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FLEXIBLE WAVE GUIDE FOR ULTRA HIGH FREQUENCY ENERGY

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Fig. 1

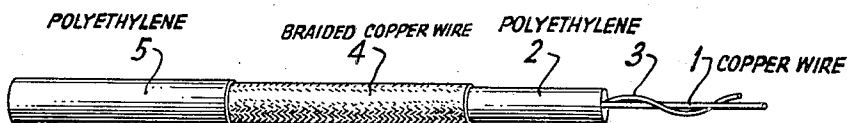
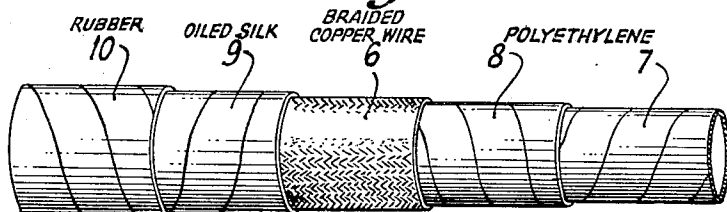


Fig. 2



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FLEXIBLE WAVE GUIDE FOR ULTRA HIGH
FREQUENCY ENERGY

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This invention relates to the transmission of electrical energy by electric cables of the concentric line type comprising an inner conductor held in spaced relationship with respect to a surrounding tubular conductor, and electric wave guides in the form of hollow conductors along which electric waves radiated from a source (such as a dipole aerial) can be propagated, and to systems embodying such cables and wave guides.

The outer tubular conductor of a concentric cable sometimes comprises a lead sheath, but such a cable is not found to be satisfactory where flexibility is desired, since although a certain degree of flexibility is inherent in the cable, nevertheless, if the cable is bent the tubular conductor not infrequently becomes distorted with the result that the characteristic of the cable is impaired to such an extent as to render the cable unsuitable for use at ultra high frequencies corresponding to centimetre wavelengths.

In order to improve the flexibility of concentric cables, a fabricated tubular conductor of woven wire is sometimes employed, but such a construction is not altogether satisfactory at ultra high frequencies on account of the imperfect contact between said wires, which causes losses due to circulating currents. In the following specification and claims what is meant by the term "ultra high frequency energy" is energy at wavelengths up to about 20 centimetres.

The object of the present invention is to enable ultra high frequency energy to be transmitted along a hollow conductor possessing qualities of flexibility and absence of mechanical distortion upon bending and which may serve as an outer conductor of a concentric cable, or as a wave guide without undue energy losses.

One feature of the present invention consists in the use in a system for the transmission of ultra high frequency energy of a hollow conductor forming a wave guide or the outer conductor of a concentric cable for the transmission of said energy, said hollow conductor being composed of a woven or braided structure of sheath form comprising strands or strips wherein most or all of the individual strands or strips, or collective assemblies of strands or strips, are insulated from each other in order to reduce ultra high frequency energy losses.

According to another feature of the invention, a high frequency wave guide for the transmission of ultra high frequency energy consists of a single hollow conductor in the form of a woven or braided structure composed of strands or strips, and wherein most or all of the individual

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strands or strips, or collective assemblies of strands or strips, are insulated from each other in order to reduce ultra high frequency energy losses, said woven or braided structure being supported upon a flexible member of insulating material of low energy loss at ultra high frequencies, and which permits the wave guide to be bent without deleterious deformation of the cross-sectional form of the guide.

According to a further feature of the invention, a concentric cable for the transmission of ultra high frequency energy as hereinbefore defined is provided with an outer conductor consisting of a woven or braided structure of sheath form composed of strands or strips, most or all of the strands or strips or collective assemblies of strands or strips being insulated from each other in order in operation to reduce energy losses at ultra high frequencies, said outer conductor being supported by a continuous sheath of insulating material, known as polyethylene.

