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Scott

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[54] **PNEUMATIC CONTROL SYSTEM FOR A FUEL BURNING APPARATUS OR THE LIKE**

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Related U.S. Application Data

[62] Division of Ser. No. 197,538, Nov. 10, 1971, Pat. No. 3,754,572, which is a division of Ser. No. 5,709, Jan. 26, 1970, Pat. No. 3,635,645.

[52] **U.S. Cl.** **236/82,** 236/87

[51] **Int. Cl.** **G05b 11/58**

[58] **Field of Search** 236/87, 82; 137/625.66, 137/625.65, 630.22, 103

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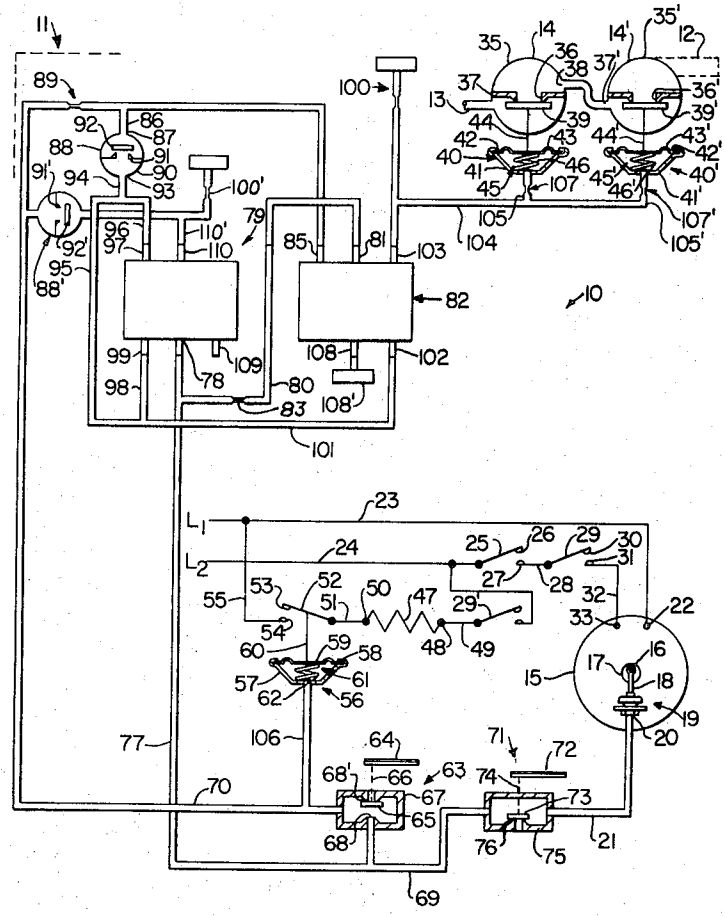
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[57] **ABSTRACT**

This disclosure relates to a pneumatic control system for a clothes dryer wherein the flow of fuel to the main burner means is pneumatically controlled in such a manner that the ignition means for the main burner means must be first pneumatically actuated before the pneumatic control system will pneumatically open the fuel supply means to the main burner means, the control system including a pneumatically operated logic "memory" unit to assure that the ignition means is always pneumatically operated before the main burner means can be pneumatically operated to its on condition by a pneumatically operated "nand" unit each time there is a requirement to turn on the main burner means. The "memory" unit is prevented from transmitting atmosphere therethrough when being switched by its setting signal.

