

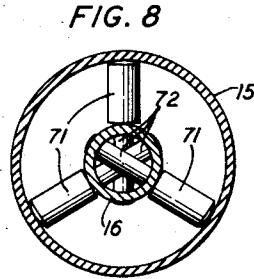
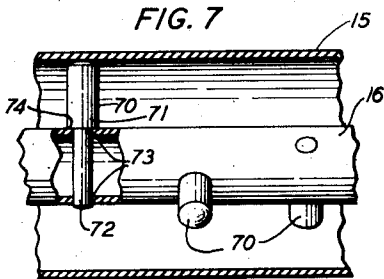
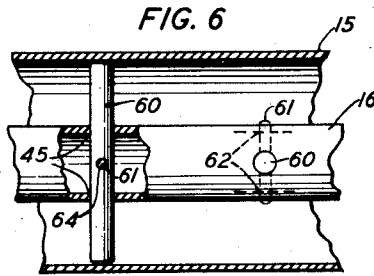
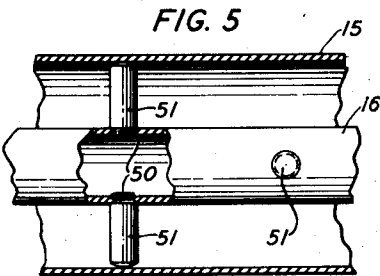
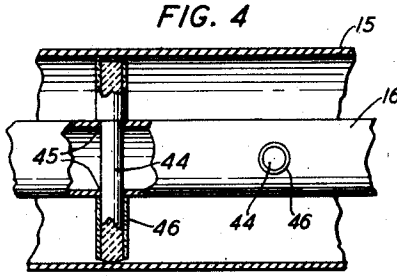
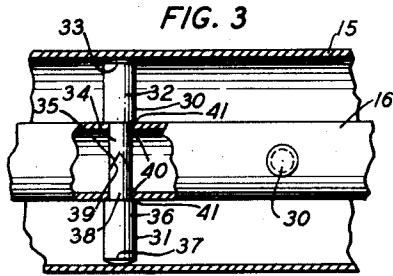
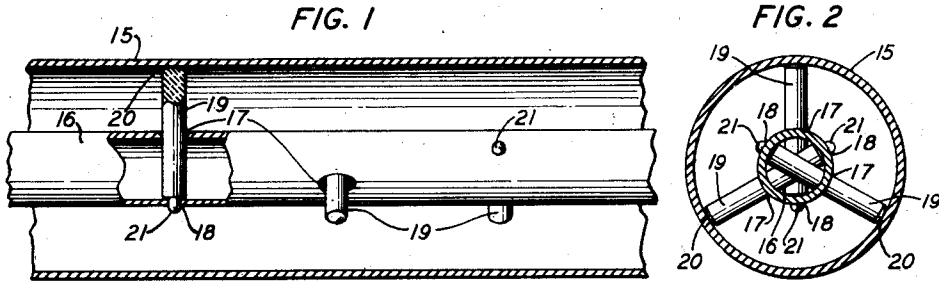
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2,216,893

CONCENTRIC CONDUCTOR TRANSMISSION LINE

Filed March 24, 1938



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CONCENTRIC CONDUCTOR TRANSMISSION LINE

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1 Claim. (Cl. 174—28)

This invention relates to concentric conductor transmission lines, and more particularly to arrangements for retaining concentric spacing between the conductors of such lines.

One form of concentric conductor line known heretofore comprises a tubular inner conductor disposed in a tubular outer conductor and spaced concentrically therefrom by insulating rings or the like mounted on the periphery of the inner conductor at intervals therealong. In such arrangement insulating rings are held in place on the inner conductor in one of the following ways: (a) friction, (b) crimping the inner conductor on both sides of the insulating ring, (c) soldering metal rings on the inner conductor or both sides of the insulating ring and (d) springing resilient wires on the inner conductor on both sides of each insulator.

Accordingly, these insulating rings create gaps between themselves and the inner conductor along a radial extending from the center of the line, and in addition, introduced between the inner and outer conductors a relatively large mass of material which has a high dielectric constant compared to air or gas surrounding it and which, in addition to increasing the dielectric losses that are proportional to the mass of this material, alters the distribution of the voltage gradient on the outer surface of the inner conductor. This distribution would be uniform for a line assumed to have a uniform air or gas dielectric intervening exclusively between the inner and outer conductors, or a line provided with insulators having a dielectric constant equivalent to that of the surrounding air, or gas, if such were possible. However, since a solid material having a dielectric constant equivalent to that of air or gas is physically non-existent, the nearest approach to the desired condition of a uniform air or gas dielectric is realized with an insulator having minimum mass.

