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COMMUNICATION SYSTEM

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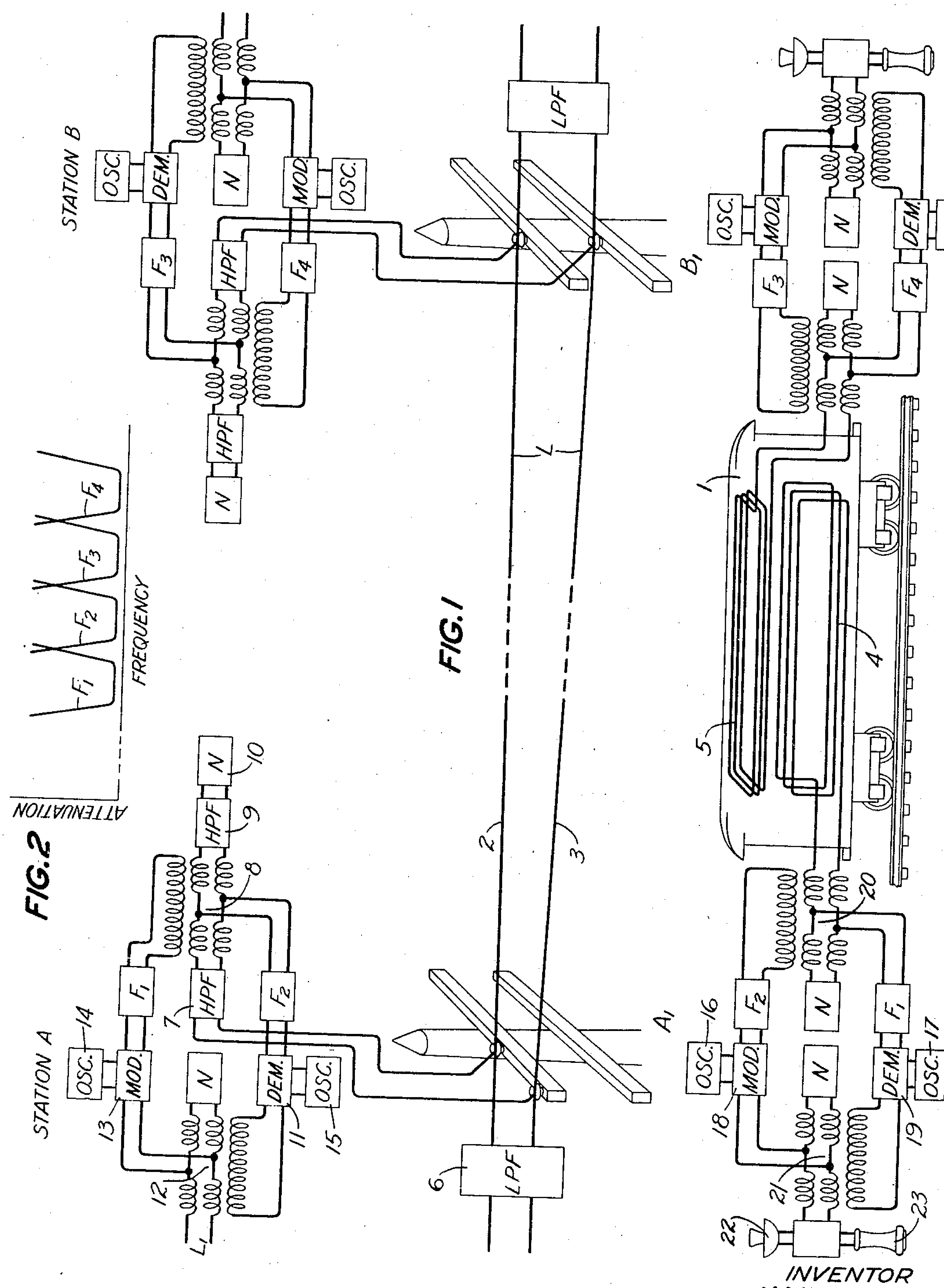

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COMMUNICATION SYSTEM

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This invention relates to systems of communication, and more particularly to systems for communicating with vehicles in motion as, for instance, railway trains.

One system for communicating between moving vehicles and a terminal station is disclosed in Patent 1,453,387 to H. A. Affel, patented May 1, 1923. In this system a loop comprising a plurality of turns of wires, located on the vehicle, is inductively coupled with a line paralleling the vehicle's right of way. Sufficiently close coupling for adequate transfer of energy is obtained, in this instance carrier frequencies being used. Aboard the vehicle there are connected to the loop a modulator and demodulator for transmitting and receiving signals, while similar sending and receiving stations are placed along the line for communicating therewith.

