

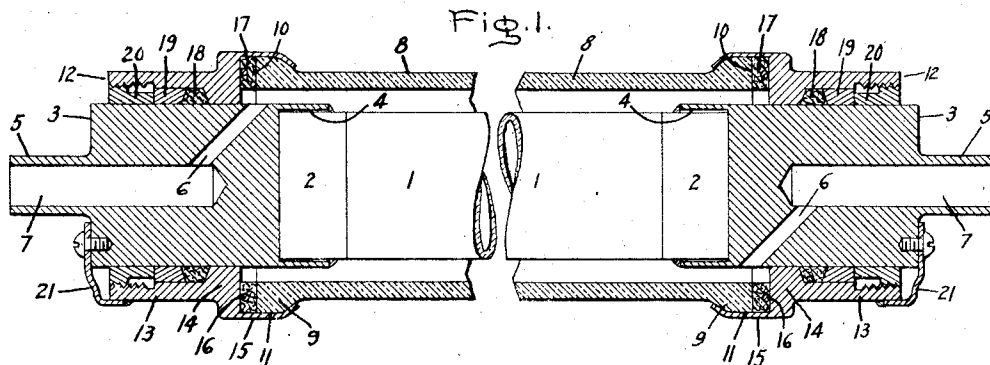
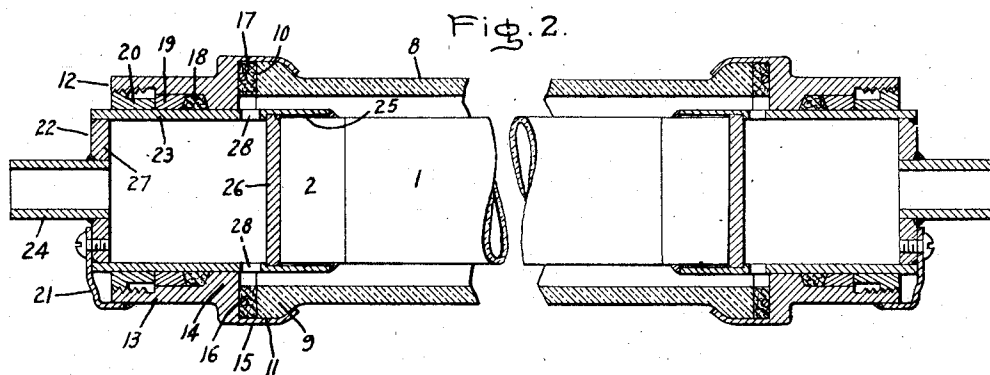
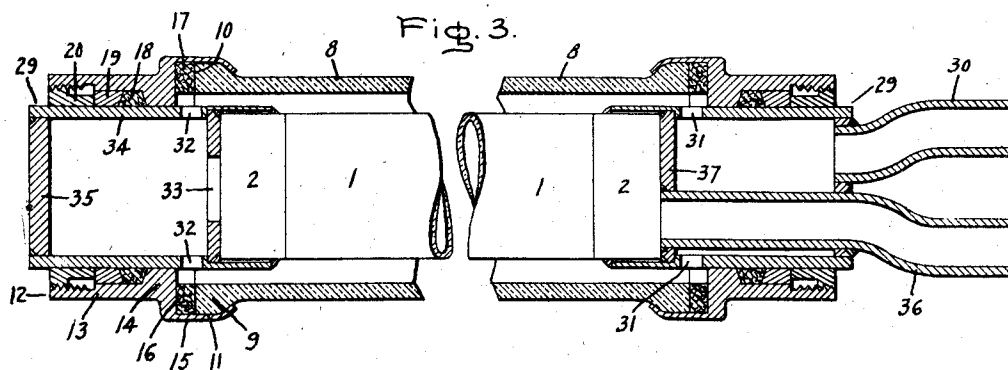
Feb. 24, 1942.

L. W. RICHARDSON

2,274,381

LIQUID COOLED RESISTOR

Filed July 16, 1941



Inventor:  
 Lycurgus W. Richardson,  
 by *Harry E. Dunham*  
 His Attorney.

