

Feb. 3, 1942.

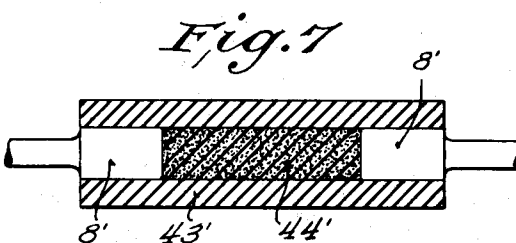
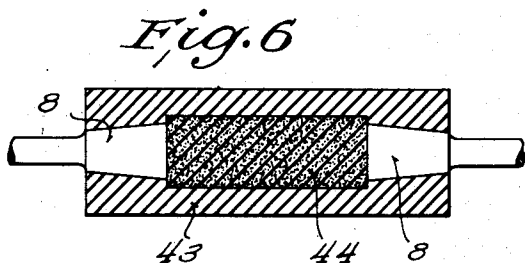
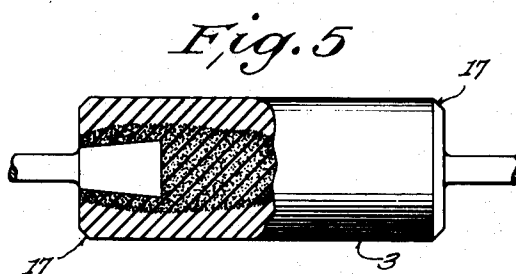
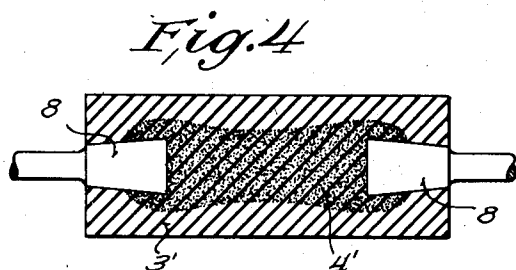
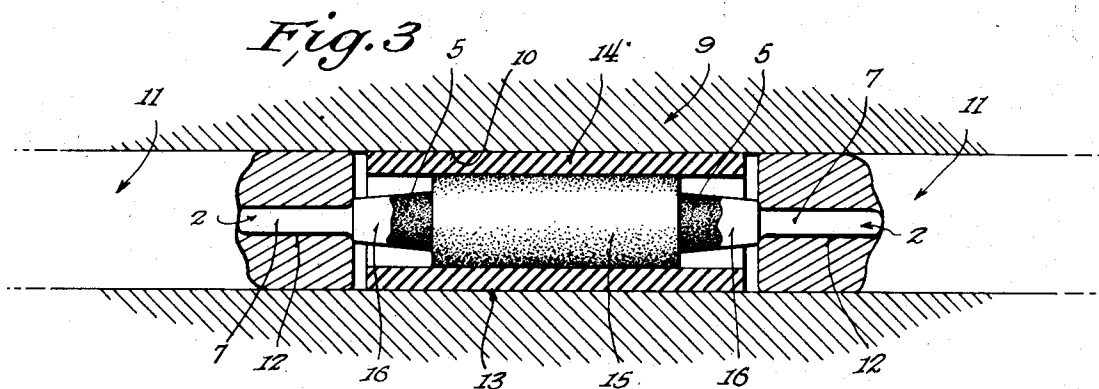
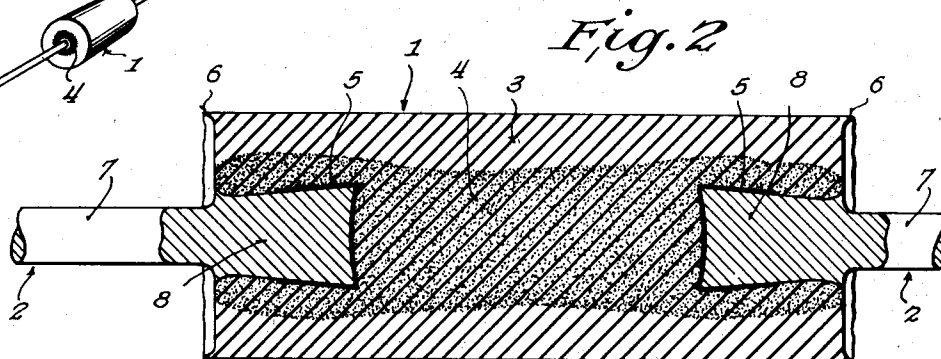
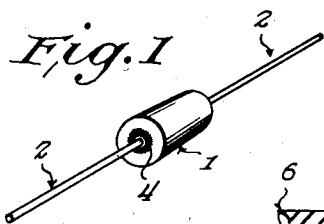
G. E. MEGOW ET AL