In such a system, because of the fact that the train moves from one station to another, a variable attenuation may occur in the strength of the signals being received from and transmitted to the stations along the line, causing the volume of the sound to gradually increase or decrease, depending upon whether the train is moving toward or away from a given station.

An object of this invention is to render the attenuation of the signals transmitted between a moving vehicle and the stations between which it is moving, constant, notwithstanding the motion of the vehicle with respect to the stations.

In order to accomplish this object, a line is located parallel to the path of the moving vehicle and is inductively related to a pair of loops placed at right angles to each other on the vehicle in such a way as to make the coupling between the line and each loop vary with distance from train to station. Each loop is connected to terminal apparatus on the train for communicating with a different one of the terminal stations. In order to provide for constant attenuation not withstanding the increasing or decreasing distance between the stations and the vehicle due to its motion, the plane of the wires comprising the line strung along the track is rotated through an angle in passing from one terminal station to the other, or between repeater points. The relation of the loops and the direction of rotation is such that as the train passes from one station to the other, the coupling between the line and the loop associated with apparatus for communicating with the station from which the train is moving is gradually increased, whereas the coupling between the other loop associated with apparatus for communicating with the station toward which the train is moving is decreased. Thus, the coupling between the respective loops aboard the vehicle and the line varies in accordance with the distance between the vehicle and the respective station with which the loops are associated. This scheme of providing an evenly varying coupling results in constant attenuation of the signals being transmitted between either station and its associated terminal apparatus aboard the vehicle.

A better understanding of the invention may be had from the following description together with the accompanying drawings, of which Fig. 1 shows a schematic view of the circuit embodying the invention and Fig. 2 shows curves representing the characteristics of the filters used in the circuit.

The apparatus and general layout of the system is similar to that disclosed in the Affel patent referred to, and reference may be made to that patent for detail disclosure of various portions of the system.

Referring to Fig. 1 a vehicle 1 as, for example, a railroad train or other moving body is represented as traveling between two stations, which for convenience have been designated station A and station B. Paralleling the right of way and connecting stations A and B is a line L comprising a pair of conductors 2 and 3 which may be placed on poles or located in some convenient place adjacent the road bed. Aboard the vehicle 1 are two loops 4 and 5 consisting of a plurality of turns, the loops being located in planes perpendicular to each other and arranged so as to be inductively coupled with the line L. Associated with the line L at stations A and B are terminal apparatus for sending signals to and receiving signals from the vehicle 1. Connected respectively to the loops 4 and 5 are terminal apparatus A_1 and B_1 on the vehicle for communicating respectively with the stations A and B. In order to secure an adequate transfer of energy between the line L and the loops 4 and 5 relatively high frequencies are used. This is also desirable since it permits the simultaneous communication between the stations A and B and the vehicle by using different carrier channels.

At station A a low pass filter 6 and a high pass filter 7 are connected to the line L for discriminating between carrier and voice frequencies, since it may be desirable to have both superimposed upon the line. The sending and receiving apparatus at this station is of a well-known type comprising a hybrid coil 8 for aiding in separation of the incoming and outgoing signals into their respective channels. The hybrid coil terminates in a high pass filter 9 simulating the impedance of the high pass filter 7 and a network 10 for balancing the line.

Connecting with station A is an ordinary telephone line L_1, carrying currents in the speech range to be impressed on the modulator at station A or resulting from demodulation of waves received at station A from the train. Line L_1 may extend to an ordinary telephone exchange where it may be connected to ordinary subscribers' lines.

A hybrid coil 12 connected to the line L_1, serves the same purpose as the hybrid coil 8 and permits signals coming thereover to be transmitted to the modulator 13 which may be of any well-known type as, for instance, that disclosed in U. S. Patent 1,343,307 issued to John R. Carson on June 15, 1920. An oscillator 14 which may also be of any well-known type as, for instance, that disclosed in U. S. Patent 1,356,763 to R. V. L. Hartley, patented October 26, 1920 supplies the carrier frequency to the modulator 13. A modulated wave or a side band thereof is selected from the output of the modulator by the band-pass filter F_1, which may be of the type disclosed in U. S. Patent 1,227,113 to G. A. Campbell, patented May 22, 1917, and is transmitted to line L through the hybrid coil 8. Incoming signals from the line L from the terminal apparatus A_1 aboard the vehicle are selected by the band-pass filter F_2, which is similar to F_1 although covering a different range of frequencies, and transmitted to the demodulator 11 which may also be of any well-known type as, for instance, that disclosed in U. S. Patent 1,343,308 issued to John R. Carson on June 15, 1920. A reenforcing carried frequency is supplied to the demodulator 11 from an oscillator 15 similar to oscillator 14 for the purpose of demodulating the incoming carrier band. The resultant signals in the output of the demodulator are transmitted to the line L_1 through the hybrid coil 12 to a suitable receiving circuit. Fig. 2 shows the relative positions of the frequency ranges transmitted by the band-pass filters F_1 and F_2.

