

Jan. 15, 1935.

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1,987,918

ELECTRICAL CONDUCTOR

Filed Nov. 3, 1932

2 Sheets-Sheet 1

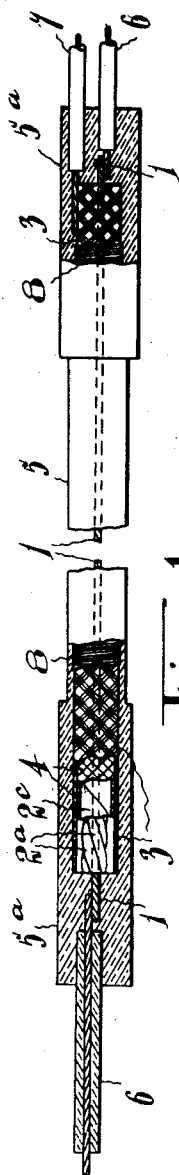


Fig. 1.

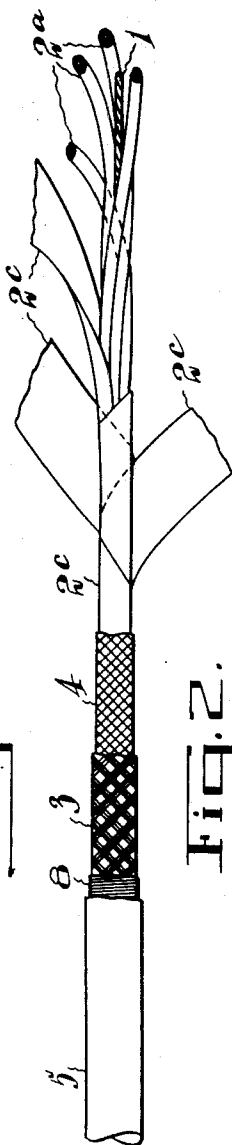


Fig. 2.

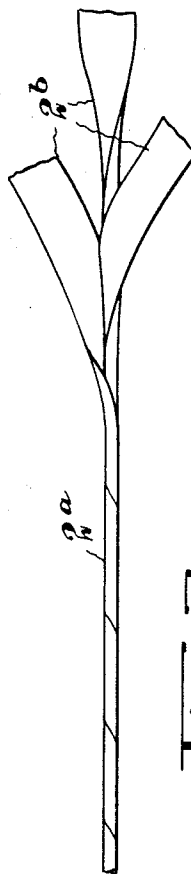


Fig. 3.

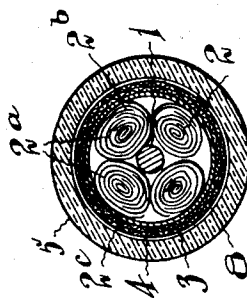


Fig. 4.

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2 Sheets-Sheet 2

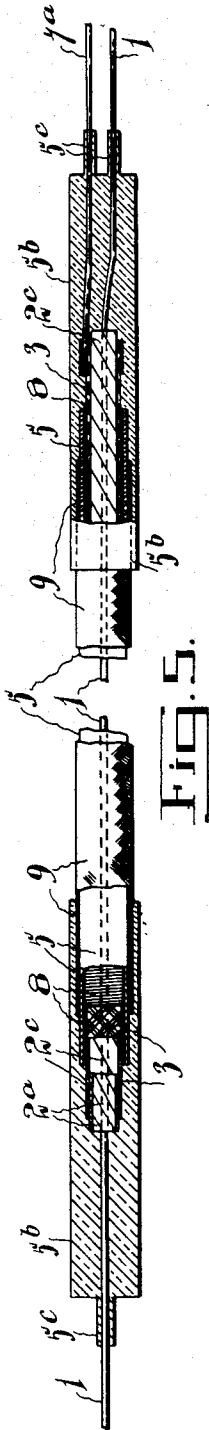


Fig. 5.