## UNITED STATES PATENT OFFICE

2,274,381

## LIQUID COOLED RESISTOR

Lycurgus W. Richardson, Scotia, N. Y., assignor  
to General Electric Company, a corporation of  
New York

Application July 16, 1941, Serial No. 402,612

5 Claims. (Cl. 201-63)

My invention relates to resistor devices of the type comprising a tubular resistor element usually coated with a high resistance material, particularly to liquid cooled resistor devices, and the object of the invention is to provide an improved, simple, and reliable device of this character.

Resistor devices comprising a thin walled tube of porcelain or the like having a high resistance coating thereon, or in some cases a wire resistance, or even a tubular element of resistance material such as carbon, are commonly employed in radio transmitters, for example. Because of space requirements such resistors are often required to be operated at ratings beyond the values at which they can be air cooled sufficiently and in these cases it is necessary to circulate a liquid cooling medium such as water or oil over their surface.

In resistors of the type above mentioned, particularly as employed in radio transmitters or the like, the voltage drop from one end to the other may be several thousand volts and the resistors may be required to operate in extremely high frequency circuits. These conditions necessitate that the coverings or housings provided for water or oil cooling of the resistance element be of high grade insulation material and also that the space capacity of the assembly be as low as possible.

Difficulties have been encountered at times in the manufacture and operation of water and oil cooled resistors. For example, it has been found difficult in certain cases to make proper electrical connections to such resistors and to seal them against leakage without at the same time subjecting the resistor elements or tubes, the insulating covers or housings, and the mounting means to such strains that impaired operation resulted either when power was applied, because of thermal expansion, or after a short service period. Further, it has proved difficult in certain cases to provide a liquid cooled resistor assembly of the above-described type in which the resistor element could be easily and quickly removed and replaced.

In accordance with the present invention these difficulties are overcome by the provision of a resistor assembly comprising two main assembly parts. One assembly part is constituted by the thin-walled tubular resistor element and two cylindrical members into which the ends of the resistor element are securely fastened. The other assembly part is constituted by a covering member in which the resistor element may be

removably inserted in such manner that oil or water may be circulated over its surface. The latter assembly part comprises an insulating housing having enlarged end portions secured liquid tight to members slidable on the resistor terminal members and cooperating therewith to form liquid tight joints between the two assembly parts.

The novel features which are considered to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing wherein Fig. 1 is a side elevational view partly in section of a liquid cooled resistor device in accordance with my invention; and Figs. 2 and 3 illustrate modifications of the resistor device of Fig. 1.

Referring to Fig. 1, a resistor element 1 is shown therein which may be constituted as in usual practice by a thin-walled tube of porcelain or other suitable insulator having on its surface a resistance which is preferably a coating of high resistance metallic material but which may be in the form of a winding. To aid in making reliable electrical connection to the resistance material, bands 2 of highly conductive material such as silver are deposited on the resistor element 1 at the ends thereof.

Two terminal members 3 are provided for the resistor element 1 which are of slightly larger diameter than the latter element and each of which has a thin-walled cup-shaped portion 4 turned or otherwise formed in its inner end into which the resistor element is adapted to fit loosely. The terminal members 3 are turned down or otherwise formed at their other ends to provide hose connections 5, and holes, as 6 and 7, are provided for the flow of cooling liquid to and from the outside of the resistor element 1. If a tubular resistor element formed entirely of resistance material such as carbon is used, it will of course be necessary to provide holes to pass the cooling liquid both on the outside of the tube and through the center also.

In assembling the sub-assembly or assembly part comprising the tubular resistor element 1 and the terminal members 3, the two latter members are placed respectively over the opposite ends of the resistor element and are then held in a jig (not shown) in such a manner that the longitudinal center line of one terminal mem-

ber is a continuation of the longitudinal center line of the other. The silver coated end portions of the resistor element 1 are then soldered into the cup-shaped portions 4 of the terminal members 3, the solder filling the joint between these cup-shaped portions and the silver coating. A low melting point solder is used having a melting point preferably not less than 212 degrees F., and also, preferably, having a slight expansion when solidifying.

