Aug. 18, 1936. F. L. CREAGER 2,051,517

RESISTOR

Filed Jan. 31, 1934

Fig. 1.

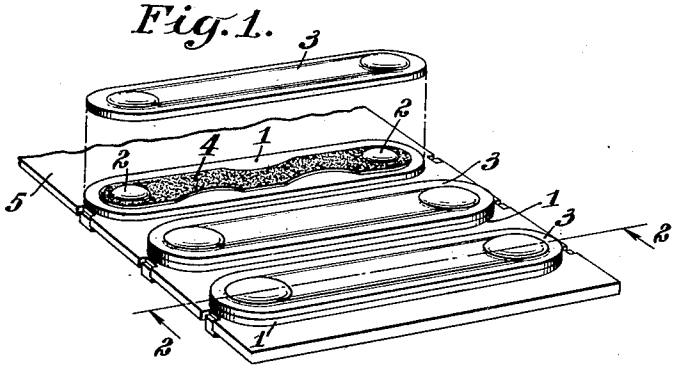


Fig. 3.

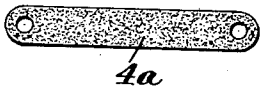


Fig. 2.

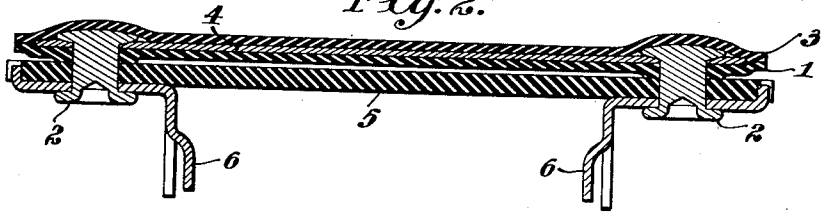


Fig. 7.

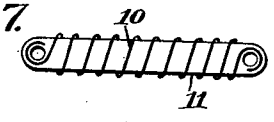


Fig. 5.

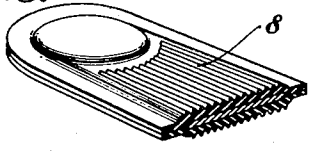
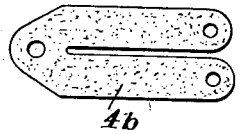


Fig. 4.



Fig. 6.



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Patented Aug. 18, 1936 2,051,517

UNITED STATES PATENT OFFICE

2,051,517

RESISTOR

Frederick L. Creager, Camden, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application January 31, 1934, Serial No. 709,110

1 Claim. (Cl. 201—76)

My invention relates to resistors and more particularly to resistors of fixed low current value such as those commonly used in radio receivers, television apparatus and the like.

In the manufacture of resistors in large quantities and of all the various ohmic values that are required in commercial radio apparatus, considerable difficulty has been experienced in the past in holding each particular resistance value to within a reasonable tolerance. As more sensitive circuits are developed, the resistor values become more critical and consequently their tolerances need continually to be reduced. Under some of the methods practiced in the past, no determination of ultimate resistance value could be made until the resistor was finished. The percentage of "rejects" would, under such conditions of manufacture, be excessively high.

Other requirements of a satisfactory resistor for use in radio and television work are such that it has been difficult to produce a low cost unit which would meet the required specifications and not entail considerable expense for equipment, materials and labor of fabrication.

Accordingly, it is one of the objects of my invention to produce a resistor in which the conductor has a consistently reproducible resistance value when manufactured according to low cost quantity production methods.

Another object of my invention is to provide a resistor, the shape and size of which may be standardized while the resistance element thereof can be varied in conductance and current carrying capacity within a very wide range to satisfy widely varying requirements.

A further object of my invention is to devise a resistor which is impervious to moisture.

A further object of my invention is to provide resistors which are adapted for attachment singly or in multiple to a base or support by using the terminal rivets which are an integral part of each resistor.

A further object of my invention is to provide a resistor which can be manufactured out of low cost materials and with a minimum of processing labor.

