Nov. 12, 1935. L. L. STOFFEL 2,020,810

RESISTOR

Filed March 31, 1934

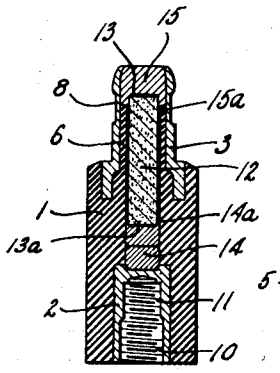


FIG. - 1

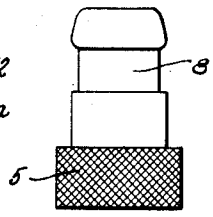


FIG. - 2

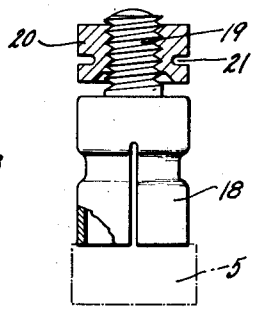


FIG. -2A

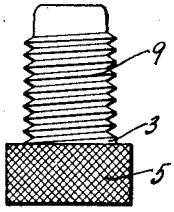


FIG. - 3

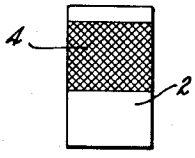


FIG. - 4

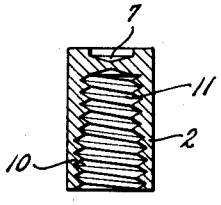


FIG. - 5

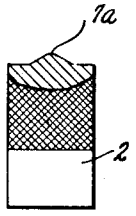


FIG. - 5A

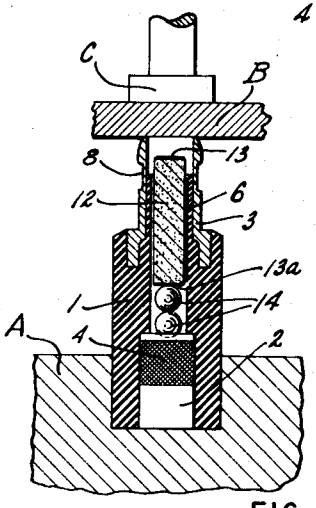


FIG. - 6

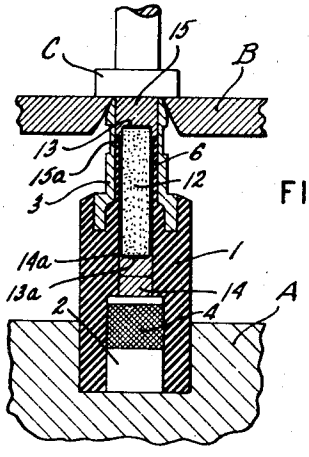


FIG. - 7

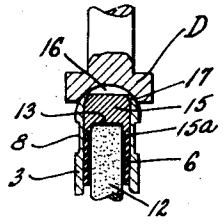


FIG. - 8

INVENTOR
LESTER L. STOFFEL
BY
Brockett, Hyde, Higley & Meyer
ATTORNEYS

Patented Nov. 12, 1935

2,020,810

UNITED STATES PATENT OFFICE

2,020,810

RESISTOR

Lester L. Stoffel, Lakewood, Ohio, assignor to The Ohio Carbon Company, Lakewood, Ohio, a corporation of Ohio

Application March 31, 1934, Serial No. 718,411

4 Claims. (Cl. 201—76)

This invention relates to electric resistors and to the method of making the same. The invention has more particular relation to that form of resistor ordinarily employed on or in connection with the ignition circuits of motor vehicles for prevention of interference with radio apparatus upon the vehicle, although the resistor is capable of other uses.

One object of the invention is to provide a resistor of this kind which is of minimum size; which can be made and sold at low cost; which comprises but a few parts and is readily made and assembled by simple operations; which in finished form has all of its parts permanently connected in rigid form and therefore not likely to become loose or out of order; wherein the resistance parts are wholly enclosed within a sealed cavity and therefore are protected against the weather; and which resistor is capable of being manufactured by simple and improved method steps.

