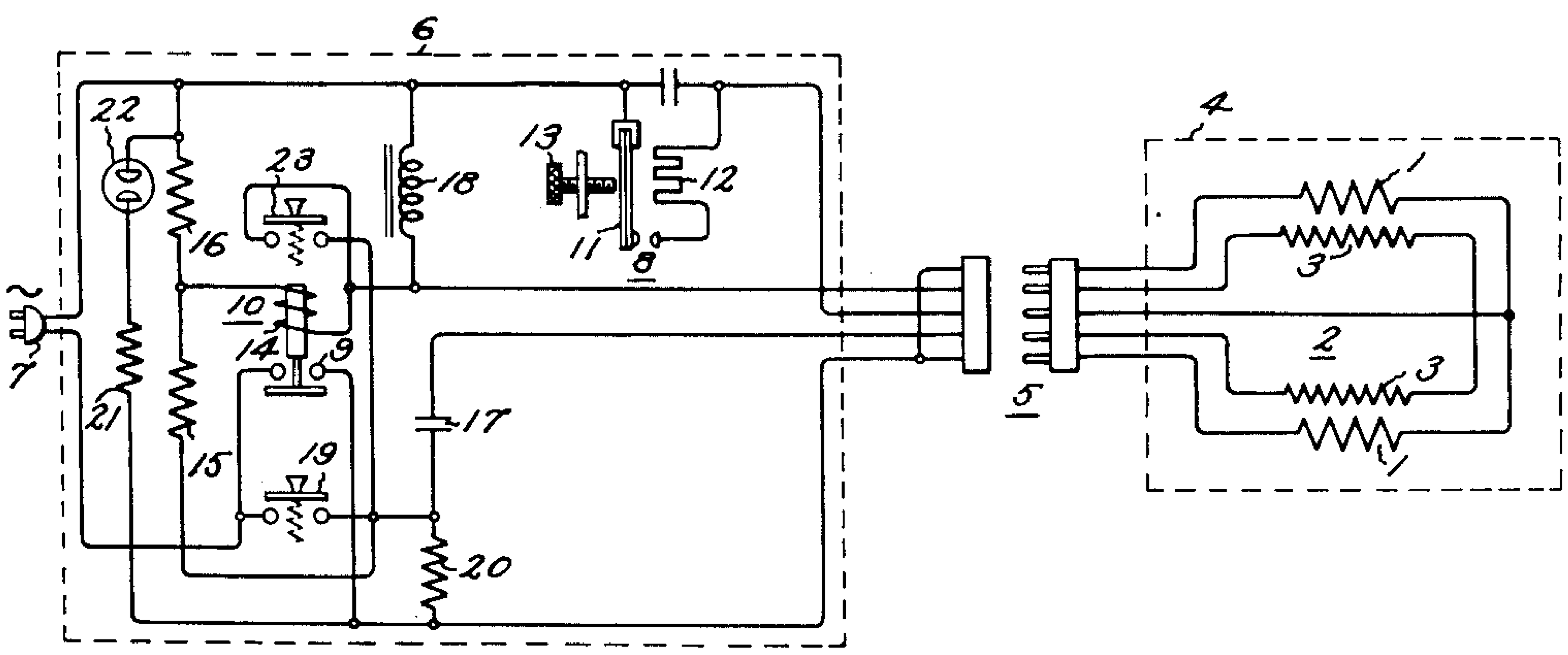
Jan. 6, 1953

G. C. CROWLEY

2,624,825

TEMPERATURE CONTROL CIRCUIT

Filed April 11, 1951



Inventor:
George C. Crowley,
by [signature]
His Attorney.

Patented Jan. 6, 1953

2,624,825

UNITED STATES PATENT OFFICE

2,624,825

TEMPERATURE CONTROL CIRCUIT

George C. Crowley, Stratford, Conn., assignor to General Electric Company, a corporation of New York

Application April 11, 1951, Serial No. 220,440

3 Claims. (Cl. 219—20)

1

My invention relates to temperature responsive control circuits and more particularly to such control circuits for use with electric blankets and the like.