1 Claim, 2 Drawing Figures



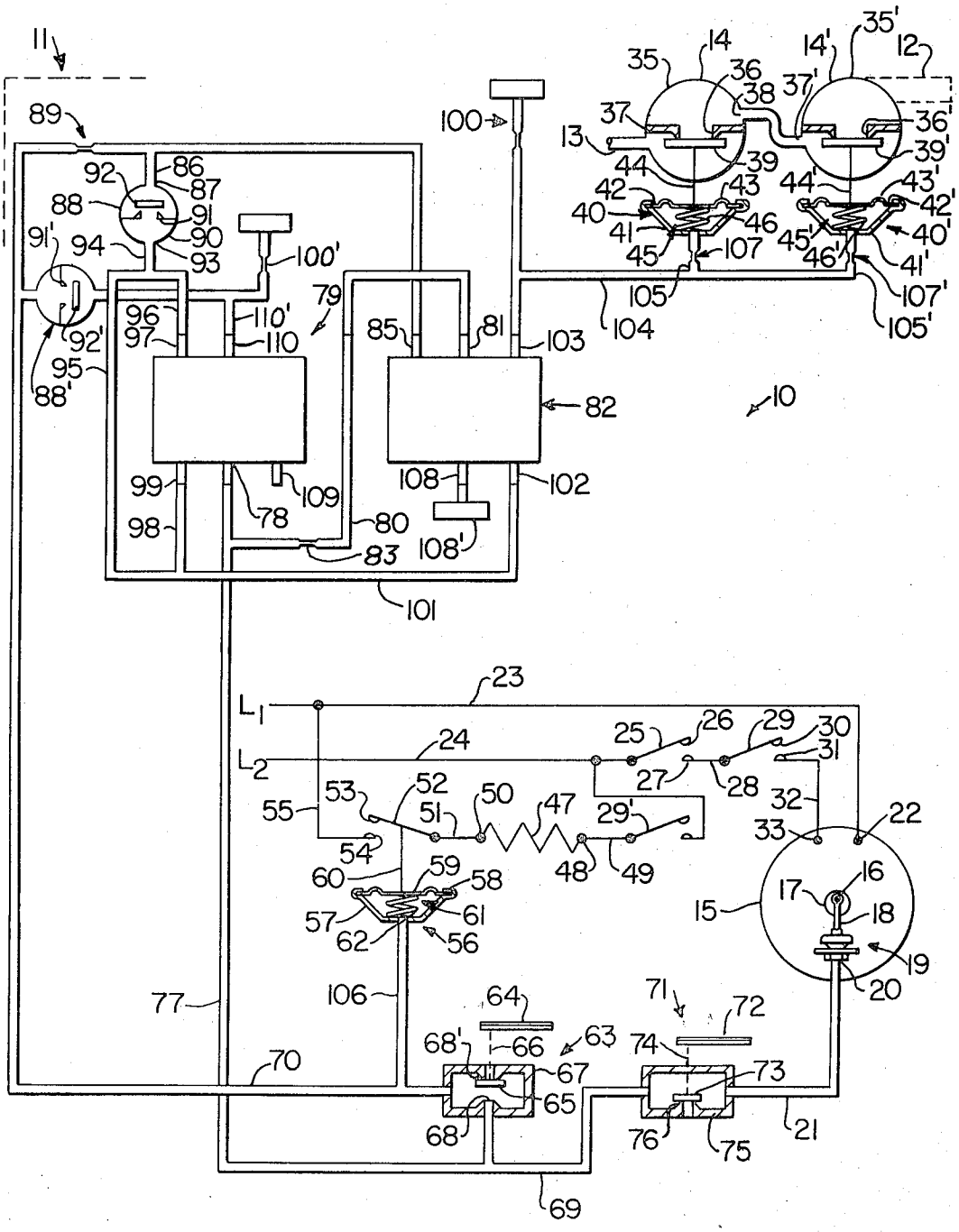

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FIG.1

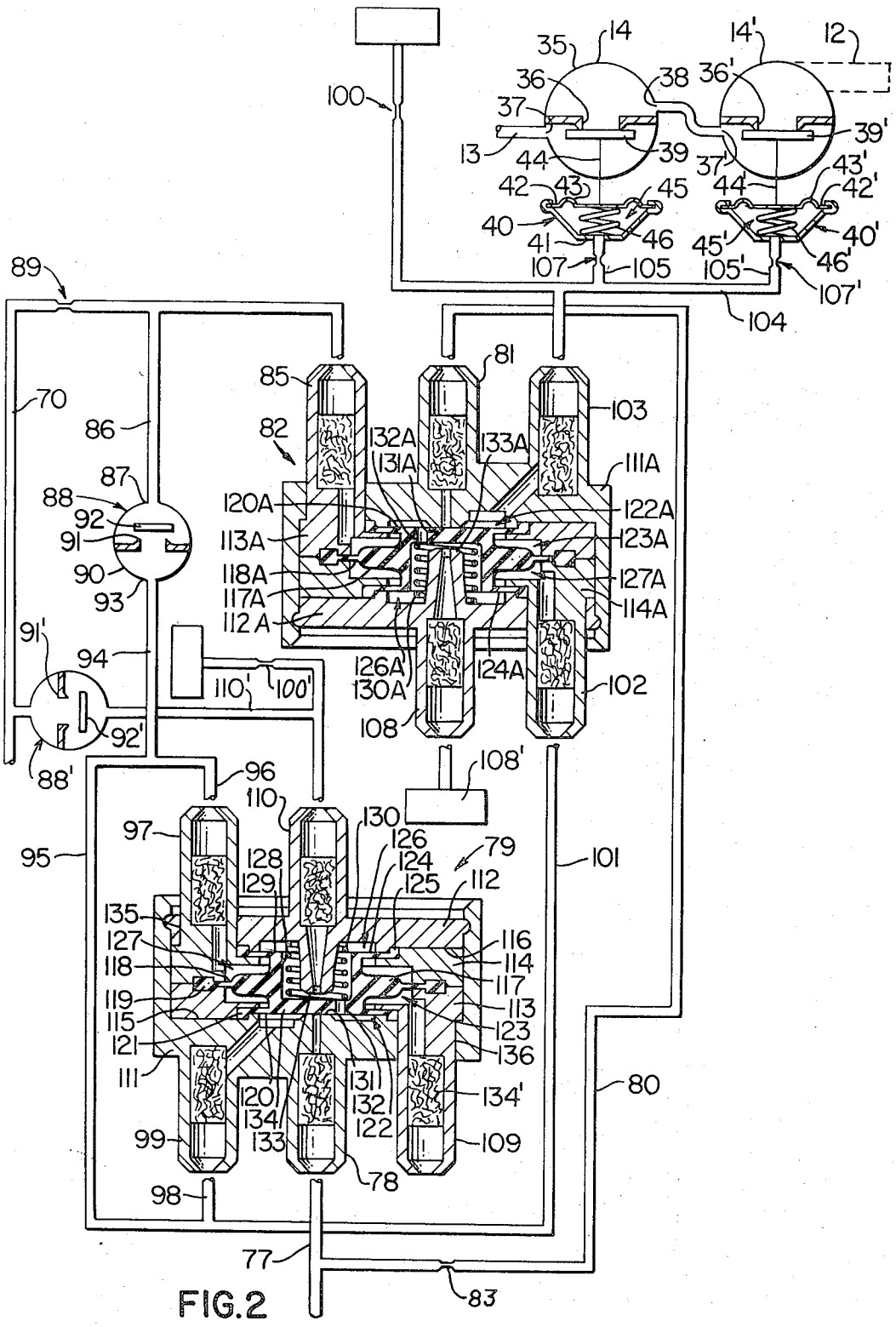

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132A
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134'
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133
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78
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80
77
83

FIG.2

PNEUMATIC CONTROL SYSTEM FOR A FUEL BURNING APPARATUS OR THE LIKE

This is a division, of application Ser. No. 197,538, filed Nov. 10, 1971, now U.S. Pat. No. 3,754,572, which, in turn, is a division of Ser. No. 5,709, filed Jan. 26, 1970 now U.S. Pat. No. 3,635,645.

