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G. M. EHLERS

2,213,067

FIXED RESISTOR

Filed Feb. 27, 1937

Fig. 1.

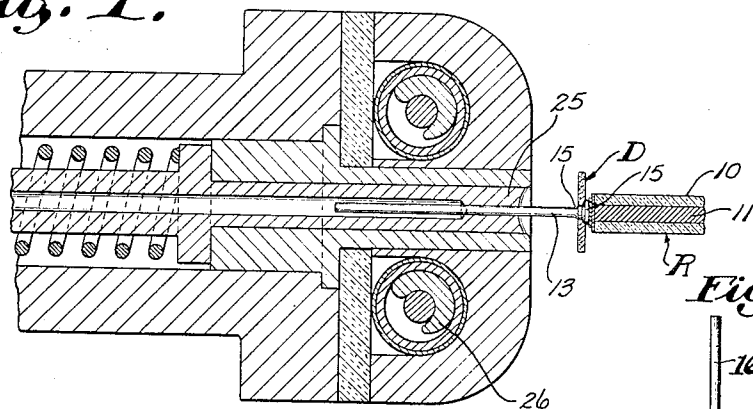


Fig. 2.

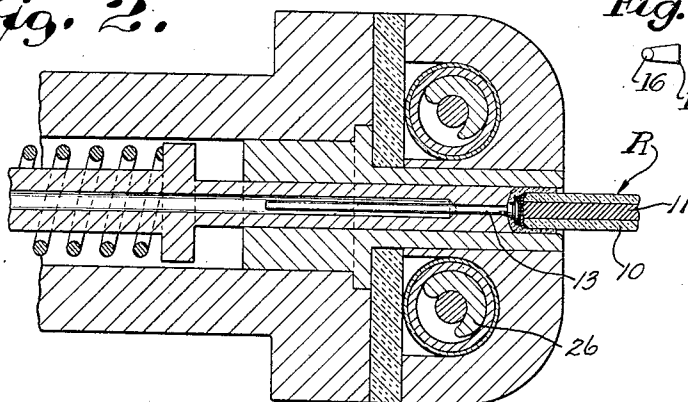


Fig. 6.

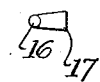


Fig. 5.



Fig. 7.

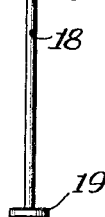


Fig. 8.

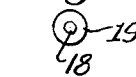


Fig. 3.

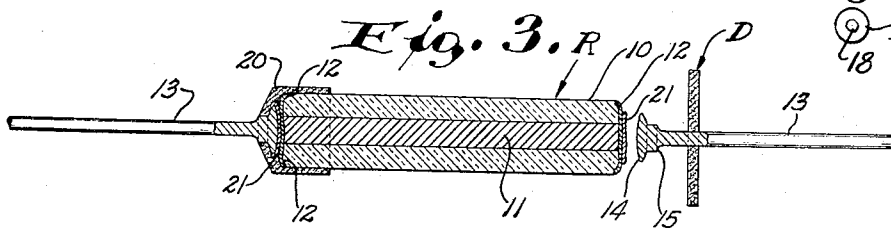
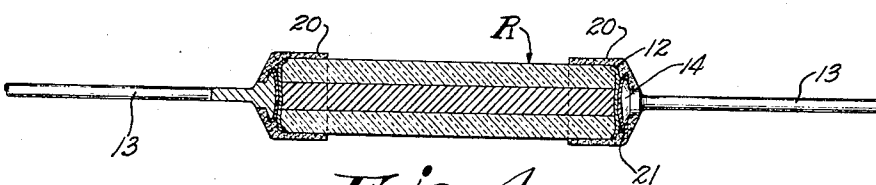


Fig. 4.



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FIXED RESISTOR

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10 Claims. (Cl. 201-64)

This invention relates to an improvement in fixed resistors and to a method of making the same.

One of the principal objects of the invention is to provide a fixed resistor with an improved lead-wire construction, one wherein the lead-wires are effectively connected electrically with the conductive path of the resistor, securely maintained in position mechanically and this in a construction in which the ends of the resistor are properly insulated. The construction is such that it is convenient to provide resistors of this character with coaxial lead-wires, that is, wires that are aligned with the longitudinal axis of the resistor and project beyond the ends thereof.