Heretofore, various control circuits have been developed for providing over-temperature protection for electric blankets and like heating devices, several of these circuits being disclosed in my copending application, Serial No. 91,402, now Patent 2,565,478, patented August 28, 1951, entitled "Temperature Responsive Control Circuit," filed May 4, 1949, and owned by the General Electric Company, assignee of the present invention. In the circuits shown therein, the operation of the automatic circuit breaking means is controlled by a temperature sensitive structure which contains a pair of conductors having between them a thin layer of material which is substantially an insulator at one temperature and at a predetermined high temperature is a conductor of electricity of conventional domestic voltage and frequency. Upon overheating of the blanket, the thin layer of material passes current from one conductor to the other, and thereby causes operation of the circuit opening means. The temperature sensitive structure itself is disclosed and claimed in the copending application of Spooner et al., Serial No. 91,396, entitled "Thermosensitive Devices and Apparatus Incorporating the Same," filed May 4, 1949, now Patent 2,581,212, patented January 1, 1952, and also assigned to the General Electric Company.

Although the circuits disclosed in my aforementioned application, Serial No. 91,402, have, on the whole, given excellent results when used with electric blankets, they do not make quite enough allowance for a mistake made by certain inexperienced persons in operating the blankets. More specifically, although the control circuits must, of course, operate when only a portion of the blanket is overheated as well as when the entire blanket is too hot, these inexperienced persons often do not realize that danger exists when only a portion of the blanket is overheated, and they attempt to re-energize the heating circuit by jamming closed the "on" switch before the overheated portion of the blanket is allowed to cool to the temperature at which it may operate safely.

In a number of the aforementioned control circuits, the automatic circuit opening means consist of the contacts of an electromagnetic relay, and it has been found that the jamming closed of the "on" switch upon an overheat condition results in rapid opening and closing, i. e.,

2

chattering, of this relay. Naturally, the chattering is objectionable both because it causes severe wear of the relay and its contacts and also because the blanket is energized during the periods that the relay is closed. Moreover, the chattering is extremely discomforting to the owner of the blanket, often convincing him that there is something wrong with the control circuit or with the blanket itself. This conclusion is a particularly undesirable one because ordinarily overheating of a portion of the blanket does not indicate a circuit failure, since any portion of the blanket may overheat merely because there is a tight fold or tuck formed in it which prevents the normal dissipation of heat.

It is a general object of my invention, therefore, to provide a new and improved control circuit for use with electric blankets and the like, and it is a more specific object of my invention to provide such a control circuit in which the jamming closed of the "on" switch upon an overheat condition does not result in chattering of the control relay.

The features of my invention which I believe to be novel are pointed out with particularity in the appended claims. The invention, itself, however, both as to organization and mode of operation, together with further objects and advantages thereof, may be best understood by reference to the following description to be taken in conjunction with the accompanying drawing which is a schematic diagram of a control circuit embodying my invention.

Referring to the diagram, one conductor or heater resistor **1** of a combined heat generating and thermosensitive element **2** is separated from the second conductor or signal wire **3** of the element by a thin layer (not shown) of one of the organic materials disclosed in the aforementioned Spooner et al. application, Serial No. 91,396, a synthetic polyamide resin, commonly called nylon, being preferable. The thin layer of organic material is essentially an insulator at normal operation temperatures of element **2** and is a conductor of electricity at predetermined higher temperatures. The combined heating and thermosensitive element **2** may be arranged inside a blanket **4** in any one of the suitable patterns well known to the art and may be joined through a multi-terminal plug and socket **5** to a control circuit which is housed in the control box **6**. A plug **7** provides the supply terminals for connecting the control circuit to a source of power, for example, a conventional 115 volt, 60 cycle, A. C. domestic circuit.

The control circuit performs a dual function. Firstly, it serves to regulate the current supply to the blanket load or heating circuit, which is comprised of resistor 1, and secondly, it serves to completely de-energize the load circuit upon the overheating of any portion of the blanket. Thus, resistor 1, which, for example, may be divided into two parallel-connected sections having an over-all resistance of approximately 60 ohms, is connected to one side of the power source through a cycling control 8 and to the other side of the source through the contacts 9 of a control device, such as electromagnetic relay 10.

Cycling control 8 regulates the blanket temperature under normal operating conditions and preferably is of the room temperature-responsive type of control described and claimed in the U. S. patent to William K. Kearsley, 2,195,958, April 2, 1940. It accomplishes this temperature regulation through a cycling bimetallic switch member 11 which alternately opens and closes the heating circuit in response to the heat supplied to it by a series resistance 12 and the surrounding atmosphere. In order that adjustment of the control may be made to obtain various blanket temperatures, an external regulating knob 13 is provided to act on switch member 11.

