Oct. 16, 1934. L. BRADLEY 1,976,918

METHOD OF FORMING RESISTOR UNITS

Original Filed Aug. 19, 1925

FIG. 1.

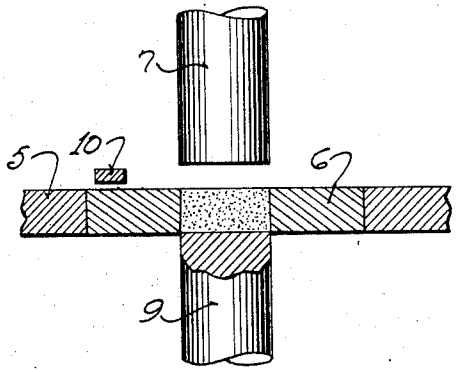


FIG. 2.

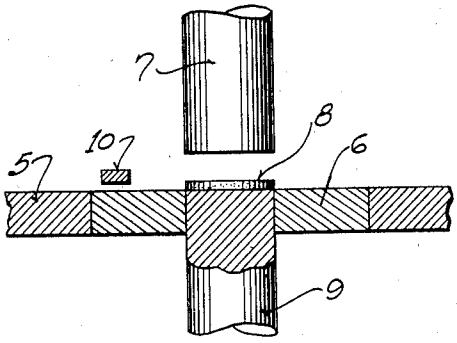


FIG. 3.

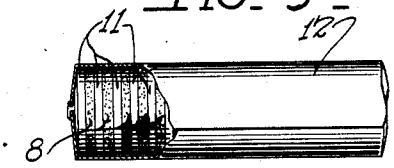


FIG. 4.

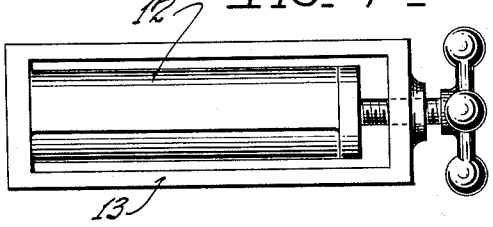
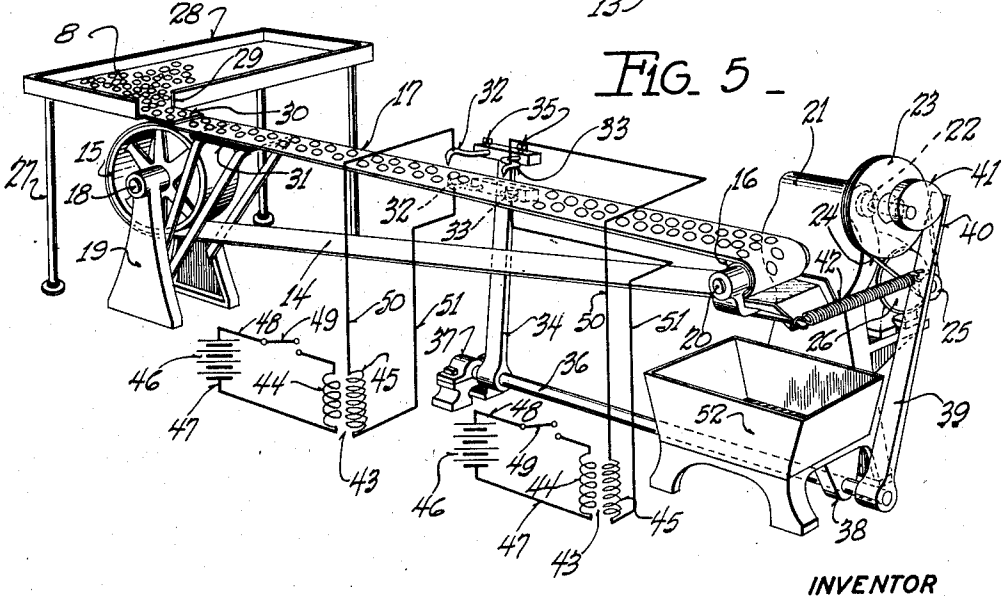


FIG. 5.



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METHOD OF FORMING RESISTOR UNITS

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Original application August 19, 1925, Serial No. 51,273, now Patent No. 1,845,828, dated February 16, 1932. Divided and this application June 3, 1931, Serial No. 542,834

3 Claims. (Cl. 201—75)

This invention relates to the formation of resistor units particularly adapted for use in radio receiving and broadcasting apparatus circuits, and is a division of a copending application, Serial No. 51,273, now Patent No. 1,845,828.

One object of this invention resides in the provision of a compressible resistor element in which the units or discs comprising the same each have a low internal resistance and a high surface contact or microphonic resistance, so that the column of units or discs comprising the element will have a comparatively low resistance to the passage of an electrical current under maximum pressure in comparison to its resistance under minimum or no pressure, thus imparting to the element a range or variation of resistance under varying pressures greater than that heretofore obtained in compressible pile resistors.

