



## UNITED STATES PATENT OFFICE

2,487,675

## ALARM CIRCUITS

Victor S. Rutherford, East Cleveland, Ohio, assignor to Bailey Meter Company, a corporation of Delaware

Application July 3, 1947, Serial No. 758,760

8 Claims. (Cl. 177-311)

1

2

This invention relates to alarm circuits, and more particularly to circuits which are sensitive to a variable condition and operate when the condition exceeds a predetermined value for giving an alarm.

It is sometimes desirable that there be provided a circuit which is responsive to a variable condition, such as temperature, and operates when the condition goes either above or below a predetermined value to give an alarm. Such a circuit may include, when responsive to temperature, a device subjected to the temperature and operating to affect the balance of a balanceable network which is desirably energized from a source of alternating current. Output terminals of the network may be connected to the grid circuit of a tube having its plate circuit energized from the source of alternating current used for the network. When the network is unbalanced in one direction, its output voltage is in phase with the voltage applied to the plate circuit, and current flows in the latter. An unbalance in the opposite direction results in an output voltage which is 180° out of phase with the voltage of the plate circuit, and current flow in the latter is cut off. A relay may be connected in the plate circuit and operate to control the flow of current in a circuit including an alarm, such as a light or bell. The relay is desirably arranged so that it opens the alarm circuit when current flows in the plate circuit of the tube, and operates to close the alarm circuit when the current flow in the plate circuit is cut off. With such an arrangement, the alarm circuit is closed with failure of the power supply as well as with a change in the condition to a value at which the output of the balanceable circuit is out of phase with the plate voltage of the tube. Adjustable means may be provided for varying the point at which the temperature responsive device effects a change in the unbalance of the network from one direction to the other, and means may also be provided for reversing the connections of the plate circuit to the source of power so as to reverse its phase with respect to the output of the balanceable network, thus varying the direction of change required of the condition to bring it to the point at which the alarm is given.

An object of my invention is to provide an improved alarm circuit. Another object is to provide an improved circuit responsive to a variable condition and operating when the condition reaches a predetermined value to give an alarm. Still another object is to provide an improved circuit including a balanceable network, and

means controlled by said network and operating on unbalance of the latter in one direction for giving an alarm. Yet another object is to provide in an improved circuit, an electron discharge device and a balanceable network energized from a common source of alternating current and connected together so that the unbalance of the network regulates the flow of current through the electron device, a means responsive to a condition and controlling the unbalance of the network, and an alarm circuit controlled by the current flow through the electron discharge device. Other objects will appear in the course of the following description.

In the accompanying drawing there is shown for purposes of illustration, one form which my invention may assume in practice; the single figure being a schematic diagram of my improved circuit adapted to give an alarm when the temperature of the furnace reaches a predetermined value.

As shown in the drawing, my improved circuit, generally designated 1, is responsive to the temperature within a furnace 2, and operates at a predetermined temperature to give an alarm, as by completing a circuit including a lamp or a bell 3. The circuit 1, as shown, comprises a bridge 5 having impedance windings 6 and 7 of reactor converters A and B forming one pair of its legs, and fixed resistances 8 and 9 forming the other pair of legs. Input windings 11 and 12 of the converters are connected in series in a circuit including a thermocouple 14 and a potentiometer 15. The thermocouple is subjected to the temperature produced in the furnace by the burning of fuel supplied through a conduit 16, and the potentiometer is subjected to a constant D. C. voltage, as by a battery 17 or a regulated D. C. supply. One terminal of the thermocouple is connected by a conductor 18 to one end of the input winding 12, while the other terminal of the thermocouple is connected by conductors 20, 21, a variable portion of the potentiometer, an adjustable potentiometer contact 22, and a conductor 23 to one end of the input winding 11. The connection between the thermocouple and the potentiometer is such that the voltage drop across the portion of the potentiometer included in the circuit with the input windings opposes the voltage of the thermocouple in determining the flow of current through the circuit. Bias windings 25 and 26 of the reactor converters are connected in series across the battery 17 in such a way that one opposes one of the input windings while the other aids the other input winding in determining

3

the reactance of the impedance windings 6 and 7.

