Sept. 2, 1941. J. W. CONKLIN ET AL 2,254,838

RESISTOR

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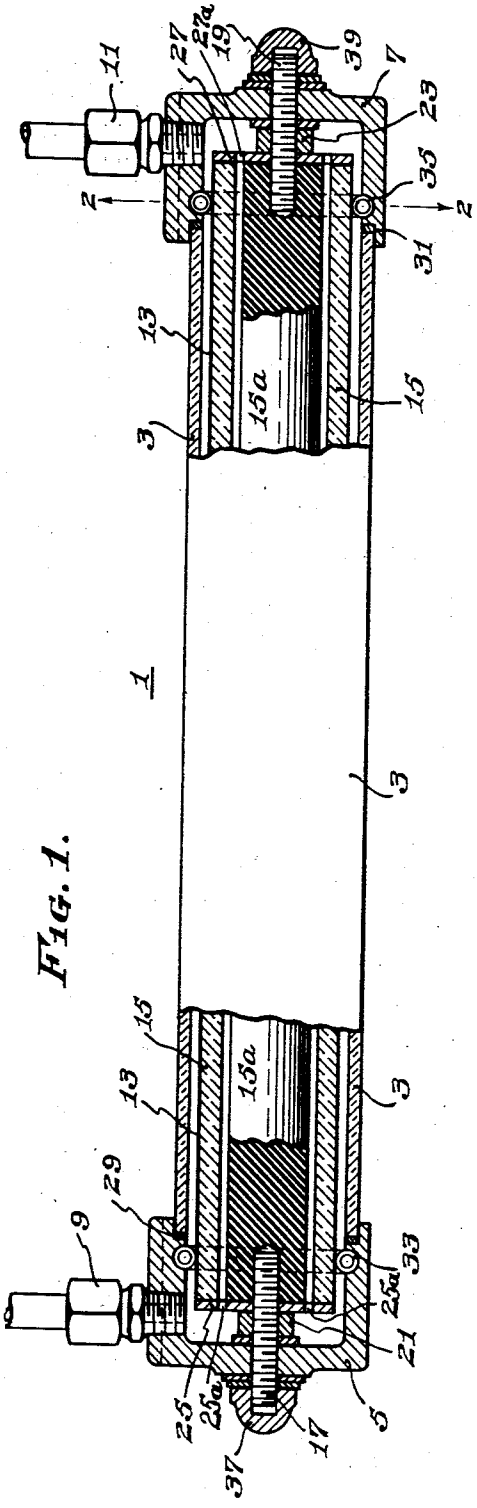


FIG. 1.

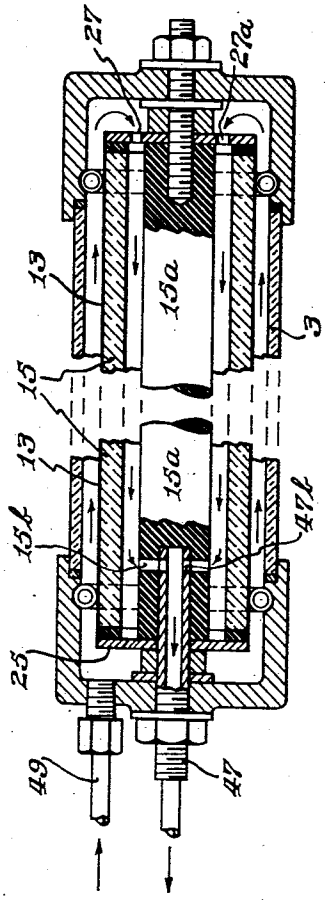


FIG. 3.

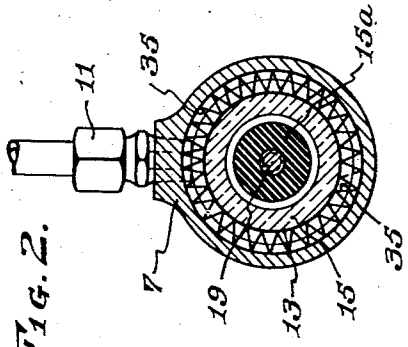


FIG. 2.

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RESISTOR

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4 Claims. (Cl. 201—63)

This invention relates to high frequency apparatus and has special reference to the provision of an improved resistor capable of effectively dissipating large amounts of energy derived from relatively intense high frequency currents. The resistors of the invention find useful application in radio and television systems where they may be employed as coupling resistors (e. g. in video modulating circuits), as loading resistors (e. g. in antenna loading circuits) or they may be employed in test circuits (e. g. as a dummy antenna). The apparatus of the invention finds maximum utility where space is at a premium and rapid and effective dissipation of large quantities of electrical energy is required.

An object of the present invention is to provide a non-inductive resistor capable of effectively dissipating larger quantities of energy than similar resistors of comparable size.

Another object of the invention is to provide a non-inductive fluid-cooled resistor which shall exhibit a high capacitive reactance.

Still another object of the invention is to provide a durable, inexpensive, trouble-free, water-cooled resistor and one characterized by the simplicity and economy of its parts.

Other objects and advantages, together with certain details of construction, will be apparent and the invention itself will be best understood by a reference to the following specification and to the accompanying drawing, wherein

Figure 1 is a longitudinal sectional view of a fluid-cooled non-inductive resistor constructed in accordance with the principle of the invention;

Figure 2 is a cross-sectional view taken on the line 2—2 of Fig. 1; and

Figure 3 is a fragmentary longitudinal sectional view of an alternate form of water-cooled resistor embodying the invention.