It has been proposed to compose high-frequency conductors of woven or braided wires, and to insulate the individual wires from each other. In particular in the specification of British Patent No. 352,011 it has been proposed to construct the inner and outer conductor of a concentric cable of a large number of relatively small wires each insulated from the other in some suitable manner as, for instance, by coating the wire with an insulating enamel, the wires being braided together. The insulation of the separate wires from each other is said to reduce the skin effect at high frequencies. The transmission of television signal frequencies by concentric conductors is referred to in the British patent, but no reference is made to ultra high frequencies. At such ultra high frequencies it is found that energy losses occur mainly as a result of the setting up of local circulating currents between individual braided conductors, unless these conductors are insulated from each other; and the present invention is therefore not concerned with reduction of the skin effect, but with reduction of energy losses due to local circulating currents in the braided conductor or guide.

It is found that by insulating the strands or strips forming the sheath conductor, circulating currents therein are eliminated and losses due to such currents are prevented. Further, by weaving or braiding the insulating strands together they may be held sufficiently close to prevent any substantial leakage of flux which would cause losses even when the sheath conductor is flexed.

In order that the invention may be more clearly understood and readily carried into effect, one form of concentric cable and one form of wave guide, each provided with a sheath conductor according to the invention, will now be described in greater detail by way of example with reference to Figs. 1 and 2 respectively, of the accompanying drawings.

Referring to Fig. 1 of the drawings, the concentric cable there diagrammatically shown, consists of an inner conductor 1 of drawn copper wire of 18 S. W. G. which is held centrally of a sheath 2 of insulating material (known as polyethylene) by a thread 3 of the same material, and the outer conductor consists of a braided sheath 4 composed of strands of copper wire of 38 S. W. G., the individual strands being insulated from each other by enamelling or shellac. The outer protective covering of the cable consists of a sheath 5 of polyethylene.

Since the cable is especially suitable for use at centimetre wavelengths, it is important that the insulating materials employed should be of low loss at such wavelengths. The material polyethylene has been selected for the purposes described as it combines the advantages of good insulating qualities with low energy loss at high frequencies and flexibility, although mechanically strong. It is also durably resistive to weather conditions.

The inner conductor 1 of the cable may be of any suitable form and may be held in spaced relationship from the sheath 4 in any other suitable manner known in the art. For example, the central conductor may be maintained in spaced relationship with respect to the conducting sheath 4 by providing a wrapping of insulating material around the central conductor, the wrapping being composed of any suitable material such as a length of string impregnated with an insulating material wound around the central conductor with a long pitch, in the manner illustrated by the thread of polyethylene 3 in Fig. 1.

While it has been stated that the individual strands composing the conducting sheath 4 are insulated by enamelling or shellac, they may be covered with cotton or other suitable insulating material. The weaving of the strands is preferably effected so that each strand lies with respect to the central conductor with a long pitch. While as shown the braided sheath is composed of sets of single conductors, individually insulated, a number of conductors may be twisted together and then insulated as a whole, assemblies of stranded conductors insulated in this manner then being woven to form the conducting sheath.

Although the strands are preferably circular in cross-section, they may, if desired, be in the form of substantially flat strips or tapes. If desired, two or more conducting sheaths may be provided, one enclosing the other.

Referring to Fig. 2 of the drawings, the wave guide shown consists of a braided conducting sheath 6 which is made in a manner similar to the conducting sheath 4 shown in Fig. 1, but is of larger diameter. The principal mechanical support for the sheath 6 consists of a tube 7 of polyethylene, which is made by winding a strip of this material into tubular form. In order to prevent the sheath 6 from sagging in gaps which may be formed between abutting edges of the wound strip of polyethylene, a layer 8 of thinner strip polyethylene is wound upon the base 7. The outer surface of the conducting sheath 6 is protected firstly by a layer 9 of oiled silk or simi-

lar material of strip form, and wound upon this again is a substantial protective covering 10 of rubber in strip form which is wound to a desired thickness.

The diameter of the conducting sheath 6 will be determined by the frequency and type of the radiation that it is desired to propagate, and also it will depend upon the dielectric constant of the insulating material employed to support the sheath. In a practical construction the external diameter may be 4 centimetres, the sheath 6 being constructed of strands of copper wire of 38 S. W. G. enamelled and closely braided around the supporting tube of polyethylene.

