The present invention relates to improvements in domestic clothes dryers and especially to an operating control which operates in response to the pressure of the air flowing through the drier air circuit system.

Clothes dryers of the domestic type generally employ a clothes containing chamber in which the clothes are placed while being subjected to a circulating heating air which causes an evaporation of the moisture therein to dry the clothes. The container is usually in the form of a rotating drum and an intake conduit having a heater therein directs warm air to the drum and a discharge conduit leads the air away from the drum. A powered fan is usually provided to provide a circulation of air through the drum. During circulation the air may pick up lint from the clothing. A lint trap may be provided at the discharge conduit to catch the lint and prevent the lint from being discharged into the room.

During continuous operation especially with certain types of clothing or garments, the lint trap may catch an excess amount of material thereby slowing the flowage of air through the conduit below a safe level so as to cause an overheating of the heating elements in the intake conduit. If the heating elements are not turned off damage to the machine may occur and a conflagration of the combustible materials in the neighborhood of the drier, such as the oil for the bearings, the waste lint which may be caught in the corners of the machine or even the clothing within the drier may catch fire.

It is also important that the other operating elements such as the blowers do not overheat and that the air heater does not reach a dangerous temperature for any reason. Another problem which is encountered in drier operation is the control of the heating elements. With a substantial flow of air through the drier, heat from heating elements of considerable size must be supplied. If these elements are electrical in nature, they suddenly throw them on the supply circuit will create too high a current and will very likely blow a fuse. Further the heaters must be capable of bringing the heating chamber quickly up to the appropriate temperature and then be controllable to maintain the chamber at the proper temperature during operation.

It is therefore an object of our invention to provide a simplified reliable safety mechanism which will automatically turn off the heating elements for the clothes drier when an emergency condition is encountered.

Another object of the invention is to provide a control mechanism for the heating elements which will automatically function to either turn off the heating elements or signal the operator when a reduced flow of air through the drier occurs or prevent overheating of the elements. Another object of the invention is to provide an improved control mechanism for the heater elements which is capable of being used to vary the number of heating elements used in accordance with the temperature in the air heating chamber and in accordance with the amount of air flowing through the drier.

Another object of the invention is to provide a control mechanism for the heaters of a drier in which a plurality of heaters are provided and an automatic time delay is used for placing the various heaters into operation. A still further object of the invention is to provide an improved simplified and more reliable time delay mechanism which is operated by the air circulating through the clothes drier.

Another object of the invention is to provide a mechanism for simply and quickly turning off the heaters at the end of operation or for an emergency condition without the provision of additional switches or expensive equipment.

A further object of the invention is to provide a safety mechanism which will turn off operating elements of the machine automatically when the lint filter is filled with lint.

A further object of the invention is to provide improved and simplified electrical circuits which will reduce the number of switches and operating elements required and the size of the elements and switches to perform a starting and stopping of the machine as well as a means for terminating operation as a safety measure.

Other objects and advantages will become more apparent to those skilled in the art with the following specification and appended drawings, in which:

Figure 1 is an elevational view of the clothes drier taken from the rear of the drier with portions of the cabinet broken away and with parts of the interior shown schematically to illustrate the operating elements of the machine;

Figure 2 is a side elevational view of the machine with portions of the cabinet broken away to better show the important and basic operating elements, with portions of the elements being shown schematically;

Figure 3 is a plan view of the improved time delay mechanism of the present invention;

Figure 4 is a vertical sectional view taken along the line IV—IV of Figure 3;

Figure 5 is a vertical sectional view taken along line V—V of Figure 4;

Figure 6 is a sectional view taken along line VI—VI of Figure 4;

Figure 7 is an enlarged detailed sectional view taken along line VII—VII of Figure 4;

Figure 8 is a diagrammatic view of the circuit employing the preferred embodiment of the principles of the invention;

Figure 9 is a circuit diagram of an alternative circuit which may be used; and,

Figure 10 is another diagram of an alternative embodiment of a circuit that may be used.

The features and principles of the invention are shown in the drawings and described in the present description as the means being incorporated in a domestic type clothes drier. Although this construction confers and partakes of the advantages and attainments of the invention, it is to be understood that the methods and processes of the invention and the features thereof may be utilized in various other types of mechanisms and in various other circumstances without departing from the scope of the invention intended to be protected hereby.

In the drawings in Figure 1 the operating mechanism for the domestic drier is shown enclosed in a cabinet. Within the cabinet a cylindrical drum 12 is provided which functions to contain the clothes while they are being subjected to the heated drying air. The drum 12 is supported for rotation on a horizontal axis on a shaft 14 suitably secured to the end of the drum and the shaft or axis 14 is suitably supported in a bearing 16 which may be of the cantilever type. Secured to the shaft 14 is a driving pulley 18, and for purposes of rotating the drum to tumble the clothes therein a belt 20...
is trained over the pulley 18 which may be a V-pulley and the belt be a V-type belt. The lower end of the belt is trained over a small pulley 22 which is carried on a speed reduction idler shaft 24 which may be spring loaded if desired to maintain a tension on the V-belts. The shaft 24 and the small pulley 22 are driven by a large pulley 26 which is rotateably mounted on the idler shaft 24. Another V-belt 28 is trained over the large pulley 26 and is driven by the drive pulley 30 carried on the drive shaft 32 of a motor 34. The motor 34 is suitably mounted on the base 36 of the cabinet 10. The base also supports the vertical post 38 which carries the drum support bearing 16 in its upper end and which carries the bearing for the idler shaft 24.

The V-belt 28 also passes over a small pulley 40 which is mounted on the drive shaft 42 of a fan 44. The fan is mounted in a small housing or fan scroll 46 which is suitably supported on the bulkhead 54 within the cabinet 10 so as to be secured adjacent to the rotating drum 12. The fan scroll 46 is an enclosure for the fan and is provided with a discharge opening 48 through which the air is discharged. The fan scroll is provided with an intake opening 50 which leads axially to the hub of the fan and through which air passes from the drier drum to be centrifugally discharged by the fan through the fan scroll and out through the discharge opening 48 where it passes into the surrounding air such as into the room.

