

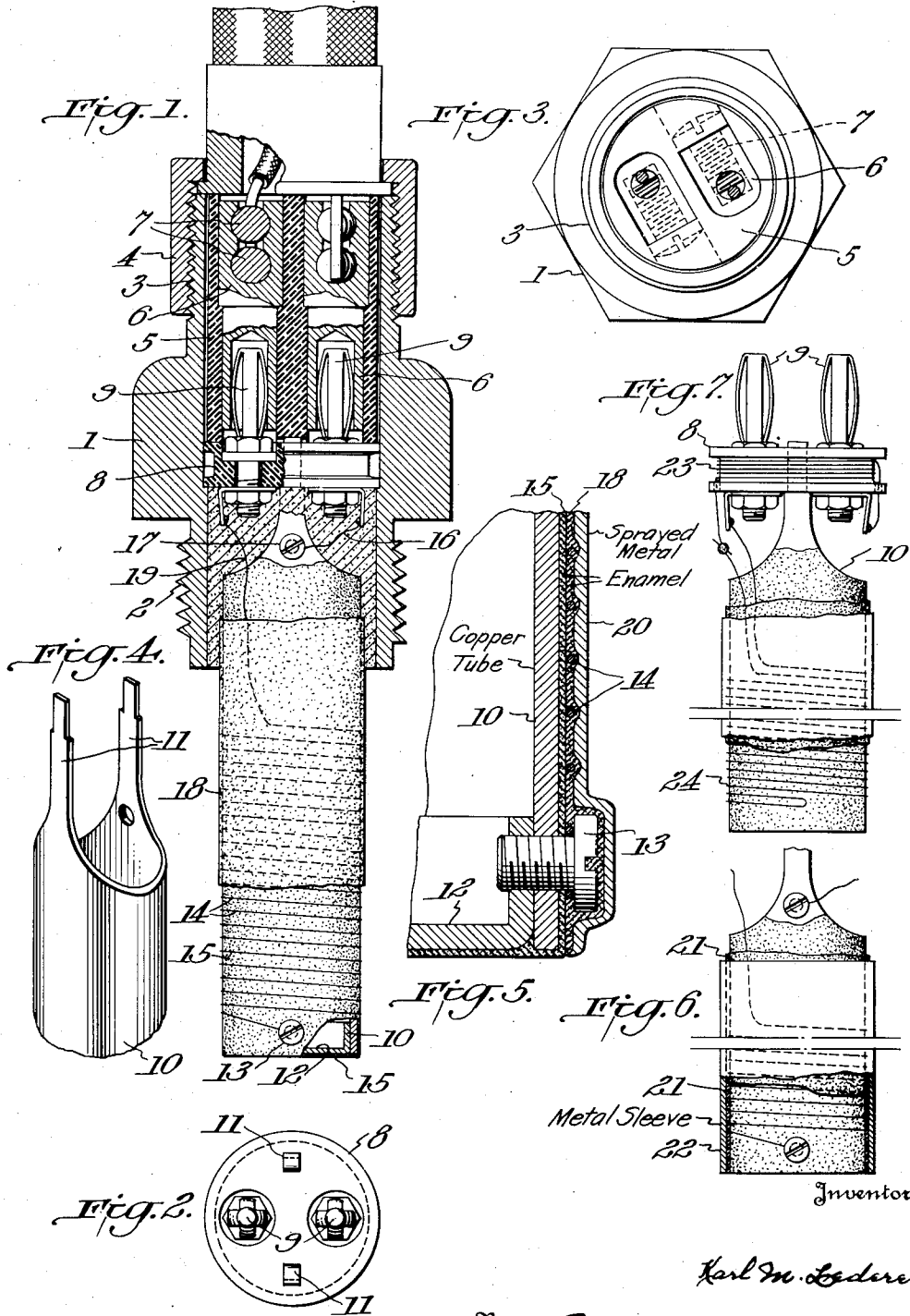
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RESISTANCE ELEMENT

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RESISTANCE ELEMENT

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This invention relates to resistance elements and particularly to resistor bulbs for use in the electrical measurement of temperatures.

Systems of this type are employed for many purposes, such as that of maintaining a continuous observation of the temperatures at different points of an airplane engine. Resistor bulbs are inserted in the water jackets of one or more cylinders, in the lubricating oil system and in the air inlet to the carburetor. Relatively high temperatures are present at the air inlet and some constructions which have been employed for measuring water and oil temperatures have failed at higher temperatures.

