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[54] **PNEUMATIC MEMORY RELAY**

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[51] **Int. Cl.**... **F16k 11/02,** F16k 31/385, G06d 1/02

[58] **Field of Search**..... 137/625.66, 625.6, 625.27, 137/608; 235/201 ME, 200; 251/65, 61.2, 331, 367, 28

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[57] **ABSTRACT**

A memory relay has a poppet movable between two positions in a space of the relay housing. The poppet surfaces are arranged to sealingly engage in each position a seat which bounds an input conduit arranged to receive a fluid under pressure.

An output conduit is in communication with both the space and the exterior of the housing. Elements are provided for moving the poppet from one position to the other in response to the application of a set or reset signal to the relay whereby the pressure in one or in the other input conduit is caused to appear at the output conduit. A magnet arrangement is provided for retaining the poppet in at least one position independently of the presence or absence of the pressures in the input conduits.

23 Claims, 4 Drawing Figures

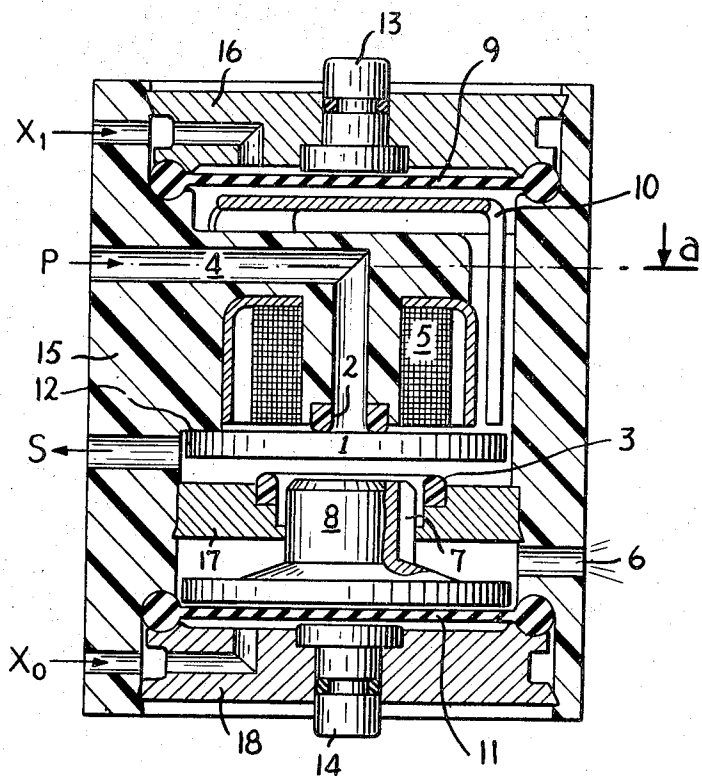


FIG. 1

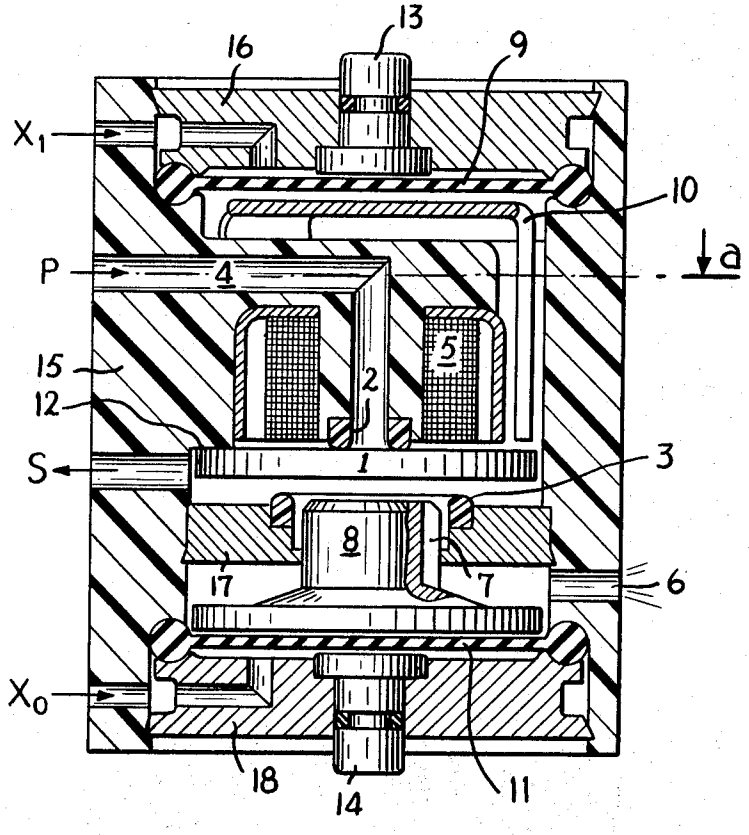


FIG. 2

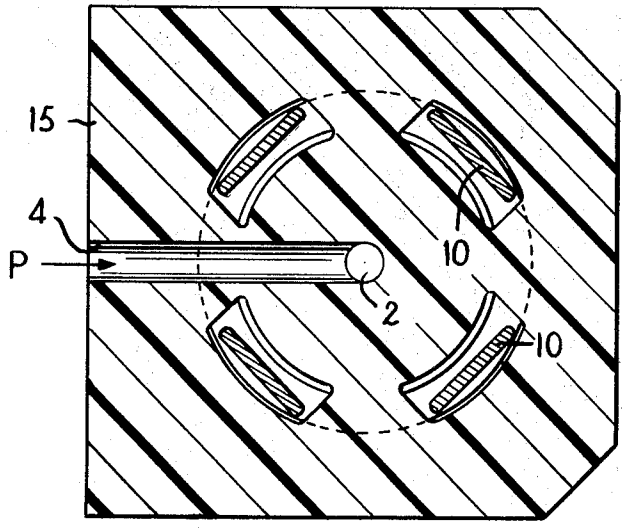


FIG. 3

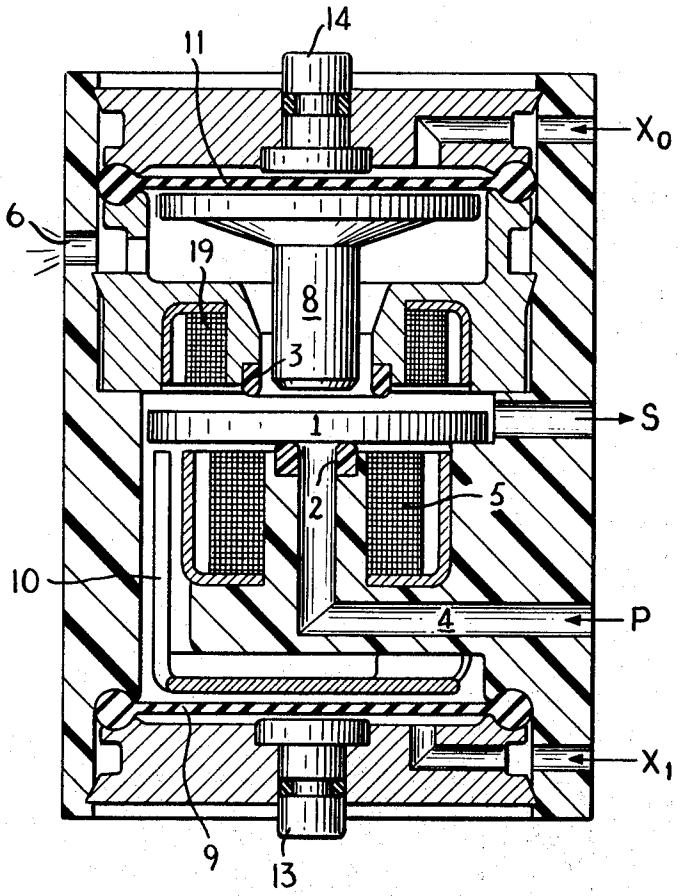
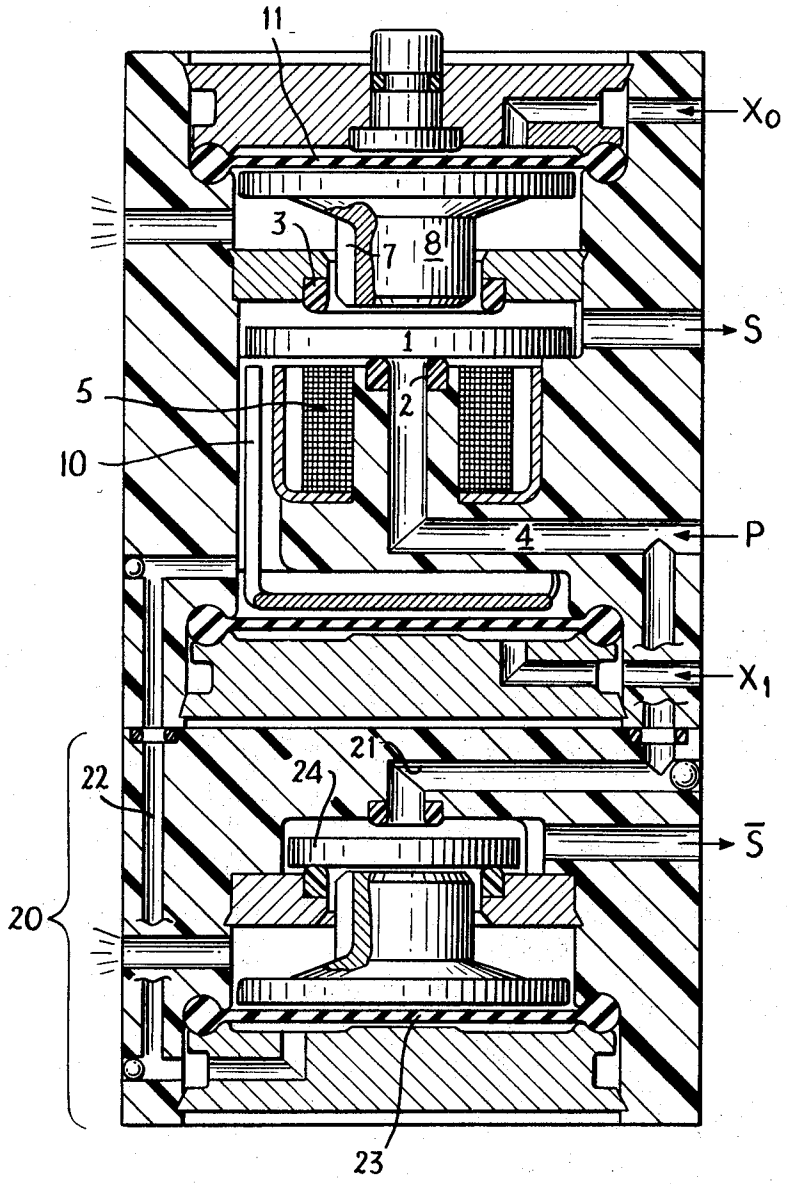


FIG. 4



PNEUMATIC MEMORY RELAY

BACKGROUND OF THE INVENTION

The present invention relates to a pneumatic control device for automatic systems, and more particularly to pneumatic relays which can be controlled by pneumatic pulses and which have a memory or operate as a flip-flop, i.e. they retain the state set by a control pulse even after the pulse has disappeared.

