June 17, 1958 C. E. ERICKSON 2,838,845

CONTROL CIRCUITS FOR CLOTHES DRYING MACHINES

Filed May 29, 1956 3 Sheets-Sheet 1

FIG. 1

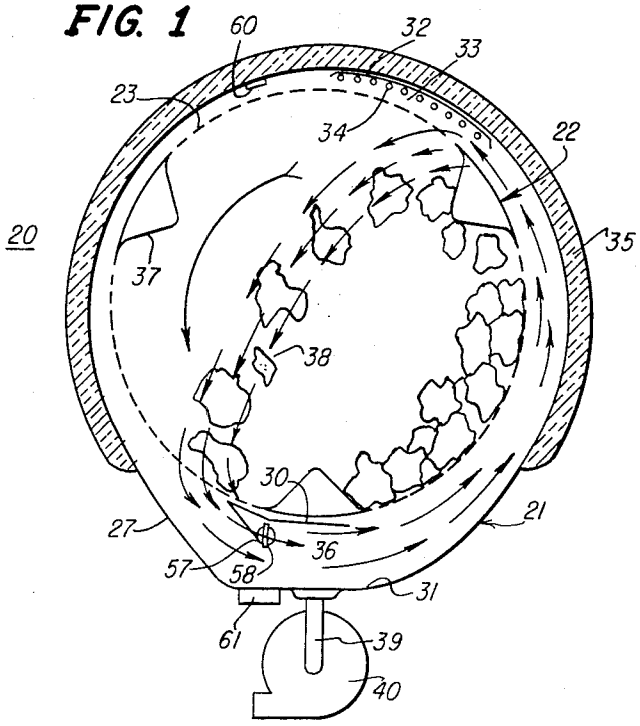
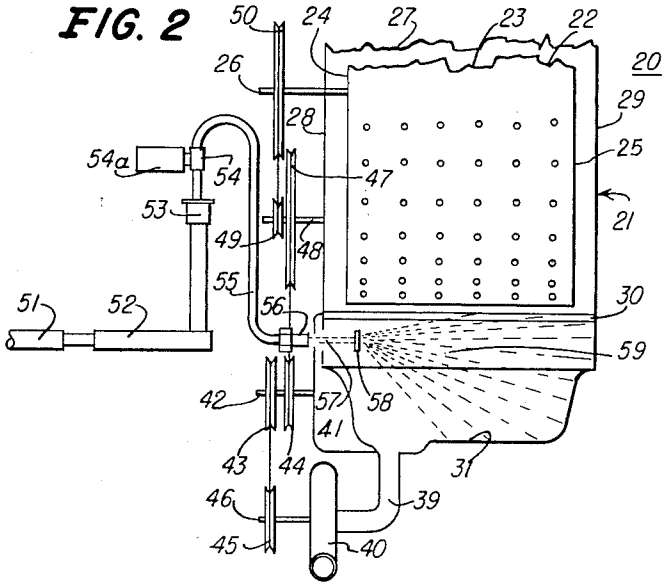


FIG. 2



INVENTOR.
Clifford E. Erickson

BY

Smith, Olsen, Baird & Miller,
Attys.

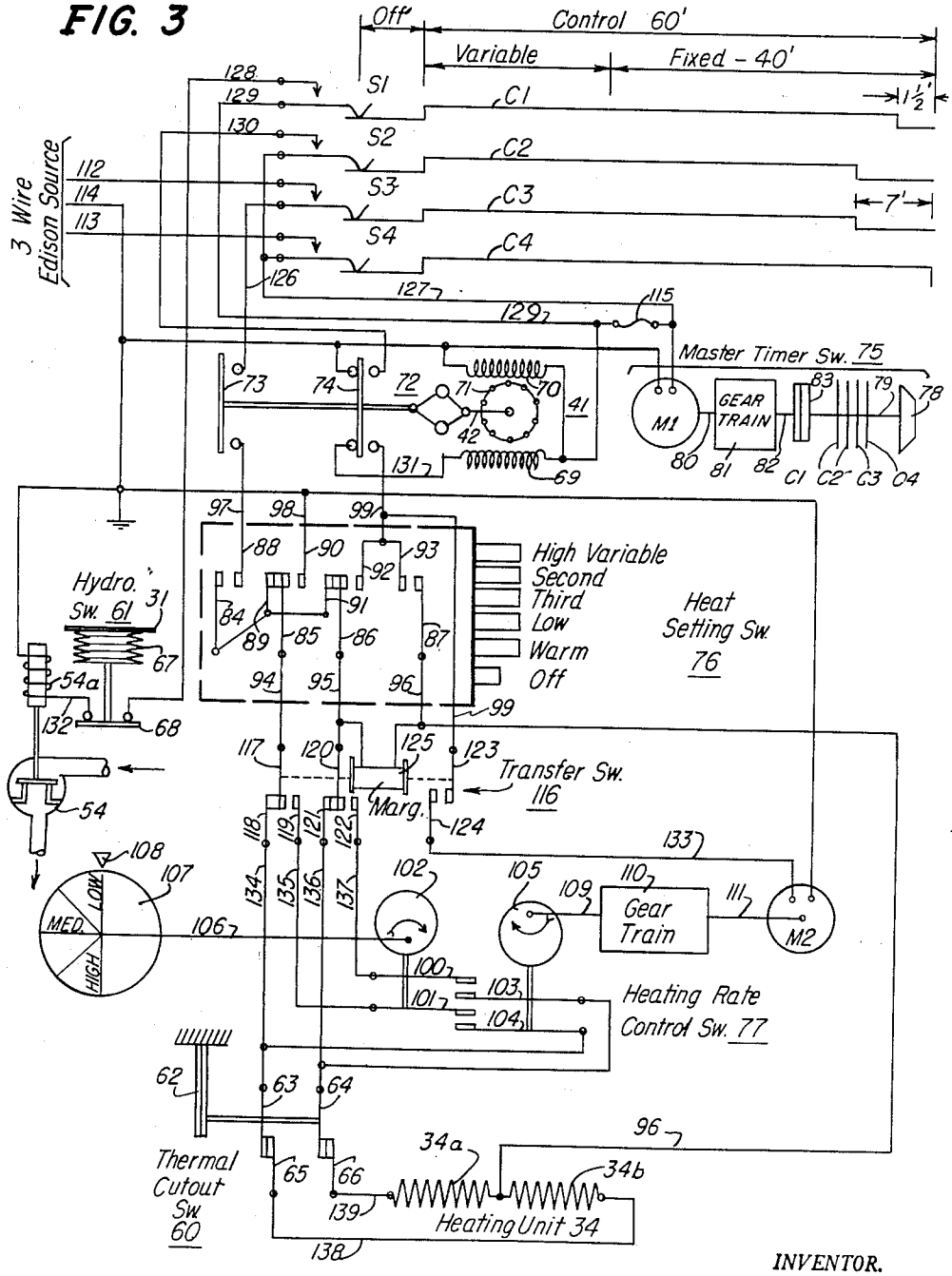
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CONTROL CIRCUITS FOR CLOTHES DRYING MACHINES

