Jan. 4, 1966 M. J. BRAUN 3,227,983

STACKED RESISTOR

Filed Aug. 7, 1963

FIG. 1.

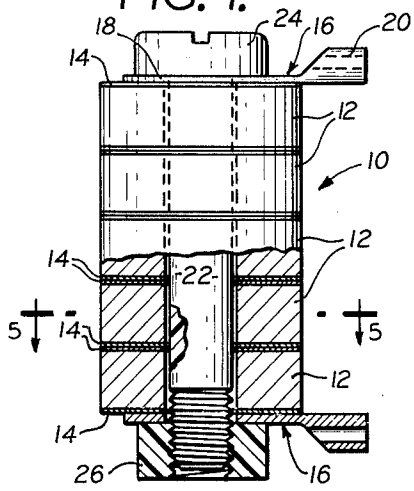


FIG. 2.

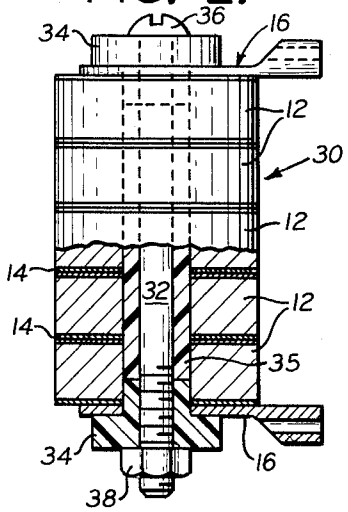


FIG. 3.

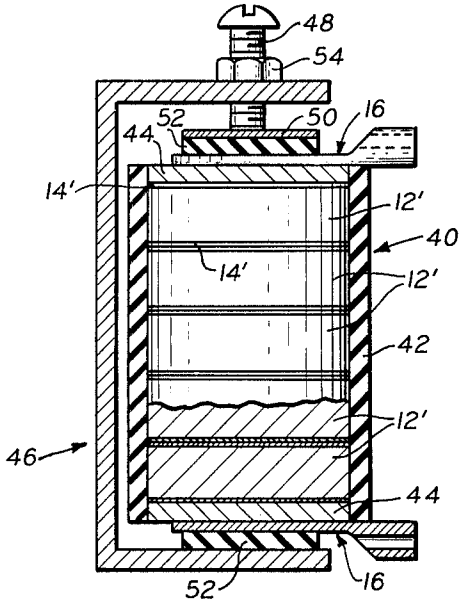


FIG. 4.

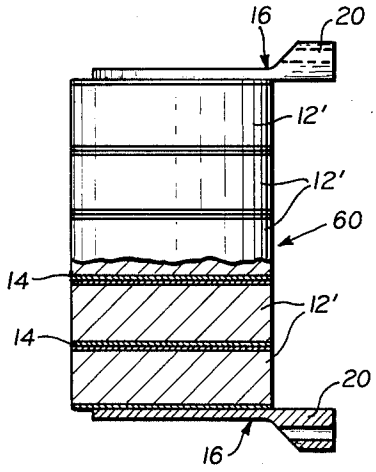
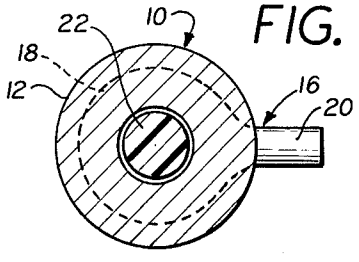


FIG. 5.



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STACKED RESISTOR

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2 Claims. (Cl. 338—21)

This invention relates to resistors and more especially to that type of resistor that is used as a surge resistor; for example, in the circuits of automobile horns; but the resistor of this invention can be used in a wide variety of combinations where it is desirable to have a resistor of known and substantially constant resistance value.

It is an object of the invention to provide an improved stacked resistor in which resistance elements are stacked together in end-to-end relation and with means for holding them in their stacked relation with one another. The resistor can be given any selected resistance by adding resistor elements to the stack; and the stack has any length as desired and affords "N" resistance where N is the sum total of the resistance of all of the individual resistance elements of the stack.

Another object is to provide an improved resistor, of the character indicated, and with the individual resistor elements constructed and stacked so that the resistance of the stack is independent of the pressure on the individual elements. The resistor of this invention withstands high surges and maintains the proper resistance value thereafter. By providing conductive, low electrical resistance coatings on both end faces of each individual resistor element of the stack, the flow of current is dissipated to minimize hot spots.

The stacked resistor of this invention lends itself to the construction of stacked resistors having total resistance values that are accurate within close tolerances, and that can be assembled with the resistance value necessary to test new circuits.