A further object of the invention is to provide a resistor of the character described provided at its opposite ends with terminal members, one for securement to the standard terminal binding post of the ordinary spark plug and provide a new attachment for the lead wire thereto, said terminal members being connected to the resistance element by malleable material which not only provides a firm, immovable connection but also serves to seal the cavity containing the resistance element, and in which the terminal portions have ample electric union with the resistance material.

A further object of the invention is to provide an improved method of making such a resistor, which not only insures good mechanical and electrical connection between the terminals and resistance material but also accomplishes in a very simple manner closure of the resistance containing cavity.

Further objects and advantages of the invention will in part be obvious and in part appear hereinafter.

In the drawing, Fig. 1 represents a sectional elevation, somewhat exaggerated as to size, of a finished resistor embodying the invention; Fig. 2 is a detail elevation of the upper terminal portion; Fig. 2*a* is an adapter for use with the upper terminal; Fig. 3 is a similar view showing a modified form of upper terminal; Fig. 4 is an elevation of the lower terminal portion; Fig. 5 is a detail sectional elevation thereof, considerably enlarged, to show the thread formation and arrangement; Fig. 5*a* is a modification of the lower terminal; Fig. 6 is a detail sectional elevation illustrating one step in the formation of the resistor; Fig. 7 is a similar view illustrating completion of the same step; and Fig. 8 is still another view illustrating the final act of assembly.

Referring first to the complete resistor shown in Fig. 1, it includes a composite unit consisting of a body of insulating material provided with a through cavity at the opposite ends of which are brass or other metal terminal members, one adapted for connection to the threaded binding post of the spark plug and the other adapted to receive the lead wire connection. Said terminal members are mechanically and electrically connected to a resistance element located within the cavity. The body may be made of any suitable insulating material. Because it is desirable to produce this part by a molding or like operation which permanently unites or anchors the end terminals to the body, the body, shown at 1, is usually made of hard rubber, a phenolic condensation product of well known composition, or other suitable material. This body is molded in a manner to include as a practically permanent part thereof a lower terminal member 2 and an upper terminal member 3, each of which may be provided with means to prevent movement thereof relative to the body, such as the knurled portions 4, 5. The body is in general of tubular or cylindrical shape, with a reduced portion 6 at one end which enters the opening through the upper terminal member 3, but terminates short of the outer end of such opening.

The lower terminal member 2 is of thimble form and may have its upper cross wall provided with a shallow recess 7 to receive connecting material, as will appear more fully hereinafter.

The upper terminal member 3 is generally of hollow tubular form extending outwardly endwise from the body 1 and externally is of suitable form to receive the connection to the lead wire which ordinarily is fastened to the spark plug, such as by being provided with the customary shallow annular groove 8, Fig. 3, for a snap connection, or it may be externally threaded, as indicated at 9, Fig. 3.

The lower terminal member 2 is of course intended to be screwed upon the threaded binding post (not shown) of the ordinary spark plug. Such binding posts, in spark plugs manufactured by different companies, vary in size. They usually vary slightly in diameter but the threads of different sizes are frequently of the same pitch. In other words, one manufacturer may use an 8/32 thread and another a 10/32 thread, each

having the same pitch of 32 threads to the inch but differing slightly in diameter. To make the present resistor adaptable to either type of spark plug terminal, I preferably provide the lower terminal 2 with both types of thread, for which purpose it is bored out half way on the larger diameter and for the remaining distance on the smaller diameter, being thereupon threaded with 32 threads to the inch along both diameters. This arrangement provides 10/32 threads in the outer portion of the opening, as at 10, and 8/32 threads in the inner part of the opening, as at 11, Fig. 5, and the terminal can be firmly screwed upon spark plug terminal posts of either size.

