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SYSTEM FOR COMMUNICATING WITH MOVING VEHICLES

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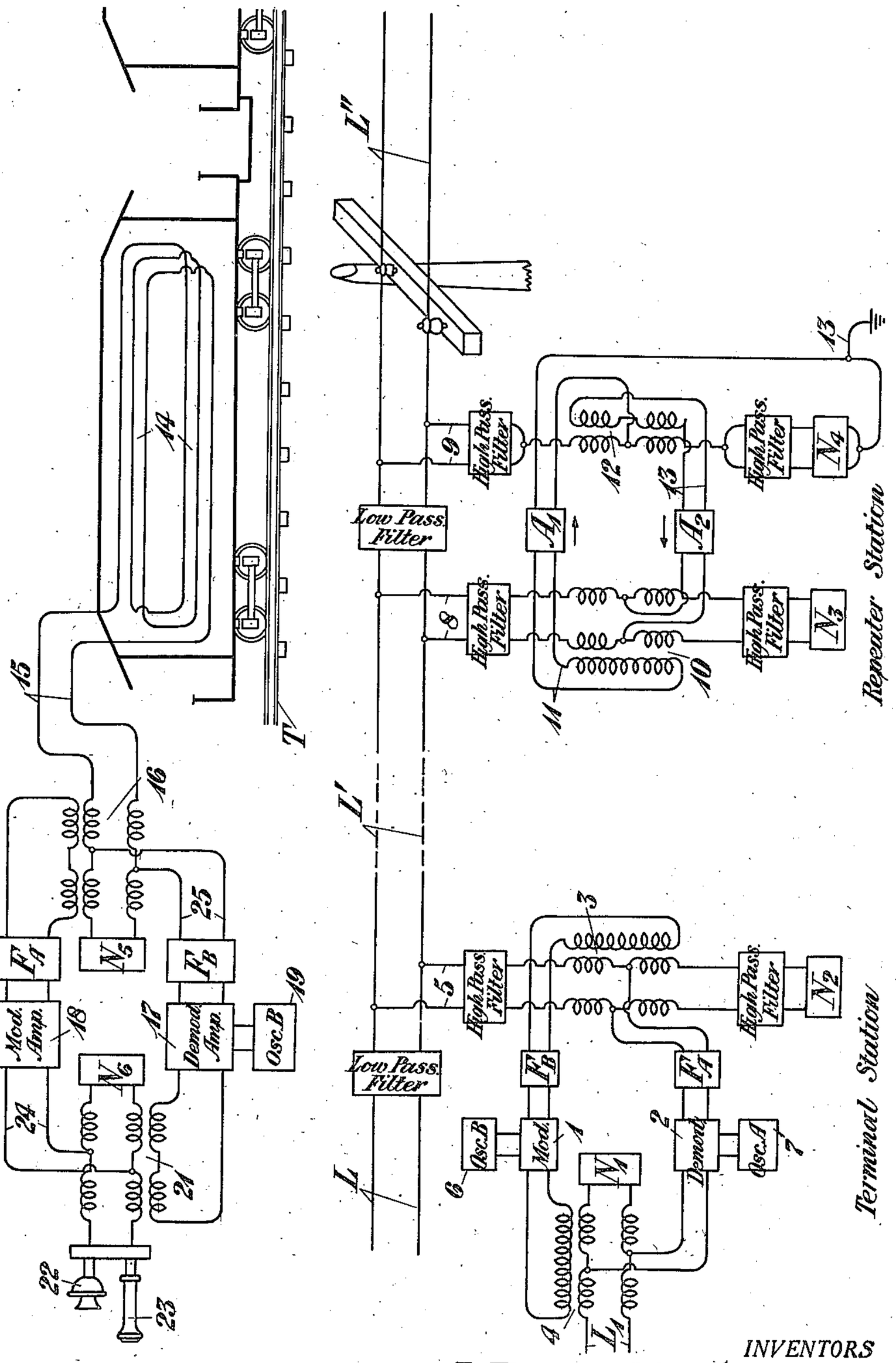

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SYSTEM FOR COMMUNICATING WITH MOVING VEHICLES.

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To all whom it may concern:

Be it known that we, LLOYD ESPENSCHIED and HERMAN A. AFFEL, residing at Hollis and Brooklyn, in the counties of Queens and Kings and State of New York, respectively, have invented certain Improvements in Systems for Communicating with Moving Vehicles, of which the following is a specification.

