

UNITED STATES PATENT OFFICE

2,510,041

ELECTRIC BLANKET CONTROL

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Application April 22, 1948, Serial No. 22,570

11 Claims. (Cl. 219—20)

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The present invention relates to electric blankets of the type having an electric heating unit arranged in a blanket fabric and is more particularly directed to an improved arrangement for controlling the application of electrical energy to the heating unit so as to insure the complete safety and comfort of the user.

It is an object of the invention to provide a control arrangement for an electric blanket which is extremely sensitive in operation such that the amount of heat generated within the blanket can be precisely established and controlled.

Another object of the invention is to provide a control arrangement which is responsive to blanket temperature or ambient temperature, or preferably to both, so that the amount of heat required for the comfort of the user can be automatically determined under varying conditions of use and so that any incipient fire hazard will be immediately detected and avoided.

A further object of the invention is to provide a control arrangement including a motor timer, preferably an electrically driven timer, such that the thermally operated switches and relays commonly used in electric blanket controls with their attendant inaccuracies, slow operation and noisy functioning are eliminated and such that there may be incorporated into the controls as part of the timer a bedside clock to indicate time and with provision for automatic opening of the heating circuit at a predetermined selected time as desired.

Another object of the invention is to provide a control means in which the electric heating unit itself may be utilized as an instrumentality in the blanket which is utilized for rendering the control responsive to temperatures within the blanket.

Another object of the invention is to provide a control arrangement which is simple and economical to fabricate and assemble from standard parts and which is so constructed that it will not readily get out of order or require adjustment or replacement over long periods of time.

Other objects will be in part obvious and in part pointed out more in detail hereinafter.

The invention accordingly consists in the features of construction, combination of elements and arrangement of parts which will be exemplified in the construction hereafter set forth and the scope of the application of which will be indicated in the appended claims.

In the drawing, the single figure is a diagram-

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matic view of one embodiment of the control arrangement of the present invention.

Referring to the drawing, the main elements of the arrangement shown are the electric blanket A, a resistor B which is subjected to ambient temperatures, an adjustable reference resistor C, a transformer D, an electronic tube E, a self-locking relay F and a timer G. In the embodiment shown, the control circuit, the timer G and the electric blanket A are energized by connection to the lines L1 and L2 of a conventional household lighting system.

The electric blanket A may be of conventional construction and therefore is shown merely diagrammatically. The heating element 10 may be a resistance wire of any suitable metal or alloy and preferably is disposed throughout the blanket in a plurality of convolutions. In the preferred embodiment, the heater wire metal or alloy selected is one which has a resistance which varies proportionately with its temperature. A copper wire, for example, would have such characteristics. For the purposes of the present disclosure, it will be assumed that the temperature co-efficient of resistance of the heating element 10 is strongly positive, i. e., its resistance appreciably increases in relationship to increases in its temperature.

The resistor B similarly is composed of a metal or alloy which has a resistance responsive to its temperature changes and, as in the case of the heating element 10, it will be assumed that the temperature co-efficient of resistance of the resistor B is positive. The resistor B may be a suitable length of copper wire, for example, wound in the form of a grid. The resistor B is intended to be located where it will be subjected to ambient temperatures, that is, so that in normal usage of the blanket it will be subjected to the same temperature as that of the air in the room. In general, this desired location of the resistor B may be accomplished by placing the same in the bedside control box provided the latter is suitably ventilated.

The reference resistor C is constructed of a material having a substantially constant resistance at varying temperatures, i. e., a substantially zero or very small temperature co-efficient of resistance. As a result, the reference resistor C, when suitably adjusted to provide a desired resistance, will remain a substantially constant factor regardless of the temperature conditions to which it is subjected.

The transformer D includes a primary 15 having terminals 17 and 18 and being provided with

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taps 16, 19 and 20. The secondary 21 of the transformer D is utilized to provide the heating current for the filament 29 of the electronic tube E or other tubes utilized in the control system.