This invention is related to the pneumatic control systems and methods set forth in the copending U.S. Pat. applications, Ser. No. 717,586, filed Apr. 1, 1968, and Ser. No. 732,784, filed May 28, 1968, which are assigned to the same assignee to whom this application is assigned.

It is well known that a fuel burning apparatus, such as a clothes dryer or the like, has been provided wherein the flow of fuel to the main burner means thereof is controlled by an electric thermostat means that will not permit the flow of fuel to the main burner means until after an electrical ignition means has been electrically actuated so as to assure that the flow of fuel to the main burner means will be properly ignited.

The first aforementioned patent application discloses and claims a pneumatic control system for controlling the flow of fuel to a main burner means of an apparatus or the like in such a manner that the ignition means for the main burner means must first be pneumatically actuated each time before the control system will permit a flow of fuel to the main burner means.

The second aforementioned patent application relates to a pneumatic control system for a fuel burning apparatus that has fewer control parts that the control system of the first aforementioned patent application as well as an improved arrangement that is substantially fail-safe in the logic units thereof so that the source of fuel will automatically be disconnected or not be interconnected to the main burner means upon any one or combination of a number of possible component failures.

Accordingly, one of the features of this invention is to provide such a pneumatic control system which will perform the same functions as the control systems of the aforementioned patent applications while providing a more accurate and responsive system.

In particular, the embodiment of this invention provides a pneumatically operated logic memory unit which is utilized in combination with a pneumatically operated logic nand unit so that the same must each receive particular pneumatic signals from the control system before the nand unit will pneumatically turn on the main burner means, the pneumatically operated logic nand unit only causing the fuel source to be interconnected to the burner means if the pneumatically operated ignition means of the control system has been first pneumatically actuated to ignition condition as will be apparent hereinafter. The memory unit prevents the flow of atmosphere therethrough during the switching of the memory unit by its control signal.

Accordingly, it is an object of this invention to provide an improved pneumatic control system for a fuel burning apparatus or the like, the system of this invention 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 schematic view illustrating the improved control system of this invention.

FIG. 2 is an enlarged, fragmentary view of the pneumatically operated logic units of the control system of FIG. 1 with the logic units being illustrated in cross section.

While the various features of this invention are hereinafter described and illustrated as being particularly adapted to pneumatically control the operation of a domestic clothes dryer or the like, it is to be understood that the various features of this invention can be utilized singly or in any combination thereof to provide control means for other types of apparatus as desired.

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

Referring now to FIG. 1, the improved control system of this invention is generally indicated by the reference numeral **10** and is utilized for controlling the operation of a clothes dryer, generally indicated by the reference numeral **11**, having a main burner means **12** adapted to be interconnected to a fuel source manifold **13** by a pair of pneumatically operated valve means **14** and **14'** in a manner hereinafter described.

The apparatus **11** includes an electric motor **15** which rotates the clothes-receiving drum (not shown) of the apparatus **11** during the entire cycle of operation of the apparatus **11** in a conventional manner, the electric motor **15** being adapted to be interconnected across two power source leads L^1 and L^2 in a manner hereinafter described.

The electric motor **15** is adapted to drive an eccentric cam **16** that is interconnected to its output shaft **17** as long as the electric motor **15** is energized whereby the eccentric cam **16** will continuously move a piston rod arrangement **18** to operate a vacuum pump means **19** so as to provide a continuous vacuum source for the system **10** of this invention as long as the electric motor **15** is energized, the vacuum pump means **19** having its inlet **20** interconnected to a conduit means **21.**

The power source lead L^1 is interconnected to one side **22** of the electric motor **15** by a lead **23.** The other power source lead L^2 is interconnected by a lead **24** to a conventional timer operated switch blade **25** that has its contact **26** cooperable with a fixed contact **27** that is interconnected by a lead **28** to a dryer door operated switch blade **29.** The dryer door operated switch blade **29** has a contact **30** cooperable with a contact **31** that is interconnected by a lead **32** to the other side **33** of the electric motor **15.**

Therefore, it can be seen that in order for the electric motor **15** to be placed across the power source leads L^1 and L^2 for the electric motor **15** to be energized, not only must the dryer door be disposed in its closed position to close and hold the switch blade **29** against the contact **31,** but also the housewife or the like must manually set the cycle timer means (not shown) of the control system **10** so that the same is in an on condition to hold the switch blade **25** against the contact **27** for a preset time period after the lapse of which the timer cycle means will automatically open the switch blade **25** away from the contact **27** to terminate the operation of the control system **10** in a conventional manner.

The pneumatically operated valve means **14** and **14'** for interconnecting the fuel source conduit **13** to the

main burner means 12 of the apparatus 11 are identical in construction and operation and while one such valve means could properly control the on-off condition of the main burner means 12, the use of two such valve means merely provides a safety factor so that if one of the valve means fails, the other valve means will still perform its function. Thus, only the pneumatically operated valve means 14 will be described and like parts of the valve means 14' will be indicated by like reference numerals followed by a prime mark.

