(No Model.)

J. C. REILLY.

ELECTRIC CABLE.

No. 445,234. Patented Jan. 27, 1891.

Fig. 1.

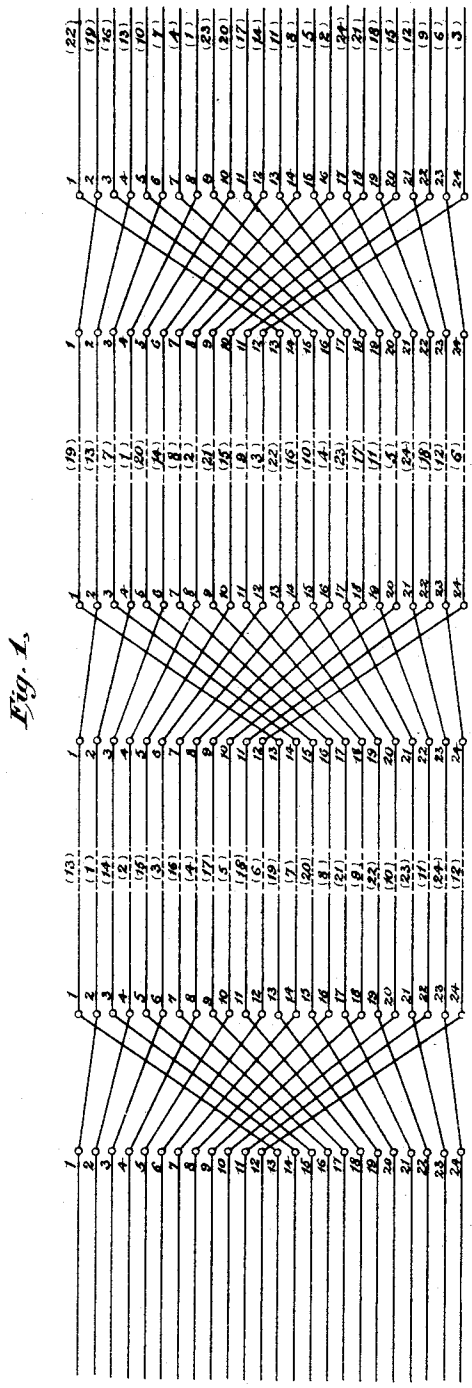


Fig. 2.

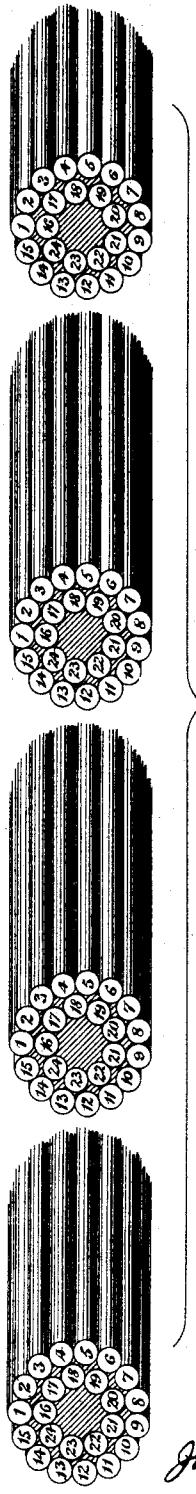


Fig. 3.



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UNITED STATES PATENT OFFICE.

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ELECTRIC CABLE.

SPECIFICATION forming part of Letters Patent No. 445,234, dated January 27, 1891.

Application filed May 20, 1890. Serial No. 352,448. (No model.)

To all whom it may concern:

Be it known that I, JOHN C. REILLY, a citizen of the United States, and a resident of Brooklyn, in the county of Kings and State of New York, have invented certain new and useful Improvements in Electric Cables, of which the following is a specification.

My invention is an improvement in the method of constructing or arranging an electric cable whereby the evil effects of dynamic induction in parallel and adjacent conductors is obviated.

The practice of my improved method results in the production of a cable in which the several conductors are systematically and regularly displaced as regards the contiguous parallelism of any given pair, and the cable resulting from the practice of my improved method is a cable in which the contiguous parallism of any two adjacent conductors is reduced in extent and effect to a minimum.