Other objects, features and advantages of the invention will appear or be pointed out as the description proceeds.

In the drawing, forming a part hereof, in which like reference characters indicate corresponding parts in all the views;

FIGURE 1 is a side elevation, partly broken away and in section showing a resistor element made in accordance with this invention;

FIGURE 2 is a view similar to FIGURE 1 but showing a modified form of the invention;

FIGURE 3 is a view, mostly in section, showing another modified form of the invention;

FIGURE 4 is a view similar to FIGURES 1 and 2 showing still another modified form; and

FIGURE 5 is a sectional view taken on the line 5—5 of FIGURE 1.

FIGURE 1 shows a resistor made up of a plurality of individual resistor elements **12**. Each of the resistor elements **12** is of similar ring shape and there is a coating **14** on the annular surface at both ends of each of the individual resistor elements **12**.

The individual resistor elements **12** are preferably made of a compressed resistor mixture consisting of carbon powder and a binder and these resistor elements can be made in accordance with the process disclosed in the Krellner Patent 2,903,666. In accordance with the disclosure of that patent, the coating **14** on the end faces of each individual resistor element **12** is made of powdered copper molded simultaneously with the body of the resistor. While this is the preferred construction, the coatings **14** are representative of material of high electrical conductivity bonded to the high resistance material of the individual resistors **12**.

This construction obtains a widespread and large area of contact between the inner faces of the resistor elements **12** and the coatings **14**. There is, therefore, no substantial change in the resistance of individual resistor unit **12** when there is a difference in pressure exerted against the surfaces of the coatings **14**. Because of the good electrical conductivity of the coatings **12**, and the smooth faces on these coatings, there is good electrical contact between successive individual resistor elements **12** and the resistance between them is independent of the pressure with which they are held together.

The individual resistor elements **12** are all similar in construction and none of them has any terminal for leads connected with it; but the stack of resistor elements has terminal pieces **16** at each end clamped against the coating **14** of the end elements **12**. Each terminal piece **16** has a washer portion **18** with an opening through it similar in size to the openings through the individual resistor elements **12**; and each terminal piece **16** also has a lead portion **20** to which conductors are connected for joining the resistor **10** with an electric circuit in which it is to be used.

The resistor elements **12** are secured together in FIGURE 1 by a bolt **22** made of material which is a non-conductor of electricity, such as nylon. The bolt **22** has a head **24** which provides a shoulder for clamping the terminal piece **16** against the top coating **14** of the uppermost resistor element **12**. There is a nut **26** threaded over the lower end of the bolt **22**, and this nut **26** clamps the lower terminal piece **16** against the coating **14** on the lowermost individual resistor element **12**. The nut **26** is screwed up tight enough to hold all of the resistor elements **12** and the terminal pieces **16** secured in assembled relation with one another and with the contacting faces of the various parts under substantial pressure.

There is always uniformity in the resistance across the confronting coatings **14** of the successive resistor elements **12**, but even though the individual resistor elements are made by the same method and with the same amount of material, there are manufacturing tolerances which produce some differences in the resistance through the carbon mix between the coatings **14** of the different resistor elements **12**. In order to make resistors having accurate values of resistance, individual resistor elements are initially sorted and grouped according to precise resistance tolerances. When a resistor of a given value is to be assembled, the resistor elements are selected which add up to the total resistance desired for the particular resistor.

For example, if the individual resistor elements **12** are designed to have a resistance of four ohms each and four resistor elements are selected which produce a total resistance of only 15.8 ohms, then the fifth element or the resistor shown in FIGURE 1 must be selected from a group having a resistance of 4.2 ohms in order to have the resistor with a final resistance of exactly 20 ohms.

Although the resistor **10** is shown with individual resistor elements **12** which are of the same size, the invention can be made with resistor elements of different thickness for example, a resistor could be made with one resistor element having a resistance of 8 ohms and three resistor elements having individual resistances of 4 ohms each in order to produce a resistor having an overall resistance of 20 ohms.

FIGURE 2 shows a resistor **30** which is similar in construction to the resistor **10** shown in FIGURE 1 except for the clamping means. Individual resistor elements **12** are indicated by the same reference characters as in FIGURE 1, and so are the coatings **14**, there being no difference between the individual resistor elements in FIGURES 1 and 2. The terminal pieces **16** are also the same.