The discharge opening 48 leading from the fan scroll 46 leads outwardly through the rear wall 49 of the cabinet to a lint basket 51. The lint basket 51 is formed of screening material which is provided with a multiplicity of small air flow openings so as to permit the normal passage of an air stream but to filter lint from the air. The lint being discharged from the air circuit of the drier must first pass through this lint basket before escaping to the surrounding air and therefore any lint picked up enroute, such as from the clothing within the drier drum, will be caught and not be permitted to escape into the room. This lint basket is removable so as to allow cleaning or the operator to forget to clean the lint basket and thus the flow of air from the fan scroll 46 will be impeded. When the flow of air decreases below a safe level the present invention employs a mechanism as will be described later to automatically terminate the operation of the heater elements and to activate an alarm to thereby prevent damage to the machine and to alert the operator as to what has occurred.

The fan as is illustrated in the present drawings serves as a suction fan to draw air through the drier drum 12 and the intake opening 50 is in constant communication with the interior of the drum through an annular perforate area 52 of the drum. The perforate annular area 52 in the rear of the drum 12 which leads to the interior thereof also provides a means of constant communication to the interior of the drum for the air intake or admission conduit 56 which leads the warm air to circulate within the rotating drum 12.

The heater box 59 carries heating elements 57 and 58 which are shown as resistance electrical coils but also may be in the form of gas heating elements and are used in order to raise the temperature of the air which passes through the rotating drum.

The heating elements if electrical in form as shown at 57 and 58 are operated by control switch such as a relay as will be described later in connection with Figure 5. If they are gas operated they will be electrically controlled by a solenoid valve, not shown. The heating elements of the drawings utilizes a fan 44 which is on the discharge side of the rotating drum 12 to provide a suction to draw air in through the air circuit, which consists of the air intake conduit 219, air admission conduit 56, the drum 12, and the fan scroll 46, the fan may be placed in other locations with respect to the drier mechanism. For example the fan may be located on the base of the intake conduit so as to force air up through the heater box 59 and to force the air through the complete air circuit including the drier drum and out through the discharge opening 48. Further two fans may be used with one fan in the location shown and an additional fan in the intake conduit.

It will be recognized however that with the fan in the location shown in Figure 1, the portion of the enclosure 46 which has been called the fan scroll will be under pressure from the fan forcing the air ahead of it out fan discharge opening 48 and the interior of the drier drum 12 and the air intake conduit 219 and the air admission conduit 56 and heater box 59 will be under a slight suction or vacuum as the air is drawn into the drier drum due to the suction of the fan 44. If the fan 44 is omitted and a substitute fan is placed at the admission conduit 56 the entire system will be under a slight pressure due to the air being forced through the drum and out the discharge chamber. The build up in pressure due to the air being forced ahead of the fan is due to the frictional resistances and change of size of air passageways of the system.

In any event it will be recognized that wherever a fan is placed, when the air is flowing through the air circuit there will be a pressure differential between the ambient or room air and the air within the drum within the air intake conduit 219 and within the air admission conduit 56 and within the fan scroll 46. The present invention contemplates utilizing this pressure differential in order to detect the quantity of flow of air through the machine and in order to control a signal and the air heater in response to the quantity of flow.

It is to be understood therefore that in the specification and claims when the pressure within the air circuit or air system is spoken of the position of the fan in the embodiment shown in the drawings is given by way of example and not by way of limitation. The pressure differential which in the present embodiment is due to the pressure within the discharge conduit would be caused in a different part of the air circuit and could be due to a lower pressure within the circuit if the fan for circulating air were located in a different portion of the air circuit.

The control mechanism is shown generally at 60 in Figures 1 and 2 and is shown in detail in Figures 3 through 7. The control mechanism is shown in the location illustrated relative to the cabinet 10 for purposes of the present description only and may be mounted at any location within the cabinet or at some portion remote from the cabinet. The control is a pressure responsive time delay mechanism and it is essential that it be connected in some way to the air circuit of the air system which creates the flow of air through the drier. In the illustration the control mechanism 60 is shown mounted within the drier cabinet at a place handy to the fan scroll 46. The flexible connecting tubing 62 will communicate the pressure within the fan scroll 46 to the control mechanism.

As is shown in the detail drawing of Figure 4, the control mechanism consists primarily of an actuating member 64 which is operated by a pressure differential across its two opposing surfaces. One of these surfaces exposed to atmospheric air and the other of said surfaces is exposed to the pressure of the air in the drier air circuit to cause movement of the actuating member 64. The actuating member moves to sequentially operate a series of switches which are connected to operating elements of the drier. For terminating operation of the elements the actuating member 64 is rapidly returned to its original position by mechanism for equalizing the pressure on the two sides of the actuating member.

The actuating member is shown in the form of a thin flexible diaphragm 66 which is circular in shape and
which may be formed of a thin pliable material such as rubber. The central portion of the diaphragm is reinforced by thin reinforcing metal disks 68 and 70 clamped to either side. In addition to these reinforcing disks an additional disk 72 is clamped on the top side to engage the operating members of the switches as the diaphragm is moved due to pressure differential. To clamp the disks 68, 70 and 72 to either side of the diaphragm, a reduced shank 74 of a switch actuating pin 76 is projected through a hole in the center of the reinforcing disks and the diaphragm. To secure the switch actuating pin in place with the pin extending vertically upright, a fastening member 79 such as a speed nut is secured beneath the diaphragm to the shank 74 of the switch.

The diaphragm is mounted within a housing 78 which is comprised of an upper dish-shaped portion 80 and a lower dish-shaped portion 82. The portions 80 and 82 have outer flanged edges which are brought together to clamp the outer edge of the diaphragm 66 therebetween. To secure the upper and lower members of the housing 78 together and to clamp the edge of the diaphragm firmly therebetween the lower flange 86 is bent over the upper flange.