It is often required in industrial applications to utilize a pneumatic relay which operates as a flip-flop, i.e. can be alternatingly set to one of two stable states by pneumatic control pulses. Various types of such relays are already known. Most of the known relays are of the spool valve type, wherein the fluid switching is achieved by the movement of a spool that slides under the action of control pressures which are applied at its ends. After the control pressures have disappeared, the spool can be maintained in the position set by the control pressure pulse, by the inherent friction present in the structure, i.e., the friction between the seals needed to seal the fluids in the relay, by mechanical locking (also called mechanical detent because of its detent effect) obtained by an elastic lock that deforms during the spool movement: or by magnetic force obtained by the action of magnets that are placed at both ends of the spool.

Generally, these spool valve "memories" are provided with two outputs. In the one state or position of the relay, one of the output ports is under pressure and the other output port is at or below atmospheric pressure. In the other spool position or state, the output conditions at the two output ports are inverted. In some cases, these memory relays are constructed with only one output. With the latter type, the two output pressure conditions appear alternatingly at the single output by the application of appropriate control pulses.

Spool valve relays, however, present the disadvantage that they are difficult to construct in mass production. The reason for this is that the operative elements of such relays must be constructed with high precision for proper and reliable operation of the sliding parts and for satisfactory sealing. Additionally, their lifespan is limited and their cost, because of the required precision, is high.

Also known are poppet-type valve relays which allow switching by moving a poppet between two seats. The input pressures, which are to be communicated to the output ducts, are provided at opposite sides of the poppet. The relays of this type have the advantage that they only require very short strokes of the poppet to effect switching, so that very little wear takes place. Additionally, high precision is not required in the construction of such relays. However, poppets are not pressure balanced, i.e., their position is affected by the action of the pressure of the fluid utilized for effecting switching, and thus different locking mechanisms must be employed to retain the poppet in a preset condition. The locking mechanisms frequently require special elaborate designs, which increases the price of the relays. Finally, if two output relays are required, the use of multiple poppets leads to complicated constructions because of the precision which is necessitated in order to permit all the poppets to simultaneously engage their respective seats. Thus, while the input pressures to be switched to the output conduits are not intended to change the state of the relay, once switching has been effected by a control pulse, the construction of the poppet valve relay frequently results in these pressures undesirably changing the state of the relay.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a pneumatic memory relay which does not posses the disadvantages of similar relays known in the prior art.

It is another object of the present invention to provide a pneumatic relay of the type under discussion which is simple in construction and economical to manufacture, and which can be provided with one or two outputs.

It is still another object of the present invention to provide a relay of the above type which is adapted to maintain a desired state, into which it is placed by an appropriate control pulse, subsequent to the removal of the pulse.

It is a further object of the present invention to provide a pneumatic relay as above described which includes magnetic locking means for maintaining the relay in a desired state.

It is a still further object of the present invention to provide a pneumatic relay which can easily be modified from a single output relay to a double output relay in which the two respective outputs are complementary to one another.

According to the present invention, a pneumatic memory relay comprises a housing having a space interiorily therein. First and second input conduits are provided in said housing, said conduits respectively having outer ends accessible exteriorly of said housing and respectively having inner ends each communicating with said space. First and second seat means are respectively provided at said inner ends. An output conduit in said housing communicates with said space and with the exterior of said housing. Poppet means is arranged to move in said space between a first position in which it sealingly engages said first seat means and places said output conduit in communication with said second input conduit, and a second position in which it sealingly engages said second seat means and places said output conduit into communication with said first input conduit. First and second actuating means, including means for receiving set and reset signals, are provided for moving said poppet means to said second and first positions respectively, in response to application of said set and reset signals. Retaining means are provided for retaining said poppet means in at least one of said positions, absent the application of the respective signal.

According to a presently preferred embodiment, said retaining means comprises magnetic means in the form of a permanent magnet. Said poppet means is in this case made from a magnetizable material such as ferrous metal and is in the form of a flat disk, each flat surface of the disk being arranged to sealingly engage a different one of said seat means.

