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J. R. FISHER

2,091,259

RESISTANCE UNIT

Filed July 11, 1935

FIG. 1

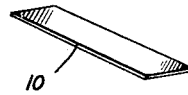


FIG. 2

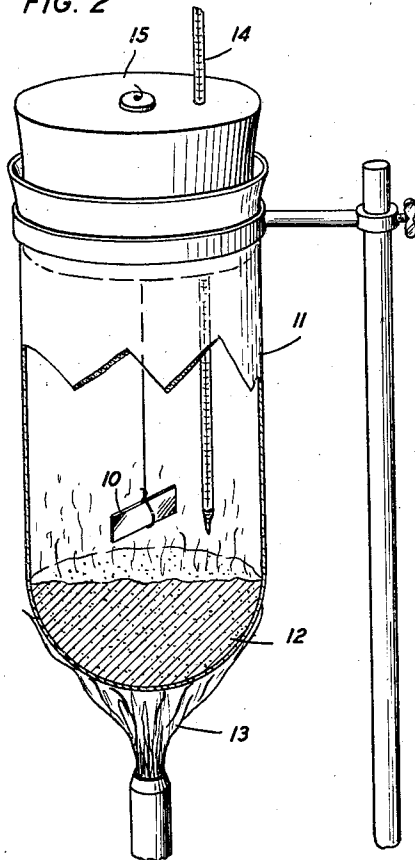


FIG. 3

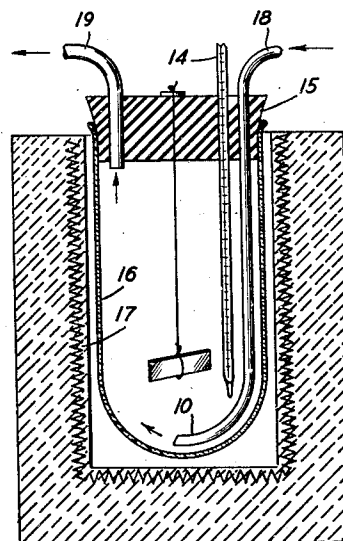


FIG. 4

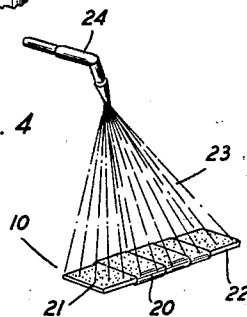


FIG. 5

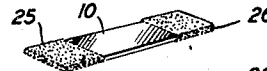
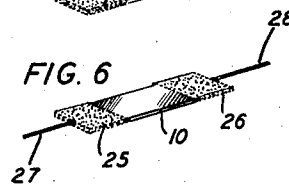


FIG. 6



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RESISTANCE UNIT

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3 Claims. (Cl. 201—76)

This invention relates to electrical resistance units.

The object of the invention is to produce a resistance unit of silver sulphide and a method of making the same.

A further object of the invention is the production of a resistance unit which will have a high negative temperature coefficient of resistance; that is, one whose resistance decreases with an increase in temperature, over the range of temperatures from room temperature to about 200° C. and whose resistance will be reproducible and reversible; that is, have the same value at a given temperature regardless of the direction from which this temperature is approached.

Another object of this invention is to provide a resistance having a high negative temperature coefficient of resistance whose resistance will be independent of voltage and frequency.

A further object of this invention is the provision of a resistance having a high negative temperature coefficient of resistance which can be easily made into units having a range of resistances depending upon their size and shape.

Many materials are known to have a high negative temperature coefficient of resistance and this property is possessed in common by all semiconductors to some degree. However, most of these materials are unsatisfactory for use in electrical control devices either because the change in resistance is not sufficient or because they are not stable and/or reversible, or because of their refractory nature they are not readily fabricated into a suitable form.

I have discovered that silver sulphide has a combination of properties which make it uniquely suitable for use in electrical devices either as a means for compensating for resistance changes in metallic structures which have a positive temperature coefficient of resistance, or as a control device to operate when a change in resistance reaches a certain value.

By the following method, resistor units may be prepared which are suitable for use in electrical devices of the above-mentioned type.

In accordance with my invention, I suspend a mass of silver, which is to be formed into a resistance unit, in a tube or vessel containing a small quantity of sulphur and apply sufficient heat to the vessel to provide a heated sulphur vapor at a temperature of approximately 300° C. The sulphur vapor within the vessel is held at approximately this temperature until the silver article is converted to silver sulphide.

