

July 3, 1945.

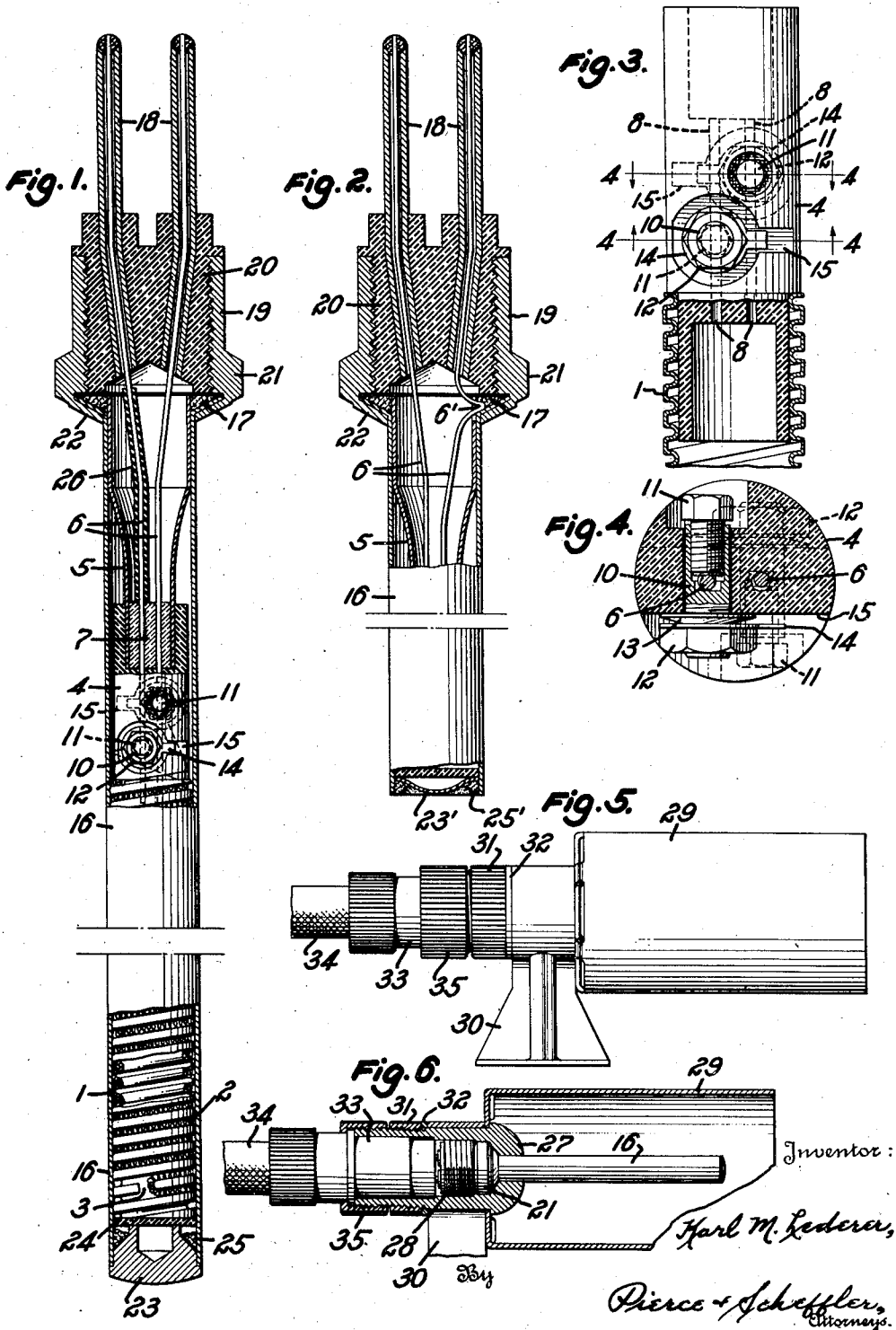
K. M. LEDERER

2,379,530

RESISTANCE ELEMENT

Filed Sept. 30, 1941

2 Sheets-Sheet 1



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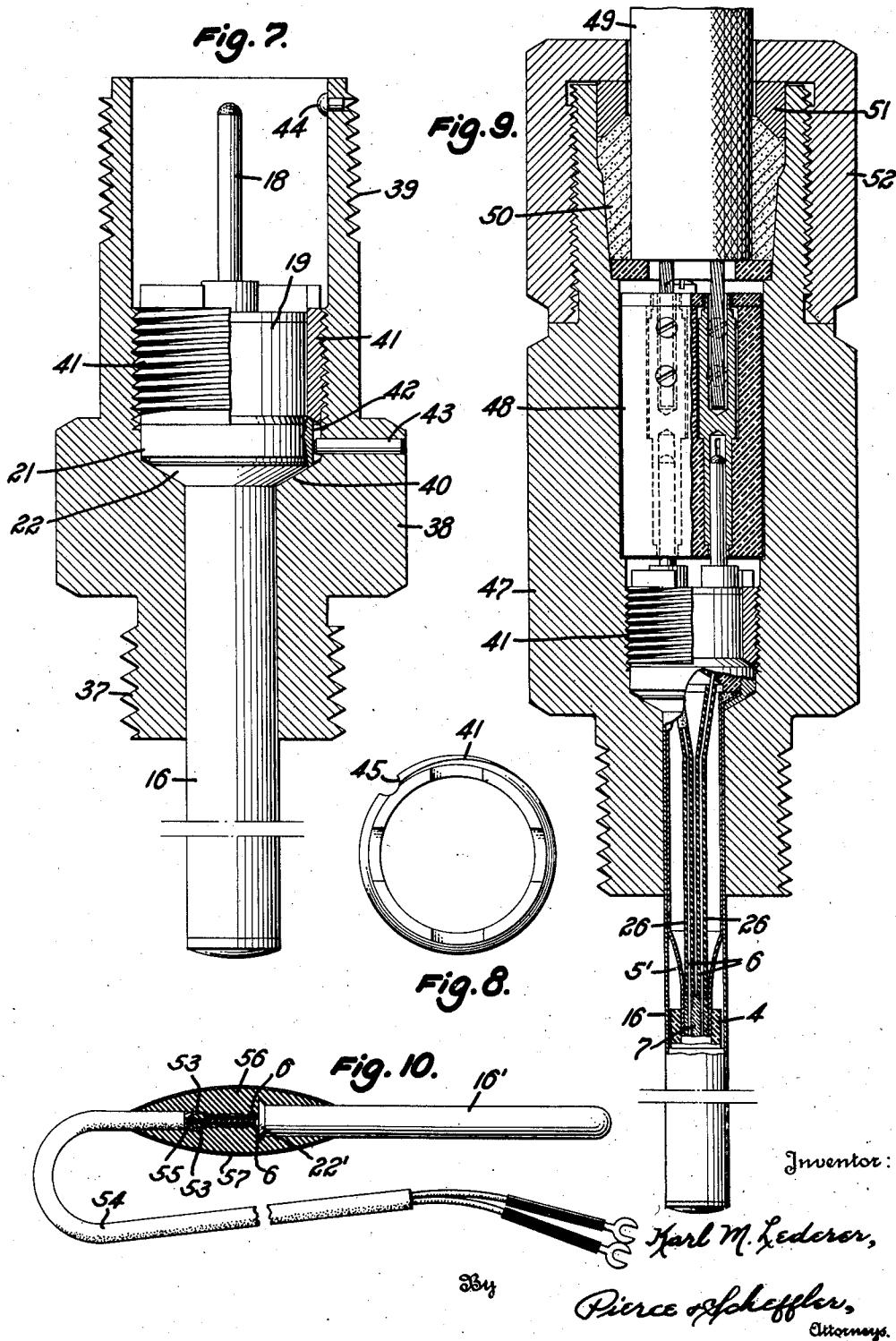
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

2,379,530

RESISTANCE ELEMENT

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15 Claims. (Cl. 201-67)

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

A resistor bulb comprises, in general, a winding of resistance wire upon a suitable form such as a metal tube, a protective shell enclosing the resistance wire, and a mounting head for attaching the resistor bulb to a support or to the wall of a chamber containing a media whose temperature is to be measured. Resistor bulbs of this type are described and claimed in my prior Patent No. 2,120,335 and in Patent 2,149,448, K. M. Lederer and A. Dempster. The ohmic resistance of the winding varies with the temperature of the surrounding media, and the measuring circuit includes the resistor bulb in series with a constant potential current source and an electrical indicating instrument having a scale graduated in temperature values.

