Feb. 5, 1946. K. L. WOODMAN 2,394,130

RESISTOR AND METHOD OF MAKING

Filed March 27, 1943

Fig. 1.

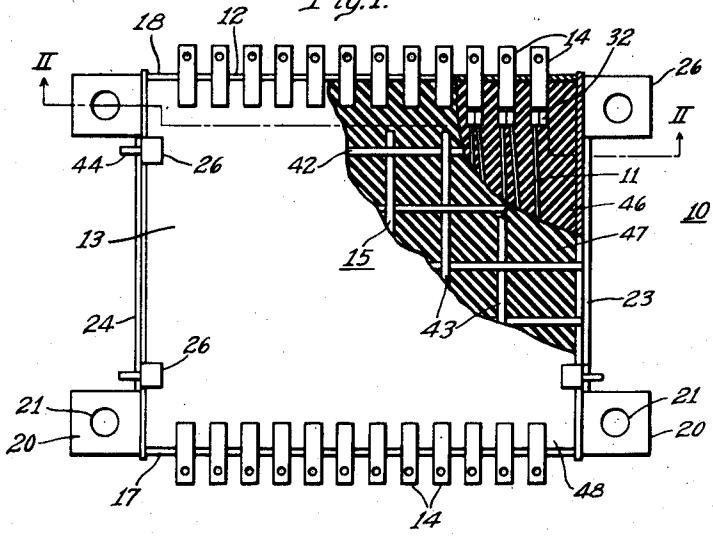



Fig. 2.

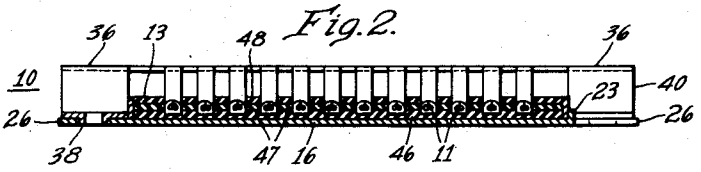



Fig. 3.

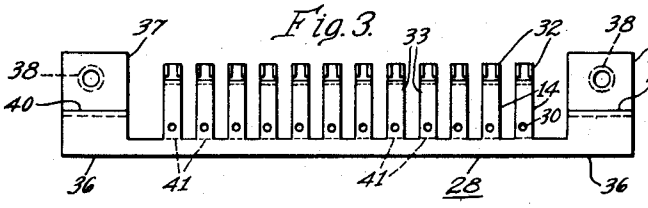



Fig. 4.

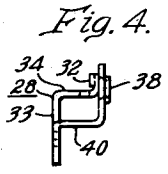
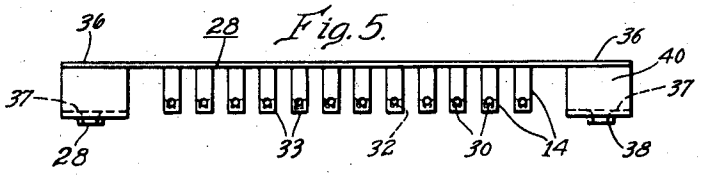



Fig. 5.




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# UNITED STATES PATENT OFFICE

2,394,130

## RESISTOR AND METHOD OF MAKING

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Application March 27, 1943, Serial No. 480,732

13 Claims. (Cl. 201—64)

My invention relates, generally, to resistors and it has reference in particular to a construction for, and a method of making, resistors of the type wherein the resistance element and terminals are secured to a support by a cementitious insulating material.

Generally stated, it is an object of my invention to provide a multiple terminal imbedded type resistor which is simple and inexpensive to manufacture and is durable in service.

More specifically, it is an object of my invention to provide for forming a plurality of resistor terminals with an integral connecting portion which serves to space the terminals relative to each other and relative to the resistor support during assembly.

It is also an object of my invention to provide for protecting the insulating material by which the resistor element is secured to the support.

Still another object of my invention is to provide for imbedding a protective screen in the insulating material covering a resistance element mounted on a metal base.

A further object of my invention is to provide for maintaining a predetermined spacing between a plurality of terminals during the manufacture thereof, and for supporting the terminals in predetermined relation to a support by means of a severable common connecting portion.

A further object of my invention is to provide for forming a plurality of terminals from a common strip of conducting material and leaving them connected by an integral connecting portion which may be removed therefrom after the terminals have been properly secured.

Other objects will in part be obvious, and will in part be explained hereinafter.

