United States Patent

[11] 3,550,847

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a corporation of Delaware
Continuation-in-part of application Ser. No. 717,586, Apr. 1, 1968, now Patent No. 3,522,661. This application May 5, 1969, Ser. No. 821,928

[54] PNEUMATICALLY OPERATED LOGIC SYSTEM OR THE LIKE

7 Claims, 27 Drawing Figs.

[52] **U.S. Cl.** **235/201,** 137/625.66; 251/61
[51] **Int. Cl.** **G06d 3/00**
[50] **Field of Search** 235/200, 201; 251, 61; 137/84

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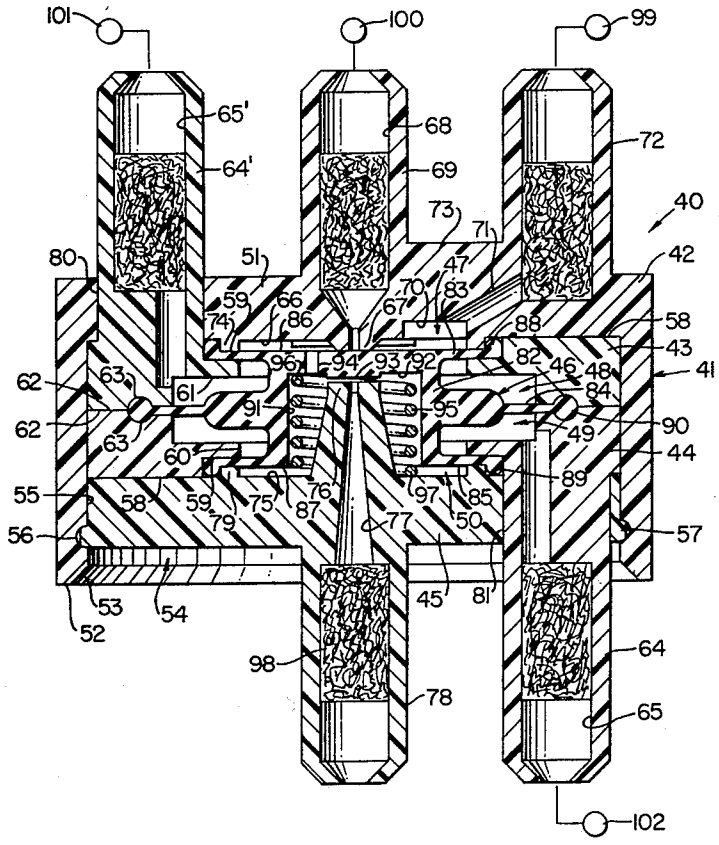
ABSTRACT: A logic unit that can be pressure operated or vacuum operated in a system to provide logic functions such as an AND function, an OR function, a NOT function, a DELAY function, a PULSE SHAPER function, a MEMORY function, an OSCILLATOR function, a FLIP-FLOP function, and the like, the logic unit comprising an integral three-diaphragm member cooperating with a housing means to define four stacked chambers respectively interconnected to four ports of the housing means with a fifth port also being fluidly interconnected to one of the outboard chambers. The diaphragm member has passage means passing therethrough always fluidly interconnecting the two outboard chambers together with the ports for the two outboard chambers defining valve seats adapted to be respectively opened and closed by the diaphragm member. Urging means tends to move the diaphragm member in one direction to close the valve seat of the outboard chamber having the fifth port interconnected thereto.



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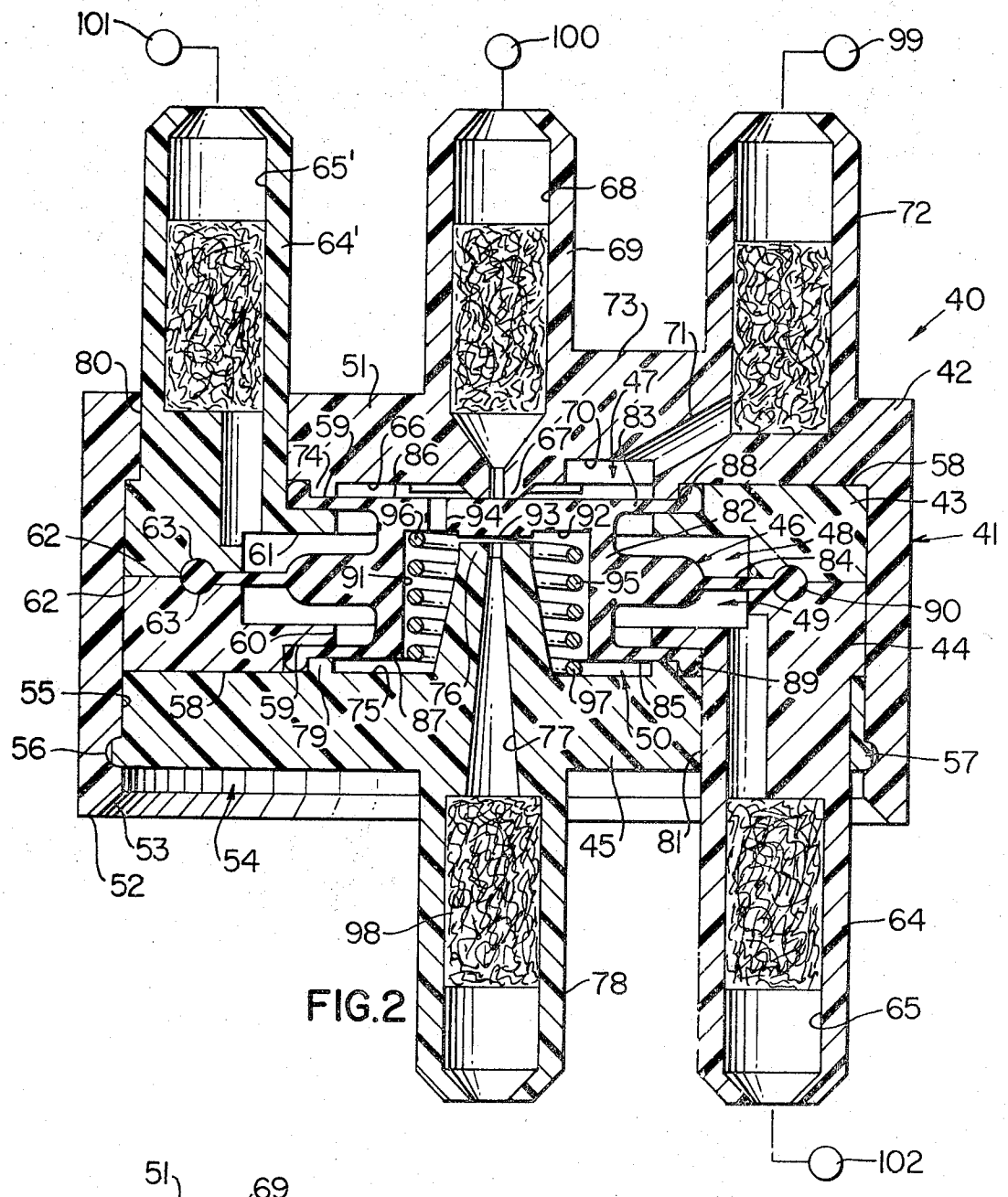

FIG. 2

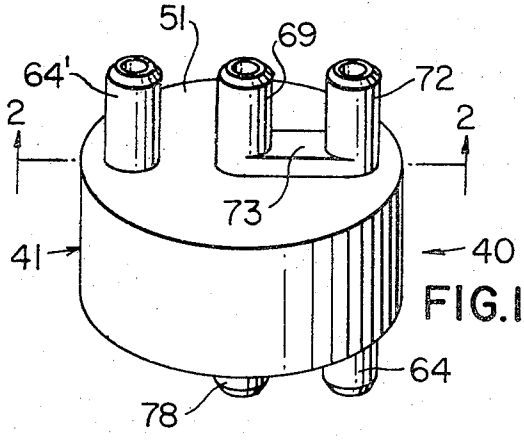

FIG. 1

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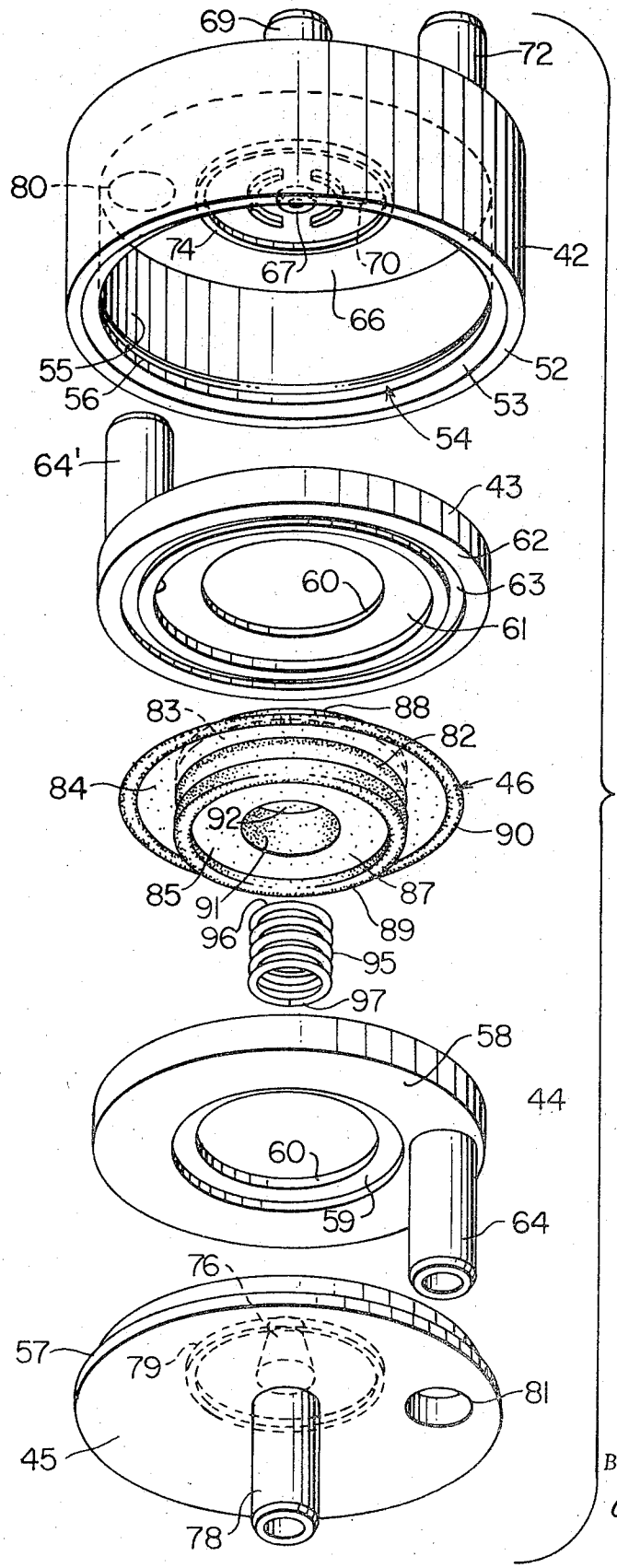

FIG. 3

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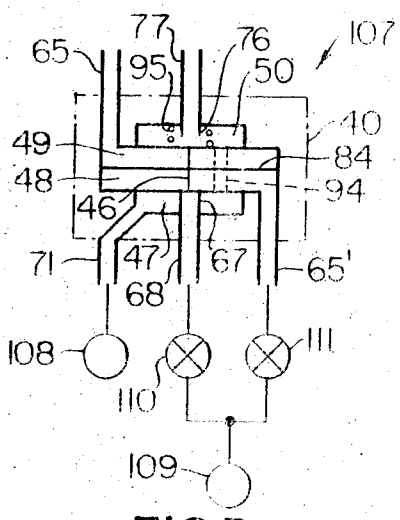

FIG.5

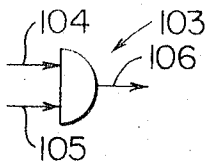

FIG.4

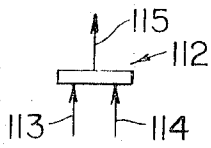

FIG.6

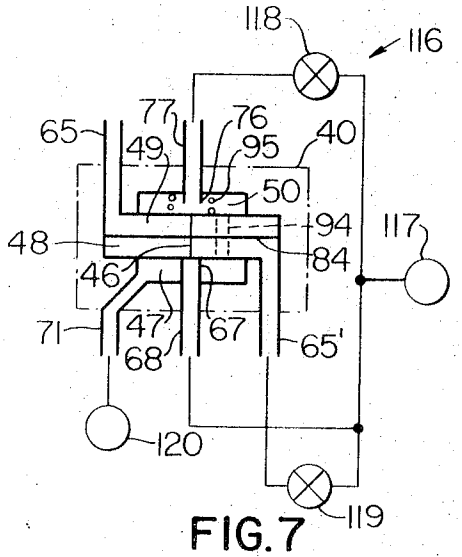

FIG.7

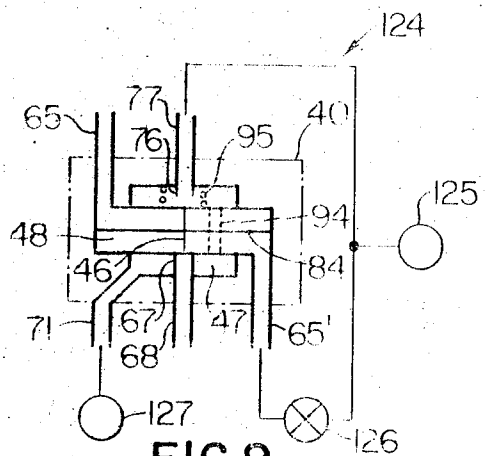

FIG.9

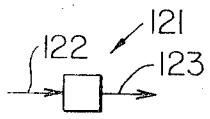

FIG.8

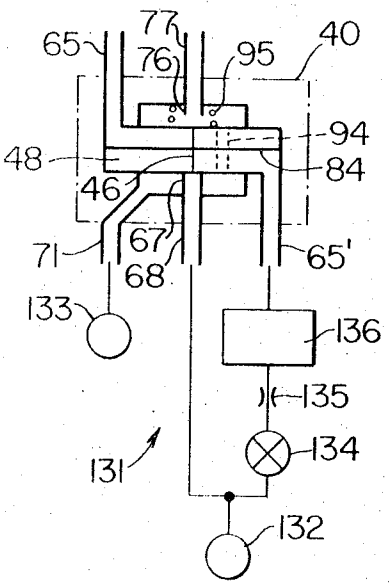

FIG.11

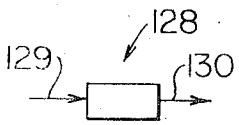

FIG.10

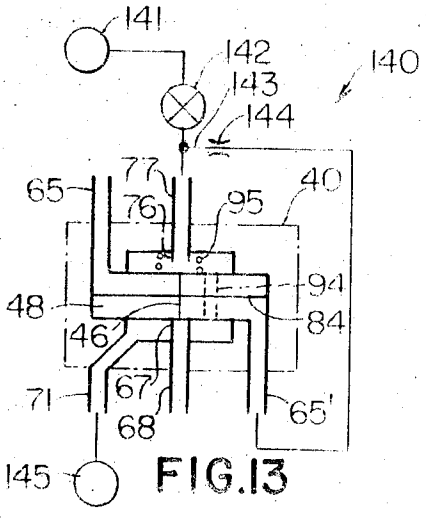

FIG.13

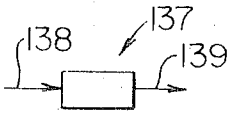

FIG.12

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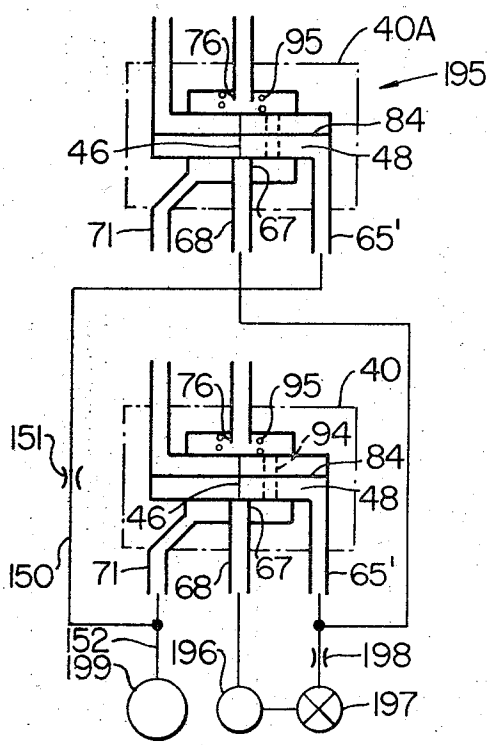

