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J. C. BURLEY

2,416,979

ELECTRIC CABLE

Filed April 27, 1943

Fig. 1.

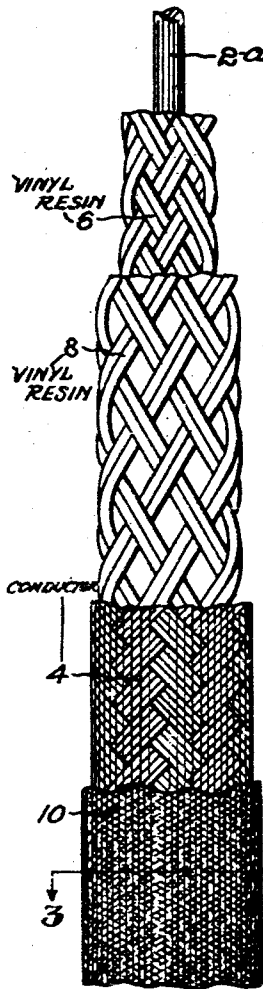


Fig. 2.

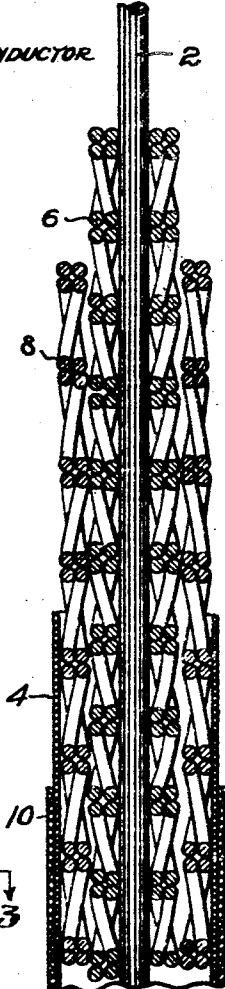


Fig. 4.

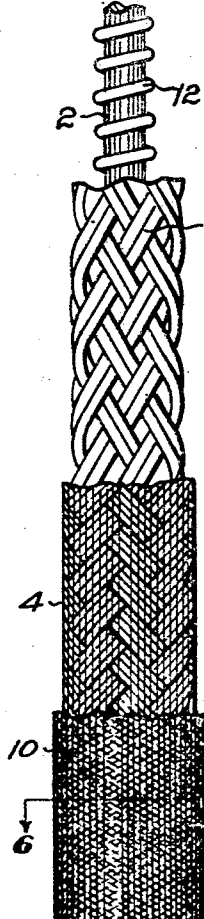


Fig. 5.

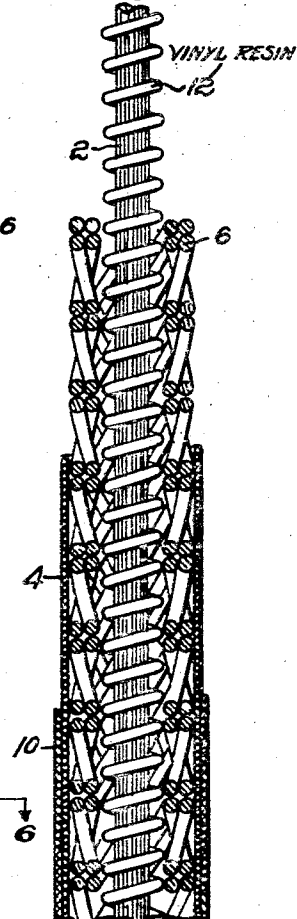


Fig. 3.

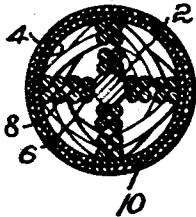


Fig. 7.

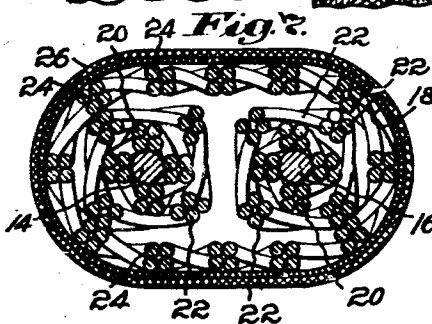
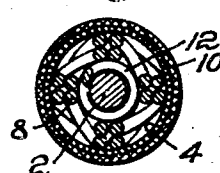


Fig. 6.



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UNITED STATES PATENT OFFICE

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ELECTRIC CABLE

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7 Claims. (Cl. 174-29)

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This invention relates to electric cables.

The invention and its aims and objects will be readily understood from the following description, taken in connection with the accompanying drawing, of embodiments of the invention herein given for illustrative purposes.