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FIG. 3



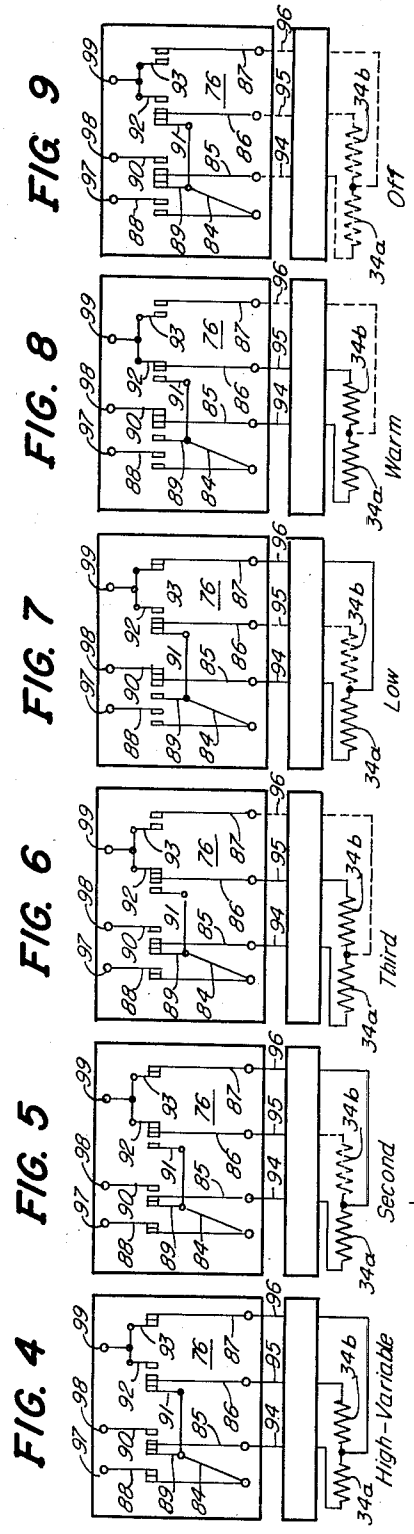
INVENTOR.
Clifford E. Erickson

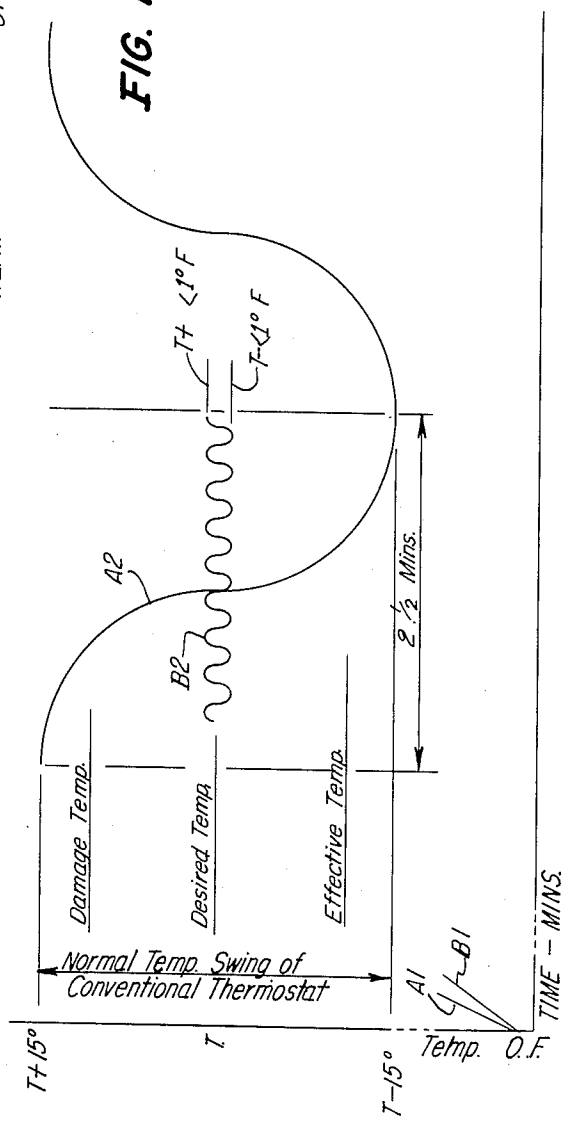
BY
Smith, Olsen, Baird & Miller
Attys.

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CONTROL CIRCUITS FOR CLOTHES DRYING MACHINES

Filed May 29, 1956 3 Sheets-Sheet 3





INVENTOR.
Clifford E. Erickson
BY
Smith, Olsen, Baird & Miller
Attys

United States Patent Office 2,838,845 Patented June 17, 1958

2,838,845

CONTROL CIRCUITS FOR CLOTHES DRYING MACHINES

Clifford E. Erickson, Chicago, Ill., assignor to General Electric Company, a corporation of New York

Application May 29, 1956, Serial No. 588,056

10 Claims. (Cl. 34—45)

The present invention relates to control circuits for clothes drying machines of the home laundry type, and more particularly to an improved control circuit for a clothes drying machine of the character of that disclosed in U. S. Patent No. 2,686,373, granted on August 17, 1954, to Clifford E. Erickson.

It is a general object of the invention to provide a control circuit for a clothes drying machine that incorporates improved facility for selectively setting the desired heating rate of the electric heating unit thereof that is to be maintained in the clothes drying operation of the machine.

Another object of the invention is to provide a clothes drying machine control circuit that incorporates improved facility for selectively setting different heating connections between the electric power source thereof and the electric heating unit thereof so as to set corresponding different heating rates of the heating unit in the clothes drying operation of the machine.

A further object of the invention is to provide a clothes drying machine control circuit of the character noted, wherein the facility mentioned essentially comprises electric switches that may be selectively set for the heating rate control purpose.

A still further object of the invention is to provide an electric heating system for a clothes drying machine, or the like, that is of improved and simplified connection and arrangement.

