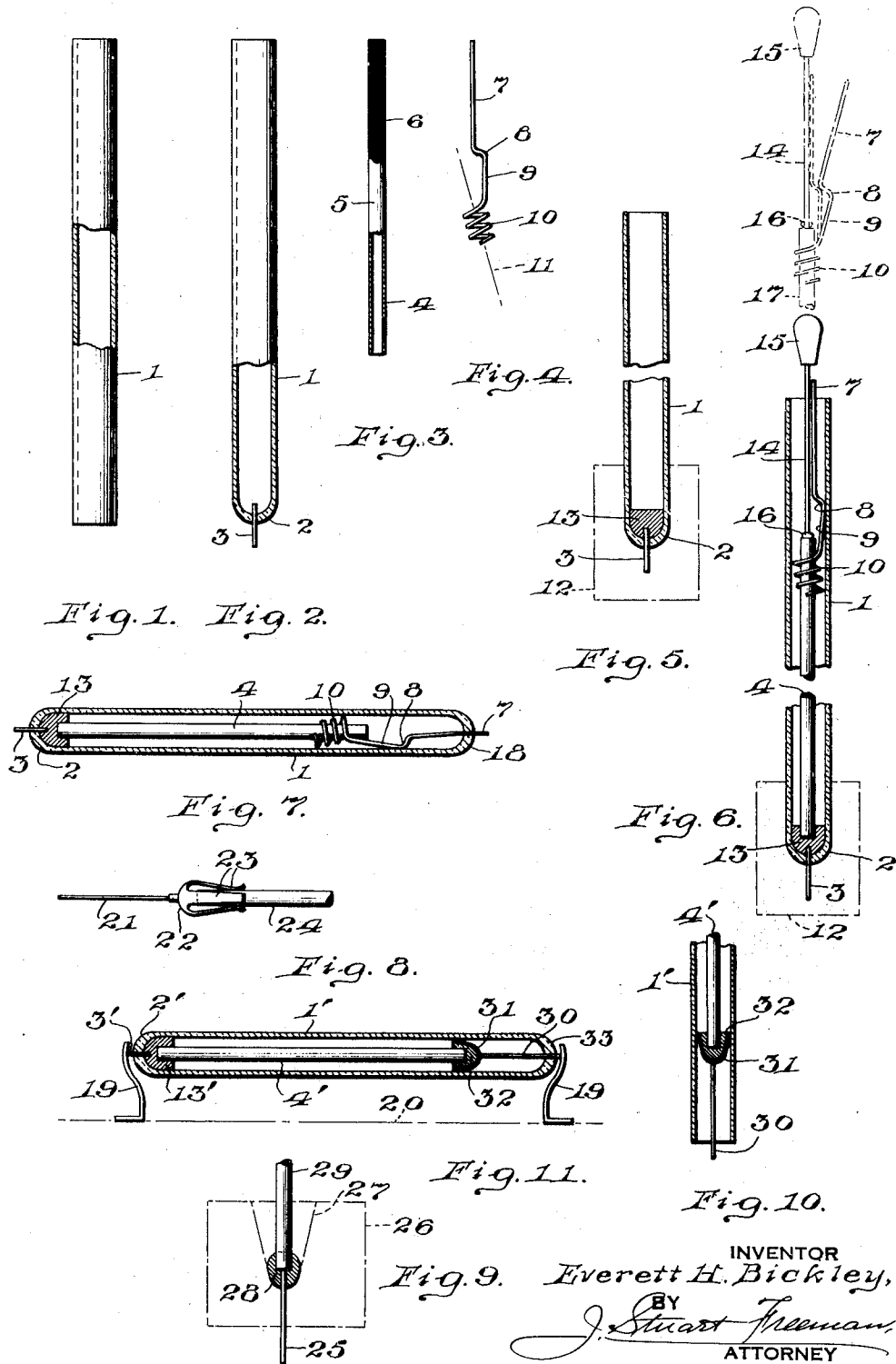


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ELECTRIC RESISTANCE
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ELECTRIC RESISTANCE

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The object of the invention is to provide improvements in electrical resistance units or resistors, and more particularly in resistors characterized by relatively small size but high ohmic rating, such as are employed in association with selenium and similar photoelectric or light-responsive units, as well as in radio apparatus of various sorts, and innumerable other types of electrical apparatus in which the resistance must be depended upon to remain constant under all ordinary working conditions, and must, therefore, be maintained at all times in a perfectly dry condition.

