

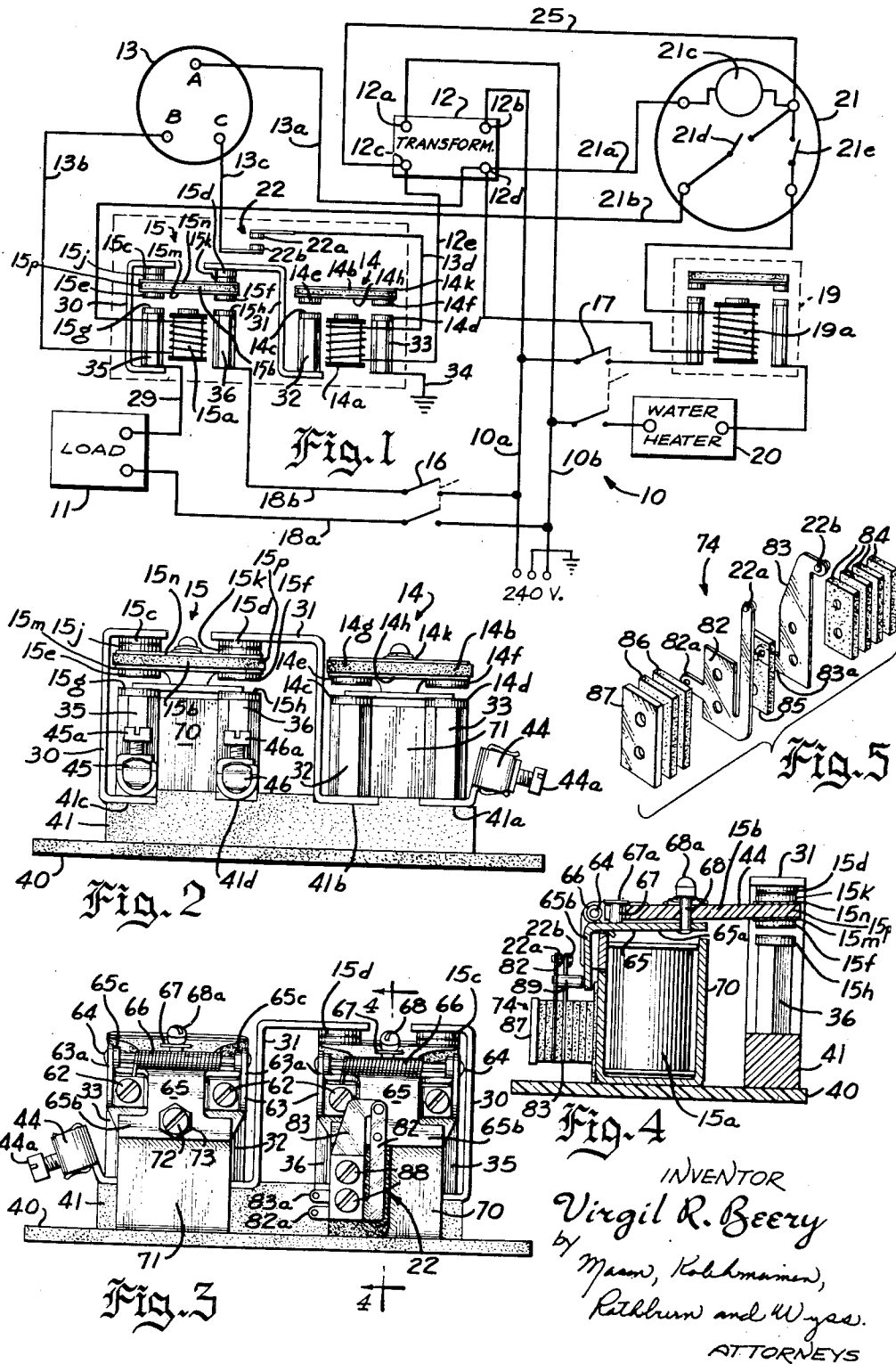
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# DUAL VOLTAGE CONTROL SYSTEM

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## DUAL VOLTAGE CONTROL SYSTEM

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This invention relates to a dual voltage control system and more particularly to an improved dual voltage control system comprising high and low voltage control devices and interlocking means associated therewith for rendering one control device inoperative in synchronism with the actuation of the other control device.