As illustrated in FIG. 1, the pneumatically operated valve means 14 comprises a housing means 35 having a valve seat 36 that interconnects its fuel source inlet 37 to its fuel source outlet 38, the valve seat 36 being opened and closed by a valve member 39 that is moved between its opened and closed positions by a vacuum operated actuator that is generally indicated by the reference numeral 40. The vacuum operated actuator 40 comprises a cup-shaped housing member 41 having its open end 42 closed by a flexible diaphragm 43 that is interconnected to the valve member 39 by a tying means 44 in a conventional manner whereby the flexible diaphragm 43 cooperates with the housing 41 to define a chamber 45 therebetween. A compression spring 46 is disposed in the chamber 45 to tend to normally move the flexible diaphragm 43 upwardly as illustrated in FIG. 1 to maintain the valve member 39 in its closed position against the valve seat 36 to prevent any flow of fuel to the main burner means 12. However, when the vacuum source 19 is interconnected to the chamber 45 in a manner hereinafter described to evacuate the chamber 45, the pressure differential acting across the diaphragm 43 moves the diaphragm 43 downwardly in opposition to the force of the compression spring 46 to move the valve member 39 to its open position so that the fuel source 13 will be interconnected to the main burner means 12 as long as the pneumatically operated actuators 40 and 40' are in their actuated condition.

The ignition means for the main burner means 12 comprises an ignition coil 47 having one side 48 thereof interconnected by a lead 49 to the lead 24 through a door operated switch 29', similar to door switch 29, so that the side 48 of the ignition coil 47 is always interconnected to the power source lead L^2 when the dryer door is closed. The other side 50 of the ignition coil 47 is interconnected by a lead 51 to a switch blade 52 that has a contact 53 cooperable with a contact 54 that is interconnected to the power source lead L^1 by a lead 55.

A vacuum operated actuator 56 controls the switch blade 52 and comprises a cup-shaped housing 57 having its open end 58 closed by a flexible diaphragm 59 that is interconnected to the switch blade 52 by a suitable tying means 60, the flexible diaphragm 59 cooperating with the housing 57 to define a chamber 61 therebetween that receives a compression spring 62 that normally tends to urge the flexible diaphragm 59 upwardly to hold the switch blade 52 out of contact with the contact 54 and thereby maintain the ignition coil 47 in its de-energized condition. However, when the chamber 61 of the actuator 56 is interconnected to the vacuum source 19 in a manner hereinafter described, the resulting pressure differential acting across the diaphragm 59 moves the diaphragm 59 downwardly in opposition to the force of the compression spring 62 to place the switch blade 52 into contact with the contact 54 so as to place the ignition coil 47 across the power source leads L^1 and L^2.

When the ignition coil 47 is placed across the power source leads L^1 and L^2 by the vacuum operated actuator 56 in a manner hereinafter described, the ignition coil 47 subsequently heats up to a temperature that will be sufficient for igniting fuel issuing from the main burner means 12 in a conventional igniting manner.

An ignition coil temperature sensing means 63 is provided for the system 10 and comprises a bimetal member 64 that is interconnected to a valve member 65 by a typing means 56, the valve member 65 being disposed in a housing means 67 having a valve seat 68 fluidly interconnecting a conduit 69 to a conduit 70. When the bimetal member 64 senses a temperature of the ignition coil 47 below a temperature sufficient for igniting fuel issuing from the main burner means 12, the bimetal member 64 is in such a condition that the same maintains the valve member 65 away from the valve seat 68 and against a valve seat 68' taht leads to the atmosphere so as to fluidly interconnect the conduits 69 and 70 together. However, when the ignition coil 47 reaches an ignition temperature, the bimetal member 65 warps in such a manner that the same moves the valve member 65 against the valve seat 68 to terminate the fluid connection between the conduits 59 and 70 and opens the valve seat 68' so that atmosphere is interconnected to the conduit 70 for a purpose hereinafter described. In addition, when the main burner means 12 is operating, the bimetal member 64 also senses the flames at the main burner means 12 so that the bimetal member 64 will maintain the valve member 65 in its closed position against the valve seat 68 as long as fuel is burning at the main burner means 12.

Another temperature sensing device 71 is provided for the control system 10 and is adapted to sense the temperature effect of the main burner means 12. The temperature sensing means 71 comprises a bimetal member 72 that is interconnected to a valve member 73 by a tying means 74, the valve member 73 being disposed in a housing means 75 to open and close a valve seat 76 thereof that is adapted to fluidly interconnect the atmosphere with the interior of the housing 75 when the valve seat 76 is open. However, when the valve seat 76 is closed, the housing 75, in effect, interconnects the conduit 21 to the conduit 69 of the ignition temperature sensing means 63.

As long as the temperature effect of the burner means 12 of the apparatus 11 is below a predetermined temperature effect setting of the sensing means 71, the bimetal member 72 maintains the valve member 73 against the valve seat 76 to, in effect, fluidly interconnect the conduits 21 and 69 together whereby if the electric motor 15 is energized, the vacuum source 19 will be interconnected to the conduit 69. However, when the temperature sensing means 71 senses a temperature effect of the burner means 12 above the set temperature effect setting of the thermostatic means 71, the bimetal member 72 warps in a manner to move the valve member 73 away from the valve seat 76 and, thus, in effect, disconnects the vacuum source 19 from the conduit 69 as the atmosphere is not interconnected to the conduit 69 through the opened valve seat 76 for a purpose hereinafter described. Of course, it is to be understood that the sensing device 71 could be manually adjustable for temperature selection purposes by

the housewife or the like or could be factory set for an optimum drying temperature for the apparatus **11**.

The conduit **69** is interconnected by a conduit **77** to a port means **78** of a pneumatically operated logic memory unit **79** later to be described, the conduit **77** also being fluidly interconnected to a conduit **80** that leads to a port means **81** of a pneumatically operated logic nand unit **82** of this invention. The conduit **80** has a restriction **83** therein intermediate the port means **81** of the logic nand unit **82** and the conduit **77**.

The conduit **70** leading from the ignition temperature sensing means **63** is interconnected to another port means **85** of the logic nand unit **82** as well as to a conduit **86** that is interconnected to one side **87** of a check valve **88**, the conduit **70** having a restriction means **89** therein in advance of the conduit **86**.