According to a further feature of the present invention, an associated relay means has an auxiliary output conduit and cooperates with said memory relay, being provided with conduit means which communicates with said first and second input conduits as well as with said means for receiving said set and reset signals. Two complementary signals normally appear at said output

conduits alternatively, in response to the application of the set and reset signals. Means are provided in the associated relay means which cooperate with said conduit means for generating at said auxiliary output conduit an output signal which is complementary to that appearing at the first-mentioned output conduit.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is an elevational axial section through a pneumatic memory relay with magnetic locking in accordance with the present invention, showing one output and one retaining magnet;

FIG. 2 is a section taken on line "*a*" of FIG. 1;

FIG. 3 is an elevational axial section through a further embodiment of the invention, showing two retaining magnets; and

FIG. 4 illustrates a still further embodiment of the invention, and including an associated relay connected with the pneumatic memory relay to provide two outputs which are complementary to one another.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The single output relay illustrated in FIG. 1 comprises a poppet 1 which is made of ferrous metal and is in form of a flat disk. The poppet is arranged to move between two positions in a space 1′ provided interiorly of the housing 15. Seats 2 and 3 are provided at opposite sides of the space 1′ and are arranged to be engaged by respective ones of the major surfaces of the poppet 1 when the latter is in one of the two positions. The seats 2 and 3 are preferably made from an elastomeric material, such as rubber, which is capable of providing a good seal when the poppet 1 comes into contact therewith. An inlet conduit 4 provided in the housing 15 has an outer end accessible exteriorly of the housing, and an inner end which is bounded by the seat 2 and communicates with the space 1′. The conduit 4 is arranged to receive a fluid under a predetermined pressure. The pressure which is normally applied and which exists in the conduit 4 is represented by the reference character P. The pressure P is provided by a permanent pressure supply (not shown). In one position of the poppet 1, the upper surface, as viewed in FIG. 1, engages or makes contact with the seat 2 to thereby close or seal the inner end of the conduit 4. Magnet means, in the form of a permanent magnet 5, is provided in the region of the seat 2 and the poppet 1 is made from a magnetizable material which is attracted to the magnet 5. The force of attraction draws the poppet 1 in an upward direction, as viewed in FIG. 1, to insure a good seal between the poppet 1 and the seat 2 so that the pressure P does not appear in the relay beyond the conduit 4.

An output conduit 15′ has an inner end in communication with the space 1′ and an outer end which is externally accessible. The output conduit 15′ is provided to communicate the pressure conditions in the space 1′ to the exterior of the housing -- the thus provided output signal being represented by the reference character S. A further inlet conduit 6 has an outer end communicating with the exterior of the housing 15 and an inner end communicating with the space 1′ through a seat 3 which bounds the inner end of this conduit. With the position of the poppet 1 as shown in FIG. 1, it will be clear that the output conduit 15′ is in communication with the inlet conduit 6 through the seat 3. To improve the fluid communication between the space 1′ and the conduit 6, at least one slot 7 is provided in a piston 8 — the purpose of the piston 8 to be described hereafter.

The conduit 6 is arranged to receive a fluid at a predetermined pressure. In accordance with the presently preferred embodiment of the invention, the conduit 4 is supplied with a fluid at a pressure above atmospheric pressure, while the conduit 6 is placed at atmospheric pressure. To this end, the inlet conduit 6 extends through the housing 15, and the exhaust port 6*a* of the conduit 6 is schematically illustrated as communicating with the atmosphere.

When the poppet 1 is in the upper position so that the conduits 6 and 15′ communicate with each other, the memory relay is said to be in the "0" state, that is that its output S is at a relative pressure of zero. Stated another way, the 0 state of the relay indicates that the pressure S at the output or outer end of the conduit 15′ is at atmospheric pressure.

Actuating means are provided which can move the poppet from the position wherein it engages one seat, to a position where it engages the other seat. The actuating means are adapted to bring the poppet 1 into abutment against the seat 3, and include a conduit 4′ arranged to receive fluid under pressure, particularly to receive pneumatic pulses X_1, which will hereinafter be referred to as "set signals." When a set signal is transmitted to the conduit 4′, the pneumatic control pulse is applied to one side of a diaphragm 9 which is movable in a downward direction. Upon the application of a set signal X_1, the diaphragm deforms downwardly and causes an actuating member 10, in the form of a fork or bifurcated member having a portion extending towards the space 1′, to abut against the poppet 1 and more the same towards the seat 3.

As described above, the magnetizable poppet 1 is attracted by the magnet 5, this attraction being effective to normally retain the poppet 1 in abutment against the seat 2. When a set signal X_1 forces the poppet 1 to move away from the seat 2 and towards seat 3, as described above, the poppet 1 nevertheless remains under the decreased influence or attraction of the permanent magnet 5. Advantageously, the diaphragm 9 is arranged to deform sufficiently so as to cause the bifurcated actuating member 10 to move in a downward direction, as shown in FIG. 1, by a distance sufficient to urge the poppet 1 towards seat 3 until engagement has been effected. Once the lower surface of the poppet 1 has come into contact with the seat 3, the inner end of the conduit 4 is now open and communicates with the space 1′ and, therefore, with the output conduit 15′. The pressure P is thereby transmitted to the output conduit 15′ and the pressure output S is equal to the pressure P. Now, however, the conduit 6 has its inner end, bounded by the seat 3, sealed and the conduit 6 is no longer in communication with the space 1′. It will become evident that the pressure output S at the output conduit 15′ changes from the atmospheric pressure in

conduit 6 to the pressure P in conduit 4. The memory relay is then said to be in the "state 1" or "set" position. When the relay is in the "state 1" position, it is possible to switch the output S back, from the pressure P, to atmospheric pressure by the application of a reset signal X_0 in conduit 6'. A pneumatic pressure applied in the conduit 6', as in the case of a pressure in conduit 4', operates on a diaphragm 11 which is arranged to deflect in the direction of the space 1'. A piston 8 has a portion configurated to pass into and extend through the seat 3, and another portion which is adjacent to the diaphragm 11. Upon deformation or flexing of the diaphragm 11, the piston 8 is urged in an upward direction, as viewed in FIG. 1, the portion extending through the seat 3 abutting against the poppet 1 to urge the same to move towards the seat 2. The lifting of the poppet 1 from seat 3 is facilitated by making the cross section of the diaphragm 11 as well as the cross section of the portion of the piston engaging therewith greater than the effective cross-section of seat 3.

