United States Patent

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[72] Inventor **Gerard C. C. J. Delrue**
Pontarlier, France

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[73] Assignee **Scovill Manufacturing Company**
Waterbury, Conn.

[54] **PNEUMATIC CONVERTIBLE RELAY CAPABLE OF PERFORMING LOGIC FUNCTIONS**
7 Claims, 11 Drawing Figs.

[52] **U.S. Cl.** **137/625.66,** 137/269, 137/112
[51] **Int. Cl.** **F16k 11/02**
[50] **Field of Search** 251/61.2, 61.3, 367; 137/269, 271, 625.6, 625.66, 112

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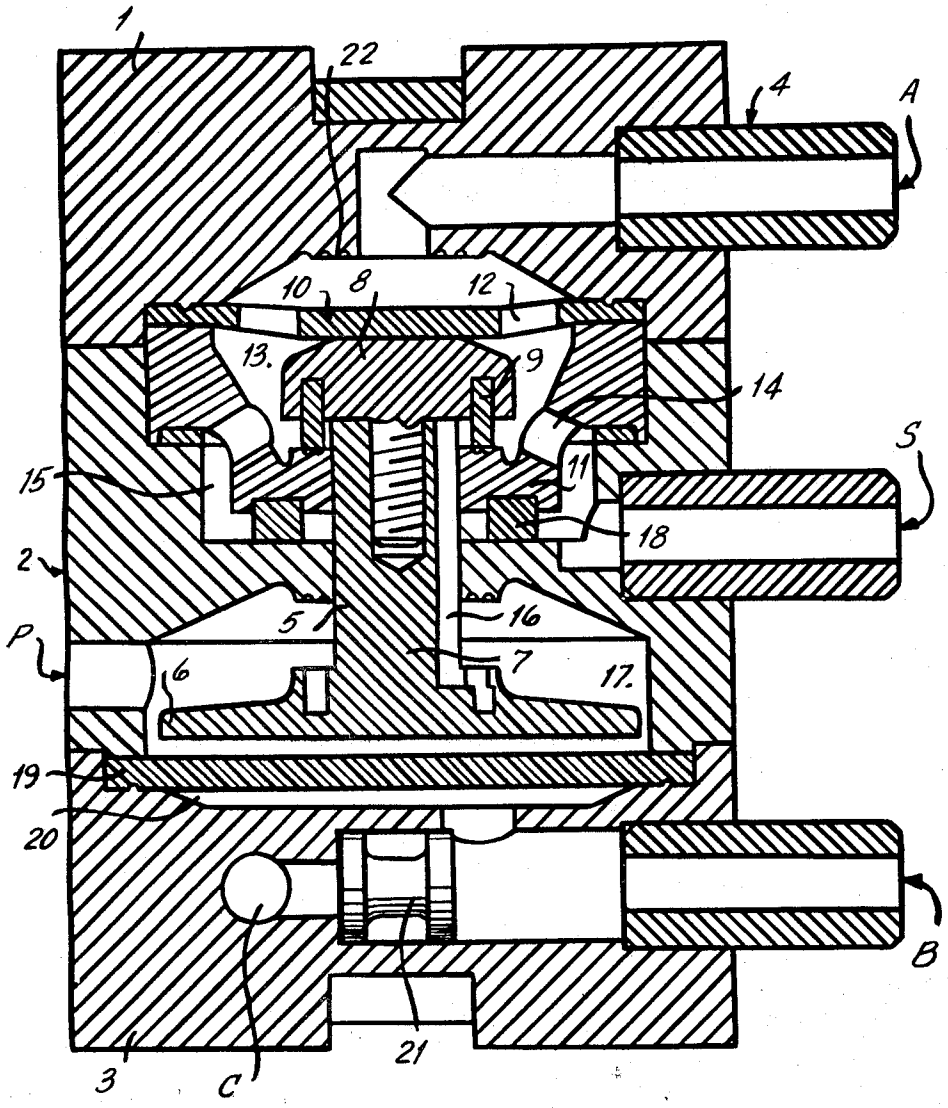
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Primary Examiner—Henry T. Klinksiek
Attorney—Sughrue, Rothwell, Mion, Zinn & Macpeak