2,271,774

MOLDED INSULATED RESISTOR

Filed March 9, 1939

3 Sheets-Sheet 1



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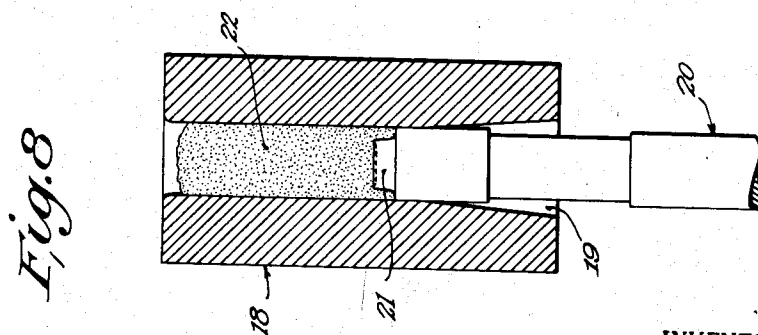
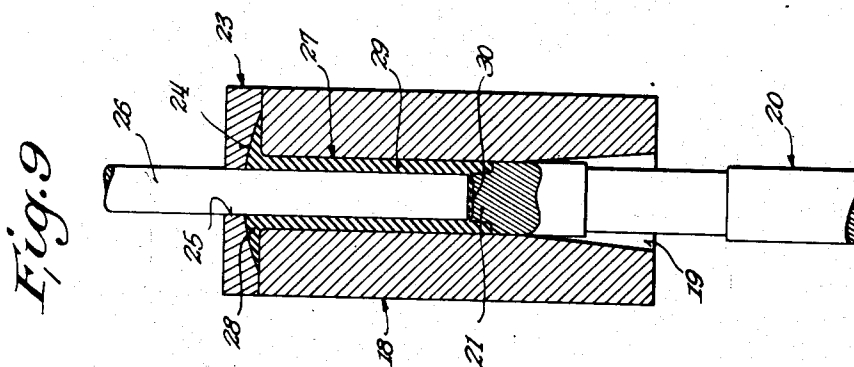
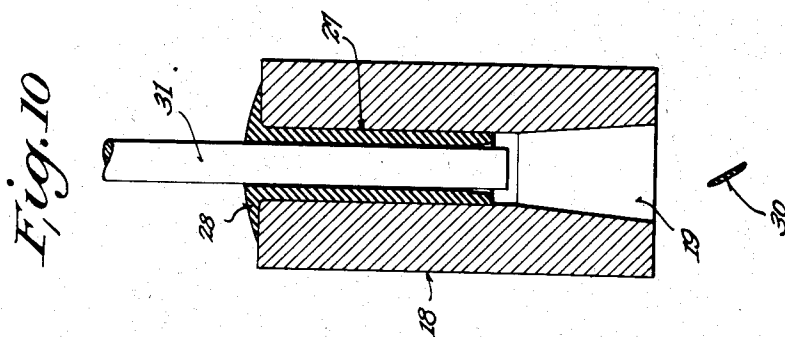
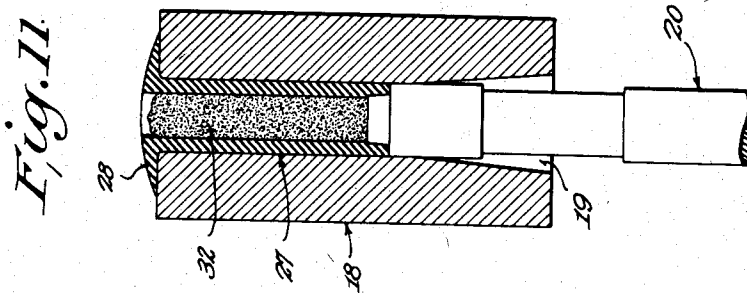
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MOLDED INSULATED RESISTOR

2,271,774

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3 Sheets-Sheet 2



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Feb. 3, 1942.