The lower dish-shaped portion 82 of the housing forms a closed or sealed chamber 88 beneath the diaphragm 66. This chamber is sealed with the exception of a vent opening 90, which is normally closed but which may be opened to outside air, and with the exception of the tubing 62 which leads to the air circuit system of the drier. The housing 78 is provided with a hollow bore 110 over which the tubing 62 may be slid for easy connection.

The vent opening 90 comprises a hole through the lower dish-shaped portion 82 of the housing in which is mounted a rubber grommet 92. Against the outer face of the grommet is positioned a valve head 94 carried on a valve stem 98. The stem 98 acts as the armature or movable core of a solenoid, the coil of the solenoid being shown at 102. The valve stem or core 98 is slidable mounted in a metal bearing member 100 secured within a sleeve 101 in the coil 102. Electrical leads 104 and 106 lead to the coil from a suitable switching arrangement which will be described later to supply electricity to the solenoid coil 102. The valve stem 98 is normally held during operation in its closed position by the solenoid against the action of a coil spring 111 which connects to the valve head 94 and is connected at its other end to the metal bearing member 100 secured within the coil.

When the coil of the solenoid is deenergized, the valve stem will be drawn downwardly to move the valve head 94 away from the opening 90 to open the sealed chamber 88. When the coil of the solenoid is energized the valve will again move to closed position. The solenoid as a whole is supported on a bracket 108 suitably mounted on the housing 78.

In normal operation therefore, the vent opening 90 is sealed and the closed chamber 88 beneath the diaphragm actuating member 64 is subjected to the pressure of the air circuit of the drier as communicated to the closed chamber 88 via the tubing 62.

The diaphragm or actuating member 64 is shown in Figure 4 in its first or starting position before being subject to pressure from the air circulating system of the drier. When this air pressure is admitted to the closed chamber 88, the pressure on the lower face of the diaphragm will begin moving the diaphragm upwardly. The boss 110 leading from the tubing 62 to the closed chamber 88 has a small circular bore 112 through the center which is the communicating hole leading from the tubing 62 to the chamber 88. This hole is considerably smaller in cross-sectional area than the diaphragm and therefore the air will bleed up into the chamber 88 slowly to cause the diaphragm to move slowly upwardly. This slow upward movement of the diaphragm will create a time delay during which the diaphragm engages its sequence of switches. Thus through normal operation the starting up of the drier and the circulation of air therethrough will cause a slow upward movement of the actuating member or diaphragm 64.

The chamber 114 above the diaphragm is exposed to atmosphere and the upper portion 80 of the housing is not sealed. Various openings in the upper portion of the housing are present because of the switch connections and in addition a vent opening 116 may be specifically provided to expose the upper face of the diaphragm 64 to the atmosphere.

As the diaphragm moves upwardly it engages a sequence of three switches. The switches 1, 2 and 3 are selected by enclosed members 1, 2 and 3 which also indicates the sequence of operation of the switches. The first switch as will be later described in detail with the circuit diagram of Figure 8, operates a first heating element 87 within the heater box 59 and the second switch 2 places in circuit the second heating element shown at 88 in Figure 1. The third switch is not operated in normal operation but is an emergency switch and is connected to an audible or visual signal.

Switches 1 and 2 are similar in construction with the body of switch 1 incorporating a beam member 118 having upturned ears 120 and 122 which pivotally support the beam as is shown in the detail sectional view of Figure 5. Extending through holes in the ears is a pintle bar 124 which also extends through downwardly turned support ears 126 and 128 from a support member riveted to the circular plate 130 which forms the upper part of the housing 76 and which is attached thereto by screws 132, 133.

The forward end of the beam carries a shaped leaf spring 134 to which is connected a T-bar 136 that serves to bridge the electrical conducting strips 138 and 140. As is shown in the Figure 3 and Figure 6 the leaf spring 134 is arranged to resiliently carry the T-bar 136 for engagement with and to bridge the conducting strips 138 and 140. The conducting strips are shown in Figure 3 with 140 being the power terminal or the hot strip supplied by the power input terminal 142. The strip 138 supplies the terminal 144 which leads to the heater element. Thus when the T-bar 136 bridges the strips 140 and 138 the electricity will flow from the strip 140 to the strip 138 and to the heating element, the circuit having been completed. The beam 118 which carries the switch 1, the switch 2, the T-bar 136 is rocked by a coil compression spring 146 which is secured to the lower face of the beam 118. The lower end of the spring 146 rests on top of the diaphragm 64 and is in direct engagement with the reinforcing disk 72 which is secured to the actuating member or diaphragm 64. Therefore as soon as the diaphragm 64 begins moving upwardly, the spring 146 will become compressed until the beam 118 swings in a counterclockwise direction as shown in Figure 4 to snap the bridging elements across the conductor strips 138 and 140. The switch moves upwardly with such an action rather than with a slow action which would cause an arcing across the contacts because of the permanent magnets 148 at the free end of the beam 118. When the pressure in the spring 146 becomes sufficiently large the end of the beam will break away from the magnet and the switch will snap shut. It will be recognized that overcenter or toggle type switch linkage may be utilized instead of the magnet arrangement shown. Through the center of the magnet 148 extends an adjustment screw 158 which bears downwardly against the beam 118 and which is adjustable to adjust the spacing between the beam and the magnet to reduce or increase the resistance necessary to swing the beam 118. This adjustment is made in accordance with the requirements of the system as dictated by the strength of the actuator diaphragm 64 and of the spring 146.
heating element 58. In order to close the second switch, the actuator diaphragm 64 must have moved up to the dotted line position of Figure 4 by compressing spring 146 until it reaches and begins to compress the spring 160. The spring 160 is secured beneath the end of the beam 162 which supports switch 2. The beam 162 of switch 2 also carries at its end a leaf spring 164 which supports a T-bar 166. The T-bar is moveable upwardly with the rocking of the beam 162 to create a bridge across contact strips 140 and 168 as is shown in Figure 3. Strip 140 is continuous from the terminal 142 and is the power strip and when the T-bar 166 bridges across from the power strip to the strip 168 electrical current is fed to the terminal 170 which leads to the second heating element 58.