The foregoing objects and other objects which will hereinafter be brought out I prefer to accomplish by the use of prepared sheet material from which the elements of the resistor can be blanked out and assembled with metallic rivets or eyelets, these being pressed into close contact with an inner lamination or laminations of treated material constituting a conductor of the desired resistance value. This inner lamination preferably of insulating material is made conductive by any one of various known methods. It may be impregnated with a current conducting medium, or one or both sides may be provided with a conducting surface film applied by coating, spraying, or electrical, chemical or electro-chemical deposition.

It is preferred at this time to use graphite and carbon-black as a conducting medium. Modification of the formula and its thickness of application are the first two controls employed to obtain a given overall value of the final resistor.

The advantages of using different mixtures of graphite and carbon-black have been discussed at length in the co-pending application of Sidney Bloomenthal, Ser. No. 699,707, filed November 25, 1933, and assigned to the assignee of the present invention. Since the subject matter of the graphite and carbon-black mixtures as discussed in Bloomenthal's application forms no part of the present invention, it is unnecessary here to dwell further upon how the resistance element may be prepared.

After treatment of the inner lamination material to give it the desired conductive value, the lamination elements are blanked out and then surrounded by and hermetically sealed within an infusible insulating jacket of paper or cloth impregnated with one of the many synthetic resinoids.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claim. The invention itself, however, both as to its organization, the manner of processing the resistor and the objects and advantages to be had from carrying out my invention will best be understood from the following description of specific embodiments when read in connection with the accompanying drawing in which:

Fig. 1 is a perspective view showing several of the resistors assembled onto a common mounting base, the top of one of the resistors being shown as lifted off so as to expose to view a notched conductive element between two terminals;

Fig. 2 is an enlarged cross sectional view along the line 2—2 of Fig. 1 showing the assembly of the several insulating and conducting laminations, together with a pair of rivets and a pair of terminals for soldering leads thereto;

Fig. 3 is a plan view of a conducting element which may be used either as shown or after reducing its effective width by notching;

Fig. 4 shows an edgewise view, partly in section, of one of my resistors to which pigtails may

be attached by looping around the terminals before riveting;

Fig. 5 is a perspective view of a section of one of my resistors showing a corrugated surface which is of value in radiating heat from the resistor, thus increasing its current carrying capacity;

Fig. 6 is a plan view of a conducting element suitable for a resistor having an intermediate tap; and

Fig. 7 is a plan view of a conductor wound as a helix about an insulating core to be subsequently sealed up in one of the envelopes of my invention.

In order to minimize the cost of manufacturing, I have found that it is desirable to perform the various operations of blanking out, assembling and molding the parts of the resistor in such a manner that, as the resistors are successively finished, they may be immediately subjected to test whereby correction may be applied to the subsequently processed units as quickly as possible so as to bring them within the prescribed limits of variation.

Accordingly, I prefer to build up my resistor units out of pieces of sheet material, one of which is a bottom cover piece 1, blanked and perforated for the rivet terminals 2, and a top cover piece 3, blanked but not perforated. Between the two cover pieces 1 and 3 is a smaller strip 4 which forms the base or core for the conductive material. According to the preferred practice the conductor piece 4 is first assembled with the rivets 2 and then with the bottom cover 1. These are then placed in a mold together with the top cover piece 3. All of the laminations are then subjected to heat and pressure.

The objects to be attained in the molding operation will be better understood by noting that the cover blanks 1 and 3 are preferably made of material which has been impregnated with a synthetic resin, such as phenol formaldehyde or cresol formaldehyde. This resin impregnation permits polymerizing the cover portions when subjected to heat and pressure and in this manner the top and bottom covers are effectively sealed together along their edges. The holes in the bottom cover are also closed up against the shanks of the rivets 2, so that the conductor, sandwiched between the two cover pieces, is securely incased to protect it from moisture, dirt and rough handling.