In place of a bolt made of electrical insulating material, FIGURE 2 uses a metallic bolt 32 and in order to prevent this bolt from short-circuiting the terminal pieces 16, the resistor 30 has bushings 34 made of electrical insulating material. Each of these bushings has an opening through it for passage of the bolt 32 but the bolt is considerably smaller than the opening through the resistor elements 12 and the terminal pieces 16. The openings in the bushings 34 are of substantially the same diameter as the bolt 32 so that a head 36 of the bolt provides a shoulder for clamping the bushing 34 against the uppermost terminal piece 16. The bolt 32 has a nut 38 for clamping the lower bushing 34 against the lowermost terminal piece 16 and for holding all of the individual resistor elements 12 together in assembled relation with one another and with the terminal pieces 16. In order to center the bolt 32 and the terminal pieces 16, each of the bushings 34 has a portion of reduced diameter extending through the openings in the terminal pieces 16 and into a portion of the length of the end resistor elements 12. An insulating sleeve 35 covers the bolt 32 between the bushings 34.

FIGURE 3 shows a resistor 40 which has individual resistor elements 12' similar to the resistor elements 12 as shown in the other figures but without any hole extending through them. The individual resistor elements 12' are solid cylinders. They have a coating 14' over their upper and lower faces and this coating is similar to the coating 14 of FIGURES 1 and 2 except that its area is more extensive since it covers the area of a circle instead of an annular end face such as is formed by the ring shape of the resistor element 12.

The resistor elements 12' are surrounded by a sleeve 42 of electrical insulating material and there are terminal pieces 16 at opposite ends of the resistor 40; but these terminal pieces 16 contact with electrical conductive discs 44 instead of being clamped directly against the coating of the resistor elements.

The resistor 40 has a C-clamp frame 46 and has a screw 48 which threads through the upper portion of the C-clamp frame and which presses a clamping plate 50 against the upper terminal piece 16. This clamping piece 50 can be made of metal, like the rest of the C-clamp frame 46, because there are discs 52 of electrical insulating material between the C-clamp frame 46 and the terminal pieces 16 to prevent short-circuiting by the C-clamp.

The screw 48 is turned to force the clamping piece 50 downward so as to clamp the terminal pieces 16, discs 44, and individual resistor elements 12' together between the clamping piece 50 and the insulation disc 52. The screw 48 is tightened so as to maintain firm contact between the clamped parts and the screw is then locked in position by a lock nut 54.

FIGURE 4 shows a resistor 60 which is made up of individual resistor elements 12' identical with those used in FIGURE 3 and with terminal pieces 16 which are the same as in all of the other figures. The resistor 60 has the individual resistor elements permanently secured together by bonding their confronting, high conductivity coatings 14' to one another. The terminal pieces 16 have their confronting faces bonded to the faces of the endmost resistor elements 12' of the stack so that all of the parts of the resistor 60 are permanently connected together by electrical conductive bonding to hold the parts in assembled relation. Although this form of invention requires no clamping element, it still has the advantages of being made up of individual resistor elements which can be selected for their specific resistance so as to obtain the

resistor 60 with an overall resistance value of close tolerance.

The terminal pieces 16, which are preferably made of sheet metal, can be stampings, or can be made by any other inexpensive method.

The preferred embodiment of the invention has been illustrated and described, but changes and modifications can be made, and some features of the invention can be used in different combinations without departing from the invention as defined in the claims.

What is claimed is:

1. A surge resistor comprising a stack of individual resistor elements stacked together in end-to-end relation, clamping means pressing against opposite ends of the stack and holding the individual resistor elements in assembled relation, each of said resistor elements comprising a cylindrical carbon body and integrally formed metal end portions, said metal end portions being simultaneously molded with the carbon body whereby the electrical resistance of each of the resistive elements is independent of physical pressure of the clamping means against the stack, the width of each of said resistor elements being at least twice as great as the height of each of said resistor elements, each of the resistor elements having an opening therein, electrical terminal means adjacent to and electrically contacting each end of said stack, and said clamping means comprising a bolt made of material that is a nonconductor of electricity, said bolt passing through said opening in each of the resistor elements and holding the electrical terminals and individual resistor elements in assembled relation.

2. A surge resistor comprising a stack of individual resistor elements stacked together in end-to-end relation, clamping means pressing against opposite ends of the stack and holding the individual resistor elements in assembled relation, each of said resistor elements comprising a cylindrical carbon body and integrally formed metal end portions, said metal end portions being simultaneously molded with the carbon body whereby the electrical resistance of each of the resistive elements is independent of physical pressure of the clamping means against the stack, the width of each of said resistor elements being at least twice as great as the height of each of said resistor elements, each of said resistor elements having an opening therein, electrical terminal means adjacent to and electrically contacting opposite ends of said stack, said clamping means comprising a metal bolt enclosed by bushings of material that is a nonconductor of electricity, said metal bolt and bushings being inserted through said openings for holding the electrical terminals and individual resistor elements in assembled relation.

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