The switch-carrying beam 162 is shown in the switch-closed position in Figure 4. In this position the end of the beam 162 is separated from its magnet 172, the magnet also being provided with an adjustable spring member. The beam itself is supported by upturned ears 176, only one of which is shown since the constructions is similar to that of the beam 118 shown in detail in Figure 5. The upturned ear 176 is connected to the ear 178 of the support by a pintle bar 180 which extends through holes in the ears.

When the coil compression springs 146 and 160 have been sufficiently compressed to close the respective switches 1 and 2, the resistance of the springs will be such to hold the actuating diaphragm 64 in a static position since their resistance will equal the force of the air pressure in the closed chamber 88 beneath the diaphragm. Therefore only an increase in pressure which is in excess of a normal amount will cause a further upward movement of the diaphragm. This excessive amount of pressure will be caused only by an abnormal operating condition such as occurs if the lint basket becomes stopped to slow down the circulation of air below a safe volume.

In the normal operating position the switch actuating pin 76 will be in the dotted line position of Figure 4. However, when an excessive pressure builds up within the drier to cause the actuating diaphragm 64 to compress the springs 146 and 160 an abnormal amount, the switch actuating pin 76 will move upwardly to close the switch 3.

Switch 3 closes the circuit to a signal mechanism to warn the operator of the clogged lint screen. Since a reduced flow of air would cause a sudden increase in temperature of the heating elements and a possibility of the occurrence of a fire and at least damage to the machine, it is important that the heating elements be immediately turned off.

It will be understood that although electrical heating elements are shown in the preferred embodiment, the mechanism can be employed with gas heaters wherein solenoid valves are used to supply gas to the heaters. The solenoid valves will therefore be controlled to turn off the gas of the heater instead of the heater being turned directly off by being taken out of the electrical circuit.

It will also be understood that although switch 3 is shown in the circuit and is described herein as being connected to a signal mechanism, other operating elements of the drier could be operated by switch 3 and if desired the entire machine could be turned off or only selected elements of the machine turned off in addition to or instead of operating the signal.

Switch 3 is shown in detail in Figures 3 and 7. As is shown in Figure 7 the switch incorporates a cantilevered leaf spring switch arm 182 which carries a switch contact 184. The extreme end of the leaf spring switch arm 182 is bent upwardly by the normal tension of the spring against an adjustment screw 188 which is adjustably threaded into the plate 130. Adjustment of the screw 188 controls the spacing between the terminal 184 and the electrical strip 140. This will of course control pressure required for the switch actuating pin 76 to move the contact 184 against the electrical strip 140. As the pin 76 moves up wardly and engages the leaf spring 182, the terminal 184 will be pushed against the conducting strip 140 to close the circuit to the terminal 190. Terminal 190 completes the circuit, as will be shown later in connection with the circuit diagram, to the alarm which may take the form of a buzzer in order to alert the operator of the reduced air flow creating a build up of pressure within the drier.

With reference to the circuit diagram of Figure 8 it will be seen that electricity is supplied for operating the machine through the usual 220 volt line wherein the leads are labeled L1 and L2. The neutral line is labeled with N. The heater elements shown at 57 and 58 are connected across the 220 volt line whereas the other operating mechanism is connected from the neutral to one of the lines to operate on 110 volts. The drier is preferably automatic in nature and as such is controlled by a time cycle switch which is not shown in detail since it is not absolutely essential to the operation of this invention and if used may be of various types known to the art. The switch generally is operated by timer motor as is labeled in the circuit diagram and operation of the timer motor is begun by manually turning or setting the switch until the timer switch is closed to complete the circuit through the timer motor. The timer motor then begins operating automatically and will sequentially separate the contact 190 from the power contact 192 and later separate contact 194 from the power contact 196 of the machine. Separation of the first contact 190 from the power contact 192 will turn off the heater elements and separation of contact 194 will terminate operation of the machine by stopping the drier motor. The .110 volt circuit through the timer switch to the timer motor and drier motor is completed through a door switch 197 which may or may not be provided but if provided breaks the circuit to stop the drier motor and timer motor automatically when the door 15, as shown in Figure 2, of the drier is opened. When the door is again closed the circuit is completed to reconvene operation of the timer motor and drier motor.

Bringing the contacts 190 and 192 of the timer switch together also completes the circuit through the valve solenoid 96 which is in series circuit with the fan housing safety switch and the heater box safety switch 196 and 198, respectively. The heater box safety switch 198 is a heat responsive switch which will cut off the flow of current when an excessive heat is encountered within the heater box 59 as is shown in Figure 1. During normal operation this switch will remain closed and complete the circuit through the valve solenoid 96 but only on excessive temperatures as are encountered with some mechanical breakdowns of the machine will this switch automatically open the circuit to the valve solenoid. This of course will vent the under surface of the diaphragm causing it to drop and open the switches to the heater elements.

The fan housing safety switch 196 is mounted in a suitable location in close adjacency to the fan 44. If something goes wrong with the fan 44 causing it to overheat, the fan housing safety switch 196 which is a thermoster responsive switch set to open at excessive temperatures, will break the circuit to the valve solenoid 96. However, during normal operation the safety switch 196 will remain closed or the circuit open.

As previously described the valve solenoid 96 in operative position closes the vent hole 90 to seal the chamber below the diaphragm actuator 64. Thus the diaphragm actuator will keep switches 1 and 2 closed, but if the circuit to the valve solenoid is opened, the diaphragm actuator will drop, opening the switches to the heater elements.