The poppet 1, as a result of the high attractive force of the magnet 5, returns into abutment against the seat 2, at which time the conduit 15' is again placed into communication with the conduit 6 so that the memory relay is again placed into the 0 state.

With the above described arrangement, the poppet 1 remains in the 0 state even after the disappearance of reset signal X_0 and only reverts to the state 1 when a set signal X_1 appears at the conduit 4'. Because of this characteristic, the relay is said to have a memory since it retains its 0 state indefinitely if no external control pulses are applied to it. In order to assure the memory function, it is necessary that the forces which act on the poppet 1 be properly balanced in each state. It will be assumed that

P is the value of the relay supply pressure P,

S_2 is the effective cross-sectional area of the seat 2,

S_3 is the effective cross-sectional area of seat 3,

S_9 is the active area of the diaphragm 9,

S_{11} is the active area of diagram 11,

F_2 is the attraction force developed by the magnet 5 on the poppet 1 when the latter abuts against the seat 2, and

F_3 is the attraction force developed by the magnet 5 on the poppet 1, when the latter abuts against the seat 3. Also, it will be assumed that the control signals X_1 and X_0 represent pressures equal to the pressure P present in conduit 4. The following relationships must then be satisfied for proper operation:

$$P \times S_2 < F_2 < P \times S_9$$

$$F_3 < P \times S_3 < P \times S_{11}$$

The characteristic of a permanent magnet is such that the attraction forces it exerts quickly diminish with distance of the magnetizable elements from the magnet. Therefore, F_3 will be relatively small and F_2, which can easily be regulated by limiting the distance between the poppet and the magnet 5 by means of the poppet stop 12, will be relatively high. Because all of these above variables may be easily modified by changing the seat cross-sectional areas, etc., the inequalities may readily be satisfied and proper operation can reliably be obtained. This versatility similarly exists for a wide range of working pressures P sufficient to meet most applications.

Push buttons 13 and 14 are manual overrides which permit changing the states of the memory relay by simple manual control. Upon depressing of a respective pushbutton, a force is exerted on a respective diaphragm 9 or 11 which has the same effect as the forces exerted by the pressures on said diaphragms caused by the control signals X_1 and X_0 respectively. Thus, pushbutton 13 sets the memory to state 1 and pushbutton 14 resets it to state 0.

According to the presently preferred embodiment, the housing 15 is composed of molded plastic and the holding or mounting parts 16, 17 and 18 are press fitted in the housing. The parts 16–18 are advantageously provided with annular sharp edges that achieve sealing and also firmly maintain the parts in the housing. With such sealing means, no threads are necessary, and the relay assumes a very compact form, which may be built very economically. The present invention is not, however, limited to this construction and other economical methods of construction can also be used in the framework of the invention, as for example, assembling by riveting, snapping-together of elastic parts or ultrasonic welding of plastic parts, etc.

A particular advantage of the relay in accordance with the present invention, as described and illustrated with reference to FIGS. 1 and 2, is the feature of the relay which permits automatic resetting in case of failure or lack of supply pressure P. The attraction force F_3 of magnet 5 on poppet 1 is very low when the latter abuts against the seat 3. However, the force F_3 is generally sufficient to pull the poppet 1 towards the seat 2 when the pressure P equals zero, even if the poppet weight has to be overcome. This automatic reset feature in case of lack or failure of supply pressure P, is useful and, indeed, important in some automatic systems. However, in other systems it is important to use a relay that keeps its state, even when the supply pressure fails. Referring to FIG. 3, a further embodiment of the present invention meets the last-mentioned requirement. A second magnet 19 is provided to hold or maintain the poppet 1 in abutment against the seat 3, even after the supply pressure P is removed.

Referring to FIG. 3, the seat 3 which no longer serves to hold the poppet 1 by pressure differentials applied thereacross, may have its effective cross-sectional area reduced to a minimum so that X_0 reset signals, when applied to diaphragm 11, can overcome both the force generated by the magnet 19 and the force generated by the pressure P applied to the effective cross-sectional area of seat 3.

Two complementary output signals are frequently utilized in automation systems. The memory that has just been described in conjunction with FIGS. 1–3, comprises a single output memory. Thus the single output S at the conduit 15' is either in communication with the greater pressure P of the conduit 4 or with the lower or atmospheric pressure of the conduit 6. These input pressures, as described above, can selectively be applied to the output conduit 15' by the application of suitable set and reset signals to the conduit 4' and the conduit 6' respectively.

