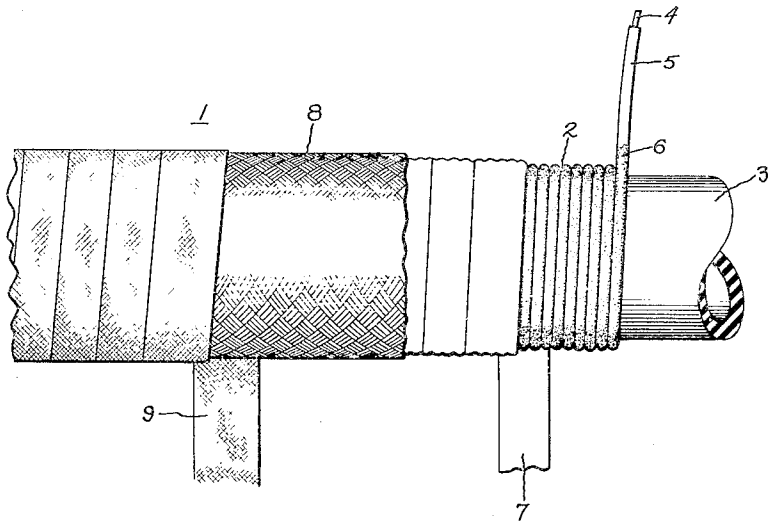
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DELAY TRANSMISSION LINE

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DELAY TRANSMISSION LINE

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My invention relates to transmission systems of high frequency energy and has for its object to provide an improved transmission line for obtaining a desired delay in the transmission of such energy. In the copending application of John H. Rubel and Roy E. Troell, Serial No. 498,380, filed August 12, 1943, now Patent No. 2,467,857, issued April 19, 1949, there is disclosed a delay transmission line comprising an insulated conductor which is formed into a helical coil of closely wound turns and is closely surrounded by a layer of small insulated wires, which are braided together throughout their length, to form a section of transmission line having a low velocity of propagation for high frequency currents.

It is an object of my invention to provide an improved transmission line of this type in which the distortion in phase of currents transmitted over the line is reduced.

It is a still further object of my invention to provide a new and improved transmission line over which currents varying over a large range of high frequencies may be transmitted with a low velocity of propagation and with a minimum amount of phase distortion.

One of the features of my invention is the use, in an artificial transmission line having an insulated conductor formed into a helical coil and surrounded by a layer of small insulated wires, of a layer of insulated metallic particles between the coil and the layer of wires to reduce the phase distortion of currents transmitted over the line and to improve the resultant shape of pulses of current transmitted over the line.

The features of my invention which I believe to be novel are pointed out with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation together with further objects and advantages thereof may best be understood by reference to the following description taken in connection with the accompanying drawing in which the single figure shows a portion of the transmission line, partly in section, of my invention.

Referring to the drawing, I have shown the transmission line 1 as comprising a closely coiled insulated conductor 2 wound on a supporting insulator 3. The conductor forming the coil 2 preferably comprises a solid wire 4 covered with a thin layer of dielectric 5 of any suitable material, such as enamel. The insulator 3 may comprise any suitable dielectric material having low losses to high frequency fields and may be formed, for example, of a suitable molded resinous material such as polyvinylidene chloride. Such a dielectric material is sufficiently rigid that the coil 2 may be machine wound on the insulator and yet flexible enough that it can be coiled on a small radius after winding. The coil 2, after being formed on the insulator 3, is painted with a metallic paint 6 which may consist, for example, of an aluminum powder mixed with a suitable insulating paint having a polystyrene base. Preferably, the proportions are such that each of the metal particles are insulated from the remaining particles by the insulating paint.

