ABSTRACT: A track communication system for moving trains, has an open wire transmission line extending along the track comprising two insulated conductors, the characteristic impedance of the transmission line being maintained substantially constant by the presence of a sectionalized conductor adjacent one of the insulated conductors each section of which is short circuited to a conductor adjacent the other insulated conductor of the transmission line. In an alternative embodiment, one insulated conductor of the transmission line is replaced by a rail of the track to which each section of the sectionalized conductor is short circuited.
FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

FIG. 6

FIG. 7

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This invention relates to wayside communication systems for moving trains in which an inductive coupling is established between the wayside and train for conveying information therebetween. More particularly the invention relates to such wayside communication systems of the kind having an open wire transmission line carrying the required information in the form of electric currents which produce the magnetic field for the inductive coupling or which are induced therein by reason of this magnetic field, said open wire transmission line comprising at least one insulated conductor extending along the track rails and either a further insulated conductor or a rail of track.

The transmission line in a wayside communication system of this kind is normally laid at ground level, and when it comprises two insulated conductors is laid for example on the sleepers and between the rails, the conductors being spaced for example at approximately 30 cm. apart; the conductors are insulated sufficiently to permit free space conditions to be assumed under favorable ground conditions.

When ground conditions deteriorate, for example as a result of snow, heavy rain or flooding, free space conditions are no longer assumable; hence increased attenuation is experienced and a variation in characteristic impedance occurs. These in turn lead to a reduction in the signal level, which, unless the transformer operates at a sufficiently high power level, can result in a loss of communication.

The object of this invention is to maintain the attenuation and characteristic impedance at a substantially constant value under all ground conditions.

According to one aspect of the invention, in a wayside communication system of the kind hereinbefore described and having an open wire transmission line comprising a pair of insulated conductors, each insulated conductor has a further electrically conductive member extending closely adjacent to it and arranged not to interfere substantially with said inductive coupling, the conductive member associated with one insulated conductor being short circuited to the conductive member associated with the other insulated conductor. The conductive member associated with each of said insulated conductors may comprise a metal sheathing for the insulated conductor, the sheathing of at least one of the conductors being in sections insulated from each other. Both said sheathings may be in sections insulated from each other and the sections of the sheathing of one conductor are then preferably each short circuited with the nearest section of the sheathing of the other conductor.

According to another aspect of the invention, in wayside communication system of the kind hereinbefore described and having an open wire transmission line comprising an insulated conductor and a rail of the track, said insulated conductor has a conductive element extending closely adjacent to it and arranged not to interfere substantially with said inductive coupling, said conductive member being short circuited to said rail.

The invention will now be further explained with reference to the accompanying diagrammatic drawings, in which:

FIG. 1 is a typical arrangement of wayside conductors,
FIG. 2 is the equivalent circuit thereof.
FIG. 3, 4 and 5 are further equivalent circuits to facilitate the understanding of the theoretical considerations of the wayside conductors under certain track conditions, and
FIGS. 6 and 7 are two arrangements of the wayside conductors in accordance with the invention.

An equivalent circuit of a longitudinal element of the transmission line assuming free space conditions is shown in FIG. 2; attenuation may be calculated in accordance with normal theory, losses being due to I^2R, and V^2/R. In practical operating conditions however, ground losses occur and in extreme conditions both conductors may be covered by snow or water. These conditions can be described, approximately, by the equivalent circuit shown in FIG. 3. The transmission line capacitance C (FIG. 1) is no longer that associated with conductor spacing but is determined principally by the insulation thickness and permittivity represented by capacitance C0 and C1 in FIG. 3; capacitance C0 can be neglected for the purpose of this description and the equivalent circuit is then given by FIG. 4, or FIG. 5, where capacitance C1 in combination with leakage conductance G is the parallel equivalent of capacitance C2/2 and resistance R0.

When the increased losses due to ground conditions are significant, the current through resistance R0 is determined by capacitance C2/2 since this predominates and is essentially constant. Thus if resistance R0 (FIG. 4) is made zero, i.e. leakage conductance G (FIG. 5) is zero, the loss due to leakage V^2/G is zero.

In FIGS. 6 and 7 are shown two ways in which this effect can be achieved using a transmission line comprising two insulated conductors A', B'. Each conductor A', B' of FIGS. 6, corresponds to conductors A and B of FIG. 1 in having a conducting core 1 and insulation 2. Additionally each conductor A', B' is provided with a thin metal sheath 3 in the manner of a coaxial cable. The metal sheath 3 of each conductor is divided into sections 3', 3'' etc. insulated from each other and a sheath section of one conductor is short circuited to the adjacent sheath section of the other conductor by connections 4.

Thus the condition of conductance G being zero is achieved and since the sheath sections are insulated from each other the circulation of a screen current is prevented. Therefore, since this arrangement is virtually identical to a transmission line of the open wire type, the electromagnetic field at X (FIG. 1) is essentially similar. Furthermore the increase in capacitance caused by the conductive sheaths 3, which are short circuited, reduces the characteristic impedance Z0. Thus the power requirement is essentially lower than that needed for the open wire transmission line shown in FIG. 1 and correspondingly, significant savings in terms of transmitting and receiving equipment is possible.

In FIG. 7 the conductors A", B" again corresponding to conductors A and B in having conducting cores 1 and insulation 2, are provided with a metal sheath but only the sheath 3 of conductor A" is in insulated sections 3', 3'' etc. The conductor B" in this arrangement has a continuous sheath 3. If desired the conductor B" may be used as an independent coaxial transmission line.

In the case where the open wire transmission line comprises an insulated conductor and one rail of the track, this will correspond to FIG. 7 arrangement, except that the conductor B" together with its sheath 3 will be replaced by one rail of the track.

In a modification of the arrangements of FIGS. 6 and 7, the sheathing of each of the conductors can be replaced by an auxiliary conductor wire running in the insulation and which is split up into insulated sections in like manner to the sheaths in FIG. 6. The auxiliary wire of one conductor is, in the case of the metal sheaths described above, short circuited with the auxiliary wire of the other conductor. This provides a compromise solution of the same problem.

I claim:

1. A train-wayside communication system for moving trains wherein an inductive coupling is established between the wayside and train for conveying information therebetweeen, said system including an open wire transmission line extending along the track for carrying said information in the form of electric currents which produce a magnetic field for the inductive coupling of said information to said train and alternatively have electric currents induced therein by reason of a magnetic
field for the inductive coupling of said information to the wayside, said open wire transmission line comprising a pair of insulated conductors each having a metal sheathing, the sheathing of each conductor being in sections insulated from each other and each section of sheathing of one conductor being short circuited to a section of sheathing of the other conductor.

2. A train-wayside communication system for moving trains wherein an inductive coupling is established between the wayside and train for conveying information therebetween, said system including an open wire transmission line extending along the track for carrying said information in the form of electric currents which produce a magnetic field for the inductive coupling of said information to said train and alternatively have electric currents induced therein by reason of a magnetic field for the inductive coupling of said information to the wayside, said open wire transmission line comprising an insulated conductor together with one rail of the track, said insulated conductor having a metal sheathing which is in sections insulated from each other, the sections of said sheathing being short circuited to the rail.