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2,297,780

HERMETICALLY SEALED RESISTOR

Filed July 27, 1940

Fig. 1.

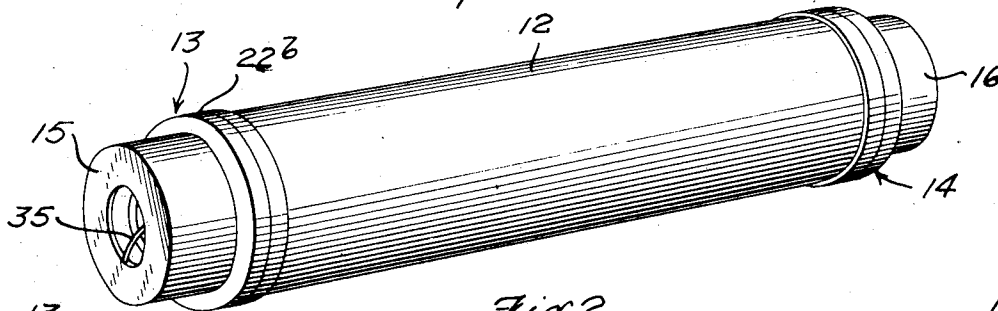


Fig. 2.

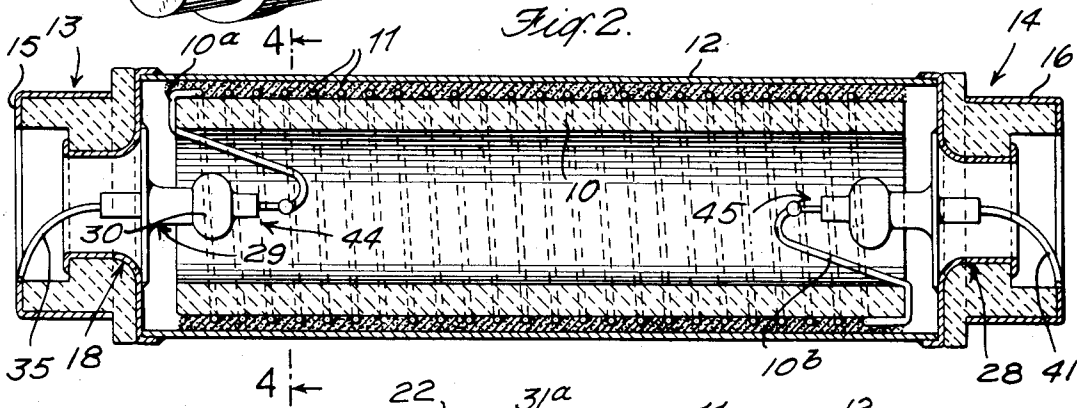


Fig. 3.

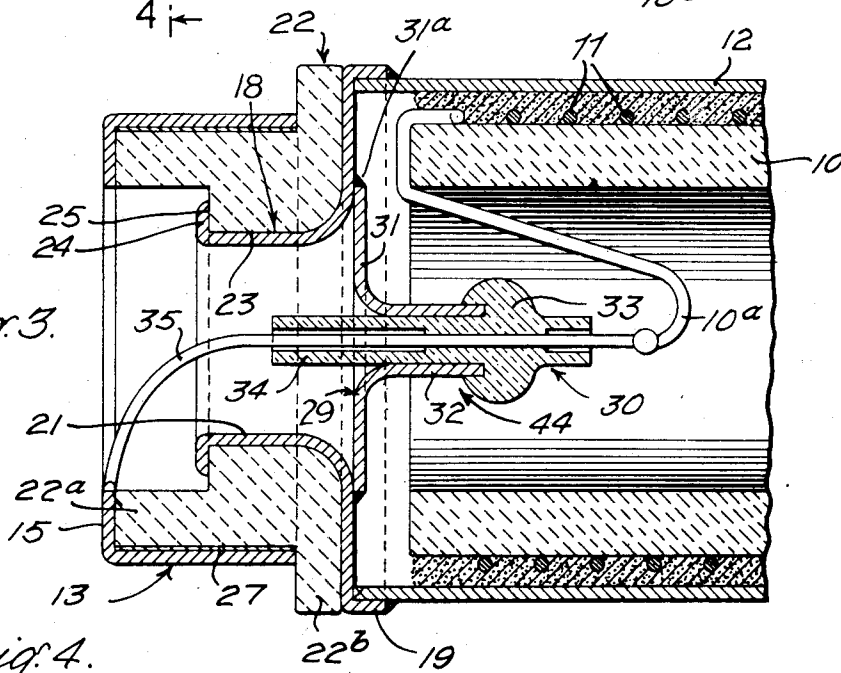
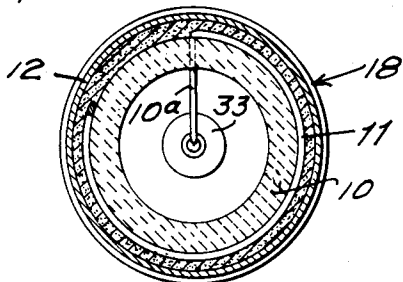