In heat control systems of the type employing dual voltage control devices such as relays actuatable by conventional two-stage, three wire thermostats the high voltage control device is customarily energized simultaneously with the low voltage control device whenever conditions demand the application of "quick" or high voltage heat. This condition exists because of the inherent characteristics of two-stage, three wire thermostats wherein both the high and low voltage control devices are energized in response to high heat requirements. Generally, in such systems, the contacts of the high voltage control device are effective in both the high heat and low heat circuits with the result that deenergization of the high voltage control device produces high voltage arcing across its contacts. In addition to the usual disadvantages with respect to pitting and burning of the surfaces and edges of the contacts, the described arcing across the contacts of the high voltage control device is frequently of sufficient intensity to freeze the contacts of either or both of the voltage control devices, thereby rendering the control system completely ineffective to perform the desired control functions.

Accordingly, it is an object of the present invention to overcome the above described disadvantages of the control systems of the prior art.

It is another object of the present invention to provide a dual voltage control system which embodies a pair of interlocked voltage control devices wherein one of the dual voltage control devices is rendered inoperative substantially simultaneously with the operation of the other control device.

It is a further object of the present invention to provide a dual voltage control system wherein a high voltage control device and low voltage control device are interconnected by interlocking means adapted to disconnect the low voltage control device upon operation of the high voltage control device.

It is still another object of the present invention to provide a dual voltage control system of the type including a two-stage thermo-responsive device together with high and low voltage control relays operable by said thermo-responsive device, wherein said control devices are interconnected by an interlocking mechanism designed to deenergize the low voltage relay simultaneously with the energization of the high voltage relay and to energize the low voltage relay following a predetermined time delay after deenergization of the high voltage relay.

Other objects and advantages of the present invention will become apparent from the following description of an illustrative embodiment thereof, in the course of which reference is had to the accompanying drawings, wherein:

Fig. 1 is a partially diagrammatic, partially schematic view of a dual voltage control system characterized by the features of the present invention;

Fig. 2 is a front elevational view of a relay embodying the present invention;

Fig. 3 is a back elevational view of the relay shown in Fig. 2;

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 3; and

Fig. 5 is an enlarged exploded view of a portion of the relay shown in Fig. 3.

In accordance with the present invention, the foregoing and other objects are realized by interlocking the high and low voltage control relays in such manner as to render the low voltage relay inoperative when the high voltage relay is energized in response to demand for high heat by a thermo-responsive unit. In particular, the interlocking means includes a pair of control contacts associated with and operable by the movable contact arm or pole of the high voltage relay, which control contacts are connected in the electrical circuit between the thermo-responsive unit and the operating coil of the low voltage relay. Thus, as the high voltage relay is energized the interlock contacts are opened and energizing current for the low voltage relay is interrupted.

Referring now to the drawings and in particular to Fig. 1 thereof, there is illustrated a dual voltage control system 10 including a load 11 which may be an electrical heating unit energized by either 240 volts (high heat) or 120 volts (low heat), the particular voltage supplied to the load being determined by the control circuit 10 in a manner described more fully below. In the embodiment of the invention illustrated in Fig. 1, the heating unit 11 is adapted to supply heat to a room or building or the like in response to a call for heat by a thermostat or temperature responsive device 13. Thus, when the thermostat demands a large amount of heat, i. e., when its contacts A—B and A—C are simultaneously closed, the control system 10 is adapted to apply a high voltage across the heater 11 and, correspondingly, when the thermostat calls for a small amount of heat, i. e., when its contacts A—C are closed, the control system 10 supplies a low voltage across the load 11. Obviously, the 240 volt and 120 volt energizing potentials recited above are purely illustrative and other suitable high or low voltages may be employed in accordance with the requirements of the load.

