

March 30, 1937.

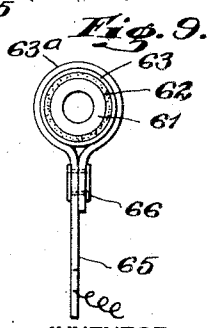
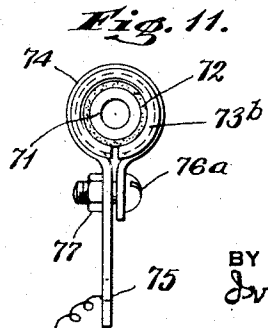
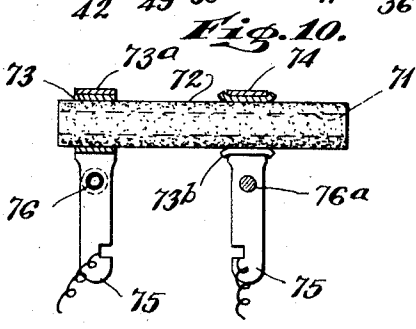
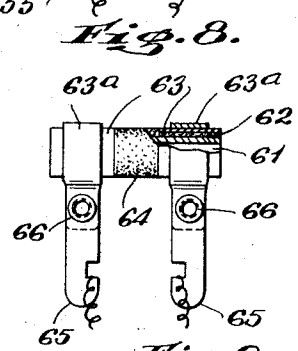
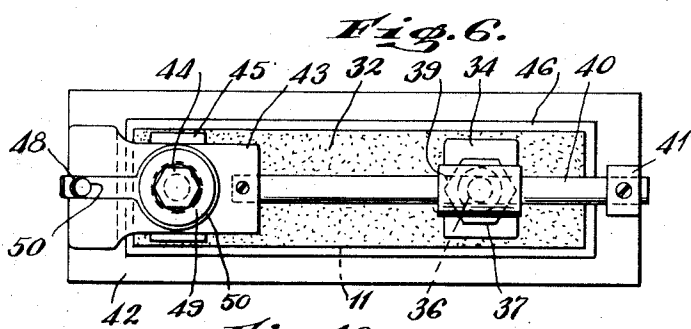
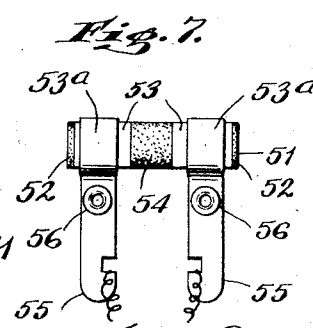
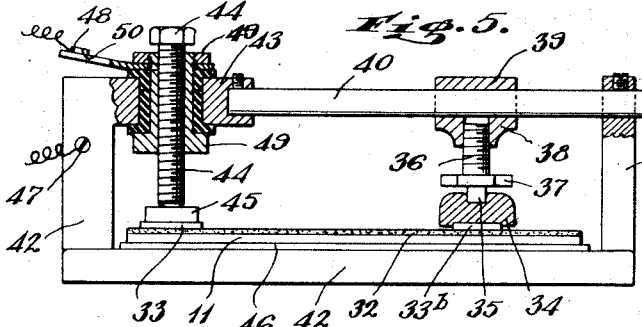
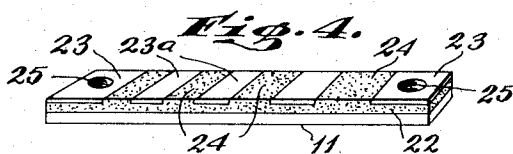
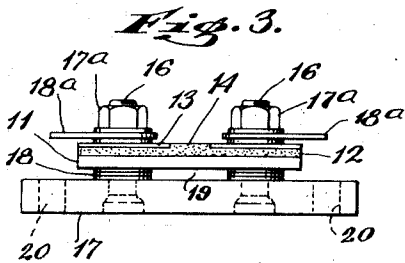
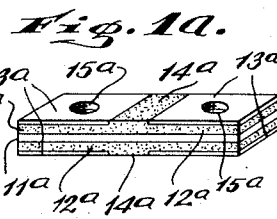
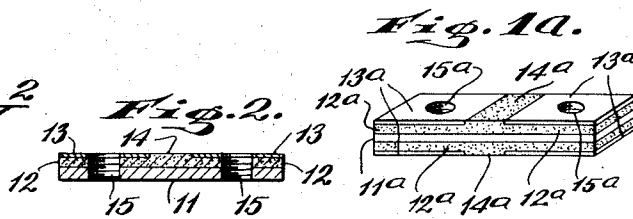
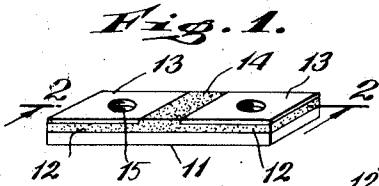
M. LAZARUS