The primary 15 of the transformer D, the reference resistor C, the ambient temperature responsive resistor B and the blanket heating element 10 are arranged to be connected in the form of a bridge circuit. One leg of the bridge circuit comprises the resistor B and the heating element 10; a second leg of the bridge circuit includes the portion of the primary 15 extending between tap 19 and terminal 17; a third leg of the bridge includes the portion of the primary 15 extending between taps 18 and 19, and the fourth leg of the bridge comprises the reference resistor C. Terminals 25 and 26 of the reference resistor C and the ambient temperature responsive resistor B, respectively, are connected to a normally open switch 27 and when this switch 27 is closed the bridge circuit is completed. The values of the resistors C and B and the location of the taps 18 and 19 are selected so that the bridge is in balance when the resistance B and the heater element 10 are at a predetermined temperature such as room temperature. In general, it is desirable to select a resistance value for resistor C which is substantially equal to the sum of the resistances of resistor B and heater unit 10. The resistance value of resistor B is selected in accordance with the desired proportionate sensitivity of the circuit to ambient and blanket temperatures. The greater the resistance of B, the greater will be the relative effect of changes in ambient temperatures as compared with blanket temperatures.

The terminal 16 of the transformer D is connected to the plate 30 of the electronic tube E through the normally closed switch 28 and the solenoid winding 40, switch arm 41 and terminal 42 of the relay F. When the solenoid winding 40 is not energized, the switch arm 41 is in the position shown in the drawing. However, when the solenoid winding 40 is energized, the switch arm 41 is moved to an upper position at which it comes into contact with terminal 43.

The terminal 25 of the bridge circuit is connected to the cathode 31 of the electronic tube E. Accordingly, when the switch 27 is in the open position shown in the drawing, there is only a very small plate voltage impressed on the electronic tube E, namely, that generated between tap 18 and terminal 16 of the transformer primary winding 15. When the switch 27 is closed, however, the bridge circuit is put into operation thereupon placing the cathode 31 under a voltage which, when the resistor B is substantially equal to the sum of resistor B and heating unit 10, is approximately half of the line voltage plus the additional voltage induced in the segment of the primary between terminal 16 and tap 18. The additional voltage supplied by the portion of the primary between terminal 16 and tap 18 is desired particularly when the electronic tube E is a thyratron which requires an operating voltage higher than half of the line voltage.

The flow of current through the electronic tube E is controlled by the grid bias on the control grid 32. The control grid 32 is connected through resistor 34 to a potentiometer 35 which is connected across taps 19 and 20. Inasmuch as the terminal 25 of the bridge circuit is connected to the cathode 31, it will be seen that the grid bias will be equal to the voltage unbalance of the bridge circuit plus a voltage increment developed in the potentiometer 35. If desired, the potenti-

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ometer 35 may be situated that it may be manipulated by the user as a control member for predetermining the amount of heat which will be generated in the blanket for a given set of temperature conditions to suit his comfort. This result obtains because the setting of potentiometer 35 determines the amount of unbalance of the bridge which will be required to cause the electronic tube E to discharge and the amount of unbalance is a function of the temperature of resistor B and heating element 10.

Inasmuch as the circuit is operated on alternating current, the resistor 34 is employed to prevent grid current during the reverse cycle. The screen grid 33 in this instance is connected directly to the cathode 31.

As will be noted in the drawing, the line L2 of the household supply circuit is directly connected to one side of the heating element 10 while terminal 39, intermediate resistor B and heating unit 10, may be connected through terminal 44 and switch arm 45 of the relay F to the tap 18 of the transformer D which, in turn, is connected by a circuit to be described hereinafter to the line L1 of the household lighting circuit. When the solenoid winding 40 is energized, the switch arm 45 is drawn downwardly to make contact with the terminal 44 thus connecting the heater unit 10 directly across the lines L1, L2.

Terminal 43 of the relay F is connected to the tap 19 of the transformer D so that when the solenoid winding 40 is energized and the switch arm 41 is moved to an upward position making contact with terminal 43 the solenoid winding 40 is placed across tap 19 and terminal 16 through switch 28 thus locking the relay F in such energized position so long as switch 28 remains closed.