To control the selective application of these high and low voltages to the load 11, the control system 10 comprises a low voltage control device or relay 14 and a high voltage control device or relay 15. The high voltage described above is furnished by a suitable source (not shown) connected across conductors 10a and 10b, the latter being connected to the load 11 through conductor 18a and through a manually actuated on-off switch 16 and the former being connected through the switch 16, through conductor 18b and through the high voltage control device 15 to the load. The high voltage lines 10a and 10b are also connected to input terminals 12a and 12b of a line transformer 12. As illustrated in Fig. 1, the conductors 10a and 10b may be further connected, if desired, through a manually operated switch 17 and through a control relay 19 to supply energizing potential for a water heater 20 or any other device of this nature. The transformer 12 steps down the line voltage appearing across its input terminals 12a and 12b and develops a suitable and relatively low potential across its output terminals 12c and 12d. The relatively low output voltage from the transformer 12 is impressed across the heat responsive element or thermostat 13 which is of conventional two-stage, three-wire construction, the terminal 12d being connected to terminal A of the thermostat through

3 conductor 13a and the terminal 12c being connected to contact C of the thermostat through conductor 12e, through actuating coil 14a of the low voltage relay 14, through conductor 13d, through contacts 22a and 22b of an interlock 22 to be described in detail hereinafter, and through conductor 13c.

To supply energizing potential for the high voltage relay 15, the output terminal 12c of the transformer 12 is connected through conductor 25, through a suitable timing device 21, through conductor 21b, through the actuating coil 15a of the relay 15 through conductor 13b through contacts B—A of the thermostat 13, and through conductor 13a to the output terminal 12d of the transformer 12. The low voltage relay 14, in addition to the operating coil 14a mentioned above, comprises a pair of stationary contacts 14c and 14d and a movable arm or pole 14b carrying spaced contacts 14e and 14f adapted to engage the stationary contacts 14c and 14d, respectively, only when the operating coil 14a is energized.

The movable arm 14b comprises an insulating layer 14g sandwiched between a pair of conducting plates or wafers 14h and 14k, the lower plate 14h carrying the contacts 14e and 14f. The fixed contacts 14c and 14d are respectively mounted upon contact supports 32 and 33 extending parallel to each other and formed of electrically conducting material.

The high voltage relay 15, in addition to the operating coil 15a previously referred to, comprises a pair of spaced stationary contacts 15c and 15d, a second pair of spaced stationary contacts 15g and 15h and a movable arm or pole 15b. The arm 15b, like the arm 14b described above, includes a pair of conducting wafers or plates 15m and 15n separated by an insulating member 15p. The fixed contacts 15g and 15h are respectively mounted upon spaced, parallel, contact supports 35 and 36 formed of conducting material, the support 35 being connected directly through conductor 29 to one side of the load 11 and the support 36 being connected to the conductor 18b. The arm 15b carries on its underside a pair of spaced contacts 15e and 15f mounted on wafer 15m and on its upper side carries a pair of spaced contacts 15j and 15k mounted on wafer 15n. Thus, with the coil 15a in its deenergized condition as shown in Fig. 1, the contacts 15j and 15k respectively engage fixed contacts 15c and 15d while, when the coil 15a is energized, the contacts 15e and 15f are moved into respective engagement with the fixed contacts 15g and 15h. A bus bar 30 electrically connects the fixed contacts 15c and 15g and, as indicated above, is in turn connected through conductor 29 to one side of the load 11. A bus bar 31 electrically connects the fixed contact 15d of the high voltage relay with the fixed contact 14c of the low voltage relay. The fixed contact 14d of the latter relay is connected directly to ground as indicated at 34.

