

219/121

Nov. 25, 1924.

CROSS REFERENCE

SEARCH ROOM

1,516,646

P. N. ROSEBY

ELECTRIC RESISTANCE MATERIAL AND PROCESS FOR MANUFACTURING THE SAME

Filed July 25, 1921

4 Sheets-Sheet 1

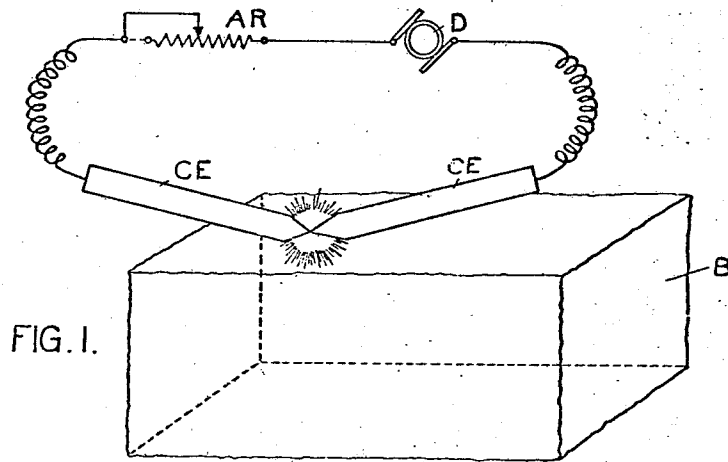


FIG. 1.

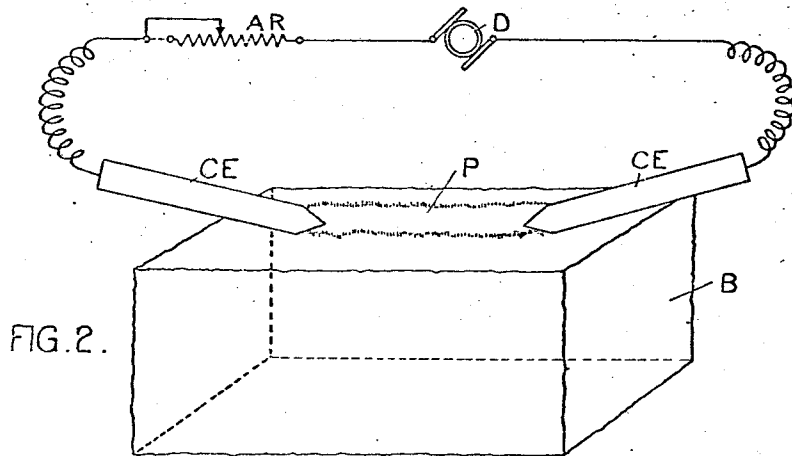


FIG. 2.

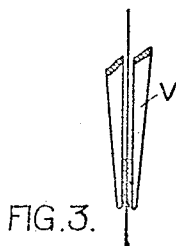


FIG. 3.

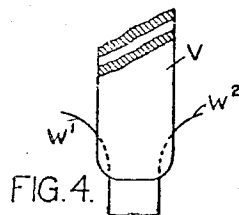


FIG. 4.



FIG. 5.