However, as mentioned above, in addition to the normal temperature regulation of the blanket, the control circuit also provides over-temperature protection to completely de-energize the blanket circuit upon any dangerous overheating in the blanket. It is by means of relay 10 that such protection is obtained. The operating coil 14 of relay 10 is connected to be energized across opposite terminals of a 4-legged impedance bridge which, itself, is energized from the same power source as the heating circuit. Comprising two legs of this impedance bridge is a series resonant circuit, while comprising the other legs are a pair of 12,000 ohm resistors 15 and 16. The series resonant circuit includes in serial relationship a 0.1 mfd. capacitor 17, signal wire 3 and a 75 henry choke coil 18, the resistance of signal wire 3 being preferably less than 400 ohms. Choke 18 and resistor 16 are connected directly to one side of the power source or line but capacitor 17 and resistor 15 are connected to the load side of a switch 19 which is biased to the open position and manually operable to the closed position. The other side of switch 19 is joined directly to the opposite side of the line.

Connected in parallel with or across switch 19, as far as the resonant circuit is concerned, is a series circuit consisting of contacts 9 and a 12,000 ohm resistor 20. However, with respect to the heating circuit, it may be said that contacts 9 are in parallel with the series combination of switch 19 and resistor 20. In any case, the closing of contacts 9 serves to energize the heating circuit directly and to energize the impedance bridge through resistor 20. Also connected to be energized directly by the closing of contacts 9 is an operation indicating circuit consisting of a 200,000 resistor 21 and a neon glow-lamp 22 serially connected. As its name intimates, this circuit is added merely to provide a means for indicating to the user whether the blanket is in operation or not.

Means for de-energizing the blanket circuits at the option of the user is provided by a switch 23 which, like switch 19, is biased to the open position and manually operable to the closed position. Although, as will become apparent hereinafter, there are various ways in which switch 23 may be connected into the circuit, preferably it is connected between the load side of switch 19 and some point in the resonant circuit so that when closed, it forms a parallel path around a portion of the circuit effective to disturb the circuit resonance. Thus, as shown in the diagram, one side of switch 23 is joined to switch 19 and the other side is joined to the junction of choke 18 and signal wire 3.

Also connected to this junction point, which actually is one of the aforementioned opposite terminals of the impedance bridge, is the relay operating coil 14. The other point to which coil 14 is connected, i. e., the other bridge terminal, is the junction of resistors 15 and 16. With the other circuit components being of the magnitudes given, the impedance presented between the bridge terminals by coil 14 should be approximately 90,000 ohms with the relay armature closed, and the construction of relay 10 should be such that it operates to close contacts 9 with approximately 115 volts applied to the operating coil 14 and drops out to open the contacts when the coil voltage falls to a value someplace between 90–75 volts depending on the relay calibration. It must be understood, however, that these numerical values, as well as those given for the various resistances and impedances, are for a circuit to be energized from the standard 115 volt, 60 cycle, A.-C. domestic voltage source. Different voltage sources, of course, would require different values for the circuit components.

To energize the circuit, assuming that the thermostatic cycling control 8 is calling for heat, switch 19 is closed to connect the impedance bridge directly across the line. Resistors 15 and 16 act as voltage dividers to cause the voltage appearing at the one terminal of the bridge to be approximately half the line voltage. The voltage at the other terminal of the bridge is, however, considerably higher due to the effect of the resonant circuit; in other words, the voltage drop across choke 18 is much greater than the voltage drop across resistor 16. In fact, the voltage across choke 18 rises considerably above line voltage so that with a line voltage of 115 volts, a voltage of approximately 150 volts appears across coil 14. This causes relay 10 to operate and close contacts 9 placing the heating circuit directly across the line.

As soon as relay 10 operates, switch 19 may be released since the impedance bridge is energized through contacts 9 and resistor 20 to keep relay 10 locked in the closed position. The addition of resistor 20 to the bridge circuit limits the current in the resonant circuit and the voltage divider circuit, but under normal conditions does not diminish the voltage across coil 14 enough for the relay to drop out. This is true since the voltage falls off at both the bridge terminals, in the case of the terminal between resistors 15 and 16 falling to about ⅓ of the line voltage. Thus, assuming that the entire circuit is in good working order, once relay 10 operates, the heating circuit will remain in operation dependent upon the cycling of control 8.