Another object is to provide an improved method whereby the lead-wires are properly and effectively organized with the ends of the resistor.

Other objects and advantages reside in certain novel features of the construction, arrangement and combination of parts which will be hereinafter more fully described and particularly pointed out in the appended claims, reference being had to the accompanying drawings forming a part of this specification, and in which:

Figure 1 is a fragmentary view in transverse section showing the manner in which the resistor, its lead-wire and end cap are pressed to the mold;

Figure 2 is a view similar to Figure 1 showing the manner in which the cap is molded over the head of the lead-wire and the adjacent end of the resistor;

Figure 3 is a view partly in longitudinal vertical section and partly in side elevation showing a resistor embodying the present invention, one of the lead-wires and the disc from which one of the end caps is formed being shown prior to assembly;

Figure 4 is a view similar to Figure 3 but showing the completely assembled device;

Figure 5 is a view in elevation of a modified form of lead-wire;

Figure 6 is a view in end elevation of the lead-wire shown in Figure 5;

Figure 7 is an elevation of still another lead-wire construction; and

Figure 8 is a view in end elevation of the lead-wire shown in Figure 7.

Referring to the drawings and more particularly to Figures 3 to 6, inclusive, the fixed resistor designated generally at R comprises an insulating jacket 10 of ceramic material and a conductive core 11 which may be a mixture of carbon and ceramic. One type of composition which may be advantageously used is shown, described

and claimed in my application for Electrical resistor elements, filed December 4, 1933, Serial No. 700,872, and my application for Apparatus for and method of making resistor elements, filed October 1, 1934, Serial No. 746,340.

The ends of the resistor may be coated with a material having a low electrical resistance. This material may be simply a carbon paint although preferably it is a copper metal spray designated at 12. A lead-wire 13 is provided at each end of the resistor. In the assembly, these lead-wires are coaxial with the resistor and project outwardly beyond the ends thereof. Each lead-wire is formed at its inner end with a head 14 and between the head and the main portion of the lead-wire a shoulder 15 is provided. This is a preferred lead-wire construction although in many instances the particular formation of the lead-wire may be varied. For example, the lead-wire designated at 16 in Figure 7 may be employed. The lead-wire 16 is provided with a lateral projection 17 at one end which takes the place of the head 14. Or, as illustrated in Figure 9, a lead-wire 18 may be employed. The lead-wire 18 is provided at one end with a circular metal head 19 but the shoulder formation is omitted.

In the preferred construction the lead-wires 13 with these shouldered heads are employed and they are held in position by means of molded insulating caps 20, one at each end of the resistor. Interposed between the head 14 of each lead-wire and the adjacent conductive coating 12 is a lead wafer 21 or similar wafer-like layer of conductive material. When the lead-wires are assembled the heads 14 are pressed with considerable force against the wafers 21 to cause the heads of the lead-wires to embed in the wafers and some of the material of the wafers to penetrate or embed in the pores or interstices of the end coatings 12 whereby to obtain good electrical contact between these parts.

The invention contemplates the omission of the conductive end coatings 12, the wafers 21 alone being relied on to provide the desired electrical contact. And where the heads of the lead-wire are of soft metal the wafers 21 also may be omitted in some instances.

Each molded cap 20 is made up of disc of paper, linen, canvas duck, felt, or other similar material which is suitable for impregnation with a thermo-setting resin or a high temperature thermo-plastic, such as Bakelite resin, and capable of being molded into a sufficiently strong cap under the influence of heat and pressure. In lieu of

of a resin impregnated disc of material of the character mentioned, a pellet washer of molding powder preformed under pressure may be employed. However, good results are obtained by using a 9 oz. to an 18 oz. canvas duck impregnated with Bakelite resin. The size of the impregnated disc or preformed pellet is dependent upon the desired length of the cap. In this connection it has been found that greater pull-out strength is attained by piercing the hole of the lead-wire in the impregnated washer with a hot pin punch or while the resin is warm in order to prevent tearing of the threads of the fabric due to their being impregnated with a resin which is brittle when cold. Shorter molding time and cleaner molds may be obtained with some of the impregnated cloths by semi-curing them before molding. A preferred method of doing this is to immerse the impregnated cloth in a bath of beeswax at about 300° F. for a time of ten seconds. In this method the wax serves to prevent sticking of the resin to the molds.