FIG. 14

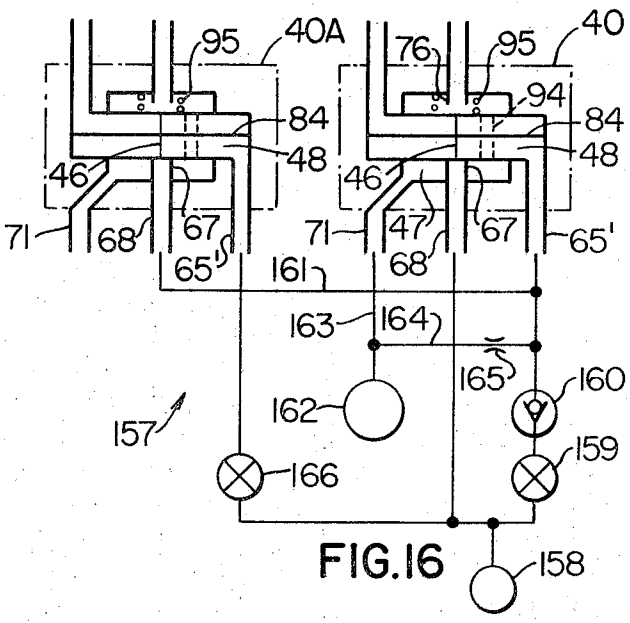

FIG. 16

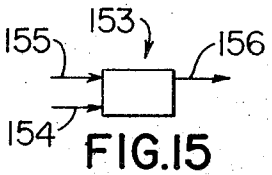

FIG. 15

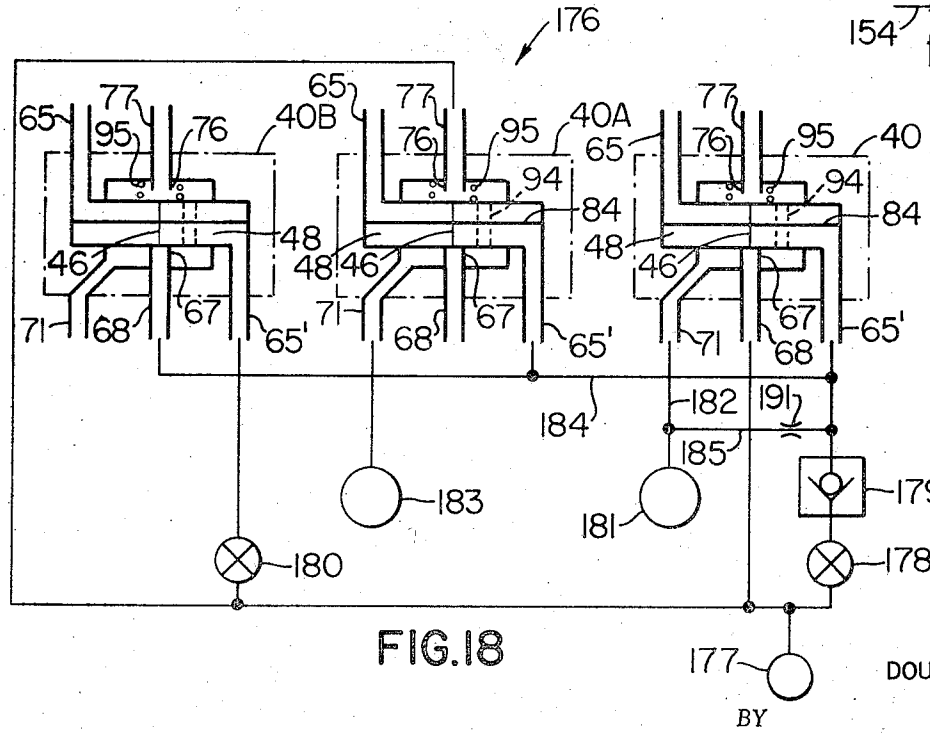

FIG. 18

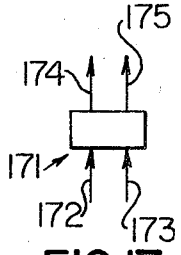

FIG. 17

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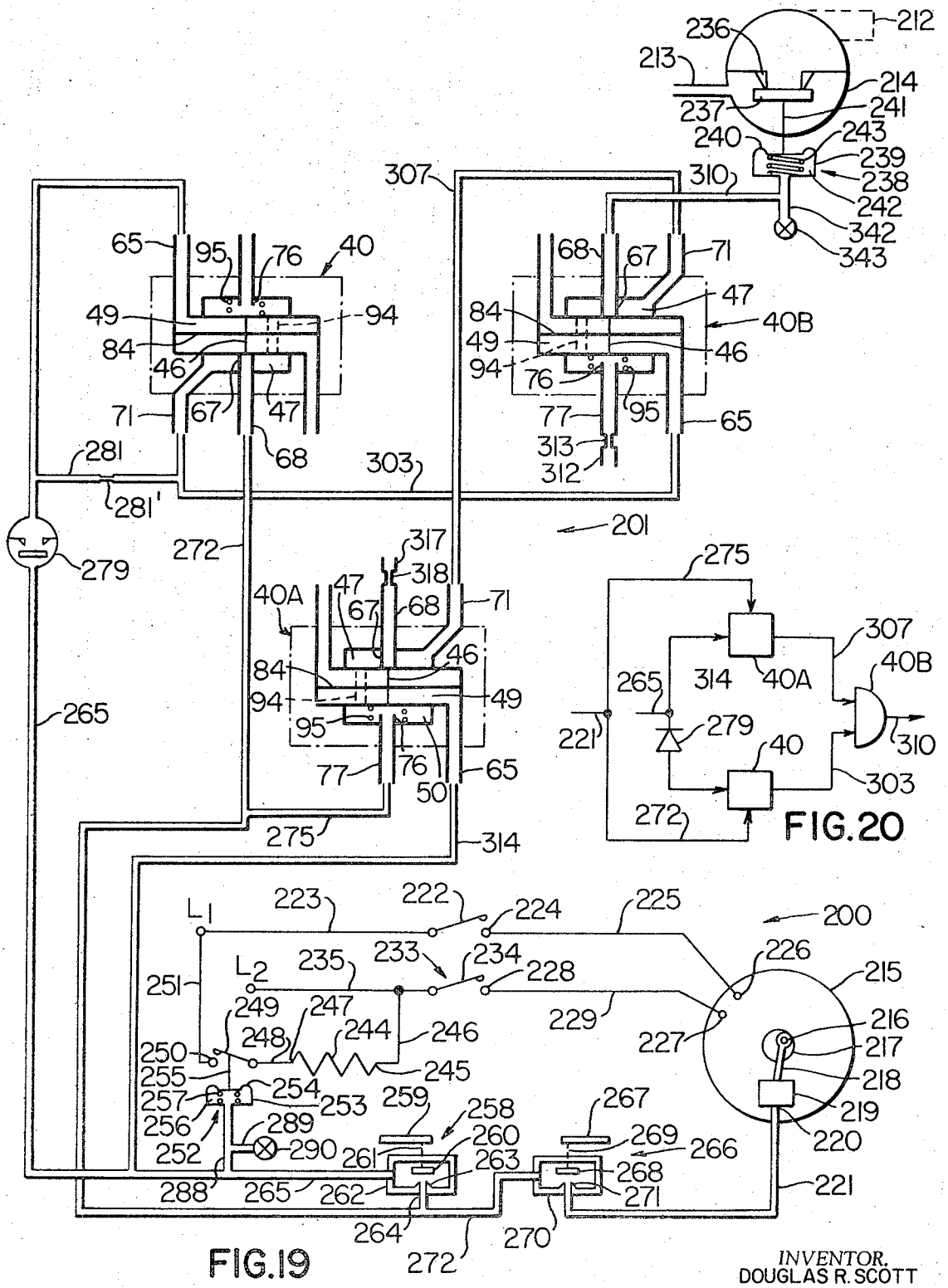

FIG.20

FIG.19

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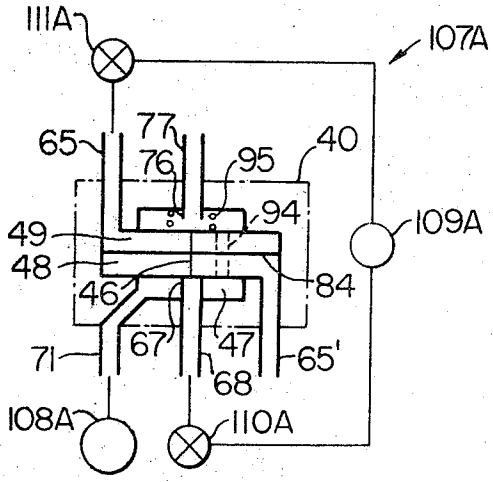

FIG.21

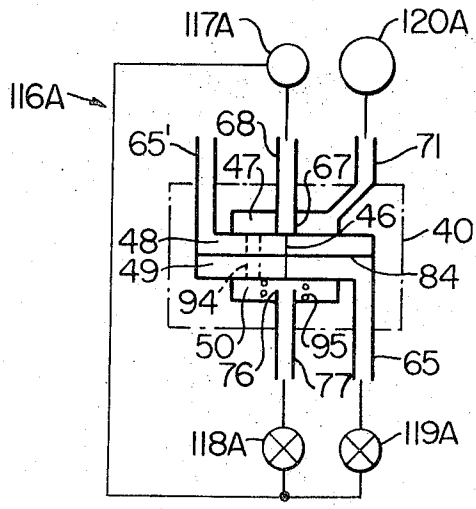

FIG.22

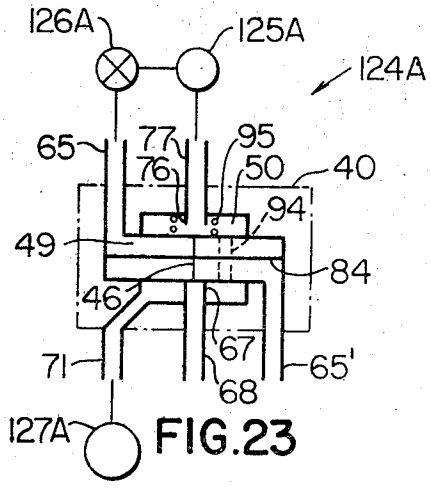

FIG.23

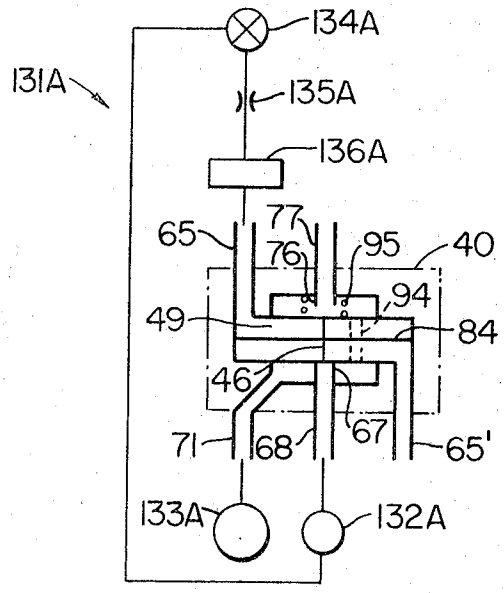

FIG.24

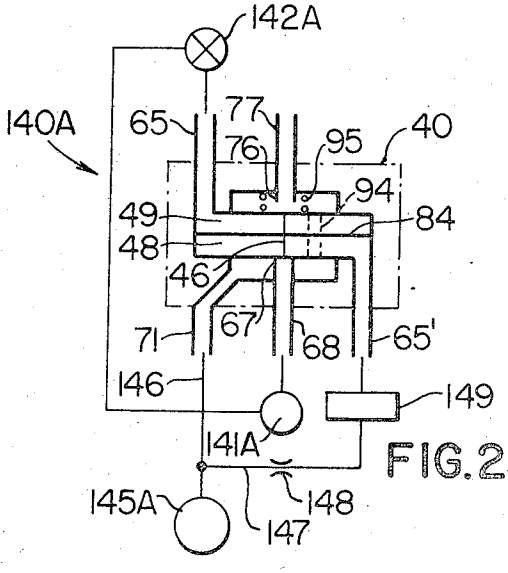

FIG.25

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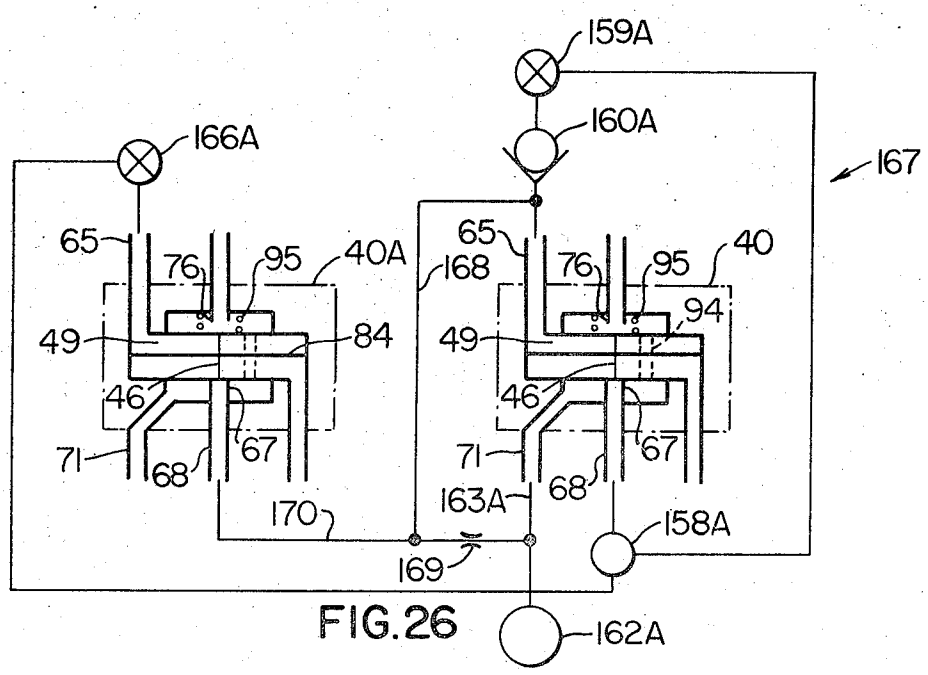

FIG.26

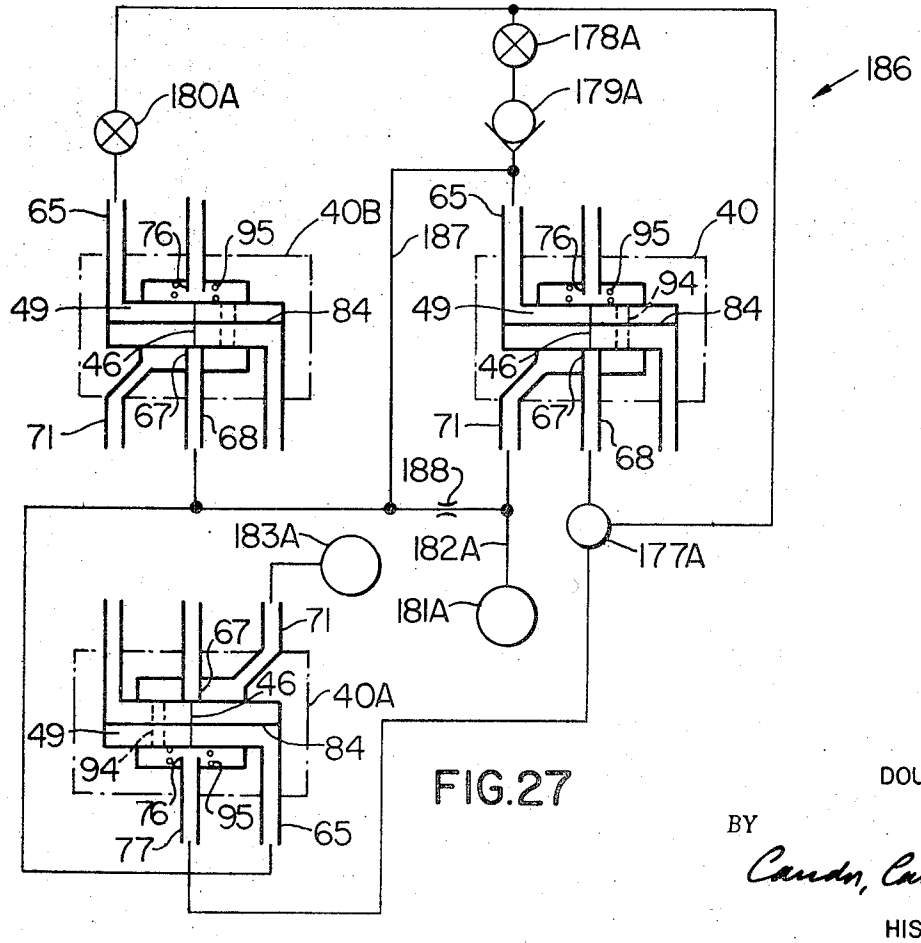

FIG.27

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PNEUMATICALLY OPERATED LOGIC SYSTEM OR THE LIKE

This application is a continuation-in-part patent application of its copending parent patent application, Ser. No. 717,586, filed Apr. 1, 1968, now U.S. Pat. No. 3,522,661 and is assigned to the same assignee to whom the parent application is assigned.