As shown in FIG. 4, the just described memory relay may be modified by connecting to the same a "NOT" relay in the form of a switch 20. The switch is in communication with the conduit 4 via a conduit 21. The pressure P taken from the input conduit 4 can be selectively applied to the output S and the output $\bar{S}$ which

is the inverse of the output S. The actual construction of the "NOT" relay is known and does not form part of the present invention. The "NOT"relay **20** is adapted for connection to the memory relay as shown. Conduit means are provided in the housing, including the conduit **21** which is in communication with the conduit **4.** Thus, the pressure P is simultaneously applied to the conduits **4** and **21,** the latter being bounded by a seat **2'** having a smaller effective cross section. Cooperating with a diaphragm **23,** the conduit **22** of the "NOT" relay is in communication with the space **1'.** When a control signal X_1 is supplied to the conduit **4',** the control pulse is applied to the diaphragm **9.** Thus, the two relays are mounted back-to-back and when the poppet **24** is urged against the seat **2',** the poppet **1** is urged against the seat **3,** and vice versa. The second output of the memory relay is designated by reference $\overline{S}$ to indicate that it is the complement of the output S.

In the position illustrated in FIG. **4,** the output S is at the pressure existing in conduit **6** —this typically being atmospheric air pressure. The conduit **22** is in communication with the space **1'** so that the pressure in conduit **6** is also applied to the diaphragm **23.** On the other hand, the pressure P exerts a force on the poppet **24.** The pressure differential on the poppet **24** causes the latter to abut against the seat **3** and thereby the output $\overline{S}$ is essentially at the pressure P — this being the supplement of the output S. In the condition illustrated in FIG. **4,** the basic memory relay is in the state 0 since the output S of the concuit **15'** is at the 0 while the auxiliary output $\overline{S}$ is in the 1 state. Accordingly, when the main relay is set, as described above, the pressure in the space **1'** rises to the pressure P. Since conduit **22** communicates the pressure in the space **1'** to the diaphragm **23,** the latter, via a piston **23',** urges the poppet towards the seat **2'.** In the set position of the main relay, therefore, the relay **20** has its output at $\overline{S}$ at the 0 level.

The above described memory function, very much used in automation, has heretofore remained difficult and costly to obtain in penumatic devices as compared to the memory functions obtained with electrical or electronic devices. The pneumatic memory relays with magnetic locking achieve the object of this invention dependably, and the relays are easy to construct in miniaturized form. A pneumatic relay of this type makes the use of such relays practical in many applications where up to this point they have been impractical.

It will be noted that during the switching from one state to another, the movement of the parts, and in particular the poppets, is reduced to a very small travel and this results in increased lifetime and dependability of the relay. Because no sliding seal is utilized the components can operate perfectly without any lubrication. Finally, the relay does not require precautions for guiding and sealing, and can be mass produced, for example with the use of plastic molded parts, thus leading to a very low unit price.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of pneumatic relays differing from the types described above.

While the invention has been illustrated and described as embodied in pneumatic memory relays with magnetic locking, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can be applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is:

1. A pneumatic memory relay comprising a housing having a space interiorly therein: first and second input conduits in said housing, said conduits respectively having outer ends accessible exteriorly of said housing and respectively having inner ends each communicating with said space; first and second seat means respectively provided at said inner ends; an output conduit in said housing commincating with said space and with the exterior of said housing; poppet means arranged to move in said space between a first position in which said poppet means sealingly engages said first seat means and places said output conduit in communication with said second input conduit, and a second position in which said poppet means sealingly engages said second seat means and places said output conduit into communication with said first input conduit; first and second actuating means including means for receiving set and reset signals for moving said poppet means to said second and first positions, respectively, in response to application of said set and reset signals; and retaining means for retaining said poppet means in at least one of said positions absent the application of the respective signal, wherein said retaining means comprises magnetic means, wherein said poppet means is made from a magnetizable material, wherein said first and second seat means are spaced from each other, and wherein said first input conduit is arranged to receive fluid under a predetermined pressure, and said magnetic means is positioned in the region of said first seat means and retains said poppet means in said first position against the force applied to said poppet means by said predetermined pressure.

2. A pneumatic relay as defined in claim **1,** wherein said first seat means comprises resilient means defining an opening substantially free of obstructions.

3. The relay defined in claim **1;** and further comprising means for establishing in said first input conduit said predetermined pressure.

4. The relay defined in claim **1;** and further comprising means for establishing in said first input conduits said predetermined pressure, and wherein said retaining means comprises means automatically operative after said poppet means has been moved to said first position thereof for maintaining said poppet means in said first position even in the absence of a reset signal and even the absence of said predetermined pressure, and automatically operative after said poppet means has been moved to said second position thereof for maintaining said poppet means in said second position even in the absence of a set signal and even in the absence of said predetermined pressure.

5. A pneumatic relay as defined in claim **1,** further comprising another magnetic means positioned in the region of said second seat means, said magnetic means

being so selected that each magnetic means retains said poppet means in the position associated with the respective magnetic means against the influence of the other magnetic means.

6. A pneumatic memory relay comprising a housing having a space interiorly therein; first and second input conduits in said housing, said conduits respectively having outer ends accessible exteriorly of said housing and respectively having inner ends each communicating with said space; first and second seat means respectively provided at said inner ends; an output conduit in said housing communicating with said space and with the exterior of said housing; poppet means arranged to move in said space between a first position in which said poppet means sealingly engges said first seat means and places said output conduit in communication with said second input conduit, and a second postion in which said poppet means sealingly engages said second second seat means and places said output conduit into communication with said first input conduit; first and second actuating means including means for receiving set and reset signals for moving said poppet means to said second and first positions respectively, in response to application of said set and reset signals; and retaining means for retaining said poppet means in at least one of said positions absent the application of the respective signal, wherein said first and second input conduits are connected to stronger first and weaker second sources of pressure, respectively, and wherein said first and second seats, respectively, bound said inner ends of said first and second input conduits, the inner end of said second input conduit having a cross-sectional area greater than that of the inner end of said first input conduit.

