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TEMPERATURE CONTROL FOR WARMING BLANKETS

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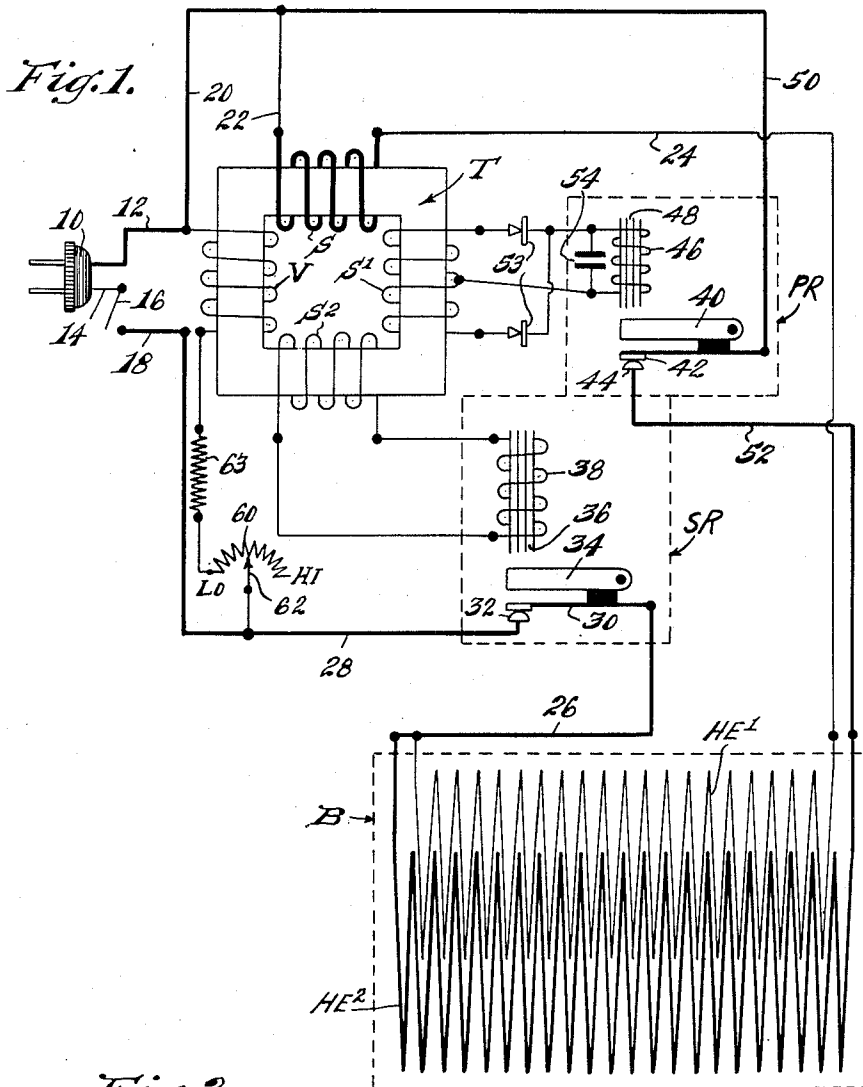
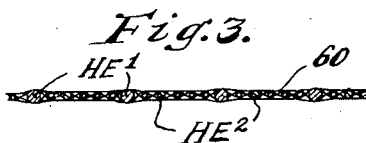
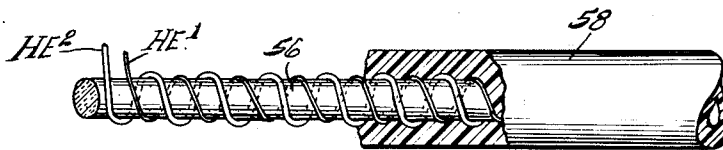


Fig. 2.



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TEMPERATURE CONTROL FOR WARMING
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This invention relates to a temperature control in which a primary control for maintaining a warming blanket at substantially a constant temperature is provided and a secondary control is also provided to deenergize the blanket and maintain it in the deenergized condition in the event of damage to or malfunctioning of either the blanket or the primary control.