Practical considerations as to size, rapidity of response to temperature changes, and ease of replacement present difficult and conflicting design requirements. The physical structure should be small and rugged, while the resistance element should be of relatively large size or area and in good heat transfer relation to the gas or liquid surrounding the bulb. It has been proposed to obtain a rapid heat transfer to a resistance coil by cementing a prewound coil to the inner wall of a thin metal tube, but this method of manufacture is difficult and relatively expensive.

Objects of this invention are to provide simple resistor bulbs which may be conveniently and economically manufactured. An object is to provide a resistor bulb including a mounting head having a bore therethrough, and an insulating disk located within the head and supporting both the resistance and terminal pins for the same, the outer part of the mounting head enclosing the terminal pins and forming a socket for receiving a cable plug having terminals complementary to the terminal pins. A further object is to provide a resistor bulb having a winding of relatively large diameter wire of high resistance-temperature coefficient, and a compensating winding of wire of low or zero temperature-resistance coefficient for imparting to the resistor bulb the temperature characteristics of standard bulbs of copper wire.

These and other objects and advantages of the invention will be apparent from the following specification when taken with the accompanying drawing in which:

Fig. 1 is a side elevation, with parts broken away, of one embodiment of the invention;

Fig. 2 is an end view of the terminal side of assembled disk and tube;

Fig. 3 is an end view of a resistor bulb having a cable plug inserted in the socket thereof;

Fig. 4 is a fragmentary perspective view of one end of the tube on which the resistance wire is wound;

Fig. 5 is an enlarged fragmentary section of a resistor bulb similar to Fig. 1 but having an added metal protective layer;

Fig. 6 is a fragmentary view of a further modification; and

Fig. 7 is a side elevation of a resistor bulb having a composite winding.

In the drawing, the reference numeral 1 identifies the central section of the mounting head of the resistor bulb, this section being preferably of hexagonal outline to receive a wrench for securing the threaded sleeve section 2 in a tapped hole in an engine cylinder wall or the like. A second sleeve 3 projects from the other end to receive a threaded cap 4 which secures the cable connections to the mounting head. The cylindrical cable plug 5 of insulating material carries tubular terminals 6 which are provided with screws 7 for clamping the cable leads.

The bore which extends through the mounting head is of somewhat larger diameter at the outer or cable side, and an insulating disk 8, preferably of ceramic material, is seated upon the radial shoulder which is thus formed at an intermediate section of the head. The threaded shanks of the flexible pin contact terminals 9 extend through the disk 8 and are received within the tubular terminals 6 of the cable plug to provide a wiping contact of low resistance. The contact terminals 9 extend well above the disk 8 and thus decrease the tendency for oil to collect upon the terminals. Increased contact resistance from oil deposits upon the terminals is a problem which is particularly troublesome with installations on aircraft but the long terminals rising above the base of the plug socket and the wiping contacts substantially eliminate errors arising from variable contact resistance at the cable connections.

A small diameter metal tube 10, preferably of thin copper, is secured to the disk 8 by the bent ends of strap extensions 11 that are formed by cutting away opposite sides of the tube. The lower end of the tube 10 is tightly closed by an inserted cap 12 that may be locked in place by a screw 13 by which one end of a copper resistance winding 14 is attached to the tube. The intermediate section of the tube 10 is coated with a thin layer 15 of a vitreous enamel which is applied by a dipping or spraying operation, followed by baking. The winding 14 may consist of spaced turns of bare copper wire of small diameter, say

of the order of 0.0015 inch, which is wound upon the insulating enamel layer 15. The end of the winding adjacent the head 1 is connected to one of the pin terminals 9, and the other terminal is grounded on the copper tube 10 by a lead 16 and screw 17. The winding 14 is protected mechanically and is insulated by the application of another layer 18 of enamel, preferably a vitreous enamel fusing at a temperature lower than that of the first enamel coating.

In the manufacture of the resistor bulb, the winding is applied to an enameled tube and, after the second enamel layer is applied, the resistor unit is secured to a disk 8 by the tube extensions 11, and the connections are made to the terminals. The tube is then inserted through the outer end of a mounting head 1 to seat the disk 8 on the radial shoulder, and the parts are secured in place by ceramic material or cement 19 which forms a hermetic seal across the bore through the mounting head and also seals off the upper end of the tube 10.