It now will be observed that, in accordance with the invention, the closing of switch 27 will complete the bridge circuit and if there is a sufficient unbalance of the bridge as when the temperature conditions in the blanket or ambient temperatures require the addition of heat through the heater unit 10, then there will be a flow of current through the electronic tube E which energizes the solenoid winding 40 causing the relay F to lock into energized position, thus placing the heating unit 10 across the line. The duration of the heating period may be interrupted at any time by opening the switch 28 which deenergizes the solenoid winding 40 permitting the relay F to return to the position shown in the drawing. By opening the switch 28 and closing the switch 27 momentarily and in sequence at intervals, it is possible to make periodic measurements of the temperature conditions both ambient and in the blanket and, if the temperature conditions are such that heat is desired, the blanket heating unit 10 may be energized for the interval during which the switch 28 remains closed. The momentary and sequential operation of the switches 28 and 27 is accomplished in accordance with the invention by the timer G previously referred to which may be any conventional clock mechanism or constant speed motor. In the specific embodiment shown in the drawing, an electric clock motor, if utilized, may be connected by leads 50 and 51 to lines L1 and L2, respectively. A shaft 52 preferably driven by the second train of the timer mechanism has mounted thereon a plurality of cams 53 and 54 having nibs 53' and 54' which are adapted to actuate the switches 28 and 27. Upon each revolution of the shaft 52, the nib 54' of cam 54 will momentarily open switch 28 following which the nib 53' will

momentarily close the switch 27. When shaft 52 is operated by the second train, it will make a complete revolution every 60 seconds which is found to result in a desired periodic operation of the switches 27 and 28. However, greater or lesser time intervals could be employed. By reason of the above described mechanical operation of the switches 27 and 28, the control circuit is momentarily placed in a measuring condition for a brief period each minute, which period is of sufficient duration to cause the relay F to close and lock itself to the line if the blanket or ambient temperature indicates that additional heat is required. The closing of relay F places the heater unit 19 into operation for the remainder of the period, approximately 50 seconds, until the switch 28 is operated. On the next cycle, when the switch 27 is closed, the measuring function of the control circuit is repeated and if the blanket is still too cold the heating circuit is again energized. On the other hand, if the blanket has acquired a sufficient amount of heat, there will be no operation of the relay F and no heat will be applied to the blanket until a following cycle when the measuring circuit may detect that further heat is required. It thus will be seen that the desired amount of heat generated in the blanket A will be closely regulated as desired by the user.

The operation of the switches 27 and 28 by the motor driven timer G insures that the operation of the bridge or measuring circuit will be dependable and only of very brief duration. Accordingly, it is possible to use a heavy bridge current resulting in a large control signal which will make normal tube variations immaterial while at the same time keeping the duration of such current to an unobjectionable minimum. Another feature of the arrangement is that in most cases, after the switch 62 or 63 is first closed, there will be a time interval before the switches 27 and 28 will be actuated by the timer G, this because such actuation occurs very briefly only once in each cycle. As a result, the tube E will normally have an opportunity to warm up before being subjected to a heavy plate voltage. This warm-up period plus the fact that the tube is conducting for only a minor fraction of the time that the blanket is in operation will tend to prolong the life of the tube or tubes utilized.

The circuit hereinbefore mentioned for connecting the tap 18 to the line L1 comprises a pair of leads 60 and 61 which are adapted to be connected together either through switch 62 or switch 63.

The switch 63 is a snap action type switch and is constructed and arranged such that when it is moved to open or closed position it will remain in such position until again actuated. As shown diagrammatically in the drawing, the switch 63 is adapted to be closed by pressing downwardly on the push button 64 and is adapted to be moved to the open position by contact with a nib 65' on the cam 65 which preferably is driven by the hour train of the timer and which preferably is adjustable in the same manner that the alarm is set on a conventional alarm clock.

In the embodiment shown in the drawing, the timer is provided with a conventional clock dial 65 and provided with time indicating hands 67 and 68. An indicator 69 may be provided to show the setting of the cam 65 and thus indicate at what time the switch 63 will be actuated to the open position by the nib 65'. As will be apparent, the timer G may be provided with an alarm

mechanism, if desired, so that it may be utilized as a bedside alarm clock and the ringing of the alarm and the opening of the switch 63 may be arranged to occur simultaneously, although it will be equally obvious that the operation of the alarm and the switch 63 could be made to occur independently, if desired.

By virtue of the snap action switch 63 and the timer G, it is possible for the user to turn on the blanket upon retiring merely by pushing the push button 64 and then the blanket will be turned off automatically at whatever time is set by the indicator 69. On the other hand, if the user desires to operate the blanket without the automatic shut-off feature, he may close the circuit merely by closing the switch 62 which places the blanket and control circuit in operation independently of the operation of switch 63, which operation will continue until the switch 62 is again opened.

