May 15, 1956 J. D. HEIBEL 2,745,931

RESISTORS AND METHOD OF MAKING THE SAME

Filed March 25, 1953 4 Sheets-Sheet 1

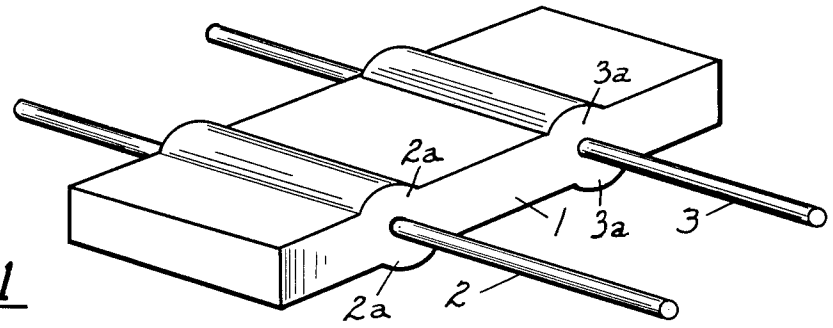

FIG. 1

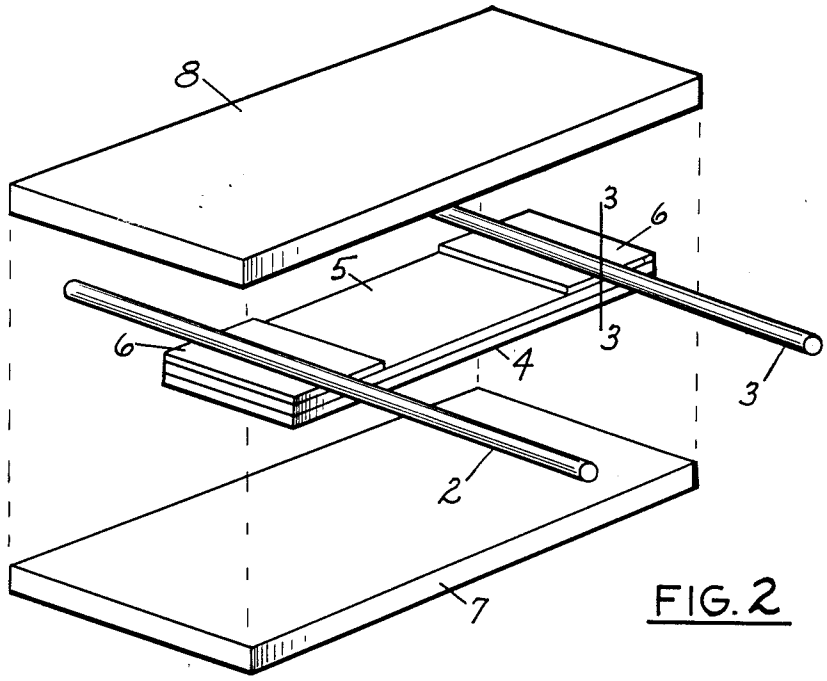

FIG. 2

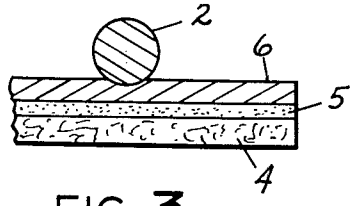

FIG. 3

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RESISTORS AND METHOD OF MAKING THE SAME

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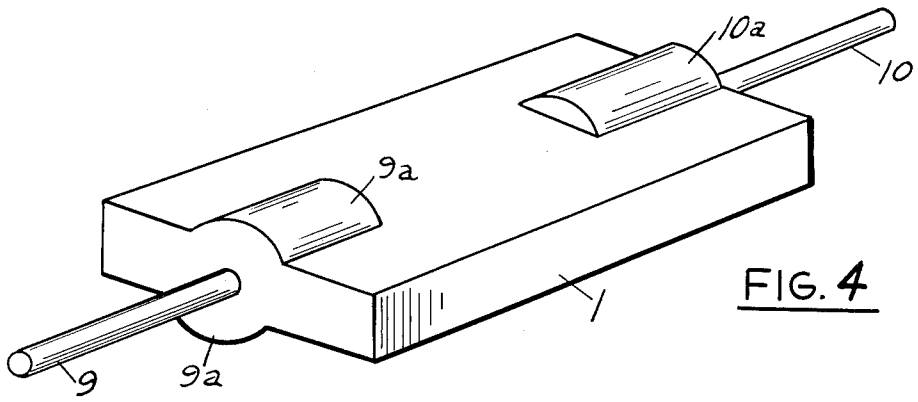