One object of the invention is to provide a specially wound transformer having differentially wound primary coils connected in circuit with a pilot heating element of the blanket so that heating thereof will so upset the balance between the primary coils as to permit sufficient magnetomotive force to be built up in the form of flux flow through the core of the transformer to energize a secondary coil sufficiently to operate a relay that cuts off current from the supply line to a main heating element of the blanket.

Another object is to provide the differentially wound coils arranged so that one is in parallel and the other in series with the pilot heating element so that when the pilot heating element is cold the current in the two coils buck each other and the coils are substantially balanced electrically thereby producing a minimum of magnetization in the core of the transformer, whereas an increase in the resistance of the pilot heating element due to rise in blanket temperature reduces the current in the series coil so that the parallel coil then predominates the series coil and causes sufficient magnetization of the transformer core to produce current in a secondary coil of sufficient quantity to operate a sensitive relay.

A further object is to provide a sensitive relay of the D. C. type by having the secondary coil formed in two parts and connected with a full-wave rectifier circuit to eliminate A. C. chatter in the relay and provide a relay in which pull-in and drop-out values are closer than in A. C. relays inasmuch as the relay must be particularly sensitive because it operates as a result of the change in resistance of the pilot heating element in the blanket as that element responds to temperature of the blanket, the differential between off and on being especially dependent upon the accuracy of the relay and the current density in the wire of the pilot heating element.

Still a further object is to provide another secondary on the transformer core which is operable to actuate a second or safety sensitive relay, the second one being of the A. C. type and serving as a secondary temperature control in the event of damage to the primary control or mal-

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functioning thereof, the relay just mentioned when once operated to deenergize the heating element remaining in the deenergized position because of the parallel coil remaining in the circuit but the circuit for the series coil being broken at the A. C. relay.

An additional object of the invention is the spacing (attained by the knitting method) between the pilot heating element and the main heating element, the knitting method of fabrication insuring accurate maintenance of spacing between the two elements both during fabrication of the blanket and during its subsequent use.

With these and other objects in view, my invention consists in the construction, arrangement and combination of the various parts of my device whereby the objects contemplated are attained, as hereinafter more fully set forth, pointed out in my claims and illustrated in the accompanying drawings, wherein:

Figure 1 is an electrodiagrammatic view of a temperature controlling circuit for a warming blanket or the like and showing also the warming blanket.

Figure 2 is an enlarged view partly in section of a special heating cable for use in the warming blanket, and

Figure 3 is a sectional view of another type of warming blanket constructed to have the main and pilot heating elements knitted therein in such manner as to maintain proper spacing between them.

On the accompanying drawings I have used the reference numeral 10 to indicate a current supply plug which may be plugged into a service outlet of the ordinary type found in residences. Wires 12 and 14 extend from the plug and a main control switch 16 is connected with the wire 14 and interrupts the current to a wire 18 when desired.

The wires 12 and 18 connect with a voltage or parallel coil V of a transformer T and the wire 12 is connected by wires 20 and 22 to a series coil S. The coils V and S are in fact primary coils for the core of the transformer T and are wound so that current flows through them in opposite directions. Whenever the switch 16 is closed accordingly current flows continuously in the coils S and V. As the blanket heats up the current decreases in the coil S but does not change in the coil V and as the blanket cools off the current increases in the coil S and again does not change in the coil V. The coils V and S are so wound on the transformer T that they buck each other electrically so that when equally

energized they tend to produce opposed magnetic fields that minimize magnetization of the core of the transformer.

The circuit for the coil S from the wire 22 extends through a wire 24 to a pilot heating element HE¹ in a blanket B and then through wires 25 and 28 to the wire 18. The element HE¹ is a resistance element having a positive temperature coefficient of resistance. The wire 26 is connected to a contact spring 30 and the wire 28 is connected to a contact 32 normally coacting therewith. A pivoted armature 34 supports the spring 30 and will break the circuit at 30—32 when a core 36 is magnetized by current flow in a relay coil 38. The elements 30, 32, 34, 36 and 38 constitute a secondary or safety relay SR.