G. E. MEGOW ET AL
MOLDED INSULATED RESISTOR

2,271,774

Filed March 9, 1939

3 Sheets-Sheet 3

Fig. 15

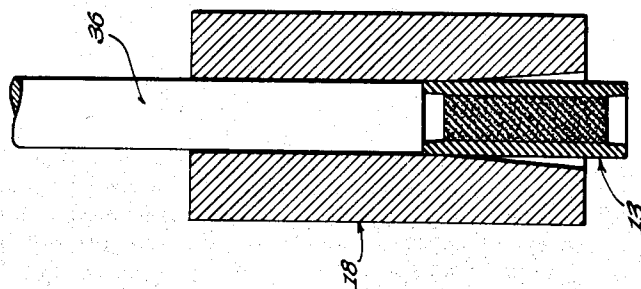


Fig. 14

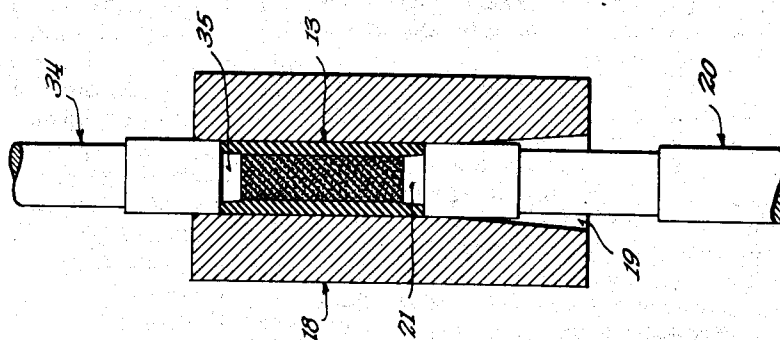


Fig. 13

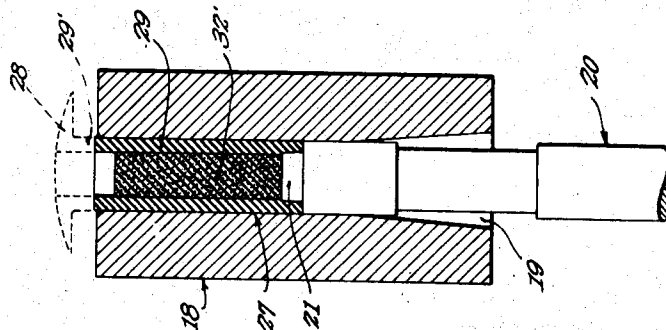
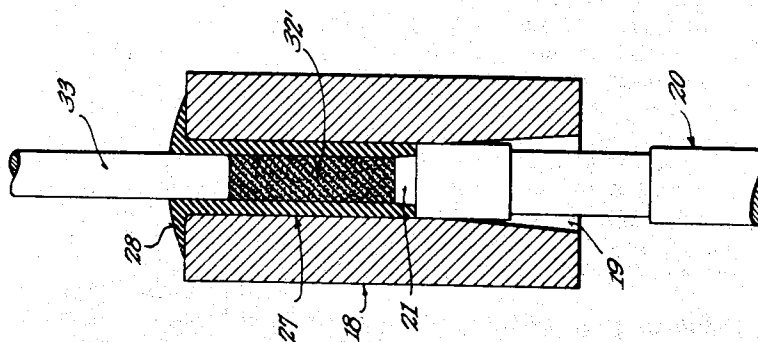


Fig. 12



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UNITED STATES PATENT OFFICE

2,271,774

MOLDED INSULATED RESISTOR

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Application March 9, 1939, Serial No. 260,756

7 Claims. (Cl. 201—64)

This invention relates in general to a molded insulated electrical resistor and in particular to resistors of this type as used in radio receiver circuits, or in other communication circuits.

The present types of radio receivers commonly require from six to twenty or more fixed resistors together with numerous other component parts, such as condensers, inductors, electronic tubes, tube receptacles, switch devices, and connecting leads. These different component parts are all assembled quite closely together on the chassis of the radio receiver. In numerous cases a comparatively high potential, 350 volts or over, is present in the various electrical devices and it is therefore necessary that the various component parts be properly insulated.

In some instances this problem has been solved in a large way by reducing the size of the component parts and by careful arrangement of the terminal connections and of the wire connectors. However, such a solution makes imperative skillful assembly of the different parts.