ABSTRACT: A pneumatic convertible relay capable of performing logic functions has a relay body that includes a control mechanism for moving a valve member. The valve member includes a slideable stem with a foot on one end and a head on the other end. For a normally open construction the head carries an angular valve head seal and in normally closed construction the foot also carries a seal for controlling flow between a mating seat and a passage along the slidable stem. The valve body is in three sections and includes an inlet, an outlet, an exhaust, and two control openings. The control mechanism includes a diaphragm positioned to act on the foot of the valve member under control of pressure applied to either of the control openings. A slideable shuttle provides alternative operation. The valve is convertible from a normally open construction to a normally closed construction by changing the position of a passage in a valve seat to connect either the inlet to the outlet or the exhaust to the outlet and the position of the annular valve seal, while the other components remain the same.



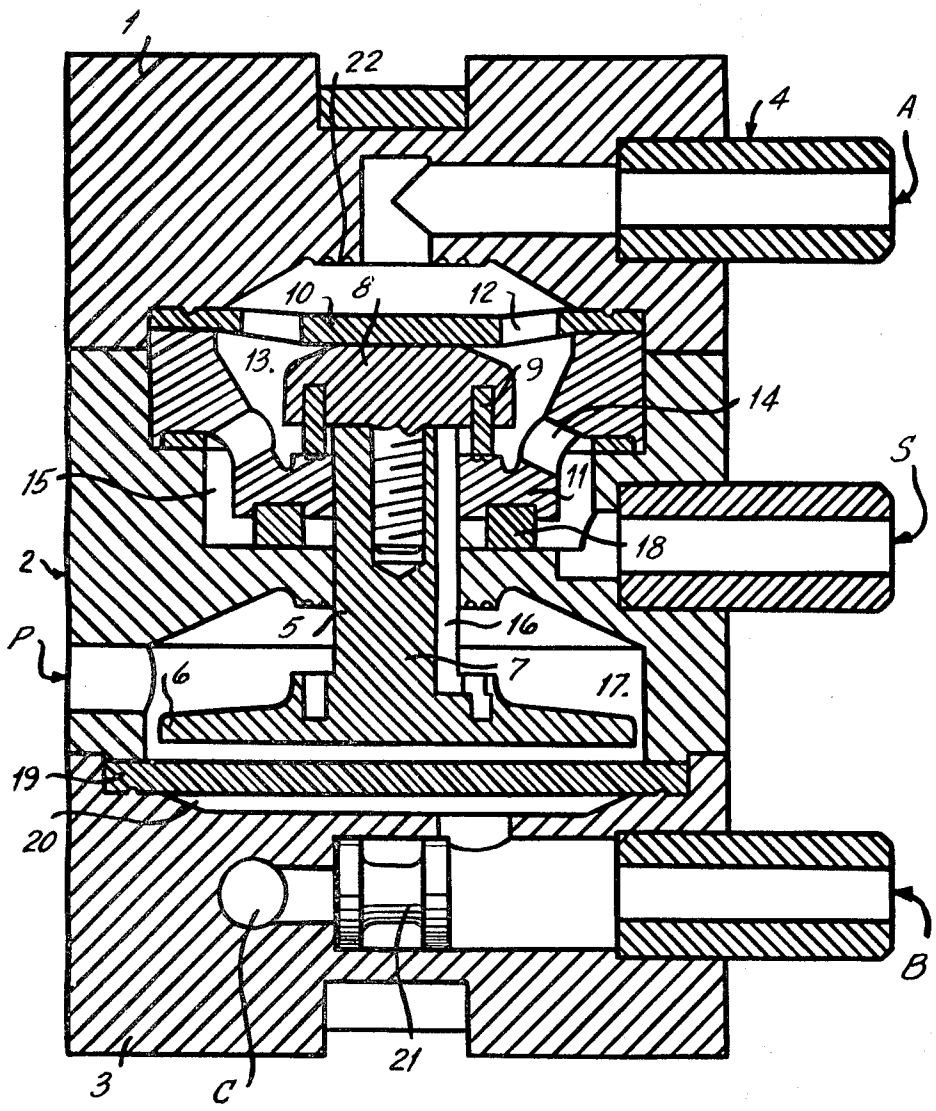


FIG. 1

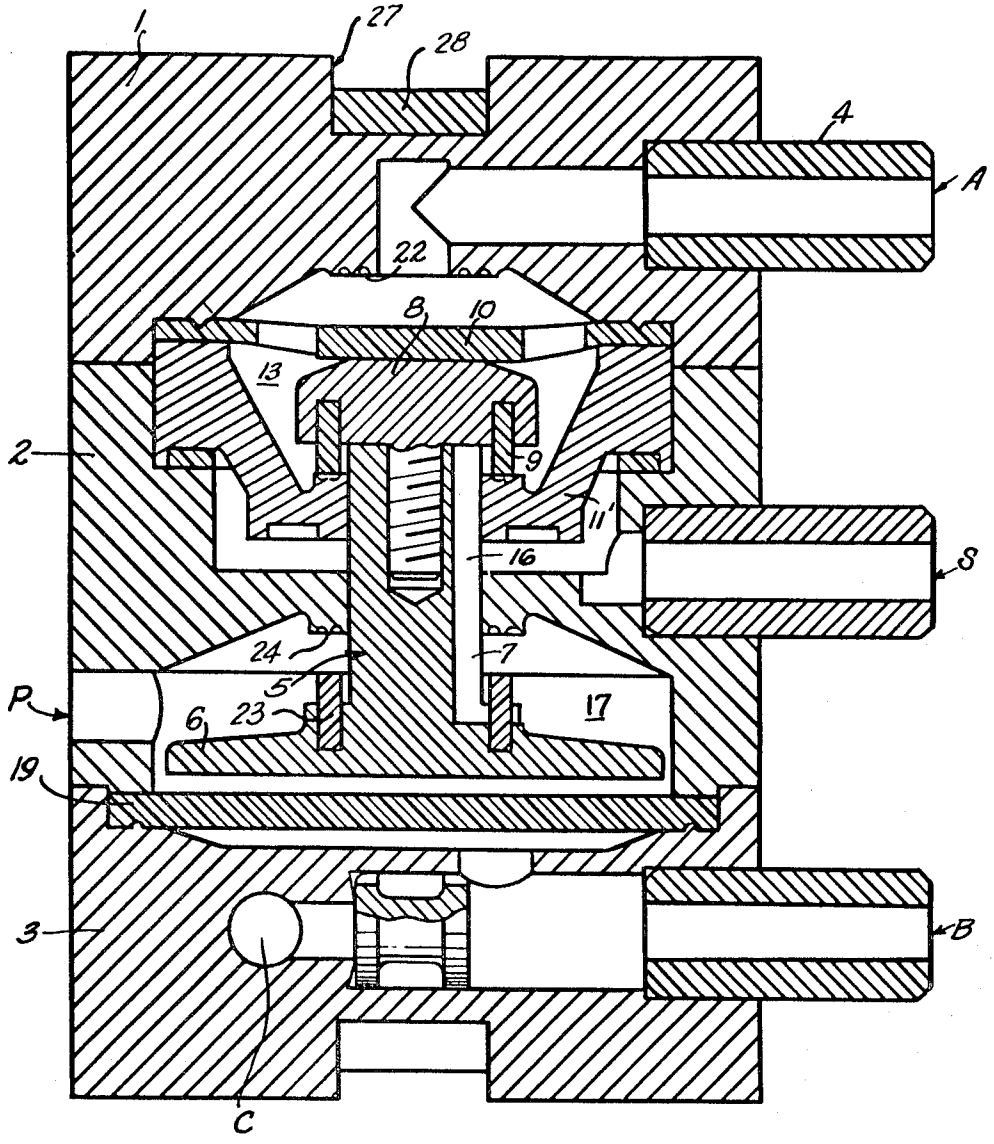