Fig. 4.



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HERMETICALLY SEALED RESISTOR

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4 Claims. (Cl. 201-67)

This invention relates to an electrical resistor and more particularly to a resistor that is hermetically sealed.

One of the objects of this invention is to provide a resistor construction which is simple, thoroughly practical, and durable in use. Another object is to provide a construction of the above character which may be manufactured from inexpensive materials without undue labor costs. Another object is to provide a construction of the above character whose strength is greatly increased due to the durability and lasting quality of the more vulnerable portions thereof. Still another object is to provide a construction of the above character which is well adapted to withstand continuous hard use. A further object is to provide a hermetic seal for a resistor which is not affected by adverse weather conditions. A still further object is to provide a hermetic seal for a resistor which is able to withstand a maximum of variation in temperature conditions without being adversely affected. Other objects will be in part obvious and in part pointed out hereinafter.

The invention, accordingly, consists in the features of construction, combinations of elements, and arrangements of parts, as will be exemplified in the structure to be hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawing, in which is shown one of the various possible embodiments of my invention:

Figure 1 is a perspective view of the resistor;

Figure 2 is a longitudinal sectional view of the resistor shown in Figure 1;

Figure 3 is a fragmentary longitudinal sectional view of the resistor shown in Figure 2 on an enlarged scale; and

Figure 4 is a section taken along the line 4-4 of Figure 3.

Similar reference characters refer to similar characters throughout the several views of the drawing.

As conducive to a clearer understanding of certain features of this invention, it might here be pointed out that resistors when used in naval or marine service are subject to extremely adverse weather conditions. Heretofore, to protect resistors from these conditions, a coating of Bakelite, vitreous enamel, cement, or similar material has been used, but such resistors have been unable to withstand these rigorous conditions of use. At best, the effect has been primarily to delay the ravaging effects of adverse

weather conditions; and in time a saline humid atmosphere will find its way to the resistance wire either through deterioration of the protective coating or through a vulnerable spot in the mechanical construction of the resistor. After the atmosphere reaches the resistance wire, it results in the failure of the resistor either through corrosion or through electrolytic action; salt water is an electrolyte and resistance wires usually are alloys comprising dissimilar metals; the water therefore sets up an electrolytic action disastrous to the wire.

Another factor which works in conjunction with humid atmosphere to attack resistors is variation in temperature. This is caused both by the climate in which the resistor is being used and also by heat generated in operation and has a deteriorating effect both on the resistor's protective coating and on its internal construction. Resistors now in use often have external coverings made from material having different coefficients of expansion and changes in temperature create seams for the penetration of damaging atmosphere. It is, accordingly, another object of this invention to provide a resistor construction in which these difficulties as well as many others are successfully overcome.

