May 4, 1948. G. E. MEGOW ET AL 2,440,806

PRESSURE-MOLDING APPARATUS

Original Filed July 15, 1937 2 Sheets-Sheet 1

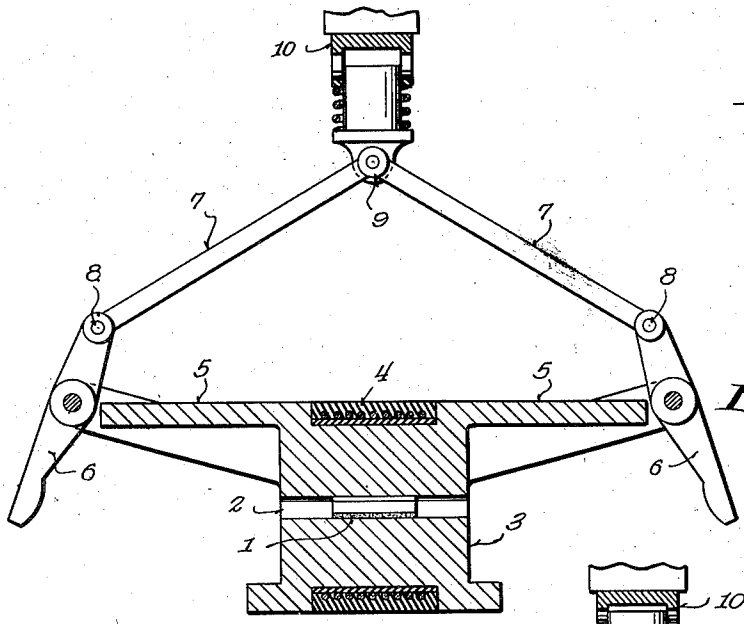


Fig. 2

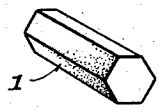


Fig. 1

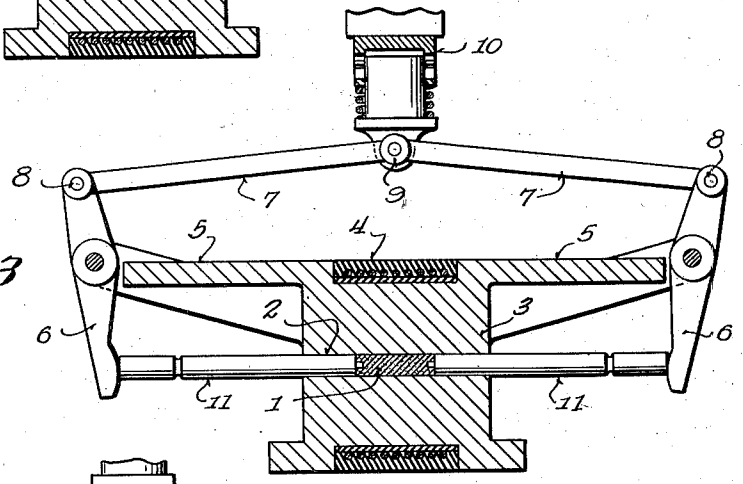


Fig. 3

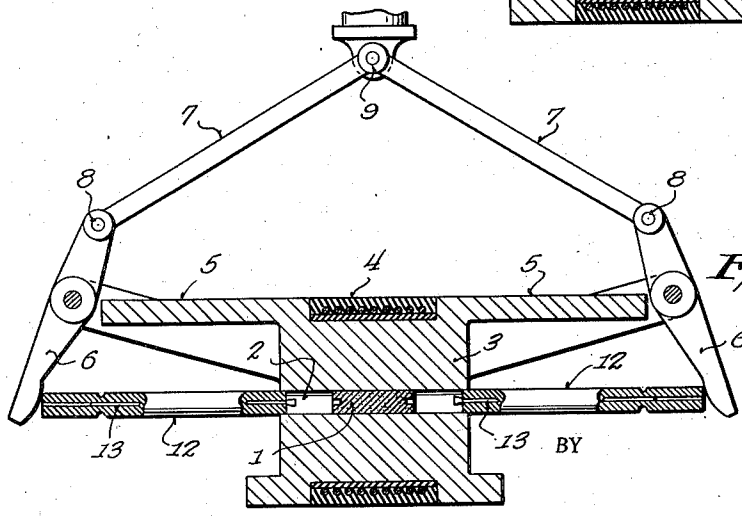