FIG. 2

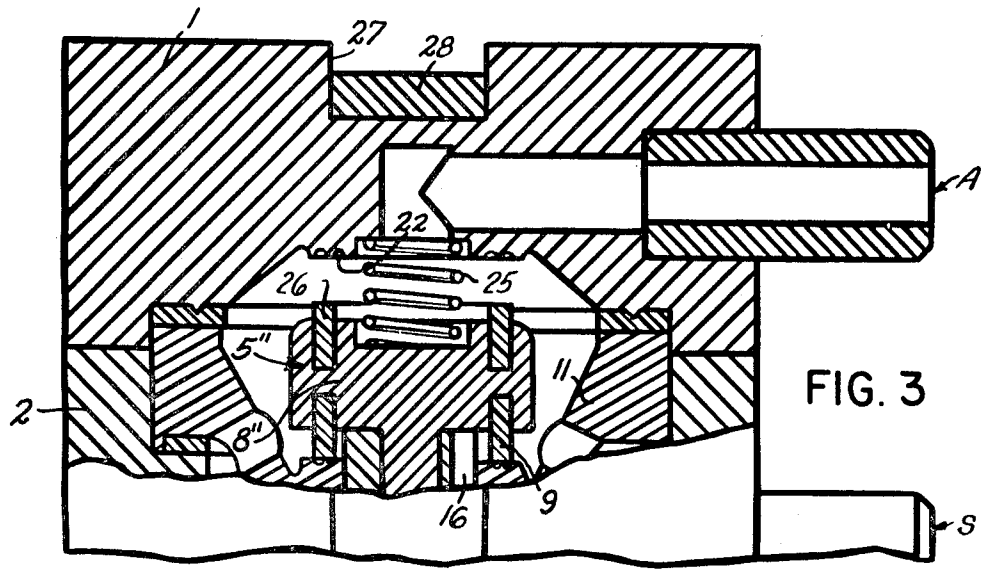


FIG. 3

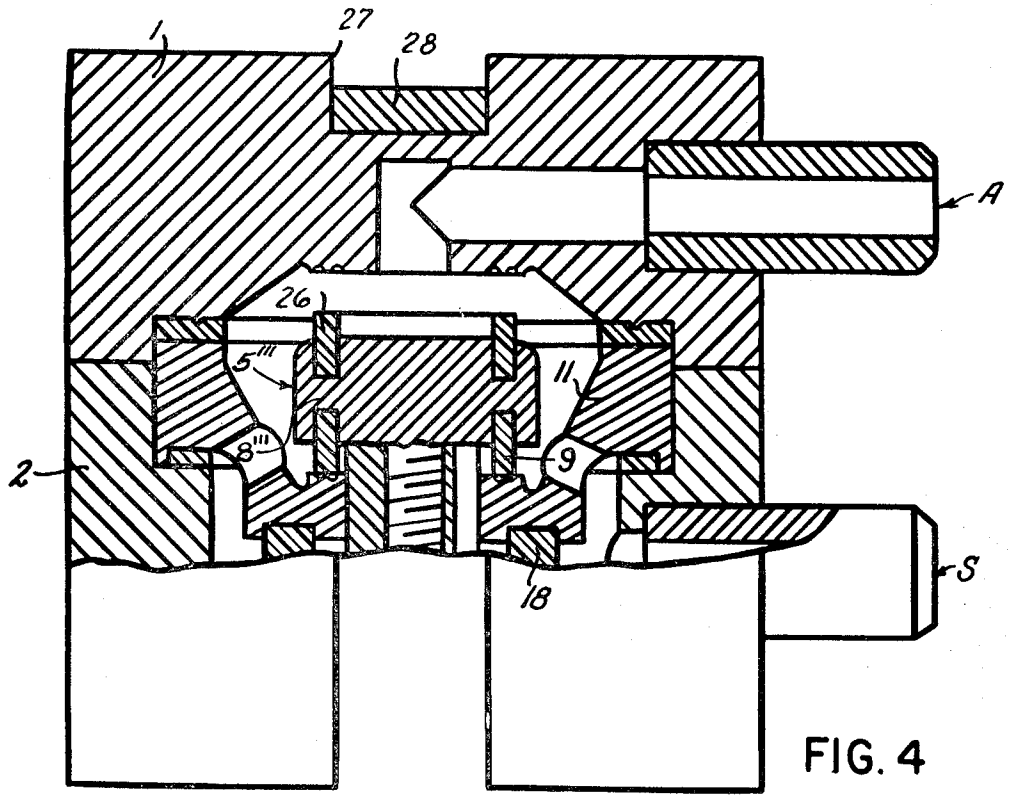


FIG. 4

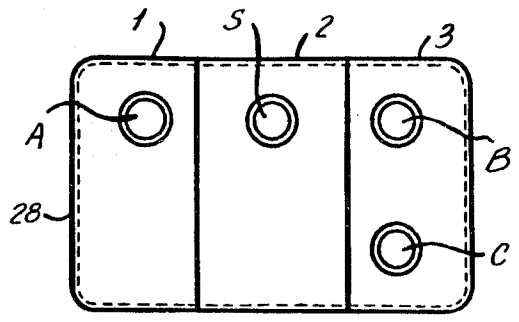


FIG. 5

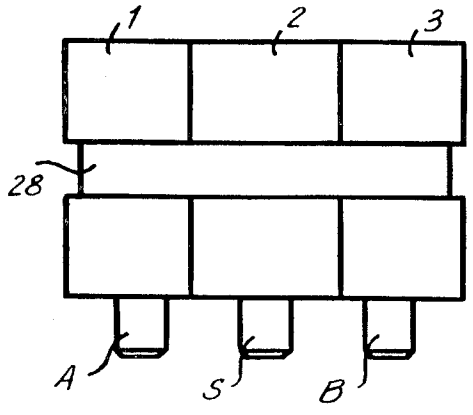
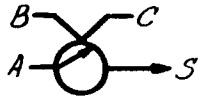


FIG. 6

FIG. 7



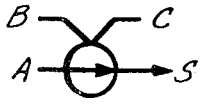


FIG. 8

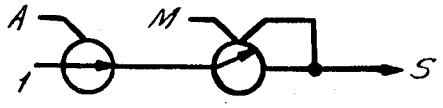


FIG. 9

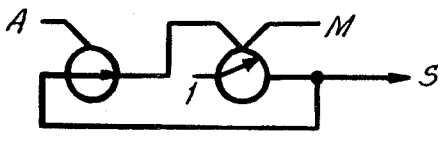


FIG. 10

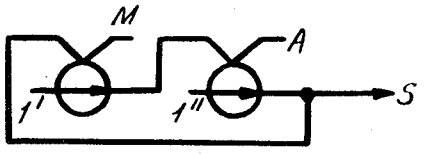


FIG. 11

PNEUMATIC CONVERTIBLE RELAY CAPABLE OF PERFORMING LOGIC FUNCTIONS

This invention relates to improvements in pneumatic relays with logic functions.

There are many types of pneumatic relays known in the art which allow for various combinations or sequences of control. These relays may be generally classified in two categories.

One category of prior art relays are those capable of performing logic functions according to their mode of connection to various control openings. These relays allow the construction of predetermined automatic controls with the help of a reduced number of relays. However, these relays are relatively complicated and complex as well as expensive.

