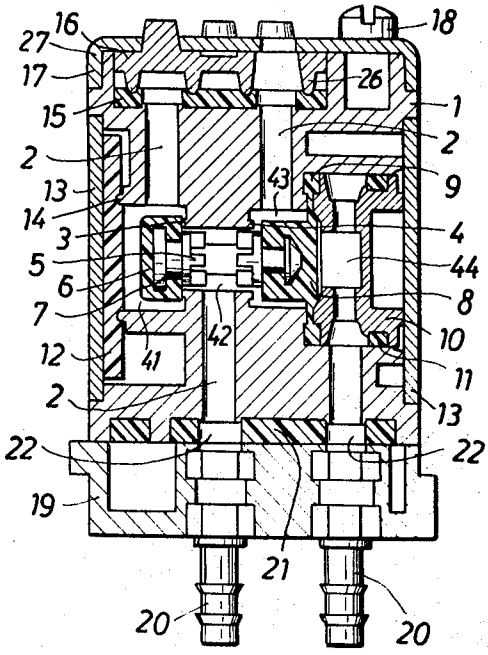



FIG. 3

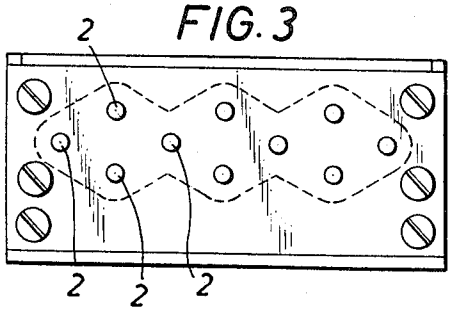



FIG. 4

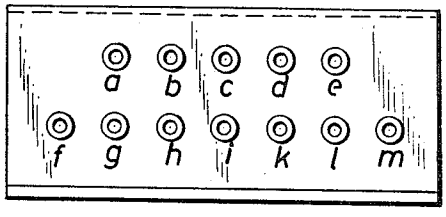



FIG. 5

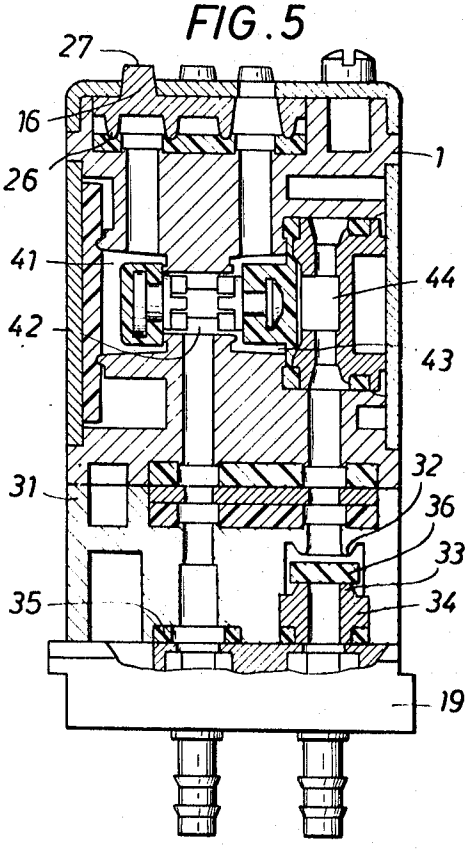



FIG. 6

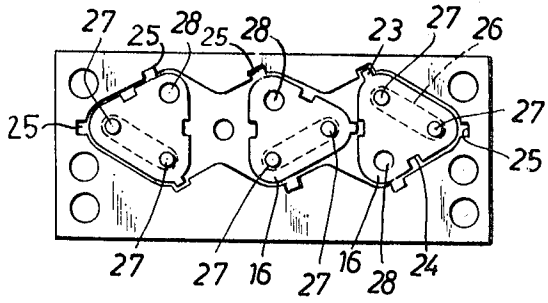


FIG. 7a

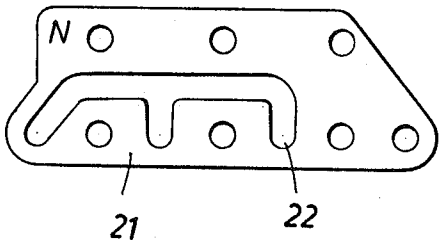



FIG. 7b

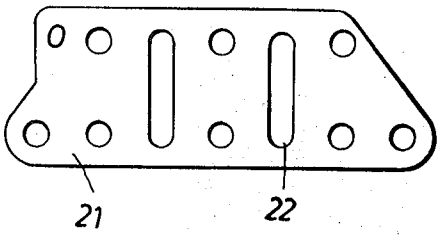



FIG. 7c

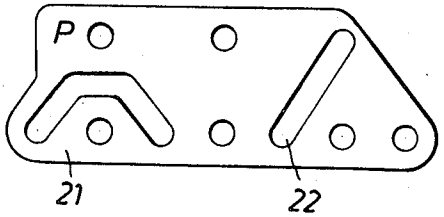



FIG. 8a

IDENTITY

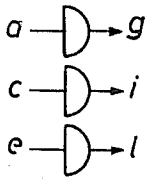



FIG. 8b

NO

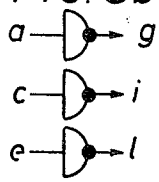



FIG. 8c

AND

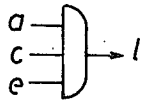



FIG. 8d

INHIBITION

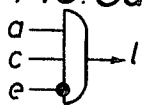



FIG. 8e

NOR

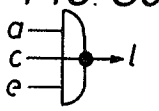



FIG. 9a

STORAGE (WITH ERASING CIRCUIT)

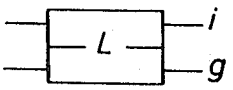



FIG. 9b

STORAGE (WITH STORING CIRCUIT)

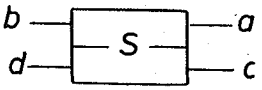



FIG. 9c

OR

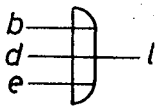



FIG. 9d

IMPLICATION

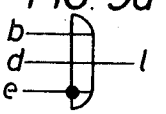
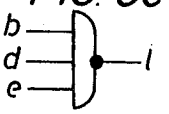



FIG. 9e

NAND



# FLUID-OPERATED LOGIC ELEMENTS

## BACKGROUND OF THE INVENTION

This invention relates to fluid-operated logic elements of the static type adapted to transmit individual or combined switching functions for complex control programs and including three- or four-way valves affected by control pressures. Fluid-operated logic elements and circuits find application in those environments where a high degree of operational safety is required prohibiting the use of electronically operated logic elements.

It is known to build fluid-operated logic elements of the dynamic and static type as closed modules so that the individual elements may function as IDENTITY, NO, AND, INHIBITION, NOR, STORAGE, FLIP-FLOP, OR, IMPLICATION and NAND members. The elements are interconnected in a manner depending upon the particular control program. Static elements are known which operate with pressures up to 10 kg./cm.$^2$ so that setting members, such as pistons or the like, may be operated by direct exposure to pressures appearing at the output of the logic elements.

Elements and modules of the static type known heretofore are, depending upon their required internal fluid circuit, provided with various particular channels and ports in such a specific manner that outwardly the desired fluid logic member is obtained. Since for reasons of circuitry technics, fluid logic members with positive or negative input are required, either logic modules having fixed positive or negative inputs, such as the so-called dual-membrane relays are used or piston plungers are resorted to which, selectively, have positive or negative connections.

It is a disadvantage of the known modules that substantially different steps in the manufacturing process are necessary to obtain the particular internal circuitry required for the aforenoted elements. Such variety is even greater and may be practically unlimited if, for example, in one module four AND members are used, wherein either the input **1**, **2** or **3**, or combinations thereof are to be negative, while the remaining inputs are to be positive. In case of known modules which have selectively positive and negative inputs, the inconvenience is encountered that during the installation or replacement of the members, the connections are liable to be mixed up or that an excessive number of attachment nipples or joints results, rendering the modules unnecessarily complex and costly.

## OBJECT AND SUMMARY OF THE INVENTION

It is an object of the invention to provide an improved unitary basic fluid logic module which, through simple adjustment, may perform the usual IDENTITY, NO, AND, INHIBITION, NOR, STORAGE, FLIP-FLOP, OR, IMPLICATION, NAND or other functions.

