

Dec. 12, 1961

G. P. McKNIGHT

3,013,240

RESISTORS AND METHOD OF MANUFACTURE

Filed Oct. 27, 1959

Fig. 4

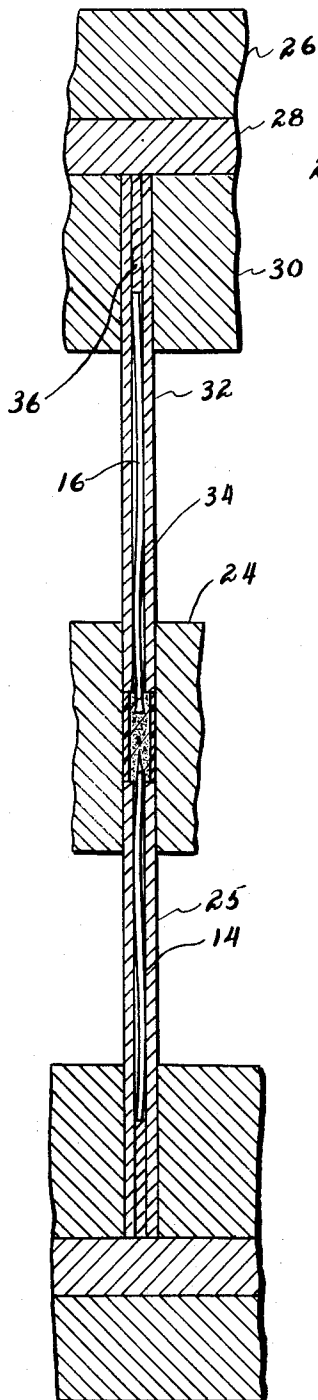


Fig. 3

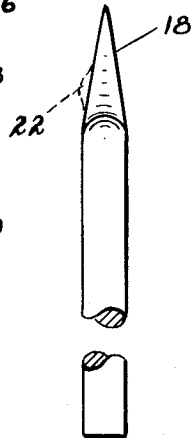


Fig. 2

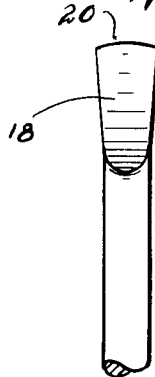


Fig. 1

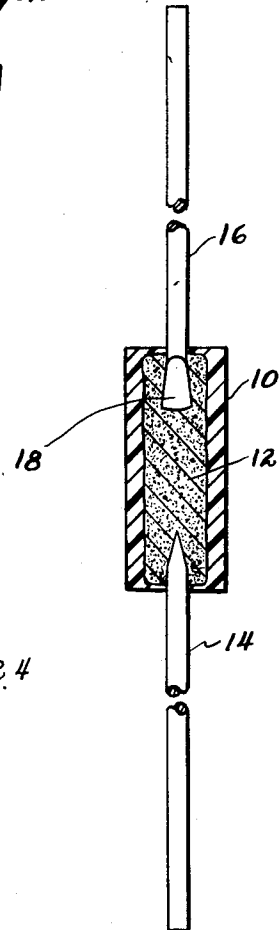
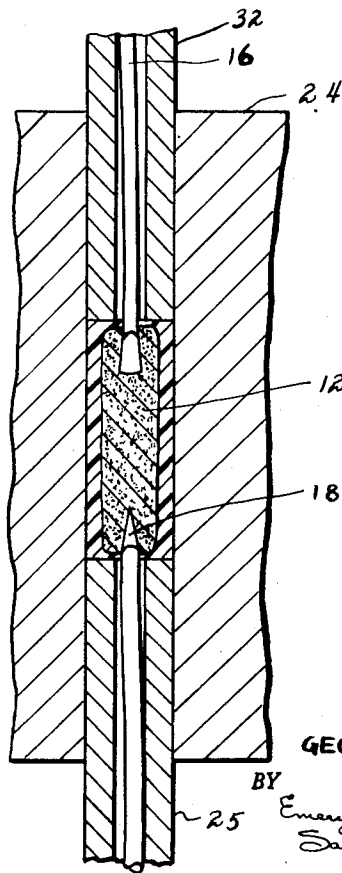


Fig. 5



INVENTOR.
GEORGE P. McKNIGHT

BY
Emery, Whittamora,
Sandoz & Graham
ATTORNEYS

1

3,013,240

RESISTORS AND METHOD OF MANUFACTURE
George P. McKnight, Bradford, Pa., assignor, by mesne assignments, to Speer Carbon Company, Inc., a corporation of Delaware

Filed Oct. 27, 1959, Ser. No. 849,112

3 Claims. (Cl. 338—331)

This invention relates to resistors and methods of making the same and has particular reference to small size carbon composition resistors.