The terminal apparatus A_1 connected to loop 4 aboard the vehicle is similar to that at station A and comprises the oscillation generators 16 and 17, modulator 18, demodulator 19, and filters F_1 and F_2 properly connected for communication with station A. The modulator 18 receives signals from the transmitter 22 for modulating the high frequency wave from the oscillator 16 for transmission to the line, while the signals resulting from demodulation in the demodulator 19 are transmitted to the receiver 23 by means of the hybrid coil 21. Transmitter 22 and receiver 23 may be of any well-known type, as for example, an ordinary subscriber's telephone subset.

Terminal apparatus at stations B and B_1 (the latter connected to loop 5) is identical with that at stations A and A_1 except that different carrier channels are necessary to prevent interference with communication between stations A and A_1. The relation of the carrier channels used for transmitting between stations B and B_1, and between A and A_1 is shown in Fig. 2. The frequency bands, designated as F_1, F_2, F_3 and F_4 in Fig. 2 are those transmitted respectively by the band-pass filters F_1, F_2, F_3 and F_4 at the terminal stations A, A_1, B, B_1.

As the line L passes from station A to B the plane of conductors 2 and 3 is rotated through an angle of 90°. Thus, for the purpose of illustration conductors 2 and 3 are represented as being in a horizontal plane in the vicinity of station A. In passing from station A to station B the plane of the wires is gradually rotated until at station B the plane has acquired a vertical position. It will be understood, of course, that in practice a long length of line is traversed before the entire 90° rotation takes place, and that intermediate the two poles shown on the drawing there would ordinarily be several miles of line with numerous other poles not shown. As has already been pointed out, the loops 4 and 5 are at right angles to each other. When vehicle 1 is near station A the plane of loop 4 is nearly at right angles to the plane of the conductors 2 and 3 whereas the plane of loop 5 is nearly parallel to the plane of conductors 2 and 3. Thus positioned, the loop 5 has maximum coupling with the conductors whereas loop 4 has minimum coupling therewith. In passing from station A to station B the respective conditions of coupling of the loops 4 and 5 with the conductors 2 and 3 are gradually changed until upon reaching station B the reverse conditions obtain, namely, loop 4 has maximum coupling and loop 5 minimum coupling with the conductors 2 and 3.

In general, high frequencies such as those used in this invention are subject to greater attenuation on the line than low frequencies. For this reason during transmisison from either station the energy of the signals which is available at any point along the conductors 2 and 3 is less as the distance of the point from the station transmitting the signal increases. Suppose, for instance, the vehicle 1 is moving from station A to station B. If station A communicates with apparatus A_1 in the vehicle 1, ordinarily the strength of the signals received at either A or A_1 would become weaker the greater the distance from the sending station. However, due to the fact that the coupling of the line L with the loop 4 gradually increases as the vehicle moves away from station A as pointed out above, the increase in efficiency of energy transfer from the line to the loop and vice versa compensates for the gradual decrease in available energy resulting from the attenuation on the line. In this manner the level of the received signals may be maintained approximately constant.

Likewise, for communication between station B and the vehicle 1 as it is passing from station A to station B, an analogous condition exists, since in passing from station A to station B the coupling of the loop 5 with conductors 2 and 3 decreases from maximum to minimum, causing the efficiency of energy transfer to decrease to compensate for the increasing energy available as the vehicle approaches station B.

By means of this invention communication can be maintained simultaneously between a moving vehicle and two or more stationary points relative to which it is moving, while at the same time the energy level of the signals is maintained constant notwithstanding the motion of the vehicle.

Although this invention has been described with reference to a particular embodiment thereof other embodiments will at once suggest themselves to those skilled in the art within the spirit of the invention which is to be limited therefore only by the scope of the appended claims.

What is claimed is:

1. In a system for communicating between a moving body and a plurality of terminal stations between which it is moving, a transmission line connecting said stations adapted to transmit signal variations imposed thereon, transmission means on said moving body inductively coupled with said line in which are induced currents responsive to those transmitted over said line, and means for changing the transfer efficiency between said transmission means and said line from point to point along the route of travel of the moving body to provide a substantially constant transmission equivalent between said line and said transmission means, regardless of the position of said moving body with respect to said terminals.