In carrying out the invention thus broadly stated, another object is to provide an improved and simplified method of making the new resistance units, the details of which are hereinafter fully set forth. In this connection and more specifically, an improved method has been developed wherein the resistance element, of whatever character, can be completely sealed within a glass shell, and wholly without danger of said elements being affected by the temperature at which the glass melts when said shell is being sealed.

A further object is to provide a resistor, from which the terminal leads of relatively small diameter extend for a distance substantially only as far as the diameter of such leads, in order to eliminate joints and at the same time provide substantially rigid terminal members, adapted to be directly engaged by extraneous current-carrying contact devices.

Still another object is to provide the combination of a substantially rigid resistance element, in which only a surface coating serves as the conductor, in combination with a flexible terminal lead, in turn comprising a spiral of greater internal diameter than the external diameter of said element, and the opposite sides of said spiral electrically engaging said coating, when said lead is flexed from an initial angular position, into a position substantially co-axial with said element, and is held in such position by and upon being sealed in said shell.

With the objects thus broadly stated, the invention comprises further details of construction and operation, which are hereinafter fully brought out in the following description, when read in conjunction with the accompanying drawing, in which Fig. 1 is an elevational view of a section of tubing, partially in section and preferably made of glass; Fig. 2 is a similar view of the same after a lead wire has been sealed in the lower end thereof; Fig. 3 is an elevational

view of a slender tubular glass support, a portion of the outer surface of which is shown as being covered with electrically conductive resistance material, this tube when completely so covered comprising the filament or resistance element; Fig. 4 is an elevational view of the second lead wire for the finished unit; Fig. 5 is a sectional view of the tube and first lead wire, as shown in Fig. 2, positioned within a heating device illustrated by dot-and-dash lines, and showing the solder or equivalent conducting material therein; Fig. 6 is a view similar to Fig. 5, but showing the method by which the resistance element and second lead wire are inserted into said tube; Fig. 7 is a longitudinal sectional view of the improved resistance unit, after the opposite end has been closed by sealing about the second lead wire; Fig. 8 is a side elevational view of a modified form of lead, operatively supporting the adjacent portion of a resistance element; Fig. 9 shows a modified method of attaching a lead wire to the filament element; Fig. 10 shows a still further modification of the same; and Fig. 11 is a longitudinal section through the improved resistance unit in which is embodied the last-mentioned modified lead wire connection.

Referring to Figs. 1 to 7 inclusive, the improved method consists in taking the proper length of glass or equivalent tubing 1 and fusing one end 2 so as to close the same, and to simultaneously seal therein a lead wire 3 of any desired length initially, but essentially of such metal or metallic alloy as possesses substantially the same coefficient of expansion as that of the tube.

The so-called filament or resistance unit, shown in Fig. 3, may likewise comprise a relatively slender glass tube 4, the outer surface 5 of which is coated throughout its length with electrically conductive resistance material 6, which may comprise, for purposes of illustration, an extremely finely divided deposit of carbon, such for instance as that contained in well-known types of black drawing inks, said deposit or coating obviously being placed upon said last-mentioned tube in a uniform layer, in order to provide uniform resistance to an electric current passing therethrough, after which it is of course thoroughly dried.

The second lead wire preferably comprises an elongated terminal section 7, having an offset to provide a shoulder 8, through which it merges into an intermediate, substantially rectilinear portion 9 and thence into a spiral 10, the axis 11 of which initially extends angularly with re-

spect to the axis of the terminal section 7. In assembling the improved resistance unit, the lower or sealed end portion of the tube 1 is inserted upright in a suitable heating device 12, which if desired, may comprise a small heater energized by electricity, gas, or otherwise. Into this tube is placed either a lump or a small portion of granulated solder 13 or the like, which upon being heated melts and thereby enters into positive and fixed electrical contact with the inwardly extending free end portion of the first lead 3.