Another type of relay is that capable of performing only one basic logic function. These relays are of relatively simple construction and low cost; however, allow only one logic function to be accomplished, e.g., the inhibit function.

The association of these relays, according to the rules of Boolian algebra allows several complex logical functions to be performed.

In order to simplify the construction of a network to provide a desired logic function and reduce the cost of it, it is preferable to use only two elementary cells or relays. One, normally open (n/o) corresponds to a negation or inhibit function. The other, normally closed (n/c) corresponds to an affirmative function.

Of course, normally open relays as well as normally closed relays are known in the art. However, these known relays have very different functions, and cannot be constructed form identical elements. This invention provides a pneumatic relay capable of being constructed from identical components which may take the form of either normally open or normally closed with minor variations. The relay, in accordance with this invention, allows provision of all the logic functions and the construction of a hazard free memory.

Consequently, this invention relates to a pneumatic relay with logic functions characterized in that, inside the relay's body, it includes a control assembly with at least two access openings. A valve slide member has a foot on one end and a head on the other end provided with a valve seal, and the valve member is guided in the valve body. A passage extends in the valve body along the stem of the slideable valve member, and the valve seal on the valve head controls the communication between an inlet chamber and this passage, which may be in the form of a groove in the stem of the valve member. In a normally closed construction, an outlet port is in communication with the groove passage in the valve stem, and the valve head seal closes this passage from the inlet chamber in normal condition. In the normally open construction, a passage is provided in the valve seat, normally connecting the inlet and outlet chambers, while the groove passage in the stem of the valve member is normally connected only to exhaust, but when the control mechanism changes the position of the valve, the valve head closes the passage between the inlet and outlet chambers, and connects the outlet chamber to exhaust through the groove in the valve stem.