Further features of the invention pertain to the particular arrangement of the elements of the clothes drying machine control circuit, whereby the above-outlined and additional operating features thereof are attained.

The invention, both as to its organization and method of operation, together with further objects and advantages thereof, will best be understood by reference to the following specification taken in connection with the accompanying drawings, in which:

Figure 1 is a diagrammatic lateral sectional view of a clothes drying machine of the home laundry type that incorporates a control circuit embodying the present invention;

Fig. 2 is a diagrammatic longitudinal sectional view of the clothes drying machine as shown in Fig. 1;

Fig. 3 is a schematic diagram of the electric control circuit incorporated in the clothes drying machine and embodying the present invention;

Figs. 4 to 9, inclusive, are schematic diagrams of the different heating connections that are completed between the electric power source and the electric heating unit in the corresponding different positions of the manually operable pushbutton switch that is incorporated in the control circuit shown in Fig. 3; and

Fig. 10 is a graphical representation of the temperature variations in two identical clothes drying machines respectively incorporating a conventional control circuit and the control circuit embodying the present invention illustrated in Fig. 3.

Referring now to Figs. 1 and 2 of the drawings, the clothes drying machine **20** there illustrated is of the home

laundry type and of the general construction and arrangement of that disclosed in detail in the previously mentioned Erickson patent, and comprises a control circuit embodying the features of the present invention. Specifically, the machine **20** comprises an upstanding housing, not shown, that encloses an upstanding casing **21**, that, in turn, encloses a substantially cylindrical drum **22** that is mounted for rotation about its longitudinal axis disposed in a substantially horizontal position. The drum **22** includes a substantially cylindrical perforated side wall **23**, a substantially circular imperforate rear end wall **24**, and a substantially circular front end wall **25** having a substantially centrally disposed front opening, not shown, formed therein and affording access to the interior of the drum **22**. The housing, not shown, that encloses the casing **21** is provided with a front wall having a front opening formed therein and affords access through the drum front opening itno the interior of the drum **22**; which housing also carries a front door, not shown, operatively associated with the cabinet front opening. The drum **22** is mounted for rotation upon a stub shaft **26** that is secured to the rear end wall **24** thereof. The casing **21** includes a substantially tubular side wall **27** and rear and front end walls **28** and **29**; and a baffle **30** is arranged below the bottom of the drum **22** and above a sump **31** formed in the bottom of the tubular side wall **27**. The configuration of the tubular side wall **27** of the casing **21** is generally scroll-shaped, so that it cooperates with the cylindrical side wall **23** of the drum **22** to provide a fan casing so that the mere rotation of the drum **22** in the counterclockwise direction, as viewed in Fig. 1, brings about the circulation of a current of air through the drum **22** and through the casing **21**.

More particularly, a baffle **32** is arranged in the upper right quadrant of the tubular side wall **27**, as shown in Fig. 1, and cooperates therewith and with the associated cylindrical side wall **23** of the drum **22** to define a heating chamber **33**; which heating chamber **33** has a heating unit **34** disposed therein. In the arrangement, the baffle **32** also constitutes a heat reflector for the purpose of reflecting radiant energy from the electric heating unit **34** onto the cylindrical side wall **23** and through the perforations therein onto the clothes contained in the drum **22**; and the upper portion of the tubular side wall **27** of the casing **21** carries a layer **35** of thermal insulation. The lower portion of the tubular side wall **27** of the casing **21** cooperates with the baffle **30** to define a condensing chamber **36** therebetween; and the opposite ends of the baffle **30** terminate short of the adjacent portion of the tubular side wall **27** to define two spaced-apart and communicating passages therebetween. Further, the cylindrical side wall **23** of the drum **22** comprises a plurality of substantially equally spaced-apart inwardly disposed clothes tumbling vanes **37**, three being illustrated, that bring about tumbling of the clothes, indicated at **38**, when the drum **22** is rotated into the counterclockwise direction as viewed in Fig. 1. The vanes **37** and the clothes **38** tumbling in the drum **22** also assist in the circulation of the current of air through the drum **22** and within the casing **21**; whereby a current of air is circulated from the heating chamber **33** through the drum **22** into contact with the contained clothes **38** tumbling therein and thence via one of the passages previously mentioned through the condensing chamber **36** and then via other of the passages previously mentioned and back into the heating chamber **33**.

The current of air is heated and dried in the heating chamber **33** by the electric heating unit **34**; whereby the clothes **38** tumbling in the drum **22** are heated and dried by the current of air. In the condensing chamber **36**, a spray of cool water is provided, as explained more fully hereinafter, whereby moisture contained in the cur-

rent of air is condensed therefrom and accumulated in the sump 31. Also the spray of cool water in the condensing chamber 36 scrubs the current of air circulated therethrough removing lint therefrom; whereby the water, the condensate and the lint accumulate in the sump 31 and are removed to the exterior of the machine 20 via a drain conduit 39 that is connected to an associated pump 40 that communicates with drain plumbing, not shown.

As shown in Fig. 2, the arrangement for rotating the drum 22 and for operating the pump 40 comprises an electric drive motor 41 provided with an operating shaft 42 carrying two pulleys 43 and 44. The pulley 43 is belted to a pulley 45 carried by the pump shaft 46; while the pulley 44 is belted to a pulley 47 carried by an idler shaft 48, that also carries a pulley 49. The pulley 49 is belted to a pulley 50 carried by the drum shaft 26 that is secured to the end wall 24 of the drum 22. Accordingly, it will be understood that when the drive motor 41 is operated, the drum 22 is rotated in the counterclockwise direction, as viewed in Fig. 1, and the pump 40 is operated to discharge the water, the condensate and the lint from the sump 31 formed in the bottom of the casing 21.

Also the machine 20 comprises a cooling water supply system including an inlet conduit 51 that is adapted to be supplied with cool water under gauge pressure from the city water main, a communicating fixture 52 housing a strainer, not shown, a communicating flow regulator 53, a communicating control valve 54, a communicating tube 55, and a communicating jet nozzle 56. The control valve 54 is of the solenoid-controlled type being provided with an operating solenoid indicated at 54*a*, the control valve 54 being biased into its closed position and being operated into its open position when the solenoid 54*a* is energized. The jet nozzle 56 is arranged in alignment with a hole 57 formed in the rear end wall 28 of the casing 21 and below the baffle 30; and within the condensing chamber 36 there is arranged a target 58 disposed in alignment with the hole 57; whereby the stream of water projected from the jet nozzle 56 and passing through the hole 57 impinges upon the target 58 breaking-up the same and producing the spray of cool water in the condensing chamber 36, as indicated at 59, and as previously explained.