While the invention has been particularly described in connection with the preferred specific embodiment shown in the drawing, it will be apparent that many variations in the circuits employed may be utilized for various reasons without departing from the scope of the invention. For example, it will be apparent that either the resistor B or the heating element 10 may be eliminated from the bridge circuit, if desired, whereupon the control of the supply of electrical energy to the heating unit 19 would be responsive to ambient temperatures or blanket temperatures only. If the control circuit were responsive only to ambient temperatures, however, additional means, such as thermostatic switches in the blanket, might have to be employed to protect against the hazards of fire. Also, if desired, the instrumentality in the blanket for rendering the control circuit responsive to blanket temperatures may be a second resistor wire separate from the heating unit 19.

For simplicity of presentation, the electronic tube E has been illustrated as a conventional thyatron. It will be readily apparent to one skilled in the art that other types of electronic tubes or a series of them could be substituted for the thyatron shown in the drawing without material departure from the teaching of the invention.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

It is also to be understood that the language used in the following claims is intended to cover all of the generic and specific features of the invention herein described and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

I claim as my invention:

1. A heat control arrangement for an electrically heated blanket comprising, in combination, a blanket, an electric heating element in said blanket whose resistance changes in relationship to changes in its temperature, a resistance element exterior to the blanket and subject to ambient temperatures whose resistance changes in relationship to its temperature, means including a normally open self-locking relay for applying substantially full line voltage to said heating element from a source of electric power, a bridge

circuit having one leg comprising said heating element and said resistance element, means for periodically opening and closing said bridge circuit, means responsive to unbalance of said bridge circuit when the bridge circuit is closed for energizing the relay, and means for periodically unlocking said relay.

2. A heat control arrangement for an electrically heated blanket comprising, in combination, a blanket, an electric heating element in said blanket whose resistance changes in relationship to its temperature, an electrically driven timer, a first circuit for applying a predetermined voltage to the heating element including a normally open self-locking type relay, a normally open second circuit including said heating element, means operative when the second circuit is closed and the resistance of the heating element departs from a predetermined value for energizing the relay, means operated by the timer for periodically closing the second circuit, and means operated by the timer for periodically unlocking the said relay.

3. A heat control arrangement for an electrically heated blanket comprising, in combination, a blanket, an electric heating element in said blanket whose resistance changes in relationship to its temperature, an electrically driven timer, means including a normally open self-locking type relay for applying a predetermined voltage to the heating element, a normally open bridge circuit including said heating element, means operated by the timer for periodically closing said bridge circuit, means responsive to unbalance of said bridge circuit when the bridge circuit is closed for energizing the relay, and means operated by the timer for periodically unlocking said relay.

4. A heat control arrangement for an electrically heated blanket comprising, in combination, a blanket, an electric heating element in said blanket whose resistance changes in relationship to its temperature, an electrically driven timer, a first circuit for applying a predetermined voltage to the heating element including a normally open self-locking type relay, a second circuit including said heating element and a normally open switch, means operative when the switch is closed and the resistance of the heating element departs from a predetermined value for energizing the relay, means operated by the timer for periodically unlocking the said relay, and means operated by the timer for momentarily closing the said switch after the relay is unlocked.

5. A heat control arrangement for an electrically heated blanket comprising, in combination, a blanket, an electric heating element in said blanket whose resistance changes in relationship to its temperature, a first circuit including a normally open self-locking type relay for applying a predetermined voltage to the heating element, means including a normally open second circuit containing the heating element for energizing the relay when the second circuit is closed and the resistance of the heating element departs from a predetermined value, time indicating means having a constant speed electric motor for driving same, and means including a switch operated periodically by said motor for momentarily opening the first circuit to unlock the relay and momentarily closing the second circuit in sequence.

6. A heat control arrangement for an electrically heated blanket comprising, in combination,

a blanket, a heating element in said blanket whose resistance changes in relationship to its temperature, a resistor subject to ambient temperature whose resistance changes in relationship to its temperature, a bridge circuit including said heating element and resistor for developing a voltage which varies in relationship to changes in the combined resistances of said heating element and resistor, electronic tube means arranged to conduct current responsive to changes in said developed voltage, a circuit for applying substantially full line voltage to the heating element from a source of electric power, a normally open self-locking relay energized by the flow of current through the tube means for closing the last named circuit, a timer, and means actuated periodically by the timer for opening the last named circuit and closing the bridge circuit in sequence.