In practicing my invention a plurality of terminals for a resistance element which is to be secured to a metal support by a cementitious insulating material are formed from a common sheet of material. The normally free ends of the terminals are left connected to a common connecting portion of the sheet which is provided with independent legs at the ends for engaging the support on which the resistor is to be mounted, so as to both position the terminals in predetermined spaced relation to each other and to the resistor support. While the terminals are thus positioned and after they have been connected to the resistance element, both the resistance element and the terminals are secured to the support by a cementitious insulating material which is flowed around the resistance element and the portions of the terminals connected thereto. A protective metal screen positioned over the element is bonded to the support by the insulating material. When the insulating material hardens, the common connecting portion of the terminals may be removed therefrom, leaving the terminals properly spaced and firmly secured.

For a more complete understanding of the nature and scope of my invention, reference may be had to the following detailed description which may be read in connection with the accompanying drawing, in which:

Figure 1 is a partially broken out plan view of a resistor embodying the principal features of the invention:

Fig. 2 is a sectional view taken along the line II—II before the common connecting portion of the terminals is removed;

Fig. 3 is a plan view of the terminal assembly before the common connecting portion is removed;

Fig. 4 is an end elevational view of the terminal assembly of Fig. 3; and

Fig. 5 is a side elevational view of the terminal assembly of Fig. 3.

Referring to Fig. 1 the reference numeral 10 may denote, generally, a resistor of the type wherein one or more resistance elements 11 may be secured to a metal support 12 by means of a cementitious insulating material 13 and provided with one or more sets of terminals 14 for effecting connection thereto at spaced intervals. A protective screen 15 may be provided for protecting the resistor against damage from shock.

Referring to Figs. 1 and 2 it will be seen that the support 12 may comprise a substantially rectangular tray of sheet metal or the like having a relatively flat back portion 16 provided with upstanding integral edge portions 17 and 18 along the sides thereof. Means such as the ears 20 may be provided adjacent the ends having openings 21 therein for securing the resistor to a suitable support or panel (not shown). The support 12 may also be provided with upstanding end portions 23 and 24, which may either be integral or separate as shown. Tabs or ears 26 may be provided on the end portions for a purpose which will be explained hereinafter.

Since the resistance element 11 is to be secured to the support 12 by means of the cementitious insulating material 13 and provided with a plurality of relatively closely spaced terminals 14, it is necessary to insure the proper spacing of these terminals during assembly, and before they

are firmly secured to the base by the insulating material.

Accordingly, as shown in Figs. 2 through 5, the terminals 14 may be formed in any suitable manner such as by punching or forming them from a common strip of conducting material. Instead of forming the terminals 14 separately, they may be formed with a common connecting strip 28 joining the normally free ends. Openings 30 may be provided in the terminals adjacent the connecting strip for effecting the connection of a conductor thereto when the resistor is completed, and means such as the upstanding lugs or ears 32 may be provided adjacent the other ends of the terminals for effecting a connection to the resistance element.

The terminals may be of any desired shape having, as shown, in the present instance, somewhat of a Z-shape with a substantially horizontal portion 33 adjacent the common connecting strip and a substantially vertical intermediate portion 34 adjacent the end to be connected to the resistance element. The end to be connected to the resistance element may be bent substantially parallel to the portion 33 to facilitate connection to the end turns of the resistance element as shown in Fig. 1. It is to be understood, however, that the shape of the terminal is generally a matter of convenience and it may have various other forms within the scope of the invention.

In order to position the terminals 14 relative to the support 12 during the manufacture of the resistor, suitable means may be provided such as the projecting end portions 36. For example, the ends of the connecting strips 28 may be formed with feet 37 adapted to engage the ears 20 of the support 12 and having bosses 38 arranged to fit in the openings 21 of the ears so as to position the terminals 14 in predetermined relation to the support 12. The feet 37 may be arranged as shown in Fig. 4 being, for example, connected to the projecting end of the common connecting strip 28 by means of dependent intermediate portions 40, so as to be positioned in a plane substantially parallel to the ends of the terminals to be connected to the resistance element 11 at a predetermined distance below said ends. As shown in Fig. 2 this enables the lower ends of the terminals 14 to be positioned a predetermined distance above the relatively flat back portion 18 of the support, so as to insure adequate insulation being provided between the terminals and support.