2. In a system for communicating between a moving body and a terminal from which it is moving, a transmission line paralleling the route of said moving body, transmission means on said body inductively related to said transmission line for the two-way transfer of energy therebetween, and means to change the coupling between said line and said transmission means as a function of the distance of the moving body from the terminal to provide substantially constant attenuation of the energy resulting from said two-way transfer regardless of the position of said moving body with respect to said terminal.

3. In a system for communicating between a moving body and the terminal stations between which it is moving, a transmission line connecting said terminals and paralleling the route of said moving body, transmission means on said body inductively related to said transmission line for the two-way transfer of energy therebetween, the coupling between said transmission line and said transmission means being a function of the distance of the moving body from the terminal.

4. In a system for communicating between a moving body and the terminal stations between which it is moving, a transmission line for carrying the signal energy transmitted to and received from said body, said transmission line comprising a pair of conductors the plane of which is rotated through an angle of 90° in traversing the distance between the stations.

5. In a system for communicating between a moving body and a terminal station, a transmission line comprising a pair of wires connected to said station, a conducting loop for receiving energy positioned on said body inductively coupled with said transmission line, the coupling of said line with said loop being different for different positions of said body with respect to said station, the amount of said coupling being determined by the angle which the plane of said wires makes with the plane of said loop.

6. In a system for communicating between a moving vehicle and a plurality of stations along the route of said vehicle, a transmission line comprising a plurality of wires paralleling said route and to which said stations are connected, conducting loops positioned on said vehicle inductively coupled with said line, said coupling being varied as the vehicle traverses the distance between said stations, said variation being secured by gradually rotating the plane of said wires in such a way that the loop associated with its re-

spective terminal station has its position of minimum coupling when the vehicle is in close proximity thereto and its maximum coupling at a point remote therefrom.

7. In a system for communicating between the moving vehicle and a plurality of stations between which the vehicle is moving, a transmission line comprising a plurality of wires paralleling the route of said vehicle and connecting said stations, and individual conducting loops inductively coupled with said line positioned on said vehicle and associated with each of said stations, the plane of said line with respect to the said loops being rotated from a position of maximum coupling with one of said loops and minimum coupling with another, at one station, to a position in which the respective degrees of coupling are reversed, at another station.

8. In a system for communicating between a moving vehicle and a plurality of stations between which the vehicle is moving, a transmission line comprising a plurality of wires paralleling the route of said vehicle and connecting said stations, a pair of conducting loops positioned at right angles to each other on said vehicle inductively coupled with said line, each of which is associated with a respective terminal station for intercommunication therewith, the coupling of said line with said loops being varied as the vehicle moves from one of said stations to the other by rotating the plane of said line wires from a position of perpendicularity with the loop associated with the station from which it is about to leave to a position of parallelism with the same loop upon reaching the other station.

9. In a system for intercommunicating between a vehicle and a plurality of stations situated at intervals along its route, a transmission line comprising a pair of wires running adjacent the route of said vehicle, transmission means aboard said vehicle inductively related to said transmission line to provide for the reciprocal transfer of signaling energy therebetween, and means for providing constant attenuation of the signals received at said stations and aboard said vehicle, regardless of its motion between said stations, comprising provisions for producing gradual inclination of the plane of said transmission line with respect to said transmission means at an angle determined by the position of the vehicle with respect to said stations.

10. In a system for intercommunicating between a vehicle and a plurality of stations situated at intervals along its route, a transmission line comprising a pair of wires running adjacent the route of said vehicle, transmission means aboard said vehicle comprising a plurality of conducting loops inductively related to said line, sending and receiving apparatus connected to said line at said stations and to said loops aboard said vehicle for the transmission of signals therebetween, and means for providing constant attenuation of the signals received by said receiving apparatus irrespective of the position of said vehicle with respect to said stations, said means comprising said pair of line wires the plane of which is rotated with respect to the planes of said loops to increase the efficiency of energy transfer between the line and one of said loops as increasing distance between one station and the vehicle decreases the energy available for transfer along said line, and to decrease the efficiency of energy transfer between the line and the other of said loops as the decreasing distance between the vehicle and the other of said stations increases the energy available for transfer along said line.

11. In a system for communicating between a moving body and a terminal station, transmission means on said moving body and at said terminal station, respectively, a transmission line connected to said station and inductively coupled with said transmission means located on said body, the plane of said line with respect to said latter transmission means being a function of the distance of the moving body from said station.

In witness whereof, I hereunto subscribe my name this 21st day of November, 1928.

JOSEPH W. HORTON.