FIG. 4

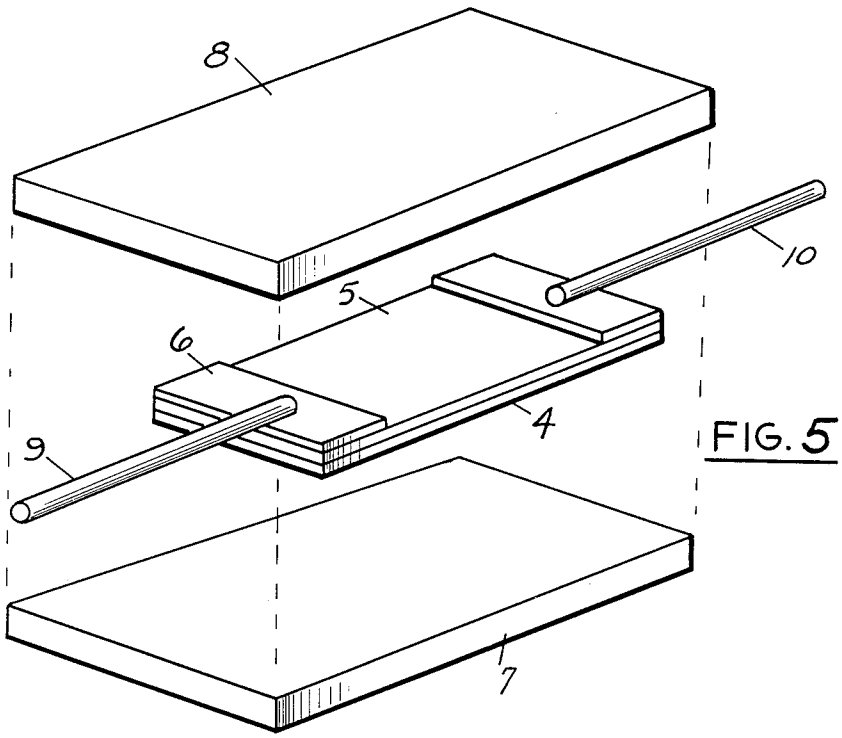

FIG. 5

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RESISTORS AND METHOD OF MAKING THE SAME

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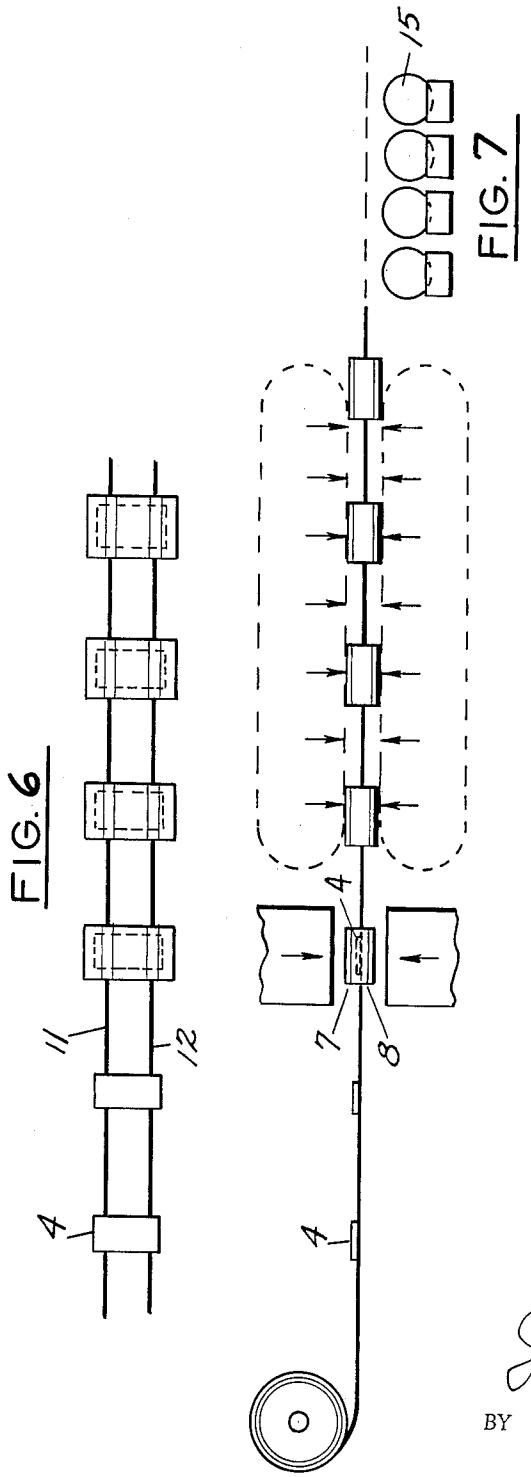