7. A pneumatic relay as defined in claim **6,** wherein said second actuating means comprises movable piston means arranged to at least partially extend through said second seat means on the application of a reset signal to thereby move said poppet means from said second to said first positions.

8. The relay defined in claim **6,** wherein said retaining means comprises means automatically operative after said poppet means has been moved to said first position thereof for maintaining said poppet means in said first position even in the absence of a reset signal and even in the absence of operation of one of both of said sources of pressure, and automatically operative after said poppet means has been moved to said second position thereof for maintaining said poppet means in said second position even in the absence of a set signal and even in the absence of operation of one or both of said sources of pressure.

9. A pneumatic memory relay comprising a housing having a space interiorly therein; first and second input conduits in said housing, said conduits respectively having outer ends accessible exteriorly of said housing and respectively having inner ends each communicating with said space; first and second seat means respectively provided at said inner ends; and output conduit in said housing communicating with said space and with the exterior of said housing; poppet means arranged to move in said space between a first position in which said poppet means sealingly engages said first seat means and places said output conduit in communication with said second input conduit, and a second position in which said poppet means sealingly engages said second seat means and places said output conduit into communication with said first input conduit; first and second actuating means including means for receiving set and reset signals for moving said poppet means to said second and first positions, respectively, in response to application of said set and reset signals; and retaining means for retaining said poppet means in at least one of said positions absent the application of the respective signal, wherein said retaining means comprises magnet means, wherein said poppet means is made from a magnetizable material, wherein said first and second seat means are spaced from each other; and wherein said magnet means is positioned in the region of one of said seat means and is so selected that it retains said poppet means in the position associated with said one seat means when said first and second input conduits are at atmospheric pressure.

10. A pneumatic memory relay comprising a housing having a space interiorly therein; first and second input conduits in said housing, said conduits respectively having outer ends accessible exteriorly of said housing and respectively having inner ends each communicating with said space; first and second seat means respectively provided at said inner ends; an output conduit in said housing communicating with said space and with the exterior of said housing; poppet means arranged to move in said space between a first position in which said poppet means sealingly engages said first seat means and places said output conduit in communication with said second input conduit, and a second position in which said poppet means sealingly engages said second seat means and places said output conduit into communication with said first input conduit; first and second actuating means including means for receiving set and reset signals for moving said poppet means to said second and first positions, respectively, in response to application of said set and reset signals; and retaining means for retaining said poppet means in at least one of said positions absent the application of the respective signal, wherein said first actuating means comprises an actuating member having a first movable portion and at least one second portion extending towards said space and arranged to abut against said poppet means in response to movement of said first portion toward said space; and diaphragm means adjacent to said first portion and arranged to displace said actuating member so as to abut against said poppet means in response to receipt of a set signal, to thereby urge said poppet means to move from said first to said second position.

11. A pneumatic relay as defined in claim **10,** wherein said actuating member is substantially fork-shaped.

12. A pneumatic relay as defined in claim **10,** further comprising manual override button means slidably mounted on said housing and arranged to act on said diaphragm means when said button means is depressed.

13. The relay defined in claim **10,** and further comprising means for establishing in at least one of said input conduits a predetermined pressure different from atmospheric pressure, and wherein said retaining means comprises means automatically operative after said poppet means has been moved to said first position thereof for maintaining said poppet means in said first position even in the absence of a reset signal and even in the absence of said predetermined pressure, and au-

tomatically operative after said poppet means has been moved to said second position thereof for maintaining said poppet means in said second postion even in the absence of a set signal and even in the absence of said predetermined pressure.

14. A pneumatic memory relay comprising a housing having a space interiorly therein; first and second input conduits in said housing, said conduits respectively having outer ends accessible exteriorly of said housing and respectively having inner ends each communicating with said space; first and second seat means respectively provided at said inner ends; an output conduit in said housing communicating with said space with the exterior of said housing; poppet means arranged to move in said space between a first position in which said poppet means sealingly engages said first seat means and places said output conduit in communication with said second input conduit, and a second postion in which said poppet means sealingly engages said second seat means and places said output conduit into communication with said first input conduit; first and second actuating means including means for receiving set and reset signals for moving said poppet means to said second and first positions, respectively, in response to application of said set and reset signals; and retaining means for retaining said poppet means in at least one of said positions absent the application of the respective signal, wherein said second actuating means comprises a movable actuating member having a portion configurated to extend through said second seat means and arranged to abut said poppet means when the latter is in said second position; and diaphragm means adjacent to said actuating member and arranged to displace the latter into abutment with said poppet means in response to receipt of a reset signal, to thereby urge said poppet means to move from said second to said first position.

15. A pneumatic relay as defined in claim **14,** wherein aid retaining means comprises magnetic means positioned in the region of said first seat means, and said poppet means is of magnetizable material, whereby said poppet means is attracted towards said first seat means subsequent to being urged from said second position by said actuating member.