In forming and assembling the other sub-assembly or assembly part constituting a covering member for the above-described assembly part which includes the resistor and its terminal members, an insulator tube 8, preferably glass of the "Pyrex" type, having an internal diameter greater than the outside diameter of resistor 1 by an amount sufficient to provide room for the efficient flow of the cooling liquid, is heated and upset at its ends to form ridges or flanges 9 on the outside of the tube. The shape and size of these ridges may be controlled fairly accurately by the use of a graphite mold (not shown). The tube 8 is then ground if necessary across each end to produce flat end surfaces 10 accurately parallel to each other and at right angles to the axis of the tube, and also to ensure that the tube is of accurate length. The outside surfaces 11 of the ridges 9 are then ground if necessary to an accurate diameter, these surfaces being in line with each other and parallel to the tube axis.

Two shells 12 of suitable material as brass or copper are provided, to be connected to the ends of glass tube 8. Each shell includes a cylindrical portion 13 having at its inner end a flange portion 14 which is adapted to be a close sliding fit on the terminal members 3 and is of slightly larger diameter than that of the ground ridges or flanges 9 of glass tube 8. From the flange portions 14 extend rings or sleeves 15 which may be in the form of thin soft tubing brazed to the flanges 14, or, as shown in the figure, may be formed as an integral part of the latter flanges. On the face of the flange portion 14 of the shells 12 annular projections 16 are provided which, as shown in figures, may be in the form of a ring of small diameter wire tinned to the surface of the shell, or may be an annular projection formed integral with and machined from this surface.

As a part of the means for insuring a liquid tight joint between the glass tube 8 and the shell members 12 when the parts are assembled, soft gaskets 17 are provided preferably of a suitable grade of the material known as "Neoprene," or other oilproof, long aging artificial rubber, fitted within the rings or sleeves 15.

To assemble the assembly part comprising the covering member which includes the glass housing tube 8 and the metal shells 12, these parts are placed in the proper order on a metal rod (not shown) having the same outside diameter as the terminal members 3 and are then clamped together with such end pressure that the annular projections or wire rings 16 are completely embedded in the soft gaskets 17. While the parts are held in this position the thin soft tubing sleeves 15 are spun tightly over the flanges 9 of glass tube 8. The assembled covering member is then removed from the metal rod.

In performing the final assembly of the resistor device the sub-assembly or assembly part comprising the resistor element 1 and the two terminal members 3 connected thereto is slid into the sub-assembly or assembly part comprising the

glass housing tube 8 connected liquid tight to the two shell members 12, with the shell members 12 on the corresponding terminal members 3. Stuffing boxes at the ends of the device each comprise one of the shell members 12, packing 18, collar 19, and spanner nut 20. These stuffing boxes provide a sliding liquid-tight joint between the two sub-assemblies.

It is desirable that the shell members 12 be used as terminals for connection to outside circuits (not shown), but since the metal surfaces of the resistor terminal members 3 and of the shell members 12 are not clamped together a reliable electrical contact does not exist between the resistor and the shell members 12. It is therefore desirable to add flexible connectors 21 which may be soldered to the shell members 12 and fastened to the resistor terminal members 3 by screws or also by soldering. The complete resistor device may be conveniently mounted in the transmitter, or other apparatus of which it forms a part, by means of clamps (not shown) connected to the cylindrical main body portions 13 of the shell members 12.

To change or replace a resistor as thus mounted in the transmitter the complete assembly may be removed from the clamps or other mounting means after disconnecting the hose from the hose connections. Or, if desired, the assembly part comprising the glass housing 8 and the shell members 12 connected thereto may be left clamped in place in the transmitter. In this case, after removing the hose and the flexible connectors 21 and loosening the spanner nuts 20, the sub-assembly consisting of resistor 1 and its terminal members 3 may be pulled out from one end of the sub-assembly comprising glass housing 8 and its shell members 12. To replace a resistor this sequence of operation for removal is reversed.

Referring to Fig. 2 the resistor device shown therein is the same as that of Fig. 1 except that in Fig. 2 the resistor terminal members, 22, instead of being turned from solid stock are assembled from two pieces of tubing, one of these, 23, constituting the main body of the terminal, into a cup-shaped portion 25 of which the ends of the resistor 1 is soldered, and the other tube, 24, being the hose connection. A disk, 26, within tube 23 closes the end of the resistor tube 1, and a second disk, 27, supporting the hose connection, is provided at the outer end of the terminal member. Holes 28 in the tube 23 connect the interior of this tube to the space between the resistor element 1 and the glass housing tube 8. The resistor terminal construction above described, and illustrated in Fig. 2, is in many cases preferable as the resistor assembly part is materially lightened and cost in quantity production is reduced.