To de-energize the circuit, i. e., turn off the blanket, switch 23 is closed. The closing of switch 23 effectively shorts out capacitor 17 and disturbs the resonance of the normally resonant circuit. This causes the voltage across choke 18 to drop appreciably, while the voltage across coil 16 remains the same, approximately ⅓ the line voltage. The voltage between the bridge terminals therefore decreases to a value insufficient to keep relay 10 locked in, and the relay drops out opening contacts 9 and de-energizing the entire circuit. Obviously, switch 23 may be placed at any point in the circuit where, by its closing, it will reduce the voltage between the bridge terminals enough to allow relay 10 to drop out.

Means are also provided for an automatic circuit opening if the blanket overheats to a predetermined cut-off temperature, for example, when it heats over an external temperature of 180° F. if the temperature of the blanket rises to or beyond this value, the impedance of the nylon layer between conductors 1 and 3 decreases sufficiently in magnitude that it passes appreciable current from heater resistor 1 to signal wire 3. The current paths formed between resistor 1 and signal wire 3 effectively complete parallel circuits around capacitor 17 and choke 18 which disturb the resonance of the normally resonant circuit. As above, the disturbance of the series resonant effect causes the voltage across choke 18 to drop off and since the voltage across resistor 16 does not change, results in the voltage across coil 14 falling to a value insufficient to keep relay 10 from dropping out to clear the circuit. Thus, overheating of any portion of the blanket brings about an automatic shut-off of the blanket.

It is when the blanket shuts off automatically in this manner that an inexperienced owner may jam the "on" switch 19 closed trying to turn the blanket on again. Under normal operating conditions of the original circuit disclosed in the copending application, Serial No. 91,402, i. e. in the original circuit with its relay contacts closed and the "on" switch open, the current limiting resistor 20 (using the numbers of the present case) is in series with condenser 17 and choke 18 across the supply potential, and the voltage across each of the voltage divider resistors 15 and 16 is approximately ½ the line voltage. However, when the relay contacts open due to an overheat and the "on" switch is jammed, the voltage across each of the voltage divider resistors drops to approximately ⅓ of line voltage, due to the fact that these resistors are then connected in series with the current limiting resistor 20. The voltages across choke 18 and condenser 17, however, increase as their circuit is then connected directly across the power source. Since the voltage across the choke increases while the voltages across the voltage divider resistors decrease, the result is an increase in the voltage across the relay coil. This increased voltage across the coil causes the relay to operate and close the relay contacts, which, in turn, increases the voltage on the voltage divider resistors. The rise in voltage across the resistors decreases the voltage on the relay coil and allows the relay to drop out. The cycle then repeats itself, causing rapid chattering of the relay.

However, in this new circuit, current limiting resistor 20 is in series with impedance bridge as a whole when the relay contacts are closed. When the contacts open, due to overheat, and the "on" switch is jammed closed, resistor 20 is removed from the bridge circuit entirely, both the voltage divider circuit and the resonant circuit being connected directly across the power source. Thus, opening of the relay contacts and jamming of the "on" switch changes the potential to all the bridge elements and thereby does not cause any unbalance of the voltage appearing at the relay coil. The relay then stays out and no chattering occurs.

When the nylon control layer between resistor 1 and signal wire 3, and thus, the blanket itself, has cooled sufficiently that there are no longer any parallel circuits effective to disturb the resonant circuit, the closing of switch 19 will again restore the blanket to normal operation. However, besides the shut-off due to overheating, the blanket control will also automatically de-energize the blanket due to the permanent failure of any circuit component, since such a failure disturbs the resonance of the resonant circuit. In that case, though, reclosing of the "on" switch after a length of time sufficient to allow cooling of the blanket will not return the blanket to operation, and thereby the user may determine whether his blanket has shut off due to a minor causes, such as a tight fold in some portion of the blanket, as is the usual case, or whether it has shut off due to failure of one of the circuit components.

The subject matter of this application is also related to that of G. C. Crowley, R. G. Holmes, and P. A. Check, Serial No. 236,208, filed July 11, 1951, and to that of J. W. McNairy, Serial No. 134,002, filed December 20, 1949, all having the same assignee as the instant application.

