Dec. 10, 1946. J. MARSTEN 2,412,462

RESISTOR CONSTRUCTION

Filed April 5, 1944

Fig. 1.

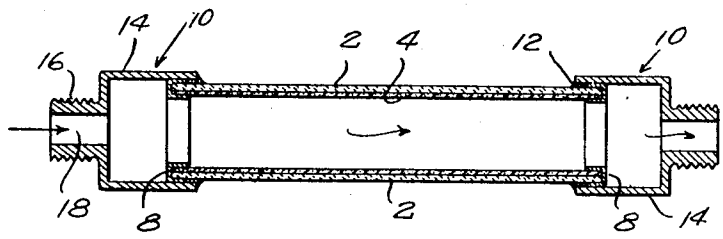


Fig. 2.

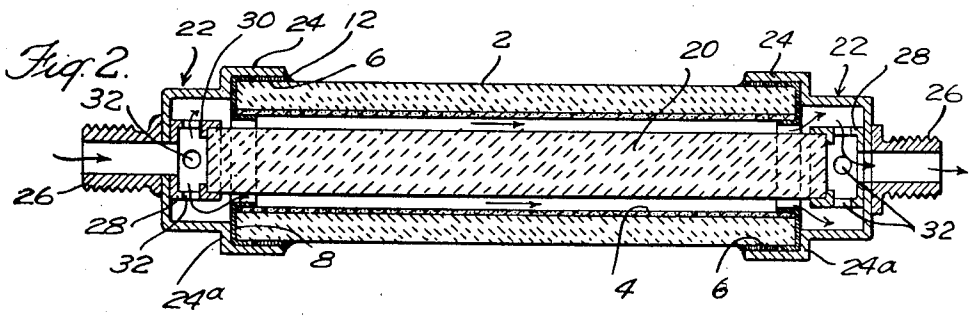


Fig. 3.

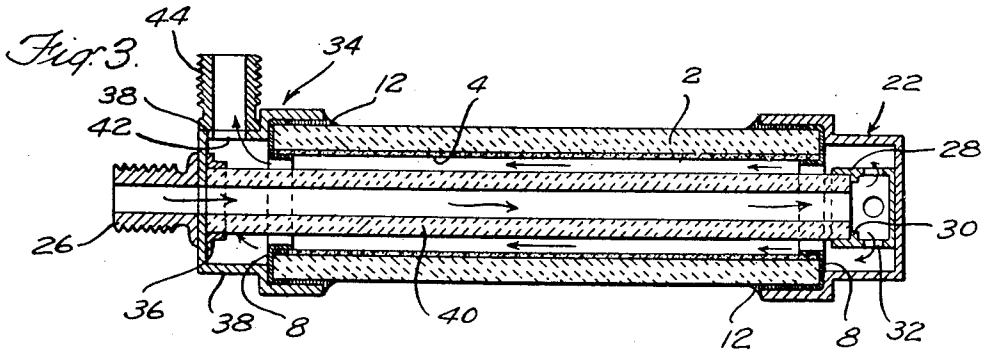
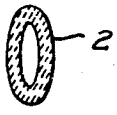


Fig. 5.



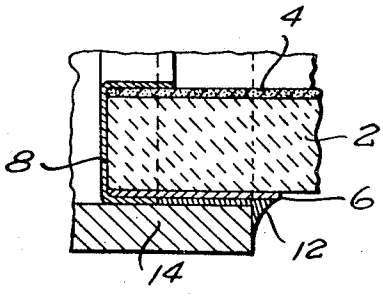


Fig. 4.

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RESISTOR CONSTRUCTION

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Application April 5, 1944, Serial No. 529,593

11 Claims. (Cl. 201—65)

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This invention relates to resistance devices, and more particularly to water-cooled resistors, where the resistance path is formed by a resistance coating of conducting material which is contacted by the coolant water.

An object of this invention is to provide a resistance unit of high current-carrying capacity which may be used at radio frequencies. A further object is to provide a fluid-cooled resistor of simplified and sturdy construction which is economical and easy to manufacture, and which is adaptable for use under a wide variety of conditions. A still further object is to provide a resistor of the above character which is cooled in an efficient manner and which will meet the many demands of commercial use. These and other objects will be in part obvious and in part pointed out below.

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 are shown several of the various possible embodiments of this invention,

Figure 1 is a longitudinal sectional view of one embodiment of the invention;

Figures 2 and 3 are views similar to Figure 1, but showing other embodiments of the invention;

Figure 4 is an enlarged view of a portion of Figure 1; and

Figure 5 is a cross section of another embodiment of the invention.