FIG. 7

FIG. 6

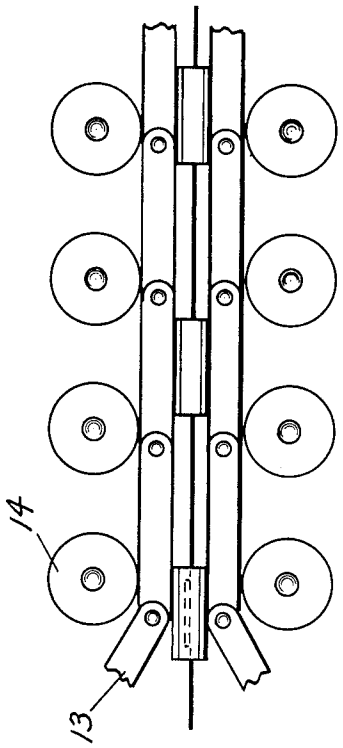

FIG. 8

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RESISTORS AND METHOD OF MAKING THE SAME

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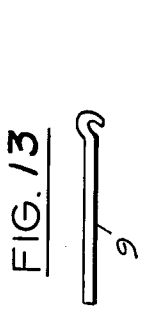

FIG. 13

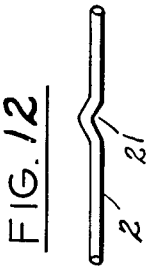

FIG. 12

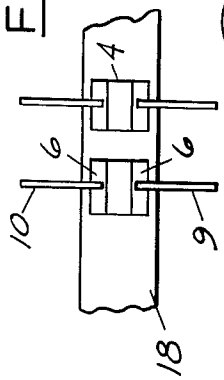

FIG. 9

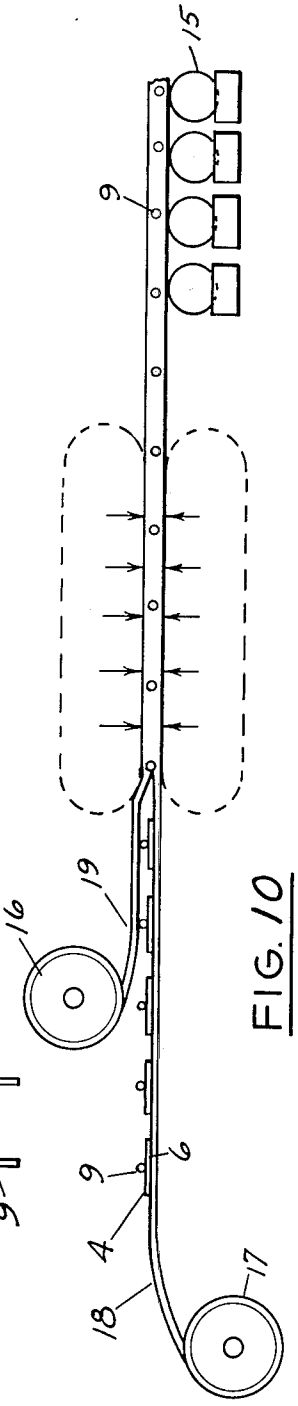

FIG. 10

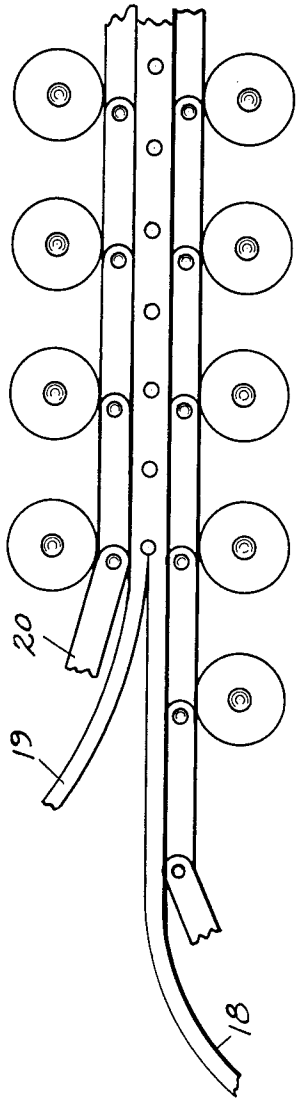

FIG. 11

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United States Patent Office 2,745,931 Patented May 15, 1956

2,745,931

RESISTORS AND METHOD OF MAKING THE SAME

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Application March 25, 1953, Serial No. 344,580

9 Claims. (Cl. 201—73)

This invention is intended to provide an insulated strip resistor in which a strip of resistance material with leads resting on the terminal portions thereof is sandwiched between plastic sheets which are cured together to form the completed resistor. The resistor is adapted to continuous manufacture.

In the accompanying drawing, Fig. 1 is a perspective of a resistor, Fig. 2 is an exploded perspective of the component parts positioned for molding, Fig. 3 is a section on line 3—3 of Fig. 2, Fig. 4 is a perspective of a modification, Fig. 5 is an exploded perspective of the Fig. 4 resistor, Fig. 6 is a top plan view of a strip of resistors, Fig. 7 is a diagrammatic side view of apparatus for molding the Fig. 1 resistors as a continuous process, Fig. 8 is an enlarged view of the molding section of the apparatus, Fig. 9 is a top plan view of a strip of the Fig. 4 resistors, Fig. 10 is a side view of apparatus for molding the Fig. 4 resistors as a continuous process, Fig. 11 is a side view of the molding section of the Fig. 10 apparatus, Fig. 12 is a view of one of the leads for the Fig. 1 resistor provided with a kink or bent section to mechanically anchor the lead in the plastic case, and Fig. 13 is a view of one of the leads for the Fig. 4 resistor provided with an anchoring section.

In Fig. 1 is shown a fully insulated strip type resistor having a rectangular plastic case **1** with leads **2** and **3** extending crosswise through the body of the case at each end. The leads **2** and **3** may project from only one edge of the case or from both edges as shown in Fig. 1.

Within the plastic case is a strip or film type resistor comprising a narrow fibrous tape **4** coated with resistance material **5** which may for example consist of a mixture of carbon black or graphite and a resin binder. The film type resistance coatings are well known and may have a wide variety of compositions depending upon the desired characteristics of the resistor. The resistance film **5** may be applied by a suitable coating technique, such as spraying, brushing, rolling or screening. While the resistance coating will usually be applied in liquid form, powdered coatings have been used. The tape **4** carrying the resistance coating **5** may be made of paper or textile fibers. Asbestos fibers have been used. The tape merely serves as a carrier for the resistance film coating **5**. Other strip resistors for example those having a mixture of carbon black or graphite and flexible plastic are self-supporting and do not require the additional support of a tape. The flexible plastic may be flexible after curing or it may be flexible in the uncured state, such as some of the alkyd resins. There of course is no necessity for flexibility of the strip resistor after the resistor is molded into the plastic case **1**.