From the foregoing description it will be observed that when the thermostat 13 calls for low heat by closing its contacts A—C, the low voltage relay 14 is operated while the high voltage relay 15 is inoperative thereby connecting conductor 29 to ground 34 through the bus bar 30, through closed contacts 15c—15j, through conducting plate 15n of the movable arm 15b, through closed contacts 15k—15d, through bus bar 31, through closed contacts 14c—14e, through the conducting plate 14h and through closed contacts 14f—14d. When the latter circuit is completed the load 11 is energized by the voltage appearing between conductor 10b and ground which voltage in the described arrangement has a value of 120 volts with the result that low heat is delivered by the load.

When the thermostat 13 calls for rapid or high heat by simultaneously closing its contacts A—B and A—C in accordance with the normal operation of a two-stage, three-wire thermostat of the described construction, the coil 15a is actuated with the result that the movable

arm 15b breaks the circuit between the conductor 29 and ground and, at the same time, completes an electrical circuit between conductor 29 and conductor 18b through the support 35, through closed contacts 15g—15e, through conducting plate 15m, through closed contacts 15f—15h, and through contact support 36. When the latter circuit is completed the relatively large voltage appearing between conductors 10a and 10b is applied across the load and high heat is delivered.

In accordance with an important feature of the present invention, the movement of the arm 15b has another very important effect in that it breaks the interlock contacts 22a and 22b and, hence, severs the energizing circuit for coil 14a. Obviously, with the coil 14a deenergized the pole 14b is moved to the position shown in Fig. 1 and the application of high voltage across contacts 15f and 15h is prevented thereby avoiding dangerous arcing across the pairs of contacts 15d—15k and 15c—15j with attendant pitting and corrosion. Specifically, in the absence of the interlock contacts 22a and 22b, the coil 14a would remain energized when thermostat 13 called for or demanded high heat. As a result, when the thermostat 13 again reverted to its low heat condition, i. e., with only contacts A—C closed and the coil 15a deenergized, the arm 15b would draw away from the fixed contacts 15g and 15h thus tending to draw an arc. In addition to the described disadvantages with respect to pitting and corrosion of the contacts of relay 15, the arc current in many instances is of sufficient magnitude to freeze the contacts of the relays 14 and 15 and prevent proper operation of the control circuit 10.

Turning now to the operation of the control system shown in Fig. 1, such operation is initiated by manually closing the switches 16 and 17 which, as illustrated, may be ganged together for single throw actuation. The line voltage applied between conductors 10a and 10b excites the transformer 12 and induces the latter to develop energizing potential for the control devices 14, 15 and 19. The timing device 21 is connected in the circuit leading to both of the control devices 15 and 19 and, accordingly, functions to prevent the application of energizing voltage to either one of these devices until the timing circuit is properly conditioned. Specifically, the timing device 21 includes a clock or other timer 21c for automatically closing contacts 21d and 21e only during certain periods of a complete twenty-four hour operating cycle. Preferably, the timing of the device 21 is such that the switches 21d and 21e will be open during all peak periods of current use and, as a result, the water heater 20 will not draw current during these peak periods nor will the load 11 be energized with high voltage. Such a timing device is frequently employed in rural areas where a greater charge is made for power consumed during peak operating periods. In these particular installations, the switch 21e maintains control device 19 inoperative and, hence, prevents the water heater 20 from drawing current during peak periods. However, since these periods are generally of brief duration, the heat stored in the water is usually sufficient to supply the normal demands. The switch 21d, as indicated above, is connected in series with the operating coil 15a of the control device 15 and, accordingly, prevents the application of high voltage to the load 11 during all of the peak periods. Thus, during the peak periods of operation, the load 11 can be excited only with low voltage when the control device 14 is operated in the manner previously described. In any event, when the timing device 21 is conditioned to close its switches 21d and 21e, the control device 19 is actuated to supply current from the conductors 10a and 10b through the switch 17 and through the closed contacts of the control device 19 to the water heater 20. At the same time, the switch 21d is effective to permit the application of control voltage to the coil 15a whenever the thermostat 13 is conditioned to demand high heat. When the thermostat 13

is in its low heat position with the contacts A—C closed and with the contacts A—B opened, the operating coil 14a of the control device 14 will be energized through conductor 12e and through the closed contacts 22a and 22b of the interlock device 22 which contacts are closed whenever the control device 15 is not actuated. The control device 14 when energized functions in the manner previously described to supply to the load 11 the low voltage appearing between conductor 18a and ground 34.