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4 Sheets-Sheet 2

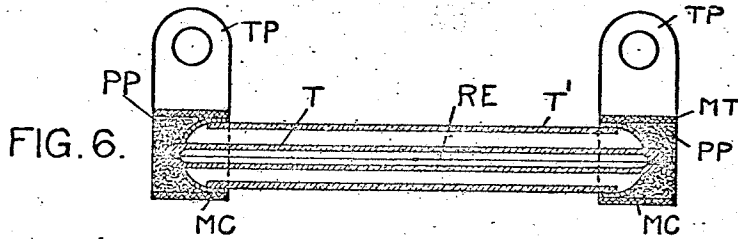
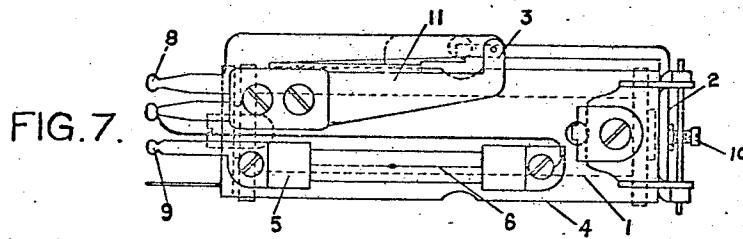
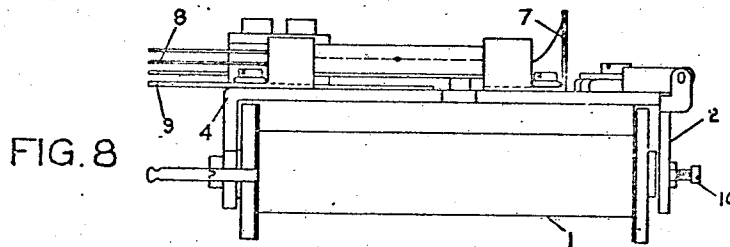
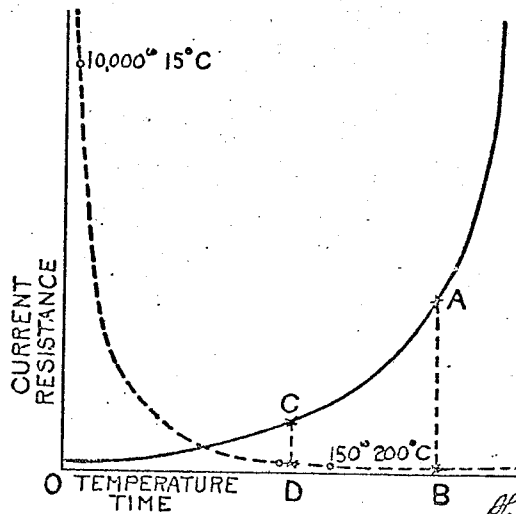


FIG. 9.



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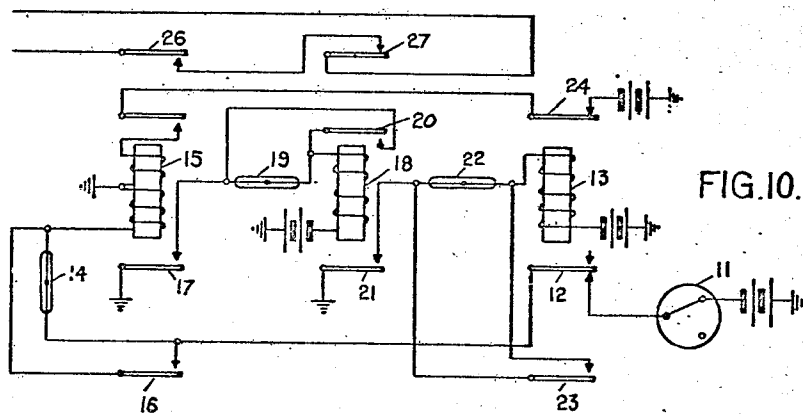
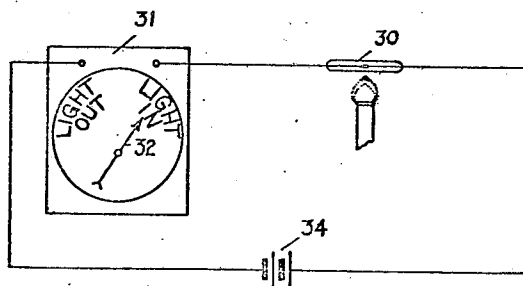
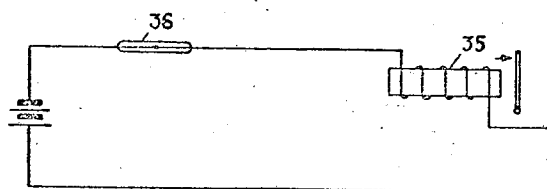
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ELECTRIC RESISTANCE MATERIAL AND PROCESS FOR MANUFACTURING THE SAME