Prior to the introduction of this invention, the predominating practice in the manufacture of insulated resistors was to merely cover the then available noninsulated resistor with an insulating material. In practically all cases the noninsulated structure was complete in itself and did not rely on the insulating material for the principal support of the terminals except in the case of the so-called filament type resistor. It should be noted, however, that in the filament type the terminals are attached to, and electrically connected with, the resistor core, forming a complete noninsulated resistor which is then covered with insulating material. In effect, all of the processes employed required that first a noninsulated resistor with attached terminals be formed and then properly insulated.

A method has also heretofore been employed in which the insulated structure is obtained by means of an assembly of nonintegrally united parts. This structure consists essentially of a finished, noninsulated resistor core (with leads and with or without low resistance ends or terminals) placed within an insulating sleeve and there held by friction or other restraining means. In an assembled structure of this type, numerous modifications have been resorted to. The terminals have been used to lock the insulating sleeve in place, the insulating sleeve has been used to provide additional support for the core and terminals, or the insulating sleeve has been cemented to the core and/or terminals. The methods employed in manufacturing the insulated resistors made prior to this invention are expensive.

An important object of this invention is the obtainment of a molded electrical resistor insu-

lated to obviate the above difficulty, which resistor is of strong mechanical design, which has good electrical properties and which is of an efficient small size.

A particular object of this invention is the obtainment of an insulated resistor having the manufacturing and structural features of the noninsulated type disclosed in our pending application, Serial No. 153,746, filed July 15, 1937.

It is a further particular object of this invention to obtain an insulating jacket surrounding the body of the resistor, which jacket and resistor are bonded together into an integral form.

It is also an object of this invention to obtain a molded insulated resistor in which insulation has been obtained without the sacrifice of other desirable electrical and mechanical properties.

Another further particular object of this invention is the obtainment of a molded insulated resistor which has the very minimum of parts, namely, core, insulating jacket and terminals.

The invention may be practiced in one mode by producing a preform of moldable compound having an inner core of resistance material and an outer cylindrical sleeve of insulation material.

In order to clearly describe our invention, reference is made to the following drawings forming a part hereof, from which, in connection with the description following, it will be apparent that many economies in manufacture and other advantages have been secured through our invention.

In the drawings:

Fig. 1 shows a complete resistor of this invention;

Fig. 2 shows an enlarged sectionalized view of the body of the resistor in its preferred form;

Fig. 3 shows the component parts of the resistor in the molding die just prior to the molding operation;

Fig. 4 shows in section a view of the resistor body in a modified form;

Fig. 5 shows in partial section a view of the resistor body having the ends chamfered;

Figs. 6 and 7 show in section two further modified forms of the resistor;

Figs. 8 to 15, inclusive, show the various steps employed in forming the resistor preform.

Referring more particularly to the drawings:

Fig. 1 shows the complete insulated resistor consisting of an insulated resistor body 1 and terminals 2, 2.

Fig. 2 shows the preferred form of the insulated resistor in which the terminals 2, 2 each have a shank or lead wire portion 7 and embedded head portion 8. The insulated resistor body 1 consists of an insulating sleeve 3 and a conducting core 4. The insulating portion has two circumferential flashes 6, 6. Spaced intermediate between the end portion of each em-

bedded head 8 and the conducting core 4 is a film of contact material 5.

Fig. 3 shows the manner in which the insulated resistor is formed. The moldable insulated resistor preform 13, consisting of moldable insulation material 14 and moldable resistor material 15, is placed in the aperture 10 of heated die block 9. Molding pins 11, 11 having centrally located apertures 12, 12 each carry a terminal 2 with shank or lead wire portion 7, each head portion 16 being coated with contact material 5. The molding pins 11 with their respective terminals are placed in the die block aperture 10 and pressure is exerted upon the insulated resistor preform 13.

Figs. 4 and 6, consisting of insulating sleeves 3 and 43, respectively, conducting cores 4 and 44, respectively, and lead wire heads 8, 8, show two modified forms of this invention. For example, the form shown in Fig. 4 can be obtained by increasing the proportion of insulating material 14 to conducting material 15 in the preform 13 shown in Fig. 3, or by altering the flow characteristics of the two moldable materials. Fig. 6 shows a form, molded from preform 13, in which the conducting material 15 had either no flow or substantially zero flow with respect to the insulating material 14.