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The coil 2, after being covered with the paint 6, containing metallic particles, has wound thereon an insulating tape 7 such as an aceto-butyrate tape. The taped coil 2 is then surrounded by a layer 8 of small insulated wires which consist, for example, of a litz wire, i. e., a wire composed of fine copper strands each insulated and braided together and which constitutes an outer conductor for the transmission line. The resultant transmission line preferably then is covered with a layer 9 of cotton tape.

In a transmission line of this construction, the distributed capacity is the capacity not only between the two windings 2, 8, but also the capacity between each of the metallic particles in the paint 6 and the windings 2, 8. Each little metallic particle forms a capacitor giving a distributed capacity between turns of the solenoid coil 2. It has been found that a suitable mixture for painting on the coil 2 consists of two parts of paint having a polystyrene base to one part of aluminum powder.

An important advantage of my improved transmission line structure is that the distributed capacity gives a phase component which, below the resonant frequency of the line, opposes the change in delay per unit length due to the change of inductance with frequency. On the other hand, at frequencies above the resonant frequency of the line, the distributed capacity of the metallic particles aids the change of inductance with frequency. As a result, for a line of this construction, the phase shift for a 10 megacycle signal over that of a 100 kilocycle signal, both occurring in a one microsecond width square wave pulse having a repetition rate less than 100 kilocycles, is considerably reduced from the phase distortion for a similar signal in a line without the metallic paint. The shape of pulses transmitted over the delay line is therefore improved so that more accurate transmission of pulse signals is obtained.

Another advantage of the invention is that the frequency of signals transmitted without phase

distortion is considerably greater than that of a distortionless signal transmitted over a line which does not include the layer of metallic particles.

While I have shown a particular embodiment of my invention, it will of course be understood that I do not wish to be limited thereto since various modifications may be made and I contemplate by the appended claims to cover all such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. An artificial transmission line having a low velocity of propagation for currents thereon comprising an insulated conductor formed into a helical coil of closely wound turns, a layer of small insulated wires closely surrounding said coil, and means to reduce the phase distortion of high frequency currents transmitted over said line comprising a layer of finely divided non-magnetic metallic particles disposed between said coil and said layer of wires, said particles being insulated from said coil and said layer of wires.

2. An artificial transmission line having a low velocity of propagation for currents thereon comprising an insulated conductor formed into a helical coil of closely wound turns, a layer of small insulated wires closely surrounding said coil, said wires being braided together throughout the length of said layer, and a layer of finely divided non-magnetic metallic particles disposed between said coil and said layer of wires, said particles being insulated from each other and from said coil and said layer of wires.

3. An artificial transmission line having a low velocity of propagation of currents thereon comprising a flexible tubular insulator, an insulated conductor formed into a helical coil of closely wound turns wound on said insulator, a layer of small insulated wides closely surrounding said coil, and a layer of finely divided non-magnetic metallic particles disposed between said coil and said layer of wires, said particles being insulated from said coil and said layer of wires.

4. An artificial transmission line having a low velocity of propagation of currents thereon comprising a flexible tubular insulator, an insulated conductor formed into a helical coil of closely wound turns wound on said insulator, a layer of small insulated wires closely surrounding said coil, said wires being braided together throughout the length of said layer, and a layer of finely divided non-magnetic metallic particles disposed between said coil and said layer of wires, said particles being suspended in an insulating binder and being insulated from each other and from said coil and said layer of wires.

5. A transmission line having a high characteristic impedance and a low propagation velocity comprising a coil of closely wound turns of a conductor, a layer of small insulated wires surrounding said coil, a layer of finely divided non-magnetic metallic particles disposed between said coil and said layer of wires, said particles being suspended in an insulating binder and being insulated from each other and from said coil and said layer of wires, and an insulating tape disposed between said layer of particles and said layer of wires.

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REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
1,899,501	Gabriel	Feb. 28, 1933
2,111,710	Van Loon	Mar. 22, 1938
2,228,798	Wassermann	Jan. 14, 1941
2,387,783	Tawney	Oct. 30, 1945
2,420,559	Nelson	May 13, 1947