In practicing my method of arranging cabled conductors I take a number of insulated conductors and arrange them compactly in concentric rows. I then apply some suitable sheathing and assign a number, as an arbitrary designation, to each conductor. Beginning with one of the conductors in the outermost row, I number it 1. I then continue with each successive conductor consecutively, numbering each and every one in the outermost row. Then beginning with the next inner row, and so on till all are numbered. I then divide the entire cable into longitudinal sections and lay the sections out successively end to end. I then connect the conductors of one section to those of the next succeeding section in the following manner: In order to determine the number of the conductor in the succeeding section with which the conductor to be transposed is to be connected, I multiply the number of the conductor to be transposed by two, and the product is the number of the conductor in the next succeeding section to which said conductor is to be connected. When this product exceeds the number of conductors to be transposed, I divide the said product by one plus the total number of conductors to be transposed, obtaining a whole number and a fraction for the quotient. The numerator for this fractional part of the quotient is now substituted for the number assigned to the conductor to be transpssed, and when multiplied by two the product indicates the number of the conductor with which connection must be made in the next succeeding section, and I again proceed as before. Whenever the product arising from multiplying by two exceeds the total number of conductors, I divide by one plus the total number of conductors and take the numerator of the fractional part of the quotient for a new factor to be multiplied by two, and so on indefinitely, or until the number of longitudinal sections into which the cable is divided is reached. This operation may be concisely and accurately stated in an algebraic formula or equation as follows: Let c equal the number assigned to the location of the conductor in any given section of cable, b equal the multiplication factor employed, m equal the total number of conductors to be transposed, n equal the numerator of the fractional part of the quotient derived from the equation

$$= \frac{cb}{1+m} \qquad = a + \frac{n}{1+m}$$

a equals the integral number of times $1+m$ is contained in the product of $c\ b$. Then, whenever $c\ b$ exceeds m, n must be substituted for c.

The accompanying drawings illustrate my invention.

Figure 1 shows a series of lengths of cable with the connections between successive lengths arranged according to my method. Fig. 2 shows the concentrically-arranged cabled conductors divided into lengths diagrammatically shown in Fig. 1, and Fig. 3 is a modification in which the conductors are laid up in twisted pairs.

The cable, divided into a series of lengths, is shown in Fig. 2. I have selected a cable containing twenty-four insulated conductors for the purpose of illustration. In practice a mile of such cable would be divided into, say, ten sections. Each insulated conductor is provided with an arbitrary numerical designation, beginning with 1 and terminating with 24, in regular succession.

The diagram Fig. 1 shows three sets of numerical designations. The arbitrary desig-

nation of the conductors is shown at both terminals of each section, and each of the conductors of the first section is indicated in its transposed position by a numeral in parenthesis at or near the center of the section. No two conductors occupy the same relative position in any two longitudinal sections, the transposition being in every case shown in accordance with the operation of my method of transposition. To illustrate, take conductor 2 in section one and follow the transpositions and apply the formula above given. In the case of cables having conductors laid up, either singly or in twisted pairs, the multiplication factor is two. We are transposing conductor 2. To find the number of the conductor in the next succeeding section with which it is to be connected, we multiply two by two equals four, so that conductor 4 of section two is the one to which it is to be connected. To find the number of the conductor in the third section, we multiply four by two equals eight, which is the number of the conductor in the third section with which it is to be connected. So for the fourth section we say two times eight is sixteen, and conductor 16 is the one with which said conductor is connected in the next succeeding section. Now if we continued this multiplication a section further we should have two times sixteen is thirty-two; but there are only twenty-four conductors in the cable. We therefore modify the formula by dividing thirty-two by twenty-four plus one equals twenty-five. The quotient of thirty-two divided by twenty-five is one and seven twenty-fifths, and the numerator of this fractional part of the quotient indicates the number of the conductor to which it is to be connected in the next or fifth section of the cable. This may also be shown by taking a conductor in the first section having a number so great that when multiplied by two it will exceed the total number of conductors in the cable. Let us take conductor 17 of the first section and follow it through the successive sections, applying the formula seventeen multiplied by two is thirty-four and twenty-four plus one is twenty-five. Divide thirty-four by twenty-five and we have one and nine twenty-fifths. The numerator of the fractional part of the quotient is nine, and nine is the number of the conductor in section 2 with which it is connected. Multiply nine by two equals eighteen, the number of the conductor in the third section. Eighteen times two is thirty-six, divided by twenty-five equals one and eleven twenty-fifths. Eleven is the number of the conductor in the fourth section with which said conductor 17 is connected, and so on.

Generally speaking, the greater the number of conductors in the cable the greater number of sections you can divide the cable into without bringing the same pair of conductors into the same relative position a second time.

When the conductors are laid up singly, as in Fig. 2, or in pairs, as in Fig. 3, the multiplication factor is two, the pairs being treated as strands of one conductor, to which you assign a single arbitrary designation; but if the conductors are laid up in fours or double pairs a different multiplication factor can be employed with greater advantage, although my method, herein shown and described, would be applicable to such an arrangement.

It will thus be seen that my improved method furnishes a regular and uniform transposition at the junction of any two sections, and the practice of my improved method furnishes a cable having the conductor so arranged that the contiguous parallelism of any two conductors is reduced in extent and effect to a minimum.

What I claim, and desire to secure by Letters Patent, is—

The method herein described of constructing electric cables, which consists in insulating a series of conductors, arranging them in concentric rows, applying a suitable sheathing, dividing them into a series of longitudinal sections, arbitrarily designating the terminals of each conductor of each section in regular succession with consecutive numerals, and then connecting each conductor of one section to a conductor of the next succeeding section by the formula $c\,b$ unless and until $c\,b$ exceeds m, when n is substituted for c, substantially as described.

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