

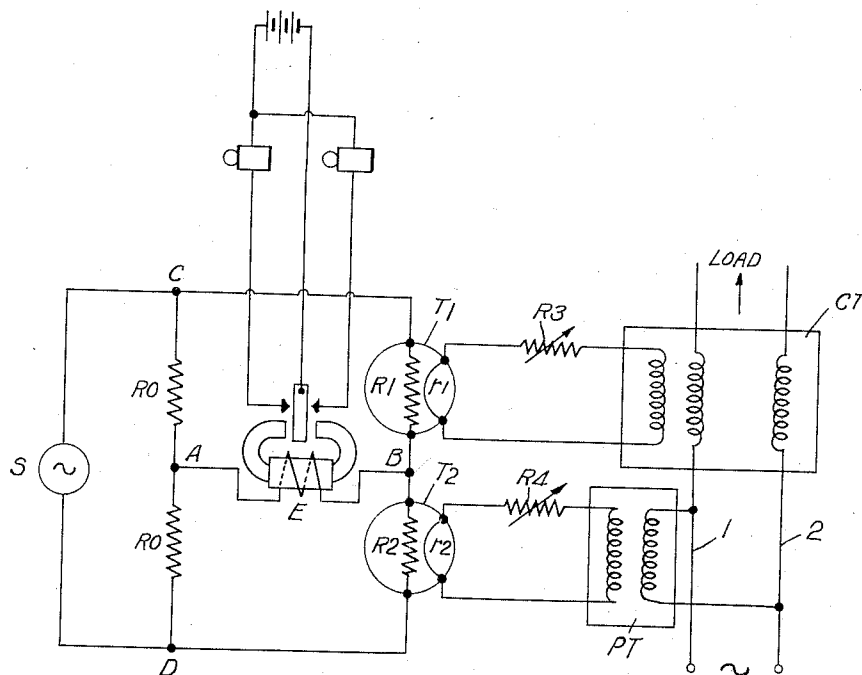
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SUPERVISION OF ELECTRIC POWER SUPPLY CIRCUITS

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SUPERVISION OF ELECTRIC POWER
SUPPLY CIRCUITS

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The present invention relates to circuit arrangements for detecting changes in the load on electric power supply circuits, and in particular to circuits employing thermally sensitive resistance devices known as thermistors.

Thermistors have been in use for some years and are characterised by a temperature coefficient of resistance which may be either positive or negative and which is moreover many times the corresponding coefficient for a pure metal such as copper. This property renders thermistors particularly suitable for a variety of special applications in electric circuits.

Various different materials are available for the resistance element of a thermistor, these various materials having different properties in other respects; as one example, a resistance material having a high negative temperature coefficient of resistance comprises a mixture of manganese oxide and nickel oxide, with or without the addition of certain other metallic oxides, the mixture being suitably heat treated.

Thermistors have been employed in two different forms: (a) known as a directly heated thermistor and comprising a resistance element of the thermally sensitive resistance material provided with suitable lead-out conductors or terminals, and (b) known as an indirectly heated thermistor comprising the element (a) provided in addition with a heating coil electrically insulated from the element. A directly heated thermistor is primarily intended to be controlled by the current which flows through it and which varies the temperature and also the resistance accordingly. Such a thermistor will also be affected by the temperature of its surroundings and may therefore be used for thermostatic control and like purposes with or without direct heating by the current flowing through it. An indirectly heated thermistor is chiefly designed to be heated by a controlling current which flows through the heating coil and which will usually, but not necessarily, be different from the current which flows through the resistance element, but this type of thermistor may also be subjected to either or both of the types of control applicable to a directly heated thermistor.

More detailed information on the properties of thermistors will be found in an article by G. L. Pearson in the Bell Laboratories' Record, December 1940, page 106.

In electric power supply systems it is of considerable importance to be able to detect with the minimum of delay abnormal changes in the load which may be due to incipient fault conditions and the like so that a complete power failure may be prevented. It may thus be necessary to be able to detect rather small changes in load, and this has in the past presented some difficulty due to the necessity for close marginal

limits for the operation of relays, or to other like requirements.

The properties of thermistors render them particularly suitable in cases of this sort because they enable small current changes to be augmented without a complicated arrangement so that relays without very critical adjustments may be used.

According to the present invention, therefore, there is provided a circuit arrangement for detecting changes in the load on a power supply system comprising a pair of similar indirectly heated thermistors whose resistance elements occupy adjacent arms of a Wheatstone bridge network the heating coils of the thermistors being supplied with currents proportional to the current in the load, and to the voltage of the power supply, respectively.

The invention will be better understood by reference to the following detailed description of an embodiment which is illustrated in the figure on the accompanying drawing.

The figure shows a schematic circuit diagram of an arrangement according to the invention for detecting abnormal changes in the load on a single phase alternating current system. The power wires of the system are indicated by 1 and 2, and a current transformer CT is connected with its two primary windings in series with these wires. A potential transformer has its primary winding bridged across them. The secondary windings are connected respectively to the heating coils r_1 and r_2 of two similar thermistors T_1 and T_2 , preferably having a negative temperature coefficient of resistance.

It will be noted that r_1 is supplied with current proportional to the current in the load, and that r_2 is supplied with current proportional to the voltage of the power supply. The resistance elements R_1 and R_2 of the thermistors are connected in adjacent arms of a Wheatstone bridge circuit, the two other adjacent arms being occupied by a pair of equal constant resistances R_3 and R_4 . A relay E is connected to one pair of diagonal points A, B and a local source S of electromotive force is connected to the other pair of diagonal points C, D. Adjustable constant resistances R_3 and R_4 are connected respectively in series with the heaters r_1 and r_2 . The source S may be any convenient alternating current or direct current supply.