The check valve **88** comprises a housing means **90** having a valve seat **91** adapted to be opened and closed by a valve member **92**, the valve seat **91** being adapted to interconnect the conduit **86** at the side **87** thereof to the other side **93** of the check valve **88** that leads to a conduit **94**. The valve member **92** normally seats against the valve seta **91** to prevent fluid communication between the conduits **86** and **94** so that when the conduit **70** is interconnected to the vacuum source **19** by the valve means **63** and **71** being disposed in the positions of FIG. **1**, the vacuum source **19** opens the valve member **92** away from the valve seat **91** so as to be interconnected to the conduit **94**.

The conduit **94** is fluidly interconnected to a conduit **95** that has one end **96** thereof interconnected to a port means **97** of the logic memory unit **79** while the other end **98** of the conduit **95** is interconnected to another port means **99** of the logic memory unit **79**.

The conduit **95** is fluidly interconnected to a conduit **101** that leads to a port means **102** of the logic nand unit **82**, the logic nand unit having another port menas **103** thereof fluidly interconnected to a conduit means **104** that is fluidly interconnected to branch conduit means **105** and **105'** that are respectively fluidly interconnected to the chambers **45** and **45'** of the vacuum actuators **40** and **40'**. The branch conduits **105** and **105'** respectively have restrictions **107** and **107'** therein.

The conduit **104** intermediate the actuators **40** and **40'** and the nand unit **82** is interconnected to the atmosphere by a controlled bleed means **100** for a purpose hereinafter described. However, the controlled bleed means **100** interconnects the conduit **104** to the atmosphere at a controlled rate that is less than the effective rate of fluid interconnection provided by the restriction **83** in the conduit **77** as will be apparent hereinafter.

The conduit **70** leading from the ignition temperature sensing means **63** is fluidly interconnected to a conduit **106** that is fluidly interconnected to the chamber **61** of the actuator **56**.

A remaining port means **108** of the logic nand unit **82** is interconnected to the atmosphere through a filter **108'** and a port means **109** of the logic memory unit **79** is interconnected to the atmosphere.

The remaining port means **110** of the memory unit **79** is interconnected by a conduit **110'** to the conduit **70** intermediate the restriction **89** and the sensor **63** for a purpose hereinafter described and to the atmosphere through a restriction **100'**, the conduit **110'** having a one-way check valve **88'** similar to the check valve **88** whereby like parts are indicated by like reference numerals followed by a prime mark.

As previously stated, the control system **10** is so constructed and arranged that the ignition coil **47** for the burner means **12** must be first energized to a temperature thereof that will be sufficient for igniting fuel issuing from the burner means **12** each time before the actuators **40** and **40'** will be actuated to simultaneously move the valve members **39** and **39'** from their closed positions to their open positions to cause fuel to issue from the main burner means **12**.

Thus, since both temperature sensing devices **63** and **71** are normally disposed in the positions illustrated in FIG. **1** when the control system **10** is initially turned on by the housewife or the like setting the timer cycle means in its "on" position to close the switch blade **25** against the contact **27**, the thus energized electric motor **15** will operate the vacuum pump **19** and since the temperature effect of the apparatus **11** is below the temperature effect setting of the thermostatic device **71**, the vacuum pump **19** is adapted to evacuate the conduit **69** through the closed housing **75** as well as to evacuate the conduit means **70** and **77** leading respectively to the logic memory unit **79** and logic nand unit **82**.

The logic nand unit **82** will now receive a pneumatic signal at the port means **102** thereof from the memory unit **79** as well as a pneumatic signal at the port means **85** thereof as long as the valve member **65** of the ignition temperature sensing means **63** is in its open position from the valve seat **68** and is closed against the valve seat **68'** whereby the nand unit will be in a deactivated condition to prevent the vacuum source **19** from being interconnected to the conduit **104** so that the valve means **14** and **14'** remain in their closed positions to prevent fuel from reaching the main burner means **12**. However, after the ignition coil **47** reaches its ignition condition, the valve means **65** closes against the valve seat **68** and opens the valve seat **68'** so as to terminate the pneumatic signal to the port means **85** of the nand unit **82** whereby the nand unit **82** will now be activated to a condition thereof to interconnect the vacuum source **19** to the conduit **104** so that the actuators **40** and **40'** will be evacuated to open the valve members **39** and **39'** so that fuel can issue from the burner means **12** and be ignited by the ignition means **47**.

Accordingly, the logic units **79** and **82** always require that the valve member **65** must first be in its open position away from the valve seat **68** and then be moved to a closed position against the valve seat **68** after each closing of the main valve means **14** and **14'** before the main valve means **14** and **14'** can be again opened, the valve member **65** only closing against the valve seat **68** after an open condition thereof by the ignition coil **47** being energized to a temperature suitable for igniting fuel that is to subsequently issue from the main burner means **12**.

The details of the logic units **79** and **82** for accomplishing the above function will now be described in detail whereby reference is now made to FIG. **2**.

As illustrated in FIG. **2**, the logic units **79** and **82** are substantially identical in construction whereby only the particular details of the logic memory unit **79** will now be described and like parts of the logic nand unit **82** will be indicated by the same reference numerals followed by the reference letter "A". In this manner, it

will be appreciated that the logic units of this invention can be made from the same parts in a simple and effective manner while producing different logic functions as will be apparent hereinafter so that the cost of the control system **10** of this invention is relatively small when considering the costs of prior known electrical and pneumatic control systems.