2,075,733

RESISTANCE AND IMPEDANCE ELEMENTS FOR ELECTRIC CIRCUITS

Filed March 11, 1936

2 Sheets-Sheet 1



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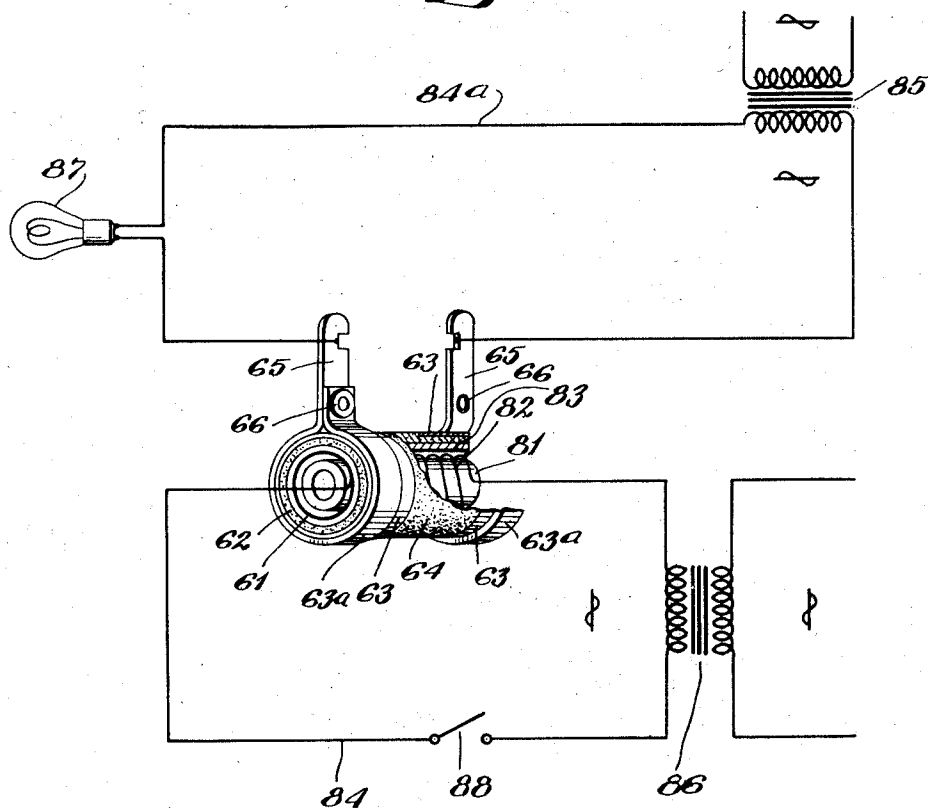
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Fig. 8a.



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RESISTANCE AND IMPEDANCE ELEMENTS
FOR ELECTRIC CIRCUITSMeyer Lazarus, Brooklyn, N. Y., assignor to Co-
prox, Incorporated, Brooklyn, N. Y.

Application March 11, 1936, Serial No. 68,242

6 Claims. (Cl. 201—76)

My invention relates to improvements in thermo-sensitive resistance elements for electric circuits, such as used for fire protection, electric signaling, radio devices, moving pictures, sound circuits and for electric measuring instruments, etc., particularly where a resistance unit is required in which the resistance or impedance shall decrease with a rise in temperature or an increase in the current density; and it consists in the novel features which are hereinafter described.

One of the objects of my invention is to provide an oxide resistance or impedance element with a metal carrier, whereby the said element is rendered self-sustaining and more reliable than as made heretofore.