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4 Sheets-Sheet 3



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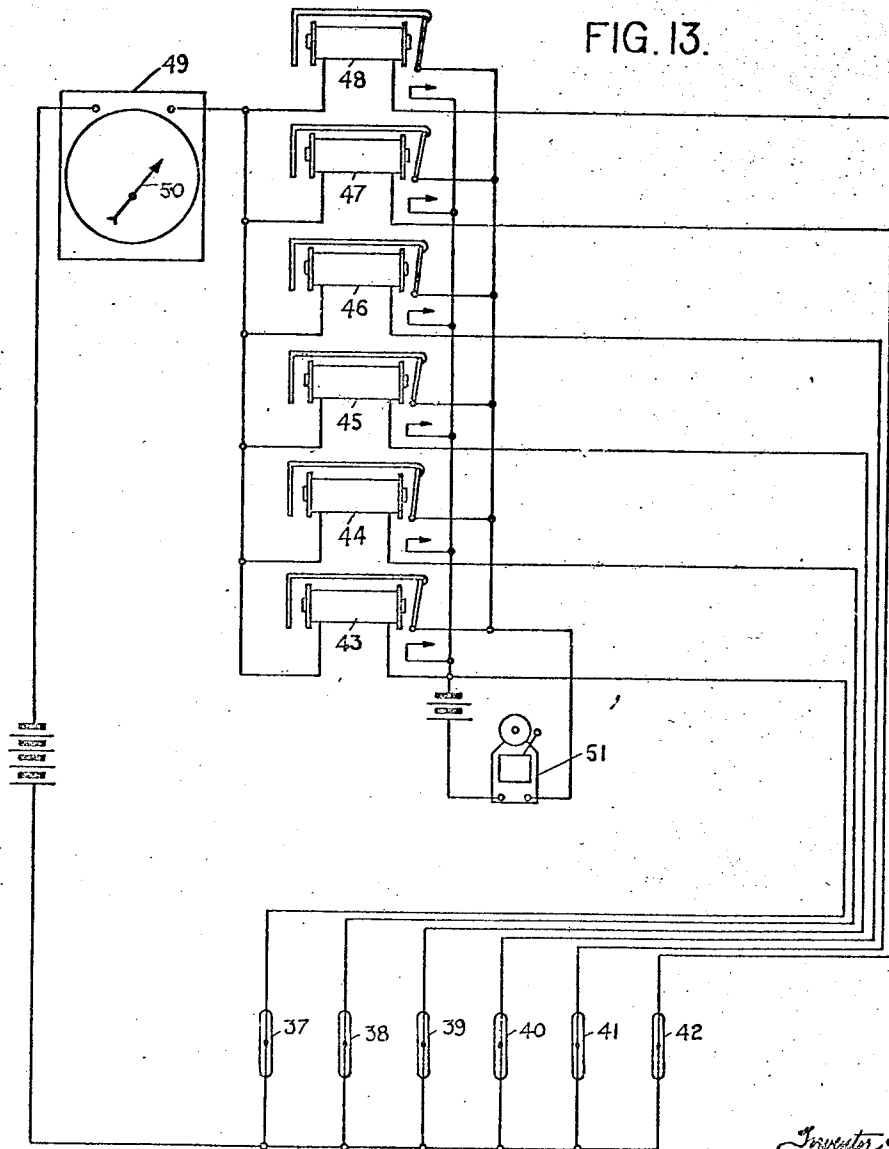
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ELECTRIC RESISTANCE MATERIAL AND PROCESS FOR MANUFACTURING THE SAME

Filed July 25, 1921

4 Sheets-Sheet 4



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UNITED STATES PATENT OFFICE.

PHILIP NORTON ROSEBY, OF LIVERPOOL, ENGLAND, ASSIGNOR TO AUTOMATIC TELEPHONE MANUFACTURING COMPANY LIMITED, OF LIVERPOOL, ENGLAND.

ELECTRIC RESISTANCE MATERIAL AND PROCESS FOR MANUFACTURING THE SAME.

Application filed July 25, 1921. Serial No. 487,258.

To all whom it may concern:

Be it known that PHILIP NORTON ROSEBY, residing at 7 Isabel Grove, Tue Brook, Liverpool, England, has invented certain
 5 new and useful Improvements in Electric Resistance Materials and Processes for Manufacturing the Same, of which the following is a specification.