As illustrated in FIG. **2**, the logic memory unit **79** comprises two housing parts **111** and **112** suitably secured together to hold two annular members **113** and **114** between the opposed and respective inner end wall means **115** and **116** thereof. A flexible, one-piece diaphragm member **117** is disposed in the housing means **111** and **112** and has an intermediate or large central outwardly directed diaphragm portion **118** provided with an outer peripheral portion **119** that is secured and sealed between the annular members **113** and **114.** An outboard smaller spaced diaphragm portion **120** of the diaphragm member **117** has its outer periphery **121** secured and sealed between the housing member **111** and the annular member **113** to define a chamber **122** between the diaphragm portion **120** and the end wall means **115** of the housing member **111** while cooperating with the larger central diaphragm portion **118** to define a chamber **123** between the diaphragm portions **118** and **120.** An opposed smaller outboard spaced diaphragm portion **124** of the diaphragm member **117** has its outer periphery **125** secured and sealed between the annular member **114** and the housing member **112** to define a chamber **126** between the diaphragm portion **124** and the end wall means **116** of the housing member **112** while cooperating with the central diaphragm portion **118** to define a chamber **127** between the diaphragm portions **118** and **124.**

The diaphragm member **117** has a bore **128** interrupting the end **129** thereof so as to receive a compression spring **130** that has one end bearing against the end wall means **116** of the housing member **112** and the other end thereof bearing against the diaphragm member **117** to normally urge the diaphragm portion **120** against a frustoconical valve seat **131** that projects inwardly from the end wall means **115** of the housing member **111** into the chamber **122.** The valve seat means **131** of the logic memory unit **79** is interconnected to the port means **78** thereof that leads to the conduit **77** whereas the valve seat means **131A** of the nand unit **82** is interconnected to the port means **81** that leads to the conduit **80.**

The diaphragm member **117** has a passage means **132** passing through the diaphragm portion **120** in offset relation to the valve seat **131** so as to always fluidly interconnect the chambers **122** and **126** together, the passage **132** also being in offset relation to a frustoconical valve seat **133** that projects inwardly from the end wall means **115** of the housing member **112** and is received in the bore **128** of the diaphragm member **117** to be opened and closed by the end wall **134** of the diaphragm member **117** that defines the closed end of the bore **128** and forms part of the effective surface of the diaphragm portion **124** that defines the chamber **126.** The valve seat **133** of the logic memory unit **79** is interconnected to the port **110** which leads to the conduit **110'** and the valve seat **133A** of the logic nand unit **82** is interconnected to the port means **108** that leads to the atmosphere.

The port means **78** and **99** of the housing member **111** and the port means **110** of the housing member **112** can comprise outwardly extending tubular nipples that can be effectively telescoped into flexible conduit means to fluidly interconnect the same to such conduit means, such nipple extension containing suitable air filtering means **134'**. In the embodiment illustrated in FIG. **2**, the nipple port means **99** and **78** of the logic memory unit **79** are fluidly interconnected respectively to the conduits **98** and **70** whereas the nipple port means **81** and **103** of the logic nand unit **82** are respectively interconnected to the conduits **80** and **104.**

The annular member **114** carries the port means **97** in the form of a nipple extension projecting out of an opening means **135** in the housing member **112** and the port means **109** comprises a nipple extension of the annular member **113** projecting out of an opening means **136** of the housing member **111.** The nipple port means **97** of the logic memory unit **79** is interconnected to the end **96** of the conduit member **95** and the nipple port means **109** is interconnected to the atmosphere whereas the corresponding nipple port means **102** and **85** of the logic nand unit **82** are respecitvely interconnected to the conduits **101** and **70.**

Accordingly, it can be seen that the chamber **122** of the logic memory unit **79** is always interconnected to the port means **99** and, thus, to the end **98** of the conduit **95** whereas the port means **78** and, thus, the conduit **77** is adapted to be interconnected to the chamber **122** when the diaphragm member **117** opens the valve seat **131.** The atmosphere port means **109** is always interconnected to the chamber **123.** The chamber **127** is always interconnected by the port means **97** to the end **96** of the conduit means **95.** As previously stated, the chamber **126** is always interconnected to the chamber **122** by the passage means **132** and is adapted to be interconnected to the atmosphere or effectively blocked from the atmosphere at the port means **110** except for the controlled rate provided by the bleed restriction **100'** when the diaphragm member **117** opens the valve seat **133** depending on whether the valve **88'** is open or closed as will be apparent hereinafter.

In regard to the logic nand unit **82,** the chamber **122A** thereof is always interconnected by the port means **103** to the conduit **104** and is adapted to be interconnected to the port means **81** and, thus, to the conduit **80** when the diaphragm member **117A** opens the valve seat **131A,** the chamber **122A** always being interconnected to the chamber **126A** by the passage means **132A** in the diaphragm member **117A.** The chamber **123A** is always interconnected by the port means **85** to the conduit **70.** The chamber **127A** is always interconnected by the port means **102** to the conduit **101.** The chamber **126A,** while always being interconnected to the chamber **122A** by the passage means **132A** in the diaphragm member **117A,** is adapted to be interconnected to the atmosphere at the port **108** when the diaphragm member **117A** opens the valve seat **133A.**

The operation of the control system **10** of this invention will now be described.

Assuming that the dryer door is in its closed position to hold the switch blades **29** and **29'** in their closed positions, the housewife or the like sets the timer selector means for operating the dryer **11** for a predetermined length of time whereby the timer mechanism closes and holds the switch blade **25** against the contact **27** and will maintain the switch blade **25** against the contact **27** during the entire cycle of operation of the

dryer 11 so that at the conclusion of such time period, the timer means will automatically open the blade 25 away from the contact 27 to terminate the operation of the apparatus 11.