Also the machine 20 comprises certain auxiliary control equipment, including a high temperature thermal cutout switch, indicated at 60 in Fig. 1, and a hydrostatic pressure cutout switch, indicated at 61 in Fig. 1, the switches 60 and 61 being best shown in Fig. 3. Specifically, the switch 60 is of the thermostatic type including a bimetallic heat-responsive element 62 controlling a pair of movable contacts 63 and 64 that respectively cooperate with a pair of stationary contacts 65 and 66. The thermal element 62 normally biases the movable contacts 63 and 64 into their closed positions with respect to the contacts 65 and 66, moving the contacts 63 and 64 into open position with respect to the contacts 65 and 66 only in the event of an unusually high temperature of the thermal element 62 in the zone within the casing 21 in which the thermal cutout switch 60 is disposed. Specifically, the switch 61 is of the hydrostatic type including a movable bellows 67 arranged to be responsive to the head of water accumulating in the sump 31, and a contact bridging member 68 selectively controlled thereby, the contact bridging member 68 governing an associated contact pair. In the arrangement, the bellows 67 biases the contact bridging member 68 into its closed position, operating the same into its open position, only in the event of accumulation of an unusual head of water in the sump 31.

As shown in Fig. 3, the drive motor 41 is of the split-phase type including a start winding 69, a run winding 70, and an inductively coupled rotor 71 supporting the operating shaft 42 and carrying a start and run control switch 72 of the speed-responsive type and including two contact bridging member 73 and 74. The contact bridging member 73 controls a pair of front contacts; and the contact bridging member 74 controls both a pair of back contacts and a pair of front contacts. Further, the heating unit 34 is of the two-section type including the sections 34*a* and 34*b* indicated.

Continuing the reference to Fig. 3, the machine 20 further comprises a manually operable master program controller or timer switch 75, a manually operable heat-setting switch 76 of the pushbutton type and a manually operable heating rate control switch 77; which elements may be carried by the backsplash of the housing, not shown, in a conventional manner.

Specifically the master timer switch 75 comprises a manually rotatable dial 78 provided with a rotatably mounted operating shaft 79 carrying four insulating control cams C1, C2, C3 and C4, which respectively cooperate with four sets of switch springs S1, S2, S3 and S4. Further, the master timer switch 75 comprises an electric timer motor M1 of the synchronous type and provided with an operating shaft 80 that is connected to a gear train 81 that is provided with an operating shaft 82; the operating shafts 79 and 82 being interconnected by a slipclutch 83. The manual dial 78 has an "off" position and a variable "on" position; whereby operation of the manual dial 78 out of its "off" position effects rotation of the operating shaft 79 relative to the operating shaft 82 by virtue of the provision of the slipclutch 83 so that the control cams C1, C2, C3 and C4 selectively govern the sets of switch springs S1, S2, S3 and S4, respectively. Rotation of the manual dial 78 out of its "off" position effects operation of the timer motor M1; whereby the operating shaft 80 thereof effects rotation of the operating shaft 79 through the gear train 81, the operating shaft 82 and the friction clutch 83, so that the operating shaft 79 is further rotated one complete revolution and ultimately back into its "off" position.

The heat-setting switch 76 is of the pushbutton type and of the general construction and arrangement of that disclosed in U. S. Patent No. 2,431,904, granted on December 2, 1947, to John L. Andrews; which switch 76 comprises six individual pushbuttons designated "high variable" "second", "third", "low", "warm", and "off", as well as an interlock mechanism that is responsive to operation of any one of the six pushbuttons into its depressed position to effect the return of the last-operated one of the six pushbuttons back into its normal projected position. Further, the heat setting switch 76 comprises four movable switch blades 84, 85, 86 and 87 that are selectively operated by the selective operations of the six pushbuttons mentioned. The movable switch blade 84 cooperates with a front stationary switch blade 88; the movable switch blade 85 cooperates with respective back and front stationary switch blades 89 and 90; the movable switch blade 86 cooperates with respective back and front stationary switch blades 91 and 92; and the movable switch blade 87 cooperates with a back stationary switch blade 93. The movable switch blade 84 is commonly connected to the stationary switch blades 89 and 91; the movable switch blades 85, 86 and 87 are respectively connected to three outgoing terminals that are respectively connected to three conductors 94, 95 and 96; the stationary switch blades 88 and 90 are respectively connected to two incoming terminals that are respectively connected to two conductors 97 and 98; and the stationary switch blades 92 and 93 are commonly connected to a third incoming terminal that is connected to a conductor 99.

As illustrated in Figs. 3 and 9, when the off pushbutton of the switch 76 occupies its operated position, the movable switch blades 84 and 87 respectively disengage the stationary switch blades 88 and 93, and the movable switch blades 85 and 86 respectively engage the stationary switch blades 89 and 91; as shown in Fig. 4, when the high-variable pushbutton of the switch 76 occupies its operated position, the movable switch blades 84, 85, 86 and 87

respectively engage the stationary switch blades **88**, **89**, **91** and **93**; as shown in Fig. 5, when the second pushbutton of the switch **76** occupies its operated position, the movable switch blades **84**, **85**, **86** and **87** respectively engage the stationary switch blades **88**, **89**, **92** and **93**; as shown in Fig. 6, when the third pushbutton of the switch **76** occupies its operated position, the movable switch blades **84**, **85** and **86** respectively engage the stationary switch blades **88**, **89** and **92** and the movable switch blade **87** disengages the stationary switch blade **93**; as shown in Fig. 7, when the low pushbutton of the switch **76** occupies its operated position, the movable switch blade **84** disengages the stationary switch blade **88** and the movable switch blades **85**, **86** and **87** respectively engage the stationary switch blades **90**, **91** and **93**; and as shown in Fig. 8, when the warm pushbutton of the switch **86** occupies its operated position, the movable switch blades **84** and **87** respectively disengage the stationary switch blades **88** and **93** and the movable switch blades **85** and **86** respectively engage the stationary switch blades **90** and **92**.

