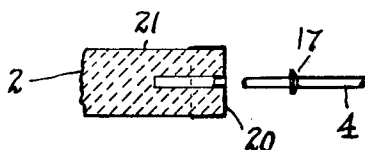
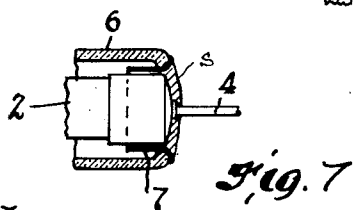
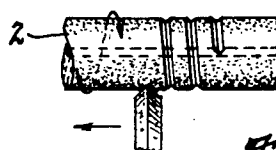
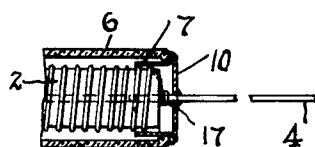
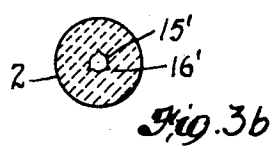
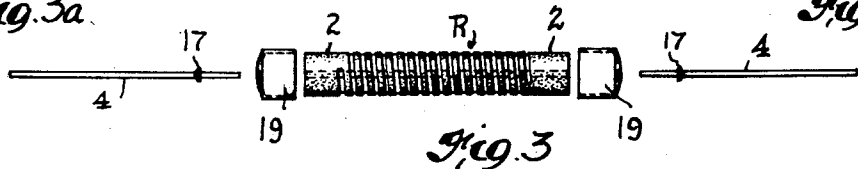
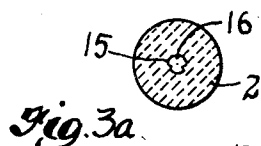
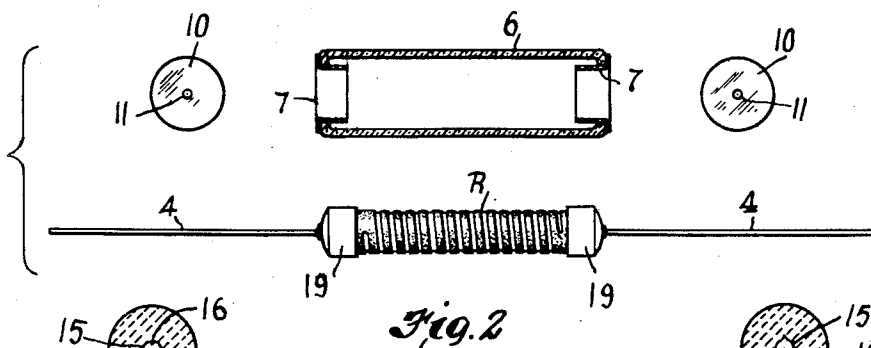
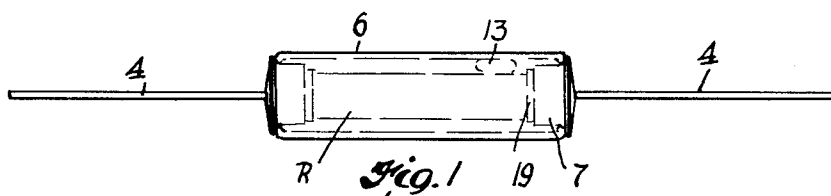


April 14, 1953

W. M. KOHRING
ELECTRICAL RESISTANCE

2,635,162

Filed Feb. 25, 1949



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UNITED STATES PATENT OFFICE

2,635,162

ELECTRICAL RESISTANCE

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Application February 25, 1949, Serial No. 78,310

10 Claims. (Cl. 201-63)

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This invention relates to electrical resistances, such as required in communication and signaling systems, radio, television, laboratory apparatus, etc., and it is among the objects of the invention to provide construction which is particularly "noiseless" and durable, and which may be manufactured in quantity production to high precision, and of desired ratings and desired degrees of protection either for ordinary or special duty usages. Other objects and advantages will appear from the following description.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawing setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawing:

Fig. 1 is a side elevational view of an embodiment of the invention;

Fig. 2 is an exploded view showing the components of structure as aforesaid;

Fig. 3 is an exploded view of the resistance unit apart from the extra protective shell;

Figs. 3a and 3b are slightly enlarged sectional views near the end of insulating cores as of Fig. 3;

Fig. 4 is a fragmentary sectional view showing a detail of a construction analogous to Fig. 1;

Fig. 5 is a fragmentary side elevational view showing a stage in one manner of forming a resistance element;

Fig. 6 is a fragmentary sectional view showing detail construction of terminal connections; and

Fig. 7 is a fragmentary sectional detail to show more clearly the relationships in construction as of Fig. 1.

In general, the construction involves a core of insulating material 2 carrying a resistance element R and terminals 4, the latter being in contact with the resistance element and available for making connection in electrical circuits of desired character.