When the thermostat 13 calls for high heat, its contacts A—B are closed simultaneously with the contacts A—C and, with the timing device 21 conditioned to close the switch 21b, the operating coil 15a of the control relay 15 is energized. Energization of the control device 15 draws its movable arm 15b downwardly as viewed in Fig. 1 and at the same time breaks the interlock contacts 22a and 22b. When the interlock contacts are broken the energizing circuit for the operating coil 14a is opened and the control device 14 is restored to its inoperative position illustrated in Fig. 1 with its movable arm 14b out of engagement with the fixed contacts 14c and 14d. As previously described, the interruption of the low voltage control circuit prevents arcing between the contacts of the control relay 14 and 15. In addition, when the movable arm 15b is drawn downwardly into engagement with the fixed contacts 15g and 15h the high voltage existing between the conductors 10a and 10b is applied through conductors 18a and 18b and through the control device 15 to energize the load 11 in the manner described above. Obviously, when the thermostat 13 no longer demands high heat the contacts A—C are broken and the control device 15 is rendered inoperative. When this event takes place the movable arm 15b is moved back to the position shown in Fig. 1 and the high voltage energizing circuit to the load 11 is broken. At the same time, however, interlock contacts 22a and 22b are closed to again complete the energizing circuit for the low voltage control device 14 with the result that the low voltage appearing between conductor 18a and ground is again supplied to the load 11.

Referring now in greater detail to the construction of the low voltage and high voltage control devices or relays 14 and 15 and their associated interlock 22 to perform the functions described above, an elevational view of these devices is illustrated in Fig. 2. Specifically, these devices are mounted upon a generally rectangular, thin blank 40 formed of fiber or other suitable insulating material which may be referred to as a base. An elongated rail or block 41 also formed of insulating material, is suitably secured to the base 40 and is provided with transversely extending grooves 41a, 41b, 41c and 41d in its upper surface for receiving electrical conducting members to be described more fully hereinafter.

In order to correlate the description of the structural details of the control relays 14 and 15 with the control circuit 10 shown in Fig. 1, corresponding elements have, of course, been assigned the same reference characters. Thus, the electrical conducting contact support 33 of the relay 14 is connected at its lower end to a lug conductor 44 seated within the recess 41a of the rail 41. The connector 44 includes suitable connecting means such as the terminal screw 44a for accommodating an electrical conductor leading to ground 34 as illustrated in Fig. 1. The contact supports 32, 33, 35 and 36 may be secured to the blank 40 and to the rail 41 by means of fasteners such as machine screws (not shown) inserted upwardly through aligned apertures in the base 40 and the rail 41 and into threaded engagement with an axially extending tapped bore in each of the contact supports. In this manner the contact supports, the rail and the base are held in assembly with the contacts 14c, 14d, 15g and 15h carried upon the top of the supports 32, 33, 35 and 36, respectively, being disposed at the same height and in spaced relationship with respect to each other. The bus bar 31 interconnecting the support 32 and the fixed contact 15d of the relay 15 is seated within the recess 41b and is held in

position between the support 32 and the block 41 in the manner described above.

As previously indicated, the movable arm 14b of the relay 14 is adapted to provide electrical connection between the fixed contacts 14c and 14d respectively mounted upon the top of supports 32 and 33. To this end, the movable arm 14b, as previously described comprises an insulating arm 14g sandwiched between a pair of conducting strips or wafers 14h and 14k. Suitable rivets may be passed through these strips in order to hold the contacts 14e and 14f on the bottom of the arm 14b. Thus, when the operating coil 14a of the relay 14 is energized, the movable arm 14b is drawn downwardly until the contact 14f engages the contact 14d and the contact 14e engages the contact 14c. Electrical connection will thus be completed between these engaged pairs of contacts through the bottom wafer 14h with the results described above.