With the switch blade 25 now moved to its closed position against the contact 27, it can be seen that the electric motor 15 is placed across the power source leads L^1 and L^2 so that the electric motor 15 will continuously rotate the laundry receiving drum to tumble the clothes in an atmosphere to be heated by the burner means 12 for drying of the laundry or the like. As the output shaft 17 of the motor 15 is continuously rotating, the same through the eccentric cam 16 reciprocates suitable pumping mechanism of the vacuum pump 19 to continuously provide a vacuum source for the control system 10

At the initial operation of the control system 10, not only is the ignition coil 47 not at an ignition temperature, but also the temperature effect of the apparatus 11 is below the temperature effect setting of the thermostatic means 71 whereby both valve members 65 and 73 are in the position as illustrated in FIG. 1 so that the vacuum source 19 is not only interconnected to the vacuum operated actuator 56 to evacuate the chamber 61 thereof and close the switch blade 52 against the contact 54 to place the ignition coil 47 across the power source leads L^1 and L^2, but also the vacuum source 19 is interconnected by the conduits 77 and 80 to the valve seats 131 and 131A of the memory unit 79 and nand unit 82, which valve seats 131 and 131A are normally closed by the diaphragm members 117 and 117A due to the force of the respective compression springs 130 and 130A, and by the conduit means 70 to the chambers 127 and 122 of the memory unit 79 and the chamber 123A of the nand unit 82. The vacuum in the conduits 70 and 110' causes the check valve 88' to close so that the open valve seat 133 of the memory unit 79 is effectively blocked from the atmosphere as the bleed 100' does not effect evacuation of chamber 126.

In particular, since the conduit 70 is interconnected to the inlet 20 of the vacuum pump 19 by the positioned valve members 65 and 73, the vacuum pump 19 can evacuate the chamber 123A of the nand unit 82 to maintain the diaphragm member 117A thereof in its de-activated and seating position against the valve seat 131A so that the vacuum source in the conduit 80 leading to the valve seat 131A cannot reach the actuators 40 and 40' to open the valve means 14 and 14'.

Also, since the conduit 86 is now being evacuated, the check valve 88 opens whereas the check valve 88' closes so that the conduit 95 can be evacuated whereby the end 96 thereof evacuates the chamber 127 of the memory unit 79 so that the resulting pressure differential acting across the large central diaphragm portion 118 causes the diaphragm member 117 to move upwardly in FIG. 2 in opposition to the force of the compression spring 130 to its activated position to open the valve seat 131.

However, before, the evacuation of the chamber 127 of the memory unit 79 can effect the switching of the diaphragm member 117 upwardly in FIG. 2, the vacuum source 19 now being interconnected to the chamber 126 by the way of conduit 95, chamber 122 and diaphragm passage 132 to chamber 126, assists in the complete evacuation of the chamber 122 so that when the diaphragm member 117 does switch to its up position in FIG. 2, no atmospheric pressure is permitted to pass out into the conduit 95 and, thus, slow down or prevent the setting of the memory unit 79 in its on position.

With the valve seat 131 now being opened by the actiavted memory unit 79, the vacuum source 19 is interconnected by the conduit 77 through the restriction means 83 to the chamber 122 of the memory unit 79 so that the conduit 101 effectively leading from the chamber 122 of the memory unit 79 is evacuated to evacuate the chamber 127A of the nand unit 82.

With the chamber 127A of the nand unit 82 now being evacuated, it can be seen that as long as the valve member 65 of the ignition temperature sensing means 63 is in its seated position against the valve seat 68', the opposing chamber 123A of the nand unit 82 is also evacuated so that an equal vacuum condition exists across the central diaphragm portion 118A of the diaphragm member 117A of the nand unit 82 so that the compression spring 130A maintains the diaphragm member 117A in its up or de-activated position in FIG. 2 to maintain the valve seat 131A thereof closed and the chamber 122A thereof that leads to the chambers 45 and 45' of the actuators 40 and 40' of the valve means 14 and 14' interconnected to the atmosphere through the passage means 132A of the diaphragm member 117A and the open valve seat 133A whereby the valve members 14 and 14' cannot be opened to interconnect the fuel source 13 to the main burner means 12 as long as a vacuum signal is directed to the chamber 123A by the ignition sensing means 63.

However, when the energized ignition coil 47 subsequently heats up to ignition condition, the sensing member 64 warps downwardly in FIG. 1 to open the valve seat 68' and close the valve member 65 against the valve seat 68 and thereby disconnect the vacuum source 19 from the conduit 70 which begins to return to atmospheric condition by the opened valve seat 68' so that not only is the chamber 61 of the actuator 56 returned to atmospheric condition to open the switch blade 52 away from the contact 54 and de-energize the ignition coil 47, but also the chamber 123A of the nand unit 82 returns to atmospheric condition whereby the resulting pressure differential acting across the diaphragm portion 118A of the diaphragm member 117A of the nand unit 82 causes the diaphragm member 117A to move downwardly in FIG. 2 in opposition to the force of the compression spring 130A to its activated position to not only open the valve seat 131A to the chamber 122A, but also to close the valve seat 133A from the chamber 126A.

In this manner, since the valve member 73 of the temperature effect sensing means 71 in its open condition, the vacuum source 19, in effect, is interconnected to the chambers 45 and 45' of the actuators 40 and 40' to move the valve members 39 and 39' to their open position so that the fuel source 13 is now interconnected to the main burner means 12 and is ignited by the ignition coil 47.