Briefly stated, according to the invention, a unitary base block is provided which contains all bores and channels necessary for obtaining any of a great plurality of internal circuits for performing selected ones of the aforenoted functions or their combinations. With the base block there are associated routing elements each of which may be inserted therein in a plurality of predetermined positions for establishing communication between preselected channels to obtain the desired internal circuit of the fluid logic element. In the base block, remote from the routing elements, there is further inserted a replaceable routing gasket which has a particular slot configuration interconnecting selected ones of said channels.

The aforeoutlined structure is advantageous, because it permits a more rationalized manufacturing, it is more compact, it requires shorter connections, it is convertible in function in a simple manner and it is more economical.

The invention will be better understood as well as further objects and advantages will become more apparent from the ensuing detailed specification of a preferred, although exemplary embodiment taken in conjunction with the drawing.



## BRIEF DESCRIPTION OF THE DRAWING

FIG. **1** is a front elevational view of a fully assembled complete fluid logic element forming a preferred embodiment of the invention and consisting of three individual elements;

FIG. **2** is a sectional view of one of the individual elements taken along line II—II of FIG. **1**;

FIG. **3** is a plan view of the same embodiment;

FIG. **4** is a bottom view of the same embodiment;

FIG. **5** is a view similar to FIG. **2**, showing the fluid logic element with an additional insert;

FIG. **6** is a plan view of the fluid logic element with the top closure plate removed;

FIGS. *7a–7c* are plan views of different routing gaskets for different switching functions and

FIGS. *8a–8e* and *9a–9e* show symbols of different circuits that may be obtained by the rearrangement of some components of the fluid logic element.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to FIGS. **1–4**, there is shown a base block **1**, made of plastic or any other suitable material, in which there are provided a plurality of channels **2** which terminate in, and are open at either the top or bottom face of the base block, or are throughgoing, or are open at the sides of the base block. It may be generally stated that the channels **2** are so arranged and their quantity so selected that with appropriate interconnections—as will be described hereinafter—different fluid circuits within the element may be obtained to perform any of the aforelisted functions.

Turning now to FIGS. **2**, the depicted individual element (three of which, for example, may form a complete logic element) has two valve seats **3** and **4**.

A guide element **5** carries a valve plug **6** which, by virtue of its elasticity, is snapped into a groove **7** of the guide element **5**. The central or valving portion of a membrane **8** is similarly secured to the guide element **5**. The O-ring-type thickened, peripheral portion **9** of membrane **8** is clamped against base block **1** by a closure disk **10** which, in turn, carries on O-ring **11**. The valve formed of elements **3**, **5**, **6** shown at the left-hand side of FIG. **2** is sealed by a sealing gasket **12**. Lateral closure plates **13**, which are held in place by means of rivets, screws or the like (not shown), press the closure disk **10** and the sealing gasket **12** against the membrane **8** and a circumferential rim **14** of base block **1**, respectively. A head gasket **15** is disposed on the top face of base block **1** and is provided with as many openings as there are channels **2** that terminate on said top face.

On the head gasket **15**, there are disposed a plurality of routing elements **16** (FIGS. **2**, **5** and **6**), each establishing communication between two selected channels **2** terminating on the upper face of the base block **1**. The routing elements **16** are securely clamped to base block **1** in a preselected position—as it will be described hereinafter—by a closure plate **17** which, in turn, is tightened to the base block **1** by means of bolts **18**. To the bottom face of base block **1** there is tightened a connection plate **19** provided with nipples **20** or other appropriate means for receiving the terminal portions of flexible external conduits.

Depending upon the desired function of the logic element, a routing seal or gasket **21** of a preselected design is disposed between the connection plate **19** and the base block **1** to interconnect two or more channels **2** with one another by means of slots **22** provided therein, or to close off those channels **2** which, for the preselected function, are not in use. Three exemplary routing gaskets having different slot configurations are depicted in FIGS. *7a–7c*.