After removal from the mold the resistors are allowed to cool and are then subjected to test for determining their electrical characteristics. An important feature of the process as I prefer to carry it out is that this testing operation may be performed automatically without the necessity for handling the resistors individually. When the test is so performed indications are given as to whether the resistance value is within the prescribed tolerances. If not, then a further step of my preferred process is to be carried out, namely to modify the blanking operation for the cores subsequently utilized in successively fabricated resistors so that the resistance value may be either increased or decreased. As an example of how this further step can be accomplished I show in Fig. 1 that the resistance element 4 may be blanked out with a plurality of scollops along the edges thereof; while in Fig. 3 I show a resistance element 4a having a given maximum width. The blanking dies will, therefore, preferably be provided with independently controllable punches for producing these scolloped formations along the edge. In practice the standard resistance value will be obtained as far as possible when punching out two of the scollops. If, during the automatic testing, it is found that the resistance is too high, then one or more of the notches may be omitted, thereby increasing the cross section of the conductor and decreasing the resistance value thereof. If, however, the automatic testing operation shows too low a resistance, then a third scollop may be formed so that the resistance value of the elements so blanked may be increased. It is of course to be understood that it is entirely within the scope of my invention to extend the variation in the blanking of successive resistance elements so that as many notches as desired may be formed along the edges thereof.

The use of tubular rivets in place of rivets made from solid rods is entirely within the scope of the contemplated modifications of my invention. The rivet formed from solid rod material is shown in Fig. 2, while a tubular rivet 2a is shown in Fig. 4.

After testing the resistors and rejecting those failing to conform to the required specifications, those that are acceptable may be assembled on a mounting base 5 as shown in Figs. 1 and 2. In such an assembly any suitable form of terminal clip 6 may be used for soldering the leads thereto. Both the resistor and the clips may be held in place by flanging a head on the end of each rivet. If the resistor is to be used without mounting on a base plate, it may be preferable to employ short wires or pigtails 7 which can be looped around the rivets and then riveted, crimped or soldered thereto as shown in Fig. 4.

If it is desired to employ a core element both sides of which are coated with a conductive film, then it will be seen that means must be employed by which dependable contacts may be made between the rivets and the opposed film surfaces. To meet this requirement, I have found that a thin washer 9 of copper or aluminum foil or the like may be assembled on to the rivets after inserting the latter through the holes of the conductor core. When the bottom cover 1 is then fitted over the rivets and the complete assembly is placed in the mold for compressing, it will be seen that both the rivet head and the washer 9 will be compressed against opposite filmed surfaces of the conductor core and in this manner dependable contact therewith will be established. To insure that the best possible contact is made between the washer 9 and the rivet 2 or 2a, the hole in the washer can be made slightly smaller than the diameter of the rivet shank. Then, in forcing the washer onto the rivet, a burr will be formed around the edge of the hole in the washer which will cause it to hug the rivet tightly.

While it is true that for some of the uses to be made of my resistors there would be no appreciable radiation of heat due to the passing of a current through the conductor, there are, nevertheless, other uses to which the resistor may be put in which it is quite desirable that means be provided for dissipating the heat generated in such a resistor. To accomplish this object corrugations may be made in the mold whereby when the resistance unit is compressed therein, similar corrugations 8 may be formed on the outer surfaces of the cover blanks as shown in Fig. 5. Even where the corrugations are only about .01" in depth, the increased area of radiation has been found to be very effective.

It will, of course, be appreciated that resistors may be made in accordance with the foregoing

disclosure for a very wide variety of uses, and by various modifications of the process of fabrication. For example, it is within the scope of my invention to form the conductive elements of other shapes than those shown, and even to coil a conductor 10 about the insulating core piece 11, as shown in Fig. 7, and afterwards to seal this conductor within the polymerized envelope. Furthermore, the resistor may be provided with taps simply by introducing additional rivets 2 or eyelets 2a intermediate the electrical extremities of the resistance element. This last mentioned modification is illustrated in Fig. 6, which shows a resistance element 4b perforated for three rivet terminals, the one to the left being intermediate the electrical extremities of the conductor.

The embodiments of my invention as herein described will be understood to be more or less illustrative of other embodiments modified to a considerable extent without departing from the spirit of my invention. My invention is therefore, not to be limited except insofar as is necessitated by the prior art and by the scope of the appended claim.

I claim as my invention:

A resistance unit comprising an apertured strip of material treated with a conducting substance and forming an electrical resistance element, a plurality of solid rivets each disposed with the head thereof in contact with a portion of said resistance element and the shank thereof extending in a single direction from said element through an aperture in said strip and an envelope of insulating material hermetically encasing said resistance element and said flange heads and a portion of the shank of each rivet, the unenveloped portion of each rivet shank constituting a projecting terminal for connecting said unit in an electrical circuit.

FREDERICK L. CREAGER.