The present invention relates to an electrical resistance material, a process of
 10 manufacturing the same, an electrical resistance element constructed of said material and the application of the resistance element to various industrial arts where the
 15 peculiar properties of the material can be used to advantage.

By striking an arc over a mass of black copper oxide, a fused mass of material was obtained which on being tested was found
 20 to possess the property of being of very high electrical resistance when cold, which resistance fell to a remarkable degree as the temperature was increased.

The principal features of the invention
 25 therefore consist in the process of obtaining a resistance material by fusing black copper oxide, preferably by striking an arc across its surface, the material so obtained which presumably consists of a combination or mixture of the two oxides of copper
 30 in a fused condition, an electrical resistance element comprising two metallic or conducting electrodes connected by a mass of the material and the application of the electrical resistance element to industrial arts
 35 generally where its peculiar properties may be used to advantage.

In order that the invention may be better understood reference should be had to the
 40 accompanying drawings in which Figures 1 and 2 illustrate diagrammatically, a new process by which the electric resistance material may be obtained. Figures 3, 4, and 5
 45 illustrate different steps in the construction, of a resistance element consisting of a globule of fused material connecting two platinum wires. Figure 6 illustrates the resistance element in the completed form. Figures 7 and 8 illustrate in plan and elevation, an electrical relay which is made
 50 slow to act by placing in series with it an element as shown in Figure 6. Figure 9 illustrates the properties of the resistance element. Figure 10 illustrates the applica-

tion of the invention to cause the successive
 55 operation of devices at definite times. Figure 11 shows the application of a resistance element as a lamp indicator. Figure 12 shows the application of the invention arranged as a compensator for variations of
 60 temperature. Figure 13 shows the application of the invention to a fire alarm system.

In order to obtain the resistance material, it is necessary to procure a supply of powdered copper oxide or preferably, copper
 65 carbonate which is usually more easily obtainable. The copper carbonate is heated to a red heat so as to obtain copper oxide in a powdered form, which on cooling is mixed
 70 with water and squeezed under pressure and baked, so as to obtain a brick, such a brick being illustrated by the reference letter B in Figures 1 and 2.

It is desirable that all impurities should
 75 be kept out of the way, and that at most, only cupric or cuprous oxides should be present. The fused material is then obtained by connecting two copper electrodes
 80 CE (other materials have been tried but have not been found satisfactory) which are connected in series with a source of electricity preferably direct current represented
 85 by the dynamo D and in series with an adjustable resistance AR. It is important that the dynamo should give a comparatively high voltage, for instance, 230 volts has
 90 been found suitable. The copper electrodes CE are brought into contact and slightly separated in the usual manner of forming
 95 an arc: one of the electrodes may be firmly embedded in the block of oxide B while the other electrode is also brought into contact with the surface of the oxide and gradually
 100 drawn apart from the other electrode. The effect of the arc is to heat up the oxide in the vicinity, and thereby bring it to a molten state, in which condition its resistance
 105 is very considerably reduced. The electrodes are then gradually separated, with the result that more oxide is heated and eventually the arc is extinguished, the current path being extended between the
 110 two electrodes through a path formed on the surface of the copper oxide. This path is illustrated at P in Figure 2 and is usually of a bright red heat. The copper oxide in
 115 this path is all molten and may be removed

as required and fresh oxide replaced or added in order to maintain the supply, and if desirable, to increase the size of the molten path.

5 The object of using a brick of copper oxide is that molten copper oxide will attack silica and most fire clays of which the usual form of crucible is made, though of course the fused oxide could be obtained for instance, by heating in a platinum crucible, but the process described, striking an arc on the surface of a block of copper oxide is preferred, as it lends itself readily to methods of manufacturing, and particularly in the production of the resistance element which will now be described.

In order to obtain a resistance element which can be readily incorporated in electrical circuits, the following process may be conveniently employed provided that the current consumption is not excessive. Two lengths of platinum wire which may be of very fine gauge are taken, and a loop formed on one of the wires W' as shown at L' in Figure 5. Through this loop L' a second wire W^2 is threaded and a loop L^2 also formed so that the loops L' and L^2 of the wires W' and W^2 respectively interlink. These wires are then bent as shown in Figure 4 and supported in a vise or pair of pincers V as shown in Figures 3 and 4, so that the loop L' and loop L^2 are supported centrally with respect to each other without either wire touching. The wires may then be dipped into the molten path P and a globule of fused material collected at the interlinked loops which when removed from the path, sets solid in intimate contact with both wires.