This invention relates to pneumatically operated logic systems and the like.

A logic unit is provided by this invention which can be pressure operated or vacuum operated and can be utilized in various pneumatically operated systems to provide different logic functions without any change in the structure of the logic unit.

Such a pneumatically operated unit when utilized as a valving means is disclosed and claimed in the copending U.S. Pat. application, Ser. No. 772,788, filed Nov. 1, 1968, and assigned to the same assignee to whom this application is assigned.

Parent copending U.S. Pat. application, Ser. No. 717,586, discloses and claims a pneumatically operated clothes dryer control system wherein the logic unit can be utilized as a vacuum operated AND logic unit, a vacuum operated NOT unit and a vacuum operated MEMORY unit.

This application further discloses such a pneumatically operated logic unit having universal application for other types of logic functions such as pressure operated or vacuum operated AND functions, OR functions, NOT functions, DELAY functions, PULSE SHAPER functions, MEMORY functions, OSCILLATOR functions and FLIP-FLOP functions.

For example, the logic unit of this invention comprises a housing means carrying a diaphragm member that has three integral diaphragm portions in axially stacked spaced relation and cooperating with the housing means to define four axially stacked chambers separated from each other, the diaphragm member having passage means therein always fluidly interconnecting the two outboard chambers together. The housing means has only five ports therein of which four ports thereof respectively lead to the four chambers with the ports for the two outboard chambers respectively defining valve seats respectively leading to the two outboard chambers and being adapted to be opened and closed respectively by the diaphragm member, the fifth port leading to one of the outboard chambers to always be in fluid communication therewith regardless of the position of the diaphragm member. The housing means has an urging means always tending to move the diaphragm member in one direction to close the valve seat of the one outboard chamber having the fifth port interconnected thereto and to open the valve seat of the other outboard chamber. A pneumatic source is operatively interconnected to one of the valve seat ports and a pneumatically operated device is operatively interconnected to the fifth port. Pneumatic signal means is operatively interconnected to at least one of the remaining ports so as to cause the logic unit to provide a logic function for the system, such function being an AND function, an OR function, a NOT function, a DELAY function, a PULSE SHAPER function, a MEMORY function, an OSCILLATOR function, a FLIP-FLOP function and the like.

Accordingly, it is an object of this invention to provide an improved pneumatically operated logic system having one or more of the novel features set forth above or hereinafter shown or described.

Other objects, uses and advantages of this invention are apparent from a reading of this description which proceeds with reference to the accompanying drawings forming a part thereof and wherein:

FIG. 1 is a perspective view of the logic unit of this invention;

FIG. 2 is an enlarged cross-sectional view of the logic unit of FIG. 1 and is taken on line 2–2 of FIG. 1;

FIG 3 is an exploded perspective view of the various parts of the logic unit of FIGS. 1 and 2;

FIG. 4 is a schematic view illustrating an AND logic function;

FIG. 5 is a schematic view illustrating the logic unit of FIG. 2 providing an AND logic function in a pressure system of this invention;

FIG. 6 is a schematic view illustrating an OR logic function;

FIG. 7 is a schematic view illustrating the logic unit of FIG. 2 providing an OR logic function in a pressure system of this invention;

FIG. 8 is a schematic view illustrating a NOT logic function;

FIG. 9 is a schematic view illustrating the logic unit of FIG. 2 providing a NOT logic function in a pressure system of this invention;

FIG. 10 is a schematic view illustrating a DELAY logic function;

FIG. 11 is a schematic view illustrating the logic unit of FIG. 2 providing a DELAY logic function in a pressure system of this invention;

FIG. 12 is a schematic view illustrating a DIFFERENTIATOR logic function;

FIG. 13 is a schematic view illustrating the logic unit of FIG. 2 providing a PULSE SHAPER logic function in a pressure system of this invention;

FIG. 14 is a schematic view illustrating two logic units of FIG. 2 providing an OSCILLATOR logic function in a pressure system of this invention;

FIG. 15 is a schematic view illustrating a MEMORY logic function;

FIG. 16 is a schematic view illustrating two logic units of FIG. 2 providing a MEMORY logic function in a pressure system of this invention;

FIG. 17 is a schematic view illustrating a FLIP-FLOP logic function;

FIG. 18 is a schematic view illustrating three logic units of FIG. 2 providing a FLIP-FLOP logic function in a pressure system of this invention;

FIG. 19 is a schematic view illustrating a control system for a fuel burning clothes dryer utilizing three logic units of FIG. 2 for performing logic functions in controlling the dryer burner;

FIG. 20 is a schematic view illustrating the logic function of the system of FIG. 19;

FIG. 21 is a schematic view illustrating the logic unit of FIG. 2 providing an AND logic function in a vacuum system of this invention;

FIG. 22 is a schematic view illustrating the logic unit of FIG. 2 providing an OR logic function in a vacuum system of this invention;

FIG. 23 is a schematic view illustrating the logic unit of FIG. 2 providing a NOT logic function in a vacuum system of this invention;

FIG. 24 is a schematic view illustrating the logic unit of FIG. 2 providing a DELAY logic function in a vacuum system of this invention;

FIG. 25 is a schematic view illustrating the logic unit of FIG. 2 providing a PULSE SHAPER logic function in a vacuum system of this invention;

FIG. 26 is a schematic view illustrating two logic units of FIG. 2 providing a MEMORY logic function in a vacuum system of this invention; and

FIG. 27 is a schematic view illustrating three logic units of FIG. 2 providing a FLIP-FLOP logic function in a vacuum system of this invention.

While the various features of this invention are hereinafter illustrated and described as providing certain specific logic functions, it is to be understood that the various novel features of this invention can be utilized singly or in various combinations thereof to provide other pneumatically operated logic systems as desired.

Therefore, this invention is not to be limited only to the embodiments illustrated in the drawings, because the drawings are merely utilized to illustrate some of the wide variety of uses of this invention.

Referring now to FIGS. 1—3, the logic unit of this invention is generally indicated by the reference numeral 40 and is the same structure and design as disclosed and claimed in the aforementioned copending U.S. Pat. application, Ser. No. 772,788, such application merely disclosing such unit 40 as a pneumatic valving means and not as provided in this application and in the aforementioned copending parent application, Ser. No. 717,586, of which this application is a Continuation-in-Part patent application thereof.

As illustrated in FIGS. 1—3, the unit 40 has a housing means 41 formed from four housing parts 42, 43, 44, and 45 secured together in a unique manner hereinafter described to hold a diaphragm member or means 46 in the manner illustrated in FIG. 2 whereby the housing parts 42—45 and the diaphragm means 46 cooperate together to define a plurality of chambers 47, 48, 49 and 50 in axially stacked relation.

The housing member 42 is substantially cup-shaped so as to define a closed end wall 51 and an open end 52, the open end 52 being beveled at 53 completely around the open end 52 with the annular bevel 53 leading to a substantially cylindrical cavity 54 being defined by a substantially cylindrical interior wall means 55. An annular groove 56 is formed in the cylindrical wall means 55 adjacent the open end 52 to snap-fittingly receive an outward directed annular tongue 57 of the housing member 45 to secure the housing members 42—45 and diaphragm means 46 together as illustrated in FIG. 2.

The housing members 43 and 44 are substantially identical in construction with the housing member 44 being inverted relative to the housing member 43 and being rotated 180° relative thereto in the assembled condition illustrated in FIG. 2.

The like sides 58 of the housing members 43 and 44 have an annular recessed shoulder 59 joining an opening 60 passing completely and centrally therethrough and adjoining an annular recessed shoulder 61 in the opposite sides 62 thereof, the sides 62 of the housing members 43 and 44 each being provided with an annular groove 63 for a purpose hereinafter described. The housing members 43 and 44 each has an integral, outwardly extending tubular projection 64' and 64 extending from the sides 58 thereof with suitable passage or port means 65' and 65 passing therethrough and being interconnected adjacent the juncture of the annular recesses 61 with the sides 62 thereof.

The closed end wall 51 of the outboard housing part or member 42 has an inside surface 66 provided with an inwardly directed, substantially frustoconical valve seat means 67 interconnected to the exterior thereof by a passage or port means 68 in an outwardly directed, integral tubular projection 69, the surface 66 being interrupted by a recess 70 that is interconnected by passage or port means 71 to the exterior of the housing member 42 through an integral nipple means or tubular projection 72, the nipple means 69 and 72 having a reinforcing ridge 73 interconnecting the same together as illustrated in FIGS. 1 and 2. An inwardly directed annular ridge 74 is concentrically disposed about the valve seat means 67.

The other outboard housing member 45 has a substantially flat inner surface 75 carrying an inwardly directed substantially frustoconical valve seat means 76 interconnected to the exterior thereof by a passage or port means 77 extending through an outwardly directed integral tubular projection 78. An annular ridge 79 similar to the annular ridge 74 of the housing member 42 is concentrically disposed about the valve seat means 76 and extends inwardly from the surface 75 of the housing member 45.

The housing members 42 and 45 respectively have openings 80 and 81 passing therethrough and adapted to respectively telescopically receive the tubular projections 64 of the housing members 43 and 44 when the parts are disposed in their assembled relation illustrated in FIG. 2.

Therefore, it can be seen that the housing members 42—45 can be formed of plastic materials suitably molded or otherwise formed in a simple and economical manner to provide the valve means 40 of this invention. Of course, the housing members 42—45 can be formed of any other suitable material, as desired.

However, while the housing parts 42—45 are illustrated as being circular, it is to be understood that the same could be of other configurations such as rectangular, square or the like as desired.

The diaphragm means 46 is a one-piece flexible structure having a body portion 82 provided with three outwardly directed and axially spaced diaphragm portions 83, 84 and 85 with the outboard diaphragm portions 83 and 85 being coplanar with the opposed sides 86 and 87 of the body portion 82. The outer peripheral portion of the upper diaphragm portion 83 is provided with an annular bead means 88 similar to an annular bead means 89 on the outer peripheral portion of the lower diaphragm portion 85. The intermediate, larger diaphragm portion 84 has an annular bead means 90 at the outer peripheral portion thereof. The side 87 of the body portion 82 is interrupted by a circular opening means 91 that terminates at a surface means 92 in the body portion 82 that has an outwardly directed circular projection 93 on the surface thereof, opening 91 being interconnected to the side 86 of the body portion 82 by one or more opening means 94 passing through the upper diaphragm portion 83 in offset relation to the circular part 93.

When it is desired to assemble the housing members 42—45 and the diaphragm means 46 together to form the valve means 40 of this invention, the diaphragm means 46 can be disposed between the two inboard housing members 43 and 44 so that the annular bead 90 of the intermediate diaphragm portion 84 is disposed in the cooperating annular recesses 63 in the abutting sides 62 of the housing members 43 and 44, the diaphragm portions 83 and 85 being respectively disposed through the opening means 60 of the housing members 43 and 44 so that the same have their outer peripheral portions 88 and 89 respectively received against the annular shoulder means 59 on the sides 58 thereof. Thereafter, the assembled together inboard housing members 43 and 44 and diaphragm means 46 are inserted into the cavity 54 of the cup-shaped housing member 42 so that the tubular projection 64' of the housing member 43 passes through the opening 80 of the housing member 42 and the annular bead means 88 of the upper diaphragm portion 83 is disposed outboard of the annular ridge 74 of the housing member 42. Thereafter, a compression spring 95 is disposed in the opening 91 of the diaphragm means 46 so that one end 96 of the spring means bears against the surface 92 of the diaphragm means 46. Thereafter, the remaining outboard housing member 45 is disposed into the cavity 54 of the housing member 42 with the opening 81 registering with the tubular projection 64 on the housing member 44 so that the housing member 45 can be pushed inwardly and have its annular tongue 57 camming against the beveled surface 53 at the open end 52 of the housing member 42 to facilitate the snapping of the tongue 57 into the annular groove 56 of the housing member 42 as illustrated in FIG. 2 whereby the outer peripheral bead 89 of the diaphragm portion 85 is disposed outboard of the annular ridge 79 of the housing member 45.

In this manner, the diaphragm portion 83 is compressed between the annular ridge 74 of the housing member 42 and the shoulder means 59 of the housing member 43 to seal the chambers 47 and 48 from each other, the lower diaphragm portion 85 similarly being compressed between the annular ridge 79 on the housing member 45 and the shoulder means 59 of the housing member 44 to seal the chambers 50 and 49 from each other. The intermediate diaphragm portion 84 is compressed between the cooperating surfaces of the sides 62 of the housing members 43 and 44 to seal the chambers 48 and 49 from each other.

Therefore, it can be seen that the unique snap fit relation between the outboard housing members 42 and 45 of the unit 40 not only secures the housing members 42—45 and diaphragm means 46 together, but also such snap fit relation causes positive sealing of the diaphragm portions 83—85

between their cooperating housing members to assure a sealed condition of the various chambers from each other without requiring auxiliary sealing means.

Since the other end 97 of the compression spring 95 now bears against the surface 75 of the assembled housing member 45, the force of the compression spring 95 normally tends to move the diaphragm portion 83 upwardly to seal closed the valve seat means 67 from the chamber 47 while opening the valve seat means 76 to the chamber 50. However, when the pressure differential between the chambers 48 and 49 overcomes the force of the compression spring 95, such pressure differential between the chambers 48 and 49 causes the diaphragm portion 83 to move downwardly in opposition to the force of the compression spring 95 to have the diaphragm portion 83 close off the valve seat means 76 while opening the valve seat means 67.

If desired, air filtering means 98 can be disposed in the passage or port means of one or more of the outwardly directed nipple means as illustrated to prevent dust and the like from clogging the various passageways and chambers of the valve means 40.

If it is desired to utilize the unit 40 as a valve means as disclosed in the aforementioned U.S. Pat. application, Ser. No. 772,788, it can be seen that the tubular projection 72 can be interconnected to a pneumatically operated device 99 while the tubular projection 69 can be interconnected to a pneumatic source 100, the source 100 being a vacuum source or a pressure source as desired. The tubular projection 64' of the housing member 43 can be interconnected to one pneumatic signal source 101 while the tubular projection 64 of the housing member 44 can be interconnected to another pneumatic signal source 102, the nipple means 78 being interconnected to the atmosphere.

Therefore, as long as the signal sources 101 and 102 being directed respectively to the chambers 48 and 49 are equal or the pressure differential therebetween does not overcome the force of the compression spring 95, the pneumatic source 100 remains disconnected from the pneumatically operated device 99 because the diaphragm portion 83 is closing off the valve seat 67 and the atmosphere is interconnected through the opened valve seat means 76, chamber 50, passage means 94 and chamber 47 to the device 99. However, when the pressure differential between the chambers 48 and 49 exceeds the force of the compression spring 95 to move the diaphragm means 46 downwardly, the diaphragm portion 83 opens the valve seat 67 and closes the valve seat means 76 whereby the atmosphere is disconnected from the pneumatically operated device 99 and the pneumatic source 100 is interconnected thereto to operate the device 99 until a change in the signal sources 101 and 102 again causes the diaphragm means 46 to move upwardly in the manner illustrated in FIG. 2.

As previously set forth, one of the features of this invention is to provide pneumatically operated logic systems utilizing such unit 40 without changes therein regardless of the particular logic function to be performed by the same in a particular pneumatically operated logic system.

Before describing the various systems of this invention, it should be understood that normal air leakage or controlled air leakage, such as by restricted air bleeds, are utilized in the various systems of this invention hereinafter described to prevent a locked up condition of any chamber or device when the particular signal directed thereto is terminated as such chamber or device will return to its normal atmospheric condition through such air leakage when the particular pressure or vacuum signal directed thereto has been terminated.

Accordingly, reference is now made to FIG. 4 wherein the conventional binary logic gate function of an AND circuit is generally indicated by the reference numeral 103 and can be defined as having two pneumatic inputs 104 and 105 and a single pneumatic output 106 whereby whenever both inputs 104 and 105 are "on," the output 106 is "on" and when one or more of the inputs 104 and 105 are "off," the output 106 is "off."