In manufacturing the resistors the body of the resistors consisting of the insulating jacket 10 and conductive core 11 are first produced and are cut to appropriate length. The impregnated discs D from which the insulating caps 20 are formed are assembled on the lead-wires as shown in Figure 1, after, of course, having been appropriately pierced. When presented to the molding die the discs D lie flush up against the head 14 of its lead-wire so that the shoulder 15 is exposed and presented to the plunger 25 actuated by a spring 27, or other suitable means, of the molding die. The main portion of the lead-wire is received in the axial bore of the plunger 25 and supported thereby. The resistor R with its end coating 12 and lead wafer 21 is then pressed against the exposed surface of the head of the lead-wire to force the plunger 25 inwardly and thereby cause the disc D to be molded into the cap 20, as illustrated in Figure 2. The head of the molding die is provided with suitable heating elements 26 so that the caps 20 are molded and cured while in the die.

Good electrical contact between the lead-wire and the conductive path of the resistor may be insured by the use of the lead wafers 21 or in various other ways. For example, the end coating 12 of the resistor or the adjacent portion of the head 14 or both may be tinned or a mixture of powdered solder and flux may be placed on the head 14 of the lead-wire or on the end coating 12 of the resistor or on both before molding. Then again, instead of providing a separate lead wafer the lead-wire head may be dipped in molten lead prior to being pressed against the end coating of the resistor.

During the molding of the discs over the ends of the resistor the plunger of the die bears directly against the shoulder 15 so that the shoulder takes the better part of the strain incident to the molding. This avoids thinning or weakening of the material making up the insulated end caps as they are subjected only to sufficient pressure to form them and mold them in position. Furthermore, when the plunger applies its force directly to the shoulder, the wire head is forcibly pressed against the end coating or against the interposed lead wafer and any possibility of the resin being extruded from the impregnated discs and forced between the contacting surfaces of the lead-wire head, wafer and end coating is avoided.

During the molding operation the end of the plunger shapes or forms the end of the insulating

resistor cap while the female part 27 of the molding die forms the side of the cap.

In the process as illustrated, the resistor is held and forced toward the die in any suitable manner so that it acts as a punch to push the disc D into the heated mold. The process can, of course, be reversed by holding the resistor stationary and moving the mold.

As has been indicated, many of the advantages of the invention may be realized with modified types of lead-wires, as, for example, those shown in Figures 7 to 10, inclusive. In any event, the dead soft copper wire constituting the lead-wire should be headed in such manner that when the wire is pulled lengthwise it does not unwrap or deform to such extent that it will slip through the hole in the insulating cap. When the insulating caps have been molded and cured they tenaciously adhere to both the head of the wire and the peripheral end portions of the insulating jacket of the resistor proper.

With a resistor constructed in this manner, the lead-wires may be coaxially disposed, are securely held mechanically in position and have good electrical contact with the conductive path of the resistor. Furthermore, the end caps insulate the ends of the resistor.

The foregoing description of the resistor and process embodying the present invention is to be understood as illustrative rather than restrictive as the present invention contemplates various changes in structure, material and sequence without departing from the spirit of the invention or the scope of the subjoined claims.

The invention claimed is:

1. The hereindescribed method of making a fixed resistor with lead-wires connected thereto by molded insulating caps which consists in assembling a resin impregnated disc on a headed lead-wire, pressing the headed end of the lead-wire toward the end portion of the fixed resistor, and subjecting the disc to the action of heat and pressure to form it into a molded and cured cap enclosing and secured to the head of the wire and the end portion of the resistor.