As shown in Figs. 1, 2, 4 and 7, the resistance unit may be enclosed in a protective shell 6 preferably of glass, although in some instances insulating material of other composition can be applied. In construction employing glass, there are metal eyelets 7 assembled in the ends of the glass shell and sealed therewith by sufficient fusion of the glass. By employing glass and metal having similar coefficient of expansion, such metal-to-glass seals are readily made and are durable and

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tight under drastic conditions of usage. Such metals and glass are known in the electrical industry, and, for instance, a typical metal is an alloy of iron, nickel and cobalt, commercial products being available under the trade names of "Kovar," "Fenico," etc., and similarly suitable glass compositions are commercially available in the 700 Series of the Corning Glass Company. The technique of making glass-to-metal seals being well-known, it is sufficient here to state that the metal collars or eyelets 7 assembled with the glass shells 6 of desired length are subjected to the localized heating at the ends requisite to fuse the glass and complete the seal. With the prepared shell thus as shown in the upper portion of Fig. 2, there is assembled the resistance unit, this being inserted into the shell such that the wire terminals 4 project from each end. Then, the shell and resistance unit are secured together. While in some cases this may be sufficiently accomplished by applying plastic sealing over the ends, for more particular precision usages it is preferable to seal metallicity, by soldering or flowing molten metal to adequately cover in the ends of the assembly. Where the shell is of considerable size, metal disks 10, Fig. 2, having central openings 11, may be threaded onto the wire terminals 4 up into engagement with the metal collars or eyelets 7, thereby enclosing the resistance unit, and requiring less solder or molten metal to complete the end sealing. For high precision usage, the space between the shell 6 and the resistance unit inside is desirably filled with insulating oil, such for instance as known in connection with transformer and like usage. Where the resistor is to undergo usage involving generation of considerable heat, it is further desirable to provide some expansion space along with the oil, illustrated in Fig. 1 by the air space or bubble 13. It is understood, of course, that where an oil filling is employed, the oil is introduced after one end has been solder-sealed, and before the final closing of the other end. Advantageously, in the introducing of such oil filling, a vacuum apparatus is used, and the oil may in connection therewith be readily flowed in when the vacuum in the particular unit is broken. The advantage of such an oil filling is that it makes possible a more efficient heat dissipation, and if some air expansion space, as above noted, is present, very considerable heat loads may be successfully carried. A filling merely of air, however, is adequate for usages where less drastic heat conditions are to be encountered. The end disks 10 may be applied irrespective of what the detail

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construction of the resistor R is, whether wire-wound as shown in Fig. 4, or carbon coated as more particularly shown in Fig. 3. It is understood that end disks 10 are required only in larger sizes of resistances, and for the smaller range of sizes they are dispensed with, and the metal collar or eyelet of the glass shell and the end cap of the resistor are directly soldered together, as shown in Fig. 7, by the solder s.

While the construction including the protecting shell 6 is advisable for heavy duty usages, the resistor may be employed in other cases as merely covered by a plastic covering or coating sufficient to exclude ordinary moisture conditions and associated requirements.

Conveniently, the resistor, whether for application with or without the shell 6, may involve a core of insulating material, plastic, porcelain or ceramic, with an applied coating of carbon. This may be put on in the form of a liquid coating composition of carbon or graphite with a minimal amount of synthetic resin binder, and a volatile solvent thinner, but a preferred form of coating is obtained by pyrolysis or thermal decomposition of hydrocarbon gases or vapors, with deposit of carbon on a ceramic core. Carbonaceous gases such as natural gas, methane, ethylene, acetylene, and higher hydrocarbons, saturated and unsaturated, are thermolytically decomposed at temperatures above 1200° and up to about 2100° F., depending upon the particular hydrocarbon. By subjecting the desired ceramic cores to an atmosphere of hydrocarbon gas at such elevated temperature in a suitable furnace guarding against oxidizing conditions, a dense firm coat of graphitized carbon may be deposited upon the ceramic surface. Such a carbon coated core may then be provided with terminals connecting each end of the carbon coating, and giving a resistor which can be rated by the dimensions. Such a coated core, furthermore, instead of being applied as such, may also be used as a starting point for preparation of resistances of various desired ratings. For this, the coated core, by suitable mechanism on the order of lathe equipment, may be machined or ground to a thread cut form, as illustrated in Fig. 5. An advantage of this form of construction over all is that from a given coated core a wide range of desired resistance ratings can be made up, according to the pitch of the thread cut. Coarse pitch cutting yields lower ranges of ratings, and finer pitch cutting yields the higher desired ratings.

