July 22, 1930. N. C. SCHELLENGER 1,771,236

RESISTANCE STRIP

Filed Oct. 6, 1926

Fig. 1.

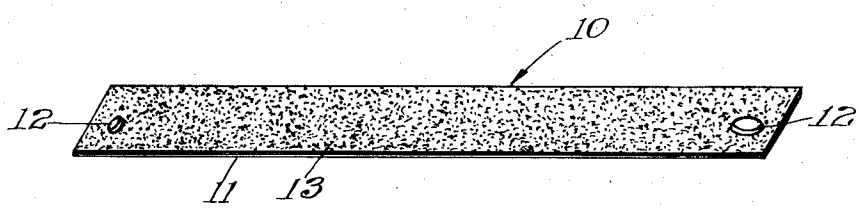


Fig. 2.

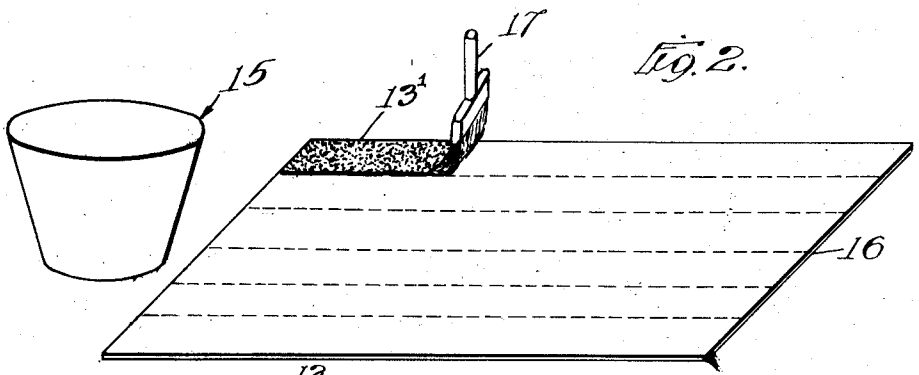
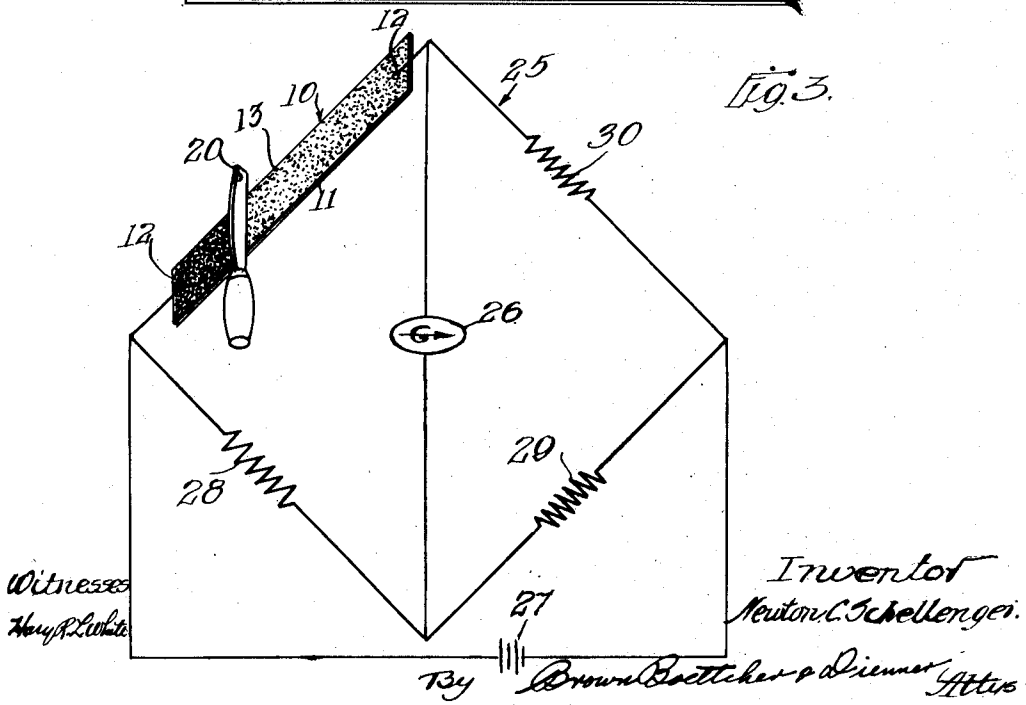


Fig. 3.



Witnesses
Henry R. White

Inventor
Newton C. Schellenger.