To produce the AND logic function with the unit 40 of this invention, reference is made to FIG. 5 wherein a fluid pressure operated logic system of this invention is generally indicated by the reference numeral 107 and comprises the logic unit 40 of this invention having its fifth means 71 fluidly interconnected to a fluid pressure operated device 108. A pressure fluid source 109 is provided and is disposed in fluid communication with the ports 68 and 65' of the unit 40 respectively by control means 110 and 11. The ports 65 and 77 of the unit 40 are respectively interconnected to the atmosphere.

Therefore, it can be seen that the atmosphere is interconnected to the outboard chamber 50 when the valve seat 76 is opened by the diaphragm member 46 being in its normally urged position to close the valve seat 67 and that the atmosphere is interconnected to the intermediate chamber 49 while the signal means 111 is adapted to be interconnected to the intermediate chamber 48 that is adjacent to the outboard chamber 47 which is always disposed in fluid communication with the pneumatically operated device 108. The pneumatic source 109 is also adapted to be interconnected by the means 110 to the valve seat 67 of the outboard chamber 47.

Thus, should both control means 110 and 111 prevent fluid communication between the source 109 and the respective chambers 47 and 48, the compression spring 95 maintains the diaphragm member 46 against the valve seat 67 so that the atmosphere in the outboard chamber 50 is interconnected to the pneumatically operated device 108 through the opening means 94 that passes through the diaphragm member 46 to always fluidly interconnect the two outboard chambers 50 and 47 together. If only the means 110 interconnects the source 109 to the valve seat 67, the diaphragm member 46 remains in the position illustrated in FIG. 5 so that there is no output pressure signal to the pneumatically operated device 108. Conversely, if only the means 111 interconnects the pneumatic pressure source 109 to the chamber 48, the resulting pressure differential across the intermediate diaphragm portion 84 of the diaphragm member 46 will move the diaphragm member 46 upwardly in FIG. 5 in opposition to the force of the compression spring 95 to open the valve seat 67 and close the valve seat 76, but since the control means 110 is preventing fluid communication between the pressure source 109 and the outboard chamber 47, no output pressure signal is directed by the unit 40 to the pneumatically operated device 108.

Thus, it can be seen that it requires both means 110 and 111 to respectively direct signals from the pneumatic source 109 to the chambers 47 and 48 to produce a pressure output signal to the pneumatically operated device 108 because the signal from the control means 111 moves the diaphragm member 46 upwardly to open valve seat 67 and the control means 110 provides the pressure signal to the valve seat 67 to pass therethrough to the device 108, whereby the pneumatically operated logic system 107 of this invention provides the AND logic function.

In order to illustrate the AND function of the unit 40 of this invention when utilized with a vacuum system, reference is now made to FIG. 21 wherein a vacuum operated logic system of this invention is generally indicated by the reference numeral 107A and parts thereof similar to the system 107 of FIG. 5 are indicated by like reference numerals followed by the reference letter A.

As illustrated in FIG. 21, the logic unit 40 of the system 107A is identical to the logic unit 40 of the system 107 previously described. However, the vacuum source 109A is adapted to be respectively interconnected by the control means 110A and 111A to the ports 68 and 65 of the unit 40 while the vacuum operated device 108A is interconnected to the port 71 of the unit 40, the ports 65' and 77 being interconnected to the atmosphere.

Therefore, it can be seen that the system 107A will prevent any vacuum output signal to the device 108A if one or both control means 110A and 111A prevent fluid communication between the vacuum source 109A and their respective chambers 47 and 49 of the unit 40.

For example, with the ports 77 and 65' being respectively interconnected to the atmosphere and the means 110A and 111A preventing fluid communication between the chambers 47 and 49 and the vacuum source 109A, the compression spring 95 maintains the diaphragm member 46 against the valve seat 67 so that the vacuum operated device 108A is interconnected to the atmosphere through the opening means 94 in the diaphragm member 46. With only the means 110A interconnecting the vacuum source 109A to the valve seat 67, the diaphragm member 46 remains in its closed position against the valve seat 67 so that no vacuum output is directed to the device 108A. Conversely, with only the means 111A interconnecting the vacuum source 109A to the chamber 49, the resulting pressure differential across the intermediate diaphragm portion 84 of the diaphragm member 46 causes the diaphragm member 46 to move upwardly to close the valve seat 76 and open the valve seat 67, but since the vacuum source 109A is not interconnected to the valve seat 67 by the means 110A, no vacuum output signal is interconnected to the vacuum operated device 108A until the means 110A also interconnects the vacuum source 109A to the valve seat 67 while the means 111A is interconnecting the vacuum source 109A to the chamber 49 to move the valve member 46 upwardly.

In this manner, it can be seen that the logic unit 40 can provide an AND logic function for a vacuum operated system.

The logic unit 40 of FIG. 2 can also perform the OR logic function schematically illustrated in FIG. 6 and generally indicated by the reference numeral 112 wherein the OR unit 112 has two inputs 113 and 114 and one output 115, the OR function of the OR unit 112 always providing the output 115 when any one or more of the inputs 113 and 114 are "on." However, the output 115 is "off" only if all of the inputs 113 and 114 are "off."

Accordingly, the logic unit 40 of this invention is schematically illustrated in FIG. 7 for providing an OR logic function in a pressure operated system 116 of this invention which comprises a fluid pressure source 117 that is directly interconnected to the port 68 that leads to the valve seat 67 of the outboard chamber 47 and is respectively interconnected by a first control means 118 and a second control means 119 to the ports 77 and 65' whereby the first control means 118 is adapted to direct a pressure signal to the other outboard chamber 50 of the unit 40 and the second control means 119 is adapted to direct a pressure signal to the intermediate chamber 48 that is adjacent to the one outboard chamber 47. The other intermediate chamber 49 is interconnected to the atmosphere at the port 65 and a pressure operated device 120 is interconnected to the fifth port 71 of the unit 40 so as to always be disposed in fluid communication with the one outboard chamber 47.

Accordingly, it can be seen that when one or both of the control means 118 and 119 are directing a pressure signal to the unit 40, a pressure output is directed to the device 120 and when neither control means 118 and 119 are directing a pressure signal to the unit 40, no pressure output is directed to the device 120.

In particular, with the pressure source 117 operating and the control means 118 and 119 preventing fluid communication respectively to the chambers 50 and 48 of the unit 40, the diaphragm member 46 of the unit 40 is closing the valve seat 67 by the force of the urging means 95 whereby the pressure source 117 is prevented from being directed to the device 120 and since no pressure exists in the outboard chamber 50, the chamber 50 also does not direct a pressure output to the device 120 through the passage means 94 of the diaphragm member 46. However, when only the first control means 118 is directing a pressure signal to the outboard chamber 50, it can be seen that such pressure signal passes through the opening means 94 of the diaphragm member 46 to the outboard chamber 47 and, thus, to the device 120. However, if the second control means 119 is directing a pressure signal to the intermediate chamber 48, regardless of whether the first control means 118 is directing a pressure signal to the outboard chamber 50 or not, the resulting pressure differential across the intermediate diaphragm portion 84 of the diaphragm means 46 overcomes the force of the compression spring 95 and moves the diaphragm member 46 upwardly to open the valve seat 67 and close the valve seat 76 whereby the opened valve seat 67 directly interconnects the pneumatic source 117 to the device 120.

Therefore, it can be seen that the logic unit 40 of this invention is adapted to provide an OR logic function for a pressure operated system.

Reference is now made to FIG. 22 wherein the logic unit 40 of this invention is adapted to provide an OR logic function in a vacuum operated system of this invention that is generally indicated by the reference numeral 116A and parts of the system 116A that are identical to the system 116 are indicated by like reference numerals followed by the reference letter A.

As illustrated in FIG. 22, the vacuum source 117A is directly interconnected to the port 68 of the unit 40 and, thus, to the valve seat 67 thereof. The vacuum source 117A is also adapted to be respectively interconnected by first control means 118A and second control means 119A to the ports 77 and 65 of the unit 40 so that the control means 118A is adapted to direct a vacuum signal to the outboard chamber 50 through the valve seat 76 thereof and the control means 119A is adapted to direct a vacuum signal to the intermediate chamber 49 that is adjacent to the outboard chamber 50, the other intermediate chamber 48 being interconnected to the atmosphere at the port 65' and the vacuum operated device 120A being interconnected to the fifth port 71 of the unit 40 so as to always be in fluid communication with the outboard chamber 47.

With the vacuum source 117A operating and the control means 118A and 119A each failing to direct a vacuum signal to the respective chambers 50 and 49, the urging means 95 maintains the diaphragm member 46 against the valve seat 67 so that no vacuum output is directed to the vacuum operated device 120A. However, if only the first control means 118A is directing a vacuum signal to the outboard chamber 50, such vacuum signal in the chamber 50 is interconnected to the device 120A because of the opening means 94 through the diaphragm member 46.

However, if the second control means 119A is directing a vacuum signal to the intermediate chamber 49, regardless of whether the first control means 118A is directing a vacuum signal to the outboard chamber 50 or not, the resulting pressure differential across the intermediate diaphragm portion 84 of the diaphragm member 46 overcomes the force of the compression spring 95 and moves the diaphragm member 46 to close the valve seat 76 and open the valve seat 67 whereby the vacuum source 117A is interconnected to the device 120A.

Therefore, it can be seen that the logic unit 40 of this invention can provide an OR logic function in either a pressure operated system or a vacuum operated system without any change in the structure thereof.

Referring now to FIG. 8, a conventional logic arrangement is generally indicated by the reference numeral 121 and illustrates schematically a NOT logic function that has one input 122 and one output 123, the unit 121 functioning so that the output 123 is "on" when the input 122 is "off" and, conversely, if the input 122 is "on", the output 123 is "off."

Accordingly, the logic unit 40 of this invention is adapted to provide the above described NOT logic function and is illustrated in FIG. 9 as being in a pressure system 124 of this invention wherein a pneumatic pressure source 125 is directly interconnected to the port 77 and a control means 126 is adapted to interconnect the source 125 to the port 65' that leads to the intermediate chamber 48 that is adjacent to the one outboard chamber 47 that has its port 71 interconnected to a pressure operated device 127 and has its valve seat port 68 interconnected to the atmosphere. The port 65 is also interconnected to the atmosphere.

Thus, it can be seen that when the control means 126 prevents a pressure input signal means to the chamber 48 of

the unit 40, the compression spring 95 maintains the diaphragm member 46 against the valve seat 67 while maintaining the valve seat 76 in an open condition so that the pneumatic pressure source 125 is interconnected to the device 127 by passing through the opening means 94 in the diaphragm member 46. However, when the control means 126 directs a pressure input signal means to the chamber 48 of the unit 40, the resulting pressure differential across the intermediate diaphragm portion 84 overcomes the force of the compression spring 95 and moves the diaphragm member 46 upwardly to close the valve seat 76 and open the valve seat 67 whereby the source 125 is disconnected from the device 127 and the device 127 is interconnected to the atmosphere through the opened valve seat 67 and the port 68.

Therefore, it can be seen that the system 124 of this invention utilizes the unit 40 to provide a NOT logic function because the output to the device 127 is only provided when the control means 126 does not provide an input pressure signal means to the device 40 and, conversely, the device 127 does not have any output pressure directed thereto when the control means 126 directs an input pressure signal means to the unit 40.

Referring now to FIG. 23, a vacuum operated logic system is generally indicated by the reference numeral 124A and parts thereof similar to the system 124 of FIG. 9 are indicated by like reference numerals followed by the reference letter A.

As illustrated in FIG. 23, the vacuum source 125A is directly interconnected to the port 77 of the unit 40 and is adapted to be interconnected by the control means 126A to the port 65 of the unit 40 that leads to the intermediate chamber 49 that is adjacent to the outboard chamber 50, the ports 68 and 65' being interconnected to the atmosphere while the fifth port 71 of the unit 40 is interconnected to a vacuum operated device 127A.

Thus, when the control means 126A is not directing a vacuum input signal to the intermediate chamber 49 of the unit 40, the compression spring 95 maintains the diaphragm member 46 against the valve seat 67 while maintaining the valve seat 76 open so that the vacuum source 125A is interconnected to the vacuum operated device 127A through the opening means 94 in the diaphragm member 46. However, when the control means 126A is directing a vacuum input signal to the chamber 49 of the unit 40, the resulting pressure differential across the intermediate diaphragm portion 84 overcomes the force of the compression spring 95 and moves the diaphragm member 46 upwardly to open the valve seat 67 and close the valve seat 76 so that the vacuum source 125A is disconnected from the device 127A and the device 127A is interconnected to the atmosphere through the opened valve seat 67.

Therefore, it can be seen that the vacuum operated logic system 124A of FIG. 23 utilizes the unit 40 to provide a NOT logic function without any changes in the structure of the logic unit 40.

Referring now to FIG. 10, a conventional DELAY logic arrangement is generally indicated by the reference numeral 128 and is adapted to function in such a manner that when an input signal 129 is initially turned "on", the output signal 130 will not occur until after a predetermined time period. Conversely, when the input signal 129 is initially terminated, the output signal 130 is not terminated until after a predetermined time period.

Accordingly, reference is now made to FIG. 11 wherein the logic unit 40 of this invention is utilized in a pressure logic system that is generally indicated by the reference numeral 131 to provide the previously described DELAY logic function, the system 131 comprising a pressure source 132 interconnected to the port 68 of the unit 40 and a pressure operated device 133 interconnected to the fifth port 71 of the unit 40 while the ports 65 and 77 are connected to the atmosphere. A control means 134 is adapted to interconnect the source 132 to the port 65' of the unit 40 that leads to the intermediate chamber 48. However, a restrictor 135 and an accumulator 136 are disposed in series between the control means 134 and the port 65' for a purpose now to be described.

If control means 134 is preventing fluid communication between the source 132 and the port 65', the urging means 95 maintains the diaphragm member 46 against the valve seat 67 so that the source 132 is prevented from being interconnected to the device 133 and the device 133 is disposed in fluid communication with the atmosphere through the passage means 94 of the diaphragm member 46 and the opened valve seat 76.

When the control means 134 initially directs a pressure signal from the source 132 toward the port 65' of the unit 40, the restriction 135 and accumulator 136 prevent a buildup of pressure in the intermediate chamber 48 for a delayed time period after the lapse of which the pressure buildup in the intermediate chamber 48 results in a pressure differential across the intermediate diaphragm portion 84 that moves the diaphragm member 46 upwardly in opposition to the force of the compression spring 95 to close the valve seat 76 and open the valve seat 67 so that the pressure source 132 is interconnected to the pressure operated device 133 through the opened valve seat 67.

Conversely, when the control means 134 initially terminates the pressure signal to the port 65' after the diaphragm member 46 has been moved upwardly in the manner previously described, the accumulator 136 and restrictor 135 function to maintain a sufficient pressure in the intermediate chamber 48 to maintain the diaphragm member 46 in its up position against the valve seat 76 for a predetermined time period after the lapse of which the dissipation of the pressure in the intermediate chamber 48 by the previously described air leakage is sufficient to permit the urging means 95 to move the diaphragm member 46 downwardly to close the valve seat 67 and open the valve seat 76 so that the source 132 is disconnected from the device 133.

Therefore, it can be seen that the unit 40 of this invention provides a DELAY logic function wherein the pressure output to the pressure operated device 133 is delayed for a predetermined time period from the time that a pneumatic pressure signal is initially directed to the unit 40. Conversely, the unit 40 continues to provide a pressure signal to the device 133 for a predetermined time period after the pneumatic pressure signal to the unit 40 is terminated.

Referring now to FIG. 24, the logic unit 40 of this invention is illustrated in a vacuum operated logic system that is generally indicated by the reference numeral 131A for providing the aforedescribed DELAY logic function, the parts of the system 131A similar to the system 131 of FIG. 11 are indicated by like reference numerals followed by the reference letter A.

As illustrated in FIG. 24, the vacuum source 132A is directly interconnected to the port 68 of the logic unit 40 and the vacuum operated device 133A is interconnected to the fifth port 71 of the unit 40. The ports 77 and 65' of the unit 40 are directly interconnected to the atmosphere. A control means 134A is adapted to interconnect the source 132A to the port 65 of the unit 40 that leads to the intermediate chamber 49. However, a restrictor 135A and accumulator 136A are disposed in series between the control means 134A and the port 65.

If the control means 134A is in an "off" condition thereof, the urging means 95 maintains the diaphragm member 46 against the valve seat 67 so that the vacuum source 132A is prevented from being interconnected to the device 133A which is at atmospheric condition because of the passage means 94 through the diaphragm member 46 and the opened valve seat 76.

When the control means 134A initially directs a vacuum signal from the source 132A toward the port 65, the restrictor 135A and accumulator 136A function in a manner to prevent an effective evacuation of the chamber 49 for a predetermined time period after the lapse of which the evacuation of the chamber 49 results in a pressure differential across the intermediate diaphragm portion 84 sufficient to move the

diaphragm member 46 upwardly in opposition to the force of the compression spring 95 to open the valve seat 67 and close the valve seat 76 so that the vacuum source 132A is now interconnected to the device 133A.