An object of this invention is the provision of a resistor bulb responsive to temperature changes in a minimum time. An object is the provision of a resistor bulb which is completely sealed against attack by moisture, fumes, etc. whereby accuracy and long, trouble-free service is maintained. Another object is the provision of an accurate resistor bulb of improved and rugged construction that may be used either with or without a mounting head, is quick in response and economical to manufacture. Still another object is the provision of a resistor bulb comprising an inner tube carrying a coil of resistance wire, terminal wires connected to the ends of the resistance wire and extending through a medium providing a hermetical seal, and an outer protective tube surrounding the inner tube, the tubes being joined together to complete the hermetical sealing of the resistance wire. Another object is the provision of a resistor bulb of the above construction and provided with a threaded adapter whereby the completed unit may be attached to the wall of a chamber containing the media to be investigated.

These and other objects and advantages will be apparent from the following description when taken with the accompanying drawings. The drawings are for purposes of illustration and are not to be construed as defining the limits of the invention, reference being had, for this purpose, to the appended claims.

In the drawings wherein like parts are identified by like reference characters in the several figures:

Fig. 1 is an enlarged and fragmentary eleva-

tion, with parts in section, of a resistor bulb embodying the invention;

Fig. 2 is a similar enlarged and fragmentary elevation of another embodiment;

Fig. 3 is a fragmentary elevation on a larger scale, with parts in section, of the insulating coupling bushing and an outer portion of the grooved inner tube which carries the resistance winding;

Fig. 4 is a transverse section of the same as seen on either of the planes indicated by the section lines 4-4 of Fig. 3 when looking in the directions indicated by the arrows associated with the section lines;

Fig. 5 is a side elevation, on a somewhat reduced size scale, of a resistor bulb assembly for the measurement of free air temperature adjacent a moving body, such as an aircraft, upon which the resistor bulb is mounted;

Fig. 6 is a fragmentary vertical section through the resistor bulb assembly of Fig. 5;

Fig. 7 is a fragmentary elevation, with parts in section, of a resistor bulb assembled in a mounting head;

Fig. 8 is a plan view of the gland nut for securing the resistor bulb in the mounting head;

Fig. 9 is a fragmentary elevation, with parts in section, of a mounted resistor bulb and cable connections to the same; and

Fig. 10 is a fragmentary elevation, partly in section, of an unmounted resistor bulb and cable assembly.

In the drawings, the reference numeral 1 identifies a thin metal tube, preferably of aluminum or an aluminum alloy, into which double threads of approximate sine form are pressed or rolled to provide grooves in which the helically coiled resistance wire 2 is positioned in the manner described and claimed in Patent 2,149,448. The grooved tube 1 is "anodized" on its outer surface to provide an insulating layer of oxide that permits use of a bare resistance wire 2, usually a loosely coiled helix, of nickel or any appropriate alloy. A sharp depression 3 extends between adjacent grooves at one end of the tube 1 to provide an anchor for the central portion of the helically coiled winding. The other end of tube 1 fits over and is cemented or otherwise secured to the reduced diameter section of an insulating bushing 4 of lava or other material that is stable at the temperatures to which the resistor bulb will be exposed. The bushing 4 is counterbored from its opposite ends to reduce its mass and heat inertia, and to facilitate its connection to the cylindrical end of an inner or coupling tube member 5

through which lead-in wires 6 of a suitable metal and diameter extend and are hermetically sealed by an insulating material 7 that may be, and preferably is, glass. The central portion of the coupling tube 5 is approximately conical and its upper end is cylindrical and of slightly larger diameter than the bushing 4.