Like reference characters designate the same or corresponding parts in all figures.

Referring first to Figs. 1 and 2, 1 indicates generally a fluid-tight vessel comprising an elongated hollow cylinder 3 constituted of glass, Pyrex or other preferably transparent heat resistant material, closed at its opposite ends by cup-shape metallic caps 5 and 7, respectively. Each of the caps 5 and 7 is provided with a tapped orifice which accommodates a nipple or gland coupling 9, 11, respectively, through which water or other cooling fluid may be circulated.

A non-inductive resistor which may comprise a non-soluble resistive material applied in the form of a coating 13 to a tubular or rod-like porcelain or similar base 15, is mounted within the vessel in spaced relation with respect to its inner walls as by means of threaded metal studs 17 and 19 which extend axially through the caps 5 and 7, and through retaining nuts 21 and 23, respectively, to engage the terminal ends of the resistor base 15. In the illustrated embodiments of the invention the resistor base 15 is of hollow cylindrical construction fitted somewhat loosely (to avoid the effects of expansion) upon an inner core or rod 15a which may be constituted of Bakelite or other suitable insulating material. As previously indicated, however, base 15 may comprise a unitary or solid rod-like structure. Metal washers 25 and 27 serve to maintain the base 15 carrying the resistive coating 13 against longitudinal displacement. The washers 25 and 27 or one of them may be perforated, as shown at 25a, 27a and at 27a, Fig. 3, to permit the cooling fluid to circulate in the space between the resistor base 15 and its supporting core 15a.

Gaskets 29 and 31 are seated in suitable recesses in the rims of the cup-shape caps 5 and 7, respectively. When the studs 17 and 19 are tightened a clamping force is applied to the gaskets through the caps 5 and 7 so that a fluid-tight metal to glass seal is achieved.

An annular recess or groove in each of caps 5 and 7 accommodates a coiled wire spring 33, 35, respectively. These springs serve to establish electrical connections from the studs 17 and 19 to the resistor 13 through the metal cap 5 and 7, respectively. The open work construction of the springs 33 and 35 permits the cooling fluid to flow therepast without being retarded. Cap nuts 37, 39 on the free ends of the studs 17 and 19 may be employed in making electrical connections to the device.

It will be observed upon inspection of the drawing that the space between the resistor 13 and the inner surface of the tubular body portion 3 of the enclosing vessel is quite narrow. This spacing is quite important where the device is to be employed in ultra-high frequency circuits (say, above 20 megacycles) as it has been found that the cooling fluid comprises the dielectric of a "phantom" capacitor whose armatures comprise the metal caps 5 and 7.

If the cross sectional area of the dielectric medium (in this case water) is doubled, the capacitance is doubled. This is evidenced by the formula:

$$C=0.0885K\frac{S}{t}$$

where:

S is the surface area of one side of one plate,
t is the thickness of the dielectric, and
K is the dielectric constant.

Since the dielectric constant (K) of water is substantially 80 it will be appreciated that disturbing values of capacitance are much more readily developed than in the case of ordinary capacitors employing the usual dielectric materials. Accordingly, wherever, as in high frequency work, a high capacitive reactance rating is required, it is desirable to employ the minimum instantaneous quantity of cooling fluid consistent with efficient operation. In one device designed to handle 5 kilowatts and having an overall length of 12 inches and circumference of 3½ inches, the spacing between the resistor and inner walls of the vessel was substantially no greater than 1/16 of an inch. Spacings less than 1/32 of an inch may give rise to air bubbles which impede the flow of the cooling fluid.

Referring to Fig. 3, in some installations it is desirable to have the water inlet and outlet terminate at the same end of the device. In this event a hollow nipple or coupling **47** is employed in place of the solid axially arranged stud **17** of the device of Fig. 1. A second hollow coupling **49** shown mounted parallel to the central coupling **47** preferably comprises the inlet for the cooling fluid. The path of the cooling fluid is indicated by the arrows. Substantially the only other difference between this and the first described embodiment of the invention is in the provision of a lateral orifice **15***b* in the supporting core **15***a*, which orifice is in register with a similarly oriented orifice **47***b* in the hollow stud **47**.

Other modifications of the invention will suggest themselves to those skilled in the art. It is to be understood therefore that the foregoing is to be interpreted as illustrative and not in a limiting sense except as required by the prior art and the spirit of the appended claims.

What is claimed is:

1. A device for dissipating electrical energy comprising a fluid tight vessel containing a hollow insulating member coated with a resistive material and mounted in spaced relation with respect to the inner surface of said vessel, and means for circulating a cooling fluid in contact with the inner surface of said vessel, the coated surface of said coated hollow member, and the interior surface of said coated hollow member.

2. The invention as set forth in claim 1 wherein said vessel comprises an elongated tubular structure provided with metal terminals through which electrical connections may be established to said resistive coating, and wherein said fluid is admitted into said vessel through one and discharged through the other of said metal terminals.

3. The invention as set forth in claim 1 wherein said vessel comprises an elongated tubular structure provided with metal terminals through which electrical connections may be established to said resistive coating and wherein said fluid is admitted into said vessel and discharged therefrom through a common of said metal terminals.

4. A device for dissipating electrical energy comprising a hollow cylinder provided with cup-shape metal terminal members closing the otherwise open ends thereof, a non-inductive resistor mounted between said cup-shape terminal members within said hollow cylinder, means for circulating a cooling fluid through said device and an electrical connection between a cup-shape member and said resistor, said connection comprising a coiled spring seated within the cup in contact with said resistor and between the turns of which said cooling fluid passes.

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