As conducive to a clearer understanding of certain features of this invention, it might here be pointed out that for some time fixed resistors of the coated ceramic tube type have been recognized as advantageous in many applications, particularly for radio use. Such tubular resistors have become a standard item in radio design, but in recent years many applications have called for resistors of greater capacity than possible with the usual methods and materials. It was therefore suggested that such resistors be water cooled in order to increase their capacity and to this end a number of designs for cooling such resistors with water have been developed. These designs are generally characterized by a container within which the tubular resistor is mounted so that water may flow through the container for cooling. The great difficulty with structures of this type now available is their complex structural detail making for manufacturing costs far out of

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proportion to the advantages to be obtained. One of the various objects of this invention is to provide a construction in which these difficulties are successfully overcome.

Referring particularly to Figure 1 of the drawing a ceramic tube 2 has on its inner surface a resistance coating 4. The composition of this coating may vary considerably according to the results desired: it may be carbonaceous applied by deposition from hydrocarbons; it may be a carbonaceous film formed from particles of carbon or graphite mixed with a suitable binder; or it may be a metallic deposition applied by sputtering, spraying, evaporation or other well-known methods.

Adjacent the outer surface of each end portion of the tube 2, there are metallic bands 6, such as silver or platinum, as best seen in Figure 4. These bands are integral parts of the tube, being preferably deposited or burned into its body by any well-known method, such as electroplating or electrochemical deposition. The silver bands 6 are connected to the resistance coating 4 by a conductive coating 8 which may comprise silver cement or other well-known materials of high conductivity. Coatings 8 extend over the ends of resistance coating 4 and the silver bands 6 to make good electrical connections therewith. Thus, the bands 6 on the outer surface of the tube 2 are each connected with one end of the resistance coating.

Metal cap members generally indicated at 10 fit over each end of the tube 2 and are securely sealed to the silver bands 6. Preferably the caps are secured to the bands by solder 12 (Figure 4) in such manner that there are no fissures for leakage of a fluid therebetween. More specifically, the caps 10 include the portions 14 of large diameter connected to the ends of the tube and the threaded nipples 16 with openings 18 may be connected by piping to a supply of cooling water in such manner that the water will travel therethrough and thus cool the resistance coating 4.

With this resistor the cooling water is used efficiently and is dependably sealed so that no leakage occurs. The resistance element, formed by the ceramic tube and the conductive coating, performs in addition to its usual function the function of permitting the water stream to pass through the inside of the tube. This water stream cools the resistance film on the inside of the tube and so limits the temperature rise of the resistor, permitting operation at higher powers than would otherwise be the case. The entire out-

side surface of the stream of water is utilized as the cooling surface and the movement of the water is straightforward through the resistor so that no water pockets are present.

During use, caps 10 are held in spring clips (not shown) which also act as electrical connections to the resistor; thus, caps 10 support the unit, provide the electrical connection thereto, and direct the cooling water through it.

In the embodiment shown in Figure 2 rod 20, which is a dielectric and may be ceramic, is mounted within the tube 2 but spaced from the coating 4. This directs the water in fast stream past the resistance coating as will be apparent from an understanding of the structure.

Metallic caps generally indicated at 22 have enlarged portions 24 fitting over the ends of tube 2 with the shoulders 24*a* resting against the ends of the tube. Portions 24 of the caps are preferably secured in the above-described manner to the bands 6 on the tube 2.

Separate threaded nipples 26 are soldered or otherwise secured to the cap for the same purpose as nipple 16 in the preferred embodiment. Secured within caps 22 and aligned with nipples 26 are the supporting cups 28 which fit over the ends of rod 20 to hold it in the desired position. Ears 30 extend inwardly over the ends of the rod 20 and a ring of circumferentially spaced holes 32 are formed in the cups 28 for the passage of water. The unit is connected up as described above so that water may flow through in the direction indicated by the arrows. Thus the water flows through holes 32 in cup 28, through cap 22 and into the annular space between rod 20 and the resistance coating 4. The interior volume of tube 12 being considerably reduced, the velocity increases appreciably for a given water pressure resulting in a greater dissipation of heat generated along the coating 4. This thin wall of water prevents the formation of any appreciable static film of water along the coating, and there are no pockets along the coating where water may remain static. The manner of connection and support is preferably similar to that described with reference to Figure 1.

Under some circumstances, it is desirable to provide the water inlet and outlet at one end of the resistor. Accordingly, in the embodiment shown in Figure 3, the right-hand cap 22 and cup 28 are the same as shown in Figure 2 and cap 22 is secured to the tube 2 in the same manner. The left-hand cap generally indicated at 34 is substantially the same as caps 24 and is secured to tube 2 in the same manner. A ring 36 is secured to cap 34 in the reduced portion 38 thereof and in alignment with the nipple 26. A hollow insulating tube 40 which is preferably formed from ceramic material is supported between ring 36 and cup 28 so that one end thereof abuts the inner end of cap 34 and the other end abuts the ears 30 of the cup 28. A hole 42 is formed in the periphery of portion 38 of the cap 34 and a threaded nipple 44 is secured to the cap as by soldering and in alignment with this hole.