The diagonally opposite points of the bridge between the pairs of legs are connected by conductors 28 and 29 to the secondary winding of a transformer 30 which has its primary winding connected by conductors 31 and 32 to a source of alternating current. The diagonally opposite points between the legs of each pair are connected by conductors 34 and 35 to the grid 36 and the cathode 37 of a tube 38. As disclosed more fully in an application by A. J. Hornfeck, Serial Number 453,486, filed August 3, 1942, the reactor converters operate in the bridge circuit to change a low level direct current signal of given polarity to a greatly amplified alternating current signal of given phase, and to reverse the phase of the alternating current signal 180° when the polarity of the direct current signal is reversed. The amplified A.-C. signal is applied by the conductors 34, 35 to the tube to establish a voltage difference between the grid 36 and the cathode 37. The cathode and an anode 39 of the tube are connected by conductors 40 and 41 to a reversing switch 42 which is adapted to connect them in one direction or another to the conductors 31, 32 leading to the source of A.-C. Connected in the circuit in series with the anode is a winding 44 of a relay having its armature 45 connected to a contact arm 46 pivotally supported at 47 and adapted to engage a contact 48 or a contact 49. A spring 50 tends to hold the contact arm in engagement with the contact 49, and the relay operates when energized to move the contact arm into engagement with the contact 48. A conductor 52 connects the contact 49 to one terminal of the bell 3, and a conductor 54 connects the other terminal of the bell through a battery 55 to the contact arm.

When the bridge output voltage applied to the grid of the tube is in phase with the anode or plate voltage applied by the power source to the tube through the conductors 40, 41, current will flow through the plate circuit including the winding 44 of the relay, and the contact arm 46 will be moved by the relay into engagement with the contact 48. As soon as the bridge output becomes out of phase with the plate voltage, the flow of current through the plate circuit is cut off, and the contact arm is moved by the spring 50 into engagement with the contact 49, completing the circuit through the bell to give an alarm. The point at which the output of the bridge changes from one phase to the other is determined by the adjustment of the potentiometer contact 22. As long as the voltage drop across the portion of the potentiometer connected in series with the thermocouple exceeds the voltage of the latter, the bridge is unbalanced in one direction, but as soon as the thermocouple voltage exceeds the voltage drop across this portion of the potentiometer, the bridge is unbalanced in the opposite direction.

If it is desired that the alarm be sounded when the furnace temperature goes above the value at which the direction of bridge unbalance changes, then the reversing switch 42 is moved to the position at which the plate voltage is in phase with the output of the bridge when the temperature is low. An increase in the temperature to a value at which the output of the bridge reverses in phase results in a grid voltage which is out of phase with the plate voltage. The flow of current in the plate circuit is then cut off and the contact arm 46 is moved by the spring to complete the alarm circuit.

To cause the alarm circuit to be completed

4

when the temperature drops below a predetermined value, it is only necessary to position the reversing switch 42 so that the plate voltage is in phase with the grid voltage when the temperature is above the predetermined value. It will be appreciated that the controls for the contact arm 46 as described will operate on failure in the power supply or of any part of the system to complete the alarm circuit.

While there is described in this application one form which my invention may assume in practice, it will be understood that it may be modified and embodied in various other forms without departing from the spirit or the scope of the appended claims.

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

1. A system for giving an alarm upon changes in a condition in one direction beyond a predetermined value comprising, in combination, a balanceable network, means for energizing said network from a source of alternating current, said network operating to produce an alternating current output voltage of one phase on unbalance in one direction and of opposite phase on unbalance in the opposite direction, means sensitive to the condition and operating to unbalance said network in one direction or the other as the condition goes above or below the predetermined value, an electron discharge device having an anode, a cathode and a grid, means for energizing said grid by the output of said network, a circuit for energizing said anode from said source of A.-C., an alarm circuit having a contactor movable to open and closed positions, means for urging said contactor to one of said positions, and a relay having a winding connected in said first mentioned circuit and an armature connected to said contactor, said armature operating when said winding is energized to move said contactor to the other of said positions.