By loosening the bolts **18**, the closure plate **17** may be either removed or released to such an extent that the routing elements **16** may be rotated 120° or 60° and reinserted into a new connecting position. As shown in FIG. **6**, the routing elements **16** are, in the example illustrated, of triangular outline and are provided with lugs **23** and notches **24** so that they may be inserted only in particular interrelated positions; thus, a direct

transversal connection between chambers **41** and **43** may not be established. Simultaneously, the outlet conduit is vented through bore **28**. The base block **1** of the embodiment shown is provided with a plurality of notches **25**, which, cooperating with lugs **23**, permit each routing element **16** to assume a maximum of four positions. For example, the left-hand routing element **16**, in addition to its position shown, may be reinserted into the same location after being rotated 120° clockwise. Or, it may be shifted to the right and inserted immediately adjacent the middle routing element **16** after a rotation of 60° or 180° counterclockwise. Thus, selected positions may be established while others that do not result in operational or useful circuits, are excluded. The underside of each routing element **16** is provided with ribs **26** integral therewith for providing the necessary seal with the head gasket **15** to ensure that at all times only two channels **2** are interconnected with one another. The position of each routing element **16** is indicated by two lug members **27** integral with the top face thereof and protruding through the closure plate **17**.

Turning now to FIG. **5**, the logic element shown therein includes an additional base block **31** which is securely clamped between the connection plate **19** and the lower face of the base block **1**. In the auxiliary block **31** there are disposed valve seats **32** and **33** which may be directly machined into block **31** or may be inserted thereinto as separate sleeves **34**. Between the lower face of auxiliary base block **31** and connection plate **19** there is inserted a packing **35**. The elastic valve disk **36** or the individual packing elements, according to their actuation by fluid pressure, operate as an OR member.

## OPERATION OF THE PREFERRED EMBODIMENT

The guide element **5**, the valve plug **6** and the membrane **8** form together a three-way valve which, depending on whether the control pressure appears on one or the other side of the membrane, establishes or interrupts communication. The four chambers **41**, **42**, **43** and **44** are interconnected between the valve seats and across the membrane **8** by means of routing gasket **21** and routing elements **16** in such a manner that the desired logic combination is obtained. The routing gasket **21** permits the establishment of an internal connecting chain of the three individual elements.

The basic circuits (some of which are symbolically illustrated in FIGS. **8***a*–**8***e* and **9***a*–**9***e*) that may be obtained by the fluid logic element, may be developed into a plurality of further combinations within the basic module. The letters *a*–*m*, which in the symbolic illustration in FIGS. **8***a*–**8***e* and **9***a*–**9***e* designate the inlets and the outlets, are identical in meaning to the letters shown in FIG. **4** and may give a further external indication of the particular module circuit.

As indicated hereinabove, by loosening or removing the closure plate **17**, the routing members **16** may be released and transposed in such a manner that the effect of the input conduits may be inverted or other circuit combinations may be obtained. Thus, for example, without changing the external conduit connections, an IDENTITY member may be converted into a NO member in a simple manner. The routing packing **21** determines the basic function of the element.

It is within the scope of the invention to use a four-way valve instead of an aforedescribed three-way valve, or, in lieu of a membrane, to use, as a driving element, a longitudinally displaceable valve or control piston which carries a valve head in the form of an elastic packing Further, instead of elastically sealing valves, shuttles provided with a metallic seal may be used.

What is claimed is:

**1**. A fluid logic element of the static type including valve means operable by fluid pressure and means for attaching external fluid conduits, comprising,

A. a base block provided with a plurality of channels adapted to form selected ones of a plurality of possible fluid logic circuits, and

B. at least one routing element adapted to be secured to said base block in any one of a plurality of positions, said routing element, dependent upon its position, establishing communication between at least two selected ones of said channels.

**2**. A fluid logic element as defined in claim **1**, wherein said routing elements are at least two in number and are arranged in juxtaposition on said base block, means associated with said routing elements to permit only a limited number of combinations of said positions.

**3**. A fluid logic element as defined in claim **2**, wherein said means associated with said routing elements include complemental notch and lug means provided on said routing elements.

**4**. A fluid logic element as defined in claim **1**, wherein said routing element includes indicating means to outwardly reveal its position with respect to said base block.

**5**. A fluid logic element as defined in claim **4**, wherein said indicating means is formed of at least one outwardly visible lug.

**6**. A fluid logic element as defined in claim **1**, wherein said routing element includes ribs facing said base block and serving to establish said communication.

**7**. A fluid logic element as defined in claim **1**, wherein said routing element has a polygonal contour permitting attachment to said base block in any one of a plurality of angular positions.

**8**. A fluid logic element as defined in claim **1**, including a routing gasket insertable in said base block and provided with slots of predetermined course and configuration to selectively block or maintain open at least two of said channels.