By Brown Boettcher & Dienner Attys

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UNITED STATES PATENT OFFICE

NEWTON C. SCHELLENGER, OF ELKHART, INDIANA, ASSIGNOR TO CHICAGO TELEPHONE SUPPLY COMPANY, OF ELKHART, INDIANA, A CORPORATION OF DELAWARE

RESISTANCE STRIP

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My invention relates in general to electrical resistances and more particularly to resistance strips such as are commonly employed in rheostats and potentiometers. Specifically, I contemplate the provision of a novel form of carbon resistance strip.

In practice I have found the ordinary type of carbon resistance strip highly unsatisfactory for the reason that it is subject to considerable variation in resistance. This is particularly true in rheostats and other analogous current control devices where the resistance strip is frictionally engaged by a contact element such as a contact roller.

In those resistance strips employing the crystalline or graphite form of carbon the action of the contact roller on the strip results in a compression of the particles of carbon, thus increasing the conductivity of the strip. In fact, I have observed that after approximately fifty thousand operations of the contact roller there will be as much as a fifty per cent drop in the resistance value of the strip. That is to say, the resistance of the strip will have decreased to about fifty per cent of its initial value.

On the other hand, if the strip is only coated with lamp black, I have found that the action of the roller on the strip tends to increase the resistance value of the strip. In other words, lamp black has a characteristic which is apparently the reverse of that of graphite. This characteristic of the amorphous form of carbon or lamp black might be possibly attributed to the fact that when the lamp black is subjected to the frictional rubbing action of the contact roller, it tends to become more finely pulverized. It will be evident, therefore, that as the particles of carbon are broken up into smaller particles of carbon or lamp black, the conductivity of this strip is decreased.

Since both of the above mentioned two types of resistance strips are subject to variation in resistance, neither of them are satisfactory for use in accurate devices where a stable resistance is desired. Therefore, I propose to provide a novel form of resistance strip having the characteristics of both the above two forms, and yet, at the same time, being relatively stable as far as the resistance value is concerned.

I have solved the above difficulty by using a mixture of substantially equal parts of lamp black and graphite plus a suitable binder, such as shellac. It will be found that when a coating of this composition is applied to a backing sheet, such as a fibrous strip of material, the resultant resistance strip will have a substantially constant and stable resistance value.

Also, shellac makes an ideal binder since it not only is an insulator, but also serves to preserve the strip. Furthermore, the shellac binder makes the resistance element moisture resisting to such an extent that there is no apparent change in the resistance value of the element due to either excessive humidity or extreme dryness of the atmosphere. Then, too, the shellac binder possesses a marked degree of elasticity which characteristic is of great advantage in the manufacture of resistance elements due to the strips being capable of withstanding handling without resulting in the cracking of the carbon coating. Moreover, the resistance element of my invention has a much smaller negative temperature coefficient than is possessed by any other high resistance unit now available on the market. In fact, I find that my resistance element is only 41% as negative as those available on the market at the present time.

In accordance with the general features of my invention, the mixture of carbons and shellac is applied to the backing sheet by means of a varnish brush. After the strip has been thoroughly dried, the carbon coating is scraped or rubbed until the strip has the required resistance value.

Other objects and advantages of my invention will more fully appear from the following detailed description taken in connection with the accompanying drawing which illustrates one embodiment thereof and in which

Fig. 1 is a perspective view of a strip embodying the features of my invention;

Fig. 2 is a more or less diagrammatic view illustrating the apparatus for practicing my

novel method of manufacturing the resistance strip; and

Fig. 3 is a diagrammatic view illustrating the manner in which the resistance strip may be scraped in order to give it a required resistance value.

Referring now to the drawing in detail, in which like reference numerals designate similar parts throughout the several views, 10 denotes generally a resistance strip embodying the features of my invention. This strip preferably comprises a sheet of fibrous material 11 having a pair of perforations 12 and a coating of my novel composition 13.

The sheet of fibrous material 11 may be paper or any other analogous semi-absorbent material. I have attained excellent results with the common drawing paper known on the market as "Orion" detail paper.

The coating 13, as I shall more fully describe hereinafter, consists of a mixture of crystalline carbon such as graphite, and amorphous carbon, such as lamp black. These carbons are preferably held together by means of a binder such as gum shellac.

The perforations 12 serve to enable the resistance strip to be suitably fastened to a rheostat frame or the like as disclosed in my co-pending patent application Serial Number 114,126, filed June 7, 1926. I shall now proceed to describe in detail my novel carbon composition, as well as my novel method of manufacturing the strip 10.