Referring now to Figures 1 and 2, the resistance element consists of a ceramic core 10 upon which resistance wire 11 is wound. This resistance unit is enclosed by a cylindrical metal casing 12 and a pair of terminal structures, generally indicated at 13 and 14. Terminal structures 13 and 14 hermetically seal the ends of casing 12, as will be described fully hereinafter and carry a pair of metal terminal caps 15 and 16 which serve as the contactors through which the resistance unit contacts the circuit in which it is used.

Core 10 is preferably in the shape of a tube made of a dielectric ceramic material and thus able to withstand extreme temperature variation. The resistance wire is wound upon this core and its ends 10a and 10b extend over the ends of the core. This resistance element is cemented to the interior wall of the casing 12, and this cement is a dielectric to insulate the resistance element from the casing. As best seen in Figure 2, core 10 is shorter in length than casing 12 so that its ends are spaced inwardly from the ends of the casing.

As both terminal structures are preferably similar in construction, detailed description will be limited to terminal structure 13, which is shown on an enlarged scale in Figure 3. A metal

end cap, generally indicated at 18, forms the base of this terminal and has an annular flange 19 formed thereon which extends over the end of casing 12. This flange is brazed or welded to the casing to make a perfect hermetic seal therebetween.

End cap 18 has a tubular-shaped portion 21 extending outwardly from its center and into a hole 23 in a ceramic insulator, generally indicated at 22. Hole 23 in insulator 22 increases in size, providing an annular-shaped ledge 25 and the outer end or lip 24 of cap 18 is spun over this ledge, thus firmly securing insulator 22 to the end cap. The outer portion 22a of insulator 22 is preferably of a reduced diameter and carries the metal terminal cap 15 secured thereto in any suitable manner such as by cement 27. The inner portion 22b of insulator 22 effectively separates cap 15 from the metal parts which cover the resistance element such as casing 12 and cap 18.

Thus, referring to Figure 2, the resistance element is completely enclosed by casing 12 and caps 18 and 28 with the exception of the openings therein. Leads 35 and 41, which connect the ends 10a and 10b of resistance wire 11 to terminal caps 15 and 16, pass from the interior of casing 12 through glass-metal hermetic seals, generally indicated at 44 and 45, closing these openings.

Referring now to Figure 3, hermetic seal 44 includes a metal funnel-shaped member 29, comprising a disc-shaped portion 31 and a substantially tubular-shaped neck portion 32. Portion 31 of member 29 is welded or brazed to the inner surface of cap 18 covering the opening therein.

The hermetic seal is completed by a glass bead 30 comprising a head portion 33 and a substantially cylindrical shank 34, the latter extending through and filling the neck portion 32 of member 29. When the bead is thus positioned in member 29 with lead 35 extending therethrough, the metal member and the bead are heated to fuse the glass to the metal and thus form a seal therebetween.

To make this a durable hermetic seal which is not adversely affected by temperature and weather conditions, it is necessary that the metal comprising lead 35 and member 29 and the glass of bead 30 be carefully selected. First, the metal and glass must have the same coefficient of expansion and second, the glass must form a bond therewith which is unaffected by the varying conditions which the unit must withstand in use. Satisfactory results have been obtained by using a glass designated in the trade as "Corning G705AJ," manufactured by the Corning Glass Company, and a metal alloy of iron, nickel, and cobalt marketed under the trade name of "Kovar." Glass-metal seals of the type used in this construction are disclosed in considerable detail in Patent No. 2,062,335.

It is preferable that the metal be degassed before effecting the bond by heating in a hydrogen atmosphere; temperatures in the neighborhood of 1800° F. have been found satisfactory for this purpose. This heating eliminates all traces of gas from the metal so that no bubbles or pockets appear in the bead 30 after the bonding is effected. Such bubbles or pockets reduce the insulation strength of the glass and impair its ability to withstand stresses introduced by temperature changes. Other types of metals and glasses may be used, and the principal prerequisites for such metals and glasses are that they

have approximately equal coefficients of expansion and are capable of forming a strong bond with each other.