The heating rate control switch **77** comprises a first set of two movable contact springs **100** and **101** that is governed by a first rotatably mounted eccentric **102** and a second set of two movable contact springs **103** and **104** that is governed by a second rotatably mounted eccentric **105**. Specifically the eccentric **102** is carried by an operating shaft **106** that is provided with a manually rotatable dial **107** that cooperates with an index marker **108**; and the eccentric **105** is carried by an operating shaft **109** that is provided with a gear train **110** that is connected to the operating shaft **111** of a timer motor M2 of the synchronous type. In the arrangement, when the timer motor M2 is energized, the operating shaft **111** governs the gear train **110** so that the operating shaft **109** is rotated at a speed of 5 R. P. M.; whereby the eccentric **105** operates the movable contact springs **103** and **104** toward and away from the contact springs **100** and **101** at this rate. The normal position of the contact springs **100** and **101** is determined by the position of the eccentric **102** that, in turn, is determined by the adjusted position of the manual dial **107** that includes low, medium and high positions with respect to the index marker **108**. Accordingly, in the operation of the heating rate control switch **77** the movable contact springs **103** and **104** are operated cyclically to engage and to disengage the movable contact springs **100** and **101**; and in each cycle the percentage make-contact and the complementary percentage break-contact is determined by the adjusted position of the manual dial **107** through the eccentric **102** that sets the riding of the movable contact springs **100** and **101** upon the movable contact springs **103** and **104**. Specifically, the percentage make-contact may be adjusted from about 6% (with a complementary percentage break-contact of about 94%) to about 94% (with a complementary percentage break-contact of about 6%).

Further, the control circuit for the machine **20** comprises a three-wire Edison source of 236 volts, single-phase, A. C., including two ungrounded outside conductors **112** and **113** and a grounded neutral conductor **114**, a fuse link **115**, and a transfer switch **116**. The transfer switch **116** comprises a first movable switch blade **117** provided with back and front stationary switch blades **118** and **119**, a second movable switch blade **120** provided with back and front stationary switch blades **121** and **122**, and a third movable switch blade **123** provided with a front stationary switch blade **124**. The switch **116** is of the electromagnetic operated type including an operating coil **125** of the marginal type; whereby the movable switch blades **117**, **120** and **123** are operated from their rest positions into their operated positions only in response to energization of the operating coil **125** with a predetermined current, as explained more fully hereinafter. In the arrangement, when the transfer switch **116** occupies its rest position, the movable switch blade **117** engages the back stationary switch blade **118**, the movable switch blade **120** engages the back stationary switch blade **121** and the movable switch blade **123** disengages the front stationary switch blade **124**. When the transfer switch **116** occupies its operated position, the movable switch blade **117** engages the front stationary switch blade **119**, the movable switch blade **120** engages the front stationary switch blade **122** and the movable switch blade **123** engages the front stationary switch blade **124**.

In the circuit arrangement: the line conductor **112** is connected to the upper spring of the set S3, while the lower spring thereof is connected to a conductor **126**; the line conductor **113** is connected to the upper spring of the set S4, while the lower spring thereof is connected to a conductor **127**; the upper and lower springs of the set S1 are respectively connected to two conductors **128** and **129**; and the upper spring of the set S2 is connected to a conductor **130**, while the lower spring thereof is also connected to the conductor **127**. The fuse link **115** is bridged across the conductors **127** and **129**; and the neutral line **114** is commonly connected to the upper back contact of the bridging member **74**, to one terminal of the run winding **70**, to one terminal of the timer motor M1, to one terminal of the solenoid **54***a*, to the conductor **98** and to one terminal of the timer motor M2. The lower back contact of the bridging member **74** is connected to a conductor **131** that, in turn, is connected to one terminal of the start winding **69**; the other terminal of the run winding **70** and the other terminal of the start winding **69** are commonly connected to the conductor **129**; and the other terminal of the timer motor M1 is connected to the conductor **127**. The front contacts of the bridging member **73** are respectively connected to the conductors **126** and **97**; while the front contacts of the bridging member **74** are respectively connected to the conductors **130** and **99**. The other terminal of the solenoid **54***a* is connected to a conductor **132**; the contacts of the bridging member **68** terminate the conductors **132** and **128**; and the other terminal of the timer motor M2 is connected to a conductor **133**. The conductors **94**, **95** and **99** are also respectively connected to the switch blades **117**, **120** and **123**; while the switch blades **118**, **119**, **121**, **122** and **124** are respectively connected to conductors **134**, **135**, **136** and **137** and to the conductor **133**. The conductor **134** is commonly connected to the switch springs **63** and **104**; the conductor **135** is connected to the switch spring **101**; the conductor **136** is commonly connected to the switch springs **64** and **103**; and the conductor **137** is connected to the switch spring **100**. The operating coil **125** of the transfer switch **116** is connected across the conductors **95** and **96**; and the switch springs **65** and **66** are respectively connected to two conductors **138** and **139**. The section **34***a* of the heating unit **34** is bridged across the conductors **96** and **139**, while the section **34***b* of the heating unit **34** is bridged across the conductors **96** and **138**; whereby the conductor **96** is connected to the midpoint between the sections **34***a* and **34***b*.

Considering now the cycle of operation of the machine **20**, operation thereof is initiated when the manual dial **78** of the master timer switch **75** is rotated out of its "off" position into its variable "on" position, which corresponds to a time interval within twenty minutes, as indicated in the time sequence chart at the top of Fig. 3. When the manual dial **78** is thus operated out of its "off" position, rotation of the drum **22** is initiated to effect tumbling of the clothes, and energization of the heating unit **34** is determined in accordance with the position of the heat-setting switch **76**. Entirely for purposes of description, it is first assumed that the heat-setting switch **76** occupies its "off" position so as to prevent energization of the heating unit **34**; whereby in this case operation of the manual dial **78** of the master timer switch **75** out of its "off" position into its variable "on" position causes the control cams C1 to C4, inclusive, to close the sets of switch springs S1 to S4, inclusive, so that the timer motor

M1 is energized effecting operation thereof and the consequent ultimate return of the manual dial 78 back into its "off" position, as explained more fully hereinafter. Closure of the set of switch springs S4 also completes a circuit via the fuse link 115 for energizing in multiple the start and run windings 69 and 70 of the drive motor 41; whereby the drum 22 is rotated as previously explained. When the rotor 71 of the drive motor 41 is accelerated somewhat past its half normal running speed, the speed-responsive mechanism 72 operates the contact bridging members 73 and 74. Specifically, the contact bridging member 74 opens its back contacts to effect deenergization of the start winding 69 of the drive motor 41; whereby the drive motor 41 is accelerated on into its normal running speed by the enrgization of the run winding 70 thereof. Specifically, the contact bridging member 73 at its front contacts connects the conductor 126 to the conductor 97, while the contact bridging member 74 at its front contacts connects the conductor 130 to the conductor 99; whereby the line-to-line voltage of the Edison source is applied to the conductors 97 and 99 extending to the heat-setting switch 76; however, without result at this time, as it is assumed that the heat-setting switch 76 occupies its "off" position. Also when the manual dial 78 of the master timer switch 75 is operated out of its "off" position into its variable "on" position, a circuit is completed for energizing the solenoid 54*a*; which circuit also includes the contact bridging member 63, the closed set of switch springs S1, the fuse link 115 and the closed set of switch springs S4. Accordingly, the energized solenoid 54*a* operates the inlet valve 54 into its open position so that the cool water is supplied to the jet nozzle 56 producing the spray of cool water 59 in the condensing chamber 36, in the manner previously explained. Accordingly, in the present example, the heating unit 34 is not energized by virtue of the fact that the heat-setting switch 76 occupies its "off" position; whereby the tumbling clothes in the drum 22 are merely cooled during the time interval of operation of the master timer switch 75.

