Jan. 7, 1941. H. H. WILLMANN 2,228,101

RESISTOR

Filed Feb. 12, 1938

Fig. 1.

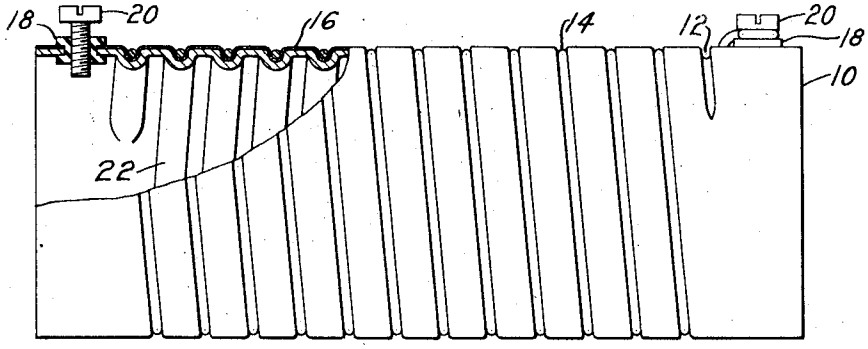
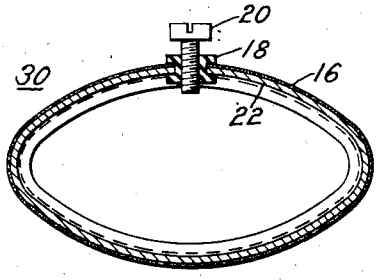


Fig. 2.



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UNITED STATES PATENT OFFICE

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RESISTOR

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3 Claims. (Cl. 201—63)

My invention relates generally to resistors, and it refers particularly to an improved form of construction for facilitating the cooling of resistor units.

Where resistors are used, some provision must necessarily be made to allow for the dissipation of the heat generated therein. Usually this is provided for by using a conductor of sufficient cross section to provide adequate conductor heat radiating surface. Where weight and space are not important factors, such provision may be allowable, but as the cross section and weight of a conductor increases as the square of the conductor diameter and the surface area of the conductor merely increases in direct proportion to the diameter, it may be seen that in providing sufficient conductor surface area for the cooling of the conductor the weight of the conductor per unit of length may in some instances be greatly increased. Furthermore, as the resistance of the conductor is lowered with increase of conductor cross section, the use of a larger conductor to provide sufficient cooling surface, will at the same time necessitate the use of a greater length of conductor in order to provide a given resistance. Thus the weight and size of the resistor is greatly increased where such provision for cooling is used.

Where weight and space are important factors, it will usually be found desirable to utilize a conductor member having a relatively small cross section so as to operate the conductor at its most efficient current density. In order to provide for the cooling of the conductor member under such circumstances, it is desirable to increase the effective cooling area of the conductor without increasing the actual dimensions of the conductor itself. In some instances this result has been attained by the use of forced draft ventilation, which increases the effective cooling area of the conductor by increasing the velocity of the air over the surface of the conductor, thereby more rapidly transferring the heat from the conductor to the surrounding atmosphere. Such a scheme, while effective in maintaining the conductor at desirable operating temperature, nevertheless utilizes additional equipment, thereby adding to the weight and space occupied. In other instances, attempts have been made to use metal supporting tubes in connection with bare resistor conductor members to increase the effective cooling surface of the conductor, a layer of enamel being provided on the surface of the metal tube to insulate the conductor member therefrom. However, it has been found that, in order to provide a film of enamel sufficiently thick to provide adequate electrical insulation between the bare conductor member and the metal tube, the resistance to the flow of heat between the conductor member and the support tube is also greatly increased and the cooling effect of the metal support tube cannot be advantageously utilized.

It is, therefore, generally an object of my invention to provide for greatly increasing the effective cooling area of a resistor conductor member without increasing the dimensions of the conductor.

More specifically, it is an object of my invention to utilize a metallic support member in close engagement with a resistor conducting member for effecting a ready flow of heat therebetween.

A further object of my invention is to utilize an oxide coated metallic support member for a bare resistor conductor member to facilitate the cooling of the conductor member.

Another object of my invention is to provide an anodized aluminum support tube for a bare resistor conductor member, wherein the conductor member is wound in close contact with the support tube to effect a ready flow of heat between the conductor and the support tube.

Still another object of my invention is to provide a light weight resistor that shall be simple and inexpensive to manufacture, and durable in operation.

Other objects will in part be obvious, and in part appear hereinafter.

For a complete understanding of the nature and scope of my invention, reference may be had to the following detailed description, taken in connection with the accompanying drawing in which:

Figure 1 is a partially sectionalized view in side elevation of a resistor embodying the principal features of my invention, and

Fig. 2 is a sectional end view of an alternative form of resistor construction embodying the principles of my invention.