A primary relay PR is provided in the form of an armature 40 carrying a contact 42 normally engaged with a contact 44. A relay coil 46 is wound on a core 48 which core when sufficiently magnetized attracts the armature 40.

The contacts 42 and 44 are connected with wires 50 and 52 respectively, extending from the wire 20 and to a main heating element HE² of the blanket B. The element HE² may carry something like 195 watts as compared to 26 watts carried by the pilot heating element HE¹. The other end of the heating element HE² is connected with the wire 26 so as to be under control of the contacts 30 and 32 of the safety relay SR.

Current is provided for the primary and safety relays in the form of secondary coils S¹ and S² respectively. The primary relay PR is of the D. C. type, and to furnish it with D. C. current the coil S¹ has a center tap and rectifier elements 53 are connected in the circuit so as to rectify the alternating current from the coil S¹. A filter condenser 54 serves to smooth out the pulsations of the rectified current.

As shown in Figure 2 the heating elements HE¹ and HE² may be wound continuously on a core 56 of flexible insulating material without contact with each other and the windings are then covered with a sleeve 58 which may be of plastic material as these materials are now available of such composition as to withstand the extreme operating temperatures such as 185° F. that might be encountered in an emergency in a heating blanket. This arrangement provides a cable which may be arranged zig-zag throughout the extent of the blanket so that both heating elements will be distributed wherever the cable is located.

Another method of construction is shown in Figure 3. The heating elements HE¹ and HE² are knitted into a blanket or pad 60 as warp or woof elements of the fabric and at predetermined spacing from each other. This spacing is maintained in the finished blanket regardless of the shape it assumes when in use. The method disclosed in the Harris Patent No. 2,157,606 of May 9, 1939 is suitable for use in incorporating the heating elements in a knitted fabric. The knitting method insures that the spacing is also accurately maintained during fabrication.

The importance of maintaining this spacing arises from the consideration that the pilot heating element should respond to both actual blanket temperature and main heating element temperature in a desired proportional dimensional and therefore thermal relationship. In some blankets I have made, ¼ inch is apparently the best spacing although, of course, this dimension must be changed when various other factors

such as wattages, etc. for the two heating elements are changed.

Practical operation

In the operation of my temperature control when the switch 16 is closed both heating elements HE¹ and HE² will receive current and the temperature of the blanket will rise. The rise in temperature causes a rise in resistance in both heating elements and the increased resistance in the pilot heating element HE¹ tends to reduce current flow through the series primary coil S. Since at room temperature the series primary coil together with the pilot heating element are electrically balanced with respect to the voltage primary coil V a reduction in current flow through S will permit the predominating current flow through V to cause magnetization of the transformer core and as the temperature of HE¹ goes up and current in the coil S therefore reduces, the magnetic effect in the transformer core increases because the differential between magnetism caused by the coil V and reverse magnetism caused by the coil S increases. When magnetism increases to a certain point it will be then inducing enough current in the secondary coil S¹ to operate the primary relay PR.

This opens the circuit of the heating element HE² at the contacts 42—44 thus limiting the temperature of the blanket and permitting the temperature to go down thereby decreasing the resistance in the heating element HE¹ again. This reduction in resistance causes an increase in current flow in the coil S resulting in a weakening in the magnetic flow of the transformer core until the core 48 of the relay PR no longer has sufficient magnetism to retain the armature 40 attracted. The contacts 42—44 will thereupon close, re-establishing the circuit in the main heating element HE².

The cycles of operations just described will continue and will maintain the blanket B at a substantially constant temperature with a fall of temperature ambient to the blanket causing faster cool-down cycles and slower heat-up cycles, thereby compensating for ambient temperature.