The three elements, to-wit, the body 1, the lower terminal 2 and the upper terminal 3, are first assembled in one-piece composite form by the molding of the hard rubber, phenolic condensation product or the like around and upon the two terminal members, which are held in proper spaced relation in a jig, mold or the like, as is usual. Thereupon the remaining parts are assembled with this preformed composite body unit. These remaining parts include the resistance element 12, which is a rod-like or cartridge-like mass of suitable resistance material, such as graphite or a composition of graphite and metal or other material, and suitable means for connecting the same to the two terminal members 2 and 3 and for sealing and enclosing the cavity in which the resistance element 12 lies. The resistance element is usually of cylindrical form and of a diameter slightly less than that of the cavity in which it lies. For more complete electrical union with the terminal members 2 and 3 the resistance member 12 may have its end portions provided with a coating of metal, as at 13, 13*a*, which coating may consist of copper or similar material plated or sprayed upon the ends of the resistance or, if desired, the ends of the resistor may be coated, for example, with copper and then be dipped in solder or other soft metal to accept and hold a thin layer of the softer metal. Complete electrical union between the resistance element and the two terminal members 2 and 3 is produced by small masses of malleable material, such as malleable metal, for example, a solder of any suitable composition, various mixtures of one or more of the metals lead, zinc, tin, aluminum, or the like, or even one of these metals alone, such as lead or tin. A mass 14 of such metal lies between the lower end of the resistance element 12 and the terminal member 2, while another mass 15 of such metal lies between the upper end of the resistance element 12 and the terminal 3 and is further used to close the cavity containing the resistance element and form a tight metal seal for such cavity. These masses of malleable metal are introduced into the resistor in such manner as to swage, deform or expand them into most intimate and into maximum surface connection both with the terminal members and with the ends of the resistance element.

The finished resistor is of minimum size, one practical embodiment being approximately one inch long. All parts are intimately, rigidly, and practically permanently connected or anchored to each other so that they will not rattle or become loose, nor does the electrical connection diminish or vary in use, notwithstanding the excessive vibration to which such parts of or upon a motor vehicle are subjected. The resistor as a whole, therefore, is of dependable electrical character.

Assembly of the parts of the resistor is accomplished by very simple methods which can be carried out commercially at low cost. As before stated, the body 1 and the terminal members 2 and 3 are first assembled as a distinct composite unit. Into the cavity within each such body unit is first inserted the necessary material for the malleable mass 14, for example, one or two small masses of lead, solder or the like, say one or two small substantially spherical shot, although small irregularly shaped pieces may be employed. However, the masses should be somewhat regular as to volume for uniformity of production. Next, the resistance element 12 is inserted into place. Its length is such that it extends slightly above the end of the reduced portion 6 of the body, but short of the end of terminal member 3. With the resistor laid on end upon a suitable support, such as the support A, Fig. 6, a plate B, in strip or sheet form, of the proper malleable metal, say lead, is applied flatwise to the upper end of the resistor. Thereupon, pressure is applied to plate B to force it downwardly toward the resistor, such as by the pressure of a tool or head C forming part of a machine or actuated by hand or applied under the blow of a hammer. This operation forces the malleable metal plate downwardly and causes the relatively sharp edges of the thimble-like end of terminal member 3 to enter the soft metal and shear out a disc-like slug of metal, somewhat after the manner of operation of a cooky cutter. The final effect or completion of such pressure is illustrated in Fig. 7, where the small slug has been sheared out from the metal strip and introduced into the opening in the resistor above the upper end of the resistance element therein. The soft metal B is chosen of such thickness in proportion to the volume of the metal mass 14 and to the length of the resistance element 13 that when this assembling step is carried to completion with the tool C pressed home or into substantial contact with the end of the upper terminal 3, not only is the small metal slug sheared out of the lead strip and inserted into the terminal, but also, both said slug and the mass of metal 14 are swaged or expanded outwardly to substantially fill their zones of the cavity within the resistor, causing the malleable metal not only to surround and closely hug each end of the resistance element and space it from the body 1, but to also spread it into very intimate contact with the neighboring surfaces of the terminal members. Indeed, the lower terminal member 2 may be provided with the shallow cavity 7 before referred to into which portions of the metal mass 14 are forced by the assembling operation. At each end of the resistance element the masses of malleable metal may be forced slightly into the annular space between the resistance element and the wall of its cavity, thus forming the skirts 14*a* and 15*a*.