As the machine is started, the circuit is completed through the drier motor and timer motor and as pressure builds up due to operation of the fan, diaphragm switches 1 and 2 will sequentially close. As the first switch 1 closes as shown in Figure 8 the heater 57 is placed in circuit. As the machine continues to operate the dia-
phragm actuator 64 continues to move upwardly against the compression of the springs 146 and 160 until it closes switch 2. When the switch 2 closes the heater element 58 will be placed in circuit. Since the heater elements are placed in the circuit over a spaced period of time, a heavy load will not be thrown on the circuit at one time to blow the fuses. Further, as the heater element heats its resistance decreases so that the current flow in the first heater will have dropped by the time the second heater is placed in the circuit. The time delay between these heaters may be adjusted and varied as for example from about two to ten seconds, and this may be controlled by various factors such as controlling the size of the opening 112 leading into the air chamber 89 below the actuator diaphragm 64 or changing the size of the diaphragm and housing.

It is to be noted that an operating thermostat 200 is included in the circuit with the second heater element 58 and during normal operations while switches 1 and 2 of the diaphragm delay control 60 are closed, the thermostat 200, which may be placed at any convenient location in the air stream passing through the drier, will open and close the second heater element 58 in accordance with fluctuations of the heat and in accordance with the adjustment to which the thermostat is set. Thus heater element 57 will keep operating at its maximum load and at peak efficiency permitting the entire unit to operate at maximum efficiency throughout its operation.

If the limit switch fills up so as to cause an abnormal build up of air pressure which indicates the reduction of air flow through the drier, switch 3 of the diaphragm delay control switch 60 will close. This will complete the circuit, as will be seen in Figure 8, through the limit switch and prevent harvesting of the thermostat to what is occurring. The operator can immediately remove the limit switch from the position to control operation to continue but if the operator does not do so the heating elements will gradually overheat until the heater box safety switch 198 opens to thereby deenergize the valve solenoid 96 which vents the chamber 88 beneath the diaphragm 64 to permit the diaphragm to immediately drop to open the switches 1 and 2 to thereby take the heating elements out of the circuit.

An alternative arrangement is shown in Figure 9 where in the diaphragm delay control 60 is connected across the 110 volt instead of the 200 volt circuit to operate relay switch 199. This permits utilization of switches of a smaller amperage rating than decreases the cost of the system. As will be seen in Figure 9, the diaphragm delay control in this case is placed in circuit only by operation of the timer switch and is not continually in the circuit as in the case of the circuit of Figure 8. When the contacts 202 and 204 are connected to the power contact 206, the timer motor and drier motor are first placed in circuit through the door switch. The diaphragm delay control is also thus placed in the circuit and as the drier begins to operate and pressure builds up due to the circulation of air, the diaphragm delay control switches 1 and 2 will sequentially close. As the first switch closes, the circuit through the first relay coil 199 will be first closed, closing its relay switch to place the heater element 57 in the circuit. As the diaphragm actuator 64 continues to rise the switch contact 2 will next close completing the circuit through the second relay 197 which closes its relay switch to complete the circuit through the heating element 58. The operating thermostat which is in series with the second relay switch will complete the circuit through the heating element 58. Both relay coils are connected in series circuit with the fan housing safety switch 196 and the heater box safety switch 198 and as these switches are normally closed, the relays will be immediately placed in circuit. These switches as will be received will remain closed unless the fan housing or the heater box reaches an excessive temperature whereupon the switches will open as a safety measure and will release the relay switches to take the heater coils 57 and 58 out of the circuit. This arrangement permits omission of the valve solenoid 96. Again, the contact 3 of the diaphragm delay control will not close unless excessive pressure builds up within the air circuit system of the drier and if this occurs and switch contact 3 closes the limit buzzer will sound to alert the operator as to what has occurred.

With reference to Figure 10 another circuit arrangement is shown. In this circuit certain details are changed for the sake of economy and for certain operational objectives. As the timer switch is closed, power line 210 is connected to contacts 212 and 214. Contact 212 closes the circuit to the timer motor and the drier motor through the door switch. The contact 214 closes the circuit to the diaphragm control and as pressure builds up within the drier, switch 1 of the diaphragm control 60 will be closed. It is to be especially noted that a simplified model of the diaphragm control is herein employed with switch 2 omitted. In this instance the only time delay which will occur will be in the closing of the first switch and there will be no time delay between placing the heating elements in circuit. The two heating elements are placed in circuit at the same time and are both connected to the relay switches 216 which are operated by relay coil 218. When the diaphragm control switch 1 closes, the relay coil 218 will immediately be in circuit with the heater box safety switch and the fan housing safety switch which are in their closed position. This electrical arrangement also permits omission of the valve solenoid 96.

The diaphragm control of Figure 10 still retains the contact 3 which is in circuit with the limit buzzer and if a stoppage of the air flow occurs, the buzzer alarm will sound by virtue of switch contact 3 being closed.

Although the operation of the mechanism will be now understood from a description of the structure and operation of the various parts an over-all description of operation will be helpful in understanding the objectives and attainments of the invention. The drier is first placed in operation by a manual starting of the timer switch as is shown in Figure 8. This closes the circuit to the motor 42 and to the timer motor shown in the circuit. As the motor 34 starts, it operates the fan 44 as shown in Figure 1 to build up a pressure within the fan scroll 46 and to draw air through the drier drum 12 and through the air intake conduit 219 and admission conduit 56. As the air circulates through the drum it passes over the heater elements 57 and 58 to be increased in temperature. As the pressure builds up in the fan scroll 46 air flows through the tubing 62 into the time delay element control 60. As is shown in Figure 4 the air will build up pressure in the closed chamber 88 to cause the actuator diaphragm 64 to be slowly raised. As the diaphragm raises it pushes upwardly on the spring 146 until the beam 118 separates from the magnet 148 to bring the T-bar 136 across the electrical strips 140 and 138. This completes the circuit to the first heating element 57. As the actuator diaphragm 64 continues to raise, it next closes switch 2 by engaging the spring 160 and causes the beam 162 to rock in a clockwise direction as is shown in Figure 4. As the T-bar 166 is brought across the contact strips 140 and 168, the circuit is completed to the second heater element 58.