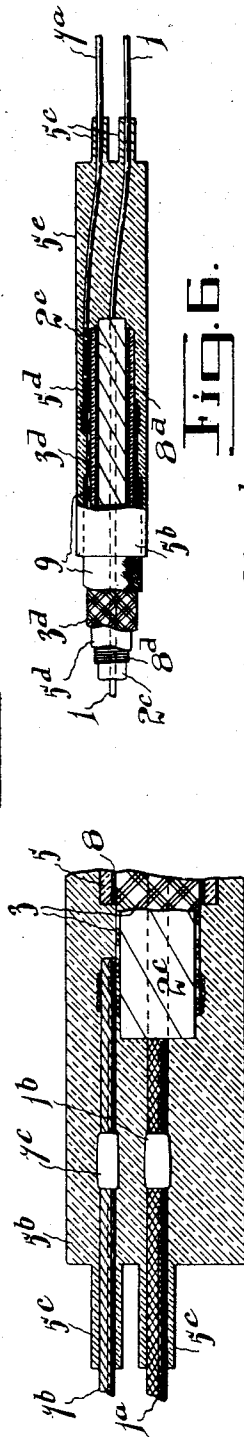


Fig. 6.

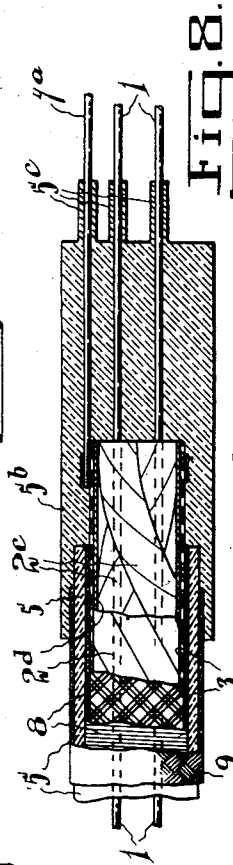


Fig. 8.

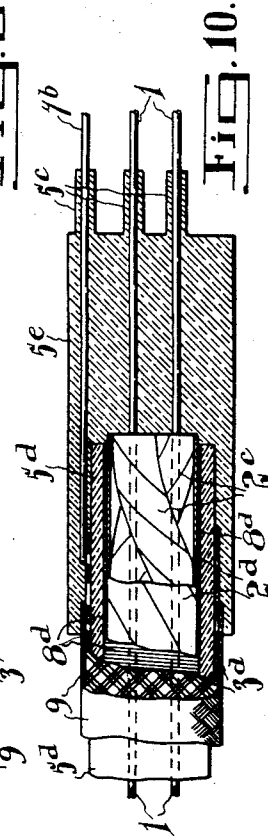


Fig. 10.

Fig. 7.



Fig. 9.

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UNITED STATES PATENT OFFICE

1,987,918

ELECTRICAL CONDUCTOR

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Application November 3, 1932, Serial No. 640,974
In Canada June 21, 1932

16 Claims. (Cl. 173—265)

This invention relates to electrical conductors and more particularly to that type of conductor in which the conducting wire is encased in and insulated from a metallic sheath and our object is to provide a conductor of this character in which the inductive capacity between the wire and sheath has been reduced to a minimum without danger of electrical contact between these parts.

We attain our objects by providing an insulation formed by one or more strands of paper wound on the conducting wire. Each strand comprises a plurality of strips of paper loosely twisted to provide a maximum air space throughout the insulation without danger of electrical contact being established between the wire and its sheath even when the conductor is bent around sharp corners. A rubber cover encases both ends of the insulation to exclude moisture therefrom. Each end of the conducting wire may extend through the cover or may be connected with a rubber covered terminal wire and these terminal wires together with a third terminal wire connected with the metallic sheath extend through the first mentioned rubber cover. The latter is vulcanized on the terminal wires or to the rubber covers thereof to form water tight joints at these outlet points.

The constructions are hereinafter more fully described and are illustrated in the accompanying drawings in which

Fig. 1 is a longitudinal section, partly broken away, of our conductor;

Fig. 2 a side elevation of a portion of the conductor which is broken away to show the interior parts;

Fig. 3 a side elevation of a strand showing the formation thereof;

Fig. 4 a cross section of the conductor;

Fig. 5 a longitudinal section, partly broken away;

Fig. 6 a longitudinal section of one end of another modified form of conductor;

Fig. 7 a longitudinal section, on an enlarged scale, of one end of another modified form of conductor;

Fig. 8 a longitudinal section of one end of a double conductor;

Fig. 9 a cross section of the conducting wires and insulations shown in Fig. 8; and

Fig. 10 a longitudinal section of one end of a modified form of double conductor.