The invention will be further understood by referring to the following description by way of a nonlimiting example and the attached drawings, in which:

FIG. 1 is a sectional elevation view of a relay in accordance with this invention constructed as a normally open relay;

FIG. 2 is a sectional elevation view of a relay in accordance with this invention constructed as a normally closed relay;

FIG. 3 is a partial sectional view of an inlet or admission chamber as a variation;

FIG. 4 is another modification of variation of the admission or inlet chamber;

FIG. 5 is a semibottom plan view of the relay of this invention;

FIG. 6 is a side elevation view of the relay according to this invention;

FIG. 7 is a diagrammatic view of a normally closed relay;

FIG. 8 is a diagrammatic view of a normally open relay;

FIG. 9 is a diagrammatic view of a memory incorporating priority cancelling construction by assembling two relays of this invention;

FIG. 10 is a diagrammatic view of a memory with priority inscription constructed by two relays of this invention; and

FIG. 11 is a diagrammatic view of a memory with priority cancelling constructed of two relays of this invention.

Referring to FIG. 1, a relay in accordance with this invention is constructed as a normally open relay. The relay body includes the three juxtapositioned sections, 1, 2 and 3. Section 1 includes an inlet or admission port A. Section 2 includes an outlet or exit port S and a cleansing or exhaust port P. Section 3 includes two control ports B and C, also see FIGS. 5 and 6.

These various ports A, S, B, and C may be provided with metal ferrules 4 for allowing the relay to be positioned and held in a circuit by simple piping or tubing or other connections. As shown in FIGS. 5 and 6 these ports are all located on the same side of the relay body.

Inside the relay body a valve slide member 5 includes a foot 6, a stem 7 and a head 8. The head 8 includes an annular seal 9 which bears against a seat 11. A membrance 10 acts as a spring to force the valve seal 9 against the seat 11, and is provided with an aperture 12 providing communication between admission port A and admission chamber 13 in which the head 8 moves.

Holes 14 are provided in the seat 11 and these place an admission chamber 13 in communication with exit or outlet chamber 15 and the outlet port S. The valve head seal 9 controls communication between admission chamber 13 and one or several grooves 16 provided along the stem 7. These grooves open into chamber 17 which is connected to the exhaust cleansing port P and in which the foot 6 moves. A ring seal fluid-blocking member 18 blocks communication between the passage provided by groove 16 and the exit chamber 15.

The control mechanism is provided in section 3 of the relay body and includes a membrane 19 which provides a wall of chamber 17 underneath the foot 6 and divides chamber 17 from control chamber 20. The two control access ports B and C are connected into control chamber 20 through a passage which includes a selection plug 21. This circuit selector performs an OR function. That is, with pressure at control port B, the selector shuttle 21 is in the position shown and pressure will be applied to the chamber 20. Similarly with pressure control port C this shuttle will be switched and the pressure will be in control chamber 20. When the control plug is in either one of its extreme positions, control pressure in both ports B and C will mean that the plug will stay in its present position due to the differential area exposed to the pressure.

In the absence of pressure in chamber 20 due to no pressure being applied at either control port B or C, the valve head is in the position of FIG. 1, valve head seal 9 seated on seat 11 and the admission A normally open is connected to the outlet S. The outlet S and outlet chamber 15 are, however, isolated from the exhaust port P.

However, if a pressure signal is applied to either one of the control inlets B or C (or both of them), the membrane 19 is flexed upwardly and moves against the foot 6 of the valve body 5 upwardly until the head 8 forces the membrane 10 against the seat 22 closing off the admission port A. The outlet S is then in communication with exhaust cleansing port P due to the fact that valve seal member 9 is moved off of its seat 11 and communication is afforded to the passages S, 15, 14, 16, 17 and P.

The logic function of this relay is therefore:

$$S=A\cdot(\overline{B}+\overline{C})$$

The amplification ratio K of the relay under pressure is therefore:

$K=P^1/P^2$ where:

P^1 = the the pressure applied to admission chamber A.

P^2 = the pressure inside chamber 20 capable of lifting the foot 6 and of overcoming the mechanical resistance of membrane 19, membrane 12 as well as the pneumatic force due to pressure P^1 acting on the top surface of the valve head 8.

Referring to FIG. 2, which illustrates the modifications necessary to convert the normally open relay of FIG. 1 to a normally closed relay, the normally closed relay includes all the elements of FIG. 1 with the exception of seal ring 18.