Fig. 4

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Fig. 5

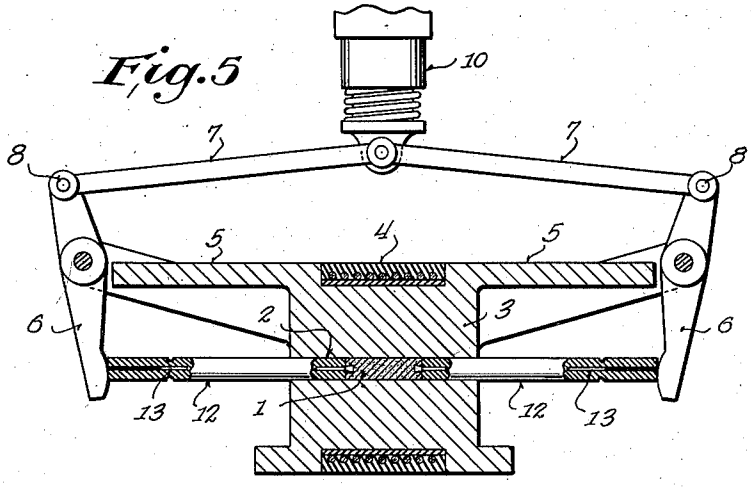


Fig. 6

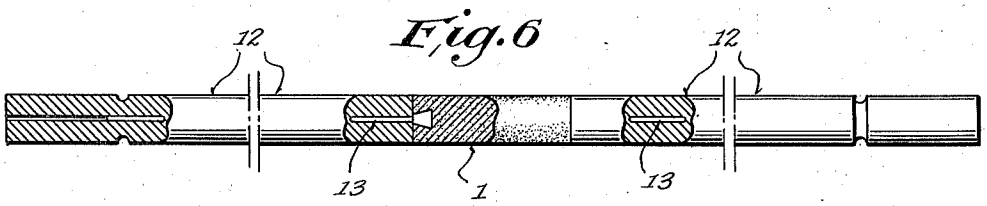


Fig. 7

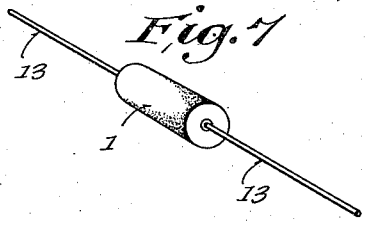


Fig. 8

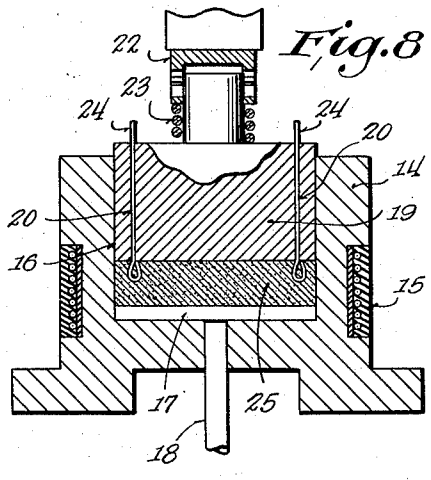
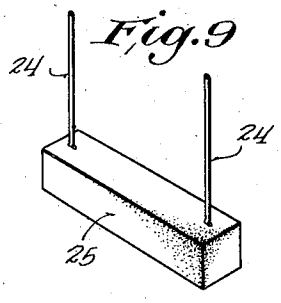