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

The advantage of telephonic communication with moving vehicles, such as railway trains, is obviously great from the standpoint of safety as well as convenience and accordingly many attempts have been made in the past to develop a system which will accomplish this successively and in such a manner as to warrant commercial exploitation. The principal problem to be solved in such a system is that of effecting transmission over the gap between the moving train and the stationary portion of the system. The solutions of this problem, which have characterized the arrangements heretofore utilized, have fallen along two general lines: first, the method of straight induction at the ordinary signaling or telephonic frequency between the train and a wire system paralleling the right of way; and second, the method of radio transmission between the train and a radio station at some point. Systems employing the first mentioned inductive method are inefficient in respect to the transfer of energy across the gap, because of the relatively low frequency employed, and the telephonic currents received by the moving train are both low in volume and distorted. The method of radio transmission across the gap suffers the limitations of radio in respect to interference from static and other stations and in respect to the large attenuation rising from the considerable separation between the train and the fixed station.

It is the general purpose of this invention to provide a system for communicating with moving vehicles, such as railway trains, which will offer considerable improvements in the transmission of energy across the gap between the moving vehicle and the stationary portion of the system so that the energy received on the vehicle or transmitted therefrom will be increased in volume and will be free from distortion, and which system will be free from the limitations and defects of former systems. A further feature or purpose of the invention consists in providing a system whereby communication may be maintained simultaneously with a plurality of vehicles or trains disposed along the same route. Other and further features and purposes of the invention will appear more fully from the detailed description hereinafter given.

The inductive method of transmitting energy across the gap between the moving train and the stationary portion of the system is employed in the arrangements of this invention. However, instead of transmitting over the transmission line strung along parallel to the track or right-of-way currents of the ordinary telephonic frequencies, there is superposed upon such a line carrier currents or channels of relatively much higher frequencies, and the telephonic variations or signals are impressed on these carrier currents. The relatively higher frequencies transmitted over the line in a carrier system of this character will produce a correspondingly higher rate of induction and accordingly a greater amount of energy will be transmitted across the gap to and from the train than in former arrangements. On the train will be provided a station for demodulating and receiving the carrier currents inductively transmitted to a coil of wire on the train, and also modulating apparatus for transmitting carrier currents from the train to the line. By providing suitable selective arrangements in the carrier apparatus or station on each train, and by transmitting several carrier channels over the transmission line, communication may be maintained simultaneously with several trains disposed along the same route. Furthermore there is associated with the section of the transmission line parallel to the track a repeater station designed to amplify the carrier currents transmitted over the line. The output circuit of the repeater apparatus is associated with the line in such a manner that the line becomes one side of a grounded phantom circuit. By utilizing a grounded phantom cir-

cuit in this manner a loop of much greater area is provided than if merely the series metallic circuit is employed, the grounded phantom loop being in the neighborhood of twentv feet in height while the series metallic loop circuit would be only two or three feet in height. The increase in the area of the loop utilized produces a higher rate of induction in the coil on the train and a greater amount of energy may be transmitted across the gap in this manner. It may furthermore be desired to include amplifying means in the telephone station apparatus on the train for further overcoming the transmission loss of the gap between the line and the train.

The invention may be more fully understood from the following description together with the accompanying drawing, in the figure of which is illustrated a schematic arrangement embodying the invention.