In addition, the seat 11' is not provided with holes such as hole 14 but is solid. With the removal of seal ring 18, the outlet or exit port *S* is in fluid communication constantly with the exhaust or cleansing port *P*; the communication between the port *A* and outlet *S* is blocked by the valve head seal 9.

In addition, another valve seal in the form condition of valve foot seal 23 is carried by the foot 6 to block communication between the passage afforded by grooves 16 and the outlet chamber 17 when the valve member 5 is in its uppermost position. This is accomplished by the valve seal member 23 seating against seat 24 before the head 8 can block the admission or inlet port *A* in its uppermost position. This membrane 10 is never seated against seat 22 due to the length of the seal member 23 and the inlet *A* is always open to admission chamber 13. In the normal condition of the valve, however, further communication is closed, and on switching of the valve communication is open to the exit yet closed to exhaust.

In the absence of pressure in control chamber 20 the valve seal member 9 rests on seat 11' and outlet or exit port *S* is closed from admission port *A* but is in communication with the atmosphere through exhaust hole *P*.

When, however, a pressure level signal *P* is applied to either one of the admission ports *B* or *C* (or both of them), the membrane 19 is deformed under pressure action and contacts the foot 6 to move the valve member 5 upwardly until the valve seal 23 seats. The upward movement, however, is stopped before the admission port *A* is sealed so that the admission port is in fluid communication with the exit *S* and those ports are isolated from the exhaust port *P*.

The logic function of the normally closed relay of FIG. 2 is therefore:

$$S=A\,(B+C)$$

The relay in accordance with the invention is susceptible of a number of variations. We refer for example to FIGS. 3 and 4. Instead of biasing the valve member 5'' to its normal position by a membrane such as 10, it is possible to bias it by a spring 25 as shown in FIG. 3 and utilize a valve seal member 26 to effect the closing of the admission port *A*.

As shown in FIG. 4, it is possible to eliminate spring 25 and utilize the pressure from admission port *A* acting on the head 8''' of valve 5''' to bias the valve member towards its normal position. Membrane 19 could also be removed and foot 6 replaced by a piston having the pressure of chamber 20 acting on an end wall.

Referring to FIGS. 5 and 6, these figures show the relay body formed of three juxtapositioned sections 1, 2, and 3, and held together with a circumferential strap 28 in a groove 27 extending around the assembled sections, see also FIG. 2.

Referring to FIG. 7, the normally closed relay of FIG. 2 is diagrammatically illustrated and as indicated above, possesses the function:

$$S=A\,(B+C)$$

which may in particular accomplish the following functions:

Function *ORI* in which $S=I$ when $A=I$ and when $B=I$, C is always O (I is an unused control access).

Function *OR* with two accesses in which $S=B+C$ if $A=I$.

$S=T$ when B or C or B and $C=I$.

Function *LT* with two accesses. If $B=O$, $S=AC$ and reciprocally if $C=O$, $S=AB$.

Referring to FIG. 8, the normally open relay, illustrated in this figure, has the functions:

$$S=A\,\overline{B}\,\overline{C}.$$

The function NOR may be realized in which $S=\overline{B}$ if $A=I$ and $C=O$ (one control access unused).

Likewise, if $A=I$, the function NOR is obtained in which $S=\overline{B}+\overline{C}$. Inhibition functions may also be realized with one inhibiting access or two inhibition accesses. Of course, all other logic functions may be realized starting from relays in accordance with this invention and combining the normally closed and normally open elements in accordance with the rules of Boolian's algebra.

Referring to FIGS. 9, 10 and 11, for examples of combining normally open and normally closed elements in accordance with this invention. The memories represented in FIGS. 9 and 10 are each constructed with one normally open and one normally closed relay of the type shown in FIGS. 1 and 2. Their functions are respectively:

$$S=\overline{A}\,(M+S) \text{ and,}$$
$$S=M+S\,\overline{A}$$

A regular memory composed of two normally open relays with two control accesses each is illustrated in FIG. 11. This memory has two feeding inlets 1' and 1'', and the resulting function is:

$$S=\overline{A}\,(M+S)$$

The memory of FIG. 11 contains a hazard in its operation. If, for example, access 1'' is fed before access 1', the memory will be entered. If on the contrary, the access 1' is fed before 1'', the memory will be cancelled. In order to remedy this drawback, recourse may be made to the introduction of a time delay in the feeding access of 1'' of the memories.

