Feb. 10, 1970 F. KESSELRING 3,495,204

ELECTRICAL RESISTORS HAVING ALCOHOL-WATER COOLANT

Filed Feb. 12, 1968

FIG. 1

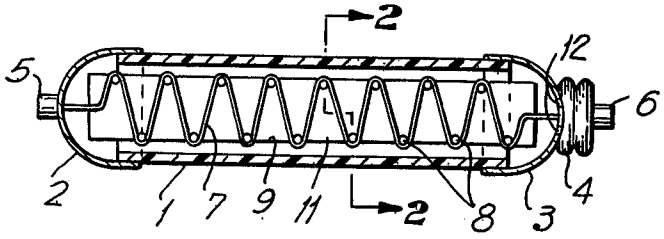


FIG. 2

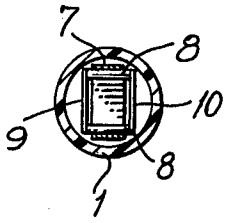


FIG. 3

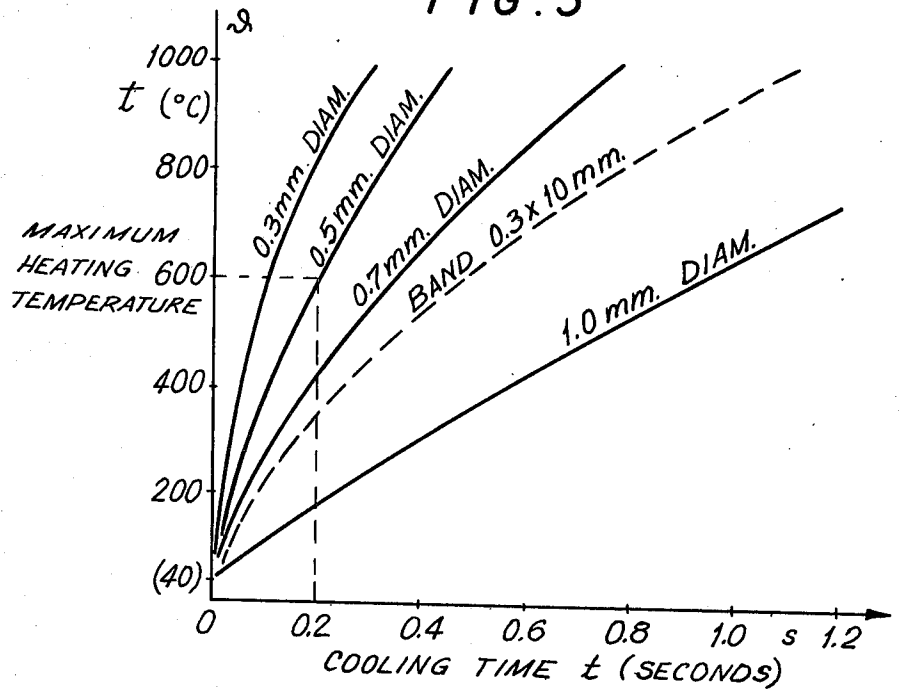


FIG. 4

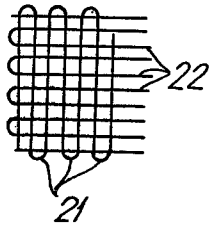
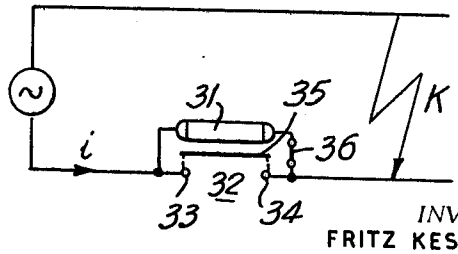


FIG. 5



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ELECTRICAL RESISTORS HAVING ALCOHOL-WATER COOLANT

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U.S. Cl. 338—231 5 Claims

ABSTRACT OF THE DISCLOSURE

An electrical resistor formed of iron is immersed in a mixture of from 20–50% by volume of a monovalent, bivalent or trivalent alcohol plus distilled water.

This invention relates to electrical resistors, and more particularly relates to cooling pure iron resistors by immersion in a mixture of alcohol and water.

Electrical resistors are commonly inserted in an electrical circuit and in parallel with a pair of circuit interrupting contacts. When the contacts open, their current shunts through the resistor. Preferably, the resistor is designed to sharply increase in resistance as the current through the resistor causes resistor heating in order to limit the rise in this current which is subsequently interrupted by a second pair of contacts in series with the resistor. Pure iron wire is commonly used for the resistor since it has a very high increase in resistance with increasing temperature.

It is necessary to cool the resistor rapidly, since it must be ready for a new operation in a relatively short time.

In accordance with the present invention, the resistor is embedded in a mixture of an alcohol and distilled water. The mixture is then deaerated by drawing a vacuum on the mixture to prevent oxidation of the resistance wire material.