A further object of this invention resides in the provision of an improved apparatus for forming resistor units in accordance with this invention in an economical and practical manner.

And a still further object of this invention resides in the provision of an improved unit or disc for use in compressible resistors which is as highly desirable in compressible pile resistors for use in circuits of motor controls and the like as well as radio circuits.

With the above and other objects in view which will appear as the description proceeds, the invention resides in the novel methods, construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the herein disclosed invention may be made as come within the scope of the claims.

In the accompanying drawing is illustrated one complete example of the physical embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a fragmentary diagrammatic illustration, partly in section and partly in elevation, of a press for forming disc-shaped resistor units;

Figure 2 is a view similar to figure 1 illustrating the ejection of a formed disc or unit from the press;

Figure 3 is a side view of a stack of disc-shaped resistor units wrapped prior to treatment in the presence of heat, part of the wrapping being broken away;

Figure 4 is a side view of a clamp or compression member applicable to the wrapped stacks of disc-shaped resistor units to maintain the same under pressure during heat treatment; and

Figure 5 is a perspective view of an apparatus employed to subject the units to the influence of an electric current having the power or capacity to reduce the specific or internal resistance of the units, a diagrammatic view of one wiring circuit being shown.

The resistor units or discs illustrated are especially adapted to be arranged in stacks or piles to form the resistor element of a compressible resistor the total resistance of which is directly proportional to the pressure imposed thereon.

In compressible resistors, it is highly desirable that the specific or internal value of the units or discs comprising the resistor element be relatively low and its surface microphonic or contact resistance be relatively high so that the electrical resistance offered by a column of the discs, when under pressure, is relatively low. A column of discs having these characteristics assures a greater spread or range from minimum to maximum degree of electrical resistance. This increased range is made possible by the hereinafter described method of treating or "shooting" the discs which eliminates the resistance that heretofore could not be "squeezed" out or eliminated.

Referring now more particularly to the accompanying drawing, in which like numerals designate like parts throughout the several views 5 designates the bed plate of a forming machine having a female die 6 mounted therein and cooperating with a male die or compression plunger 7 which is movable therein to compress materials, later described, and form the disc or unit 8. Suitable mechanism, not shown, is connected with the plunger and ejector to register the upper end of the ejector with the bottom of the die opening and move the compression plunger thereinto, an ejector 9 being moved upwardly through the die upon retraction of the plunger to eject the disc or unit 8 formed by the compressing of the substance, to be later described. The completed disc or unit is then removed from between the compression plunger and ejector by an automatic finger 10.

The resistance unit, while illustrated in the form of a disc, may be molded in any desired shape, and is preferably formed from an or-

ganic substance having a conductor and other ingredients mixed therein. The following ingredients and proportions have been found from experience to reduce a highly efficient disc or unit:

Formula for high resistance unit

Graphite #1 AF	3%	545 grams
Asbestos powder #1250	10%	4 pounds
Phenol condensation product #60	87%	34 pounds 13 oz.

Formula for low resistance unit

Graphite #1 AF	10%	1816 grams
Asbestos powder #1250	10%	4 pounds
Phenol condensation product #60	80%	32 pounds

The above formulas may be altered to suit various conditions, but experience has proven them to be very practical and efficient and the general process of manufacturing is briefly as follows:

First.—Mixing dry graphite and powdered asbestos with the dry, powdered phenol condensation product.

Second.—Wetting the mixture thoroughly with denatured alcohol to dissolve the phenol condensation product.

Third.—Grinding the wet mixture to make a thoroughly homogeneous mixture, also to form the mass into long, thin strings so it may be dried much more readily.

Fourth.—Removing the alcohol by heat and/or vacuum.

Fifth.—Pulverizing and sifting the dried product.

Sixth.—Dry-mixing the powder to make it absolutely uniform.

Seventh.—Blending mixtures containing different percentages of graphite in order to obtain mixtures which will give required resistances when molded into units.

The discs or units 8 resulting from the compression of the composition previously described are arranged in stacks of alternate resistor discs and separators 11, preferably of carbon, and wrapped with a suitable covering 12 such as heavy paper or the like. The stack of discs is then heat treated, being placed in an oven maintained at approximately 400 degrees Fahrenheit for a period of two hours and then allowed to cool. If desired, the stack may be secured in a clamping mechanism 13 to maintain the same under pressure during the heat treatment.

Upon removal from the heating oven, the units or discs are complete and may be used in a resistor column, but their specific or internal resistance is high, and for better results and increased spread of variation of surface or contact resistance through variations of pressure, it is necessary that their internal resistance be materially lowered. Tests have proven that with the method hereinafter described, resistor units may have their internal or specific resistance materially lowered while their contact or surface microphonic resistance may be restored to its original high value.