As time proceeds, the master timer switch 75 is operated from its variable "on" position into its fixed "on" position that may subtend 40 minutes, as indicated in the chart at the top of Fig. 3. Still subsequently, at a fixed time interval of 7 minutes preceding the operation of the master timer switch 75 back into its "off" position, the control cams C2 and C3 govern the sets of switch springs S2 and S3 to interrupt further points in the circuits extending to the heat-setting switch 76 so as to interrupt these circuits, described more fully hereinafter, for energizing the heating unit 34; which circuits are open in the heat-setting switch 76, in the present example. Still subsequently, at a fixed time interval of 1½ minutes preceding the operation of the master timer switch 75 back into its "off" position, the control cam C1 governs the set of switch springs S1 to interrupt the circuit for energizing the solenoid 54*a* so that the inlet valve 54 is returned back into its closed position to cut off the supply of cool water to the jet nozzle 56. Still subsequently, upon operation of the master switch 75 back into its "off" position, the control cam C4 governs the set of switch springs S4 to open the parallel circuits for operating the timer motor M1 and the drive motor 41; whereby operation of the master timer switch 75 is arrested while the manual dial 78 is in its "off" position; and whereby operation of the drive motor 41 is arrested so as to arrest rotation of the drum 22 and the consequent tumbling of the clothes contained therein. Accordingly, at this time, the cycle of the machine 20 is completed and the contained clothes in the drum 22 may be removed therefrom after opening of the associated front door, not shown.

Now assume that the heat-setting switch 76 occupies its warm position, as illustrated in Fig. 8, when the cycle of operation of the machine 20 is initiated by operation of the manual dial 78 of the master timer switch 75 out of its "off" position into its variable "on" position, as described above. In this case, in the heating portion of the cycle of the machine 20, the conductors 98 and 99 are respectively connected to the conductors 94 and 95, and the transfer switch 116 remains in its restored position; whereby a circuit is completed for energizing in series relation the two sections 34*a* and 34*b* of the heating unit 34 across the line conductor 113 and the neutral conductor 114 (118 volts) so that the heating unit 34 generates heat at the fixed warm heating rate. This cycle of operation of the machine 20 is substantially identical to that previously described; and again it is noted that at a fixed time interval of 7 minutes preceding the operation of the master timer switch 75 back into its "off" position the control cams C2 and C3 operate the set of switch springs S2 and S3 in their open positions so as to disconnect the line conductors 113 and 112 from the conductors 97 and 99 extending to the heat-setting switch 76 for the purpose of concluding the heating cycle of the heating unit 34 at this time.

Now assume that the heat-setting switch 76 occupies its low position, as illustrated in Fig. 7, when the cycle of operation of the machine 20 is initiated by operation of the manual dial 78 of the master timer switch 75 out of its "off" position into its variable "on" position, as described above. In this case, in the heating portion of the cycle of the machine 20, the conductors 98 and 99 are respectively connected to the conductors 94 and 96 and the transfer switch 116 remains in its restored position; whereby a circuit is completed for energizing the section 34*a* of the heating unit 34 across the line conductor 113 and the neutral conductor 114 (118 volts) so that the heating unit 34 generates heat at the low rate. This cycle of operation of the machine 20 is substantially identical to that previously described, and is not repeated in the interest of brevity.

Now assume that the heat-setting switch 76 occupies its third position, as illustrated in Fig. 6, when the cycle of operation of the machine 20 is initiated by operation of the manual dial 78 of the master timer switch 75 out of its "off" position into its variable "on" position, as described above. In this case, in the heating portion of the cycle of the machine 20, the conductors 97 and 99 are respectively connected to the conductors 94 and 95 and the transfer switch 116 remains in its restored position; whereby a circuit is complete for energization in series relation the two sections 34*a* and 34*b* of the heating unit 34 across the line conductors 112 and 113 (236 volts) so that the heating unit 34 generates heat at the third rate. This cycle of operation of the machine 20 is substantially identical to that previously described, and is not repeated in the interest of brevity.

Now assume that the heat-setting switch 76 occupies its second position, as illustrated in Fig. 5, when the cycle of operation of the machine 20 is initiated by operation of the manual dial 78 of the master timer switch 75 out of its "off" position into its variable "on" position, as described above. In this case, in the heating portion of the cycle of the machine 20, the conductors 97 and 99 are respectively connected to the conductors 94 and 96 and the transfer switch 116 remains in its restored position; whereby a circuit is completed for energizing the section 34*a* of the heating unit 34 across the line conductors 112 and 113 (236 volts) so that the heating unit 34 generates heat at the second rate. This cycle of operation of the machine 20 is substantially identical to that previously described, and is not repeated in the interest of brevity.

Now assume that the heat-setting switch 76 occupies its high-variable position, as illustrated in Fig. 4, when the cycle of operation of the machine 20 is initiated by operation of the manual dial 78 of the master timer switch 75 out of its "off" position into its variable "on" position, as described above. In this case, in the heating portion of the cycle of the machine 20, the conductor 97 is commonly connected to the conductors 94 and 95

and the conductor **99** is connected to the conductor **96** and the transfer switch **116** is operated; whereby circuits are completed for energizing in parallel relation the sections **34***a* and **34***b* of the heating unit **34** across the line conductors **112** and **113** (236 volts) so that the heating unit **34** generates heat at the high variable rate and depending upon the further setting of the heating rate control switch **77**, as explained below.