Fig. 7 consisting of insulating sleeve 43', conducting core 44', and lead wire heads 8', 8' shows a form molded from preform 13 in which the insulating material 14 had substantially zero flow and the lead wire heads 8', 8' are pressed into the insulating sleeve 14.

Fig. 5 shows a modification of the form shown in Fig. 2, the chamfer 17, 17 being ground on each end of the insulated resistor sleeve 3 to remove the circumferential flash 6, 6 shown in Fig. 2. This chamfer is ground on each end to remove small particles of conducting material that might become embedded near the flash 6, 6 during the forming and molding operations.

Figs. 8 to 15, inclusive, show the steps in forming the insulated resistor preform 13. The heated preform die 18 with lower punch 20 inserted in aperture 19 is loaded with the proper amount of moldable insulation powder 22, as shown in Fig. 8.

Substantially 7 seconds later the collar-forming tool 23, shown in Fig. 9, having concave recess 24 and circular hole 25 centrally located with respect to aperture 19, is placed over the top of the preform die 18, and the round tube-forming punch 26 is inserted through the collar-forming tool 23 and into the insulation powder 22, shown in Fig. 8, causing it to flow into the form 27, shown in Fig. 9. As the tube-forming punch 26 completes its stroke, it leaves a thin disc of flash 30 between the end of the tube-forming punch 26 and the tip 21 of the lower preform punch 20. The tube-forming punch 26 is withdrawn and then the collar-forming tool 23 is lifted from the preform die 18, leaving a formed insulation piece 27 consisting of sleeve portion 29, collar 28, and flash 30 in preform die 18.

After a total elapsed time of approximately seventy-one seconds, the lower preform punch 20, shown in Fig. 9, is removed from aperture 19 and punch 31 removes flash 30, as shown in Fig. 10.

Following the removal of the flash 30, the lower preform punch 20 is returned to its original position and the proper quantity of moldable resistor powder 32 is loaded into the formed insulation pieces 27, as shown in Fig. 11, and

pressed rigidly into a semi-solid 32' by means of punch 33, shown in Fig. 12.

After proper loading with moldable resistor powder 32, the formed insulation piece 27 and moldable resistor core 32' are lifted sufficiently by means of the lower preform punch 20 so that the insulation collar 28 and any excess insulation sleeve material 29' can be cut off and discarded. This is shown in Fig. 13 with the discarded portion in broken line.

Fig. 14 shows the final forming operation by means of preform punches 20 and 34 firmly pressing the insulation sleeve 29 and moldable resistor core 32, shown in Fig. 13, into resistor preform 13, with a recess in each end formed by the tip 21 of the lower preform punch 20 and the tip 35 of the top preform punch 34. The lower punch 20 is then removed from aperture 19 and the completely formed preform 13 is ejected by means of punch 36 shown in Fig. 15.

Under certain conditions it has proven to be advantageous to utilize the entire length of the insulation piece 27 and to only discard a portion of insulation collar 28. This can readily be accomplished by omitting the operation shown in Fig. 13 and with the insulation piece 27 and moldable resistor core 32' in place, as shown in Fig. 12, removing punch 33 and then by means of the top-forming punch 34 simultaneously piercing the collar 28 and completing the final forming operation shown in Fig. 14.

It will be apparent to one skilled in the art that the method of forming an insulated resistor preform disclosed above lends itself readily to automatic production and is capable of many modifications. The preform produced by this method is formed into a complete resistor by the same method that is disclosed in our pending application, Serial No. 153,746, filed July 15, 1937.

The insulation material used may consist of any suitable thermal-setting insulating composition, such as one consisting of a phenol-aldehyde resin binder, quartz filler, and a lubricant, such as stearic acid. A suitable mix for this material is as follows:

Phenol-aldehyde resin (such as #175 Durez resin).....	lbs..	3
Ground quartz.....	lbs..	12
Lubricant.....	gms..	136

This material is mixed by rolling on a hot mixing roll until it acquires the proper plasticity. After cooling, the sheets are crushed and ground to a powder suitable for loading into the preform die.