These alterations in the distribution of voltage gradient cause substantial increases of voltage gradient in the vicinity of the insulating rings and frequently result in the production of relatively steep voltage gradients on the outer surface of the inner conductor, particularly if any gaps intervene between the inner conductor and the insulating rings. Consequently, there may be produced in the vicinity of the insulating rings corona and flashover by signaling voltages applied to the line and having magnitudes substantially less than those that would be transmitted by a concentric line of the same cross-sectional dimensions and having air or gas dielectric inter-

vening exclusively between the inner and outer conductors.

Also it may happen that either in slipping the outer conductor onto the inner conductor or in handling an assembled concentric conductor line in the field the insulating rings would be subjected to longitudinal displacement on the inner conductor. Such movement tends to change the concentric relation between the inner and outer conductors, thereby causing further variation in the distribution of the voltage gradient on the outer surface of the inner conductor.

Concentric conductor lines may be used in the transmission of high frequency signals in the manner disclosed in the patent of L. Espenschied et al. No. 1,835,031, issued December 8, 1931.

It is an object of the invention to provide a concentric conductor system which, for a given cross-section and conductor diameter ratio, allows the efficient transmission of maximum signaling voltages, substantially equivalent to those that would be transmitted by a concentric conductor system of the same dimensions but embodying ideal insulating arrangements.

It is another object of the invention to provide a concentric conductor transmission line having highly efficient insulation for the transmission of signaling currents embracing a wide band of frequencies.

It is still another object of the invention to provide a concentric transmission line that can be expeditiously assembled in both factory and field, and therefore one that is relatively inexpensive to manufacture.

It is a further object of the invention to provide a concentric conductor transmission line in which there is a minimum disturbance to the air or gas dielectric intervening between the inner and outer conductors.

It is a still further object of the invention to provide a concentric conductor line in which concentric spacing is substantially maintained at all points thereof.

In a preferred form the invention comprises a concentric conductor line in which the inner conductor is provided with a plurality of pairs of diametrically aligned openings spaced therealong in such manner that adjacent pairs are angularly disposed relative to each other. In each pair of aligned openings is positioned an elongated insulator adapted to engage the inner surface of the outer conductor. This arrangement assures concentric spacing of the inner conductor within the outer conductor and provides substantially

the same amount of air dielectric at all points along the line.

The invention will be more readily understood from the following description taken together with the accompanying drawing in which:

Fig. 1 is a sectional view of a concentric conductor illustrating one form of insulator in accordance with the present invention;

Fig. 2 is an end view of Fig. 1;

Figs. 3, 4, 5, 6 and 7 are sectional views of a concentric conductor showing other forms of insulators contemplated in the present invention; and

Fig. 8 is an end view of Fig. 7.

In the following description the same reference numerals are used to indicate the same elements appearing in the several views.

Fig. 1 shows a concentric conductor comprising outer conductor 15 and inner conductor 16. The latter is provided with a plurality of pairs of diametrically aligned openings 17 and 18, the pairs being spaced at intervals therealong. Of each pair, opening 17 has a diameter that is preferably larger than that of opening 18. Preferably each opening 17 is angularly disposed 120 degrees relative to adjacent openings 17 and each opening 18 is also similarly disposed relative to adjacent openings 18 shown in Fig. 2. An electrical insulator 19 of an elongated type having a rounded end 20 and formed with a projection 21 on the opposite end is positioned in each pair of openings 17 and 18 such that the projection 21 is inserted in the opening 18 and the rounded end 20 engages the inner surface of the outer conductor substantially in a point-contact. Preferably, the diameters of the openings 17 and 18 are such that the insulators 19 fit tightly therein so as to permit a minimum amount of air dielectric to intervene between the inner conductor and each insulator. To facilitate the assembling of the insulators 19 on the inner conductor, each opening 17 is preferably formed with a rounded edge. This rounding has also been found desirable electrically. By eliminating any sharp edge on the surface of the inner conductor at the insulator the voltage gradient is further reduced resulting in somewhat greater improvement of the flashover voltage. It is evident that adjacent pairs of aligned openings 17 and 18 may be disposed on the inner conductor in any desired angular relation in addition to that mentioned above.

Fig. 3 illustrates an insulator assembly comprising diametrically cooperating members 30 and 31. The member 30 comprises a cylindrical portion 32 terminating in a rounded end 33 and a reduced cylindrical portion 34 terminating in a V-shaped end 35. The member 31 consists of a cylindrical portion 36 terminating in a rounded end 37 and a reduced cylindrical portion 38 terminating in a wedge-shaped end 39. The inner conductor is provided with a plurality of pairs of diametrically aligned openings 40, 40 spaced at intervals therealong. Each insulator is assembled by so disposing reduced portions 34 and 38 in openings 40, 40 such that each wedge-shaped end 39 is seated in each V-shaped end 35. The shoulders 41, 41 formed by the junction of the cylindrical portions 32 and 36 and the reduced portions 34 and 38, respectively, engage the outer surface of the inner conductor and may be curvilinearly shaped as to be readily fitted to inner conductors of various diameters. The rounded ends 33 and 37 engages the inner surface of the outer con-

ductor on diametrically opposite sections thereof and substantially in a point-contact. Adjacent pairs of aligned openings 40, 40 may be angularly disposed and provided with diameters to accommodate the reduced portions 34 and 38 in the manner described above in connection with Fig. 1.