2. The system of claim 1 in which a reversible switch is connected in said anode circuit for reversing the connections of the latter to said source of A.-C., the position of said reversing switch determining the direction of unbalance necessary to give an alarm.

3. A system for giving an alarm upon changes in a temperature in one direction beyond a predetermined value comprising, in combination, a Wheatstone bridge having a pair of balanced impedance arms, a second pair of arms each comprising an impedance winding of a saturable core reactor, each saturable core reactor having a bias winding and an input winding, a thermocouple-potentiometer system having a thermocouple subjected to the temperature and a slide-wire subjected to the voltage of a battery, means for connecting the output of said thermocouple-potentiometer system to said input windings, means to fixedly energize said bias winding, means for energizing one conjugate of said bridge from a source of alternating current, a thermionic tube having a grid circuit and a plate circuit, means for connecting the other mentioned bridge conjugate to said grid circuit, means for connecting said plate circuit to said source of A.-C., said last mentioned means including a winding of a relay, an alarm circuit including an alarm device, a battery, and a contactor adapted to be moved to open or closed positions, and means for connecting an armature of said relay to said contactor for positioning the latter.

4. A system for giving an alarm upon a change in a variable in one direction beyond a predeter-

5

mined value comprising, in combination, means responsive to the variable for establishing an alternating current potential of a phase varying relative to the phase of a source of A.-C. in accordance with the direction in change of the variable from said predetermined value, a thermionic tube having a grid directly energized from said A.-C. potential and a plate energized from said source, a relay having a winding connected for energization with said plate, an alarm circuit, and means connected to said relay for controlling said alarm circuit.

5. A system for giving an alarm upon a change in a variable beyond a predetermined value comprising, in combination, means responsive to the variable for establishing an alternating current potential of a phase varying relative to the phase of a source of alternating current in accordance with the direction in change of the variable from said predetermined value, a thermionic tube having a grid and a plate, means for energizing said grid directly from said A.-C. potential, a circuit for connecting said plate to said source of A.-C., an alarm circuit having a contactor adapted to be moved to open and closed positions, and a relay having a winding included in said plate connecting circuit and an armature connected to said contactor.

6. The system of claim 5 in which said plate connecting circuit includes a switch adapted to be positioned manually for reversing the connection of said plate to the source of A.-C., and said relay operates when energized to move said contactor to its open position.

7. A system for giving an alarm upon changes in a condition in one direction beyond a prede-

6

termined value comprising, in combination, a Wheatstone bridge having a pair of balanced impedance arms, a second pair of arms each comprising an impedance winding of a saturable core reactor, each saturable core reactor having a bias winding and an input winding, a circuit including a device responsive to said condition and operating to energize said input windings, means for fixedly energizing said bias windings, means for connecting said bridge at points between said pairs of arms to a source of alternating current, a thermionic tube having a grid circuit and a plate circuit, means for connecting said grid circuit to said bridge at points between the arms of said pairs, means for connecting said plate circuit to said source of A.-C., said last mentioned means including a winding of a relay, an alarm circuit having a contactor adapted to be moved to open and closed positions, and means for connecting an armature of said relay to said contactor for positioning the latter.

8. The system of claim 7 in which said means for connecting said plate circuit to said source of A.-C. includes a switch adapted to be positioned manually for reversing the connection of said plate to the A.-C. source.

VICTOR S. RUTHERFORD.

#### REFERENCES CITED

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

#### UNITED STATES PATENTS

| Number    | Name  | Date          |
|-----------|-------|---------------|
| 2,429,466 | Jones | Oct. 21, 1947 |