By contrast, the memories of FIGS. 9 and 10 have only one feed inlet and they are absolutely free of hazards at the time the logic assembly is put under pressure.

Although the invention is described in connection with particular forms and constructions, it is understood that it is in no way limited and that such changes in form or material may be brought about without changing the essence or principle of it.

What is claimed is:

1. A pneumatic relay capable of performing logic functions, comprising a body having an inlet port, an outlet port, an exhaust port, a pair of spaced control ports, an admission chamber in communication with said inlet port, an outlet chamber in communication with said outlet port, an exhaust chamber in communication with said exhaust port, said outlet chamber being disposed between said admission and exhaust chambers, and a control chamber: means for effecting communication between said control chamber and said control ports; a valve member slidably mounted within said body, said valve member comprising a head at one end thereof disposed in said admission chamber for controlling said inlet port, a stem connected to said head and extending from said admission chamber through said outlet chamber and into said exhaust chamber, said stem comprising a longitudinal groove on the outer surface thereof which is adapted to communicate with said admission, outlet and said exhaust chambers, a foot connected to said stem at the other end of said valve member, said foot being disposed in said exhaust chamber and being adapted to be controlled by the pressure in said control chamber to effect movement of said valve member; and sealing means on said valve member adapted to engage adjacent portions of said body to control flow through said stem groove and between said admission, outlet and exhaust chambers when said valve member is moved, said sealing means comprising a first annular seal on said valve head surrounding said stem; said body comprising a first seat for said seal surrounding said valve stem and being disposed between said admission chamber and said outlet chamber, said first seat having a passage therethrough for establishing communication between said admission chamber and said outlet chamber, and a second seal disposed between said first seat and an adjacent body portion for preventing communication between said outlet chamber and said stem groove.

2. The relay of claim 1 wherein spring means is disposed in said admission chamber for engagement with said head to urge it to a position wherein said seal first is in engagement with said first seat to close communication between said admission chamber and said stem groove.

3. The relay of claim 1 wherein said means for effecting communication between said control chamber and said control ports comprising a passage between said control chamber and said control ports, and a shuttle plug movable in said passage in response to pressure in said control ports.

4. The relay of claim 1 wherein said body is constructed in three sections, one section containing said inlet port, a second section containing said outlet port and said valve member, and

a third section containing said control chamber and said means for effecting communication between said control chamber and said control ports.

5. The relay of claim 4 wherein said three sections comprise an encircling groove, and are secured together by a band portion within said groove.

6. The relay of claim 1 wherein said exhaust chamber and said control chamber are separated by a flexible membrane mounted within said body, said membrane being deformed into engagement with said foot to move said valve member in response to pressure in said control chamber.

7. A pneumatic relay capable of performing logic functions, comprising a body having an inlet port, an outlet port, an exhaust port, a pair of spaced control ports, an admission chamber in communication with said inlet port, an outlet chamber in communication with said outlet port, an exhaust chamber in communication with said exhaust port, said outlet chamber being disposed between said admission and exhaust chambers, and a control chamber; means for effecting communication between said control chamber and said control ports; a valve member slidably mounted within said body, said valve member comprising a head at one end thereof disposed in said admission chamber for controlling said inlet port, a stem connected to said head and extending from said admission chamber through said outlet chamber and into said exhaust chamber, said stem comprising a longitudinal groove on the outer surface thereof which is adapted to communicate with said admission, outlet and said exhaust chambers, a foot connected to said stem at the other end of said valve member, said foot being disposed in said exhaust chamber and being adapted to be controlled by the pressure in said control chamber to effect movement of said valve member; and sealing means on said valve member adapted to engage adjacent portions of said body to control flow through said stem groove and between said admission, outlet and exhaust chambers when said valve member is moved, said sealing means comprising a first annular seal on said valve head surrounding said stem; said body comprising a first seat for said seal surrounding said valve stem and being disposed between said admission chamber and said outlet chamber, and a second seat facing said valve foot; said foot having a second annular seal mounted thereon and surrounding said valve stem, said second seal being adapted to engage said second seat when said foot is subjected to pressure in said control chamber and is moved toward said second seat.