

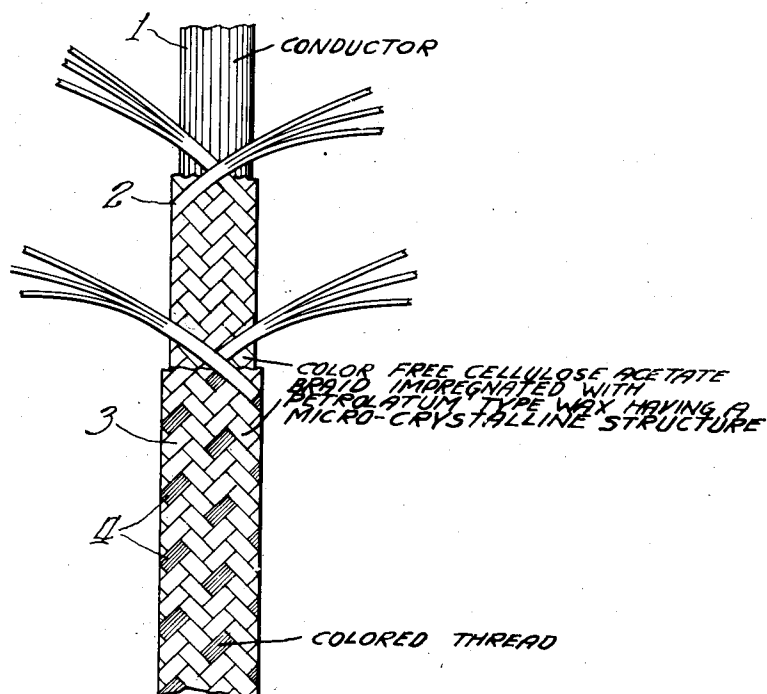
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WIRE COVERING FOR HIGH FREQUENCY CIRCUITS

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WIRE COVERING FOR HIGH FREQUENCY
CIRCUITS

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This invention relates to electrical conductors and more particularly to improvements in conductors used for carrying high frequency currents such for example as are found in radio frequency circuits of radio apparatus.

In wires carrying these high frequency currents, the losses which occur may be avoided to a great extent by practical improvements in the insulation applied on the conductor.

It is the purpose of this invention to provide a circuit or hook-up wire for use in all places where the wire is to carry current at the higher frequencies including radio frequencies of the ordinary broadcast band and the higher short wave frequencies which run up into the millions of cycles. This conductor and its insulation is designed to prevent the losses now present in the well known rubber, cotton, and silk covered wires used.

I have discovered that, by combining a certain textile with a particular impregnating substance, I obtain a remarkable reduction in certain of the losses at high frequencies, which reduction is entirely unexpected from the known characteristics of the two materials. Much of the loss in textile insulation at the higher frequencies can be traced to impurities present in fibre, moisture, saline diluents and minerals in ionic form introduced during the process of manufacturing dyes for such textile insulation. I find that the power factor loss and the phase angle for any particular conductor can be varied considerably by the type of insulation and impregnating compound used on the conductor. It will be shown hereinafter that, by combining the proper textile covering with the proper impregnating material, power factor losses may be reduced beyond normal expectation at high frequencies in the short wave band.

For convenience in identifying the various parts of the conductor and covering, I will describe the invention by reference to the accompanying drawing wherein the figure is a plan view of a conductor covered with a braided covering embodying the present invention.

In the drawing, the numeral 1 refers to a tinned copper conductor which may be either of the solid or stranded type. Upon this conductor there is provided a braided covering 2 consisting of three end cellulose acetate textile. Over the layer 2 of braid is a second layer 3 braided in the same fashion. This outer layer may contain, wherever needed for identification purposes, a tracer thread 4 suitably colored for identification. Two strands of tracer thread are used so that

various combinations of colors may be obtained readily.

The thread or yarn used is a cellulose acetate substance made from cotton linters. The cellulose obtained from cotton linters is treated with acetic anhydride in the presence of a catalytic agent usually sulphuric acid to produce a cellulose acetate which is freed of all free acids by washing with water and then dried.

The cellulose acetate is then dissolved in a solvent containing acetone and made into fine filaments by passing the solution through tiny apertures into an air chamber where the solvent is evaporated. The filaments are twisted into a yarn of any desired size. The particular size preferred in the present instance is 150 denier 3 end yarn.

This yarn is braided upon the conductor in such fashion as to obtain a covering which may be pushed back from an end of the conductor for making connections. The yarn is braided in two layers at once, the braiding being done in such fashion as to reduce the number of piques lengthwise on the wire. This makes the braid more compressible lengthwise on the wire so it can be "pushed back" readily.

The conductor covered in this fashion is next subjected to a bath in an impregnating material. The impregnation is done in such a way as to prevent inclusion of moisture in the covering. Preferably the conductor is dried in a vacuum tank heated to above 212° F. and then the impregnating material, also heated to above 212° F., is let into the tank so as to completely saturate the insulation. The vacuum drying may be omitted, and the wire merely immersed in the impregnating material which is kept above 212° F. In either case, the conductor is left in the impregnating bath until the insulation on the conductor is completely impregnated with the impregnating material. This takes usually about two hours. The finished product is then removed and permitted to dry at ordinary atmospheric temperatures.

The cellulose acetate textile is impregnated with a pure mineral wax free of acids so as to be practically neutral to acidity tests. The wax used is a petrolatum type wax which has a very fine crystalline structure as compared to waxes of the paraffin type. This wax also in its preparation is treated with acetone. The residue after the acetone treatment is a pure petrolatum wax of nearly white and translucent appearance. The color is classified as minus 12 Saybolt. The wax melts at 155°-159° F.