The unit 8, therefore, is subjected to the influence of an electrical current having the power or capacity to change the characteristics of the unit to the extent of reducing its specific or internal resistance by burning low resistance paths entirely therethrough, the contact or surface microphonic resistance being restored to its desired high value as will be later described. It has been found that a current that oscillates and is of high potential, or high frequency, has the power to so change the characteristics of a resistor unit to obtain the desired results, although it is to be understood that any current having the capacity or power to produce the desired results may be employed, and in Figure 5 I have illustrated one embodiment of a machine for subjecting resistor units to the influence of such a current.

An endless belt 14 is preferably trained about a relatively large idler pulley 15 and a relatively small drive pulley 16, the upper or topmost portions of which are substantially horizontally aligned to maintain the upper stretch 17 of the belt in a horizontal plane. The idler pulley 15 is mounted on a shaft 18 supported in standards 19 and the drive pulley 16 is fixed on a drive shaft 20 connected with a gear reduction unit 21. The drive shaft 22 of the unit 21 has a pulley 23 mounted thereon which is driven by a belt 24, trained about it and the drive pulley 25 of a motor 26, the relative sizes of the pulleys 23 and 25 and the gear reduction 21 causing the belt 14 to advance at a relatively slow speed.

The end of the belt trained about the pulley 15 is the receiving end, and mounted thereover on suitable supports 27 is a tray 28 having a discharge opening 29 from which extends a guide 30. The guide lies close to the upper stretch of the belt and the units 8 are moved thereover from the tray onto the pulley 14 by an operator, a belt support 31 being mounted under the guide 30, as illustrated.

As the upper stretch of the belt moves from the pulley 15 to the pulley 16, the units thereon are subjected to the influence of a current having the power or capacity to reduce the internal resistance of the unit. This is accomplished in the present embodiment by means of pairs of contact members 32 and 33 forming spark gaps through which the upper stretch of the belt and the units 8 thereon pass as the current jumps from one contact to the other of each pair.

The contacts of each pair are supported from an oscillating lever 34, the uppermost contacts being preferably adjustable by a screw or other means 35 to regulate the length of the spark gap. The lever 34 is supported from a shaft 36 journaled at one end in a bearing 37 and at its other end in a bearing 38, and an actuating lever 39 is secured at one end to the shaft with its other free end 40 held in engagement with a rotating eccentric 41 fixed on the shaft 22 by a spring 42. The shaft 22 being constantly rotated as the belt is advanced, rapidly oscillates the lever 34 to move the contacts across substantially the entire width of the belt to insure the passing of the units through the path of the current flowing across the spark gaps. Only one pair of contacts may be used, but the provision of more than one insures each unit coming within the influence of the current flowing across the contacts.

The circuit illustrated in connection with the present adaption of the invention consists of a spark coil 43 which may be of conventional construction having a primary coil 44 and a secondary coil 45, the primary coil being connected with a source of energy 46 by conductors 47 and 48, one of which includes a controlling switch 49. One end of the secondary coil is connected with the uppermost of one pair of contacts by a

conductor 50, and the other end thereof is connected with the lower contact of the pair by a conductor 51. A single coil or circuit may be employed if desired for both pairs of contacts, although a separate circuit for each contact is illustrated.

After the units have been subjected to the influence of the current flowing across the spark gap and consequently through the units, they are discharged automatically from the belt at its discharge end into a container 52.

After being treated as above described the opposite surfaces of the units or discs are scorched or punctured at the ends of the low resistance paths burned through the units during their subjection to the spark. These scorched or punctured surfaces are then burnished or smoothed to restore them to their original microphonic condition before being incorporated in a compressible resistor or any other type of device with which the same is adapted to be used. The restoring of the original microphonic condition of the discs can be accomplished by any ordinary smoothing or polishing device, but in practice it has been found preferable to merely tumble the discs in a revolving drum.

From the foregoing description, taken in connection with the accompanying drawing, it will be readily apparent to those skilled in the art to which an invention of this character appertains, that I provide a novel and improved resistor disc or unit and method of forming the same whereby the efficiency and reliability of the element formed of the discs or units is greatly increased.

What I claim as my invention is:

1. The method of producing a resistor unit, which comprises forming the unit from a mixture comprising a phenol condensation product and a conductor, subjecting the unit to the influence of an electrical current to reduce its internal resistance by puncturing the same with a plurality of low resistance paths extending from one surface to the other, and tumbling the unit to restore its surface microphonic resistance.

2. The method of producing a resistor disc for use in a compressible pile resistor, which comprises forming the disc from a mixture comprising a phenol condensation product and a conductor, subjecting the disc to the influence of an electrical current to burn a path of low resistance therethrough from one surface to the other to reduce the internal resistance of the disc, and tumbling the disc to restore the burned surface portions to their original conditions and thus restore the surface microphonic resistance of the disc.

3. The method of producing a resistor unit for use in compressible electrical resistors which comprises, forming the unit from a mixture of a conducting material and a material becoming conductive upon the application of heat thereto, subjecting the unit to an electric current the heat of which lowers the internal resistance of the unit, and subsequently treating the surfaces of the unit by tumbling to restore the scorched surface portions to their original conditions and impart a predetermined microphonic resistance value to the unit.

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