It is important that temperature changes encountered in use be distributed throughout the glass seal as quickly as possible in order to prevent harmful stresses being set up, and therefore the mass of glass bead 30 should be as small as possible.

Thus, the resistance element is hermetically sealed so that adverse weather conditions cannot affect it. Referring to Figure 2, a continuous metal casing encloses the element, the only openings therein being sealed by the glass bead. Accordingly, there are no points at which saline humid atmosphere or water may enter to attack the element.

Furthermore, this resistor is particularly able to withstand extreme temperature change. As was pointed out hereinabove, temperature changes have heretofore had a deteriorating effect because of the creation of openings in the resistor through which the atmosphere may enter. The parts of the metal casing are welded together in the present construction and thus, are not adversely affected by temperature changes, and the glass bead 30 as well as its supporting member 29 and lead 35 have the same coefficient of expansion. Thus, when the resistor is subjected to changes in temperature, these parts expand and contract as a unit, so that no stresses can be set up in this portion of the resistor to break the seal. In fact, this resistor is so constructed that it can be subjected to rapid temperature changes between -40° C. to 280° C. without causing a breakdown of the hermetic seal. Thus, this resistor is particularly adaptable to marine or naval work, as it can withstand the combination of both adverse temperature and weather conditions of extreme variety.

It will, thus, be seen that I have provided a thoroughly practical and efficient resistor in which the several objects hereinabove referred to, as well as many others, are successfully and efficiently accomplished.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiment above set forth, it is to be understood that all matter hereinabove set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In resistor construction, in combination, a ceramic core, a resistance element wound on said ceramic core, a metal casing enclosing said resistance element and core, insulation material forming a packing between said core and said casing, a pair of metal tubular-shaped openings extending into said casing from the ends thereof, a pair of glass members mounted in said tubular-shaped openings, and a pair of leads connected to the ends of said resistance element and extending from the interior of said casing to the exterior thereof through the central portions of said glass members, the portions of said casing contacting said glass members, said glass members and the leads extending through said glass members being bonded to each other by a glass-to-metal seal and all having the same coefficients of expansion to hermetically seal said resistance element from the atmosphere.

2. In a resistor, in combination, a resistance element, a metal casing enclosing said element,

means for supporting said resistance element within said casing, said metal casing having an opening therein, a metal funnel-shaped member covering said opening, said funnel-shaped member having a tubular-shaped neck portion, a glass member extending through and fused only to said tubular-shaped neck portion, and a lead member passing through said glass member connected to said resistance element, said members being bonded together by a glass-to-metal seal and having the same coefficients of expansion to seal said resistance element within the casing.

3. In a resistor, in combination, a resistance element, a tubular-shaped metal casing covering said resistance element, means for supporting said resistance element within said casing, a pair of end caps having holes in the central portions thereof secured to and covering the ends of said casing through hermetically sealed joints, a pair of metal members having glass inserts therein hermetically sealing said holes, and a pair of leads passing from the interior of the resistor to the exterior thereof through the central portions of said inserts, said leads, said metal members, and said glass inserts having substantially similar coefficients of expansion and being bonded together by a glass-to-metal seal.

4. In a resistor, in combination, a resistance element, a tubular-shaped metal casing covering said resistance element, insulation material positioned between said resistance element and said metal casing, a pair of metal end caps secured to the ends of said casing, a pair of tubular-shaped portions extending outwardly from said end caps, a pair of insulators having openings extending therethrough, the tubular-shaped portions of said end caps extending into said openings, means formed on the ends of said tubular-shaped portions securing said insulators to said end caps, a pair of metal terminal caps secured to said insulators, said insulators separating said terminal caps from said end caps and said casing, a pair of metal members having glass inserts therein hermetically sealing the openings in said end caps, and a pair of leads passing through said glass inserts and connecting the ends of said resistance element to said terminal caps, said metal members, said glass inserts, and said leads having substantially similar coefficients of expansion, whereby said resistance element is hermetically sealed from the atmosphere.

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