The actuator diaphragm 64 will remain in this position unless an excessive pressure is created within the discharge conduit 46 such as by stopping of the lint trap 51. This excessive pressure will cause an increase raising of the actuator diaphragm 64 until the switch actuator pin 76 closes switch 3. This will connect the circuit to a buzzer or an alarm to alert the operator as to what has occurred.

If the condition is not corrected the heater box 59 will overheat or the fan scroll 46 will overheat and the safety switches therein will open the circuit to the valve solenoid shown generally at 96 in Figure 4. When this circuit is open the valve head 94 moves downwardly to open the vent 90. This immediately bleeds air from the closed
1. Chamber 88 permitting the diaphragm 64 to drop thus immediately opening the switches 1 and 2 of the time delay element control and taking the heating elements 57 and 58 out of circuit to prevent danger of a fire or prevent damage to the operating mechanism.

Thus it will be seen that we have provided a control mechanism for a heater which meets the objectives heretofore set forth. The mechanism is simple and reliable in operation and presents an improved time delay mechanism which operates from the air pressure differential which occurs with operation of the drier system. The mechanism positively prevents the dangers of fires and prevents damage to the equipment by automatically turning off the heater in case of a decreased flow of air through the machine. Further, the time delay mechanism places the heater elements in circuit in sequence so as to prevent a severe load being thrown on the circuit at one time.

The mechanism is provided with a simplified inexpensive air escape vent which functions to quickly and surely turn off the heater elements in cases of emergency as determined by the safety control switches. The entire mechanism utilizes a minimum number of switches and the structure is simple and foolproof in construction and will operate over long periods of time with a minimum of attention and without adjustment.

We have, in the drawings and specification, presented a detailed disclosure of the preferred embodiments of our invention, but it is to be understood that we do not intend to limit the invention to the specific form disclosed but intend to cover all modifications, changes and alternative constructions and methods falling within the scope of the principles taught by our invention.

We claim as our invention:

1. A mechanism for controlling the operation of a clothes drier including a drier chamber, operating elements, and air admission and discharge conduits with a fan to drive air through the air circuit including the conduits and drier chamber, the control mechanism comprising an actuating member movable in response to a pressure differential between atmospheric air to which one side is exposed and air within a drier circuit to which the other side is exposed, a housing for said actuating member movably supporting said member therein, housing exposing one side of said actuating member to atmosphere, a conduit connected to the housing and exposing the outer side of said actuating member to the air circuit of the drier, a first switch means responsive to a change of condition within said control housing, said air conduit having a cross sectional area less than the cross sectional area of the diaphragm to create a relatively slow movement of the diaphragm with flow of air through said conduit, a first switch means positioned in the path of movement of said diaphragm to be engaged thereby, a second switch means in the path of movement of said diaphragm as it moves in response to a pressure change within the drier chamber to manifest a flow of air through the drier circuit.

3. A mechanism for use in connection with the operation of a clothes drier which includes a drier chamber and communicating air admission and discharge conduits with a fan to move air through the air circuit including the conduits and drier chamber, the mechanism comprising an acting member movable in response to a pressure differential on opposing sides, a support for said actuating member connected to expose one side of the actuating member to the pressure within the air circuit and to expose the other side of the actuating member to atmospheric air, said actuating member moving with a change of pressure within the air circuit when air is flowing through the drier chamber, a first switch in the path of said actuating member to be operated thereby, a second switch in the path of said actuating member by said actuating member after said first switch, resilient switch operating means located between the first switch and the actuating member and adapted to be engaged by the actuating member to operatively said first switch, means between the second switch and actuating member to operate the second switch after the first switch, and resilient switch operating means compressing with continued movement of the actuating member as the actuating member moves to operate the second switch, and first and second electrically operated means connected in circuit with said switches to be respectively operated in a sequential manner by operation of the first and second switches with movement of the actuating member.

4. A mechanism for use in connection with the operation of a clothes drier including a drier chamber and air admission and discharge conduits with a fan to move air through the air circuit of the drier including said conduits and drier chamber, the mechanism comprising a fluid operated time delay apparatus operable between zero time and a switch operating time, means for connecting the time delay apparatus to said air circuit to expose the time delay apparatus to change in pressure within the air circuit to cause operation thereof, the switch operatively connected to the time delay apparatus to be operated thereby at the switch operating time, electrically operated means connected to said switch to be operated thereby after a flow of air through the drier chamber has begun, and an emergency time delay return mechanism connected to the time delay apparatus and operative to return the time delay mechanism to zero time and to return the switch to unoperated position.

5. A mechanism for use in connection with the operation of a clothes drier including a clothes drying drum and air admission and discharge conduits with a fan to move the air through the air circuit including the conduits and drier drum, the mechanism comprising a fluid pressure differential operated time delay mechanism, means for connecting the time delay mechanism to the air circuit to expose the time delay apparatus to change in pressure in the air circuit with a flow of air through said drier drum, an operating switch connected to the time delay mechanism to be operated thereby after a predetermined time, electrically operated means connected to the switch to be actuated thereby after a flow of air through the drier has occurred for a period of time, means responsive to a change of conditions within the
drier, and time delay return apparatus connected to the time delay mechanism and operative to return the time delay to zero time and connected to said condition responsive apparatus and operative upon the presence of a condition change within the drier to deactivate said switch.