Although the circuit produces satisfactory results using the values stated for the various circuit components, these values are meant to be merely illustrative. Obviously, numerous modifications and alterations may be made by those skilled in the art without actually departing from the invention, and I therefore aim in the appended claims to cover all such equivalent variations as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a control circuit including a control element comprising a heater resistor and a signal wire having between them a layer of material which is substantially an insulator at one temperature and at a predetermined higher temperature a conductor of electricity, a pair of supply terminals, a manually operable switch biased to the open position, an impedance bridge connected in series with said switch across said terminals, two legs of said bridge collectively comprising in serial relationship a capacitor, said signal wire and reactance means, and the other two legs collectively comprising a pair of resistors serially connected, a control relay having an operating coil and contacts biased to the open position, a current limiting resistor, a circuit connecting said contacts and said current limiting resistor in serial relationship across said switch, means connecting said operaing coil across said impedance bridge to derive voltage therefrom to operate said contacts to the closed position, and a circuit connecting said contacts and said heater resistor serially across said supply terminals to enable the current paths formed between said signal wire and said heater resistor upon conducting status of said layer to complete parallel circuits about two legs of said impedance bridge to effect a reduction in the voltage on said operating coil to a value such that said contacts return to said open position and said switch during said conducting status of said layer is ineffective upon being closed to energize said operating coil to again close said contacts.

2. In a control circuit including a control element comprising a heater resistor and a signal wire having between them a layer of material which is substantially an insulator at one temperature and at a predetermined higher temperature a conductor of electricity at conventional

domestic voltage and frequency, a pair of supply terminals, a manually operable switch biased to the open position, an impedance bridge connected in series with said switch across said terminals, two legs of said bridge collectively comprising a series resonant circuit including a capacitor, said signal wire and a reactance means, and the other two legs collectively comprising a pair of resistors serially connected, a control relay having an operating coil and contacts biased to the open position, a current limiting resistor, a circuit connecting said contacts and said current limiting resistor in serial relationship across said switch, means connecting said operating coil across said impedance bridge to derive voltage therefrom to operate said contacts to the closed position, a thermosensitive cycling control having a cycling switch member, and a circuit connecting said contacts, said cycling switch member and said heater resistor serially across said supply terminals to enable the current path formed between said signal wire and said heater resistor upon conducting status of said layer to complete parallel circuits about two legs of said impedance bridge effective to reduce the magnitude of energization of said operating coil to allow said contacts to return to said open position and effective to prevent operation of said contacts to the closed position upon the operation of said switch during said conducting status of said layer.

3. In a control circuit including a control element comprising a heater resistor and a signal wire having between them a thin layer of material which is substantially an insulator at one temperature and at a predetermined higher temperature a conductor of electricity at conventional domestic voltage and frequency, a pair of supply terminals, a pair of switches biased to the open position and manually operable to the closed position, an impedance bridge connected directly to one of said supply terminals and connected to the other of said supply terminals by one of said switches, two legs of said bridge collectively comprising in serial relationship a capacitor, said signal wire and reactance means, and the other two legs collectively comprising a pair of matched resistors serially connected, a control relay having an operating coil and contacts biased to the open position, a current limiting resistor, a circuit connecting said current limiting resistor and said contacts in serial relation across said one switch, means connecting said operating coil across said impedance bridge to derive voltage therefrom to operate said contacts to the closed position, means connecting the other of said switches in parallel relationship with a portion of said resonant circuit, a thermosensitive cycling control having a cycling switch member, and a circuit connecting said contacts, said cycling switch member and said heater resistor in serial relationship across said supply terminals to enable the current paths formed between said signal wire and said heater resistor upon the attainment of conducting status of said layer to complete parallel circuits about two legs of said impedance bridge effective to reduce the magnitude of energization of said operating coil to allow said contacts to return to said open position and effective to prevent operation of said contacts to the closed position upon the operation of said switch during said conducting status of said layer.

GEORGE C. CROWLEY.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
603,594	Cutler	May 3, 1898
862,740	Kallman	Aug. 6, 1907
1,325,048	Simon	Dec. 16, 1919
1,934,531	Guettler	Nov. 17, 1933
2,123,063	Peters	July 5, 1938
2,334,530	Andrews	Nov. 16, 1943
2,413,125	Walbridge	Dec. 24, 1946
2,448,470	Rypinski	Aug. 31, 1948
2,470,633	Mershon	May 17, 1949
2,565,478	Crowley	Aug. 28, 1951
2,581,212	Spooner et al.	Jan. 1, 1952
2,588,926	Holmes	Mar. 11, 1952

FOREIGN PATENTS

Number	Country	Date
338,880	Great Britain	Nov. 18, 1930