All parts of the resistor bulb are capable of withstanding temperatures well above atmospheric without damage. The resistance of the bulb may be of any desired value, and is usually 100 ohms at 25° C. The resistor responds rapidly to temperature changes as the mass of the supporting structure is thin and the shell is sealed against the fluid in which the shell is submerged. The thin layers of enamel afford mechanical protection for the winding but do not cause a material time delay in the heat transfer to the winding.

Vitreous enamels are brittle and further mechanical protection may be desirable in some instances. As shown in Fig. 5, an adherent coating 20 of metal may be sprayed upon the outer enamel layer 18 to reinforce the same. I have found that a relatively thin sprayed metal coating acts as a shock absorber or protective band about the enamel, and prevents chipping or fracture. The metal layer is a good heat conductor and does not introduce an appreciable time lag in the response of the resistor bulb to temperature changes.

An alternative design for a rugged resistor bulb is shown in Fig. 6. In this arrangement, the construction is similar to that described above except that the outer layer 18 of enamel may, if desired, be omitted. A thin layer 21 of a ceramic cement is applied over the bare wire 14 or over the enamel layer 18, and a thin shell 22 is slipped over the coated bulb and held in place by the setting and/or laking of the cement.

It is to be understood that many turns of exceedingly fine copper wire are required to obtain a resistance of 100 ohms. The drawing is not to scale as the wire has been shown in exaggerated size for clearness of illustration. The mechanical problems of forming the resistance winding may be reduced by employing other metals, such as nickel, that have a higher specific resistance than copper. Nickel wire may be of appreciably larger diameter than copper but the different temperature-resistance characteristics of nickel and copper make it impossible to use a nickel wire resistance in a measuring system designed for a copper wire resistance.

This objection to the use of high resistance materials may be overcome by the construction shown in Fig. 7. Since nickel has a higher temperature-resistance coefficient than copper, the operating characteristics of a standard copper wire resistance may be obtained by forming a

part of the resistance of nickel and the remainder of a wire having a zero or low temperature-resistance characteristic. The disk 8, terminals 9 and tube 10 may be substantially as previously described. An insulated wire of manganin is wound in the circumferential groove of the disk to form a resistance section 23 that has a substantially zero temperature-resistance characteristic, and this section is connected in series with a bare nickel wire 24 that is wound upon the enameled tube. In cases where the highest accuracy is not needed, the outer end of the nickel wire may also be connected to the copper tube by means of screw 13 (Fig. 1). Where, however, thermo effects prevent the use of the copper tube as a conductor, a bifilar winding shall be used (as per Fig. 7) starting at the outer end of the tube 10. The ends of the wire may be anchored to, but electrically insulated from, the tube by means of mica washers and bushings (not shown) by the screw 17, such as shown in Fig. 1, or directly connected to terminals (as per Fig. 7). When nickel and manganin are employed, the characteristics of a copper resistance of a given value at 25° C., say 100 ohms may be obtained by a nickel resistance of approximately 65 ohms in series with a manganin resistance of about 35 ohms. The exact ohmic resistance of either resistance material depends upon the exact temperature coefficient of the nickel wire which varies somewhat with a minute amount of impurities. Such a resistor bulb may be used in place of a standard 100 ohm resistor bulb without material change in any part of the electrical measuring system.

While I have described preferred embodiments of the invention, it will be understood that various changes may be made in the design and relationship of the several parts without departing from the spirit of my invention as set forth in the following claims.

I claim:

1. In a resistor bulb of the type stated, a head having a bore therethrough, the ends of said bore being of different diameters to provide a radial shoulder, an insulating disk seated on said shoulder, a thin metal tube secured to said disk and extending from one side thereof through the smaller diameter end of the bore, resilient friction terminal pins projecting from the opposite side of said disk, said terminal pins being located within the bore and said head forming a socket adapted to receive a cable plug having terminals complementary to said terminal pins, and a resistance winding carried by and insulated from said tube, said winding being connected between said terminals.

2. A resistor bulb having the electrical characteristics of a copper resistance winding, said bulb comprising a metal tube supported at one end by an insulating disk, terminals on said disk, a temperature-variant resistance on said metal tube and consisting of wire of relatively large diameter having a temperature-resistance coefficient greater than that of copper, a second resistance wound on said disk of wire having a substantially zero temperature-resistance coefficient, means connecting said resistances in series between said terminals, a mounting head having a bore within which said disk and terminals are located, and a cap threaded upon said head to secure thereto a cable plug to connect said terminals to an external circuit.