In the arrangements illustrated in the drawing there is shown a transmission line including the line sections L, L′, and L″. The line section L″ is constructed parallel to the track T or right of way of a railway system. Associated with line section L′ by means of circuit 5 is a terminal station whereby the high frequency telephone carrier currents may be superposed on line section L′ or received from the line section. The terminal station includes the vacuum tube modulator 1, which may be of the duplex vacuum tube type illustrated in the U. S. Patent No. 1,343,307, in the name of John R. Carson, although other well known types of modulators may equally well be employed. There is also included in the terminal station the demodulator 2, which may be of the duplex vacuum tube type illustrated in the U. S. Patent No. 1,343,308 in the name of John R. Carson, although other well known types of demodulators may equally well be employed. Associated with modulator 1 is the source 6 wherein are generated high frequency carrier oscillations of a frequency, which for purposes of illustration may be termed frequency B. The modulator 1 operates on the well known homodyne principle in which the telephonic variations are impressed upon the high frequency carrier current and thence transmitted out over the line. Associated with demodulator 2 is the source 7 wherein are generated high frequency carrier oscillations of the frequency of the carrier current sent out from another transmitting station, which frequency for purposes of illustration may be termed frequency A. The demodulator 2 also operates on the well known homodyne principle in which the incoming carrier current, which has been modulated by the telephonic variations is demodulated, and the telephonic variations separated therefrom by beating it with an unmodulated carrier current of the same frequency. Included in the output circuit of modulator 1 is the band filter F_B adapted to readily transmit a band of frequencies, such as B, but to attenuate and extinguish frequencies outside of such range. Included in the input circuit of demodulator 2 is the band filter F_A adapted to readily transmit a band of frequencies, such as A, but to attenuate and extinguish frequencies outside of such range. The filters F_A and F_B may be of the type illustrated in the U. S. Patents No. 1,227,113 and No. 1,227,114, to G. A. Campbell, dated May 22, 1917. The input circuit of modulator 1 and the output circuit of demodulator 2 are associated with the three winding transformer 4, with which is associated a line L_1 leading to ordinary telephone apparatus and with which is associated a network N_1 adapted to balance line L_1. The output circuit of modulator 1 and the input circuit of demodulator 2 are associated with the three winding transformer 3. The transformer 3 is connected to line section L′ by circuit 5 in which is included a "high pass" filter. The other side of the transformer is connected through a similar "high pass" filter to a network N_2 adapted to balance the line section L′. The "high pass" filters may be of the type illustrated in the above mentioned G. A. Campbell patents and are designed to readily transmit the high frequency carrier currents but to attenuate and extinguish currents of lower frequencies. The line section L′ is connected through a "low pass" filter with the line section L″, the latter line section being parallel to the track T. The "low pass" filter is of the above mentioned Campbell type of filter and is designed to readily transmit the relatively low frequency currents transmitted over the line but to attenuate and practically extinguish the high frequency carrier currents transmitted thereover. Accordingly the high frequency carrier currents transmitted over line section L′ must be transmitted through the repeater station before being applied to line section L″.

The repeater station is designed for the amplification of the relatively high frequency carrier currents transmitted over the transmission line and is associated with the transmission line on each side of the "low pass" filter between sections L′ and L″ by means of circuits 8 and 9 respectively. The circuits 8 and 9 include the previously mentioned type of "high pass" filters designed to readily allow the transmission of the high frequency carrier currents and to attenuate and extinguish frequencies below such range. The circuit 8 includes windings of a three winding transformer 10, a second "high pass" filter and a network N_3 adapted to balance line section L′. Circuit 9 includes a "high pass" filter, one of the

windings of a transformer 12, a second "high pass" filter and the network N_4 adapted to balance line section L''. Associated with transformer 10 is the input circuit of an amplifier A_1 and the output circuit of an amplifier A_2. The amplifiers A_1 and A_2 may be of the well known vacuum tube type although other well known types of amplifiers may equally well be employed. The input circuit of amplifier A_2 is associated with transformer 12. The output circuit of amplifier A_1 is associated with transformer 12 and circuit 9 and also with a tap 13 to ground so that the carrier currents transmitted from amplifier A_1 will be transmitted over a phantom circuit comprising the metallic conductors of line section L'' connected in parallel and ground. As has been pointed out the utilization of a phantom circuit in this manner gives a transmission loop of much greater area than if only the metallic line was utilized and accordingly increases the rate of induction across the gap to the moving train and gives greater transmission of energy thereto.

The train station comprises a large loop 14 of wire consisting of many turns, or of series connection of separate loops each of multiple layers on successive cars of the train if desired. Connected to loop 14 by means of circuit 15 are the usual modulating and demodulating arrangements of a carrier current system and the telephone set including the transmitter 22 and receiver 23. The modulating and demodulating arrangements comprise the duplex vacuum bulb modulator 18 and the duplex vacuum bulb demodulator 17 which are similar to the devices 1 and 2 heretofore mentioned with respect to the terminal station. Furthermore vacuum bulb amplifiers may be associated with the devices 17 and 18 to make up any transmission loss in the gap between the moving train and the transmission line. Included in the train station are the networks N_6 and N_5 adapted to balance the telephone set and the circuit 15 and coil 14 respectively. A carrier current of frequency A is supplied from the oscillator generator 20 to the modulator 18 and the demodulator 2 at the terminal station is designed to operate with carrier currents of this frequency. A carrier current of frequency B is supplied to the demodulator 17 from the oscillator generator 19 as this is the carrier frequency transmitted out from the modulator 1 at the terminal station. The different carrier frequency bands, A and B, employed for transmission in opposite directions are desirable from a transmission standpoint and serve to lessen the losses due to transmission between the transmission line and the coils 14 on the train, which loss represents the equivalent of a long transmission line. There is also included in the output circuit of the modulator 18 a band filter F_A adapted to readily transmit carrier currents of frequency A and to extinguish currents of frequencies outside of this range. Included in the input circuit of demodulator 17 is the band filter F_B designed to readily transmit carrier currents of frequency B and to extinguish currents of frequencies outside of this range. The band filters F_A and F_B are similar to those already mentioned and similarly designated.