40 In order to protect the electrical element thus formed, it is desirable that it should be enclosed in order to protect it from either a reducing gas or from excessively high temperatures which would tend to reduce the fused materials to copper.

One construction by which the resistance element may be mounted for commercial use is shown in Figure 6 in which the resistance element RE is shown enclosed within a narrow tube T through the ends of which the platinum wires project, and each end is sealed up with a compound such as plaster of Paris PP . For greater security, a second outer tube T' is provided fitted with a metal cap MC at each end, through which the inner tube T projects.

The metal caps are surrounded by a metal tube MT formed in one piece with a terminal plate TP , by means of which the resistance element may be connected to an external circuit, the ends of the platinum wire being soldered or otherwise secured to the metal tube MT .

Before proceeding any further with the application of the invention, it will be as

well to point out how it is possible to alter the resistance or to obtain various resistances of heating element, and also certain of the properties of the fused material which must be taken into consideration if satisfactory results are to be obtained in practice.

As stated before, it is believed that the fused material consists of a combination or mixture of the two oxides of copper in various proportions, and bearing in mind that the cuprous oxide is of very much lower resistance than the cupric oxide, it would appear to follow, that the more cuprous oxide is present, the lower the resistance of the material, while the more cupric oxide was present, the higher the resistance of the material.

Now it is found that in the molten path P in Figure 2, if direct current is used, the resistance material has a much higher resistance as it approaches the positive electrode, and a much lower resistance as it approaches the negative electrode, so that by obtaining the material nearer the vicinity of one electrode than that of the other, the resistance of the material may be varied as desired. It should be mentioned that by increasing the current the variations of resistance may be considerably increased. It is believed that this is due to an electrolytic effect in the molten path causing the copper to concentrate at the positive pole and oxygen to accumulate at the negative pole.

In order to adjust the resistance of a completed element, all that is necessary is to heat it to the requisite degree in air or an atmosphere of oxygen when oxygen will be absorbed and the resistance increased accordingly. On the other hand, if it is required to reduce the resistance, the heating should take place in an atmosphere of hydrogen or other reducing gas; it will thus be appreciated that by this means, one is able to compensate for the variations which must inevitably occur in the resistance element formed according to the above mentioned process. If the element is liable to be subjected to fairly high temperatures, as it is in certain of its applications about to be described, it will be found that its resistance will alter in accordance with the nature of the atmosphere in which it is placed, and for that reason, it is important that it should be enclosed. A convenient way of doing this, is depicted in the construction shown in Figure 6, the heating element after having been placed in position could be heated, thereby absorbing all oxygen present in the enclosed air when its resistance will remain steady whatever other variations of temperature may take place.

It should be mentioned, that for all normal temperatures, the fused material is perfectly stable and it is only in extreme cases

that such precautions are necessary. Variations of 200° C., have no appreciable effect.

In Figure 9 two curves are shown illustrating the property of the resistance element. The dotted curve shows the relation between resistance and temperature from which it will be noted that the resistance falls from 10,000 ohms at normal temperatures to approximately 150 ohms at 200° C.

It will thus be appreciated that whereas at normal temperatures, it may be considered approximately as an insulator, at 200° C. it would permit the passage of sufficient current to operate a relay or like device, thereby possessing in itself the properties of a thermal relay.

A simple application of the invention is shown by way of example in Figures 7 and 8, which consists of placing a resistance element in series with a relay in order to render it slow to act. Figure 7 shows the plan view of a relay of well known construction, while Figure 8 shows the elevation. The exciting coil 1, armature 2, contact springs 3, yoke 4 are all of standard construction, while on the back of the yoke, a tube 5 containing the resistance element 6 is fitted, one end of the resistance wire being connected to one of the terminals of the relay by the flexible wire 7 so that the terminals to which external wires would be connected to the relay are the tags 8 and 9 as will be readily appreciated.