I preferably add eight parts of lamp black to seven parts of graphite and thoroughly mix these carbons in a suitable receptacle such, for example, as the pail 15 shown in Fig. 2. In practice I actually measure the lamp black and graphite in terms of pennyweight. For example, to each eight pennyweight of lamp black, I add seven pennyweight of graphite. To this mixture of carbon I then add a suitable binder, such as a gum shellac solution of from seven to twelve fluid ounces, depending upon the resistance desired in the resistance element or strip being manufactured. If a 500,000 ohm element is desired, twelve fluid ounces of shellac are used. On the other hand, if a 50,000 ohm resistance element is being manufactured, seven fluid ounces of shellac are used. It is apparent therefore, that the thicker the "paint" is, the lower the resistance will be.

The shellac which I employ in the manufacture of this carbon composition is made of gum shellac and alcohol. The shellac should be diluted with alcohol until a mixture is attained which will read 29 on a Beaumé ammonia hydrometer scale. The alcohol used reads 45 on the same scale before any shellac has been mixed with it.

It will be found that a mixture of the above mentioned ingredients, namely, eight pennyweight of lamp black, seven pennyweight of graphite and ten fluid ounces of shellac, will give a hydrometer reading of approximately 23.75 when all the ingredients are properly mixed.

After the carbon mixture has been thoroughly stirred in the pail 15, the same may be applied to sheets of semi-absorbent detail paper, such as sheet 16, by means of a suitable varnish brush 17. The sheet 16, as previously pointed out, may be standard size drawing paper. Subsequent to the application of the carbon composition to the sheet 16, the sheet is dried in a well ventilated room for approximately four hours at a temperature of approximately 170° F. I have designated the carbon coating applied to the sheet 16 by the reference character 13'. Thereafter the coated sheet 16 is cut up into a plurality of strips 10, such as the one shown in Fig. 1. The dotted lines in Fig. 2 indicate the lines of severance.

When a resistance strip having a straight line curve resistance value is desired, the carbon composition is applied uniformly and evenly over the entire surface of the sheet. That is to say, when a resistance strip is desired which has a resistance value which is the same for all parts of the strip, the coating applied thereto must obviously extend uniformly over the entire surface. When such a strip is applied to rheostats, the resistance value will increase uniformly as the contact roller is moved over the surface of the strip.

Now whenever it is desired to vary the resistance value of any part of the strip, the same may be done by scraping off part of the "carbon paint" after the strip has been thoroughly dried. In Fig. 3 I have illustrated the manner in which the strip is measured and scraped.

Referring to Fig. 3, 20 denotes generally a scraping knife used for scraping the strip 10. In order to measure the strip, the same is connected to one leg of a Wheatstone bridge designated generally by the reference character 25. This bridge 25 includes the usual galvanometer 26 and battery 27. It also has three resistances 28, 29 and 30, the construction of which are well known to those familiar with this electrical art. The resistances 29 and 30 may be fixed in value and the resistance 28 may be of a variable nature.

It will be evident from Fig. 3 that by scraping the coating 13 with the knife 20, the resistance value of the strip 10 may be varied. The galvanometer 26 will indicate when the desired value has been reached.

Should a resistance strip be desired having a resistance value which is not uniform for the entire length of the strip, the same may be manufactured in the following manner: For example, let us assume that in a 500,000 ohm resistance element it is desired that half of the length of the strip have a resistance value of 50,000 ohms and the remaining half having a resistance value of 450,000 ohms. I manu-

facture such strips by first painting the sheet of absorbent material with a coat of material extending half the length of the sheet. When this first coat of carbon composition has dried for approximately fifteen minutes, a second coat is applied to the sheet over the entire surface thereof. This results in one-half of the strip having two coats of carbon composition and the other half having but one coat.

I find that the "carbon paint" does not peel off the paper strip when scraped; in fact, it is possible to scrape the coating down to the thinnest film without causing the "carbon paint" to chip or peel.

By employing a carbon composition having eight parts of lamp black to every seven parts of graphite, I find that this combination gives a stable resistance and which does not change in value to any appreciable extent due to the action of the contact roller thereon. I have experimented with rheostats employing my novel resistance strip, and find that even after a roller has been operated as many as a million times, the resistance of the resistance strip still remains substantially unchanged. I attribute this primarily to the action of the crystals of graphite upon the amorphous form of carbon, namely, lamp black. That is to say, as the particles of graphite are compressed, the molecules of lamp black are broken up into still further particles which compensate for the compression of the graphite crystals. In reality, the conducting area of the lamp black decreases as the conducting area of the graphite increases, due to compression. I am not as yet, however, able to fully explain the cooperation between the lamp black and the graphite in my novel carbon composition.