Normally the primary relay PR is the only one that operates. Current in the coil S² will increase and decrease but will never be sufficient to cause the core 36 of the secondary relay SR to attract its armature 34. If the primary control is damaged in any way however or any malfunctioning takes place, the blanket temperature will continue to rise because of constant current being supplied to the heating element.

A secondary or safety control is at that time desirable and the conventional method is to provide one or a number of thermostats and/or fuses in the blanket proper which serve to limit the temperature of the blanket if the primary control fails to operate. Such arrangements have several disadvantages such as requiring spliced connections to the blanket heating cable, such connections being vulnerable spots in the assembly. Also thermostats and fuses are somewhat bulky and may be damaged when the blanket is flexed or otherwise handled in bed, and they also detract from the ease of washing the blanket. In the case of temperature limiting thermostats there is no permanent deenergization of the blanket in the event of trouble in the primary control.

On the other hand with my arrangement the secondary relay SR may be included in the same housing as the primary control, that is with the

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primary relay, the transformer and the control switch 16. As temperature increases above normal operating temperatures there is still more resistance offered to the circuit by the heating element HE¹ causing less current flow through the coil S while current flow through the coil V remains constant.

Therefore beyond the operating point of the primary relay PR current in the coil S² will rise to such a value as to permit operation of the secondary relay SR to completely break the circuit to both heating elements at the contacts 30—32. These contacts are in the circuit of the coil S so that it now is completely deenergized and there is only one primary coil V in circuit with the wires 12 and 14 and there is therefore a further increase of current in the relay coil 33. This current keeps the secondary relay SR in the open position so that the blanket does not return to energized condition but is maintained open until such time as the trouble is remedied and the circuits properly re-established. The safety or secondary relay of course will close to its original position whenever the main switch 16 is opened. The safety relay also functions in case the blanket is mistreated or malfunctions. For instance, if it is folded in a number of sections its temperature and therefore the temperature of the pilot heating element rises abnormally to result in causing the relay SR to operate.

Range adjustment can be readily had by means of a rheostat 60—62 and a resistor 63 in series with the coil V to change its operating characteristics in relation to the other elements of the circuit. Any degree of temperature can be therefore approximately maintained in the blanket B within the limits of the range adjustment.

Some changes may be made in the construction and arrangement of the parts of my device without departing from the real spirit and purpose of my invention, and it is my intention to cover by my claims any modified forms of structure or use of mechanical equivalents which may be reasonably included within their scope.

I claim as my invention:

1. In a temperature control, a transformer having a core, a pair of primary coils differentially wound thereon, one of said coils being connected across the source of current for said transformer a blanket having main and pilot heating elements, said pilot heating element connected in parallel with said one of said coils and in series with the other coil and said main heating element connected in parallel with said one of said coils, a primary relay having contacts in circuit with said main heating element for controlling energization thereof, said transformer supplying predetermined secondary current for operating said primary relay, and a secondary relay for controlling the current to both of said heating elements, said transformer supplying further secondary current for the coil of said secondary relay, the contacts of said secondary relay being normally closed and also in circuit with said main heating element, said secondary relay being energized sufficiently to open the contacts thereof upon an increase in the resistance of said pilot heating element due to an abnormal increase in the temperature thereof.

2. In a temperature control for warming blankets and the like, a transformer having a core, a pair of primary coils differentially wound thereon, a blanket having a pair of heating elements, one connected in parallel with one of said coils and in series with the other coil, and the

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other one connected in parallel with the first coil, said first coil being connected across the source of current to said transformer, a primary relay in circuit with said other heating element for controlling energization thereof, said transformer having a secondary coil for operating said primary relay, and a secondary relay having contacts in circuit with both of said heating elements, said transformer having a second secondary coil for supplying current to the coil of said secondary relay and operable to open the same at a higher value of current flow than the operating point of said primary relay as a result of an increase in the resistance of said first heating element due to an increase in its temperature above the normal operating temperature of said warming blanket.