After the cementitious insulating material 13 has been applied about the resistance element and the lower ends of the terminals, the connecting portion 28 and the projecting end portions 36 may be severed from the terminals leaving them accurately positioned and ready for use. Where a relatively light material is used for forming the terminals 14 it may not be necessary to make any particular provision for the severance of the connecting portion therefrom, since this may be easily done by means of shears or punching after the resistor is assembled. If it is desirable, however, the terminals may be partially severed from the connecting strip during the original forming operation either by partially shearing the terminals 14 from the connecting strip 28 along the dotted lines 41 or by providing suitable holes at the junction of the terminals and the connecting strip to weaken the union therebetween sufficiently to enable the connecting strip to be readily detached after the resistor is assembled.

In order to protect the completed resistor against damage from shock, which may crack the insulating material 13 or even rupture the bond thereof with the support 12, the resistor may be provided with a protective screen 15. The screen 15 may be of any suitable design, comprising a perforated plate of metal or any suitable material having sufficient mechanical strength, or a screen, wire mesh or the like. As shown the shield 15 comprises a screen of cross wires 42 and 43. It may be secured in any suitable manner being, for example, initially positioned relative to the support 12 by means of projections 44 of the cross wires 42 which may be retained either by merely bending the ears 26 at the ends of the support thereover or by passing them through openings in the ears 26. When the insulating material 13 is flowed over the resistance element and support, the screen 15 becomes imbedded therein and may be bonded thereto so as to substantially reinforce the insulating material and protect the resistance element from damage.

The resistance element may be assembled in any suitable manner, such as by first placing a primary layer of insulating material 46 over the inner surface of the support 12, bending the ears 32 of the terminals 14 over the end portions of the resistance element 11 and placing the resistance element, with the terminals attached, on the primary layer of insulating material with the bosses 38 of the end projections of the terminal assembly positioned in the openings 21 of the support ears 20 to position the terminals relative to the support. Additional insulating material such as the secondary layer 47 may then be applied around and between the turns of the resistance element 11. The protective screen 15 may then be placed on the secondary layer of insulating material and secured by inserting the projecting ends 34 in the openings in the ears 26 and bending the ears 26 inwardly. A further or tertiary layer of insulating material 48 may then be applied over the protective screen 15.

If the insulating material 13 is of the vitreous type the different layers may either be fused or partially fused as they are applied or they may be left in the unfused state and all fused simultaneously in a single heating operation. Likewise, if the insulating material is of a hydraulic type, the different layers may be allowed to set before the subsequent layer is applied or they may be applied one after the other and set in a single operation. Where insulating materials of the synthetic type are used for hardening by polymerization it may be desirable to use a single treatment for curing the different layers in order to permit them to fuse into a substantially homogeneous mass such as may be secured with the other types of insulating materials in either the step by step or the simultaneous operation.

When the resistance element and terminals are applied to the support, the terminals are accurately positioned relative to one another and to the support by inserting the bosses 38 on the feet of the projection and portions of the common connecting strip in the openings 21 in the ears 20 at the ends of the support 12. If desired, screws or other suitable means may be used to further insure the positioning of the feet 37 relative to the ears 20. After the insulating material 13 has flowed around and between the turns of the resistance element the ends of the terminal members and the cross wires of the screen 15 bonding them inseparably together, the common con-

necting portion 28 of the terminals, together with the projecting end portions 26 and the feet 27 may be severed from the terminals, leaving them accurately spaced relative to each other and to the support 12.

From the foregoing description and the accompanying drawing it will be apparent that I have provided in a simple and effective manner for assembling a plurality of terminals on a resistor of the imbedded type. Accurate positioning of the terminals relative to the resistor support and to each other is positively assured and removal of the positioning means may be easily effected. By protecting the resistance element through the use of a protective shield or screen imbedded in the insulating material the durability of the imbedded type resistor is greatly increased. The effective bonding power of the insulating material is also increased so that the bonding of the terminals themselves to the support is thereby improved since cracks in the insulating material which may develop at points more or less remote from the terminals are prevented from separating into the region where the terminals are located.

Since different embodiments of the invention may be made other than those illustrated, without departing from the spirit and scope of the invention as defined, it is intended that all the matter contained in the accompanying description and shown in the drawing shall be considered as illustrative and not in a limiting sense.

I claim as my invention:

1. A resistor comprising, a relatively flat support, a resistance element mounted on said support, a plurality of terminal members having feet portions substantially parallel to the support connected to the element and portions projecting at substantially right angles to the support, a cementitious insulating material substantially surrounding the resistance element and feed portions and securing them to the support.