A wave guide of the form shown in Fig. 2 may be flexed without introducing undesirable distortion of the cross-sectional form of the conducting sheath 6, and undesirable effects which would otherwise occur are therefore avoided. If the tube 7 does not combine mechanical strength with flexibility to the degree desired to avoid collapse when flexed, measures may be adopted to increase the degree of support.

In order to reduce losses which might arise due to the presence of the insulating material, the minimum amount of such material should be employed consistent with the requisite mechanical strength.

What I claim is:

1. A flexible wave guide for the transmission of ultra high frequency energy comprising a single hollow conductor, said hollow conductor being composed of a plurality of conductive strands braided and individually insulated from one another in order to reduce ultra high frequency losses, a layer of oiled silk surrounding said hollow conductor, and a flexible strip of insulating material of low energy loss at ultra high frequency, said flexible strip being wound into a tubular form and located inside said hollow conductor for supporting it.

2. A flexible wave guide for the transmission of ultra high frequency energy comprising a single hollow conductor, said hollow conductor being composed of a plurality of conductive strands braided and individually insulated from one another in order to reduce ultra high frequency losses, a layer of oiled silk surrounding said hollow conductor, a protective coating of rubber surrounding said layer of oiled silk, and a flexible strip in the form of a strip of insulating material of low energy loss at ultra high frequency, said flexible strip being wound into a tubular form and located inside said hollow conductor for supporting it.

3. A flexible wave guide for the transmission of ultra high frequency energy comprising a single hollow conductor, said hollow conductor being composed of a plurality of conductive strands braided and individually insulated from one another in order to reduce ultra high frequency losses, a layer of oiled silk surrounding said hollow conductor, and two layers of flexible insulating strips wound into a tubular member forming a continuous sheath of low energy loss at ultra high frequency located inside said hollow conductor for supporting it.

4. A flexible wave guide for the transmission of ultra high frequency energy comprising a single hollow conductor, said hollow conductor being composed of a plurality of conductive strands braided and individually insulated from one another in order to reduce ultra high frequency losses, a layer of oiled silk surrounding said hollow conductor, a protective coating of rubber sur-

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rounding said layer of oiled silk, and two layers of flexible insulating strips wound into a tubular member forming a continuous sheath of low energy loss at ultra high frequency located inside said hollow conductor for supporting it.

5. A flexible wave guide for the transmission of ultra high frequencies up to about 20 centimeters, comprising an insulating tube formed by an insulating strip being wound into a tubular form, a second insulating strip wound over said first insulating strip in an opposite direction from the winding of said first strip, a braided conductive sheath, each strand of said conductive sheath being insulated and supported by said insulating tube, a third insulating strip wound over said braided conductive sheath in the same direction as said first mentioned insulating strip, and a rubber strip wound over said third insulating strip in the same direction as said second mentioned insulating strip.

6. A flexible wave guide for the transmission of ultra high frequencies up to about 20 centimeters, comprising an insulating tube formed by a first insulating strip being wound into a tubular form, a second insulating strip which is thinner than said first mentioned insulating strip and wound over said first insulating strip in an opposite direction from the winding of said first strip, a braided conductive sheath of stranded copper wire having an external diameter of about 4 centimeters, each strand of said copper wire being insulated and supported by said insulating tube, a third insulating strip wound over said braided conductive sheath in the same direction as said first mentioned insulating strip, and a rubber strip wound

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over said third insulating strip in the same direction as said second mentioned insulating strip.

7. A flexible wave guide for the transmission of ultra high frequencies, comprising an insulating tube formed by an insulating strip being wound into a tubular form, a second insulating strip wound over said first insulating strip in an opposite direction from the winding of said first strip, a braided conductive sheath, each strand of said conductive sheath being insulated and supported by said insulating tube, a third insulating strip wound over said braided conductive sheath in the same direction as said first mentioned insulating strip, and a protective strip wound over said third insulating strip in the same direction as said second mentioned insulating strip.

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