Also, by using my novel carbon composition, I find that I am able to produce a resistance element possessing a far smaller negative temperature coefficient than is possessed by any other analogous high resistance units now available on the market. My resistance strip has a much smaller negative temperature coefficient than that possessed by resistance elements made only of graphite or only of lamp black.

Then, too, the shellac binder also serves to make the resistance element moisture-proof. The gum in the shellac functions as a moisture-proof medium to such an extent that no apparent change in resistance of the resistance strip is apparent due to either excessive humidity or extreme dryness of the surrounding atmosphere.

Now I desire it understood that although I have illustrated and described in detail the preferred embodiment of my invention, the invention is not to be thus limited, but only in so far as defined by the scope and spirit of the appended claims.

I claim:—

1. A composition of matter comprising substantially equal portions of lamp black and graphite and a binder comprising a shellac solution having a 29° Beaumé reading on an ammonia hydrometer scale.

2. A composition of matter comprising substantially seven parts of graphite, eight parts of lamp black and a moisture proof binder comprising an insulating liquid.

3. A composition of matter comprising substantially seven parts of graphite, eight parts of lamp black and from 140 to 240 parts of shellac.

4. A resistance strip comprising a backing sheet of material and a coating of a mixture of substantially seven parts of graphite, eight parts of lamp black and a binder disposed thereon.

5. A resistance strip comprising a backing sheet of fibrous material having a plurality of perforations, and a coating of resistance material disposed on said sheet comprising a mixture of substantially seven parts of graphite, eight parts of lamp black and from 140 to 240 parts of shellac.

6. A resistance strip adapted to form the variable element of a variable resistor, comprising a backing sheet having a mixture of substantially equal portions of lamp black and graphite held thereon by shellac.

7. A resistance strip adapted to form the variable elements in a variable resistor, comprising a backing sheet having a mixture of seven parts of graphite and eight parts of lamp black held thereon by a moisture binder.

8. A resistance element including two different forms of carbon having differential variation in resistance under the action of a member repeatedly sliding thereover, said forms of carbon being mixed in amounts necessary to compensate for their variation in resistance under the action of a contact member sliding over the carbon of the resistance element.

9. A composition of matter comprising intimately mixed fine particles of different forms of carbon, the particles being mixed in amounts necessary to compensate for one another's variation in electrical resistance upon the continued sliding thereover of a sliding contact of a rheostat.

10. A resistance strip for a sliding contact type of rheostat, said resistance strip comprising a supporting backing and a layer of resistance material applied thereto, said resistance material being contacted with by a sliding contact moving thereover and comprising an intimate mixture of fine particles of resistance elements having the characteristic of decreasing their resistance under the sliding action and resistance elements having the characteristic of increasing their resistance under the sliding action, said elements being mixed in amounts necessary for each to compensate for the variation in resistance of the other.

11. A resistance strip adapted to form the variable element over which a sliding contact in a variable resistor moves, said strip comprising a backing sheet having a coating of a mixture of crystalline and amorphous carbon disposed thereon, said crystalline and amorphous carbon being mixed in proportion to bring about substantially zero variation in resistance of the coating under repeated mechanical action of a sliding contact moving thereover.

12. A resistance strip adapted to form the variable element over which a sliding contact in a variable resistor moves, said strip comprising a backing sheet having a mixture of different forms of carbon disposed thereon, one of said forms of carbon being capable of decreasing in resistance, and another of said forms of carbon being capable of increasing in resistance to compensate for the change in the first carbon, said different forms of carbon being mixed in proportion to bring about substantially zero variation in resistance of the strip under repeated mechanical action of a sliding contact moving thereover.

13. A resistance strip adapted to form the variable element over which a sliding contact in a variable resistor moves, said strip comprising a backing sheet with a coating of a mixture of amorphous carbon, crystalline carbon, and a binder disposed thereon, said amorphous carbon and crystalline carbon being mixed in proportions to bring about substantially zero variation in resistance of the strip under repeated mechanical action of a sliding contact moving thereover.

14. A resistance strip adapted to form the variable elements over which a sliding contact in a variable resistor moves, said strip comprising a backing sheet of semi-absorbent fibrous material having a coating of a mixture of lamp black, graphite, and shellac disposed thereon, said lamp black and graphite being mixed in proportions to bring about substantially zero variation in resistance of the strip under repeated mechanical action of a sliding contact moving thereover.

In witness whereof, I hereunto subscribe my name this 27th day of September, 1926.

NEWTON C. SCHELLENGER.