Another object of my invention is to have the said element of a given size adapted to be made for any one of a very wide range of resistance values.

A further object of my invention is to have the said element adapted for adjustably varying the resistance value thereof in a circuit.

A still other object is to produce a resistance element consisting of two oxide layers, which are hereinafter described, provided with a common metal carrier therebetween.

Another object of my invention is to have my resistance or impedance element noiseless in operation, compact, durable non-inductive, inexpensive and easy to manufacture.

Another object is to have my resistance element capable of quickly cooling to its initial temperature after being subjected to a higher temperature.

A further object of my invention is to produce a single resistance or impedance element for electric circuits which is provided with multiple resistances, whereby either to vary the resistance value of the element or to use the same element for more than one circuit.

A still other object is to have my resistance element either in the form of a plate or in the form of a bar or tube.

A further object is to have my resistance element adapted to be easily mounted and connected into circuits without the assistance of highly skilled labor.

Other objects and advantages will hereinafter appear.

I attain these objects by the resistance or impedance element for electric circuits, several forms of which are illustrated in the accompanying drawings or by any mechanical equivalents or obvious modifications of the same.

In the drawings Fig. 1 is a perspective view of

one form of my resistance or impedance element for electric circuits; Fig. 1A is a perspective view of a subvariation of my resistance element which is shown in Figs. 1 and 2.

Fig. 2 is a longitudinal section on the line 2—2 of Fig. 1; and

Fig. 3 is a side elevation of a complete unit of my improved resistance element which is shown in Figs. 1 and 2.

Fig. 4 is a perspective view of a modification of my resistance or impedance element for electric circuits which is shown as provided with multiple resistance sections.

Fig. 5 is a side elevation, partly in vertical section, of a modification of my invention which comprises an adjustable resistance or impedance unit; and Fig. 6 is a plan view of the same.

Fig. 7 is a side elevation of another form of my invention which comprises a nonadjustable unit of my resistance or impedance element having the form of a rod or bar.

Fig. 8 is a fragmentary view partly in section of another resistance unit which comprises an element which is in the form of a tube, and Fig. 9 is an end elevation of the unit. Fig. 8a is a fragmentary side view of a subvariation of the resistance unit shown in Figs. 8 and 9.

Fig. 10 is a side elevation partly in section of another form of an adjustable unit of my resistance or impedance element; and Fig. 11 is an end view of the same, looking from right to left in Fig. 10.

The thickness of sundry parts of my resistance or impedance element is exaggerated in the drawings for the sake of clearness.

Similar numerals refer to similar parts throughout the several views:

In the form of my resistance or impedance element, which is shown in Figs. 1, 2 and 3, 11 designates a carrier which consists of a rectangular plate of metal, such as copper, iron or nickel, or an alloy of these metals adapted to have a permanent layer of oxide formed thereon when it is heated at a suitable temperature.

The carrier 11 has thereon a layer 12, which is integral therewith and may be formed substantially of an oxide of the metal or alloy of the carrier, such as cuprous oxide, if the carrier 11 is made of copper, or a combination of the said oxide with another oxide or oxides.

The said oxide may also be combined with a salt such as a silicate or a salt of manganese such as MnO_2 , MnO and MnB_4O_7 , whereby to control the coefficient of resistance of the ele-

ment. The carrier 11 extends from end to end of the layer 12.

The layer 12 on the plate 11, is produced by a suitable process, such as oxidizing the metal of the carrier 11 by heating the same in air at a suitable temperature. The layer 12 then becomes nonporous and forms a continuous crystalline coating on said carrier.

The layer 12 is shown as covered in part near the ends thereof by a pair of conductors 13, which may consist of metal films which are integral with the layer 12 and may be formed thereon either by electrolytic reduction or by a suitable process such as quenching the oxidized plate in a reducing agent, such as an alcohol solution or oil. The conductors 13 will then serve as contacting terminals.

The conductors 13 may also consist of electrodes of lead or tin which may be applied to the layer 12 by pressure.

A section 14 of the layer 12 is shown as exposed on the surface of the resistance element 11-14 at the middle part of the latter and forms a resistance area between the said conductors or electrodes 13. The section 14 acts as a shunt resistance.