6. A mechanism for use in connection with the operation of a clothes drier including a drier chamber and air admission and discharge conduits with a fan to move air through an air circuit including the conduits and drier chamber, the mechanism comprising an actuating member movable in response to a pressure differential between two operating surfaces thereof, a housing for enclosing said actuating member and creating a closed chamber on one operating surface of the actuating member, means connecting said closed chamber to the air circuit of the drier to subject the chamber to the pressure within said air circuit and cause movement of the actuating member with a change in air pressure due to flow of air through the drier chamber, switch means positioned to be engaged by the actuating member after travel of the actuating member from a first position to a second position due to said pressure differential, means responsive to a change in condition within the drier and operatively connected to said actuating means to return the actuating member to the first position with said change in condition to deactivate the switch, and an electrically operated means connected to said switch to be operated thereby after a flow of air through the drier chamber is inaugurated.

7. A mechanism for use in connection with the operation of a clothes drier including a drier chamber and air admission and discharge conduits with a fan to move air through an air circuit including said conduits and drier chamber, the mechanism comprising an actuating member subject to a pressure differential across operating surfaces and movable between a first and a second position, a housing for said actuating member providing a closed chamber surrounding one of said operating surfaces to atmosphere, means to connect said closed chamber of the housing to the air circuit of the drier to expose the actuating member to change in pressure within the same circuit as air is caused to flow through the drier chamber to move the actuating member to said second position, an air vent leading to said closed chamber and positioned in said housing to permit the closed chamber to be vented to atmosphere, valve means operatively connecting said vent and being operative to permit the actuating member to be returned to said first position when the closed chamber is vented to atmosphere, and drum control means positioned to be actuated by said actuating member when the actuating member moves between first and second positions.

8. A mechanism for controlling the operation of a clothes drier comprising a drier chamber in which the clothes are contained while being subjected to a heated drying air, an air admission conduit leading to the clothes chamber, a discharge conduit directing air away from the clothes chamber, a fan operatively associated with said conduits to move air through said drying chamber, an actuating member movable in response to a pressure differential across operating surfaces thereof, a housing for said actuating member providing a closed chamber for one of said operating surfaces and a chamber exposed to atmosphere for the other of said operating surfaces, means to connect said closed chamber to the drier air circuit including said conduits and drier chamber, a valve controlled air vent leading to said closed chamber and adapted to be opened to vent the chamber to atmosphere, means responsive to a temperature of operating elements in the drier and operatively connected to the valve air vent means to fluctuate to said closed chamber and vent upon the temperature reaching an unsafe level to permit the actuating member to be returned to starting position, switch means positioned to be engaged by the actuating member when moved by a pressure differential, said switch means being disengaged when said air vent is opened, and electrically operated means in circuit with said switch to be operated in response to the flow of air through the drier chamber.

9. A mechanism for controlling the operation of a clothes drier including a drier chamber and air admission and discharge conduits with a fan to move air through an air circuit including said conduits and drier chamber, the mechanism comprising a housing having a closed chamber at one end and a vented chamber at the other end, a diaphragm extending across said housing and having one surface exposed to the closed chamber and the other surface exposed to the vented chamber, means to connect said closed chamber to the air circuit of the drier to expose the diaphragm to pressure changes with the flow of air through the drier, switch means operated by the diaphragm as it is moved between a first and second position by a pressure differential, an electrically operated means connected in circuit with the switch to be operated upon actuation of the switch by the diaphragm, an air vent in said housing communicating between the closed chamber and the atmosphere, a solenoid operated valve operative to seal said vent or be actuated to open the vent and expose the closed chamber and diaphragm to atmospheric air to return the diaphragm to a first position, and means for operating said solenoid to vent the clothes chamber and deactivate the switch by the diaphragm moving to the first position.

10. Mechanism for controlling a clothes drier comprising a drier chamber in which clothes are contained while being subjected to a circulating drying air, an air circuit for the drying air including an intake conduit leading to the chamber, a discharge conduit leading from the chamber, means for moving air through said air circuit, an air heater located in the intake conduit to raise the temperature of the air, a lint trap positioned in the discharge conduit to capture lint which is picked up by the circulating air, actuating means responsive to a pressure differential between operating surfaces, a housing having actuating means dividing the housing into two chambers with a closed chamber on one side of said actuating means and a vented chamber on the other side of said actuating means, means for connecting said closed chamber of the housing to the air circuit to subject one side of the actuating means to the pressure of the air within said air circuit, switch means in the path of said actuating means, said switch means operative to connect said closed chamber to the air circuit of the drier, the pressure of the air within the drier causing movement of the pressure responsive member, said switch means comprising a first and a third position, first switch means operative by said actuating member, spring means between said first switch means and said actuating member to operate the switch when the actuating member moves to a second position between said first and third positions, said spring resisting movement of the actuating member and normally preventing movement to a third position, a lint trap positioned in the discharge conduit to capture lint which is picked up by the circulating air, and a second switch actuated by said actuating member when the mem-
A mechanism for controlling a clothes drier comprising a drier chamber in which clothes are contained while being subjected to a circulating drying air, an air circuit for the drying air including an intake conduit leading to the drier, a discharge conduit leading away from the chamber, a pair of heating elements in said intake conduit, a pressure responsive actuating member, a housing for said actuating member providing a closed chamber on one side of said actuating member, means for connecting said closed chamber to the air circuit of the drier with a change in air pressure within the air circuit causing movement of the actuating member, a first switch positioned in the path of the actuating member to be operated thereby, and a second switch spaced from said first switch to be actuated by the actuating member at a time later than said first switch, said first switch connected to said first heater element and a second switch connected to the second heater element to cause a sequential operation of said heater elements with a change in air pressure build-up within the air circuit of the drier.

13. A mechanism for controlling a clothes drier comprising an intake air conduit for supplying air to the drier, an exhaust conduit for directing air away from the drier, a drier chamber between said conduits and in communication therewith for containing the clothes subjected to the circulated drying air, a plurality of heaters positioned in the intake air conduit to increase the temperature of the air entering the drier in accordance with the number of heaters in operation, switches for each of the heater elements to selectively control the number of heater elements in operation, and air pressure responsive means connected to the air circuit for the drier chamber and operatively connected to the switches and operating the switches selectively in accordance with the air pressure within the drying circuit to increase the number of heaters in operation with the increase in air pressure and to decrease the number of heaters in operation with the decrease in air pressure to indicate a reduced flow of air through the drier air circuit.