The resistor material used may consist of conductor particles dispersed in an insulating thermal-setting binder, such as may be made from phenol-aldehyde resin binder, quartz filler, calcined carbon black, and a lubricant. An example of a suitable composition is as follows:

Phenol-aldehyde resin (such as #175 Durez resin).....	lbs..	4
Ground quartz.....	lbs..	10
Calcined carbon black.....	lbs..	2
Lubricant.....	gms..	136

This material may be mixed by rolling on a hot mixing roll until it acquires the proper plasticity. After cooling, the sheets are crushed and ground to a powder suitable for loading into the insulation sleeve.

In using the insulating compound referred to above, the die temperature may be maintained between 250 degrees F. and 450 degrees F., prefer-

ably at 300 degrees F., and the forming operations are carried out at time intervals, controlled in accordance with treating temperature. Where a temperature of 300 degrees F. is used the operation may be carried out according to the following preferred schedule:

Insulation powder load.....sec..	0
Insulation form.....sec..	7
Flash removed.....sec..	71
Resistor powder load.....sec..	95
Insulation collar removed.....sec..	103
Final forming.....sec..	112
Ejected.....sec..	122

In the preferred form the preform 13 includes an insulating sleeve portion 14 and resistor core portion 15 so preliminarily mixed and heat-treated that it is possible by the application of further heat and pressure to embed the lead wire heads 16—16 and to cause the insulation material and resistor material to form into a continuous integral piece, as shown in Fig. 2 where the resistor body clearly appears as being made up of a supporting framework of insulating material in the form of a sleeve having an integrally continuous, minutely cellular inner core in the cells of which core the conductor particles are lodged.

At the temperature used and with the pressure applied in the final molding operation, a flowage of the insulation material 14 and resistor material 15 takes place whereby in the finished resistor an integral structure is formed; that is, the insulation material and resistor material are united at their juncture. In the claims of this application, "integral" is used to mean united by autogenous adhesion, that is to say, more than a press fit or a superficial assembly of parts.

If desired, by adjusting the plasticity of the core material or the sleeve material, or both, there is easily obtainable a wide range of modified forms of this invention, ranging from the preferred form described in detail and shown in Fig. 2 to the form shown in Fig. 7. The conducting core portion may also be a conducting powder that does not exhibit plastic flow, or a solid resistor core loaded into the moldable insulation sleeve and then molded into an insulated resistor of the form shown in Fig. 6.

Even though the forms disclosed all show that the resistors are molded by an endwise molding operation, the invention is not limited to molding pressure applied in any particular direction, or to endwise embedment of the terminals. It has been found that the method shown is extremely practical and well adapted to completely automatic machine production of insulated resistors at a rate of more than 3600 units per hour. The simplicity of the various operations and the resistor structure all contribute to make this possible.

By means of this invention it is possible to completely form an insulated resistor without the necessity of first manufacturing a noninsulated resistor. The insulated feature of the finished resistor of this invention begins to take form simultaneously with the preforming of the resistor core. The process of the invention provides for a more economical utilization of the component parts that are used to form the insulated resistor and each component enters the structure in such form and at such stages as to provide for each a high degree of functional utility. The embedment of the terminals and

final formation of the insulating sleeve and resistor core occur together, the insulating sleeve material and resistor core material forming an integral molded piece in which the two materials are mechanically continuous.

Without departing from the spirit of the invention, the molding properties of the resistor material can be altered sufficiently so that structural discontinuity can exist between the insulating and resistor material. This alteration can continue to the point where the resistor material is added as a formed core and the embedded terminal is held in contact with the resistor core by means of the insulating sleeve material.

Although in the preferred form of this invention the insulating sleeve material and resistor core material both flux to form an integral molded piece, it is not intended that the coverage hereof be limited thereto since the invention contemplates the forming of an insulated resistor in which the terminals are placed in contact with the resistor core or resistor core-forming material and anchored or embedded by plastic deformation and flow of either the resistor core material, the insulating sleeve material, or both.

Inasmuch as many changes may be made in the above construction and many apparently widely different embodiments of this invention may be made without departing from the principles thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not by way of limitation and the protection of Letters Patent granted hereunder extend to the limits of the invention as defined by the claims hereto appended.