Part of the electric current passes along the mass of oxide in the layer 12 and the exposed section 14 and parallel to the plane thereof, and part of the current passes transversely thereto from one of the conductors 13 through the adjacent part of the layer 12 to the carrier 11 and from the latter through another part of the layer 12 to the other conductor 13.

The element 11-14 is shown as provided with a pair of apertures 15 for bolts 16, which are shown in Fig. 3 to pass therethrough.

Fig. 1A shows a subvariation of the form of my resistance or impedance element which is shown in Figs. 1, 2 and 3, and in which the carrier 11a has thereon two oxide layers 12a, one on each side thereof. The layers 12a are similar in all respects to the layer 12 of Figs. 1, 2 and 3.

The layers 12a are covered each near the ends thereof by a pair of conductors 13a which are similar to the conductors 13 of Figs. 1, 2 and 3.

A section of each layer 12a is exposed on each surface of the element 11-14a at the middle part of the latter.

The sections 14a are also similar to the section 14 of Figs. 1, 2 and 3; but the sections 14a may have each a different resistance value, if desired.

In the element 11a-14a each of the layers 12a-14a may be used independently of the other in a separate circuit; the layers may also be connected in parallel for larger currents.

In the assembled resistance unit, which is shown in Fig. 3, the base 17 of the unit has mounted thereon the element 11-14; a pair of spacing plates 18 of insulating material, such as fiber or bakelite, are interposed between the base 17 and the element 11-14, leaving therebetween an air space 19.

The bolts 16 are employed for securing the element 11-14 to the base, which is also provided with apertures 20 for passing therethrough screws, to connect the base 17 to any required object, such as a wall, a panel or a box. Nuts 17a are mounted on the bolts 16 and hold a pair of lugs 18a in position. The lugs 18a serve for attaching wires thereto.

In the resistance or impedance element which is shown in Fig. 4, the carrier 11 has thereon a layer 22, which may be integral therewith and

differs from the layer 12 only in that it is covered by a series of conductors 23a to serve as contacting terminals or electrodes which are disposed intermediate the pair of conductors 23 at the ends of the layer 22 which may also serve as contacting terminals or electrodes.

The conductors or electrodes 23 and 23a are similar in substance and character to the conductors or electrodes 13, and may be formed in the same manner.

Sections 24 of the layer 22 are exposed on the surface of the resistance element 11-24 between the said conductors or electrodes 23a and between the conductors 23 and 23a, and form multiple shunt resistance areas between the said conductors or electrodes 23 and 23a, whereby either the resistance value of the element 11-24 may be varied or the same element may be used for more than one circuit.

The first of these results may be obtained by cutting in or cutting out one or more of the said sections 24.

The element 11-24 is shown as provided with a pair of apertures 25 for bolts to pass therethrough, and may be assembled thereby into a resistance unit similar to that shown in Fig. 3.

In the form of my resistance or impedance element, which is shown in Figs. 5 and 6, the carrier 11 has thereon an oxide layer 32 which is integral therewith and extends from end to end thereof.

The layer 32 has thereon a fixed electrode 33 which preferably consists of a plate of soft metal, such as lead or tin, or a layer of graphite which may be applied thereto in any suitable manner.

The layer 32 also has thereon an adjustable electrode 33b which is supported by a holder 34, which has rotatably mounted thereon the head 35 of a screw 36, which also has thereon a member 37 which is adapted to be manually rotated.

The screw 36 is in engagement with an internally threaded hub 38 of a sleeve 39, which is slidably mounted on a rod 40, which is removably supported at one end thereof by a post 41 of a frame 42 and at the other end thereof by an extension 43 of the frame 42.

A screw 44 is in threaded engagement with a flanged plug 49 which is secured to the said extension 43; the screw 44 abuts at the lower end thereof against a pressure plate 45, which is placed therebetween and the electrode 33.

A sheet 46 of insulating material is interposed between the carrier 11 and the frame 42.

A wire connection 47 is provided on the frame 42, and another wire connection 48 is provided on a lug 50 which is connected to the plug 49, which is insulated from the extension 43 of the frame 42.

The shunting resistance of the element 11-32 varies with the distance between the electrodes 33 and 33b and is adjusted by moving the sleeve 39 on the rod 40 with the screw 36, the holder 34 and the electrode 33b to a desired position.