I have found that this wax in combination with the cellulose acetate textile produces a wire covering which shows remarkable and unexpected reduction in power losses from the wire when used as a conductor for the radio frequency currents.

Heretofore, it has been the practice to use textile coverings for conductors and to impregnate them with a wax, usually beeswax. The textiles commonly used are cotton and silk. I have conducted tests which show that the desirable reduction in power losses with my combination is not the result of one or the other of the materials but to their combination.

In making up the wire covering, I avoid the use of any materials that tend to break down the resistance of this combination to moisture. Only a small amount of colored textile is used. The inner braid is preferably entirely devoid of any coloring for tracing purposes. In the outer braid where it is necessary to have colors for tracing the conductors, I use no more than 20% of the volume of the outer braid colored. The reason for this is to avoid losses due to metallic ions introduced in the coloring matter during the process of manufacture. The effect of metallic ions in the coloring can readily be detected at the higher frequencies in the proximity of 12 megacycles.

This combination of cellulose acetate textile with a petrolatum type mineral wax is particularly resistant to breakdown and is not appreciably affected adversely by extreme variations in atmospheric conditions due to its non-hygroscopic characteristics.

The remarkable reduction in losses is particularly useful in conductors carrying high frequency current such, for example, as the conductors in the radio frequency stages of radio receiving sets and particularly of short wave receiving sets. In this application where the term radio frequency is used, it is intended to mean those frequencies which are used in broadcasting on both long and short waves. These frequencies are usually considered to range from 50 kc. upward. The change from the usual wire used in such sets to this wire has resulted in gains in output as high as twelve (12) per cent. This gain is remarkable when one considers that only a small portion of the wire used in a receiving set is found in the radio frequency stages.

A comparison of the characteristics of this covering with those of the known cotton braid beeswax impregnated covering and the known purified Tussah silk braid beeswax impregnated shows that the percentage loss due to power factor alone is twenty times greater with the best of these known coverings than with my covering. For example, I tested wires of the same size with the three coverings at a frequency of twelve megacycles at 70° F. and 50% relative humidity. I found the power factor expressed in percentage loss to be 15% for cotton covering, 10.8% for the silk covering, and .54% for my improved covering. At 120° F. and 90% relative humidity, the power factor for the silk covered wire was 19.5%, while that for the wire with my improved covering was .84%. The phase angles for the various coverings, at 70° F. temperature and 50% relative humidity, were as follows:

Cotton covering	27° 5 minutes
Silk covering	15° 48 minutes
Improved covering	4° 20 minutes

The insulation resistance at 70° F. and 50%

relative humidity was about the same for the silk covering and my improved covering was 100,000 megohms plus. For cotton the insulation resistance was only 195 megohms. At 120° F. and 90% relative humidity, the insulation resistance of the cotton covering dropped to 1.4 megohms while that of the silk dropped to 150 megohms. The insulation resistance of my improved covering dropped only to 11,250 megohms. This illustrates its superiority in resisting moisture absorption.

From the above disclosure it is believed to be evident that the new combination herein disclosed as a covering for conductors of radio frequency currents is possessed of many advantages over known textile coverings and particularly in reducing power factor losses at the higher frequencies. I do not know the correct scientific explanation for the results obtained. However, one explanation may be that the textile and the impregnating materials both being subjected to treatment by acetone have similar molecular structures which tend to cut down the energy lost in maintaining the field strength about the conductor. The fine crystalline structure of the impregnating material also permits a more complete impregnation. The wax is able to penetrate into the smaller openings in the textile.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An insulated conductor for carrying radio frequency currents, comprising a wire covered with a cellulose acetate textile, the textile being impregnated with a petrolatum type wax which is substantially devoid of acid and which has a melting point of at least 155° F., said wax having a microcrystalline structure, the insulation resistance of the impregnated textile covering being above 10,000 megohms at 120° F. and 90% relative humidity.

2. An insulated conductor for carrying radio frequency currents, comprising a wire covered with a cellulose acetate textile, the textile being impregnated with a petrolatum type wax which is substantially devoid of acid and which has a melting point of at least 155° F., said wax having a microcrystalline structure, said covering being substantially free of coloring except for tracer threads on the exterior thereof, which threads constitute less than 20% of the total textile volume in the covering.

3. An insulated conductor for carrying radio frequency currents, comprising a wire covered with a cellulose acetate textile, the textile being impregnated with a petrolatum type wax which is substantially devoid of acid and which has a melting point of at least 155° F., said wax having a microcrystalline structure, said textile being applied directly to the surface of said wire in a pair of braids which braids are compressible lengthwise of the wire to expose a length of the wire beyond the covering for connection purposes.

4. An insulated conductor for carrying radio frequency currents, comprising a wire covered with a cellulose acetate textile, the textile being impregnated with a petrolatum type wax which is substantially devoid of acid and which has a melting point of at least 155° F., said wax having a microcrystalline structure, said textile being applied directly to the surface of said wire in a pair of braids which braids are compressible lengthwise of the wire to expose a length of the wire beyond the covering for connection purposes, the outer braid having colored tracer threads

therein, which threads constitute less than 20% of the total textile volume.

5 5. An insulated conductor for carrying radio frequency currents, comprising a wire covered with a cellulose acetate textile, the textile being impregnated with a petrolatum type wax which is substantially devoid of acid and which has a

melting point of at least 155° F., said wax having a microcrystalline structure, said conductor having a power factor loss not exceeding 1% at frequencies up to 12 megacycles in ordinary working temperature and humidity.

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