The lead-in wires 6 extend through spaced passages 8 in the bushing 4, see Figs. 3 and 4, and are secured therein by electrical connecting members that extend transversely through the passages 8. Each connecting member takes the form of a metal stud 10 with a transverse opening to receive a lead-in wire 6 that is secured to the stud by a screw 11 which threads into a bore at one end of the stud. The other end of each stud is externally threaded to receive the nut 12 which clamps an end of the resistance wire 2 between a spring washer 13 and a keyhole-shaped washer 14. The tail of the washer 14 is seated in the narrow portion of a keyhole shaped depression 15 in the bushing 4 to prevent rotation of the washers that might result in a breaking of the wire 2. The mechanical assembly of the coupling tube 5 on the bushing 4 may be reinforced by an appropriate cement.

A protective shell 16 of thin metal fits snugly over the grooved tube 1 and the upper section of the coupling tube 5, and is outwardly flared at its upper end to form a shallow recess to receive solder or cement 17 for completing the hermetic sealing of the resistance wire 2 within the protective shell. The shell 16 may be of aluminum and anodized on its inner surface to prevent a short-circuiting of the bare resistance wire 2, as is described in Patent No. 2,149,448. Alternatively, the shell 16 may be formed of a corrosion resistant alloy such as stainless steel, "Monel" metal, silicon bronze or the like, when the winding of bare wire 2 is protected, after assembly on the tube 1 and connection to the lead-in wires 6, by spraying the assembly with a high temperature lacquer and baking.

The outer ends of the lead-in wires 6 extend through and are soldered to tubular terminal members 18 that are secured within a metal sleeve 19 by insulating material 20 that is molded into and anchored in grooves or threads in the inner wall of the sleeve. The radially enlarged intermediate section 21 of the sleeve 19 has an upper conical wall and terminates at its lower end, as initially formed, in a thin walled cylindrical flange 22 that may be spun into close engagement with the lower surface of the flared outer end of the protecting shell 16.

The lower end of the shell 16 is closed, for example by a plug 23 that seats against a washer 24 and is sealed to the shell 16 by a solder or cement 25.

An insulating sleeve 26 of glass fiber or other material that is stable at the temperatures at which the resistor bulb is to be used may be slipped over one or both of the lead-in wires 6, as illustrated in Fig. 1, to prevent a short-circuiting of the lead-in wires. The resistance winding 2 is insulated from the protective shell 16 in the embodiment shown in Fig. 1 but, if desired, one terminal of the resistance winding may be grounded upon the shell by embedding a bend or loop 6' of one of the lead-in wires 6 in the solder 17 that unites the shell 16 and the coupling tube 5, see Fig. 2. Also, as shown in Fig. 2, the protective shell 16 may be sealed off at its lower end by a domed end member 23' that is inserted within and sealed

to the protective shell 16 by solder or cement 25'.

The resistor bulb unit will usually be secured within a mounting head which serves as a part of a cable connection and a mechanical coupling member for mounting the resistor bulb in a threaded opening in the wall of an engine cylinder or other vessel, or in a supporting bracket when, as illustrated in Figs. 5 and 6, the temperature of the free air adjacent an aircraft is to be measured. The mounting head 27 is counterbored from its outer end to receive the resistor bulb unit, and a gland nut 28 is threaded into the mounting head to engage the outer conical surface of the enlarged section 21 of the sleeve 19, thereby clamping the resistor bulb unit into the mounting head. The inner end of the mounting head is enlarged to provide a radial shoulder for clamping the protective shell and wind scoop 29 to the edge of the cylindrical section of a stamped metal bracket 30. The outer end of the mounting head 27 is externally threaded to receive the clamping nut 31 and a washer 32 that seat against the opposite edge of the cylindrical bracket section. A double contact type of connector 33 on the end of a cable 34 is fitted over the terminals 18 of the resistor bulb unit and secured to the mounting head by a nut 35. Appropriate means are provided, as will be described hereinafter with reference to another embodiment of the invention, to prevent inadvertent rotation of the resistor bulb and of the cable connector with respect to the mounting head.