The portion of the layer 32 which extends from the electrode 33b to the electrode 33 acts as a variable shunt resistance. Part of the current passes along the said portion of the layer 32 parallel to the same, and part of the current passes transversely thereto from the electrode 33b through part of the layer 32 to the carrier 11 and from the latter through another part of the layer 32 to the electrode 33.

In the form of my invention which is shown in Fig. 7, the carrier 51 consists of a cylindrical or

prismatic rod of a metal adapted to have a permanent layer of oxide formed thereon when it is heated at a suitable temperature, and the oxide layer 52 encompasses the carrier 51 and is formed thereon in the same way as the layer 12 is formed on the carrier 11, serves the same purpose and is covered by a pair of conductors 53 which encompass the layer 52 on the rod 51; the conductors 53 are produced in the same way as the conductors 13 and act in the same way.

The layer 52 is shown as having thereon a section 54 which is exposed on the surface of the element at the middle part of the latter and forms with said layer 52 a resistance area between the said conductors 53.

A pair of bands 53a are shown as clamped onto the ends of the element 51—54 by means of eyelets 56.

The bands 53a have thereon terminals 55 for attaching wires thereto.

Instead of a cylindrical or prismatic rod the carrier may consist of a tube, as shown in Figs. 8 and 9, in which the tubular carrier 61 has thereon an oxide layer 62.

The layer 62 is covered in part by a pair of conductors 63, which encompass the layer 62 at the ends thereof to serve as contacting terminals or electrodes.

The layer 62 has thereon a section 64 which is exposed on the surface of the element at the middle part thereof and forms a shunt resistance area between the said conductors 63.

A pair of bands 63a are clamped onto the ends of the element 61—64 by means of eyelets 66.

The bands 63a have thereon terminals 65 which serve for attaching wires thereto.

In the subvariation of my invention, which is shown in Fig. 8a, 81 designates a porcelain tube which is shown as having wound thereon convolutions 82 of a wire which has a low electrical conductivity and is joined to a conductor 84 which has a high electrical conductivity and forms a circuit which is normally open and may be closed by a switch 88.

The convolutions 82 are covered by an insulating layer or air space 83, and the circuit 84 is connected to a source of electric energy 86, such as a transformer, a battery or an electric generator.

The tube 81 and the convolutions 82 are designed to act as a heating device and are inserted into the tube 61, of a resistance or impedance element 61—64, such as is hereinbefore described, with the terminals 65 thereon.

Instead of the convolutions 82 any other electric heating device may be employed, if desired.

The terminals 65 are shown as having connected thereto the ends of wires which form a circuit 84a which is connected to a source of electric energy 85, which may be a transformer, a battery or an electric generator.

The circuit 84a is shown as also having thereon a lamp 87, to serve as a signal or indicator.

Any other signalling or indicating device may be employed, if desired, in place of the lamp 87.

The operation of the device is as follows:

The element 61—64 normally has a very high resistance, thereby preventing the lamp 87 from lighting up.

In this application the character of the layer 62, and section 64 thereof is such that the resistance or impedance thereof is reduced by a rise of the temperature thereof.

By closing the switch 88 a current is applied to

the heater 82, thereby raising the temperature of the element 61—64, whereby the resistance or impedance of the section 64 is reduced, thereby causing the lamp 87 to light up. If any other signalling or indicator device is used, it will thereby be caused to produce a signal or indication.

In one species there is shown in Figs. 10 and 11, a cylindrical carrier 71 of a metal adapted to have a permanent layer of oxide formed thereon when it is heated at a suitable temperature, which may be either a tube or a rod, and is covered by an oxide layer 72 which encompasses the same and has clamped thereto at one end thereof a fixed electrode 73 of soft metal such as lead or tin by means of a band 73a which is secured to the end of the element 71—72 by means of an eyelet 76.

An adjustable cylindrical electrode 73b of soft metal such as lead or tin is connected to a band 74 which is adjustably clamped in position on the element 71—72 by means of a bolt 76a and a nut 77.

The bands 73a and 74 have thereon each a terminal 75 for connecting wires thereto.

It is evident that in all of the above modifications of my invention part of the electric current flows lengthwise the mass of the oxide in the exposed sections of the oxide layers and parallel thereto and part of the current flows transversely thereto.