Referring now to the construction of the control device 15, connector lugs 45 and 46 are respectively seated within the recesses 41c and 41d and are held in position between the contact supports 35 and 36 and the rail 41 by the fastening means previously described. The connector device 45 is actually seated upon the bus bar 30 having its lower end retained within the recess 41c and extending upwardly from the rail 41. The connector 45 includes a terminal screw 45a for receiving the conductor 29 leading to one side of the load 11 as illustrated in Fig. 1. The connector 46 includes a terminal screw 46a for accommodating the conductor 18b in order to connect the support 36 to the line conductor 10a as is also illustrated in Fig. 1. The fixed contact 15c of the control relay 15 is riveted or otherwise secured to the upper end portion of the bus bar 30 and, hence, is supported at approximately the same height as the fixed contact 15d. The movable arm 15b of the relay 15 is adapted to move back and forth between pairs of stationary contacts under the control of the operating coil 15a.

To partially enclose and protect the coils of the relays 14 and 15, a substantially U-shaped bracket 70 having its lower end portion secured to the base 40 surrounds the operating coil 15a while a similar bracket 71 is provided for the coil 14a. As is best shown in Figs. 3 and 4, a mounting means providing pivotal movement of the movable arms 14b and 15b is suitably secured to the upper end portion of one of the legs of each of the brackets 70 and 71. The mounting means for the two movable arms are identical and, accordingly, only one will be described in detail. This particular mounting means may include a somewhat channel-shaped member 63 having upwardly extending end portions 63a at its opposed sides. The member 63 may be rigidly secured to its associated bracket 70 or 71 by suitable fastening means such as machine screws 62. The end portions 63a extend parallel to each other and are provided with aligned apertures for accommodating the opposed ends of a pivot rod 64.

To retain the rod 64 in position on the member 63, the end portions thereof protruding beyond the depending portions 63a may be enlarged in any suitable manner as by peening or spinning. Pivotaly mounted on the rod 64 is an armature plate 65 having a generally L-shaped configuration as best shown in Fig. 4 wherein one of its leg portions 65b extends downwardly substantially parallel to the bracket 70 and the other leg portion 65a is adapted to overlie the coil 15a. To facilitate the attachment of the armature plate 65 to the rod 64, this plate is provided with a pair of ears 65c extending upwardly and generally parallel to each other. The ears are provided with aligned apertures through which the rod 64 is passed. A spring 66 wound about the pivot rod 64 and having one end fastened to the armature plate 65 and the other end in engagement with the bracket 70 biases the L-shaped armature plate 65 so that it normally tends to rotate in a counterclockwise direction as viewed in Fig. 4. The movable arm 15b of the relay

15 is secured to the leg 65a of the armature plate by means of a stud 68 passing upwardly from the leg 65a and through an opening in the insulating plate 15p of the movable arm. A coil spring 69 is preferably inserted between the adjustable head 63a of the stud 68 and the insulating plate 15p effectively provides for over-travel of the plate 65 so that, upon energization of the relay 15 and corresponding downward movement of the armature plate 65, the latter is drawn into engagement with the iron core of the operating coil of the relay even though the contacts carried by the movable arm have engaged their associated fixed contacts. To prevent pivotal movement of the movable arm 15b about the stud 68, the rearwardly disposed end portion of the insulating plate 15p is bifurcated to surround a stud 67 extending upwardly from the leg portion 65a of the plate 65. The stud 67 is preferably provided with an enlarged head portion 67a for the purpose of retaining the insulating plate 15p in position.