Various means for attaching electrodes to this

type of resistance have been worked out and one which the applicant has found suitable will be described in detail later on in the specification.

After the resistance unit has been removed from the sulphiding chamber, it is subjected to a heat treatment, that is, by heating it at a temperature between 200 and 300° C. in an atmosphere of pure dry nitrogen gas for approximately one hour. Without this treatment the resistor may contain more or less sulphur than is required to exactly combine with the silver which will cause a resulting change in the resistance with use.

Referring now to the drawing, Fig. 1 illustrates one form of silver resistance unit which may be employed in making the resistance unit of this invention;

Fig. 2 is a view partly in cross-section illustrating the sulphiding chamber;

Fig. 3 is a view in cross-section illustrating the heat treating and curing apparatus;

Fig. 4 illustrates one method of applying a conducting surface to the ends of the resistance unit;

Fig. 5 illustrates the resistance unit after it has been sprayed with molten metal in accordance with the method shown in Fig. 4; and

Fig. 6 shows the completed resistance unit with the terminal wires secured to the conductor surfaces on the unit.

In accordance with the preferred form of this invention, a mass of C. P. silver, which may be of any desired shape or size, such as that shown at 10 in Fig. 1, is suspended in the vessel 11 by any suitable means, this vessel containing a small quantity of sulphur 12. The sulphur 12 is caused to vaporize by means of the flame 13 which raises the temperature in the vessel to approximately 300° C. The temperature is held at this level for about ten or fifteen minutes, or a sufficient length of time to completely convert the resistance unit 10 into silver sulphide.

The heat on the interior of the vessel 11 is observed by means of the thermometer 14 which projects through the closure member 15.

After the member 10 has remained in the sulphur vapor a sufficient length of time to convert it into silver sulphide, it is removed from the vessel 11 and is suspended in the vessel 16. The vessel 16 contains pure dry nitrogen gas and is heated by means of the heating element 17 which maintains a temperature of approximately 200° C. The nitrogen gas is introduced into the vessel 16 through the inlet tube 18 and escapes through the outlet 19. This drives off the excess sulphur and thoroughly cures the resistance unit.

After the resistance unit 10 has remained in the vessel 16 the required length of time, which is approximately one hour, it is ready to have the terminal or lead-in wires secured thereto.

5 Due to the character of the resistance unit 10, the well-known method of mounting or securing connections to resistances and the like cannot be used. It is therefore necessary to provide a different method of making connections to this resistance unit.

10 As shown in Fig. 4, the resistance unit 10 has the center portion masked or covered by a tape or some other similar material 20. The exposed portions 21 and 22 on the ends of the unit 10 are now sprayed with a molten metal 23 from the gun 24, and may be the well-known Shoop process. Thus a coating of conducting metal 25 and 26 is deposited on each end of the unit 10 as shown in Fig. 5. A pair of lead-in wires 27 and 28 are then secured to the coated portions 25—26 by solder or any other suitable method.

A resistance unit formed in accordance with the above method is simple and inexpensive to manufacture and uniformity of the finished product is secured.

25 It will be understood that I do not limit myself to the precise apparatus herein disclosed as the same may be changed, modified or altered without departing from the spirit of the invention and I am only limited by the scope of the appended claims.

What is claimed is:

1. A method of producing resistors having a high negative temperature coefficient of resistance for use in electrical circuits, which consists in subjecting a mass composed of substantially pure silver to a vapor of sulphur which is heated to a temperature of 300° C. until the mass is converted to silver sulphide. 5

2. A method of producing resistances having a high negative temperature coefficient of resistance for use in electrical circuits, which consists in subjecting a mass composed of substantially pure silver to a sulphur vapor heated to a temperature of 300° C. until the mass is converted to silver sulphide, removing said mass from the sulphur vapor and then heating it in a stream of pure dry nitrogen gas at a temperature from 200 to 300° C. for approximately one hour. 15

3. A method of producing resistors having a high negative temperature coefficient of resistance for use in electrical circuits, which consists in subjecting a mass composed of substantially pure silver to a vapor sulphur which is heated to a temperature of 300° C. until the mass is converted to silver sulphide, removing said mass from the sulphur vapor and then heating it in a stream of pure dry nitrogen gas at a temperature between 200 and 300° C. for approximately one hour. 25

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