1 is a conducting wire on which is wound an insulation 2 comprising one or more strands 2^a of paper, each strand being formed of one or

more strips 2^b of paper loosely twisted as shown in Fig. 3. Preferably each strand 2^a comprises three loosely twisted strips of paper 2^b and four of such strands are stranded on the wire 1 with their convolutions closely arranged so that substantially the entire surface of the wire is covered. This arrangement not only affords numerous air spaces throughout the strands and between adjacent strands but prevents the strands from shifting longitudinally on the wire which would result in the strands being bunched at one spot and the wire being bared at another spot. One or more flat strips 2^c of paper may be helically wound on the strand or strands 2^a to form a cylindrical casing around the strands and thus provide definite interstices for air between the strands and the casing formed by the strips 2^c.

A metallic sheath 3 which may be formed of braided wire is disposed on the casing formed by the strips 2^a. Between the sheath 3 and paper strips 2^c may be interposed a textile braid 4 for the purpose of preventing the strips from unravelling.

A rubber cover 5 is applied over the metallic sheath 3 and this cover is provided with extensions 5^a which extend over the ends of the insulation 2 to encase the latter and thus exclude moisture therefrom. To prevent any longitudinal displacement of the braided wire sheath 3 during the application of the rubber cover 5, a textile winding 8 is applied to the sheath before applying the rubber cover.

Any suitable moisture proof terminal connections such as those shown in the drawings, may be provided for the sheath 3 and the opposite ends of the wire 1. Rubber covered terminal wires may be connected with the opposite ends of the wire 1 and a third rubber covered terminal wire 7 may be connected with the metallic sheath 3 as shown in Fig. 1. All these terminal wires extend through the extensions 5^a of the rubber cover 5 which extensions are vulcanized to the rubber covers of the terminal wires 6 and 7 to hermetically seal the ends of the cover and prevent any access of moisture to the ends of the paper insulation. This insulation is formed of dry, unimpregnated paper which has a lower inductive capacity than paper impregnated with water proofing materials.

From this description it is obvious that the specific formation and arrangement of the insulation 2 will reduce the inductive capacity between the wire 1 and sheath 3 to a minimum and at the same time afford ample insulation

between these parts to prevent them from coming into contact with one another when the conductor is bent or curved on a small radius.

It is to be distinctly understood that the term "conducting wire" used throughout the specification and claims means either a single solid wire, a braided conductor, or a plurality of stranded wires forming a stranded conductor.

Referring to the modification shown in Fig. 5, it will be noted that the rubber cover 5 is encased, throughout its length between the sleeves 5^b, in a textile weatherproof casing 9, that the opposite ends of the conducting wire 1 extend through the sleeves 5^b and that an uncovered terminal 7^a is connected with the sheath 3. The sleeves are vulcanized on the wires and to the casing 9 and cover 5 to seal the ends of the latter. In preparing the ends of the conductor to receive the sleeves 5^b which in this case are separate from the rubber cover 5, the insulation 2, metallic sheath 3, textile winding 8, cover 5 and textile casing 9 are made shorter than the wire 1 or cut back from the ends thereof so that the wire will extend through the sleeves 5^b and beyond the outer ends thereof. Further, the winding 8, cover 5 and casing 9 are so cut away adjacent each end of the conductor that portions of the metallic sheath 3 and the cover 5 are temporarily uncovered. These uncovered portions are then encased by the sleeves, each sleeve 5^b being vulcanized to the cover 5 and to the end portion of the casing 9.

To ensure a tight fit between the sleeves 5^b and the terminal wires 1 and 7^a projecting therethrough, the outer ends of the sleeves are provided with tubular projections 5^c which are vulcanized on the wires. As these projections 5^c are much smaller in diameter than the sleeves 5^b they will not only adhere to the wires much better but will bend therewith and thus prevent openings being formed at the junctures of the wires and sleeves. The terminal wire 7^a corresponds to the hereinbefore described wire 7 and differs from the latter in that one is rubber covered and the other is bare.

In Fig. 6, the cover 5^d is applied to the casing 2^c of the insulation 2 and the metallic sheath 3^d is interposed between the cover 5^d and the casing 9. To prevent any longitudinal displacement of the casing 2^c during the application of the rubber cover 5^d, a textile winding 8^d is applied to the casing 2^c before applying the rubber cover. In this case, the ends of the sheath 3^d and casing 9 are so cut relative to one another that the sleeves 5^c may be vulcanized to the cover 5^d and casing 9 while in contact with the ends of the sheath 3^d and wires 1 and 7^a. The cover and sleeves thus hermetically seal the ends of the paper insulation 2, and the sleeves seal the ends of the sheath 3^d and casing 9 while the latter encases the sheath and protects the whole conductor between the sleeves. With this arrangement, the insulation between the conducting wire 1 and sheath 3^d and the surface area of the latter are increased.