14. A mechanism for controlling a clothes drier comprising a drier chamber in which clothes are contained while being subjected to a circulating drying air, an air circuit for the drying air including an intake conduit leading to the drier chamber, a discharge conduit leading from the drying chamber, a pressure responsive diaphragm operated by a pressure differential across its operating surfaces, a housing for said diaphragm providing a closed chamber for one side of the diaphragm and a vented chamber for the opposite side, means for connecting said closed chamber of the housing to the air circuit of the drier to subject the diaphragm to the pressure within the drier air circuit, a valve means connecting to said closed chamber to vent the air therein to atmosphere to cause a return of the diaphragm to its original position, a first, second, and third switch means sequentially positioned in the path of movement of the diaphragm, first and second air heaters positioned in the intake conduit for the drier, said first and second switches connected to said first and second heaters, said heaters being sequentially operated as the switches are engaged by the moving diaphragm, resilient means to prevent movement of the diaphragm to a third position in engagement with said third switch, a signal means to indicate the presence of a condition to said operator, said third switch means connected to said signal means, operating means connected to said vent means to vent said closed chamber and permit movement of the diaphragm to its original position to move out of engagement with said first, second, and third switches, and a lint trap positioned in the discharge conduit of the drier, said lint trap capturing lint picked up by the circulating air and causing a stoppage of air flow and increased pressure with an excess amount of lint to move the diaphragm to the third position to operate the signal to enable the operator to disconnect the heater elements preventing overheating thereof with a reduced flow of air from the stoppage of the lint trap.

15. A mechanism for controlling a clothes drier having a drier chamber in which clothes are contained while being dried, an air circuit for the drying air including an intake conduit leading to the drying chamber, a discharge conduit leading from the drying chamber, a fan means to move air through the air circuit, a mechanism comprising a heater element located in the intake conduit of the drier for increasing the temperature of the air, an actuating member operable by a pressure differential across its operating surfaces, a housing for said actuating member presenting a closed chamber on one side of said actuating member and a vented chamber on the other side of said actuating member, means to connect said closed chamber to the air circuit of the drier, a switch positioned and operatively connected to said air circuit with the air heater means, and positioned in the path of said actuating member to be operable thereby when the change in air pressure within the air circuit causes movement of the operating member, an electrically operated valve controlled vent leading to said closed chamber to permit movement of said actuating member to its return position, a temperature responsive fan housing safety switch located adjacent said fan and operative to open said vent upon the fan reaching an unsafe predetermined temperature to cause movement of the actuator to return position to discontinue operation of the heater due to the increased temperature of the fan.

16. A mechanism for controlling a clothes drier comprising an air circuit for clothes drying air including an intake conduit, a discharge conduit, and a drying chamber between said conduits in communication therewith for containing the clothes during a drying operation, fan means for moving air through said air circuit, a heater positioned in the intake conduit to raise the temperature of the air entering the drier chamber, heater switch means electrically connected to said heater to control the operation thereof, a switch actuator member operable by a pressure differential between operating surfaces thereof, means to expose one surface of said actuating member to the pressure circuit including a housing providing a closed chamber on one surface of said actuating member in communication with said air circuit and a vented chamber on the opposing side of said actuating member, vent means for said closed chamber to vent the chamber to atmosphere permitting a return of the actuating member to its return position, said heater operating switch being in the path of movement of the actuating member when moved to actuated position, and a temperature responsive heater safety switch positioned in close proximity to said heater and operatively connected to said vent to open said vent and permit a return of the actuating member to return position, said heater operating switch means reaching an unsafe temperature to thereby deactivate said heater switch and terminate operation of the heater.

17. A mechanism for controlling a clothes dryer having a drier chamber in which clothes are contained while being subjected to a circulating drying air, an air circuit for the drying air including an intake conduit to the chamber, a discharge conduit leading from the chamber, a fan for moving air through said air circuit, the mechanism comprising first and second relay control switches, a pressure responsive time delay mechanism operative from zero time to a first time where a first switch is actuated and to a second time where a second switch is actuated, first and second heating elements located in the intake conduit to the drier, first and second relay coils operatively connected to said first and second relay control switches, first and second relay oper-
ated switches operatively connected to said first and second heating elements, and a temperature responsive thermostat positioned in close adjacency to said heating elements and having a switch in the circuit of said first heating element to open the circuit thereto when the temperature of the heating elements reaches a predetermined level, said pressure operated time delay mechanism connected to said air circuit to cause sequential operation of the heater elements upon the beginning of a circulation of air to said drier chamber.

18. A mechanism controlling a clothes drier having a drier chamber in which clothes are contained while being subjected to a circulated drying air, an air circuit for the drying air including an intake conduit leading to the chamber, a discharge conduit leading from the chamber, air circulating means adapted to move air through said drier chamber, first and second heater elements positioned in said intake conduit, a thermostat positioned in close adjacency to said heater elements, a thermostat switch connected in circuit with one of said heater elements, a relay switch connected in the circuit of both of said heater elements, a pressure responsive control switch operatively connected to said air circuit operable with increased pressure in said air circuit, a relay coil in circuit with said pressure responsive switch and connected to said relay switch to operate the heater elements with the build up in pressure in said conduit, and means to open said pressure responsive switch to terminate operation of said heaters upon the increase of said pressure in the air circuit above a predetermined limit to prevent overheating of the heating elements with a reduced flow of air due to stoppage of flow of air in the discharge conduit.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,941,308

Clifton A. Cobb et al.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 11, line 62, for "and" read -- an --; column 13, line 40, after "faces" insert -- and exposing the other of said operating surfaces --; line 53, for "sceond" read -- second --.

Signed and sealed this 10th day of January 1961.

(SEAL)
Attest:
KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,941,308

June 21, 1960

Clifton A. Cobb et al.

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