16. A pneumatic relay as defined in claim **14,** further comprising manual override button means slidably mounted on said housing and arranged to act on said diaphragm means when said button means is depressed.

17. The relay defined in claim **14,** and further comprising means for establishing in at least one of said input conduits a predetermined pressure different from atmospheric pressure, and wherein said retaining means comprises means automatically operative after said poppet means has been moved to said first position thereof for maintaining said poppet means in said first position even in the absence of a reset signal and even in the absence of said predetermined pressure, and automatically operative after said poppet means has been moved to said second position thereof for maintaining said poppet means in said second position even in the absence of a set signal and even in the absence of said predetermined pressure.

18. A pneumatic memory relay comprising a housing having a space interiorly therein; first and second input conduits in said housing, said conduits respectively having outer ends accessible exteriorly of said housing and respectively having inner ends each communicating with said space; first and second seat means respectively provided at said inner ends; an output conduit in said housing communicating with said space and with the exterior of said housing; poppet means arranged to move in said space between a first position in which said poppet means sealingly engages said first seat means and places said output conduit in commication with said second input conduit, and a second postion in which said poppet means sealingly engages said second seat means and places said output conduit into communication with said first input conduit; first and second actuating means including means for receiving set and reset signals for moving said poppet means to said second and first positions, respectively, in response to application of said set and reset signals; and retaining means for retaining said poppet means in at least one of said positions absent the application of the respective signal, wherein one of two complementary output signals appears at the output conduit; and further comprising associated relay means cooperating with said memory relay and including conduit means commicating with said first and second input conduits and said means for receiving said set and reset signals, said conduit means including an other output conduit; and means cooperating with said conduit means for generating at said other output conduit an output signal which is complementary to that appearing at the first mentioned output conduit.

19. The relay defined in claim **18,** and further comprising means for establishing in at least one of said input conduits a predetermined pressure different from atmospheric pressure, and wherein said retaining means comprises means automatically operative after said poppet means has been moved to said first position thereof for maintaining said poppet means in said first position even in the absence of a reset signal and even in the absence of said predetermined pressure, and automatically operative after said poppet means has been moved to said second position thereof for maintaining said poppet means in said second position even in the absence of a set signal and even in the absence of said predetermined pressure.

20. A pneumatic memory relay comprising a housing having a space interiorly therein; first and second input conduits in said housing, said conduits respectively having outer ends accessible exteriorly of said housing and respectively having inner ends each communicating with said space; first and second seat means respectively provided at said inner ends; an output conduit in said housing communicating with said space and with the exterior of said housing; poppet means arranged to move in said space between a first position in which said poppet means sealingly engages said first seat means and places said output conduit in communication with said second input conduit, and a second position in which said poppet means sealingly engages said second seat means and places said output conduit into communication with said first input conduit; first and second actuating means including means for receiving set and reset signals for moving said poppet means to said second and first positions, respectively, in response to application of said set and reset signals; means for establishing in at least a predetermined one of said input conduits a predetermined pressure which when said poppet means is in the position thereof sealingly engaging the seat means associated with said predeter-

mined one of said input conduits exerts a pushing force upon said poppet means in a direction tending to move said poppet means to the other position thereof; and retaining means for retaining said poppet means in at least said predetermined position absent the application of the respective one of said set and reset signals.

21. The relay defined in claim **20,** wherein said retaining means comprises means automatically operative after said poppet means has been moved to said first position thereof for holding said poppet means in said first position even in the absence of a reset signal and even in the absence of said predetermined pressure, and automatically operative after said poppet means has been moved to said second position thereof for holding said poppet means in said second position even in the absence of a set signal and even in the absence of said predetermined pressure.

22. A pneumatic memory relay comprising a housing having a space interiorly therein; first and second input conduits in said housing, said conduits respectively having outer ends accessible exteriorly of said housing and respectively having inner ends each communicating with said space; first and second seat means respectively provided at said inner ends; an output conduit in said housing communicating with said space and with the exterior of said housing; magnetically attractable poppet means arranged to move in said space between a first position in which said poppet means sealingly engages said first seat means and places said output conduit in communication with said second input conduit, and a second position in which said poppet means sealingly engages said second seat means and places said output conduit into communication with said input conduit; first and second actuating means including means for receiving set and reset signals for moving said poppet means to said second and first positions, respectively, in response to application of said set and reset signals; and magnetic retaining means operative after said poppet means has been moved to said first position thereof for holding said poppet means in said first position even in the absence of a reset signal by applying to said poppet means a magnetic attracting force holding said poppet means in said first position, and operative after said poppet means has been moved to said second position thereof for holding said poppet means in said second position even in the absence of a set signal by applying to said poppet means a magnetic attracting force holding said poppet means in said second position.

23. A relay defined in claim **22,** further including means for establishing in at least one of said conduits a predetermined fluid pressure, and wherein said magnetic retaining means comprises means operative after said poppet means has been moved to said first position thereof for holding said poppet means in said first position even in the absence of a reset signal and even in the absence of said predetermined pressure by applying to said poppet means a magnetic attracting force holding said poppet means in said first position, and operative after said poppet means has been moved to said second position thereof for holding said poppet means in said second position even in the absence of a set signal and even in the absence of said predetermined pressure by applying to said poppet means a magnetic attracting force holding said poppet means in said second position.

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