At the ends of the tape where electrical contact is to be made to the leads **2** and **3**, the resistance coating **5** is overcoated with a layer **6** of conductive paste, which may for example consist of finely divided metallic particles and a resin binder. Such conductive pastes are well known. The purpose of the coating **6** is to make good electrical contact to the resistance coating **5** and to the leads **2** or

3. Instead of applying the conductive coating **6** to the resistor, the same results are obtained by applying the conductive paste directly to the leads. Aquadag or similar colloidal graphite coatings on the leads have been used. The conductive coatings are preferably applied to the leads and to the resistance coating so as to insure good contact between the leads and the resistance.

The plastic case as indicated in Fig. 2 may comprise two rectangular sections **7** and **8** of uncured or partially cured or even fully cured plastic. The plastic sections **7** and **8** are longer and wider than the tape **4** so that when the tape with the leads **2** and **3** resting on the coatings **6** and **7** is sandwiched between the plastic sections **7** and **8** and the sections **7** and **8** are joined together under molding conditions the resistance tape is surrounded on all sides by the plastic case. The plastic sections **7** and **8** may be made of any suitable plastic. Feltlike paper fibers impregnated with uncured or partially cured phenolic resin can be easily cut to the desired shape and will join together under molding conditions to produce the insulating case surrounding the resistance tape. The selection of the plastic is however determined by the molding conditions and by the desired electrical properties in the finished product.

The plastic sections **7** and **8** whether cut out of sheets of feltlike plastic impregnated material or otherwise made are in the nature of preforms. If the plastic sections **7** and **8** are made out of fully cured material it will usually be necessary to coat the adjacent faces which are to join together with an adhesive.

While the resistor **4—6** is shown in Fig. 2 below the leads **2**, **3**, it could be inverted so as to rest on top of the leads. Also the resistor could be supported on one of the plastic sections **7**, **8**, in which case if the plastic section had sufficient rigidity prior to molding the resistance coating **5** could be applied directly to the plastic section. The leads **2**, **3** are more firmly anchored and the distortion of the strip resistance **4** during molding which might interfere with the electrical properties is minimized by having projections **2***a* and **3***a* above and below the leads.

The resistor shown in Figs. 4 and 5 is of the same construction as the resistors shown in Figs. 1 to 3. The sole difference being in the leads **9** and **10** which come out of each end of the insulating case **1**. Projections **9***a* and **10***a* above and below the leads have the same function as the projections **2***a*, **3***a*.

Both resistors illustrated are adapted to continuous manufacture. As shown in Figs. 6–8, the manufacture of the Fig. 1 resistor can be carried out by using spaced wires **11** and **12** which are subsequently to form the leads **2** and **3** as a conveyer. At spaced intervals, the strip or tape resistor **4** with the registering plastic sections **7** and **8** are brought into contact with each other and the wires and are cured between hinged mold sections **13** which are pressed together by rolls **14**. Before the wires **11** and **12** are cut to form the leads **2** and **3**, the molded plastic case can be passed over color coating rolls **15**.

In the apparatus shown in Figs. 9–11 for making the Fig. 4 resistor there are rolls **16** and **17** of feltlike paper impregnated with plastic. The paper **18** unwound from the lower roll **17** serves as a conveyer and at spaced intervals the strip or tape resistors **4** with the leads **9** and **10** registering with the conductive cement coating **6** are placed on the paper **18**. The spacing of the tape resistors is such that after the upper sheet of paper **19** is joined to the paper **18** by passing through the opposed hinged mold sections **20**, there is sufficient space between the tape resistors so that the molded strip can be cut into individual resistors. The cutting of the strip into individual resistors is a step following the color coating rolls **15**.

Figs. 12 and 13 show expedients which may be used to provide a more secure anchoring of the leads. In Fig.

12, the lead 2 (or the wires 11 or 12 which are to form the leads) are provided with bent sections or kinks 21 which when embedded in the plastic case 1 mechanically anchor the leads. The bent sections 21 contact the conductive coatings 6. In Fig. 13 the lead 9 has a hook 22 which is embedded in the plastic case 1 to anchor the lead. The mechanical anchoring is effected by almost any irregularity in the leads.