Referring to Figure 1, it will be seen that in practicing a preferred form of my invention a metallic support tube 10 may be provided having a spiral conductor groove on the outer surface thereof, wherein a bare conductor member 14 may be positioned. In order to insulate the conductor member 14 from the metallic support tube 10, an insulating film 16 may be provided over the surface of the support tube 10 comprising, for example, an oxide film. Such a film may

be formed thereon in any well known manner, such, for example, as by immersing the tube in a bath of salts of a desired composition and making the tube the anode in an electrical circuit, whereby an anodic coating may be deposited on the surface of the tube.

It has been found from practice that if the support tube 10 be of aluminum this coating, while exceedingly thin, has very desirable insulating characteristics, and may be subjected to relatively high mechanical stresses without failing. It has further been found that by making the conductor groove 12 of such dimension that the conductor 14 will be relatively deeply embedded in the surface of the support tube 10, a high degree of heat conductivity may be secured between the conductor and the supporting tube which was not possible with previous forms of support tube constructions.

In this manner the cooling surface of the supporting tube may be efficiently utilized to aid in cooling the conductor member, as by facilitating the flow of heat between the conductor and the supporting tube, the conductor may be maintained at a temperature which is but slightly greater than the temperature of the support tube, and the surface area of the support tube may be practically considered as an extension of the surface of the conductor, so that the conductor may be operated at a relatively high current density without fear of overheating. Thus a smaller and lighter conductor member may be used than would otherwise be possible, and the weight and size of the resistor may be greatly reduced.

In order to provide terminal connections for the resistor, insulating bushings 18 may be provided, being for example, inserted in openings in the tube itself in any well known manner, for accommodating terminal screws 20. It has, however, been found that if the tube 10 is provided with an anodic coating over the entire surface, terminal members may be fastened directly to the metallic tube without the use of such insulating bushings, and thus the bushings 18 may be dispensed with, if desired.

It has been found that by providing cooling fins on the support tube 10, the cooling effect of the support tube and hence the effective cooling area of the conductor member 14, may be further increased. As the metallic support tube 10 need only be relatively thin in order to provide sufficient mechanical strength for supporting the conductor 14, I have found it advantageous to produce the conductor groove 12 by means of a pressing operation, whereby the metal of the support tube 10 is deformed to provide the groove 12 on the outer surface and a projecting rib 22 on the inner surface. This form of construction facilitates in cooling the support member by making provision for the imbedding of the conductor in the outer surface of the support, so as to aid in the transfer of heat therebetween, and at the same time provides additional radiating surface for the support tube.

Referring to Fig. 2, it may be seen that in certain instances where it is desirable to group a number of such resistors in close association, it may be desirable to use a support tube 30 having a cross section other than circular. In this instance the oval cross section herein shown may readily be provided by deformation of a resistor having a circular cross section after the conductor member 14 has been positioned thereon.

It may, therefore, be seen that by my invention full advantage may be taken of the high heat conductivity and radiation characteristics of a metallic support member in connection with a bare conducting member. By interposing an oxide film between the support and the conductor the flow of heat therebetween is not appreciably impeded, while the electrical insulation thereby provided is exceedingly good. Thus the resistance element may be worked at relatively high current densities without any danger of overheating, and the weight and size of the resistor may therefore be greatly reduced. Since the mechanical qualities of metal supports are decidedly superior to those of the refractory or other insulating material, a further reduction in weight may be effected by use of thinner cross sections of metallic support members without any sacrifice of either strength or cooling effect.

Since certain changes may be made in the above construction and different embodiments of the invention may be made without departing from the spirit thereof, it is intended that all the matter contained in the above description or shown in the accompanying drawing should be considered as illustrative and not in a limiting sense.

I claim as my invention:

1. The combination in a resistor of a tubular metallic support member deformed to provide a groove on the outside surface thereof and a cooling fin on the inside surface, an oxide insulating film covering at least said outside surface, and a bare resistance member disposed in the outside surface groove in close contact with the support member, whereby the support member is utilized to increase the effective cooling area of the resistance member.

2. A resistor comprising, a hollow elongated metallic support member having relatively thin side walls with a continuous helical groove formed about the outer surface thereof so as to provide a corresponding ridge on the inner surface, an insulating oxide film formed on the outer surface of the support member, and a bare resistance element positioned in the groove on the outer surface and insulated from the support member by the oxide film.

3. In a resistor in combination, a relatively thin walled tubular aluminum support having a helical groove formed in the outer surface so as to provide a projecting ridge on the inner surface thereof, a bare resistance wire positioned in the helical groove, and an insulating oxide film formed on the support so as to insulate the resistance wire therefrom.

HANS H. WILLMANN.