The resistance element must of course be so chosen that the energy it absorbs will be such as to raise its temperature so that its resistance will fall sufficiently to enable the relay to energize. This is of course, simply a matter of the design of the circuit as mentioned, as it is obviously possible to select a voltage which would not heat the element sufficiently to reduce its resistance and enable the relay to energize.

In Figure 9 the curve illustrating the relationship between current and time for a circuit comprising a relay and resistance element in series is shown in full lines, from which it will be appreciated that the time it takes the relay to operate will depend upon the sensitiveness or otherwise of the relay; if the relay is so adjusted as to require a comparatively large operating current as represented by the amount AB, then obviously the time taken for the relay to operate will be represented by the line OB; on the other hand if the relay requires an operating current represented by the line CD, then the time taken for the relay to operate will be represented by the line OD. The relay shown in Figures 7 and 8 is a well known type in which means are provided for adjusting the operating current, for instance, by means of the screw 10 and the adjustment of the springs 11, and consequently, it will be seen by means of

this element, the subject of the invention, it is possible to obtain a relay which will operate in any desired predetermined time.

It will also be appreciated that the time element can be used in places where at present it has been necessary to use a dash pot or other mechanical equivalent arrangement for lengthening the time action of a member, and in Figure 10 an arrangement is shown in which, by means of relays and the resistance element, it is possible to successively close circuits at predetermined intervals of time which may be much greater than it is usually possible, to obtain with simple electrical circuits.

The initial energizing circuit is started by operating the switch 11 to the position shown in full lines, so that a circuit may be traced from battery through the resting contact of armature 12 of relay 13, resistance element 14, lower winding of relay 15 to earth. After a predetermined interval of time, the current through the lower winding of relay 15 increases sufficiently to enable this relay to pull up when a locking circuit is formed through both its upper and lower windings, the armature 16 however, acts in addition to short circuit resistance element 14 to permit it to cool. At its armature 17, relay 15 closes a circuit for the relay 18 in series with the resistance element 19, so that this relay in turn operates after a predetermined time and at its armature 20 short circuits the resistance element 19 while at its armature 21 it completes a circuit for relay 13 in series with the resistance element 22. Relay 13 energizes and at its armature 23 short circuits the resistance element 22, while at its armatures 24 and 25 the locking and energizing circuits of relay 15 are broken. Relay 15 therefore de-energizes and is immediately followed by the de-energization of relay 18 and relay 13. The conditions are then restored to their original condition and relay 15 is again energized as soon as the resistance element 14 has heated sufficiently by the current flowing through. Consequently, it will be appreciated that a circuit completed by the relay 15 at its armature 26 will remain closed for a certain time, and then be opened by armature 27 when relay 18 energizes, then after a pause, dependent upon the length of time required for relay 13 to energize the relays 15, 18 and 13 to de-energize and the relay 15 to again pull up, the circuit would again be completed. By this means, for instance, in a telephone system, a subscriber's bell would be rung successively for one second in every three seconds, followed by a pause of two seconds. Other applications will readily occur to those versed in the art.

In Figure 11, the application of the resistance element for indicating whether a signal lamp is lit or extinguished is illus-

trated diagrammatically. For instance, at a certain range from a lamp, the temperature when the lamp is lit is usually sufficiently high (approximately 200° C.) to cause the resistance element to have a sufficiently low resistance to enable an indicator such as 31 to be energized. The indicator 31 is shown in the form of a galvanometer having a pointer 32 adapted when the lamp is lit, due to the current flowing therethrough from a battery 34, to point to the indication "Light in," so that if the lamp should be extinguished, the resistance of the resistance element would immediately rise and the galvanometer would no longer be deflected to the "Light in" position, but would gradually move over to indicate "Light out." Obviously, a relay could be provided adapted to close a warning circuit or other similar device, but the advantage of a galvanometer is that it enables one to note when a lamp is failing, as in such a case, the current of the galvanometer will not be sufficient to hold the pointer over fully to the "Light in" position and in this way it is possible to replace the lamp before it has actually extinguished.