2. The hereindescribed method of making a fixed resistor with lead-wires having headed ends connected thereto by molded insulating caps which consists in assembling a disc-like structure including a thermo-setting resin on a lead-wire, pressing the headed end of the lead-wire toward the end portion of a fixed resistor, and subjecting the disc-like structure to the action of heat and pressure to form it into a molded and cured cap enclosing and secured to the head of the wire and the end portion of the resistor.

3. The hereindescribed method of making a fixed resistor having a headed and shouldered lead-wire secured to the end of the resistor by a molded insulating cap which consists in assembling a disc-like structure of thermo-setting resin composition on a lead-wire and against the head thereof while leaving the shoulder exposed, presenting the headed end of the lead-wire to a conductive end portion of the resistor, and simultaneously subjecting the shoulder and disc to pressure and the disc to heat also to force the headed end of the lead-wire toward the end of the resistor by virtue of the pressure exerted on the shoulder and to form the disc into a molded and cured cap over the head of the wire and the end of the resistor by virtue of the heat and pressure to which it is subjected.

4. The hereindescribed method of making a

fixed resistor with lead-wires having headed ends connected thereto by molded insulating caps which consists in piercing a resin impregnated disc while the same is subject to the influence of heat, assembling the pierced disc on a lead-wire, pressing the headed end of the lead-wire toward the end portion of the resistor and subjecting the disc to the action of heat and pressure to form it into a molded and cured cap over the head of the wire and the end portion of the resistor.

5. A fixed resistor including, a headed lead wire, a soft metal layer between the head of the lead wire and an end of the resistor, said head of the lead wire being pressed into intimate contact with the soft metal layer, and the soft metal layer being pressed into intimate contact with the adjacent end of the resistor, and a molded insulating cap including a thermo-setting resin composition enclosing and engaging the head of the lead wire, the metal layer and the adjacent portion of the resistor and securing these parts together by virtue of the force of adhesion set up there-between incidental to the molding and curing of the cap.

6. A fixed resistor comprising a conductive core, an insulating jacket surrounding the core, conductive coatings on the ends of the resistor and in electrical contact with the core, lead wires having heads engaged with said conductive coatings, and molded caps of insulating material including a thermo-setting resin composition enclosing the heads of the lead wires and said conductive coatings and extending over the end portions of the resistor jacket to insulate the ends of the resistor and to secure the lead wires in firm contact with said conductive coating by virtue of the force of adhesion between the engaged portions of the molded cap and the resistor.

7. A fixed resistor having a conductive terminal portion, a conductive coating over said terminal portion and in electrical contact therewith, a headed lead wire having the head thereof engaged with said conductive coating, and a molded cap of thermo-setting insulating material engaging and

enclosing the head of said lead wire and the coated end portion of the resistor and securing the lead wire and resistor together by virtue of the force of adhesion exerted between the molded cap, the lead wire and the resistor.

8. A fixed resistor comprising a conductive core, an insulating jacket surrounding the core, a conductive coating on an end of the resistor and in electrical contact with the core, a lead wire having a head engaged with said coating, and a molded cap constituted of a body of fibrous material impregnated with a thermo-setting resin and engaging and enclosing the head of the lead wire and said conductive coating and the end portion of the jacket of the resistor and securing these parts together by virtue of the force of adhesion set up between the molded cap, the lead wire and the resistor incidental to the molding and curing of the cap.

9. A fixed resistor comprising a conductive core, an insulating jacket surrounding the core, a conductive coating applied to an end of the resistor and in electrical contact with the core, a lead wire having a head engaged with said coating, and a molded cap constituted of a textile fabric impregnated with Bakelite resin and engaging and enclosing the head of the lead wire and said conductive coating and the end portion of the jacket of the resistor and securing these parts together by virtue of the force of adhesion set up between the molded cap, the lead wire and the resistor incidental to the molding and curing of the cap.

10. A fixed resistor having a conductive terminal portion, a conductive coating over said terminal portion and in electrical contact therewith, a headed lead wire having its head engaged in said conductive coating, a molded cap including a thermo-setting resin composition engaging and enclosing the head of the lead wire and the coated end portion of the resistor and united to these parts by the force of adhesion and serving to secure the lead wire to the resistor and to insulate the end of the resistor.

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