What we claim as our invention is:

1. In an insulated resistor of the class described, a supporting and insulating framework for a core of dispersed conductor particles comprising insulating material containing polymerized resin binder in the form of a solid sleeve integrally continuous with a minutely cellular inner core, minute conductor particles embedded in said cells distributed throughout said core to form a conducting path surrounded by insulating material, electrode sockets in opposite ends of said core, said sockets having inwardly extending portions along the sides thereof, and electrodes having heads embedded in said sockets, said heads having lateral extensions thereon in engagement with said inwardly extending portions of said sockets to preclude removal of said heads, said framework being in the shape of a straight-sided elongated body with transverse ends with chamfers at the juncture between the side surfaces and the end surfaces.

2. In an insulated resistor of the class described, a supporting framework for a core of dispersed conductor particles comprising insulating material containing polymerized resin binder in the form of a solid sleeve integrally continuous with a minutely cellular inner core, minute conductor particles embedded in said cells and distributed throughout said core to form a conducting path surrounded by insulating material, electrode sockets in opposite ends of said core, said sockets having a major transverse dimension sufficient to substantially subtend the transverse dimension of said core and electrodes having heads provided with retention surfaces which spread with respect to the principal axis of said heads outwardly toward the inner ends of said heads, said electrodes being embedded in said sockets with their inner ends in the bottoms of

said sockets, said sockets and said heads being of such configuration as to be mutual impressions of one another.

3. In an insulated resistor of the class described, a supporting framework for a core of dispersed conductor particles comprising insulating material containing polymerized resin binder in the form of a solid sleeve integrally continuous with a minutely cellular inner core, minute conductor particles embedded in said cells and distributed throughout said core to form a conducting path surrounded by insulating material, electrode sockets in opposite ends of said core, said sockets having a major transverse dimension which is a major fraction of the transverse dimension of said core, and electrodes having heads provided with retention surfaces which spread with respect to the principal axis of said heads outwardly toward the inner ends of said heads, said electrodes being embedded in said sockets with their inner ends in the bottoms of said sockets, said sockets and said heads being of such configuration as to be mutual impressions on one another.

4. In a resistor of the class described, a unitary body having a sleeve-like jacket composed of insulating material containing polymerized resin binder integrally united with a longitudinally extending inner core composed of conductor particles dispersed in a binder of polymerized resin, a pair of spaced electrodes axially disposed with respect to said body, one of said electrodes being embedded in each end of said body, the embedded portions of said electrodes having transverse dimensions sufficient to subtend the ends of said core, the ends of said terminals being in intimate electrical contact with said core, the sides of the embedded portions of said electrodes being surrounded by the material of said sleeve whereby said electrodes are held permanently in place principally by the strength of the surrounding sleeve material.

5. In a resistor of the class described, a unitary body having a sleeve-like jacket composed of insulating material containing polymerized resin binder integrally united with a longitudinally extending inner core composed of conductor particles dispersed in a binder of polymerized resin, a pair of spaced electrodes axially disposed with respect to said body, one of said electrodes being

imbedded in each end of said body, the imbedded portions of said electrodes having transverse dimensions sufficient to substantially subtend the ends of said core, the ends of said terminals being in intimate electrical contact with said core, the sides of the imbedded portions of said electrodes being surrounded by the material of said sleeve whereby said electrodes are held permanently in place principally by the strength of the surrounding sleeve material.

6. In a resistor of the class described, a unitary body having a sleeve-like jacket composed of insulating material containing polymerized resin binder integrally united with a longitudinally extending inner core composed of conductor particles dispersed in a binder of polymerized resin, a pair of spaced electrodes axially disposed with respect to said body, one of said electrodes being imbedded in each end of said body, the imbedded portions of said electrodes having transverse dimensions which are a major fraction of the diameter of said core, the ends of said terminals being in intimate electrical contact with said core, the sides of the imbedded portions of said electrodes being surrounded by the material of said sleeve whereby said electrodes are held permanently in place principally by the strength of the surrounding sleeve material.

7. In a resistor of the class described, a unitary body having a sleeve-like jacket composed of insulating material containing polymerized resin binder integrally united with a longitudinally extending inner core composed of conductor particles dispersed in a binder of polymerized resin, a pair of spaced electrodes axially disposed with respect to said body, one of said electrodes being embedded in each end of said body, the embedded portions of said electrodes having transverse dimensions which are a major fraction of the diameter of said core, the embedded portions of said electrodes being in intimate electrical contact with said core material and surrounded thereby, the portions of said core material surrounding the sides of said embedded portions being surrounded by the material of said sleeve whereby said sleeve material serves to provide the principal strength for holding said electrodes in place.

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