Fig. 4 delineates an insulator assembly comprising an elongated cylindrical member 44 having rounded opposite ends and positioned in diametrically aligned openings 45, 45, provided in the inner conductor as described above in connection with Fig. 3. Over each end of the member 44 is placed a sleeve 46 of suitable insulating material and whose one end engages the inner surface of the outer conductor and the opposite end engages the outer surface of the inner conductor. Adjacent insulator assemblies are shown angularly disposed at 90 degrees although these may also be angularly disposed similarly as the insulators shown and described in connection with Fig. 1.

Fig. 5 shows an insulator assembly in which diametrically aligned openings 50, 50 are provided with threads to receive the threaded ends of diametrically aligned insulating members 51, 51 each of which terminates on the opposite end in a rounded portion for engaging the inner surface of the outer conductor substantially in a point-contact. Adjacent aligned members 51, 51 are angularly disposed at 90 degrees, although these may also be angularly disposed as the insulators shown and described in connection with Fig. 1.

Fig. 6 is similar to Fig. 4 except elongated insulator 60 is held in place by a transverse insulating pin 61 extending through a mid-point aperture 64 therein and positioned in diametrically aligned openings 62, 62 provided in the inner conductor at an angle of 90 degrees relative to openings 45, 45. It is understood that the pins 61 as well as the insulators 60 are tightly fitted in the respective openings for the reason mentioned above in connection with similar elements in Fig. 1.

Figs. 7 and 8 are generally similar to Figs. 1 and 2. Fig. 7 illustrates an insulator 70 comprising a cylindrical portion 71 and a reduced cylindrical portion 72 which is disposed in diametrically aligned openings 73, 73 provided in the inner conductor. Shoulder 74 formed by the junction of the portions 71 and 72 and engaging the outer surface of the inner conductor is preferably shaped in a curvilinear manner so as to be readily fitted to inner conductors of various diameters. Fig. 8 shows adjacent insulators disposed angularly at 120 degrees, although it is evident this disposition can be 90 degrees, or any desired angular relation.

In the above arrangements, it is obvious that the insulators are precluded from longitudinal displacement on the inner conductor either in the operation of (a) slipping the outer conductor onto the inner conductor and (b) in handling an assembled concentric conductor line in the field. Consequently, the concentric relation between the inner conductor and outer conductor is retained at all points along the line.

In addition, pin-type insulators with their minimum mass of high dielectric material intervening between the inner and outer conductors tend to cause minimum dielectric losses and also minimum disturbances in the distribution of the potential gradient on the outer surface of the inner conductor. This together with the elimination of

gaps between the insulators and inner conductor along a radial extending from the center of the line and the substantial reduction of air or gas dielectric between the inner conductor and the

5 individual pin-type insulators, due to tight fit of insulators in associated openings in inner conductor, obviates the production of relatively steep voltage gradients on the outer surface of the inner conductor in the vicinity of the insulators.
10 Consequently, signaling voltages that are substantially equivalent in magnitude to voltages allowed by a line of the same dimensions having air or gas dielectric intervening exclusively between the inner and outer conductors, or an air
15 or gas dielectric line of the same dimension provided with ideal insulators for maintaining concentric spacing therebetween, may be applied to the line without causing the production of corona or flashover, and therefore may be transmitted
20 thereover with increased efficiency.

Furthermore, it is evident that a pin-type insulating arrangement of the character described above lends itself to the facile assembly of a concentric conductor line or the expeditious replacement of defective insulators. In the latter event
25 a defective insulator can be removed and replaced without disturbing the other insulators which is not so in the case of ring-type insulators as all insulators leading to the defective one must be
30 removed before the latter can be replaced.

Also, it is understood that all openings in the

inner conductor may be formed with rounded edges as shown relative to opening 17 in Fig. 1 for the reason mentioned above in connection therewith.

While the invention is particularly described 5 in connection with a concentric conductor line having a tubular inner conductor, it is obvious that it is equally well-suited to concentric conductor lines provided with solid inner conductors.
10

It is understood that the invention is capable of modifications other than those disclosed herein, and the scope thereof together with such modifications is defined in the appended claim.

What is claimed is:

15 In a concentric conductor transmission line comprising solid-walled tubular inner and outer conductors, said inner conductor having a plurality of pairs of diametrically aligned openings, each pair of openings being angularly disposed
20 relative to adjacent pairs, and insulators for retaining concentric spacing between said conductors, each of said insulators engaging the inner surface of the outer conductor on diametrically
25 opposite points and comprising an elongated member positioned in each pair of openings and a sleeve disposed on each of the opposite ends of said elongated member so as to extend between said inner and outer conductors and to engage each thereof.
30

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