A mounting head construction that has been employed with resistor units for measuring the temperature within a container, for example the cooling jacket of an engine cylinder, is illustrated in Fig. 7. The mounting head has an externally threaded lower end 37 for seating within a corresponding threaded opening in the wall of the container, an enlarged intermediate section 38 that is preferably of hexagonal form to take a wrench, and an externally threaded upper end 39 for receiving the clamping nut of a cable connector. The bore through the head 37 has a conical surface section 40 against which the conical flange 22 of the sleeve 19 is clamped by the gland nut 41 that seats upon the upper conical surface of the portion 21 of the sleeve 19 of the resistor bulb unit. A longitudinal groove 42 is cut into the sleeve section 21 to receive the inner end of a pin 43 that is secured in the mounting head. The resistor unit is thus locked against angular movement within the mounting head, and another pin 44 projects into the upper portion of the bore of the head 37 to lock the cable connector, not shown, against rotation. The gland nut 41 has a longitudinal groove 45 to permit axial movement of the gland nut past the locking pin 44, and the upper edge of the nut is notched to receive an end wrench.

The length of the resistor bulb and the shape of the mounting head may be varied to meet different design requirements. As shown in Fig. 9, the protective tube 16 and inner coupling tube 5' may be of any desired length to locate the inner end of the resistor bulb at an appropriate distance from the mounting head 47. The mounting head 47 is relatively long, as compared with the head 37 of Fig. 7, to receive both the cable coupling member 48 and the cable end 49. The upper end of the bore of the mounting head is flared somewhat to receive a packing 50 of hemp or other appropriate material that is compressed upon the cable end by the gland 51 and

the nut 52 that is threaded upon the outer end of the mounting head.

Neither the mounting head nor the supporting sleeve and pin terminal assembly, as previously described, is required in some applications of the invention. The connections to the measuring circuit may be made directly to the lead-in-wires 6, as shown in the clinical thermometer embodiment of Fig. 10. The conductors 53 of a conventional two wire cable 54 may be twisted upon and soldered to the lead-in wires 6, in the usual manner, the junctions being insulated from each other by a strip of insulating material 55 and enclosed within insulation 56 that may be a semi-plastic material within a covering 57 that may be a winding of tape or a thin plastic material shell. The conical flange 22' at the end of protective tube 16' may be of somewhat reduced diameter in this form of the invention, and the insulating material 56 extends a substantial distance over the cable 54 and tube 16' to provide a mechanically stable connection between those members.

The invention is not restricted to any particular dimensions but it is preferable to reduce the size, and thereby the mass, of the resistor bulb to a minimum to reduce to a practical minimum time lag between temperature changes at the exterior of the protective tube 16 and the resulting temperature changes of the resistance wire 2. It is possible, and desirable, to restrict the diameter of the outer tube 16 to the order of about $\frac{1}{4}$ inch, and it is to be understood that, except for Figs. 5 and 6, the patent drawings are enlarged scale views of the preferred embodiments of the invention.

For convenience and clarity of definition in the claims, the terms "inner end" and "outer end" will be employed to identify the protective shell end and the terminal wire end, respectively, of the resistor bulb. These terms do not indicate the locations of the opposite ends of the resistor bulb with respect to a supporting wall since, as disclosed in Figs. 5 and 6, the mounting arrangement may be such that both ends of the resistor bulb are at the same side of the supporting wall or housing. When the resistor bulb is threaded into and extends through a supporting wall, the "inner" or resistance wire end may be at either the interior or the exterior of the container, conduit or other housing, for example, within the water cooling jacket of an internal combustion engine or at the exterior of an airplane.

The invention is not limited to the particular constructions herein shown and described, and numerous changes may be made in the several parts, their relative sizes, shapes and relationship without departure from the spirit of my invention as set forth in the following claims.

I claim:

1. In a resistor bulb, a protective metal shell member closed at its inner end, a resistance winding within said shell member, and means hermetically sealing said winding within said shell member; said means comprising a coupling tube member telescoped into and snugly fitting the outer portion of said shell member, means hermetically sealing the junction between said members, lead-in wires extending through said tube member and connected to said resistance winding, and means anchoring said lead-in wires within and hermetically sealing off the interior of said tube member.