Conversely, when the control means 134A initially disconnects the vacuum source 132A from the port 65 of the unit 40 after the diaphragm member 46 has been moved upwardly to close the valve seat 76 in the manner previously described, the restrictor 135A and accumulator 136A function to prevent a sufficient return of air to the chamber 49 through the previously described air leakage means for a predetermined time period after the lapse of which the resulting decrease in pressure differential across the intermediate diaphragm portion 84 of the diaphragm member 46 permits the compression spring 95 to move the diaphragm member 46 downwardly to close the valve seat 67 and open the valve seat 76 so that the vacuum source 132A is disconnected from the vacuum operated device 133A.

Therefore, it can be seen that the logic unit 40 of this invention can be utilized in a pressure or a vacuum system to provide a DELAY logic function without any change in the structure thereof.

FIG. 12 schematically illustrated a logic arrangement that is generally indicated by the reference numeral 137 and that provides a PULSE SHAPER logic function somewhat similar to a DIFFERENTIATOR logic function wherein an input signal 138 initially directed to the logic unit 137 will create an output signal 139 only for a short duration of time after the lapse of which the output signal 139 is terminated even though the input signal 138 continues in an "on" condition after the lapse of the time period that the output signal 139 was "on."

Referring now to FIG. 13, the logic unit 40 of this invention is utilized in a fluid pressure system that is generally indicated by the reference numeral 140 to provide the aforementioned PULSE SHAPER logic function, the system 140 of this invention comprising a fluid pressure source 141 adapted to be interconnected by a control means 142 to the port 77 of the unit 40 and to a signal means conduit 143 that leads to the port 65' of the unit 40. However, the signal means conduit 143 has a restriction 144 therein intermediate the control means 142 and the port 65'. The pressure operated device 145 is interconnected to the fifth port 71 of the unit 40 while the ports 68 and 65 are respectively interconnected to the atmosphere.

When the control means 142 initially interconnects the pressure source 141 to the port 77 and to the signal means conduit 143, the restrictor 144 prevents a buildup of pressure in the intermediate chamber 48 sufficient to overcome the force of the compression spring 95 for a predetermined time period whereby during such time period, the pressure source 141 is directly interconnected to the pressure operated device 145 through the opened valve seat 76 and the passage means 94 through the diaphragm member 46. However, after the lapse of such time period, the buildup of pressure in the chamber 48 is such that the same results in a pressure differential across the intermediate diaphragm portion 84 of the diaphragm member 46 to move the diaphragm member 46 upwardly in opposition to the force of the compression spring 95 to close the valve seat 76 and open the valve seat 67 whereby the pressure source 141 is disconnected from the pressure operated device 145 which is now interconnected to the atmosphere through the opened valve seat 67. Thus, the diaphragm member 46 now remains in its up position closing the valve seat 76 as long as the signal means is being directed to the intermediate chamber 48 after the lapse of the aforementioned time period.

Therefore, it can be seen that the logic unit 40 of this invention is adapted to provide a PULSE SHAPER logic function in a pressure system of this invention.

Referring now to FIG. 25, the logic unit 40 of this invention is schematically illustrated in a vacuum operated logic system that is generally indicated by the reference numeral 140A with the system 140A providing the PULSE SHAPER logic function, the various parts of the system 140A similar to the system 140 of FIG. 13 are indicated by like reference numerals followed by the reference letter A.

As illustrated in FIG. 25, the vacuum source 141A is directly interconnected to the port 68 of the logic unit 40 and a control means 142A is adapted to interconnect the source 141A to the port 65 of the unit 40. The vacuum operated device 145A is interconnected by a conduit means 146 to the fifth port 71 of the logic unit 40 while the port 77 thereof is directly interconnected to the atmosphere.

A conduit means 147 interconnects the conduit 146 intermediate the vacuum operated device 145A and the port 71 to the port 65' of the unit 40, the conduit means having a restrictor 148 and an accumulator 149 in series therein intermediate the conduit 146 and the port 65'.

When the control means 142A is in an "off" condition so that the vacuum source 141A is disconnected from the intermediate chamber 49, the compression spring 95 maintains the diaphragm member 46 closed against the valve seat 67 so that the vacuum source 141A is disconnected from the vacuum operated device 145A which is interconnected to the atmosphere through the passage means 94 of the diaphragm member 46 and the opened valve seat 76.

However, when the control means 142A initially interconnects the vacuum source 141A to the intermediate chamber 49, the resulting pressure differential across the intermediate diaphragm portion 84 causes the diaphragm member 46 to move upwardly in opposition to the force of the compression spring 95 to open the valve seat 67 and close the valve seat 76 so that the vacuum source 141A is interconnected to the vacuum operated device 145A.

However, with the vacuum source 141A now interconnected to the vacuum operated device 145A, the restrictor 148 and accumulator 149 in the conduit means 147 prevents evacuation of the intermediate chamber 48 to such a degree that the same counterbalances the evacuation of the chamber 49 until after the lapse of a predetermined time period. At the lapse of the predetermined time period, the decrease in the pressure differential across the intermediate diaphragm portion 84 of the diaphragm member 46 is such that the compression spring 95 moves the diaphragm member 46 downwardly to close the valve seat 67 and open the valve seat 76 so that the vacuum source 141A is disconnected from the vacuum operated device 145A whereby the diaphragm member 46 will remain in its down position closing off the valve seat 67 as long as the control means 142A continues to direct the vacuum source 141A to the intermediate chamber 49 after the lapse of the aforementioned predetermined time period until the chamber 48 returns to atmospheric condition so that the vacuum signal in chamber 49 can again cause the diaphragm member 46 to move upwardly and repeat the PULSE SHAPER logic function in the manner previously described.

Therefore, it can be seen that the logic unit 40 of this invention can be utilized to produce a PULSE SHAPER logic function in a pressure system or a vacuum system without a change in the structure thereof.

Referring now to FIG. 14, a fluid pressure operated logic system of this invention is generally indicated by the reference numeral 195 and combines a first logic unit 40 and a like second logic unit 40A to produce an OSCILLATOR logic function, the system 195 comprising a fluid pressure source 196 interconnected to the port 68 of the unit 40 and being adapted to be interconnected by a control means 197 through a restrictor 198 to the port 65' of the unit 40 and to the port 68 of the other unit 40A. The pressure operated device 199 is interconnected to the fifth port 71 of the unit 40 and a passage means 150 having a restrictor 151 therein interconnects the port 65' of the other unit 40A to a conduit means 152 that interconnects the fifth port 71 of the unit 40 to the pressure operated device 199.

The system 195 therefore utilizes the unit 40A as a MEMORY logic unit and the unit 40 as an AND logic unit to combine the same to provide an OSCILLATOR logic function that can be defined as having one input and one output so that

when the input is "on", the output will oscillate "on" and "off" at a predetermined frequency.

In particular, it can readily be seen in FIG. 14 that when the control means 197 is in an "off" condition so that no pressure fluid is being delivered to the port 65' of the AND unit 40 and to the port 68 of the MEMORY unit 40A both diaphragm members 46 are respectively held against the valve seats 67 so that the pressure source 196 cannot deliver a pressure output to the pressure operated device 199 which is at atmospheric conditions because of the opened valve seat 76 of the unit 40 and the passage means 94 through the diaphragm member 46 thereof.

However, when the control device 197 delivers a pressure signal through the restrictor 196 to the port 65' of the unit 40 and to the port 68 of the unit 40A, the resulting pressure differential across the intermediate diaphragm portion 84 of the diaphragm member 46 of the unit 40 overcomes the force of the compression spring 95 so that the diaphragm member 46 of the unit 40 moves upwardly to open the valve seat 67 and close the valve seat 76 so that the pressure source 196 is now interconnected to the pressure operated device 199. Simultaneously the pneumatic signal means is being directed to the port 68 of the unit 40A but because the diaphragm member 46 thereof is closing the valve seat 67, the pressure signal means is not dissipated out through the fifth port 71 of the device of the unit 40A. With pressure fluid now being delivered to the device 199, it can be seen that the passage means 150 will, after a predetermined time period, deliver sufficient pressure fluid through the restrictor 151 to the port 65' of the unit 40A so that the resulting pressure differential across the intermediate diaphragm portion 84 of the diaphragm member 46 of the unit 40A will cause the diaphragm member 46 to move upwardly in opposition to the force of the compression spring 95 to open the valve seat 67 so that the pneumatic signal means will now be dissipated through the opened valve seat 67 to the atmosphere through the port 71 of the unit 40A. In this manner, the pressure fluid in the intermediate chamber 48 of the unit 40 will be dissipated and the compression spring 95 will move the diaphragm member 46 of the unit 40 downwardly to again close the valve seat 67 and thereby terminate the flow of pressure fluid from the source 196 to the device 199. The diaphragm member 46 of the unit 40A remains in its up position until the pressure fluid in the intermediate chamber 48 thereof dissipates sufficiently through the aforementioned air leakage means so that the compression spring 95 will move the diaphragm member 46 downwardly to again close the valve seat 67 of the unit 40A and thereby again permit a pressure buildup of the signal means in the intermediate chamber 48 of the unit 40 to again open the valve seat 67 thereof and interconnect the source 196 again to the device 199.

Therefore, it can be seen that as long as the control means 197 is delivering a pressure signal means through the restrictor 198, the output to the device 199 will oscillate "on" and "off" at a predetermined frequency provided by the restrictor 151 in the conduit means 150 so that the pressure operated logic system 195 provides an OSCILLATOR logic function utilizing two units 40 of this invention without changes in the structure thereof.

Referring now to FIG. 15, a logic means 153 is schematically illustrated for producing a MEMORY logic function, the MEMORY means 153 having two inputs 154 and 155 and one output 156 so that when only the input 154 is in an "on" condition, the unit 153 produces the output 156 and will maintain the output 156 even though the input 154 is subsequently terminated whereby the output 156 continues until the other input 155 is turned "on" to cause the unit 153 to terminate the output 156. Thus, it can be seen that the unit 153 provides the MEMORY logic function of remembering that the input 154 was initially "on" so as to continue to produce the output 156 until the reset input 155 is imposed thereon.

The logic unit 40 of this invention can be utilized in the pressure system 157 of FIG. 16 to produce the aforementioned MEMORY function in a manner now to be described.

As illustrated in FIG. 16, the pressure system 157 of this invention utilizes a first logic unit 40 and another logic unit 40A that is identical to the logic unit 40, the system 157 comprising a pressure source 158 directly interconnected to the port 68 of the logic unit 40 and a first control means 159 for interconnecting a pressure signal through a one-way valve means 160 to the port 65' of the unit 40. However, a first passage means 161 interconnects the port 68 of the other unit 40A to the signal means of the first control means 159 intermediate the check valve 160 and the port 65' of the unit 40.

A pressure operated device 162 is interconnected to the fifth port 71 of the unit 40 by passage means 163. A second passage means 164 interconnects the passage means 163 intermediate the port 71 and the device 162 through a restrictor 165 to the signal means of the control means 159 intermediate the check valve 160 and the port 65' of the unit 40.

A second control means 166 is adapted to interconnect a pressure signal means to the port 65' of the other unit 40A.

With both control means 159 and 166 in their "off" condition, it can be seen that both diaphragm members 46 of the units 40 and 40A are respectively closing the valve seats 67 thereof so that the source 158 is completely disconnected from the device 162 and the device 162 is at atmospheric condition because of the opened valve seat 76 of the unit 40 and the opening means 94 through the diaphragm member 46 thereof.

However, when the first control means 159 is initially turned "on" to direct a pressure signal through the one-way check valve 160 to the port 65' of the unit 40, the resulting pressure differential across the intermediate diaphragm portion 84 of the diaphragm member 46 of the unit 40 overcomes the urging means 95 thereof to open the valve seat 67 of the outboard chamber 47 to not only interconnect the pressure source 158 to the device 162, but also to supply sufficient pressure through the restrictor 165 of the passage means 164 to the intermediate chamber 48 of the unit 40 to maintain the diaphragm member 46 thereof in its up condition so that the source 158 will be continuously interconnected to the device 162 even though the first control means 159 is subsequently turned to its "off" condition, the passage 161 being closed from the atmosphere by the diaphragm member 46 of the unit 40A.

Thus, once the control means 159 has been turned to an "on" position thereof, the unit 40 maintains an interconnection between the source 158 and the device 162 until the second control means 166 is turned "on" and directs a pressure signal to the port 65' of the unit 40A to produce a pressure differential across the intermediate diaphragm portion 84 thereof that overcomes the urging means 95 thereof and moves the diaphragm member 46 thereof upwardly to open the valve seat 67 of the unit 40A so that the passage 161 is interconnected to the atmosphere through the port 71 of the unit 40A and such interconnection will dissipate the pressure in the intermediate chamber 48 of the unit 40 sufficiently so that the urging means 95 will move the diaphragm member 46 of the unit 40 downwardly to close the valve seat 67 and thereby terminate the interconnection of the source 158 to the device 162.

Therefore, it can be seen that the pressure operated logic system 157 of FIG. 16 provides a MEMORY logic function previously described.

Such logic units 40 can be utilized in a vacuum system of this invention to provide the aforementioned MEMORY logic function.

For example, reference is now made to FIG. 26 wherein a vacuum operated logic system of this invention is generally indicated by the reference numeral 167 and provides a MEMORY logic function with a first logic unit 40 and a second logic unit 40A, the parts of the system 167 similar to parts of the system 157 of FIG. 16 are indicated by like reference numerals followed by the reference letter A.

As illustrated in FIG. 26, the vacuum source 158A is directly interconnected to the port 68 of the first unit 40 and a first control means 159A is adapted to interconnect a vacuum

signal through a one-way check valve means 160A to the port 65 of the unit 40. A vacuum operated device 162A is interconnected by a passage means 163A to the fifth port 71 of the unit 40.

A first passage means 168 interconnects the signal means of the first control means 159A intermediate the check valve 160A and the port 65 of the unit 40 to the passage 163A intermediate the device 162A and the port 71 of the unit 40, the passage 168 having a restrictor 169 therein.

A second passage means 170 interconnects the port 68 of the other unit 40A to the first passage means 168 intermediate the restrictor 169 thereof and the check valve 160A.

A second control means 166A is adapted to interconnect a vacuum signal means to the port 65 of the other unit 40A.

When the control means 159A and 166A are in an "off" condition thereof, it can be seen that the diaphragm members 46 of the units 40 and 40A are respectively closing the valve seats 67 so that the vacuum source 158A is disconnected from the device 162A and the device 162A is at atmospheric condition because of the open valve seat 76 of the unit 40 and the opening means 94 through the diaphragm member 46 thereof.

However, when only the control means 159A is turned to an "on" condition thereof to direct a vacuum signal through the one-way check valve 160A to the intermediate chamber 49 of the unit 40 to overcome the urging means 95 and cause the diaphragm member 46 to move upwardly and open the valve seat 67, not only is the vacuum source 158A interconnected to the device 162A, but also the vacuum source 158A is interconnected by the first passage means 168 to the intermediate chamber 49 of the unit 40 to lock the diaphragm member 46 in its up position even if the first control means 159A is subsequently turned to an "off" condition thereof whereby the vacuum source 158A is continuously interconnected to the device 162A as long as the second control means 166A is in an "off" condition thereof.

When the second control means 166A is turned to an "on" condition thereof to direct a vacuum signal to the intermediate chamber 49 of the unit 40A so as to produce a pressure differential across the intermediate diaphragm portion 84 of the diaphragm member 46 thereof to overcome the compression spring 95 whereby the diaphragm member 46 moves upwardly to open the valve seat 67, it can be seen that the second passage 170 is now interconnected to the atmosphere through the fifth port 71 of the unit 40A so that air is now permitted to return to the intermediate chamber 49 of the unit 40 so that the urging means 95 of the unit 40 will move the diaphragm member 46 thereof downwardly to again close the valve seat 67 and thereby terminate the interconnection between the vacuum source 158A and the device 162A.

Accordingly, it can be seen that the vacuum operated logic system 167 of this invention utilizes two identical logic units 40 and 40A of this invention to produce a MEMORY logic function as previously described.

Reference is now made to FIG. 17 wherein another logic arrangement is generally indicated by the reference numeral 171 and is utilized for providing a FLIP-FLOP logic function that has two input signal means 172 and 173 and two outputs 174 and 175, the arrangement 171 being such that when the input 172 is "on", only the output 174 is "on." However, when the input 173 is "on," the output 174 is "off" and the output 175 is "on."

Such FLIP-FLOP logic function can be provided by utilizing the logic units 40 of this invention in the manner illustrated in FIG. 18 wherein a fluid pressure logic system of this invention is generally indicated by the reference numeral 176 and comprises a first logic unit 40, a second logic unit 40A and a third logic unit 40B, the logic units 40, 40A and 40B being identical without any changes in the structure thereof.