From the foregoing description it will be readily understood that the magnetic force exerted by the relay coil 15a, when energized, upon the armature plate 65 is sufficient to overcome the bias of the spring 66 and to pivot the armature plate 65 in a clockwise direction as viewed in Fig. 4 until the fixed contacts carried by the movable arm are brought into engagement with their associated fixed contacts. On the other hand, whenever the relay coil 15a is deenergized, the bias of the spring 66 is sufficient to move the leg portion 65a of the armature plate upwardly away from the contacts carried by the upright contact supports. The construction of the pivotal mounting means for the relays 14 and 15 are identical up to this point. However, in order to limit the movement of the arm 14b when the relay coil 14a is deenergized, the downwardly extending leg 65b of the armature plate 65 associated with the relay 14 is provided with an adjustable screw 72 which passes through a nut 73 welded or otherwise secured to the leg 65b. The end portion of the screw 72 protruding inwardly beyond the leg 65b is adapted to engage the leg of the bracket 71 when the relay 14 is deenergized. Obviously, the amount of pivotal movement of the armature plate 65 and, hence, the separation between the movable and fixed contacts of the relay 14a may be altered by adjusting the screw 72.

Counterclockwise movement of the armature plate 65 associated with the relay 15 is, of course, limited by engagement of the contacts 15j and 15k with the fixed contacts 15c and 15d and, accordingly, the relay 15 need not be provided with a limiting screw.

Referring now to the interlocking means 22 associated with the movable arm 15b of the high voltage control device 15, this structure includes a relay indicated generally by the reference numeral 74 and secured to the bracket 70. This relay as best shown in Figs. 3, 4 and 5 includes a pair of spaced contact arms 82 and 83 extending parallel to each other and carrying the normally closed interlock contacts 22a and 22b shown in Fig. 1. The contact arms 82 and 83 are separated by an insulating layer 85 while the arm 82 is separated from the bracket 70 by means of a plurality of stacked insulating laminations 84. Other insulating layers 86 are assembled outwardly from the contact arm 82 and the stack is completed by a retaining plate 87. Aligned apertures are provided in the plate 87, in the insulators 84, 85 and 86 and in the contact plates 82 and 83 so that machine screws 88 shown in Fig. 3 may be passed therethrough and into threaded engagement with tapped openings in the bracket 70 for the purpose of holding the stack in assembly.

The conductor 13c interconnecting the thermostat 13 and the interlock device 22 may be secured to a suitable terminal 83a extending laterally of the contact plate 83. Similarly, conductor 13d interconnecting the interlock device 22 and the operating coil 14a of the relay 14 may be connected to a laterally extending terminal or ear

82a on the contact plate 82. The ends of the conductors 13c and 13d may, of course, be soldered or otherwise secured to their associated terminals.

In order to effect the operation of the relay 74 in correlation with the operation of the control device 15, the contact plate 82 carries a cylindrical stud 89 formed of ceramic or other insulating material and having its free end in engagement with the leg 65b of the armature plate 65. When the relay 15 is in its deenergized condition as shown in Fig. 4, the armature plate 65 is pivoted about the rod 64 to its extreme counterclockwise position and the contacts 22a and 22b of the interlock device are closed. Upon actuation of the relay 15 to pivot the armature plate 65 in a clockwise direction as viewed in Fig. 4, the leg 65b moves outwardly and forces the arm 82 to draw the contact 22a out of engagement with the contact 22b. When the contacts 22a and 22b are broken in the manner just described, the energizing circuit for the operating coil 14a of the low voltage control relay 14 is broken with the results described above.

From the foregoing description it will be apparent that the interlock 22 functions to render the low voltage relay 14 inoperative at the same time as or slightly prior to completion of the high voltage circuit. Moreover, when the thermostat 13 no longer calls for high heat, that is, with only its contacts A—C closed, the interlock 22 provides a slight time delay before allowing the low voltage relay 14 to become energized. Specifically, when the coil 15a is deenergized by the opening of thermostat contacts A—B, the low voltage relay will not become energized until the expiration of the brief time period required to bring the contacts 22a and 22b into engagement.

The length of the stud 89 may be varied in order to alter the time period between the deenergization of the high voltage control relay 15 and the energization of the low voltage relay 14 and conversely to affect the time relationship existing between the energization of the high voltage relay and the deenergization of the low voltage relay.