The resistances R_3 and R_4 are first adjusted so that under normal conditions of load on the power circuit, the resistances R_1 and R_2 of the thermistor elements are equal to some suitable resistance R. The bridge will thus be balanced and no current will flow through the relay E. The thermistors will also be heated by currents from the source S and the value of R ultimately reached will depend on these currents. If the power load should in-

crease, the heating current for thermistor T_1 will increase and its resistance will decrease. This will unbalance the bridge, and the current through R_1 will increase. This will have the effect of further raising the temperature of T_1 and further decreasing its resistance until a limit set by the other resistances in the circuit is reached. The effect of a change in the current through the heater of T_1 is thus amplified on account of the current which flows through the element R_1 . There will of course, also be some increase in the current through R_2 which will reduce its value, and this will reduce the sensitivity of the arrangement; but if the resistance of the relay E be made rather small compared with R the reduction of R_2 will be rendered less important, since most of the increased current will flow through E .

When there is an increase of load, the power supply voltage upon which the heating of T_2 depends will if anything decrease slightly. This will produce if anything an increase of the resistance R_2 , which is in the direction to augment still further the unbalance of the bridge, and increase the sensitivity.

It will be evident that a decrease in the load will produce the opposite effect, and the unbalance current through the relay E will be reversed in direction.

Since the arrangement is symmetrical, no effect will be produced by a change in voltage of the power supply source since the currents flowing through r_1 and r_2 will be both changed by the same amount and will thus remain equal. Both the resistances R_1 and R_2 will therefore be changed by the same amount and the bridge will remain balanced.

The relay E can, for example, be a neutral relay designed to operate when the load changes either way by some predetermined amount, say 10%, and could be arranged to operate an alarm or carry out any desired switching operation. Alternatively, it could be a polarised relay arranged to operate separate contacts connected to different alarms according as the change in the load is an increase or a decrease.

The thermistors T_1 and T_2 could also have a positive instead of a negative temperature coefficient of resistance, but the arrangement would be less sensitive since the heating effect of the current through the resistance element would in this case oppose the change produced by the heating coil instead of assisting it.

Although the circuit of the accompanying figure is shown applied to a single phase power system, it is also applicable to a three phase system, the only modification necessary being to provide each of the transformers CT and PT with three primary windings. In the case of CT these windings could be connected in series with the three wires respectively, and in the case of PT they could be connected in star formation between the three coils and the neutral conductor or in delta formation across the three wires, in the well known way. Moreover, in a three phase system the arrangement could clearly be used to detect changes in the load of any of the phases separately: in this case the transformer CT would have one primary winding connected in series with the corresponding wire, and the transformer PT would have the primary winding connected between the corresponding wire and the neutral conductor.

Various modifications of the arrangement which has been described to illustrate the inven-

tion are possible for adapting the circuit to particular cases.

What is claimed is:

1. A circuit arrangement for detecting changes in the load of a power supply circuit comprising a Wheatstone bridge network having adjacent arms, each of which includes in series therewith the resistance element of an indirectly heated thermistor, constant resistance elements connected in series with other adjacent arms of the bridge, a relay connected to a pair of diagonal points intermediate of the thermistors and the constant resistances and a potential source connected to conjugate diagonal points as related to the relay connection, a load circuit, a heating coil of one of the thermistors being connected to be energized proportional to the load current, a heating coil of the other of the thermistors having connections arranged to be energized by the voltage of the load circuit, and indicating circuit means controlled by a movable contact of said relay.

2. A circuit arrangement for detecting changes in the load of a power supply circuit comprising a Wheatstone bridge network having adjacent arms, each of which includes in series therewith the resistance element of an indirectly heated thermistor, constant resistance elements connected in series with other adjacent arms of the bridge, a relay connected to a pair of diagonal points intermediate of the thermistor and the constant resistances and a potential source connected to conjugate diagonal points as related to the relay connection, a load circuit, a heating coil of one of the thermistors being connected in the secondary circuit of a transformer having its primary in series with the load circuit, a heating coil of the other of the thermistors being connected in a secondary circuit of a transformer having its primary connected across the load circuit and indicating circuit means controlled by a movable contact of the relay.

3. A circuit arrangement for detecting changes in the load of a power supply circuit comprising a Wheatstone bridge network having adjacent arms, each of which includes in series therewith the resistance element of an indirectly heated thermistor, constant resistance elements connected in series with other adjacent arms of the bridge, a relay connected to a pair of diagonal points intermediate of the thermistor and the constant resistances and a potential source connected to conjugate diagonal points as related to the relay connection, a load circuit, a heating coil of one of the thermistors being connected in the secondary circuit of a transformer and including in series therewith an adjustable resistance, the primary of said transformer being in series with the load, a heating coil of the other of the thermistors being connected in the secondary of a second transformer and including an adjustable resistance in series therewith, the primary of said second transformer being connected across the load and indicating circuit means controlled by a movable contact of the relay.

4. A circuit arrangement as claimed in claim 1 wherein the relay is a polarized relay and the circuit means includes oppositely positioned contacts of said relay and includes an alarm device in series with each of said contacts.

5. A circuit arrangement as claimed in claim 1 wherein both of the thermistors have a negative temperature coefficient of resistance.

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