With the solder still molten, or in flux, and the tube still positioned in the heating device 12, the spiral portion 10 is slid lightly over the upper end of the coated resistance element of Fig. 3, while the terminal section 7 is manually brought into adjacent parallelism (as shown in Fig. 6) with the shank 14 of a suitable slender tool, by which the resistance element and second lead are inserted into the tube 1.

This tool, in addition to said shank, comprises a handle 15 and a radial shoulder 16, by which the lower end of the resistance element is forced well into the molten solder 13, beyond said shoulder said tool terminating in a short slender section 17, which enters the bore of the resistance element tube 4. The method of inserting the resistance element, tool and second lead into the tube 1 is clearly shown in Fig. 6, wherein it will be noted that the shoulder 8 of said second lead engages the inner surface of the bore of the surrounding tube, while the diametrically opposite portion of the adjacent convolution of the spiral 10 usually, though not necessarily, engages the opposite portion of the internal surface of said last-mentioned tube.

With the second lead wire flexed under tension in the position shown in Figs. 6 and 7, it will be obvious that the spiral 10, in being flexed angularly, forms a positive contact throughout two or more substantially diametrically opposite areas with the electrically conductive deposit upon the filament tube 4. This being accomplished, the tool may be withdrawn and the upper end 18 of the outer tube sealed about said second lead wire, substantially as shown in Fig. 7, with the result that the outer tube and the filament are to all intents and purposes co-axial.

After the improved unit has been assembled, as thus described, the freely extending portions of the two lead wires 3 and 7 may be cut off, until they extend beyond the adjacent ends of the outer tube a distance substantially equal to the diameter of such respective leads, in order to form abbreviated terminals, as illustrated in Fig. 11, which are then adapted to engage extraneous contact members 19, carried by any suitable support, indicated by the dot-and-dash line 20. It is not essential that the freely extending portions of said leads shall be exactly equal to their respective diameters, because of the fact that different metals used for lead wires possess different degrees of hardness or rigidity. The essential qualification or characteristic is that such leads must extend sufficiently far to serve as positive contacts for the members 19, thus preventing any portion of the pressure of said members against said leads being shared by the adjacent ends of the tube, while at the same time said leads shall not extend a sufficient distance to permit them to readily flex laterally upon application of the pressure of the members 19 against them, wherefore is used the expression that the outer free portions

of said leads are substantially equal to their respective diameters.

Referring to Fig. 8, there is shown a lead wire 21 to the normal inner end of which is secured an initially planular member 22, provided with radially extending fingers 23, which are then curved to form a cup-shaped clamp, for yieldingly receiving and frictionally supporting one end of a filament resistance element 24, similar to the element 5, hereinbefore described. This form of terminal is designed to take the place of the lead wire and solder construction, also hereinbefore described, and it should be noted at this point that while the exterior surface of the resistance element is shown only in Fig. 3 as being coated with the electrically conductive carbon deposit 8, the filament resistance elements shown in Figs. 6, 7, 8, 9, 10 and 11 are likewise coated, but are not so illustrated, because of the impossibility of shading a solid black surface.

Referring to Fig. 9, there is here shown a slightly modified method of attaching the first terminal lead wire to the resistance element by means of a pre-molded soldered joint, wherein the lead wire 25 extends upwardly through the lower portion of a suitable heating unit 26, the upper portion of said wire entering a cavity 27 which is open at the top and is adapted to receive and melt solder or the like 28 around said lead wire, and also in order that the adjacent end of the tubular element 29 may be inserted into or embedded in said solder, while the same is still molten or in flux, and furthermore, if desired, brought into direct engagement with the adjacent end of the lead wire 25, in order that said wire and element will maintain a co-axial relationship after the solder has cooled and hardened.