Fig. 9



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PRESSURE-MOLDING APPARATUS

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Original application July 15, 1937, Serial No. 153,746. Divided and this application August 12, 1939, Serial No. 289,724

3 Claims. (Cl. 18—5)

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This invention relates to apparatus for forming molded resistors with terminal leads molded in place therein and resides in a novel arrangement of temperature-controlled molding dies comprising a recessed die and an electrode-embedding plunger die, or dies, movable into said recess die under controlled pressure and to an extent limited only by the volume of the blank being acted upon, this application being a division of our copending application Serial No. 153,746, filed July 15, 1937, now Patent No. 2,261,916.

The apparatus of this invention is particularly well adapted for the manufacture of resistors such as are employed in radio and other communication circuits. In these instances the resistors preferably are small and compact in size, of rugged mechanical strength, and should be of high precision and uniformity in electrical properties. Such resistors, further, must be stable in their properties with respect to changes in time, temperature, and electrical conditions and it is one object of this invention to provide apparatus which will reliably produce such resistors with great repetitive uniformity and at reasonable cost.

Heretofore in the art numerous methods and forms of apparatus have been resorted to for the purpose of molding resistors from a composition containing finely divided conducting material and thermal-setting insulating binders. In all of such apparatus, however, the load or the preformed blank of moldable composition has been placed within a mold of fixed volume or dimension and there treated to set the binder. In such apparatus, minute variations in the volume of the blank or load employed result in disproportionately large variations in the pressure to which the molding material is subjected during treatment. Poor uniformity in mechanical and electrical properties and poor quality in the final resistor follow as the result of use of such apparatus. Further, the use of such apparatus involves the necessity of escape openings or loosely fitted dies, thus precluding the application of high densifying pressures during treatment of the resistor being molded.

Through the use of the apparatus of this invention, however, densifying pressures of any degree desired may be employed and applied in a manner subject to precise control and at the same time terminal leads may be attached to and embedded in the resistor as molding takes place. As a result, resistors having good properties and having a high degree of repetitive uniformity are producible by the apparatus of this invention in a simple manner and at moderate cost.

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This invention is herein described with the aid of the accompanying drawings, which form a part hereof, and by reference to specific instances of embodiments of this invention which are set forth by way of illustration and not of limitation.

In the drawings:

Fig. 1 is a perspective view of a suitable partially condensed blank ready for treatment in one form of the apparatus of this invention;

Fig. 2 is a cross-section of one form of the apparatus of this invention, showing a blank in position ready for treatment but with plunger dies omitted;

Fig. 3 is a cross-section of the apparatus shown in Fig. 2, showing preforming plunger dies in position and acting upon a blank;

Fig. 4 is a cross-section of the apparatus shown in Fig. 2, showing the electrode-embedding plunger dies in position ready to apply final molding pressure to a blank;

Fig. 5 is a cross-section of the apparatus of this invention as shown in Fig. 2, showing molding plungers in final molding position;

Fig. 6 is a detail view showing the relationship of molding plungers to a final molded resistor;

Fig. 7 is a detail perspective view showing a finished resistor as made in the apparatus shown in Fig. 2;

Fig. 8 is a cross-sectional view of another form of the apparatus of this invention; and

Fig. 9 is a detail view of a resistor formed in the apparatus shown in Fig. 8.

Referring to drawings, Figs. 2, 3, 4, and 5, show one form of the apparatus of this invention in several positions assumed by said apparatus under one condition of normal intended use thereof.

Referring more particularly to Fig. 2, the apparatus consists of a die-block 3 pierced by a cylindrical opening 2 which passes therethrough from side to side. The cylindrical opening 2, as hereinafter more fully described, serves as a recessed die member. Surrounding the cylindrical opening 2 an electrical resistance heating element 4 is provided, by means of which the material of the die-block 3, preferably steel, may be brought to and maintained at any temperature desired. Projecting laterally from the die-block 3 is a pair of supporting arms 5 in which rocker-arms 6 are pivotally mounted. The up-

per ends of the rockers 6 are pin-connected by means of the pins 8 with toggle-links 7, which pivotally join and engage the spring-backed pressure-foot 10 at the pin 9, as shown.