The pressure source for the system 176 is indicated by the reference numeral 177 and is directly interconnected to the port 68 of the unit 40 and to the port 77 of the second unit 40A. A first control means 178 is adapted to interconnect a pressure signal means through a one-way check valve means 179 to the port 65' of the unit 40. A second control means 180 is adapted to interconnect its pressure signal means to the port 65' of the third unit 40B. A first pressure operated device 181 is interconnected to the fifth port 71 of the first unit 40 by a conduit means 182. A second pressure operated device 183 is interconnected to the port 71 of the second unit 40A.

A first passage means 184 interconnects the port 68 of the third unit 40B to the port 65' of the second unit 40A and to the single means of the first control means 178 intermediate the check valve 179 and the port 65' of the first unit 40.

A second passage means 185 having a restriction 191 therein interconnects the conduit 182 to the signal means of the first control means 178 intermediate the check valve 179 and the port 65' of the first unit 40.

The ports 71, 65 and 77 of the third unit 40B, the ports 65 and 68 of the second unit 40A and the ports 65 and 77 of the first unit 40 are interconnected to the atmosphere.

With the pressure source 177 operating and the control means 178 and 180 being in an "off" condition, it can be seen that the diaphragm member 46 of the first unit 40 is closing the valve seat 67 so that the source 177 is not connected to the first device 181 and that the device 181 is interconnected to the atmosphere through the opening means 94 of the diaphragm member 46 and open valve seat 76 of the unit 40 while the second device 183 is interconnected to the source 177 through the opened valve seat 76 of the second unit 40A and the opening means 94 passing through the diaphragm member 46 thereof.

However, when only the first control means 178 is turned to an "on" condition thereof to direct a pressure signal through the one-way check valve 179 through the ports 65' of the units 40 and 40A, the resulting differential in pressure across the intermediate diaphragm portions 84 of the diaphragm members 46 thereof causes the diaphragm members 46 to move upwardly in opposition to the force of the compression springs 95 to respectively open the valve seats 67 thereof and close the valve seats 76 thereof so that the source 177 is interconnected through the open valve seat 67 of the first unit 40 to the first device 181 while the source 177 is disconnected by the closed valve seat 76 of the second unit 40A from the second device 183 which is now interconnected to the atmosphere through the opened valve seat 67 of the second unit 40A.

The second passage means 185 of the system 176 cooperates with the one-way check valve 179 to maintain sufficient pressure in the intermediate chambers 48 of the units 40 and 40A to maintain the diaphragm members 46 thereof in an "up" condition in FIG. 18 even if the first control means 178 is subsequently turned "off" after causing an output pressure to the first pneumatically operated device 181.

Thus, the source 177 remains interconnected to the device 181 until the second control means 180 is turned to an "on" condition thereof to direct a pressure signal means to the intermediate chamber 48 of the third unit 40B to overcome the urging means 95 and cause the diaphragm member 46 to move upwardly to open the valve seat 67 thereof and close the valve seat 76 thereof whereby the first passage means 184 is now interconnected to the atmosphere through the opened valve seat 67 of the unit 40B through the fifth port 71 thereof.

With the opening of the valve seat 67 of the third unit 40B, it can be seen that the pressure in the intermediate chambers 48 of the units 40 and 40A is dissipated to the atmosphere so that the urging means 95 respectively cause the diaphragm members 46 of the units 40 and 40A to move downwardly to close the valve seats 67 thereof and open the valve seats 76 thereof so that the atmosphere is now interconnected to the first device 181 through the opened valve seat 76 and opening means 94 of the diaphragm member 46 of the first unit 40 and the source 177 is now interconnected to the second device 183 through the open valve seat 76 of the second unit 40A and the opening means 94 passing through the diaphragm member 46 thereof.

Accordingly, it can be seen that the system 176 of this invention provides a FLIP-FLOP logic function utilizing three logic units 40 of this invention without any changes in the structure of the units 40.

Reference is now made to FIG. 27 wherein three such logic units 40, 40A and 40B are utilized in a vacuum operated logic system 186 of this invention for providing the aforementioned FLIP-FLOP logic function. The parts of the system 186 that are similar to parts of the system 176 of FIG. 18 are indicated by like reference numerals followed by the reference letter A.

In particular, the system 186 comprises a vacuum source 177A interconnected to the port 68 of the first unit 40 and to the port 77 of the second unit 40A. A first control means 178A is adapted to interconnect its vacuum signal means through a one-way check valve 179A to the port 65 of the first unit 40. A second control means 180A is adapted to interconnect its vacuum signal means to the port 65 of the third unit 40B.

A first vacuum operated device 181A is interconnected by a conduit means 182A to the port 71 of the first unit 40 while a second vacuum operated device 183A is interconnected to the port 71 of the second unit 40A.

A first passage means 187 interconnects the vacuum signal means of the first control means 178A intermediate the check valve 179A and the port 65 of the first unit 40 to the conduit 182A that interconnects the fifth port 71 of the unit 40 to the first device 181A. The first passage 187 has a restriction 188 therein.

A second passage means 189 interconnects the port 65 of the second unit 40A to the port 68 of the third unit 40B and to the first passage means 187 intermediate the check valve 179A and the restriction 188.

When both control means 178A and 180A are in an "off" condition and the vacuum source 177A is operating, it can be seen that the first device 181A is interconnected to the atmosphere through the opened valve seat 76 of the first unit 40 and the passage means 94 through the diaphragm member 46 thereof while the second device 183A is interconnected to the vacuum source 177A through the opened valve seat 76 of the second unit 40A and the passage means 94 through the diaphragm member 46 thereof.

However, when only the first control means 178A is turned to an "on" condition thereof, the vacuum signal thereof that operates through the one-way check valve 179A respectively evacuates the intermediate chambers 49 of the first and second units 40 and 40A so that the resulting pressure differentials across the intermediate diaphragm portions 84 of the diaphragm members 46 thereof overcomes the urging means 95 to move the diaphragm members 46 respectively to open the valve seats 67 thereof and close the valve seats 76 thereof so that the vacuum source 177A is interconnected to the first device 181A through the opened valve seat 67 and the fifth port 71 of the unit 40 and the vacuum source 177A is disconnected from the second device 183A because of the closed valve seat 76 of the second unit 40A.

Because of the first passage means 187 cooperating with the one-way check valve 179A, sufficient evacuation of the intermediate chambers 49 of the units 40 and 40A continues to take place even though the first control means 178A may be subsequently turned to an "off" condition thereof so that the vacuum source 177A will remain interconnected to the first device 181A after the first control means 178A has been turned to an "on" condition thereof until the second control means 180A is turned to an "on" condition thereof.

In particular, when the second control means 180A is turned to an "on" condition thereof to direct a vacuum signal means to the intermediate chamber 49 of the third unit 40B so that the resulting pressure differential across the intermediate diaphragm portion 84 thereof causes the diaphragm member 46 to move in opposition to the force of the urging means 95 to open the valve seat 67 and close the valve seat 76 of the unit 40B, the opened valve seat 67 of the unit 40B now effectively interconnects the first and second passage means 187 and 189 to the atmosphere at the port 71 of the unit 40B so that sufficient air now returns to the intermediate chambers 49 of the units 40 and 40A to cause the urging means 95 to move the diaphragm members 46 respectively against the valve seats 67 thereof whereby the unit 40 disconnects the source 177A from the first device 181A and the opened valve seat 76 of the unit 40A interconnects the vacuum source 177A to the second unit 183A through the opening means 94 of the diaphragm member 46 of the unit 40A.

Therefore, it can be seen that the vacuum control system 186 of FIG. 27 provides a FLIP-FLOP logic function utilizing three logic units 40 of this invention without any change in the structure of the units 40.

Reference is now made to FIG. 19 wherein the dryer control system of the aforementioned copending parent application is illustrated and utilizes three logic units of FIG. 2 in a manner hereinafter described.

As illustrated in FIG. 19, the laundry apparatus is generally indicated by the reference numeral 200 and includes an electric motor 215 which rotates the clothes-receiving drum (not shown) of the apparatus 200 during the entire cycle of operation of the apparatus 200 in a conventional manner, the electric motor 215 being adapted to be interconnected to power source leads L^1 and L^2 in a manner hereinafter described. The electric motor is adapted to drive an eccentric cam 216 connected to its output shaft 217 as long as the electrical motor 215 is energized whereby the eccentric cam 216 will continuously move a piston rod arrangement 218 to operate a vacuum pump means 219 to provide a continuous vacuum source for the pneumatic logic control system of this invention which is generally indicated by the reference numeral 201 as long as the electrical motor 215 is energized, the vacuum pump 219 having its inlet 220 interconnected to a conduit means 221.

The power source lead L^1 is interconnected to a door operated electrical switch blade 222 by a lead 223 whereby the switch blade 222 will be closed against a contact 224 only when the access door of the dryer 200 is disposed in its closed position so as to electrically interconnect the lead 223 to a lead 225 that is interconnected to one side 226 of the electrical motor 215. The other side 227 of the electrical motor 215 is interconnected to a contact 228 by a lead 229. An "on-off" electrical switch 233 is provided for the apparatus 200, the switch 233 being automatically operated by a timer means of the apparatus 200 in a conventional manner.

In particular, when the housewife or the like, desires to utilize the apparatus 200, the housewife sets the timer knob (not shown) of the control system 201 in its selected "on" position whereby such setting of the control knob of the timer means of the apparatus 200 will close a switch blade 234 against the contact 228 to electrically interconnect a lead 235 to the lead 229, the lead 235 being interconnected to the power source lead L^2 whereby the other side of the electrical motor 215 will be interconnected to the power source lead L^2 as long as the switch blade 234 is disposed in its closed position. Thus, if the dryer door is also disposed in its closed position, the power source lead L^1 will be interconnected to the side 226 of the electrical motor 215 so that the electrical motor 215 will be energized to not only drive the clothes-receiving drum of the dryer 200, but also to continuously operate the vacuum pump 219 to automatically control the system 201 in a manner hereinafter described.

A pneumatically operated valve means 214 is provided for interconnecting a fuel source conduit 213 to a main burner means 212 of the apparatus 200 and comprises a housing means having a valve seat 236 that interconnects the fuel source 213 to the burner means 212, the valve seat 236 being opened and closed by a valve member 237 that is moved between its open and closed positions by a vacuum operated actuator that is generally indicated by the reference numeral 238 and comprises a cup-shaped housing member 239 having its open end closed by a flexible diaphragm 240 that is interconnected to the valve member 237 by a tying means 241 in a conventional manner whereby the flexible diaphragm 240

cooperates with the housing 239 to define a chamber 242 therebetween. A compression spring 243 is disposed in the chamber 242 to tend to normally move the flexible diaphragm 240 upwardly as illustrated in FIG. 19 to maintain the valve member 237 in its closed position against the valve seat 236 to prevent any flow of fuel to the main burner means 212. However, when the vacuum source 219 is interconnected to the chamber 242 in a manner hereinafter described to evacuate the chamber 242, the pressure differential acting across the diaphragm 240 moves the diaphragm 240 downwardly in opposition to the force of the compression spring 243 to move the valve member 237 to its open position so that the fuel source 213 will be interconnected to the main burner means 212 as long as the pneumatically operated actuator 238 is in its actuated condition.

The ignition means for the main burner means 212 comprises an ignition coil 244 having one side 245 thereof interconnected by a lead 246 to the lead 235 so that the side 245 of the ignition coil 244 is always interconnected to the power source lead L^2. The other side 247 of the ignition coil 244 is interconnected by a lead 248 to a switch blade 249 that is adapted to close against a contact 250 that is electrically interconnected to the power source lead L^1 by a lead 251 only when a vacuum operated actuator 242 is actuated.

In particular, the vacuum operated actuator 252 comprises a cup-shaped housing 253 having its open end closed by a flexible diaphragm 254 interconnected to the switch blade 249 by a tying means 255, the diaphragm 254 cooperating with the housing means 252 to define a chamber 256 therebetween which receives a compression spring 257 that normally urges the flexible diaphragm 254 upwardly to the position illustrated in FIG. 1 to open the switch blade 249 from the contact 250. However, when the chamber 256 is evacuated by being interconnected to the vacuum source 219 in the manner hereinafter described, the pressure differential acting across the diaphragm 254 moves the diaphragm 254 downwardly in opposition to the force of the compression spring 257 to close the switch blade 249 against the contact 250 which, in effect, places the ignition coil 244 across the power source leads L^1 and L^2 to energize the same whereby the energized coil 244 can heat up to a temperature that will be sufficient for igniting fuel issuing from the burner means 212 in a conventional igniting manner.

An ignition coil temperature sensing means 258 is provided for the system 201 and comprises a bimetal member 259 that is interconnected to a valve member 260 by a tying means 261, the valve member 260 being disposed in a housing means 262 having a valve seat 263 interconnecting an inlet conduit 264 to an outlet conduit 265. When the bimetal member 259 senses a temperature of the ignition coil 244 below a temperature sufficient for igniting fuel issuing from the main burner means 212, the bimetal member 259 is in such a condition that the same maintains the valve member 260 away from the valve seat 263 to fluidly interconnect the conduits 264 and 265 together. However, when the ignition coil 244 reaches an ignition temperature, the bimetal member 259 warps in such a manner that the same moves the valve member 260 against the valve seat 263 to terminate the fluid connection between the conduits 264 and 265. In addition, when the main burner means 212 is operating, the bimetal member 259 also senses the flames at the main burner means 212 so that the same will maintain the valve member 260 in its closed position against the valve seat 263 as long as fuel is burning at the main burner means 212.

Another temperature sensing device 266 is provided for the control system 201 and is adapted to sense the temperature effect of the main burner means 212. The temperature sensing means 266 comprises a bimetal member 267 that is interconnected to a valve member 268 by a tying means 269, the valve member 268 being disposed in a housing means 270 to open and close a valve seat 271 thereof that fluidly interconnects the conduit 221 to a conduit 272 that is fluidly interconnected to the conduit 264 of the ignition temperature sensing means 259.

As long as the temperature effect of the burner means 212 of the apparatus 200 is below a predetermined temperature setting of the sensing means 266, the bimetal member 267 maintains the valve member 268 away from the valve seat 271 to fluidly interconnect the conduits 221 and 272 together whereby if the electrical motor 215 is energized, the vacuum source 218 will be interconnected to the conduit 272. However, when the temperature sensing means 266 senses a temperature effect of the burner means 212 above the set temperature setting of the thermostatic means 266, the bimetal member 267 warps in a manner to move the valve member 268 against the valve seat 271 and, thus, disconnect the vacuum source 219 from the conduit 272 for a purpose hereinafter described. Of course, it is to be understood that the sensing device 266 could be manually adjustable for temperature selection purposes by the housewife or the like or could be factory set for an optimum drying temperature.

The conduit 272 is interconnected to the port means 68 of the logic unit 40 that performs a MEMORY logic function later to be described, the conduit 272 also being fluidly interconnected to a conduit 275 that leads to the port means 77 of another logic unit 40A that performs a NOT logic function.

The conduit 265 leading from the ignition temperature sensing means 258 is interconnected to a one-way check valve 279 that leads to the port means 65 of the logic unit 40.

The conduit 265 is fluidly interconnected to a conduit means 288 that is fluidly interconnected to the chamber 256 of the vacuum operated actuator 252, the conduit 288 also being interconnected to a conduit 289 that leads to the atmosphere by means of a restrictor 290 disposed in the conduit means 289.

The fifth port means 71 of the pneumatically operated logic MEMORY unit 40 is interconnected by a conduit means 303 to a port means 65 of a pneumatically operated logic AND unit 40B of this invention, the logic AND unit 40B having the fifth port means 71 thereof interconnected by a conduit means 307 to the fifth port means 71 of the logic NOT unit 40A. The port means 68 of the logic AND unit 40B is interconnected by a conduit means 310 to the chamber 242 of the pneumatically operated actuator 238. The port means 77 of the logic AND unit 40B is interconnected by a conduit means 312 to the atmosphere through restrictor 313.

The conduit 265 that leads from the ignition temperature sensing means 258 is fluidly interconnected to a conduit means 314 that leads to the port means 65 of the logic NOT unit 40A. The port means 68 of the logic NOT unit 40A is interconnected to a conduit means 317 that leads to the atmosphere through a restrictor 318.

The control system 201 is so constructed and arranged that the ignition coil 244 for the burner means 212 must be first energized to a temperature thereof that will be sufficient for igniting fuel issuing from the burner means 212 each time before the actuator 238 will move the valve member 237 from its closed position to its open position to cause fuel to issue from the main burner means 212.