The operation of the arrangements of the invention is as follows: If it is desired to talk from the terminal station to the station on the train. the telephonic variations transmitted over line L_1 will be transmitted through transformer 4, over the input circuit of modulator 1, to the modulator 1. At this point the telephonic variations will be impressed upon a high frequency carrier current of frequency B. This high frequency carrier current modulated by the telephonic variations will then be transmitted through filter F_B over the output circuit of modulator 1, through transformer 3, through the "high pass" filter in circuit 5, over circuit 5, and thence out over line section L' from line section L' these high frequency modulated carrier currents will be transmitted over circuit 8, through the "high pass" filter in circuit 8, through transformer 10, over circuit 11, and through the amplifier A_1. One side of the output circuit of amplifier A_1 is connected to the left hand winding of transformer 12, and thence through a "high pass" filter and over circuit 9 to the sides of line section L'' connected in parallel. The other side of the output circuit of amplifier A_1 is connected over conductor 13 to ground. Accordingly the high frequency modulated carrier currents will be transmitted in amplified form from the output circuit of amplifier A_1 over a phantom circuit comprising the two metallic conductors of line section L'' connected in parallel and ground.

The high frequency carrier current in modulated and amplified form transmitted over the above described phantom circuit. which is parallel to the track T or right of way of the moving train, will by the principles of induction produce a corresponding current in the coil 14 in the car of the train. This current will then be transmitted over circuit 15, through transformer 16, over circuit 25, through filter F_B, to the demodulator 17. At this point the incoming carrier current, which is of frequency B, will be beaten by an unmodulated carrier current of frequency B from the oscillator generator 19. In this manner the incoming carrier current will be demodulated and the telephonic variations, which furthermore may be amplified in the output circuit of the demodulator, will be transmitted through transformer 21, to the telephone receiver 23.

If it is desired to communicate from the train to the terminal station, the telephonic variations from the transmitter 22 will be transmitted through the windings of transformer 21, over circuit 24, to the modulating device 18. At this point the telephonic variations will be impressed upon a high frequency carrier current of frequency A, supplied from the oscillator generator 20. A carrier current modulated by the telephonic variations will then be transmitted through amplifying means and the filter F_A in the output circuit of the modulator, and thence through transformer 16, over circuit 15, and through the coil 14 in the car of the moving train. By the principles of induction a current of corresponding characteristics will then be produced in the previously mentioned phantom circuit running parallel to the track. As the left hand winding of transformer 12 is included in this phantom circuit, the carrier currents transmitted thereover will be transmitted through transformer 12, over circuit 13, through amplifier A_2, over the output circuit of amplifier A_2, over circuit 8, and thence over line section L'. From line section L' the modulated carrier currents in amplified form will be transmitted over circuit 5 and through the "high pass" filter included therein, through the windings of transformer 3, over the input circuit of demodulator 2 and through filter F_A included therein. At this point the modulated carrier currents, which were of frequency A, will be beaten by an unmodulated carrier current of frequency A supplied from the oscillator generator 7. The incoming carrier current will be in this manner demodulated and the telephonic variations separated therefrom. The telephonic variations will then be transmitted over the output circuit of the demodulator, through windings of transformer 4, and out over line L_1, to telephone apparatus associated therewith.

While the invention has been illustrated as providing a means for communicating with moving trains, it is pointed out that it is not so specifically limited but is suitable for use in communicating with other types of vehicles moving substantially parallel to a transmission circuit. Accordingly while the arrangements have been illustrated as embodied in certain specific arrangements which are deemed desirable, it is understood that they are capable of embodiment in many and widely varied forms without departing from the spirit of the invention as defined in the appended claims:

1. In a system of communication the combination of a transmission line arranged for the transmission of high frequency carrier currents having signal variations imposed thereon, and a transportation device moving in the vicinity of said transmission line, said transportation device including apparatus wherein may be produced high frequency carrier currents by induction from the high frequency carrier currents transmitted over said transmission line, means in said transportation device for receiving the carrier currents induced in said apparatus, said means comprising a vacuum tube amplifier demodulator and a telephone receiver, and means in said transportation device for transmitting carrier currents to said apparatus, said means comprising a vacuum tube amplifier modulator and a telephone transmitter.