More particularly, when the conductors **95** and **96** are connected to the respective conductors **97** and **99** and the last-mentioned conductors are respectively connected to the line conductors **112** and **113**, a circuit is completed for energizing the operating coil **125** of the transfer switch **116** across 236 volts, whereby the transfer switch **116** is operated from its rest position into its operated position since the operating coil **125** is of the marginal type and is responsive to the 236 volts impressed thereacross in this case. More particularly, the movable switch blades **117** and **120** are operated to disengage the respective stationary back switch blades **118** and **121** and to engage the respective front switch blades **119** and **122**, and the movable switch blade **123** is operated to engage the front stationary switch blade **124**. Accordingly, the conductors **94** and **95** are disconnected from the conductors **134** and **136** extending directly to the contact springs **63** and **64** and are respectively connected to the movable contact springs **101** and **100**; while closure of the switch blades **123** and **124** completes a circuit for operating the timer motor M2 of the heating rate control switch **77**. The operating timer motor M2 drives the eccentric **105** at a speed of 5 R. P. M. through the elements **111**, **110** and **109** so that the movable switch springs **103** and **104** respectively engage and disengage the movable switch springs **100** and **101** five times per minute. When the movable switch springs **103** and **104** are in engagement with the movable switch springs **100** and **101**, the conductors **137** and **135** are connected to the respective conductors **136** and **134** and thus to the switch springs **64** and **63** of the thermal cutout switch **60**, thereby completing the previously-mentioned circuit for energizing in parallel relation the two sections **34***a* and **34***b* of the heating unit **34** across the line conductors **112** and **113** of the Edison source.

Now in each of the five cycles per minute of the heating rate control switch **77**, the ratio between the percentage make-contact and the percentage break-contact is determined by the adjusted position of the movable switch springs **100** and **101** that, in turn, is determined by the adjusted position of the manual dial **107** cooperating with the index marker **108**. When the manual dial **107** occupies its low position illustrated, it may be assumed that the percentage make is 6% in each cycle of the switch **77**; and when the manual dial **107** occupies its high position, it may be assumed that the percentage make is 94% in each cycle of the switch **77**. The heating rate control switch **77** is of the so-called "infinitely adjustable" type; whereby any percentage-make contact between the 6% and the 94% may be effected by a corresponding rotary adjustment of the manual dial **107** with respect to the index marker **108**.

Accordingly, it will be understood that when the heat-setting switch **76** occupies its high-variable position, the actual heating rate of the heating unit **34** is adjustable over an exceedingly wide range depending upon the setting of the heating rate control switch **77** that is effected by the manual adjustment of the dial **107**. In fact, this heating rate may be adjusted from a rate disposed well below the fixed warm rate (when the heat-setting switch **76** is in its warm position of Fig. 8) to a rate disposed well above the fixed second rate (when the heat-setting switch **76** is in its second position of Fig. 5).

In this case, when the heat-setting switch **76** occupies its high-variable position, energization of the heating unit **34** continues on a cyclic basis under the control of the heating rate control switch **77** until the master timer switch **75** is operated into its fixed position disposed 7 minutes preceding its "off" position; whereby the control cams C2 and C3 operate the sets of switch springs S2 and S3 to disconnect the line conductors **113** and **112** from the conductors **99** and **97**, thereby to deenergize the operating coil **125** of the transfer switch **116** causing the transfer switch **116** to be returned from its operated position back into its restored position. When the transfer switch **116** is thus returned back into its restored position, the movable switch blade **123** disengages the front stationary switch blade **124** so as to interrupt the circuit for operating the timer motor M2 of the heating rate control switch **77**. Also the movable switch blades **117** and **120** re-engage the back stationary switch blades **118** and **121** so as to reprepare the previously traced normal rest circuits for energizing the heating unit **34**.

In view of the foregoing description of the heating cycle of the heating unit **34** incorporated in the machine **20**, it will be understood that the same is deenergized when the heat-setting switch **76** occupies its "off" position, that the same is energized at corresponding fixed heating rates when the heat-setting switch **76** occupies its warm, low, third and second positions, and that the same is energized at a variable heating rate when the heat-setting switch **76** occupies its high-variable position, and as determined by the adjustment of the heating rate control switch **77** in this case. Also in the high-variable position of the heat-setting switch **76**, the energization of the heating unit **34** is not only variable, but is also cyclic, by virtue of the cyclic operation of the heating rate control switch **77**.

The cyclic energization of the heating unit **34** under the control of the heating rate control switch **77** when the heat-setting switch **76** occupies its high-variable position is generally as indicated by the curves B1—B2 in Fig. 10 by virtue of the fact that the swing of the temperature in the drum **22** above and below the desired temperature is greatly minimized with respect to that of a conventional thermostatically controlled machine. Referring to Fig. 10, it is noted that in a conventional thermostatically controlled clothes drying machine of this character, the temperature within the rotating drum **22** is indicated by the curves A1—A2; when the thermostatically controlled switch is set at a desired temperature T. Specifically, in the normal cycle of operation of such a conventional thermostatically controlled machine, the cycle of the thermostatic switch may be in the general range: 5 to 10 minutes, after the desired temperature has been reached; whereby the temperature within the rotating drum **22** normally rises about 15° F. above the desired temperature T and then falls about 15° F. below the desired temperature T as indicated by the curve A2. Now in this temperature cycle, as indicated by the curve A2, the high temperature may rise above the damaged temperature of delicate fabrics made of synthetic materials (nylon, etc. fibers); while the low temperature may fall below the effective temperature of the clothes drying function. Accordingly, as indicated by the curve A2 in such a conventional thermostatically controlled clothes drying machine, the useful temperature within the rotating drum **22** is maintained only during a fraction of the cycle of the thermostatically controlled switch.

On the other hand, as illustrated by the curve B2 of the present clothes drying machine **20**, the temperature in the rotating drum **22** never varies more than about 1° F. from the preset desired temperature, as established by the setting of the heating rate control switch **77** when the heat-setting switch **76** occupies its high-variable position. This circumstance flows from the fact that the heating unit **34** is cyclically energized and deenergized five times per minute (every 12 seconds). Accordingly, in the present arrangement, the desired temperature in the rotating drum **22** may be accurately set by the heat rate control switch **77**, when the heat-setting switch **76** occupies its high-variable position; thereby eliminating the

usual inherent "overshoot" and "undershoot" temperature characteristics of thermostatically controlled switching equipment that is conventionally incorporated in clothes drying machines of the home laundry type.

In view of the foregoing, it is apparent that there has been provided in a clothes drying machine of the home laundry type, a control circuit of improved and exceedingly flexible connection and arrangement.