Accordingly, the nipples 26 and 44 of this unit may be connected to inlet and outlet pipes of a water supply to circulate water through the unit for cooling purposes as described above. The water takes the path indicated by the arrows, entering through the nipple 26, passing through the tube 40 into the cup 28 and through the holes 32 into the cap 22 thence along the resistance coating 4 of the tube and out through the nipple 44. Like the unit shown in Figure 2 the velocity of the water for a given pressure is increased due to the position and size of the tube 40.

In the above embodiments, tube 2 is circular in cross section, but when desirable, this tube may be elliptical in cross section, as indicated in Figure 5, and this is particularly true of the preferred embodiment of Figure 1. With the tube so shaped, the stream of water is smaller resulting in rapid flow with increased cooling.

Accordingly, I have provided a resistor construction which effectively accomplishes the several objects noted hereinabove in a thoroughly efficient and practical manner.

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

I claim:

1. In a fluid-cooled resistance device of the character described, a ceramic tube, resistance coating means on the inner surface of said tube, metallic open-ended caps fitting over and sealed to the ends of said tube and forming with said tube a closed passageway for cooling fluid flowing in contact with said resistance coating.

2. A fluid-cooled resistance device comprising a tubular resistance element formed by a tube of dielectric material having a coating on its inner surface of resistance material, a pair of metallic coatings on the outer end portions of said tube and forming annular contact surfaces, said metallic coatings being connected to the end portions of said coating of resistance material, and a pair of metallic caps fitting over and sealed to said metallic coatings, said caps having end holes for connection to a water supply.

3. A device as claimed in claim 2 wherein a rod is positioned concentrically within the resistance element but spaced from the coating to confine the fluid flow to a thin annular wall.

4. A device as claimed in claim 2 wherein the resistance element is circular in cross section and has positioned along its center a cylindrical element which directs the cooling fluid in a thin annular wall along the conductive coating.

5. A device as claimed in claim 2 wherein a fluid-directing tube is mounted within said tubular member with its outer surface forming with the resistance coating a thin annular space along which the cooling fluid is directed, one of said metal caps having an opening sealed to the end of said fluid-directing tube and another opening open to the annular space, whereby a passageway is provided from one opening along said fluid-directing tube and thence along the annular space to the other opening.

6. A water-cooled resistor comprising a resistance element formed by a ceramic tube coated on its inner surface with a resistance coating, a pair of metal caps sealed to the opposite ends of said resistance element and forming with the resistance element a sealed passageway for cooling water, means forming an electrical connection between the resistance coating at each end of the resistance element and the metal cap, a cylindrical member of insulating material positioned concentrically within said tube and forming an annular pasageway for the cooling water along the resistance coating, and means to support said cylindrical member including supporting caps positioned concentrically within said metal caps and attached thereto and having its ends in the

cups spaced from the ends of the caps, said caps having radial holes and adapted to receive the cooling water and direct the cooling water through said radial holes whereby it flows in an axial direction between the cylindrical member and the resistance coating in an annular wall to the opposite end of the resistance element.

7. A resistor as described in claim 6 wherein there are threaded nipples secured to each cap for making water connections.

8. In a resistor construction, in combination, an insulating tube having a resistance coating on its inner surface, metallic cap members fitting over the ends of said tube and being secured thereto with a tight seal, cup-shaped members secured to the interior of said cap member, and an elongated insulating member supported by said cup-shaped members.

9. In a resistor construction, in combination, an insulating tube having a resistance coating on the inner surface thereof, metal bands formed on the outer surface of the tube adjacent the ends thereof and connected to the ends of the resistance coating, and metal caps having holes in their ends soldered to said bands to form a tight seal between the caps and the tube.

10. A device as defined in claim 9 wherein an elongated member is supported within the tube, whereby fluid passing through the tube is directed in a narrow annular path adjacent the resistance coating.

11. In a resistor construction, in combination, an insulating tube having a resistance coating on its inner surface, means forming closures at the opposite ends of said tube, a second tube mounted within said first tube and spaced from said coating and being open only at one end to the interior of the first-mentioned tube, means for directing a water supply to said second-mentioned tube and means for connecting the interior of the first-mentioned tube with an outlet whereby water first flows through the second-mentioned tube and then through the first-mentioned tube along said resistance coating.

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