2. In a system of communication, a transmission line including a plurality of line sections, a terminal station wherein telephonic variations may be impressed on a high frequency carrier current and the carrier current thus modulated may be applied to one of said line sections, a repeater station interconnecting said last mentioned line section with another of said line sections, said repeater station including means for amplifying the modulated carrier currents transmitted over said first mentioned line section and for applying said modulated carrier currents in amplified form to said second mentioned line section, a transportation device moving in the vicinity of said second mentioned line section, apparatus in said transportation device wherein may be produced carrier currents by induction from the modulated carrier currents transmitted over said second mentioned line section, and means associated with said apparatus for demodulating said last mentioned carrier currents and for receiving the telephonic variations impressed thereon.

3. In a system of communication, a transmission line including a plurality of line sections, a terminal station wherein telephonic variations may be impressed on a high frequency carrier current and the carrier current thus modulated may be applied to one of said line sections, a repeater station interconnecting said line section with another of said line sections, said repeater station including means for amplifying the modulated carrier currents transmitted over said first mentioned line section and for applying said modulated carrier currents in amplified form to said second mentioned line section and to ground in such a manner that said currents will be transmitted over a phantom circuit comprising the metallic conductors of said second mentioned line section and ground, a transportation device moving in the vicinity of said phantom circuit, a circuit in said transportation device wherein may be produced carrier currents by induction from the modulated carrier currents transmitted over said phantom circuit, and a telephone station associated with said circuit in said transportation device, said tele-

phone station comprising means for demodulating the modulated carrier currents induced in said transportation device circuit and for receiving the telephonic variations impressed thereon, and means for impressing carrier currents modulated by telephonic variations on said transportation device circuit.

4. In a system of communication, a transmission line arranged for the multiplex transmission of a plurality of high frequency carrier currents, said system including a phantom circuit of large area over which said carrier currents are transmitted, a transportation device moving in the vicinity of said phantom circuit, a circuit of large area in said transportation device wherein carrier currents may be produced by induction by the carrier currents transmitted over said phantom circuit, and a carrier current telephone transmitting and receiving station associated with said circuit in said transportation device, said transmitting and receiving station comprising vacuum tube modulating means and vacuum tube demodulating means in conjugate arrangement.

5. In a system of communication, a transmission line, a telephone station associated with said line for transmitting carrier currents out over said line and for receiving carrier currents coming in over said line, said system including a phantom circuit of large area over which said carrier currents are transmitted, a transportation device moving in the vicinity of said phantom circuit, a circuit of large area in said transportation device wherein carrier currents may be produced by induction by the carrier currents transmitted over the phantom circuit, and a carrier current telephone transmitting and receiving station associated with said circuit in said transportation device.

6. In a system of communication, a transmission line including a plurality of line sections, a terminal station wherein telephonic variations may be impressed on a high frequency carrier current and the carrier current thus modulated may be applied to one of said line sections, a repeater station interconnecting said line section with another of said line sections, said repeater station including means for amplifying the modulated carrier currents transmitted over said first mentioned line section and for applying said modulated carrier currents in amplified form to said second mentioned line section and to ground in such a manner that said currents will be transmitted over a phantom circuit comprising the metallic conductors of said second mentioned line section and ground, a transportation device moving in the vicinity of said phantom circuit, a circuit in said transportation device wherein may be produced carrier currents by induction from the modulated carrier currents transmitted over said phantom circuit, and a telephone station associated with said circuit in said transportation device, said telephone station comprising means for demodulating the modulated carrier currents induced in said transportation device circuit and for receiving the telephonic variations impressed thereon, means for impressing carrier currents modulated by telephonic variations on said transportation device circuit whereby carrier currents may be induced in the phantom circuit of said transmission line, and means in said terminal station for demodulating the carrier currents coming in over said transmission line and for receiving the telephonic variations impressed thereon.

In testimony whereof, we have signed our names to this specification this 29th day of September, 1919.

LLOYD ESPENSCHIED.
HERMAN A. AFFEL.