In the drawing:

Fig. 1 shows one illustrative embodiment of the invention in its application to dual conductor coaxial cables;

Fig. 2 is a longitudinal section of Fig. 1;

Fig. 3 is a cross section on line 3-3 of Fig. 1;

Fig. 4 shows another illustrative embodiment of the invention in its application to dual conductor coaxial cables;

Fig. 5 is a longitudinal section of Fig. 4;

Fig. 6 is a cross section on line 6-6 of Fig. 4, and

Fig. 7 is a cross section of an illustrative embodiment of the invention in its application to multiple conductor cables.

The illustrative embodiment of the invention shown in Fig. 1 comprises a substantially central conductor 2 surrounded by a tubular conductor 4 which may be substantially coaxial with said conductor 2. Said conductor 4 herein illustratively consists of metal wire braid. These two conductors 2 and 4 are separated by an air space insulation. To this end said conductor 2 is surrounded by an insulating covering of braided material possessing the desirable physical and electrical properties. Said insulating covering may comprise one or more layers or sheets superimposed one upon another. In the illustrative embodiment of the invention shown in Fig. 1 two such layers 6 and 8 are provided. The numerous points of contact of the filaments or threads of the braided material with the conductors 2 and 4 are sufficiently close to one another to maintain said two conductors adequately spaced from each other, and to preclude any contact of said two conductors with each other, no matter how sharply the cable may be flexed or bent. The design and character of the braided covering allows a considerable portion of the cross-sectional area between said conductors to be air, and this fact, in conjunction with the numerous contacts of the filaments provides a very efficient low loss insulation.

This invention is superior in one respect or another to low loss insulation heretofore used, consisting of solid paper or other wrappings, or rubber or rubberlike compounds, solidly covering the conductor, or of rigid aligned insulating elements of beads or discs or the like placed upon

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the conductor. It will be understood that in the case of paper wrappings and rubber insulations, the low loss factor is primarily governed by the properties of the material, with a very small, if any, inclusion of air in the cross-section.

On the other hand while the spaced discs include a large portion of air, they are generally used for rigid coaxial cables, and are not satisfactory for flexible coaxial cables. While the cable using small beads provides greater flexibility owing to the increased number of smaller elements, said cable is more costly to produce and includes less and less air. In the present construction, on the contrary, the flexibility is still greater, being uninterrupted throughout the length of the cable, and the spacing of the two conductors remains substantially uniform.

The cable will preferably be provided with an outer protective sheath 10 of any suitable conventional material and construction, such as moisture-resisting cotton braid, for example.

In the illustrative embodiment of the invention shown in Figs. 4, 5 and 6, one of the layers or sheets of insulating braided material shown in Figs. 1, 2 and 3 is omitted and is replaced by a filament 12 helically wound upon the central conductor 2 and consisting of material having physical and electric properties similar to those possessed by said braided material. In general it will be found convenient to make the braided material and said filament 12 of the same insulating material although by no means necessary. It will be seen that this modification provides additional air space insulation next to the conductor without materially increasing the bulk and without sacrificing flexibility. The advantage of this combination of coverings over the single spiral can be readily seen when the cable is bent sharply, for in the latter case the wide openings in the outer portion of the bent helical spiral would alone offer no support for the outer tubular conductor.

In the illustrative embodiment of the invention shown in Fig. 7 three conductors 14, 16 and 18 are provided. Each of the conductors 14 and 16 is surrounded by an air space insulation comprising preferably two layers or sheets 20 and 22 of said insulating braided material and these are in turn surrounded by a further air space insulation including a layer 24 of said braided material. The conductor 18 surrounds said insulating layer 24 and is in turn surrounded by any suitable, conventional protective insulating sheath 26, which may be similar to the sheath 10 of Fig. 1.

The present invention contemplates the use of any suitable material for the construction of the braided material constituting the aforesaid layers 6, 8, 20, 22 and 24 and the filament 12. There are many factors to be taken into consideration in determining a suitable material. From the point of view of braiding it is desirable to have strong, pliable, threadlike material, such that it can be satisfactorily braided on the present day braiding machines generally used in wire manufacture.

From the electrical standpoint it is desirable to have a low dielectric constant and high electrical resistance, so that the cable will have low capacity and small loss angle. Another desirable feature is low water absorption such that the material will not be affected by high humidity conditions. For this reason it is desirable that the material be as non hygroscopic as is feasible. Another factor is a certain amount of rigidity or springiness in the material in order that air spaces will be formed between the braided strands instead of braiding these closely together as would be the case if soft cotton thread or twine were used.

Considering all of the above, I preferably use plastics as a very suitable material as these possess the desired physical and electrical properties. There are many variations in the different types of plastics, such that some are more suitable than others. This is true of plastic material of the groups comprising (1) cellulose derivatives, particularly cellulose aceto-butyrate; (2) vinyl resins plastics, more particularly vinylidene chloride; (3) polystyrenes, more particularly polystyrene and polystyrol.