3. In a temperature control for warming blankets and the like, a transformer having a core, a pair of primary coils differentially wound thereon, one of said coils being connected across the source of current for said transformer the blanket having a main heating element and a pilot heating element, said pilot heating element connected in parallel with said one of said coils and in series with the other coil, and said main heating element connected in parallel with said one of said coils, a pair of relays in circuit with said main heating element for controlling energization thereof, said transformer having a pair of secondary coils for operating said relays, one of said relays being operable to open the circuit of said main heating element at a higher value of current flow than the other as a result of an increase in the resistance of said pilot heating element due to an abnormal increase in the temperature thereof and a rheostat in series with said one of said primary coils for adjusting the range of said temperature control.

4. In a temperature control, a transformer having a core, a pair of primary coils differentially wound thereon, a blanket having main and pilot heating elements, said pilot heating element connected in parallel with one of said coils and in series with the other coil and said main heating element connected in parallel with the first coil said first coil being connected across the current supply line, a primary relay in circuit with said main heating element for controlling energization thereof, said transformer having a secondary coil for operating said primary relay, and a secondary relay having contacts in circuit with both of said heating elements, said transformer having a second secondary coil for supplying current to said secondary relay and operable to operate the same at a higher value of current flow than the operation of said primary relay by said first secondary coil resulting from an increase in the resistance of said pilot heating element due to an increase in its temperature above the normal operating temperature of said warming blanket.

5. In a temperature control for warming blankets and the like, a transformer having a core, first and second primary coils differentially wound thereon, said first coil being connected across the current source, a blanket having a pair of heating elements, one heating element connected in parallel with said first coil and in series with said second coil, and the other heating element connected in parallel with said first coil, a primary relay in circuit with said other heating element for controlling energization thereof, said transformer having a secondary coil for operating said primary relay, said secondary coil hav-

ing a center tap connected with one end of said primary relay coil, rectifier elements connecting the ends of said secondary coil with the other end of said primary relay coil whereby the relay operates on direct current, and a secondary relay having contacts in circuit with both of said heating elements, said transformer having a second secondary coil for supplying current to said secondary relay and operable to operate the same at a higher value of current flow than the operating point of said primary relay as a result of an increase in the resistance of said first heating element due to an increase in its temperature above the normal operating temperature of said warming blanket.

6. In a temperature control, a transformer having a core, a series primary coil and a parallel-primary coil differentially wound thereon, a blanket having a main heating element and a pilot heating element, said pilot heating element connected in parallel with said parallel-primary coil and in series with said series-primary coil, and said main heating element also connected in parallel with the said parallel-primary coil, said parallel-primary coil being connected across the current supply to said temperature control, a safety relay in circuit with said heating elements for deenergizing them, said transformer having a secondary coil for operating said safety relay when the resistance in said pilot heating element increases due to excessive rise in temperature thereof and thereby reduces the current through said series-primary coil so that said parallel-primary coil magnetizes said core sufficiently to induce enough current in said secondary coil to operate said safety relay as a result of an abnormal resistance increase due to a proportionate temperature increase in said pilot heating element above the normal operating temperature of said blanket, and a rheostat for said primary coil for adjusting the range of said temperature control.

7. In a temperature control device, a transformer having a core, a pair of primary coils differentially wound thereon, a blanket having a

pair of heating elements, one connected in parallel with one of said coils and in series with the other coil, and the other one connected in parallel with the first coil said first coil being connected across the current supply line, a primary relay in circuit with said other heating element for controlling energization thereof, said transformer having a secondary coil for operating said primary relay, said secondary coil having a center tap connected with one terminal of the coil of said primary relay, a pair of half-wave rectifier elements connecting the ends of said secondary coil with the other terminal of said primary relay whereby the relay operates on direct current, and a secondary relay having contacts in circuit with both of said heating elements, said transformer having a second secondary coil for supplying current to said secondary relay and operable to operate the same at a higher value of current flow than the operation of said primary relay by said first secondary coil resulting from an increase in the resistance of said pilot heating element due to an increase in its temperature above the normal operating temperature of said warming blanket.

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