Resistors of the type described above generally comprise conductive portions formed of powdered carbon, clay, asbestos and other materials mixed with a binder such as phenol-formaldehyde resin, pitch, or other similar materials. Generally, these resistors are provided with an insulating shell formed of a material compatible with the conductive portion and often formed of the same materials omitting the carbon constituent.

It has been the practice to form the insulator shell in partially compacted form having a tubular shape with the outside diameters corresponding to that of the desired finished product. The insulator shell is then filled with the conductor portion material, and the entire assembly is compacted into a resistor of the composition density and outline dimensions desired.

Axially extending leads contact the conductive portion to provide means for coupling the resistor to the operative circuit.

During manufacture of such resistors, it is of course desirable to hold the resistance within close tolerances, to decrease the necessity and expense of grading and sorting. Unfortunately, some non-uniformity in the resistance of the finished resistor has been encountered. The non-uniformity is attributable to non-uniformity in the composition of the resistance material and to variation in penetration of the leads inserted into the resistor material.

To insure uniform penetration of the leads into the resistor material, it has been regular practice in the art to provide short heads, hooks, bends or other lateral projection near the end of the lead to be imbedded. The lateral projection is then used as a locating position and the lead imbedded until the projection is flush with the resistor surface. Exemplary of a process used by the art is the process set forth in U.S. Patent 2,454,508.

While such process has been entirely satisfactory for the resistors commonly employed by the art, the art has recently faced the requirements that the physical size of resistors be decreased without decrease of the electrical capacity and dissipation power. For example, the new military type RC-20 ½ watt carbon composition resistor has a specified body length of only 0.390 inch and a body diameter of only 0.138 inch.

With such small resistors, the difficulty of fitting leads in the resistance material to uniform distances is compounded. Further, variation in the insertion distance adversely effects the uniformity of the resistance value to a greater percentile degree.

Further, the small diameter of the tubular resistor precludes the use of pronounced lateral projections on the leads for use in setting distance of lead insertion. A lateral projection, which could be used as a reference location by mechanical gripping equipment, might also project sufficiently far from the lead as to protrude through the insulating jacket.

It is therefore one object of this invention to provide a miniature tubular resistor having leads inserted therein to a predetermined depth.

It is a further object of this invention to provide an improved method for the assembly of tubular resistors having axially extending leads.

2

In accordance with these objects there is provided in a preferred embodiment of this invention a resistor having a tubular insulating shell within which is contained a tubular resistor portion. Axially extending leads are inserted into the resistor material at each end of the resistor to provide contact with the resistor material. Each of the leads comprises pointed, spade-shaped tip which is inserted a predetermined depth into the resistant material during compacting thereof to give contact with the resistor material over a uniform contact area and with improved uniformity of compact pressure.

In accordance with the preferred method of fabricating this resistor, the tubular shell is formed in a partially compacted open tubular body. The body is filled with loose resistor composition. Leads are formed of predetermined length and inserted concentric with sleeve type dies. Back-up plates establish a predetermined distance between the tip of each lead and the end of the sleeve die to insure insertion of the lead within the resistor material to a predetermined uniform depth. The tips are spade shaped to penetrate during compacting. The sleeve dies are then moved axially to compact the tubular resistor to the desired final form.

This invention will be more easily understood by reference to the following description taken in conjunction with the accompanying drawings of which:

FIGURE 1 is a partially sectioned view of a resistor constructed in accordance with this invention.

FIGURE 2 is a front elevation of the lead employed in the resistor shown in FIGURE 1.

FIGURE 3 is a side elevation of the lead shown in FIGURE 2.

FIGURE 4 is a partially sectioned view of the assembly die with the resistor inserted therein, and;

FIGURE 5 is a partially sectioned enlarged view of a portion of the apparatus shown in FIGURE 4 showing the compacted resistor.

In FIGURE 1 there is shown a tubular resistor comprising insulating jacket 10 within which is contained a tubular resistor portion 12. Axially extending leads 14 and 16 are provided at each end of the resistor to contact the resistor material. The resistor is of small size as specified, for example, as Mil type RC-20.

The resistor material is usually a carbon composition, comprising a mixture of carbon particles, silica, asbestos and binders. The insulator jacket is formed of material compatible with the resistor material. The tubular resistor is preferably molded to the desired outline dimensions in a single operation to provide uniform contact pressure between the jacket and the resistor material. The molded resistor may then be baked in usual fashion.

The leads 16 and 14 are formed of soft copper wire such as 20 gauge copper wire. The end inserted within the resistor material to make contact therewith is provided with a flattened tip 18, shown in detail in FIGURES 2 and 3. The tip is flattened to a spade-shaped tip 18 having a sharp, rounded edge 20. While such tip is preferable, slight deviations are tolerable. For example, automatic forming equipment will often distort the tip by raising a bump 22 thereon through the action of the wire gripping jaws. Such bumps do not adversely affect the invention.