2. In a resistor bulb, the invention as recited in claim 1, wherein said means sealing the junction between said members comprises a section of one of said members flared away from the ad-

jacent section of the other member above the snugly fitting portions thereof to form a recess, and sealing material within said recess and uniting said members.

3. In a resistor bulb, the invention as recited in claim 1, wherein the outer end of said shell member is flared away from the adjacent portion of the coupling tube and cooperates therewith to form a recess, and said means sealing the junction of said members comprises sealing material within the recess.

4. In a resistor bulb, a protective metal shell having a closed inner end, a coupling tube snugly fitted into the outer end of said shell and hermetically sealed thereto, terminal wires extending through said coupling tube, means anchoring said wires within and hermetically sealing off the interior of said coupling tube, a winding form within said protective metal shell, a winding of resistance wire on said form, and means electrically connecting the ends of said resistance winding to said terminal wires.

5. In a resistor bulb, the invention as recited in claim 4, wherein said connecting means includes an insulating coupling bushing mechanically secured to and connecting said winding form to said coupling tube.

6. In a resistor bulb, the invention as recited in claim 4, wherein said connecting means includes an insulating coupling bushing mechanically secured to and connecting said winding form to said coupling tube, longitudinal passages through said bushing to receive said terminal wires, transverse bores through said bushing and intersecting the respective passages, and electrically conductive members in said bores and clamped to said terminal wires, said conducting members including means for clamping thereto the ends of said resistance wire.

7. In a resistor bulb, a thin metal tube having corrugations therein forming a double thread, a resistance winding carried by said tube in the corrugations thereof with its central section at the inner end of the tube and its terminals at the outer end of the tube, a protective shell enclosing said tube and winding, a coupling tube telescoped into the outer end of said shell, lead-in wires extending through said tube, means connecting said wires to the terminals of said resistance winding, means hermetically sealing said coupling tube to said shell, and means hermetically sealing off the interior of said tube.

8. In a resistor bulb, the invention as claimed in claim 7 wherein said means connecting said wires to the terminals of said resistance winding includes a member of insulating material and means mechanically connecting the same to and between said tubes, and electrical connecting members carried by said insulating material member.

9. In a resistor bulb, a tubular protective shell, a resistance winding within said shell, means hermetically sealing said winding within said shell, lead-in wires extending through said sealing means, a sleeve mechanically secured to the outer end of said shell, hollow terminal members extending through said sleeve and insulated therefrom, said lead-in wires extending through said hollow terminal members, and means electrically connecting each lead-in wire to its associated terminal member.

10. In a resistor bulb, the invention as recited in claim 9 wherein said shell has an outwardly flared flange at its outer end, and said sleeve terminates at its inner end in a flange that is

deformed into engagement with the inner surface of said flange of the shell.

11. In a resistor bulb, a resistance winding within a protective shell, a sleeve secured to said shell and having a radially enlarged portion, a mounting head counterbored to receive said sleeve, and a gland nut threaded into said mounting head to engage said radially enlarged section of said sleeve, thereby to clamp said sleeve within the mounting head.

12. In a resistor bulb, the invention as recited in claim 11, wherein said sleeve carries pin terminals connected to said resistance winding, and said mounting head includes means for clamping a cable coupler to said mounting head to connect said pin terminals to an external circuit.

13. In a resistor bulb, the invention as recited in claim 11, wherein said sleeve and said mounting head have cooperating means locking said

sleeve against rotation within the mounting head.

14. A resistance element for use in the measurement of free air temperatures, said resistance element comprising a resistance bulb of the type including a resistance winding within a protective shell carried by a mounting head having an externally threaded outer end and a radial flange at its inner end, a supporting bracket having a cylindrical bore to receive said mounting head, and a nut threaded upon said mounting head to secure the same within the cylindrical bore of said bracket.

15. A resistance element as recited in claim 14, in combination with a wind scoop surrounding and radially spaced from said protective shell, said wind scoop being clamped to said bracket by the radial flange of said mounting head.

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