As compared to cables heretofore used, cables embodying the present invention possess other advantages in addition to those previously referred to. Small diameter low loss cables are required for high frequency applications having a high degree of flexibility, to be twisted in and about apparatus, in particular radar equipment. Cables embodying the present invention are ideally suited for this service as no reasonable amount of bending will impair the good properties they possess as coaxial cables. Furthermore, they will stand the continued vibration and jarring to which they are often subjected in service, with no signs of failure. Beaded cables are not suited for sharp bending, and constant vibration wears the surfaces and causes fracture of the insulating elements. Only rubberlike compounds possess equally good flexing and abrasion-resisting properties, but these have other characteristics which seriously impair their value, such as cold flow distortion of shape and position, and in addition the dielectric constant of the material is at present limited to about 2.6.

In evaluating low loss cables, it should be recognized that a material may be used with a relatively high dielectric constant, such as ceramic at 5 for example, or a plastic at 6, which, by proper design in keeping the air space to a maximum and placing the minimum amount of material next to the conductor, will possess lower loss factors than a solid dielectric of 2.6. I calculate this for complex cable constructions and term the result "equivalent specific inductive capacity" although in reality it is the dielectric constant of what a solid dielectric would have on a cable having the electrical properties as measured. This value varies with different sizes of cable, but given a certain size conductor and shield, it is a direct comparison of the low loss

features of various constructions of coaxial cable. Thus, a certain shaped ceramic bead might be 2.0 and a similar polystyrene bead might be 1.4 but the value of the braided cable of my invention runs about 1.8. Different modifications, however, of my invention give different values and it is not necessary to list here all the possibilities that this invention covers. Suffice it to say that different braid constructions and different materials may be combined in various layers to give a great variety of electrical and mechanical characteristics to make suitable and excellent coaxial cables.

It will be apparent that cables herein shown can be spirally cabled together to form multiple conductor cables having any number and types of conductors desired.

I am aware that the present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof, and I therefore desire the present embodiments of said invention to be considered in all respects as illustrative and not restrictive, reference being had to the appended claims rather than to the foregoing description to indicate the scope of the invention.

I claim:

1. An electric cable having low capacity and small loss angle, comprising a wire conductor; a tubular stranded flexible conductor surrounding said wire conductor and co-axial therewith; and insulating spacing means separating said two conductors and comprising a spacing helix wound upon the wire conductor and an insulating, open braided covering surrounding and supported by said helix, said helix and said braided covering being each composed of polystyrene, the dielectric between the conductors consisting largely of air.

2. An electric cable having low capacity and small loss angle, comprising a wire conductor; a tubular braided flexible conductor surrounding said wire conductor and co-axial therewith; and insulating spacing means separating said two conductors and comprising two insulating open braided sleeves surrounding said wire conductor and composed of vinyl resin plastic, whereby the dielectric between said conductors consists largely of air.

3. An electric cable having low capacity and small loss angle, comprising a wire conductor; a tubular woven flexible conductor surrounding said wire conductor and co-axial therewith; and insulating spacing means separating said two conductors and comprising two insulating open braided sleeves surrounding said wire conductor and composed of polystyrene, whereby the dielectric between said conductors consists largely of air.

4. An electric cable having low capacity and low loss angle, comprising a wire conductor; a tubular braided flexible conductor surrounding said wire conductor; and insulating spacing means separating said two conductors and comprising two insulating layers surrounding said wire conductor, at least the outer layer constituting an open braided sleeve surrounding said wire conductor and composed of vinyl resin plastic, whereby the dielectric between said conductors consists largely of air.

5. An electric cable, as set forth in claim 4, wherein said open braided sleeve is composed of polystyrene.

6. An electric cable having low capacity and low loss angle, comprising two parallel wire con-

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ductors; a tubular braided flexible conductor surrounding both of said wire conductors; and insulating spacing means separating the two wire conductors from each other and from the tubular conductor and comprising at least one open braided sleeve surrounding each wire conductor and an open braided sleeve surrounding the sleeves on both wire conductors and all composed of vinyl resin plastic, whereby the dielectric between all of the conductors is composed largely of air.

7. An electric cable, as set forth in claim 6, wherein all of said open braided sleeves are composed of polystyrene.

JOSEPH C. BURLEY. 15

Number	Name	Date
1,987,442	Harris -----	Jan. 8, 1935
2,116,268	Klimmer -----	May 3, 1938
2,116,267	Klimmer -----	May 3, 1938
2,197,616	Lehne -----	Apr. 16, 1940
2,253,967	Carl -----	Aug. 26, 1941

6

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Country	Date
476,110	British -----	Nov. 29, 1937
360,743	Italian -----	July 5, 1938
776 017	French -----	Oct. 22, 1934