As previously stated, when the valve member 65 of the ignition temperature sensing means 63 is moved to its closed position against the valve seat 68 to permit the now opened valve seat 68' to return the conduit 70 to atmospheric condition to terminate the vacuum signal to the chamber 123A of the nand unit 82 so as to activate the same, the check valve 88 closes so that such return of air into the conduit 70 cannot reach the

conduit 94 whereby the diaphragm member 117 of the memory unit 79 remains in its actuated condition wherein the valve seat 131 is in its open condition and the valve seat 133 is in its closed condition so that a continuous vacuum signal is directed from the chamber 122 to the chamber 127A of the nand unit to maintain the nand unit in its activated position for maintaining the valve means 14 and 14' in their open condition, the restriction 83 providing a greater flow than the controlled bleed means 100 in the conduit 104 so that the valve means 14 and 14' remain open. A holding circuit is provided for the memory unit from the vacuum source 19 to the chamber 122 of the memory unit 79 and by means of the conduit 95 to the chamber 127 to maintain the diaphragm member 117 in its up or activated position. Also, the return of air into the conduit 70 causes the check valve 88' to open whereby atmosphere is at the closed valve seat 133 of unit 79.

Thus, since flames now exist at the main burner means 12, the temperature sensing means 63 will maintain the valve member 65 closed against the valve seat 68 so that the burner means 12 will continue to operate unless the temperature effect being produced by the burner means 12 exceeds the predetermined temperature effect setting of the thermostat means 71.

If the temperature effect of the burner means 12 exceeds the setting of the thermostat 71, the temperature sensing member 72 will move the valve member 73 away from the valve seat 76 to effectively disconnect the conduit 77 from the vacuum source 19 whereby the air will return not only to the chamber 127 of the memory unit 79 through the opened valve seat 131 to deactivate the same, but also permit air to return to the chamber 127A of the nand unit 82 whereby the compression spring 130A of the nand unit 82 will move the diaphragm member 117A upwardly to close the valve seat 131A and open the valve seat 133A so that the chambers 45 and 45' and the actuators 30 and 30' will be interconnected to the atmosphere by the passage means 132A in the diaphragm member 117A leading to the chamber 126A that is interconnected to the open valve seat 123A that leads to the atmosphere at the port 108 as well as by the bleed means 100 in the conduit 104. Similarly, the diaphragm member 117 of the memory unit 79 moves downwardly in FIG. 2 under the force of the compression spring 130 because the chamber 127 returns to atmospheric condition so that the valve seat 131 is now closed and the valve seat 133 is opened to return the chamber 126 to atmospheric condition.

Since flames do not now exist at the main burner means 12, the ignition temperature sensing means 63 now causes the valve member 65 to move away from the valve seat 68 and against the valve seat 68' so that when the valve member 73 of the thermostat 71 is again moved to its closed condition against the valve seat 76 by the temperature effect in the dryer 11 falling below the set temperature effect of the thermostat 71, the main burner means 12 will be operated in the manner previously described wherein the igniter means 47 will again be first energized to ignition condition before the valve members 14 and 14' can be opened.

However, if during the normal operation of the control system 10, wherein the main burner means 12 has been interconnected to the fuel source 13 in the manner previously described so as to be continuously burning, the housewife or the like should open the dryer door temporarily to cause the switch blades 29 and 29' to open so as to disconnect the electric motor 15 from the power source leads L^1 and L^2 whereby the vacuum source 19 ceases to function so that the control system bleeds to atmospheric condition by the controlled bleed 100, and the housewife subsequently closes the dryer door to again activate the motor 15 before the ignition temperature sensing means 63 has moved the valve member 65 away from the valve seat 68, the nand unit 82 cannot cause reopening of the valve means 14 and 14' because the memory unit 79 has not been reset to its activated position so as to interconnect the conduit 77 to the chamber 122 thereof and, thus, to the chamber 127A of the nand unit 82 as it requires an opening of the valve member 65 away from the valve seat 68 of the ignition temperature sensing means 63 to activate the memory unit 79 and the nand unit 82 requires a subsequent closing of the valve member 65 against the valve seat 68 to terminate the vacuum signal to the chamber 123A thereof before the nand unit 82 can be activated to cause opening of the valve means 14 and 14'.

Thus, it can be seen that the control system 10 of this invention utilizes only two logic units each formed of identical structure but performing different logic functions in a manner to control the main burner means 12 so that the system requires that the ignition means 47 be always pneumatically operated to ignition condition before the main burner means 12 can be pneumatically operated to its on condition each time there is a requirement to turn on the main burner means.

Further, it can be seen that the logic unit 79 of this invention is so constructed and arranged that during the time of switching the memory unit 79, no atmospheric signal is seen by the unit 79 to slow down or prevent its switching operation.

Further, any clogging of the restrictions 89 and 83 by dirt or the like during the operation of the system 10 will not cause an adverse situation as the bleed means 100 will cause the valve means 14 and 14' to close and thereby terminate the operation of the burner 12.

Thus, it can be seen that this invention provides an improved pneumatic control system for a fuel burning apparatus or the like.

What is claimed is:

1. A pneumatically operated control system comprising a pneumatic source, a pneumatically operated unit having a housing means carrying a movable means that cooperates therewith define at least first, second and third chambers in stacked relation, said housing means having first and second valve seats leading respectively to said first chamber and to said third chamber and being adapted to be opened and closed by said movable means, first means comprising a thermostatically operated device for interconnecting said source to said second chamber to move said movable means to close said first valve seat and open said second valve seat and for interconnecting the atmosphere to said second chamber to cause said movable means to move to close said second valve seat and open said first valve seat, second means for interconnecting said source to said second valve seat, said movable means having passage means therethrough always interconnecting said first and third chambers together, said first means also interconnecting the atmosphere to said first valve seat at substantially the same time it interconnects the atmosphere to said second chamber and having disconnecting means

to disconnect the atmosphere from said first valve seat when said first means is interconnecting said source to said second chamber whereby said first chamber is disconnected from the atmosphere during the time it takes said second chamber to switch said movable means for closing said second valve seat to opening said second valve seat.

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