The resistance value of the element 71—72 depends upon the distance between the fixed electrode 73 and the adjustable electrode 73b and increases with that distance.

Otherwise the resistance element 71—72 is similar in all other respects to the resistance elements which were hereinbefore described, such as the resistance element 11—32.

Where cuprous oxide is employed wholly or in part to form the layers, such as 12, 32, 52, 62 and 72 in the hereinbefore described forms of my resistance element, the resistance may be made greater when the current is passed in one direction than when the current is passed in the opposite direction.

Variations are possible and parts of my invention may be used without other parts.

I do not, therefore, restrict myself to the details as shown in the drawings and described in the specification.

Wherever in the claims hereinafter the term "a substantially metallic oxide of said carrier" is employed, it is understood to include an oxide of the metal, with possibly an admixture of other substances such as other oxides, silicates, salts of manganese and other metals.

I claim as my invention and desire to secure by Letters Patent:

1. A self sustaining resistance or impedance element for electric circuits comprising a continuous carrier of metal adapted to have a permanent layer of oxide formed thereon when it is heated at a suitable temperature, a layer of substantially metallic oxide of said carrier on said carrier integral therewith, said carrier extending from end to end of said layer, said layer being a product of oxidation of the carrier obtained by heating the carrier in air at a suitable temperature, and a plurality of conductors on said layer spaced apart from each other on the surface of said layer on the side thereof which is remote from said carrier and out of contact with said carrier, to serve as contacting terminals or electrodes for said element.

2. A self sustaining resistance or impedance element for electric circuits as described in claim 1, said carrier having the form of a plate, said layer being positioned on the side thereof, said
5 conductors being positioned at spaced intervals on said layer on the side of the latter which is remote from said plate and out of contact with said plate, and said layer having thereon a portion which is exposed on the surface of the
10 element and forms a resistance area between the said conductors.

3. A self-sustaining resistance or impedance element for electric circuits comprising a continuous carrier consisting of a rod of metal
15 adapted to have a permanent layer of oxide formed thereon when it is heated at a suitable temperature, a layer of substantially metallic oxide of said carrier on said carrier integral therewith, said carrier extending from end to
20 end of said layer, said layer being a product of oxidation of the carrier obtained by heating the carrier in air at a suitable temperature, and a plurality of conductors on said layer, spaced apart from each other on the surface of said
25 layer, to serve as contacting terminals or electrodes for the said element.

4. A self-sustaining resistance or impedance element for electric circuits, comprising a continuous tubular carrier of metal adapted to have
30 a permanent layer of oxide formed thereon when it is heated at a suitable temperature, a layer of substantially metallic oxide of said carrier, on said carrier, integral therewith, said carrier extending from end to end of said layer, said
35 layer being a product of oxidation of the carrier obtained by heating the carrier in air at a suitable temperature, and a plurality of conductors on said layer spaced apart from each

other on the outer surface of said layer, to serve as contacting electrodes for said element, combined with an electric heater in said carrier.

5. A self-sustaining resistance or impedance element for electric circuits comprising a continuous cylindrical carrier of metal adapted to
5 have a permanent layer of oxide formed thereon when it is heated at a suitable temperature, a layer of substantially metallic oxide of said carrier on said carrier integral therewith, said
10 carrier extending from end to end of said layer, said layer being a product of oxidation of the carrier obtained by heating the carrier in air at a suitable temperature, a plurality of electrodes on said layer spaced apart from each
15 other on the surface of said layer, metal bands connected to said electrodes and adjustably clamped in position on said elements, the positions of said electrodes with said bands thereon being adjustable with relation to each other,
20 and means for adjustably securing one or more of said electrodes with said bands thereon in position.

6. A self sustaining resistance or impedance element for electric circuits comprising a continuous carrier of metal adapted to have a permanent layer of oxide formed thereon when
25 it is heated at a suitable temperature, a plurality of conductors to serve as contacting terminals or electrodes for said element, spaced apart from each other, and a layer of a substantially permanent metallic oxide of said carrier on said carrier integral therewith between each of said
30 conductors and said carrier, said carrier extending under each of said conductors, with said layer of oxide therebetween.
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