Fig. 7 is an enlarged detail of the left hand end of the conductor shown in Fig. 5 and differs therefrom in that a terminal wire 7^b is connected with the left hand end of the sheath 3 and that the wires 7^b and 1^a are formed of stranded and braided wires respectively. To prevent moisture from reaching the insulation through the interstices in either of these types of wires, we fill the interstices with solder or the like, as indi-

cated at 7^c and 1^b, to make the wires solid for portions of their lengths between the ends of the insulation 2 and the ends of the sleeve projections 5^c. It is to be understood that the right hand end of the portion of the conductor in Fig. 7 may correspond to the left hand end shown therein and that in this case both ends of the sheath 3 may be provided with terminal wires 7^b.

For certain purposes, it is required to employ a plurality of shielded conducting wires 1 in addition to the terminal wires 7^a or 7^b at opposite ends of the sheath 3 or 3^d. Referring to Figs. 8, 9 and 10, two conducting wires 1 with their insulations 2 are twisted or stranded around one another to form the core of this conductor. That is to say, on each wire 1 is wound the hereinbefore described strand or strands 2^a of paper on which strand or strands are helically wound the flat strip or strips 2^c of paper to form a substantially cylindrical casing around the strands. These cylindrical casings 2^c are then twisted or stranded on one another and are covered by a paper wrapping 2^d which may be formed of one or more flat strips of paper helically wound round the stranded casings 2^c. As a means tending to overcome any tendency of the casings 2^c from closely following the contours of one another while being stranded on one another and thus tending to close the interstices for air between the convolutions of the strands 2^a and between the latter and the casings 2^c, the strand or strands 2^a on one wire 1 may be wound in one direction of rotation (see Fig. 2) and the strand or strands 2^a on the other wire 1 will be wound in the other direction of rotation. If it be desired to make the cross sectional contour of the wrapping 2^d circular throughout its length, fillers 2^e could be stranded with the casings 2^c to round out the latter while the wrapping 2^d is applied thereto. These fillers may be formed similar to the strands 2^a.

In Fig. 8, the metallic sheath 3 is disposed on the wrapping 2^d and the winding 8, cover 5, textile weatherproof casing 9 and sleeves 5^b are applied as shown in Fig. 5 and hereinbefore described.

In Fig. 10, the cover 5^d is disposed on the wrapping 2^d and the metallic sheath 3, winding 8, textile weatherproof casing 9 and sleeves 5^c are applied as shown in Fig. 6 and hereinbefore described.

It will be noted that in all cases the construction of the insulation is substantially the same and that the rubber cover 5 or 5^a is provided with extensions 5^a or with sleeves 5^b or 5^c forming extensions of the cover to hermetically seal the ends of the paper insulation 2. When the textile winding 8 or 8^d is used, it will be noted that it is always interposed between the rubber cover 5 or 5^d and the part of the conductor it is desired to cover so that the cover may be applied by an extruding machine without danger of the said part being displaced longitudinally as it is drawn through the dies.

What we claim as our invention is:

1. An electrical conductor comprising a conducting wire; an insulation comprising a strip of paper twisted into a strand wound on the wire; a metallic sheath; and a rubber cover, the sheath and cover encasing the insulation, the cover encasing both ends of the paper insulation.

2. An electrical conductor comprising a conducting wire; a flexible insulation having a low

inductive capacity applied to the wire; a metallic sheath; a rubber cover, the sheath and cover encasing the insulation, the cover encasing both ends of the insulation; and three rubber covered terminal wires, one being connected with each end of the conducting wire and one with the metallic sheath, the terminal wires extending through the first mentioned cover and the latter being vulcanized to the rubber covers of the terminal wires.

3. An electrical conductor comprising a conducting wire; an insulation comprising a plurality of strips of paper twisted into a strand wound on the wire; a metallic sheath; and a rubber cover, the sheath and cover encasing the insulation, the cover encasing both ends of the paper insulation.