If desired, the lower terminal member 2 may be provided with an upstanding point 7*a*, as shown in Fig. 5*a*, for more effectively swaging the malleable metal mass 14 into contact with the walls of the cavity surrounding it.

The final step to complete the resistor includes a peening operation performed as shown in Fig. 8 by the application to the upper end of the resistor of a peening tool D, the cavity 16 in which slightly swages or bends inwardly the end portions of the upper terminal 3, as indicated at 17, so that they slightly overlie portions of the malleable metal mass 15 and not only permanently retain the same and prevent it from escaping,

but also insure complete and thorough seal by metal to metal of the cavity in which the resistance element lies.

By the method described, resistors may be formed which are of constant and uniform characteristics, which are relatively inexpensive, which do not get out of order in use, and which can be readily applied to the spark plugs of a motor vehicle without special tools or appliances. It will be understood, however, that the resistor described is capable of other uses and by the use of terminal elements of other form may be adapted for connection to other parts than a threaded post and a terminal wire. For instance, the device may be arranged for universal connection to various types of lead wire terminals by use of the adapter shown in Fig. 2a. This comprises a snap-on thimble 18 of a form to coact with the terminal member 3. The thimble is provided with a threaded extension 19 to which a nut 20 may be attached to secure a lead wire terminal between the nut and the upper surface of the thimble, or by use of a suitable washer. The nut 20 may be slotted as at 21 to receive the forked end of a well known style of terminal connection.

What I claim is:

1. A resistance unit, comprising an insulating body of hollow tubular form having immovably and permanently anchored thereto two end terminal members, one of said members closing one end of said tubular body and the other having a through opening, a rigid resistance element within said body, said element being a cylindrical rod of slightly less diameter than the tubular cavity of the body to provide an annular space therebetween, masses of malleable metal, one at each end of said element for electrically connecting it to the end terminals, one of said masses being exposed at the end of said through opening, and said malleable metal having skirt portions extending into the annular space between said element and said tubular cavity to seal said annular space.

2. A resistance unit, comprising an insulating body of hollow tubular form having immovably and permanently anchored thereto two end terminal members, one of said members closing one end of said tubular body and the other having a through opening, a rigid resistance element within said body, and masses of malleable metal, one at each end of said element for electrically connecting it to the end terminals, said resistance element and masses of metal and through opening being alined, one of said masses being exposed at the end of said through opening, said parts being assembled under pressure, and the end portion of said end terminal about said through opening being swaged over upon said exposed metal mass to retain the parts in position.

3. A resistance unit, comprising an insulating body of hollow tubular form having immovably and permanently anchored thereto two end terminal members, one of said members closing one end of said tubular body and the other having a through opening, a rigid resistance element within said body, said element being a cylindrical rod of slightly less diameter than the tubular cavity of the body to provide an annular space therebetween, masses of malleable metal, one at each end of said element for electrically connecting it to the end terminals, said resistance element and masses of metal and through opening being alined, one of said masses being exposed at the end of said through opening, said parts being assembled under pressure, and said malleable metal having skirt portions extending into the annular space between said element and said tubular form to seal said annular space.

4. A resistance unit, comprising an insulating body of hollow tubular form provided with a through opening, a terminal member at one end of said opening, a rigid resistance element within said opening and conductively related to said terminal member, a second terminal member having a through opening and permanently anchored in said body at the opposite end of the body opening, and a mass of malleable metal for electrically connecting the second terminal member to said element, said metal mass lying at one end of said element and within and being exposed at the end of the second terminal member, said parts being assembled under pressure, and the end portion of said second terminal member about its through opening being swaged over upon said exposed metal mass to retain the parts in position and to close and seal said through opening.

LESTER L. STOFFEL.