2. A resistor comprising, a metal base, a resistance element positioned on the base, a plurality of contact members having portions in substantially the plane of the element secured thereto at spaced intervals and angularly related portions projecting away from the base, a cementitious insulating material surrounding the resistance element and the first mentioned portions of the contact members to secure them to and insulate them from the base.

3. A resistor comprising, a resistance element having projecting terminals, a metal support positioned on one side of the element and in spaced relation thereto, a metal screen positioned on the other side of the element in spaced relation, and a fusible cementitious insulating material substantially surrounding the element fusibly bonded to the screen and support.

4. A resistor comprising, a relatively flat metal support having upstanding edge portions, a resistance element positioned in predetermined spaced relation to the support, a shield positioned on the side of the element remote from the support and operatively connected to the edge portions of the support, and a vitreous insulating material substantially surrounding the element and fusibly bonding it to the support and shield.

5. A resistor comprising, a substantially rectangular base having supporting ears at each end and upturned side portions, a resistance element supported on the base having a plurality of elongated terminal members positioned at spaced intervals adjacent one edge of the base having one end secured to the element and the other end projecting therefrom in a plane parallel to but spaced from the plane of the end secured to the element, and a fusible cementitious insulating material positioned about the element and the ends of the terminals secured thereto fusibly bonding them to the base.

6. A resistor comprising, a substantially flat metal tray having upstanding edges, a resistance element positioned in the tray, a plurality of elongated sheet metal terminals arranged in spaced relation adjacent one edge of the tray and having terminal portions projecting at an angle to the tray and feet portion in substantially parallel relation to the tray secured to the resistance element at spaced intervals.

7. A multiple terminal assembly comprising, a plurality of spaced terminal members formed from sheet metal, removable connecting means integrally formed with the terminal members to maintain a predetermined spacing thereof during assembly, and positioning means projecting from the connecting means adjacent the ends integral with the connecting means having a portion thereof in predetermined relation to portions of the terminals for positioning them in predetermined relation to a support during assembly.

8. A terminal structure for a resistance element mounted on a support comprising, a plurality of elongated sheet metal terminal members having means at one end for connection to a conductor, and a severable connecting strip connecting the other ends to maintaining the terminal members in predetermined alinement and spaced relation during assembly and having integral depending end portions projecting from the connecting strip for positioning the terminal members relative to the support during assembly.

9. The method of making a resistor having a plurality of terminals connected to a resistance element which comprises, forming the plurality of terminal members from a single piece of conducting material having a severable connecting portion along one end, securing the other ends to the resistance element and applying the resistance element and terminals to a support, applying a cementitious insulating material over the element and at least a portion of the terminals to bond them to the support, and removing the common connecting portion from the free ends of the terminals.

10. The method of making a multiple terminal resistor which comprises, forming a plurality of spaced terminals from a piece of conducting material having means at one end to make connection to a resistance element and having an integral connecting strip at the other, connecting the first-mentioned ends to the resistance element applying the terminals and element to a support, surrounding the element and the first-mentioned end portions of the terminals with a cementitious insulating material, and severing the connecting portion from the other ends of the terminals when the insulating material hardens.

11. The method of alining a plurality of spaced terminals for connection to a conductor which comprises forming the terminals from a common piece of conducting material in predetermined spaced relation with means for effecting connection to the conductor at one end and a severable spacing and connecting strip integral therewith at the other, connecting the terminals to the conductor and securing them in the desired relation

thereto, and then severing the connecting strip therefrom.

12. The method of making a resistor having a plurality of spaced terminals connected to a resistance element imbedded in a vitreous enamel on a metal support which comprises, forming the terminals in the desired spaced relation from a common sheet of conducting material with spaced ears at one end to grip the resistance element and a common connecting portion at the other with projecting end portions positioned in predetermined relation to the ends having the spaced ears, applying the terminals to the element, applying the element and terminals to the support with the projecting end portions supporting the terminals relative to the support, applying a cementitious insulating material about the element and the portions of the terminals secured thereto, and removing the connecting portion and projecting end portions from the terminal portions.

13. The method of making a multiple terminal resistor which comprises, forming a plurality of spaced terminals from a common sheet of conducting material with a common connecting portion at one end and projecting ears at the other end for gripping a resistance element, securing the terminals to the resistance element while spaced by the common connecting portion, positioning the element and terminals on a metal base having a layer of cementitious insulating material thereon, covering the element and the ends of the terminals secured thereto with additional cementitious insulating material, placing a protective screen over the element and securing it to the base, treating the cementitious material to bond with the base, resistance element and protective screen, and subsequently removing the common connecting portion.

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