7. A heat control arrangement for an electrically heated blanket comprising, in combination, a blanket, a heating element in said blanket whose resistance changes in relationship to its temperature, a resistor subject to ambient temperature whose resistance changes in relationship to its temperature, a bridge circuit connected to a source of electric power and including said heating element and resistor adapted when closed to develop a voltage which varies in relationship to changes in the combined resistances of said heating element and resistor, electronic tube means arranged to conduct current responsive to changes in said developed voltage, a circuit for impressing a higher potential on the heating element from the source of electric power, means energized by the flow of current through the tube means for closing the last named circuit, unlockable means for retaining said last named circuit in closed condition, a timer, and means operated periodically by the timer for momentarily closing the bridge circuit and then unlocking said retaining means after a predetermined heating period.

8. A heat control arrangement for an electrically heated blanket comprising, in combination, a blanket, a heating element in said blanket whose resistance changes in relationship to its temperature, a resistor subject to ambient temperature whose resistance changes in relationship to its temperature, a bridge circuit connected to a source of electric power and including a normally open switch adapted to establish the bridge circuit when closed, said bridge circuit including said heating element and said resistor and being arranged to develop a voltage when the switch is closed which varies in relationship to changes in the combined resistances of said heating element and resistor, a circuit for applying substantially full line voltage to the heating element from the source of electric power and short circuiting the switch and resistor subject to ambient temperature including a normally open self-locking relay, means including a second circuit for energizing the relay responsive to the developed bridge voltage, a timer, and means operated by the timer for unlocking the relay and momentarily closing the bridge circuit switch in sequence.

9. A heat control arrangement for an electrically heated blanket comprising, in combination, a blanket, a heating element in said blanket whose resistance changes in relationship to its temperature, a resistor subject to ambient temperature whose resistance changes in relationship to its temperature, a bridge circuit connected to

a source of electric power and including said heating element and resistor for developing a voltage which varies in relationship to changes in the combined resistances of said heating element and resistor, an electronic tube having a grid voltage determined by the bridge voltage, means including a circuit for applying substantially full line voltage to the heating element from the source of electric power, a normally open relay connected to the tube and arranged to close the heating element circuit when the grid voltage on the tube reaches a predetermined value and to lock in closed position, actuable means for unlocking the relay, a normally open switch adapted to be actuated to close the bridge circuit, and a timer for periodically and momentarily actuating the unlocking means and the bridge circuit closing switch in sequence.

10. A heat control arrangement for an electrically heated blanket comprising, in combination, a blanket, a heating element in said blanket whose resistance changes in relationship to its temperature, a resistor subject to ambient temperature whose resistance changes in relationship to its temperature, a normally open bridge circuit connected to a source of electric power and having one leg comprising the said heating element and resistor for developing a voltage varying in relationship to changes in the resistances of said heating element and resistor, an electronic tube having a grid voltage determined by the bridge voltage and arranged to conduct current when the combined resistance of said heating element and resistor fall below a predetermined minimum, a circuit for applying substantially full line voltage to the heating element from the source of electric power including a normally open relay actuated by the flow of current through the tube and adapted to lock in closed position until the last named circuit is opened, a timer including time indicating means, and a pair of switches operated sequentially and periodically by the timer for momentarily opening the last named circuit and closing the bridge circuit in sequence.

11. A heat control arrangement for an electrically heated blanket comprising, in combination, a blanket, a heating element in said blanket whose resistance changes in relationship to its temperature, a resistor subject to ambient temperature whose resistance changes in relationship

to its temperature, a bridge circuit having one leg comprising the said heating element and resistor for developing a voltage varying in relationship to changes in the combined resistance of said heating element and resistor, said bridge circuit being connected to a source of electric power and including a normally open first switch adapted to be actuated to close the bridge circuit, an electronic tube having a grid voltage dependent upon said developed voltage, a solenoid connected to the tube to be energized when the grid voltage on the tube reaches a value indicating a predetermined drop in temperature of the heating element and resistor, means including a circuit for applying substantially full line voltage to the heating element from the source of electric power including a normally open switch adapted to be closed while the solenoid is energized, a second switch operated by the solenoid when the solenoid is energized through the tube to disconnect the tube from the solenoid and to connect the solenoid to a source of electric power, a normally closed switch adapted to be actuated to disconnect the solenoid from the source of electric power, and a timer constructed and arranged to momentarily and periodically actuate said last named and first named switches in sequence.

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