In Figure 12 an application of the invention for compensation purposes is shown in which the resistance element is placed in series with the winding of a relay. Such windings are usually of copper, and consequently vary considerably with variations of temperature. By suitably selecting a resistance element as regards its resistance at normal temperatures, it will be appreciated that it is possible to compensate for the increase of resistance in the winding of the relay 35 by the corresponding reduction of the resistance of the element 36.

In Figure 13, the application of the invention is described with relation to a fire alarm system, resistance elements such as 37-42 are located in various parts of the building to be protected. One of the terminals of each element are connected together to a central battery, while the other terminals are connected to indicators 43-48 respectively, which in turn are connected together at their other terminals to an galvanometer 49, the other terminal of the galvanometer being connected to the other pole of the battery. The current through the galvanometer 49 will normally be sufficient to hold the needle 50 to the position shown in the drawings, thereby indicating that the circuit is in order, but the current through the resistance elements and through the indicators 43-48 will not be sufficient to cause the respective indicators to operate.

In case however, of the temperature at any part of the building in the vicinity of one of the resistance elements rising beyond a certain predetermined figure, then the corresponding indicator to the resistance element

which has been heated will energize. The indicators shown are of the drop type, so that when the armature falls, a number is shown indicating the position of the spot where the fire has broken out, and at the same time a general warning is given by the closure of the circuit of the bell 51.

It will be understood that these various applications have only been given by way of example, as obviously numerous applications could be made which will readily occur from an appreciation of the properties of the cell.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A process for manufacturing electric resistance material which consists in striking an arc between two copper electrodes in contact with a mass of copper oxide to melt and fuse the same to form the resistance material.

2. A process for manufacturing electric resistance material which consists in striking an arc between two copper electrodes in contact with a mass of copper oxide and gradually separating the electrodes so that the current flows through the copper oxide and renders it molten to thereby produce the resistance material.

3. A process for manufacturing electric resistance material which consists in striking a direct current arc between two copper electrodes and a mass of copper oxide and varying the current passing to thereby produce the resistance material by melting and fusing the copper oxide, the resistance material having a higher or lower resistance according as it is removed at a point nearer the positive or the negative electrode.

4. A process for manufacturing electric resistance material which consists in striking an arc between two copper electrodes in contact with a mass of copper oxide, gradually separating them so that the current flows through and fuses the copper oxide to thereby produce the resistance material and adding copper or powdered copper oxide so as to maintain or increase the molten path.

5. A process for manufacturing and mounting electric resistance material which consists in forming a loop in one platinum wire, threading a second platinum wire through said loop and forming a second loop, securing the two wires so that the intertwined loops are out of contact with each other and dipping said wires while thus secured into molten copper oxide formed by striking an arc between copper electrodes in contact with a mass of copper oxide so as to collect a globule of copper oxide on the loops in intimate contact with both wires.

6. An electric resistance element comprising a mass of fused cupric and cuprous oxide, two conductors connected to said fused mass and maintained out of direct connection with one another and a chamber enclosing the junction of said mass and said conductors.

7. An electric resistance element comprising a mass of fused cupric and cuprous oxide, two conductors connected to said fused mass and maintained out of direct connection with one another and a chamber enclosing the junction of said mass and said conductors and filled with inert gas.

8. An electric resistance element comprising a globule of fused cupric and cuprous oxide, two platinum wires connected to said globule and maintained out of direct connection with one another, a glass tube with sealed ends through which said platinum wires pass, metal caps at the ends of said tube electrically connected with said wires and terminals connected to said caps to allow connection with an external circuit.

9. An electric resistance element comprising a mass of fused cupric and cuprous oxide and two conductors connected to said mass and maintained out of direct connection with one another and means for causing the temperature of said element to be varied.

10. An electric resistance element comprising a mass of fused cupric and cuprous oxide and two conductors connected to said mass and maintained out of direct connection with one another and means for varying the electrical energy expended in the element whereby its temperature is varied.

11. An electrical resistance material consisting of a fused mass of cupric and cuprous oxide.

In testimony whereof I affix my signature in presence of two witnesses.

PHILIP NORTON ROSEBY.

Witnesses:

JAS. C. McRAE,
HENRY J. GREGORY.