What is claimed as new is:

1. A resistor comprising a tape, a resistance coating on the tape, conductive cement coatings overlying the resistance coating at the ends of the tape, leads on the conductive cement and extending away from the resistance coating, and top and bottom plastic sheets longer and wider than the tape, the tape with the leads thereon being sandwiched between the sheets and the sheets being consolidated around the sides and ends of the tape to form an insulating case, the plastic sheets initially having a projected area substantially equal to the projected area of the finished case and holding the leads in contact with the conductive cement.

2. A resistor comprising a tape, a resistance coating on the tape, conductive cement coatings overlying the resistance coating at the ends of the tape, generally parallel leads on the conductive cement and extending transverse to the length of the tape, and top and bottom plastic sheets longer and wider than the tape, the tape with the leads thereon being sandwiched between the sheets and the sheets being consolidated around the sides and ends of the tape to form an insulating case, the plastic sheets initially having a projected area substantially equal to the projected area of the finished case and holding the leads in contact with the conductive cement.

3. The method of making resistors from tapes carrying resistance coatings with overlying conductive cement coatings at the ends of the tapes which comprises arranging the tapes at spaced intervals crosswise of parallel wires with the conductive cement coatings registering with the wires, sandwiching the tapes between plastic sheets longer and wider than the tapes and curing the plastic sheets together around the sides and ends of the tapes by pressure transverse to the wires to form insulating cases, and severing the wires between the insulating cases to form individual resistors with leads projecting from the edges of the cases.

4. The method of making resistors from tapes carrying resistance coatings with overlying conductive cement coatings at the ends of the tapes which comprises arranging the tapes at spaced intervals crosswise of a strip of plastic of greater width than the length of the tapes, arranging leads at each end of the tapes projecting from the conductive cement outside the plastic strip, molding another strip of plastic against the first strip to sandwich the tapes and leads therebetween and to enclose the tapes on the sides and ends, and severing the molded strips into individual resistors by cutting between the tapes.

5. A resistor comprising a strip of resistance material, leads extending transverse to the length of the strip and in contact with the strip at each end said leads being generally parallel to each other, top and bottom plastic sheets longer and wider than the strip, the strip with the leads thereon being sandwiched between the sheets and the sheets being consolidated around the sides and ends of the strip to form an insulating case, said sheets initially having a projected area substantially equal to the projected area of the finished case, and projections on the case over the leads thickening the case opposite the portions of the leads within the case.

6. A resistor comprising a strip of resistance material, leads extending transverse to the length of the strip and in contact with the strip at each end, said leads being generally parallel to each other, plastic sheets longer and wider than the strip, the strip with the leads thereon being sandwiched between the sheets and the sheets being consolidated around the sides and ends of the strip to form an insulating case, and semicylindrical projections on the top and bottom of the case opposite the leads thickening the case opposite the portions of the leads within the case.

7. A resistor comprising a strip of resistance material, conductive cement coatings overlying the strip at each end, leads extending away from and in contact with the conductive cement coatings on the strip at each end, top and bottom plastic sheets longer and wider than the strip, the strip with the leads thereon being sandwiched between the sheets and the sheets being consolidated around the sides and ends of the strip to form an insulating case and the consolidated plastic holding the leads in contact with the conductive cement, said sheets initially having a projected area substantially equal to the projected area of the finished case, and projections on the case over the leads thickening the case opposite the portions of the leads within the case.

8. The method of making resistors which comprises arranging resistance material in strip form at spaced intervals crosswise of parallel wires and sandwiching the strips between plastic sheets longer and wider than the strips, curing the plastic sheets together around the sides and ends of the strips by pressure transverse to the wires to form insulating cases for the individual strips of resistance material, and severing the wires between the insulating cases to form individual resistors with leads projecting from the edges of the cases.

9. The method of making resistors which comprises arranging strips of resistance material at spaced intervals crosswise of a strip of plastic of greater width than the length of the strips, arranging leads at each end of the strips of resistance material, molding another strip of plastic against the first strip of plastic to sandwich the strips of resistance material and leads therebetween and to enclose the resistance material on the sides and ends, and severing the molded strips of plastic into individual resistors by cutting between the strips of resistance material.

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