Lodged in the cylindrical opening 2 there is shown in Fig. 2, in position to be acted upon by the apparatus of this invention, a suitable blank composed of partially condensed bonding material and conducting material, designated by the numeral 1. A detail perspective view of the blank 1 is set forth in Fig. 1.

To complete the apparatus of this invention, a pair of plunger dies is provided. These may take a form appropriate to the operation which is desired to be performed upon the blank 1. For example, the plunger dies may be in the form of preforming plunger dies, as shown in Fig. 3, the same being designated by the numeral 11.

It will be noted from an examination of Fig. 3 that the plunger dies 11 act toward one another, applying pressure to the blank 1, the travel of said plunger dies being limited only by the volume occupied by said blank. In this way the blank 1 may be treated under pressure at the temperature desired and at the same time the pressure applied may be regulated entirely through pressure applied through pressure-foot 10, independently of small variations in volume of the blank 1. To this end the pressure-foot 10 is arranged to act through the compression spring or equivalent means, as shown, so that pressure may be applied and maintained more or less independently of slight shifting in the location of the parts.

The apparatus of this invention may also be employed for the purpose of embedding and fastening electrodes in blank 1. For this purpose a pair of plunger dies may be furnished as shown in Fig. 4, the same being centrally bored to receive headed wire electrodes. The plunger dies in Fig. 4 are designated by the numeral 12, while the wire electrodes received in the central bores in said plunger dies are designated by the numeral 13.

Upon applying pressure through pressure-foot 10, electrode-embedding plunger dies 12 approach one another and embed electrodes 13 into the blank 1, as shown in Fig. 5. In so doing, controlled application of heat and pressure may be obtained, as explained above, regardless of small variations in the volume of blank 1. In the case of blanks made of thermal-setting insulating binder and conductor particles, precise control of the temperature applied and the pressure is important in obtaining uniformity of electrical and mechanical properties.

The relationship of electrode-embedding plunger dies 12 to the blank 1 during such molding operation is clearly shown in detailed view in Fig. 6.

At the end of the treatment the molded resistor with embedded electrodes and attached plungers is ejected from the recessed die. The plungers are then stripped from the electrodes, yielding the finished resistor.

A typical resistor formed by the apparatus of this invention is shown in perspective in Fig. 7.

Another form of the apparatus of this invention is shown in Fig. 8, the same comprising a die block 14 having a recessed opening 16 which opens in but one direction. The bottom of opening 16 is closed by ejecting shoe 17, which may be actuated by ejection-rod 18, which projects downwardly through the bottom of die-block 14. The die-block 14 is surrounded, as shown, by a heating element 15, which is of conventional construction, heat being applied thereto through electrical resistance heating wires, as shown. Cooperatively engaging die recess 16 is a plunger die 19, having openings therethrough for the accommodation of the wire electrodes 24. Plunger die 19 is engaged by a spring-backed pressure-foot 22, which resiliently engages said plunger die through the spring 23. It will be observed that a blank 25, composed of thermal-setting insulating binder with conductor particles dispersed therein may be treated under controlled temperature and pressure in this form of the apparatus of the invention. At the same time electrodes 24 may be embedded in said blank 25 simultaneously with the molding treatment. A typical resistor formed by the apparatus shown in Fig. 8 is shown in perspective in Fig. 9.