Accordingly, a primary object of this invention is to provide an improved cooling system for current limiting resistors.

Another object of this invention is to provide a cooling medium for electrical resistors which maintains a high resistivity over an extended period of time.

A further object of this invention is to provide a novel cooling medium for electrical resistors which has no corrosive action against pure iron.

Still another object of this invention is to provide a non-inflammable cooling liquid for electrical resistors.

These and other objects of this invention will become apparent from the following description when taken in connection with the drawings in which:

FIGURE 1 shows a partly schematic longitudinal section through a resistor constructed in accordance with the invention.

FIGURE 2 is a cross-sectional view of FIGURE 1 taken across section line 2—2 in FIGURE 1.

FIGURE 3 shows the cooling curves for several resistance wire shapes, plotting temperature as a function of cooling time.

FIGURE 4 schematically shows a manner of forming a woven type resistor wire.

FIGURE 5 shows a circuit diagram illustrating the connection of the resistor of FIGURES 1 and 2 in an electrical circuit.

Referring first to FIGURES 1 and 2, there is shown an insulating housing **1** having metal closure caps **2** and **3**. A resilient metal bellows **4** communicates with the interior of housing **1**. Terminals **5** and **6** are then placed in series with a resistance strip **7** which is held in a zig-zag pattern

by the metal rods **8** which are fastened between two insulating boards **9** and **10**. A coolant **11** which consists of an alcohol-water mixture is then contained in the interior of housing **1**. The ends of the resistance strip **7** are electrically connected to terminals **5** and **6**. The resilient metal bellows **4** permits the expansion of the coolant **11** upon the heating thereof through the holes **12** provided in the cap **3**. Note that the housing of FIGURES 1 and 2 is cylindrical. Clearly, any shape, such as a toroidal shape could be used.

In accordance with the invention, coolant **11** is formed of a mixture of alcohol and distilled water. The following chemically pure alcohols can be used with the alcohol consisting of 20 to 50% by volume:

Methyl alcohol CH_3OH; ethyl alcohol C_2H_5OH (monovalent)
Glycol $HOCH_2CH_2OH$ (bivalent)
Glycerin $HOCH_2CHOHCH_2OH$ (trivalent)

The use of a mixture of a chemically pure monovalent, bivalent or trivalent alcohol and distilled water containing 20–50% by volume alcohol gives the following advantages:

By the addition of alcohol, the dissolving power of distilled water is greatly reduced so that the conductivity of the coolant increases very slowly and the liquid need be replaced only after many years. The corrosive action of the mixture is also reduced to such an extent that even chemically pure iron can be used as the resistance wire or strip **7** in these coolants without injurious oxidation occurring. The resistive conductor may be formed of other materials, and tungsten has been satisfactorily used. By the addition of alcohol, the freezing point of the mixture is reduced down to about —60° C. Despite the content of alcohol, the coolant remains practically unburnable. Thus, while the coolant can be ignited in the case of a very high alcohol content, it does not continue to burn due to the development of water vapor.

FIGURE 3 shows several wire diameters and a strip, all of pure iron and the cooling time t_a in seconds as a function of the maximum heating temperature t when using a mixture of 30% by volume glycol and 70% by volume water.

If relatively high ohmic resistances are required, it is possible to form the resistor as shown in FIGURE 4. The grid of FIGURE 4 consists of a narrow wire strip **21** which is woven with an insulating thread **22**. The insulating thread can consist of chemically pure asbestos, glass fibers or quartz fibers.

FIGURE 5 shows the use of a resistor in accordance with the invention as a current limiter in which chemically pure iron is used as resistance material. The resistor **31** is in parallel with the switch **32** which has stationary contacts **33**, **34** and a movable bridging contact **35**. An auxiliary switch **36** is connected in series with resistor **31**.

If a short-circuit now takes place at the point K, the switch **32** will immediately be opened by suitable fault sensing and operating means (not shown). The current i will be shunted to the resistor **31**, the ohmic value of which is increased, for instance, 10 times by the heating of the iron wire. This leads to a sufficiently large decrease of the current i that it can be interrupted in a simple manner by the switch **36**.

The embodiments of the invention in which an exclusive privilege or property is claimed are defined as follows:

1. An electrical resistor comprising a housing; a resistive conductor contained within said housing; terminal means extending through said housing and connected to said resistive conductor; and a coolant fluid within said housing and surrounding said resistive conductor and in contact with said resistive conductor; said coolant fluid comprising a mixture of an alcohol and distilled water;

said alcohol comprising from 20% to 50% by volume in said mixture.

2. The resistor of claim 1 in which said alcohol is selected from the group consisting of monovalent, bivalent and trivalent alcohols.

3. The resistor of claim 1 in which said resistive conductor is composed of material selected from the group consisting of pure iron and tungsten.

4. The resistor of claim 1 in which said alcohol comprises 30% by volume of said mixture.

5. The resistor of claim 3 in which said alcohol comprises 30% by volume of said mixture.

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