Thus, since both temperature sensing devices 258 and 266 are disposed in their open position when the control system 10 is initially turned on by the closing of the switch blade 234 against the contact 228, either manually or automatically by a timer clock or the like, the energized electric motor 215 will operate the vacuum pump 219 and since the temperature effect of the apparatus 200 is below the temperature effect setting of the thermostatic device 266, the vacuum pump 219 is adapted to evacuate conduit 272 through the open valve means 268 as well as to evacuate conduits 272 and 314 leading respectively to the logic MEMORY unit 40 and logic NOT unit 40A.

As illustrated in FIG. 20, the logic AND unit 40B will require two vacuum signals from the logic MEMORY unit 40 and logic NOT unit 40A respectively through conduit means 303 and 307 to cause the logic AND unit 40B to direct an output vacuum signal through the conduit means 310 to open the valve means 237 so that the fuel source 213 can be interconnected to the main burner means 212. However, the

MEMORY unit 40 must first receive a signal from the conduit means 265 that is caused by the ignition temperature sensing means 258 having its valve member 260 disposed in its open condition before the MEMORY unit 40 will direct its output vacuum signal to the AND unit 40B. The logic NOT unit 40A also receives the vacuum signal from the open setting of the valve member 260 of the temperature sensing means 258 through the conduit means 314 and will not direct its vacuum output signal through the conduit means 307 to the AND unit 40A, to cause opening of the valve means 237 for the main burner means 212 until after the signal through conduit 314 is terminated by the closing of the valve member 260 against the valve seat 263 of the ignition temperature sensing means 258 so that the AND unit 40B cannot cause opening of the valve means 237 until after the ignition coil 244 has been raised to a temperature proper for ignition of fuel issuing from the burner means 212. Accordingly, the logic units 40, 40A, and 40B require that the valve member 260 must be first in an open position and then be moved to a closed position after each closing of the main valve member 237 before the main valve member 237 can be again opened, the valve member 260 only closing after an open condition thereof when the ignition coil 244 is at a temperature suitable for igniting fuel that will be issued from the main burner means 212.

A controlled bleed to the atmosphere for the logic units 40, 40A, and 40B can be provided in the conduit 272 or in the conduit 310 to reset the same to the position illustrated in FIG. 19 when the valve member 268 closes against the valve seat 263 as will be apparent hereinafter. However, in the embodiment illustrated in the drawings, the conduit 310 is interconnected to the atmosphere at a controlled rate by a conduit 342 having a restrictor 343 therein.

The conduit 303 is interconnected by a conduit 281 to conduit 265 intermediate the check valve 279 and the port 65 of the unit 40, the conduit 281 having a restrictor 281' therein.

The operation of the control system 201 of this invention will now be described.

Assuming that the dryer door is in its closed position to hold the switch blade 222 against the contact 224, the housewife or the like sets the selector timer knob for operating the dryer 200 for a predetermined length of time whereby the timer mechanism closes and holds the switch blade 234 against the contact 228 and will maintain the switch blade 234 against the contact 228 during the entire cycle of operation of the dryer 200 at the conclusion of which the timer means will automatically open the blade 234 away from the contact 228 to terminate the operation of the apparatus 200.

With the switch blade 234 now moved to its closed position against the contact 228, it can be seen that the electric motor 215 is placed across the power source leads L^1 and L^2 so that the electric motor 215 will continuously rotate the laundry receiving drum to tumble the clothes in an atmosphere to be heated by the burner means 212 for a drying of the laundry or the like. As the output shaft 217 of the motor means 215 is continuously rotating, the same through the eccentric cam 216 reciprocates suitable pumping mechanism of the vacuum pump 219 to continuously provide a vacuum source for the control system 201.

At the initial operation of the control system 201, not only is the ignition coil 244 not at an ignition temperature, but also the temperature effect of the apparatus 200 is below the temperature setting for the thermostatic means 266 whereby both valve members 260 and 268 are disposed in their open position as illustrated in FIG. 19 so that the vacuum source 219 will not only be directed to the vacuum operated actuator 252 to evacuate the chamber 256 thereof and close the switch blade 249 against the contact 250 to place the ignition coil 244 across the power source leads L^1 and L^2, but also the vacuum source 219 is interconnected to the valve seat 67 of the MEMORY unit 40, to the valve seat 76 of the NOT unit 40A, to chamber 49 of the MEMORY unit 40 through the one way check valve means 279 and to the chamber 49 of the NOT unit 40A.

Since the vacuum source is interconnected to the chamber 49 of the NOT unit 40A, the pressure differential created across the intermediate diaphragm portion 84 thereof causes the diaphragm member 46 to move downwardly in opposition to the force of the compression spring 95 so the diaphragm member 46 closes off the valve seat 76 and opens the valve seat 67 to interconnect the atmosphere from conduit 317 into the chamber 47 thereof and, thus, to chamber 47 of the AND unit 40B.

With the vacuum source 219 now being interconnected to chamber 49 of the MEMORY unit 40, the resulting pressure differential across the intermediate diaphragm portion 84 thereof causes the diaphragm member 46 to move upwardly in opposition to the force of the compression spring 95 to open the valve seat 67 and close the valve seat 76 and thereby interconnect the vacuum source to the chamber 47 of the MEMORY unit 40 and, thus, by means of the conduit 303, to the chamber 49 of the AND unit 40B. With the vacuum source 219 not interconnected to chamber 49 of the AND unit, 40B, the resulting pressure differential across the diaphragm portion 84 thereof moves the diaphragm member 46 of the AND unit 40B downwardly in opposition to the force of the compression spring 95 so that the diaphragm member 46 closes the valve seat 76 leading to the atmosphere through the conduit means 312 while opening the valve seat 67. However, since the chamber 47 of the AND unit 40B is now interconnected by the conduit 307 to the chamber 47 of the NOT unit 40A, and since chamber 47 of the NOT unit 40A is interconnected to the atmosphere by the open valve seat 67 thereof, the chamber 242 of the actuator 238 remains interconnected to the atmosphere so that the valve member 237 remains in its closed position against the valve seat 236 to prevent any flow of fuel from the manifold 213 to the main burner means 212.

When the diaphragm member 46 of the MEMORY unit 40 is moved upwardly in FIG. 19 by the vacuum source being interconnected to the chamber 49 thereof, the vacuum being created in chamber 47 by the opened valve seat 67 causes evacuation of the conduit means 281 and restrictor 281' so as to provide a vacuum holding circuit to the chamber 49 for maintaining the diaphragm member 46 of the MEMORY unit 40 in its up position even during the subsequent absence of a vacuum signal in the conduit 265 which will permit the check valve 279 to close.

In particular, it can be seen that initially when the diaphragm member 46 of the MEMORY unit 40 is moved to its up position, the diaphragm member 46 of the NOT unit 40A is moved to its down position and the diaphragm member 46 of the AND unit 40B is moved to its down position whereby the atmosphere in the chamber 47 of the NOT unit 40A is effectively interconnected to the chamber 242 of the actuator 238 so that the main valve member 237 remains closed against the valve seat 236.

Under the above described condition, the ignition coil 244 is being energized and when the same reaches a predetermined temperature that is sufficient for ignition purposes, the ignition temperature sensing means 258 causes the valve member 260 to move to its closed position against the valve seat 263 to disconnect the vacuum source 219 from the conduit means 265 and 315 while 314 while interconnecting the atmosphere to the same by means of the restrictor 290 in the conduit means 289 so that the conduit means 265 and 314 will be bled to atmospheric pressure.

However, the check valve 279 now closes to prevent the bleed of air into the portion of the conduit 265 that leads to the chamber 49 of the MEMORY unit 40 so that the diaphragm member 46 thereof remains in its up position to still interconnect the vacuum source conduit 272 to the chamber 47 thereof and, thus, to the chamber 49 of the AND unit 40B to maintain the diaphragm member 46 thereof at its down position to interconnect the chamber 47 to the chamber 242 of the actuator 238.

The bleed of air into the conduit means 314 begins to bleed air into the chamber 49 of the NOT unit 40A so that when the bleed of air into the chamber 49 sufficiently reduces the pressure differential across the intermediate diaphragm portion 84 thereof, the compression spring 95 moves the diaphragm member 46 back to the back position illustrated in FIG. 19. In this manner, the vacuum source in the conduit 272 is now interconnected to the chamber 50 through the opened valve seat 76 and, thus, is interconnected to the chamber 47 of the NOT unit 40A by the passage means 94 in the diaphragm member 46. With the vacuum source 219 now being interconnected to the chamber 47 of the NOT unit 40A and with the atmosphere being disconnected from the chamber 47 by the diaphragm member 46 closing against the valve seat 67, vacuum is now interconnected to the chamber 47 of the AND unit 40B and will therefore be interconnected to the chamber 242 of the actuator 238 through the open valve seat 67 to evacuate the actuator 238 to move the valve member 237 to its open position whereby fuel is now adapted to flow from the source 213 to the burner means 212 and be ignited by the ignition coil 244.

As previously stated, when the valve member 260 of the ignition temperature sensing means 258 was moved to its closed position against the valve seat 263, the vacuum source 219 is disconnected from the conduit 265 and, thus, from the chamber 256 of the actuator 252 so that the bleed of air into the conduit 288 from the restrictor 290 permits the chamber 256 in the actuator 252 to return to atmospheric condition and open the switch blade 249 to terminate the source of current to the coil 244. However, since the coil 244 is still at a temperature sufficient to ignite fuel issuing from the burner means 212, the now opened valve means 214 issues fuel from the burner means 212 which is ignited by the heated ignition coil 244. If the fuel from the burner means 212 is properly ignited by the ignition coil 244, the temperature sensing means 259 of the sensing device 258 maintains the valve member 260 against the valve seat 263 during the burning of fuel at the main burner means 212 whereby the main burner beams 212 continues to burn until the temperature effect thereof reaches the temperature effect being sensed by the sensing means 266. At this time, the bimetal member 267 moves the valve member 268 against the valve seat 271 to disconnect the vacuum source 219 from the conduit means 272 and 275 to cause closing of the valve member 237 in a manner now to be described.

With the vacuum source 219 now disconnected from conduit 272 by the closing of the valve member 268 against the valve seat 271, the system bleeds down by air passing through the restrictor 343 and into conduit 342 and, thus, into conduit 310 to deactuate the actuator 238 to close the valve member 237 against the valve seat 236 and thereby terminate the flow of fuel to the main burner means 212. This bleed of air into the conduit 310 also bleeds into chamber 47 of the AND unit 40B and by conduit 307 into chamber 47, passage 94 and chamber 50 of the NOT unit 40A so as to pass through the opened valve seat 76 and into conduits 275 and 272 that lead to the chamber 47 of MEMORY unit 40. Chamber 47 of unit 40 now bleeds air into chamber 49 thereof by the passage means 281 to return the MEMORY unit 40 to the condition illustrated in FIG. 19. Similarly, with atmosphere now in the chamber 47 of the MEMORY unit 40, atmosphere is directed to chamber 49 of the AND unit 40B to cause the same to return to the condition illustrated in FIG. 19 whereby the entire control system 201 is turned off except that the electric motor 215 is continuing to operate to tumble the laundry in the heated atmosphere of the dryer 200.

The temperature effect in the dryer 200 now begins to drop because of the terminated operation of the main burner means 212. When the dropping temperature effect falls below the predetermined temperature setting of the thermostatic device 266, the bimetal member 267 again moves the valve member 268 to its open position to interconnect the conduit 221 to the conduit 272. When the flames ceased to exist at the main burner means 212 when the same was turned off by the closing of the valve member 237 in the manner previously described, the bimetal member 259 moved the valve member 260 to its open position as illustrated in FIG. 19 whereby the previously described cycle of operation for energizing the ignition coil 244 and the subsequent opening of the valve member 237 is repeated in the manner previously described to again cause operation in the main burner means 212.

Thus, it can be seen that the system 201 of this invention can cycle the main burner means 212 on and off in the manner previously described to tend to maintain the temperature effect in the dryer 200 at the temperature effect setting of the thermostatic device 266 until the timer opens the switch blade 234 to deenergize the motor 215 and, thus, turn off the vacuum source 219 whereby the entire system will bleed down through the restrictor means in the manner previously described so that the valve means 237 will be maintained in its closed position and the switch blade 234 will be disposed in its open position.

If during the normal cycle of operation of the control system 201 in the manner previously described, the housewife or the like should open and then close the access door for any reason, such opening of the door will open switch blade 222 to stop the electric motor 215 and, thus, terminate the vacuum source 219 so that the system 201 will bleed down to the off condition of FIG. 19. However, the housewife after opening such access door may quickly shut the same to again energize the electric motor 215. When access door is thus momentarily opened, the vacuum source 219 is terminated permitting the entire pneumatic control system to bleed down to atmospheric conditions by means of the restrictors in the manner previously described so that the previously created vacuum in the chamber 49 of the MEMORY unit 40 will cease to exist and the diaphragm member 46 will be moved downwardly to the position illustrated in FIG. 19 by the force of the compression spring 95 so as to prevent the occurrence of a MEMORY unit output vacuum signal in the chamber 47 thereof until a vacuum signal is again created in the conduit 265 in the manner previously described. The closing of the access door restarts the main motor 215 and restores the vacuum source 219. However, due to the construction and location of the bimetal member 259 of the flame sensing device 258, the bimetal member 259 is still warm because of a thermal lag therein and acts as if a main burner flame at the burner means 212 is still present so that the valve member 260 remains against the valve seat 263 during the intermittent opening and closing of the access door during the normal cycle of operation of the apparatus 200. Accordingly, the main thermostatic means 266 is now sensing a temperature effect in the apparatus 200 below the predetermined temperature effect so that the valve member 268 thereof is moved to an open position as illustrated in FIG. 19 to interconnect the vacuum source 219 to the conduit means 272 and 275 leading to the MEMORY unit 40 and NOT unit 40A.

However, the MEMORY unit 40 of this invention cannot move from the position illustrated in FIG. 19 to its up position to interconnect the vacuum now in the conduit 272 to the chamber 47 thereof and, thus, to move the diaphragm member 46 of the AND unit 40B downwardly from the position illustrated in FIG. 19 until a vacuum signal is directed to the chamber 47 thereof by the subsequent opening of the valve member 260 of the flame sensing means 258.

Thus, before the valve member 260 of the flame sensing means 258 opens, the vacuum being created in chamber 50 and, thus, in chamber 47 of the NOT unit 40A, although being directed to the chamber 47 of the AND unit 40B, cannot be directed to the actuator 238 to open the main valve member 237 because the MEMORY unit 40 is not directing a vacuum signal through the conduit 303 to chamber 49 of the AND unit 40B so that the compression spring 95 of the AND unit 40B holds the diaphragm member 46 thereof against the valve seat 67 to prevent any vacuum to be supplied to the chamber 242 of the actuator 238.

Therefore, the main gas valve **237** will remain closed until such time as the bimetal member **259** cools so as to open the valve member **260** to furnish a vacuum signal to actuate the igniter actuator **252** while resetting the MEMORY unit **40** to its diaphragm up position and the NOT unit **40A** to its diaphragm down position. The actuated actuator **252** energizes the ignition coil **244** so that the bimetal member **259** will again be heated to close the valve **260** against the valve seat **263** and, thus, change the signal to the NOT unit **40A** that permits the AND unit **40B** to again open the valve member **237** in the manner previously described.

Thus, it can be seen that under any conditions of the control system **201** of this invention, in order for the main valve member **237** to be moved to its open condition to supply a flow of fuel from the fuel source **213** to the main burner means **212**, the MEMORY unit **40** must first be subjected to a pneumatic signal indicating that the valve member **260** of the flame sensing means **258** is moved to an open condition thereof after the last closing of the valve member **237** and the NOT unit **40A** then requires the valve member **260** to move to a closed condition thereof so as to change the signal to the NOT unit **40A** in a manner to cause the AND unit **40B** to open the main valve member **237**. In this manner, each time before the main valve member **237** can be moved to its open condition to direct fuel to the main burner **212**, the ignition actuator **252** must energize the ignition coil **244** to such a temperature that the same will cause a closing of the valve member **260** of the temperature sensing means **258**.

Accordingly, it can be seen that this invention provides improved pneumatically operated logic control systems utilizing the same logic unit of this invention by itself or in combination with one or more like logic units without structural changes therein.