In view of the foregoing description, it will be recognized that the present invention provides a practical solution to the problem of eliminating high voltage arc-overs in a dual voltage system of the type employing a two-stage, three-wire thermostat. In accordance with the present invention this problem is solved in a simple and inexpensive manner by providing an interlock associated with the high voltage relay for breaking the energizing circuit to the low voltage relay in time correlation with the completion of the high voltage circuit.

While the details of the present invention have been described in connection with an illustrative embodiment thereof, it should be understood that this is not intended to limit the invention since many modifications will be apparent to those skilled in the art which, nevertheless, fall within the true spirit and scope of the invention as set forth in the accompanying claims.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In an electrical control system for energizing a load with relatively high and low voltages, a first control device for controlling the application of said low voltage to said load, a second control device for controlling the application of said high voltage to said load, means for energizing said control devices, and means interlocking said first and second control devices to disconnect said low voltage from said load before the application of said high voltage to said load and to apply said low voltage to said load after a predetermined time delay subsequent to deenergization of said load with said high voltage.
2. In an electrical control system for energizing a load by relatively high and low voltages, a first control device for energizing said load by said low voltage, a second control device for energizing said load by said high voltage, means for energizing said control devices including

an electrical circuit associated with each device, interlocking means associated with said first and second control devices for over-controlling said first control device to remove the low voltage from said load substantially simultaneously with the energization of said load by said high voltage, said interlocking means including switch means connected in the electrical circuit of said first control device and actuated by operation of said second control device.

3. An electrical control system for controlling the selective energization of a heating unit with relatively high and low voltages, a power source, heat responsive means operably connected to said power source, a first control device for controlling application of said low voltage to said heating unit, a first electrical circuit including said heat responsive means for actuating said first control device, a second control device for controlling application of said high voltage to said heating unit, a second electrical circuit including said heat responsive means for actuating said second control device, interlocking means associated with said first and second control devices for rendering one of said control devices ineffective to supply voltage to said load substantially simultaneously with the actuation of the other control device.

4. An electrical circuit for controlling the application of relatively high and low voltages to a load comprising a first relay including a movable arm and an operating coil for controlling the application of one of said voltages to said load, a second relay including an operating coil for controlling the application of the other voltage to said load, means including electrical circuits connected to the operating coils of said relays for energizing said relays, interlocking means operated by the movable arm of said first relay and including switch contacts connected in the electrical circuit for the operating coil of said second relay for controlling the operation of said second relay.

5. An electrical circuit for controlling the application of relatively high and low voltages to a load comprising a first relay for controlling the application of said low voltage to said load including a movable arm and an operating coil to actuate said arm, a second relay including an operating coil and a movable arm for controlling

the application of said high voltage to said load, electrical circuits including heat responsive means for selectively energizing said operating coils, and interlocking means including switch means actuated by the movable arm of said second relay and connected in the electrical circuit of the operating coil of the first relay for disconnecting said low voltage from said load substantially simultaneously with the energization of said second relay.

6. An electrical circuit for controlling the application of relatively high and relatively low voltages to a load; comprising a source of high voltage; a source of low voltage; heat responsive means; a first electrical circuit including a first relay for controlling the application of said low voltage to said load, said first relay including an operating coil, a movable switching arm for completing said first circuit and resilient means normally biasing said arm to an off position; a second electrical circuit including said heat responsive means for energizing said operating coil to move said arm and supply low voltage through said first circuit to said load, a third electrical circuit including a second relay for controlling the application of said high voltage to said load, said second relay including a solenoid, a movable switching arm for completing said third circuit, and resilient means normally biasing the last mentioned arm to a low voltage position; a fourth electrical circuit including said heat responsive means for energizing said solenoid to move said last mentioned arm and apply high voltage through said third circuit to said load; and interlocking means associated with said first and second relays, said interlocking means including a switch connected in said second electrical circuit and operable by said last-mentioned arm upon energization of said solenoid, thereby to deenergize said operating coil and to disconnect said low voltage from said load in time correlation with the application of said high voltage to said load.

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