A securing of the wire terminals 4 is advantageously based on the provision of end openings in the insulating material body or core, and for convenience of manufacture, there may be a bore through the length of the core. In either case, whether merely end openings or bore throughout, the end openings are of such relation with respect to the terminals 4 that the latter are force-fitted or frictionally held in the openings. While the openings may be of the same cross section shape, e. g. circular, and of slightly smaller diameter, and a good force fit may be secured for the terminals, generally it is preferable to provide either the opening or the terminal with a different or deformed cross sectional area, whereby, on forcing of the terminal into the opening, there is scoring and a particularly tight zone of contact between the terminal and core. For example, the opening 15, Fig. 3a, in the end of the core may be in a form presenting protuberances 16 at the en-

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trance or even ribs extending back through the bore. Or along analogous lines, the opening, as 15', Fig. 3b, may have grooves 16'. Irrespective of the detail form of the openings, the terminals 4 are forced into their final position in the end openings of the core, and the grip is such that they are able to withstand the exigencies of stresses in application and usage of the resistors. While not necessary in all cases, it is advantageous to provide an upset shoulder 17 on the terminal 4, whereby to simplify uniformity of depth of insertion. To complete contact with the resistance element, in the case of wire windings, the wire may simply have a few anchoring turns inside of the shoulder, Fig. 4, before the terminal is driven completely into its final position. Otherwise, a convenient contacting of terminal with resistor element may be provided by metal caps 19, Figs. 2 and 3, and these may be positioned on the ends of the core and contacting the resistance element, and be slightly compressed into tight engagement about the ends of the structure. Thus, the resistor as shown in the lower portion in Fig. 2 provides a completely satisfactory form for many usages. A particularly convenient and adaptable contacting between the terminals and the resistance elements may be had by applying, however, on the ends of the core carrying the resistance element a coating 20 of metal, Fig. 6, desirably silver, this extending back over the ends sufficiently to amply contact the resistance element 21 on the periphery of the core 2. The terminal 4 then may be forced into position in the end opening of the core, the terminal thus contacting the metal coat which in turn contacts the resistance element; or in some cases the metal end cap 19, Fig. 3, may be applied with or without such preliminary metal end coat, the cap being then compressed onto the end of the core. The metal or silver coating on the core ends may be applied in any convenient way, as by electrodeposition, high temperature spray deposit, or painting on of the metal in liquid coating composition form. Silver liquid coating compositions are commercially available and are well-known for other established usages, these being in general made up of finely divided silver with a minimum amount of a resin binder, and a volatile solvent thinner. In any case, a sufficient metal coat is applied at the core ends to provide contact between the terminals and the resistance element on the core.

As the terminals are connected to the resistance element by being pressed into place, usually with some deformation, the connection is tight so as not to subsequently loosen and occasion trouble in usage conditions, and withal, the construction provides a unit having adaptability to a wide range of operating conditions, whether extremely drastic, or average, or mild.

Other modes of applying the principle of the invention may be employed, change being made as regards the detail described, provided the features stated in any of the following claims, or the equivalent of such, be employed.

I therefore particularly point out and distinctly claim as my invention:

1. In construction of the character described, a tubular glass shell, a metal collar sealed in each end of said shell, a core of insulating material in said shell carrying a resistance element, metal end disks secured to said metal collars and closing the shell ends, and terminals connected to said resistance element and extending through said end disks and externally of said glass shell.

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2. In construction of the character described, a core of insulating material having a resistance element and having end openings, metal end caps on said core in contact with the resistance element, and terminals having ends extending through said end caps and held in contacting-surface scored deformation force-fit in said openings.

3. In construction of the character described, a core of ceramic insulating material having end openings and provided with a resistance element, terminals held in contacting-surface scored deformation force-fit in said end openings, and a metal coating completing contact between said terminals and the resistance element.

4. In construction of the character described, a core of frangible insulating material with a resistance element, metallic coating in contact with said resistance element at each end, and terminals held in contacting-surface scored deformation force-fit in end openings in said core and contacting the metallic end coatings, and an insulating cover surrounding the resistance element.

5. In construction of the character described having a core of ceramic insulating material with a resistance element, coating the core ends with metal to also contact the ends of the resistance element, and axially forcing terminals in contacting-surface scored deformation into openings in the core ends and in contact with the metal coat.

6. In construction of the character described, a core of insulating material having end openings, a resistance element carried by the core, a metallic coating on each end of the core contacting the resistance element, and a connection secured to coating and core at the end center comprising a terminal held in contacting-surface scored deformation force-fit in each end opening.

7. In construction of the character described, a core provided with a resistance of desired value and having end openings and being of frangible material, and terminals electrically connected with said resistance and held in drive-fit in said end openings by contacting surface scored deformation therein and closing the openings.

8. In construction of the character described,

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a core provided with a resistance of desired value and having end openings and being of frangible material, and terminals making pressure contact electrically and held in drive-fit in said end openings by contacting surface scored deformation therein and closing the openings.

9. In construction of the character described, a core ceramic insulating material having a resistance element and having serrated end openings, metal end caps on said core in contact with the resistance element, and terminals extending through said end caps and held in drive-fit in said serrated openings.

10. In construction of the character described, a core of ceramic insulating material having a resistance element and having serrated end openings, metal end caps on said core in contact with the resistance element, and terminals extending through said end caps and held in drive-fit in said openings, a tubular glass shell enclosing said core, metal collars sealed with glass fusion in the ends of said shell, said metal collars being sealed to said metal end caps by molten metal, and insulating oil and an expansion space in said glass shell.

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