The spade-shaped lead tip allows the lead to be forced into the resistor material without the application of pressure sufficient to deform the material from which the lead is constructed. After manufacture of the resistor, the flattened tip of the lead assists in providing strength to resist torsional stress imposed on the lead.

During fabrication of the resistor, the insulator jacket is first formed as a tube of semi-compacted material in a die block 24, FIGURE 4. A bottom punch assembly

25 is positioned to close the bottom of the tube and the tube is filled with the conductor material. As thus far set forth, the process for fabricating a resistor is similar except for the punch assembly, to that set forth in U.S. Patent 2,454,508 to which reference is made for details of the fabrication steps.

The top punch 32 is then brought down into contact with the resistor top. The top and bottom punch assemblies are usually identical and comprise a back-up plate 26, a pin pad 28 and a punch pad 30. Each punch plate is provided with a plurality of sleeve punches 32 extending vertically therefrom and adapted for insertion within the apertures in the die block 24 to compact the resistor to the desired outline dimensions. Each punch is provided with a central axially extending bore 34 to carry the resistor lead. The lead 16 is cut to a predetermined length suitable for the application intended and is positioned within the bore by a spacer block 36. Thus, the length of the lead extending from the end of the punch is predetermined, fixing the lead insertion length.

The bore 34 is dimensioned with respect to the lead diameter to provide clearance for insertion and removal of the lead wires during loading and to support the leads during compacting of the resistor. As can be seen from FIGURE 4, the lead will bow within the bore, but the bore will prevent lead buckling.

The resistor is then formed by moving the top punch downward or by moving the top and bottom punches together to compact the resistor to the desired outline dimensions. As shown in FIGURE 5, the insulator jacket will flow over the ends of the resistor portion to form a thin insulating coating thereover. The leads will pierce into the resistor composition as the resistor is compacted to the desired final form. The leads will maintain the predetermined insertion length during compacting. The spade-shaped tips decrease the driving force necessary for lead insertion and provide an adequate surface having the desired resistance to lead removal by imposed axial and torsional stress.

On withdrawal of the top and bottom punches, the lead wires will remain within the compacted tubular resistor and the resistor can be completed by baking or other processing steps.

It has been found advantageous to form the spade-shaped tip with each side thereof angled at a 10-degree angle and to form the lead with the length thereof fixed at $1.625 \pm .005$ inch when formed of #20 wire. This lead is advantageously employed with a $\frac{1}{2}$ watt RC-20 resistor.

This invention can be variously embodied and modified within the scope of the subjoined claims.

What is claimed is:

1. The method of attaching, to a resistor element, a lead made of a conductive wire with an end portion that

tapers from the full diameter of the wire to a point when viewed in side elevation, and that expands gradually and progressively along a taper from the full diameter of the wire to a broad and sharp edge at the end of the wire when viewed at right angles to said side elevation, which method comprises inserting the shaped end of the lead into one end of the resistor element for a predetermined distance, confining the resistor element against transverse expansion, applying a longitudinal compressive force against the end of the resistor into which the lead is inserted and by said force compressing the resistor to a shorter length with resulting compacting of the material of the resistor, the material being compacted by means separate from the leads, applying other force to the end of the lead remote from the shaped end thereof, and by said other force displacing the lead and cutting through said material with the sharp edge of the lead simultaneously with at least a portion of the compacting of the resistor material, confining the portion of the lead, outside of the resistor, transversely against snaking action during the application of said other force that causes the sharp edge of the lead to cut through the material of the resistor.

2. The method described in claim 1, and in which the lead is attached to the resistor during molding of the resistor and before heating the resistor, and the resistor is made by forming a body of loose resistor material, the end of the lead having the sharp edge is inserted into the loose resistor material by cutting its way through the loose material to a desired depth, the resistor material is then compressed, prior to heating and in the direction of the axis of the lead until the resistor material is compacted to a desired density, and the lead is advanced as the resistor material is compacted and is caused to cut through the compacting material to maintain the depth of penetration of the lead into the resistor material, and the resistor is thereafter completed by heating to set the resistor composition and to lock the lead in the resistor.

3. The method described in claim 1, and in which the resistor is made by inserting uncompressed resistor material into a shell of electrical insulating material, and after the shaped end of the lead has been inserted into the uncompressed resistor material, applying longitudinal compressive force simultaneously to the end of the shell and the resistor material to reduce them both to said shorter length.

References Cited in the file of this patent

UNITED STATES PATENTS

2,203,997	Megow et al.	June 11, 1940
2,271,774	Megow et al.	Feb. 3, 1942
2,454,508	Herrick et al.	Nov. 23, 1948
2,796,504	Pritikin et al.	June 18, 1957