Referring to Fig. 3, the resistor device shown therein is essentially that of Figs. 1 and 2 except that Fig. 3 is employed when it is desired that both the inlet and outlet for the cooling liquid be at one end of the device instead of at opposite ends as in Figs. 1 and 2. In Fig. 3 the cooling liquid passes into one of the resistor terminal members, 29, as through a hose connection or tube 30, through openings 31 in the wall of the terminal member into the space between the resistor element 1 and the glass housing member 8, through openings 32 and 33 of the other terminal member 34, which includes an end wall or disk 35, into the space within the resistor element 1, and out through a tube 36 connected to

an inner wall or disk 37 of the resistor terminal 29.

My invention has been described herein in particular embodiments for purposes of illustration. It is to be understood, however, that the invention is susceptible of various changes and modifications and that by the appended claims I intend to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In combination, a resistor element having a layer of conductive material thereon at each end thereof, terminal members into which said ends are secured, a housing of insulating material for said resistor element having a flange at each end, stuffing boxes slidable on said terminal members and each including a shell having an annular projection on the inner end thereof, gaskets between each of said shells and the corresponding housing flange, and rings extending from each of said shells and adapted to be spun over said housing flanges to compress said gaskets and to embed said annular projections therein, said terminal members having cooling liquid conducting openings formed therethrough for conducting said cooling liquid in contact with said resistor element.

2. In combination, a cylindrical resistor element having a layer of conductive material on each end thereof, cylindrical terminal members of slightly larger diameter than said resistor element and each having a cup-shaped portion into which the corresponding end of said resistor element is secured, a cylindrical housing of insulating material for said resistor element having a flange at each end, stuffing boxes on each of said terminal members each including a shell having a flange portion adapted to be a close sliding fit on the corresponding terminal member, an annular projection on each of said shell flange portions, a ring of gasket material between each of said shell flange portions and the corresponding housing flange, and thin sleeves connected to said shell flange portions and each adapted to be spun over the corresponding housing flange to compress said rings and to embed said annular projections therein, said terminal members having cooling liquid conducting openings therethrough for conducting said liquid in contact with said resistor element.

3. In combination, a resistor element having a layer of conductive material thereon at each end thereof, terminal members each comprising a tube having an end portion into which the corresponding end of said resistor element is secured and a disk fastened within said tube adja-

cent to and closing the end of said resistor, a tubular housing of insulation surrounding said resistor element and having a flange at each end, stuffing boxes on said terminal members each having an annular projection, gaskets between each of said stuffing boxes and the corresponding housing flange, said stuffing boxes each having a thin annular extension adapted to be spun over the corresponding flange to embed the corresponding annular projection within the corresponding gasket, said tubes having cooling liquid conducting openings for conducting said liquid in contact with said resistor element.

4. In combination, a hollow resistor element having conductive material thereon at the ends thereof, terminal members into which said ends are secured, an insulating housing having end flanges, stuffing boxes on said terminal members each having an annular projection, a gasket between each stuffing box and the corresponding housing flange, annular extensions on said stuffing boxes adapted to cooperate with said housing flanges to compress said gaskets and to embed said annular projections therein, one of said terminal members having cooling liquid conducting tubes connected thereto communicating respectively with the space within said resistor and with the space between said housing and said resistor, the other terminal member having openings therein for conducting said cooling liquid between said spaces.

5. In combination, a hollow resistor element having conductive material thereon at the ends thereof, terminal members each comprising a tube having an end portion into which the corresponding end of said resistor element is secured and a disk across said tube adjacent to the end of said resistor element, an insulating housing having end flanges, stuffing boxes on said terminal members each having an annular projection, a gasket between each stuffing box and the corresponding housing flange, annular extensions on said stuffing boxes cooperating with said housing flanges to compress said gaskets and to embed said projections therein, one of said terminal members having cooling liquid conducting members connected thereto communicating respectively through the corresponding disk with the space within said resistor element and through the walls of the corresponding tube with the space between said housing and said resistor element, the other terminal member having openings in the corresponding disk and the walls of the corresponding tube for conducting said cooling liquid between said spaces.

LYCURGUS W. RICHARDSON.