Heretofore in the art, in apparatus employed for molding articles from thermal-setting composition said molds have been of the fixed-volume type, or have consisted of multiple recess molds in which a large number of articles are molded simultaneously. In either form of such apparatus uniform application of pressure to each article molded has been impossible, due to the fact that the pressure applied is to a substantial extent a function of the volume of the blank being acted upon. For many purposes such variation in molding pressure is not particularly disadvantageous, but in the case of molded electrical resistors, where uniformity and predictability of electrical properties are matters of primary concern, such variations in pressure cannot be tolerated. Applicants, on the other hand, have discovered through the use of the apparatus herein described that molding pressure may be controlled with great uniformity and that resistors may be produced in such apparatus having markedly improved uniformity of electrical properties. At the same time, substantial improvements in the strength and other physical properties of the molded article produced is experienced.

It is intended that the protection of Letters Patent afforded hereby extend to the full extent of the inventive concept herein set forth as represented by the scope of the claims hereto appended.

That which we claim as our invention and wish to secure by Letters Patent is:

1. In an apparatus for causing embedment of the laterally-extending heads of headed wire leads in a body of moldable resistance material while said body of resistance material is being heated and pressed to shape, a recessed die-block having a rectilinear passage therethrough open in two directions, means for heating said block, a pair of plunger dies having inner ends adapted to enter the opposite openings of said passage in close-fitting engagement therewith for applying molding pressure to a blank of resistance material contained in said passage between said plungers without substantial escape of said material beyond the pressure faces of said plungers, said plungers being longitudinally bored to receive the wire shank portions of headed wire leads without imposing endwise compression stress thereon and having adjacent said bores at the inner ends of said plungers means for engaging and preventing backward displacement of the laterally-extending heads of said leads, at least one of said plungers having a cross-section at no place greater than the cross-section of said passage so that said plunger after completion of its working stroke is adapted to be passed through and removed from the end of said passage opposite the end through

which it entered, and means adapted to press against the outward ends of said plungers for causing said plungers to act toward one another upon said blank, said means for causing said plungers to act being retractable with respect to said passage to permit complete bodily ejection of said blank when molded and said plungers from said passage as a unit by causing one of said plungers to pass completely through and out of said passage.

2. In an apparatus for causing embedment of the laterally-extending heads of headed wire leads in a body of moldable resistance material while said body of resistance material is being pressed to shape, a recessed die-block having a rectilinear passage therethrough open in two directions, a pair of plunger dies having inner ends adapted to enter the opposite openings of said passage in close-fitting engagement therewith for applying molding pressure to a blank of resistance material contained in said passage between said plungers without substantial escape of said material beyond the pressure faces of said plungers, said plungers being longitudinally bored to receive the wire shank portions of headed wire leads without imposing endwise compression stress thereon and having adjacent said bores at the inner ends of said plungers means for engaging and preventing backward displacement of the laterally-extending heads of said leads, and means adapted to press against the outward ends of said plungers for causing said plungers to act toward one another upon said blank, at least one of said plungers having a cross-section at no place greater than the cross-section of said passage so that said plunger after completing its work stroke is adapted to be passed through and removed from the end of said passage opposite the end through which it entered, said means for causing said plungers to act being retractable with respect to said passage to permit complete bodily ejection of said blank when molded and said plungers from said passage as a unit by causing one of said plungers to pass completely through and out of said passage.

3. In an apparatus for causing embedment of the ends of spaced leads in a molded body, a recessed die-block having a passage therethrough open in two directions, a pair of plungers adapted to enter the opposite ends of said passage and to act toward one another, said plungers being adapted to hold leads to be embedded with the ends of said leads projecting beyond the ends of said plungers, at least one of said plungers having a cross-section at no place greater than the cross-section of said passage so that said plunger after completing its work stroke is adapted to be passed through and removed from the end of said passage opposite the end through which it entered, and means for causing said plungers to act with relation to one another toward one another in said passage upon a blank contained therein, said means being retractable with respect to said passage to permit complete bodily ejection of said blank when molded and said plungers from said passage as a unit by causing one of said plungers to pass completely through and out of said passage.

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HOMER G. THOMSON.

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