4. An electrical conductor comprising a conducting wire; an insulation comprising a plurality of strands of paper stranded on the wire, each strand comprising a strip of paper loosely twisted; a metallic sheath; and a rubber cover, the sheath and cover encasing the insulation, the cover encasing both ends of the paper insulation.

5. An electrical conductor comprising a conducting wire; an insulation comprising a plurality of strands of paper stranded on the wire, each strand comprising a plurality of strips of paper loosely twisted; a metallic sheath; and a rubber cover, the sheath and cover encasing the insulation, the cover encasing both ends of the paper insulation.

6. An electrical conductor comprising a conducting wire; an insulation comprising a strip of paper twisted into a strand wound on the wire; a flat strip of paper helically wound on the strand of paper; a metallic sheath; and a rubber cover, the sheath and cover encasing the insulation, the cover encasing both ends of the paper insulation.

7. An electrical conductor comprising a conducting wire; an insulation comprising a strip of paper twisted into a strand wound closely on the wire to substantially cover the entire surface thereof; a metallic sheath; and a rubber cover, the sheath and cover encasing the insulation, the cover encasing both ends of the paper insulation.

8. An electrical conductor comprising a conducting wire; an insulation comprising a plurality of strips of paper twisted into a strand wound closely on the wire to substantially cover the entire surface thereof; a metallic sheath; and a rubber cover, the sheath and cover encasing the insulation, the cover encasing both ends of the paper insulation.

9. An electrical conductor comprising a conducting wire; an insulation comprising a plurality of strands of paper stranded on the wire, the strands being adapted to substantially surround the entire surface of the wire and each strand comprising a plurality of strips of paper loosely twisted; a metallic sheath; and a rubber cover, the sheath and cover encasing the insulation, the cover encasing both ends of the paper insulation.

10. An electrical conductor comprising a conducting wire; an insulation comprising a plurality of strands of paper stranded on the wire, the strands being adapted to substantially surround the entire surface of the wire and each

strand comprising a plurality of strips of paper loosely twisted; a metallic sheath; and a rubber cover, the sheath and cover encasing the insulation, the cover encasing both ends of the paper insulation; and three rubber covered terminal wires, one being connected with each end of the conducting wire and one with the metallic sheath, the terminal wires extending through the first mentioned cover and the latter being vulcanized to the rubber covers of the terminal wires.

11. An electrical conductor comprising a conducting wire; an insulation comprising a plurality of strands of paper stranded on the wire, each strand comprising a plurality of strips of paper loosely twisted; a metallic sheath; a rubber cover, the sheath and cover encasing the insulation, the cover encasing both ends of the paper insulation; and terminal wires leading from the metallic sheath and each end of the conducting wire through the cover, the latter having a moisture proof connection with the wires.

12. An electrical conductor comprising a conducting wire; an insulation comprising a plurality of strands of paper stranded on the wire, each strand comprising a plurality of strips of paper loosely twisted; a flat strip of paper helically wound on the strand of paper; a textile braid disposed on the insulation; a metallic braid disposed on the textile braid; and a rubber cover encasing the metallic braid and both ends of the paper insulation.

13. An electrical conductor comprising a conducting wire; an insulation comprising a strip of paper twisted into a strand wound on the wire; a metallic braid disposed on the insulation; a textile winding disposed on the metallic braid; and a rubber cover encasing the textile winding and both ends of the paper insulation.

14. An electrical conductor comprising a conducting wire; an insulation comprising a plurality of strands of paper stranded on the wire, each strand comprising a plurality of strips of paper loosely twisted; a flat strip of paper helically wound on the strand of paper; a textile braid disposed on the insulation; a metallic braid disposed on the textile braid; a textile winding disposed on the metallic braid; and a rubber cover encasing the textile winding and both ends of the paper insulation.

15. An electrical conductor comprising a conducting wire; a dry insulation disposed on the wire; a metallic sheath; a rubber cover, the sheath and cover encasing the insulation; a textile casing encasing the sheath and cover, the conducting wire having its ends projecting beyond the ends of the insulation, sheath, cover, and casing, the ends of the cover projecting beyond the ends of the textile casing; a terminal wire connected with the metallic sheath; and rubber sleeves surrounding the wires, the ends of the cover and the insulation and vulcanized to the cover to seal both ends of the insulation.

16. An electrical conductor constructed as set forth in claim 15 in which the outer ends of the sleeves are provided with tubular projections vulcanized on the wires, the said projections being smaller in diameter than the sleeves.

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