I claim:

1. A pneumatically operated logic system for providing a PULSE SHAPER logic function and comprising a logic unit having a housing means, a diaphragm member carried by said housing means and having three integral diaphragm portions in axial stacked spaced relation and cooperating with said housing means to define four axially stacked chambers separated from each other, said diaphragm member having passage means therein always fluidly interconnecting the two outboard chambers together, said housing means having only five ports therein of which four ports thereof respectively lead to said four chambers with said ports for said two outboard chambers defining valve seats respectively leading to said two outboard chambers and being adapted to be opened and closed respectively by said diaphragm member, said fifth port leading to one of said outboard chambers to be always in fluid communication therewith regardless of the position of said diaphragm member, said housing means having urging means always tending to move said diaphragm member in one direction to close the valve seat of said one outboard chamber and open the valve seat of the other outboard chamber, a pneumatic source operatively interconnected to one of said valve seat ports, a pneumatically operated device operatively interconnected to said fifth port, pneumatic signal means operatively interconnected to at least one of the remaining ports to cause said logic unit to provide said logic function for said system, said pneumatic source and said signal means comprising fluid pressure means, control means for interconnecting said source to the valve seat port of the other outboard chamber and said signal means to the port that leads to the intermediate chamber that is adjacent said one outboard chamber, and a restrictor between said signal means and said port of said adjacent intermediate chamber whereby when said control means initially interconnects said source to said valve seat port and said signal means to said restrictor, said restrictor prevents a buildup in pressure in said adjacent intermediate chamber sufficient to overcome said urging means to close said valve seat of said other outboard chamber until after the lapse of a time period so that only during that time period said source is interconnected to said device through said passage means of said diaphragm member regardless of the length of time that said source remains interconnected by said control means to said valve seat port of said outboard chamber after the lapse of said time period.

2. A pneumatically operated logic system for providing a PULSE SHAPER logic function and comprising a logic unit having a housing means, a diaphragm member carried by said housing means and having three integral diaphragm portions in axial stacked spaced relation and cooperating with said housing means to define four axially stacked chambers separated from each other, said diaphragm member having passage means therein always fluidly interconnecting the two outboard chambers together, said housing means having only five ports therein of which four ports thereof respectively lead to said four chambers with said ports for said two outboard chambers defining valve seats respectively leading to said two outboard chambers and being adapted to be opened and closed respectively by said diaphragm member, said fifth port leading to one of said outboard chambers to be always in fluid communication therewith regardless of the position of said diaphragm member, said housing means having urging means always tending to move said diaphragm member in one direction to close the valve seat of said one outboard chamber and open the valve seat of the other outboard chamber, a pneumatic source operatively interconnected to one of said valve seat ports, a pneumatically operated device operatively interconnected to said fifth port, pneumatic signal means operatively interconnected to at least one of the remaining ports to cause said logic unit to provide said logic function for said system, said pressure source and said signal means comprising vacuum means, means interconnecting said source to the valve seat port of said one outboard chamber, control means for interconnecting said signal means to the port that leads to the intermediate chamber that is adjacent the other outboard chamber, and a restrictor and accumulator in series in fluid communication between said means interconnecting said fifth port to said device and the port that leads to the other intermediate chamber that is adjacent said one outboard chamber whereby when said control means initially interconnects said signal means to said intermediate chamber adjacent said other outboard chamber to move said diaphragm member to open said valve seat of said one outboard chamber and interconnect said source to said device, said restrictor and accumulator prevent sufficient evacuation of said other intermediate chamber to counterbalance the evacuation of the first-named intermediate chamber for a time period after the lapse of which said urging means moves said diaphragm member to close said valve seat of said one outboard chamber so that only during that time period is said source interconnected to said device regardless of the length of time that said signal means remains interconnected by said control means to said first-named intermediate chamber after the lapse of said time period.

3. A pneumatically operated logic system for providing an OSCILLATOR logic function and comprising a logic unit having a housing means, a diaphragm member carried by said housing means and having three integral diaphragm portions in axial stacked spaced relation and cooperating with said housing means to define four axially stacked chambers separated from each other, said diaphragm member having passage means therein always fluidly interconnecting the two outboard chambers together, said housing means having only five ports therein of which four ports thereof respectively lead to said four chambers with said ports for said two outboard chambers defining valve seats respectively leading to said two outboard chambers and being adapted to be opened and closed respectively by said diaphragm member, said fifth port leading to one of said outboard chambers to be always in fluid communication therewith regardless of the position of said diaphragm member, said housing means having urging means always tending to move said diaphragm member in one direction to close the valve seat of said one outboard chamber and open the valve seat of the other outboard chamber, a

pneumatic source operatively interconnected to one of said valve seat ports, a pneumatically operated device operatively interconnected to said fifth port, pneumatic signal means operatively interconnected to at least one of the remaining ports to cause said logic unit to provide said logic function for said system, said pneumatic source and said signal means comprising fluid pressure means, another logic unit, means interconnecting said source to the valve seat port of said one outboard chamber of said first unit, control means for interconnecting said signal means to the port that leads to the intermediate chamber that is adjacent to said one outboard chamber of said first unit and to the valve seat port of said one outboard chamber of said other unit, a restrictor intermediate said control means and said ports interconnected thereto, and a restricted passage interconnecting the port of said other unit that leads to the intermediate chamber that is adjacent to said one outboard chamber thereof to said means interconnecting said fifth port of said first unit to said device whereby when said control means directs said signal means through said restrictor to said ports interconnected thereto to overcome said urging means of said first unit and cause said diaphragm member of said first unit to open said valve seat of said one outboard chamber and interconnect said source to said device, said restricted passage means after a delayed time period directs sufficient pressure to said adjacent intermediate chamber of said other unit to overcome said urging means thereof and cause said diaphragm member thereof to open said valve seat of said one outboard chamber thereof and interconnect said signal means to the atmosphere through the fifth port of said other unit to dump the pressure from said intermediate chamber of said first unit and cause said diaphragm member to close said valve seat of said one outboard chamber thereof and thereby disconnect said source from said device until the pressure in said intermediate chamber of said other unit dissipates sufficiently for said urging means thereof to close said diaphragm member thereof against said valve seat of said one outboard chamber of said other unit.

4. A pneumatically operated logic system for providing a MEMORY logic function and comprising a logic unit having a housing means, a diaphragm member carried by said housing means and having three integral diaphragm portions in axial stacked spaced relation and cooperating with said housing means to define four axially stacked chambers separated from each other, said diaphragm member having passage means therein always fluidly interconnecting the two outboard chambers together, said housing means having only five ports therein of which four ports thereof respectively lead to said four chambers with said ports for said two outboard chambers defining valve seats respectively leading to said two outboard chambers and being adapted to be opened and closed respectively by said diaphragm member, said fifth port leading to one of said outboard chambers to be always in fluid communication therewith regardless of the position of said diaphragm member, said housing means having urging means always tending to move said diaphragm member in one direction to close the valve seat of said one outboard chamber and open the valve seat of the other outboard chamber, a pneumatic source operatively interconnected to one of said valve seat ports, a pneumatically operated device operatively interconnected to said fifth port, pneumatic signal means operatively interconnected to at least one of the remaining ports to cause said logic unit to provide said logic function for said system, said pneumatic source and said signal means comprising fluid pressure means, another logic unit, means interconnecting said source to the valve seat port of said one outboard chamber of said first unit, first control means for interconnecting said signal means through a one-way check valve means to the port of said first unit that leads to the intermediate chamber that is adjacent to said one outboard chamber thereof, second control means for interconnecting said signal means to the port of said other unit that leads to the intermediate chamber thereof that is adjacent to said one outboard chamber thereof, first passage means interconnecting the valve seat port of said one outboard chamber of said other unit to said signal means of said first control means intermediate said check valve means and said port of said intermediate chamber of said first unit, and second passage means having a restriction therein interconnecting said signal means of said first control means between said check valve means and said port of said intermediate chamber of said first unit to said means interconnecting said fifth port of said first unit to said device whereby when only said first control means interconnects said signal means to said port of said intermediate chamber of said first unit to overcome said urging means thereof and cause said diaphragm member thereof to open said valve seat of said one outboard chamber to interconnect said source to said device said check valve means and said second passage means cooperate to maintain sufficient pressure in said intermediate chamber of said first unit to maintain said valve seat of said one outboard chamber thereof open even if said first control means terminates its said signal means until said second control means interconnects its said signal means to said port of said intermediate chamber of said other unit to overcome said urging means thereof and cause said diaphragm member thereof to open said valve seat of said one outboard chamber to interconnect said first passage means to the atmosphere through the fifth port thereof and dissipate the pressure in said intermediate chamber of said first unit so that said diaphragm member thereof can close said valve seat of said one outboard chamber thereof to disconnect said source from said device.

5. A pneumatically operated logic system for providing a MEMORY logic function and comprising a logic unit having a housing means, a diaphragm member carried by said housing means and having three integral diaphragm portions in axial stacked spaced relation and cooperating with said housing means to define four axially stacked chambers separated from each other, said diaphragm member having passage means therein always fluidly interconnecting the two outboard chambers together, said housing means having only five ports therein of which four ports thereof respectively lead to said four chambers with said ports for said two outboard chambers defining valve seats respectively leading to said two outboard chambers and being adapted to be opened and closed respectively by said diaphragm member, said fifth port leading to one of said outboard chambers to be always in fluid communication therewith regardless of the position of said diaphragm member, said housing means having urging means always tending to move said diaphragm member in one direction to close the valve seat of said one outboard chamber and open the valve seat of the other outboard chamber, a pneumatic source operatively interconnected to one of said valve seat ports, a pneumatically operated device operatively interconnected to said fifth port, pneumatic signal means operatively interconnected to at least one of the remaining ports to cause said logic unit to provide said logic function for said system, said pneumatic source and said signal means comprising vacuum means, another logic unit, means interconnecting said source to the valve seat port of said one outboard chamber of said first unit, first control means for interconnecting said signal means through a one-way check valve means to the port of said first unit that leads to the intermediate chamber that is adjacent to the other outboard chamber thereof, first passage means having a restriction therein interconnecting said signal means of said first control means between said check valve means and said port of said intermediate chamber of said first unit to said means interconnecting said fifth port of said first unit to said device, second control means for interconnecting said signal means to the port of said other unit that leads to the intermediate chamber thereof that is adjacent to the other outboard chamber thereof, and second passage means interconnecting the valve seat port of said one outboard chamber of said other unit to said first passage means intermediate said check valve means and said restriction thereof whereby when only said first control means interconnects said signal means

to said port of said intermediate chamber of said first unit to overcome said urging means thereof and cause said diaphragm member thereof to open said valve seat of said one outboard chamber to interconnect said source to said device said check valve means and said first passage means cooperate to maintain sufficient vacuum in said intermediate chamber of said first unit to maintain said valve seat of said one outboard chamber thereof open even if said first control means terminates its said signal means until said second control means interconnects its said signal means to said port of said intermediate chamber of said other unit to overcome said urging means thereof and cause said diaphragm member thereof to open said valve seat of said one to said chamber to interconnect said second passage means to the atmosphere through the fifth port thereof and cause a return of air to said intermediate chamber of said first unit so that said diaphragm member thereof can close said valve seat of said one outboard chamber thereof to disconnect said source from said device.

6. A pneumatically operated logic system for providing a FLIP-FLOP logic function and comprising a logic unit having a housing means, a diaphragm member carried by said housing means and having three integral diaphragm portions in axial stacked spaced relation and cooperating with said housing means to define four axially stacked chambers separated from each other, said diaphragm member having passage means therein always fluidly interconnecting the two outboard chambers together, said housing means having only five ports therein of which four ports thereof respectively lead to said four chambers with said ports for said two outboard chambers defining valve seats respectively leading to said two outboard chambers and being adapted to be opened and closed respectively by said diaphragm member, said fifth port leading to one of said outboard chambers to be always in fluid communication therewith regardless of the position of said diaphragm member, said housing means having urging means always tending to move said diaphragm member in one direction to close the valve seat of said one outboard chamber and open the valve seat of the other outboard chamber, a pneumatic source operatively interconnected to one of said valve seat ports, a pneumatically operated device operatively interconnected to said fifth port, pneumatic signal means operatively interconnected to at least one of the remaining ports to cause said logic unit to provide said logic function for said system, said pneumatic source and said signal means comprising fluid pressure means, a second logic unit, a third logic unit, means interconnecting said source to the valve seat port of said one outboard chamber of said first unit and to the valve seat port of the other outboard chamber of said second unit, first control means for interconnecting said signal means through a one-way check valve means to the port of said first unit that leads to the intermediate chamber that is adjacent to said one outboard chamber thereof, second control means for interconnecting said signal means to the port of said third unit that leads to the intermediate chamber that is adjacent to said one outboard chamber thereof, first passage means interconnecting the valve seat port of said one outboard chamber of said third unit to the port of said second unit that leads to the intermediate chamber that is adjacent to said one outboard chamber thereof and to said signal means of said first control means intermediate said check valve means and said port of said intermediate chamber of said first unit, second passage means having a restriction therein interconnecting said signal means of said first control means between said check valve means and said port of said intermediate chamber of said first unit to said means interconnecting said fifth port of said first unit to said device, and a second pneumatically operated device interconnected to said fifth port of said second unit whereby when only said first control means interconnects said signal means to said port of said intermediate chamber of said first unit to overcome said urging means and cause said diaphragm member thereof to open said valve seat of said one outboard chamber to interconnect said source to said first device and to interconnect said signal means to said port of said intermediate chamber of said second unit to overcome said urging means thereof and cause said diaphragm member thereof to close said valve seat of said other outboard chamber thereof to disconnect said source from said second device, said check valve means and said second passage means cooperate to maintain sufficient pressure in said intermediate chamber of said first unit to maintain said valve seat of said one outboard chamber open even if said first control means terminates its said signal means until said second control means interconnects its said signal means to said port of said intermediate chamber of said third unit to overcome said urging means thereof and cause said diaphragm member thereof to open said valve seat of said one outboard chamber thereof to interconnect said first passage means to the atmosphere through the fifth port thereof and dissipate the pressure in said intermediate chambers of said first and second units so that said diaphragm members thereof can close said valve seats of said one outboard chambers thereof to disconnect said source from said first device and interconnect said source to said second device through the now opened valve seat of said other outboard chamber of said second unit and said passage means of said diaphragm member thereof.

7. A pneumatically operated logic system for providing a FLIP-FLOP logic function and comprising a logic unit having a housing means, a diaphragm member carried by said housing means and having three integral diaphragm portions in axial stacked spaced relation and cooperating with said housing means to define four axially stacked chambers separated from each other, said diaphragm member having passage means therein always fluidly interconnecting the two outboard chambers together, said housing means having only five ports therein of which four ports thereof respectively lead to said four chambers with said ports for said two outboard chambers defining valve seats respectively leading to said two outboard chambers and being adapted to be opened and closed respectively by said diaphragm member, said fifth port leading to one of said outboard chambers to be always in fluid communication therewith regardless of the position of said diaphragm member, said housing means having urging means always tending to move said diaphragm member in one direction to close the valve seat of said one outboard chamber and open the valve seat of the other outboard chamber, a pneumatic source operatively interconnected to one of said valve seat ports, a pneumatically operated device operatively interconnected to said fifth port, pneumatic signal means operatively interconnected to at least one of the remaining ports to cause said logic unit to provide said logic function for said system, said pneumatic source and said signal means comprising vacuum means, a second logic unit, a third logic unit, means interconnecting said source to the valve seat port of said one outboard chamber of said first unit and to the valve seat port of the other outboard chamber of said second unit, first control means for interconnecting said signal means through a one-way check valve means to the port of said first unit that leads to the intermediate chamber that is adjacent to the other outboard chamber thereof, second control means for interconnecting said signal means to the port of said third unit that leads to the intermediate chamber that is adjacent to the other outboard chamber thereof, first passage means having a restriction therein interconnecting said signal means of said first control means between said check valve means and said port of said intermediate chamber of said first unit to said means interconnecting said fifth port of said first unit to said device, second passage means interconnecting the valve seat port of said one outboard chamber of said third unit to the port of said second unit that leads to the intermediate chamber that is adjacent to said other outboard chamber thereof and to said signal means of said first control means intermediate said check valve means and said restriction thereof, and a second pneumatically operated device interconnected to said fifth port of said second unit whereby when only said first control means interconnects said signal means to said port of said intermediate chamber of said first unit to

overcome said urging means and cause said diaphragm member thereof to open said valve seat of said one outboard chamber to interconnect said source to said first device and interconnects said signal means to said port of said intermediate chamber of said second unit to overcome said urging means thereof and cause said diaphragm member thereof to close said valve seat of said other outboard chamber thereof to disconnect said source from said second device, said check valve means and said first passage means cooperate to maintain sufficient vacuum in said intermediate chamber of said first unit to maintain said valve seat of said one outboard chamber open even if said first control means terminates its said signal means until said second control means interconnects its said signal means to said port of said intermediate chamber of said third unit to overcome said urging means thereof and cause said diaphragm member thereof to open said valve seat of said one outboard chamber thereof to interconnect said second passage means to the atmosphere through the fifth port thereof and cause a return of air to said intermediate chambers of said first and second units so that said diaphragm members thereof can close said valve seats of said one outboard chambers thereof to disconnect said source from said first device and interconnect said source to said second device through the now opened valve seat of said other outboard chamber of said second unit and said passage means of said diaphragm member thereof.