While there has been described what is at present considered to be the preferred embodiment of the invention, it will be understood that various modifications may be made therein, and it is intended to cover in the appended claims all such modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. In a clothes drying machine including a drum mounted for rotation about a substantially horizontal axis and adapted to receive and to tumble the clothes to be dried, an electric motor operative to rotate said drum, and an electric heating unit for evaporating moisture from the clothes in said drum; the electric control circuit combination comprising a source of electric power, a manually operable control switch having a plurality of control positions respectively corresponding to a plurality of heating rates of said heating unit, said control switch in its plurality of control positions respectively establishing a corresponding plurality of heating connections between said power source and said heating unit, a cycle switch included in one of said heating connections for opening and for closing in each cycle thereof said one heating connection, a manually operable device for selectively setting the ratio between the open contact time and the closed contact time of said cycle switch in each cycle thereof, thereby selectively to vary the corresponding one heating rate of said heating unit during heating thereof in said one heating connection, a master switch selectively operative to control operation of said motor from said power source and to govern opening and closing of the established one of said heating connections, and manually settable timing means for selectively operating said master switch.

2. The clothes drying machine electric control circuit combination set forth in claim 1, wherein said control switch is of the pushbutton type comprising a number of individual pushbuttons respectively corresponding to the different control positions thereof.

3. In a clothes drying machine including a drum mounted for rotation about a substantially horizontal axis and adapted to receive and to tumble the clothes to be dried, a three-wire Edison source of electric power, an electric motor operative to rotate said drum, and a two-section electric heating unit for evaporating moisture from the clothes in said drum; the electric control circuit combination comprising a manually operable control switch having a plurality of control positions respectively corresponding to a plurality of heating rates for said heating unit, said control switch in its plurality of control positions respectively establishing a corresponding plurality of heating connections between said power source and said heating unit, said plurality of heating connections respectively including different combinations of two of the three conductors of said power source and different series and parallel arrangements of the two sections of said heating unit, a cycle switch included in one of said heating connections for opening and for closing in each cycle thereof said one heating connection, a manually operable device for selectively setting the ratio between the open contact time and the closed contact time of said cycle switch in each cycle thereof, thereby selectively to vary the corresponding one heating rate of said heating unit during heating thereof in said one heating connection, a master switch selectively operative to control operation of said motor from said power source and to govern opening and closing of the established one of said heating connections, and manually settable timing means for selectively operating said master switch.

4. In a clothes drying machine including a drum mounted for rotation about a substantially horizontal axis and adapted to receive and to tumble the clothes to be dried, an electric motor operative to rotate said drum, and an electric heating unit for evaporating moisture from the clothes in said drum; the electric control circuit combination comprising a source of electric power, a heating circuit extending from said power source to said heating unit and including first and second series related switch points, a cycle switch operative to open and to close in each cycle of operation thereof said first switch point, a master switch selectively operative to control operation of said motor from said source and to govern opening and closing of said second switch point and to control operation of said cycle switch, manually settable timing means for selectively operating said master switch, and a manually operable device for selectively setting the ratio between the open contact time and the closed contact time of said cycle switch in each cycle of operation thereof, thereby selectively to establish the effective heating rate of said heating unit during heating thereof in said heating circuit.

5. The clothes drying machine electric control circuit combination set forth in claim 4, wherein the cycle of operation of said cycle switch is of a time duration of only a fraction of a minute.

6. The clothes drying machine electric control circuit combination set forth in claim 4, wherein the range of the ratio between the open contact time and the closed contact time of said cycle switch in each cycle of operation thereof is of the order of 1:N at one end thereof and N:1 at the other end thereof, where N is in the range 2 to 10.

7. In a clothes drying machine including a drum mounted for rotation about a substantially horizontal axis and adapted to receive and to tumble the clothes to be dried, an electric motor operative to rotate said drum, and an electric heating unit for evaporating moisture from the clothes in said drum; the electric control circuit combination comprising a source of electric power, a heating circuit extending from said power source to said heating unit and including first and second series related switch points, a cycle switch operative to open and to close in each cycle of operation thereof said first switch point, an electric timer operative to operate said cycle switch, a master switch selectively operative to control operation of said motor from said power source and to govern the opening and closing of said second switch point and to control operation of said electric timer from said power source, manually settable timing means for selectively operating said master switch, and a manually operable device for selectively setting the ratio between the open contact time and the closed contact time of said cycle switch in each cycle of operation thereof, thereby selectively to establish the effective heating rate of said heating unit during heating thereof in said heating circuit.

8. In a clothes drying machine including a drum mounted for rotation about a substantially horizontal axis and adapted to receive and to tumble the clothes to be dried, an electric motor operative to rotate said drum, and an electric heating unit for evaporating moisture from the clothes in said drum; the electric control circuit combination comprising a source of electric power, a manually operable control switch having a plurality of control positions respectively corresponding to a plurality of heating rates of said heating unit, said control switch in its plurality of control positions respectively establishing a corresponding plurality of heating connections between said power source and said heating unit, a master switch selectively operative to control operation of said motor from said

power source and to govern opening and closing of the established one of said heating connections, a manually settable timer for selectively operating said master switch, a cycle switch included in one of said heating connections and operative to open and to close in each cycle of operation thereof said one heating connection, means responsive to operation of said control switch into its one control position establishing said one heating connection for causing said master switch also to control operation of said cycle switch, and a manually operable device for selectively setting the ratio between the open contact time and the closed contact time of said cycle switch in each cycle of operation thereof, thereby selectively to vary the corresponding one heating rate of said heating unit during heating thereof in said one heating connection.

9. In an electric heating system including a source of electric power, and an electric heating unit; the combination comprising a plurality of heating connections extending between said power source and said heating unit and respectively corresponding to a plurality of heating rates of said heating unit, a manually operable control switch having an "off" position and a plurality of control positions respectively corresponding to said plurality of heating connections, said control switch being operative in its "off" position to open each of said heating connections and selectively operative into its control positions selectively to close said heating

connections, a cycle switch included in one of said heating connections and operative to open and to close in each cycle of operation thereof said one heating connection, an electric motor for operating said cycle switch, means responsive to operation of said control switch into its one control position to close said one heating connection for operating said motor from said power source, and a manually operable device for selectively setting the ratio between the open contact time and the closed contact time of said cycle switch in each cycle of operation thereof, thereby selectively to vary the corresponding one heating rate of said heating unit during heating thereof in said one heating connection.

10. The electric heating system combination set forth in claim 9, wherein said control switch is of the push-button type comprising a number of individual push-buttons respectively corresponding to the different control positions thereof.

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