Referring to Figs. 10 and 11, the tube 1', here shown, is illustrated as being closed and sealed at one end 2' about the terminal lead 3' by means of solder, or the like 13', and the adjacent end of the tubular resistance element 4' being secured in said solder, as hereinbefore described with respect to Figs. 1 to 7 inclusive. However, in this modification of the preferred method of assembly, the unit thus formed is then supported in inverted position, so that the opposite or then lower end of the filament hangs suspended centrally in the tube 1, as indicated in Fig. 10. A terminal connection comprising a lead wire 30, carrying a cup-shaped holder 31, for solder or the like 32, is inserted upwardly while this solder is still molten into the then lower open end of the tube 1, until the adjacent end of the tubular filament enters and becomes embedded within and secured by said solder as it cools. This being accomplished, the remaining open end of the outer tube may be fused and sealed about the lead wire 30, as shown in Fig. 11.

It will be noted particularly in Figs. 7 and 11 that a substantial distance is provided between the last-sealed tube end 33 and the adjacent end portion of the enclosed resistance element. This is for the purpose of substantially isolating the latter from the intense heat of the former during the process of sealing. More specifically, the temperature of the glass tube during and at the point of and while being fused and sealed about the terminal wires 7 and 30 respectively, approximates 2,000° F., whereas a temperature of only about 350° F. reaches the adjacent end of the tubular resistance element, which lower temperature is insufficient to destroy the electrically conductive coating hereinbefore referred to, and which coating depends upon the presence of a

binder to carry and securely attach the fine particles of carbon to the filament surface, and which binder would be destroyed by the temperature of molten glass, with the result that the coating would be disintegrated, break contact with the adjacent lead wire and make ineffective the resulting resistance unit.

It is also to be noted that by using relatively short free end portions of the respective lead wires, preferably cut off so as to leave relatively sharply pointed ends, said lead wires readily cut through any corrosion upon the mounting contacts 19 of whatever shape they may assume and thereby insure perfect electrical contact under any and all operating conditions. This construction obviously eliminates the necessity of a metal end, such as an external cup or mounted terminal, etc., attached to and enlarging the effective ends of the unit, thereby eliminating anything which can possibly loosen and give resulting trouble. In short, such terminal leads in direct engagement with supporting contact members, provides a complete elimination of hidden and, therefore, inaccessible joints at this point.

Having thus described my invention, what I claim as new and desire to protect by Letters Patent of the United States is:

1. An electrical resistor comprising in combination, a resistance element having lead wires connected thereto extending in opposite directions, a glass envelope hermetically enclosing said resistance element, said wires extending thru said envelope at substantially opposite points and terminating outside of said envelope and at a distance of substantially the diameter of said wires from the outside surface of said envelope, said wires being sufficiently rigid to support the resistor from opposed electrical contactors pressing against their ends.

2. A resistance unit, comprising a substantially rigid electrical resistance filament, a surrounding hermetically sealed casing, a lead wire sealed through said casing and fixedly connected to one end of said filament, and a transversely resilient second lead wire also sealed through

said casing and provided with a looped portion, adapted when flexed with respect to its supporting lead wire to receive and slidably contact the opposite sides of said filament, to permit relative expansion and contraction of said casing with respect to said filament.

3. A resistance unit, comprising a substantially rigid electrical resistance filament, a surrounding hermetically sealed casing, a lead wire sealed through a wall of said casing and fixedly connected to said filament, and a second lead wire also sealed through a wall of said casing, and provided with a looped inner end adapted to surround the adjacent portion of said filament, and with an intervening offset portion adapted to engage the inner surface of said casing, to minimize the conveyance of vibrations from said casing to said filament.

4. A resistance unit, comprising a substantially rigid electrical resistance filament, a surrounding hermetically sealed casing, a lead wire sealed through a wall of said casing and fixedly connected to said filament, and a second lead wire also sealed through a wall of said casing, and provided with a looped inner end adapted to surround the adjacent portion of said filament, and with an intervening offset portion, said offset portion of said last-mentioned lead wire engaging one side and said looped end portion engaging the opposite side of said casing, to maintain said casing and filament in substantially axial alignment.

5. A resistance unit, comprising a substantially rigid electrical resistance filament, a surrounding hermetically sealed casing, a lead wire sealed through said casing and fixedly connected to said filament, and a transversely resilient second lead wire also sealed through said casing and provided with a spiral end portion of slightly larger diameter than that of said filament, which when flexed axially receives and slidably contacts the opposite sides of said filament, to permit relative expansion and contraction of said casing with respect to said filament.

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