Sept. 8, 1925. 1,552,919

C. R. GAUTHIER

ELECTRICAL COMMUNICATING SYSTEM

Filed Nov. 22, 1919 4 Sheets-Sheet 1

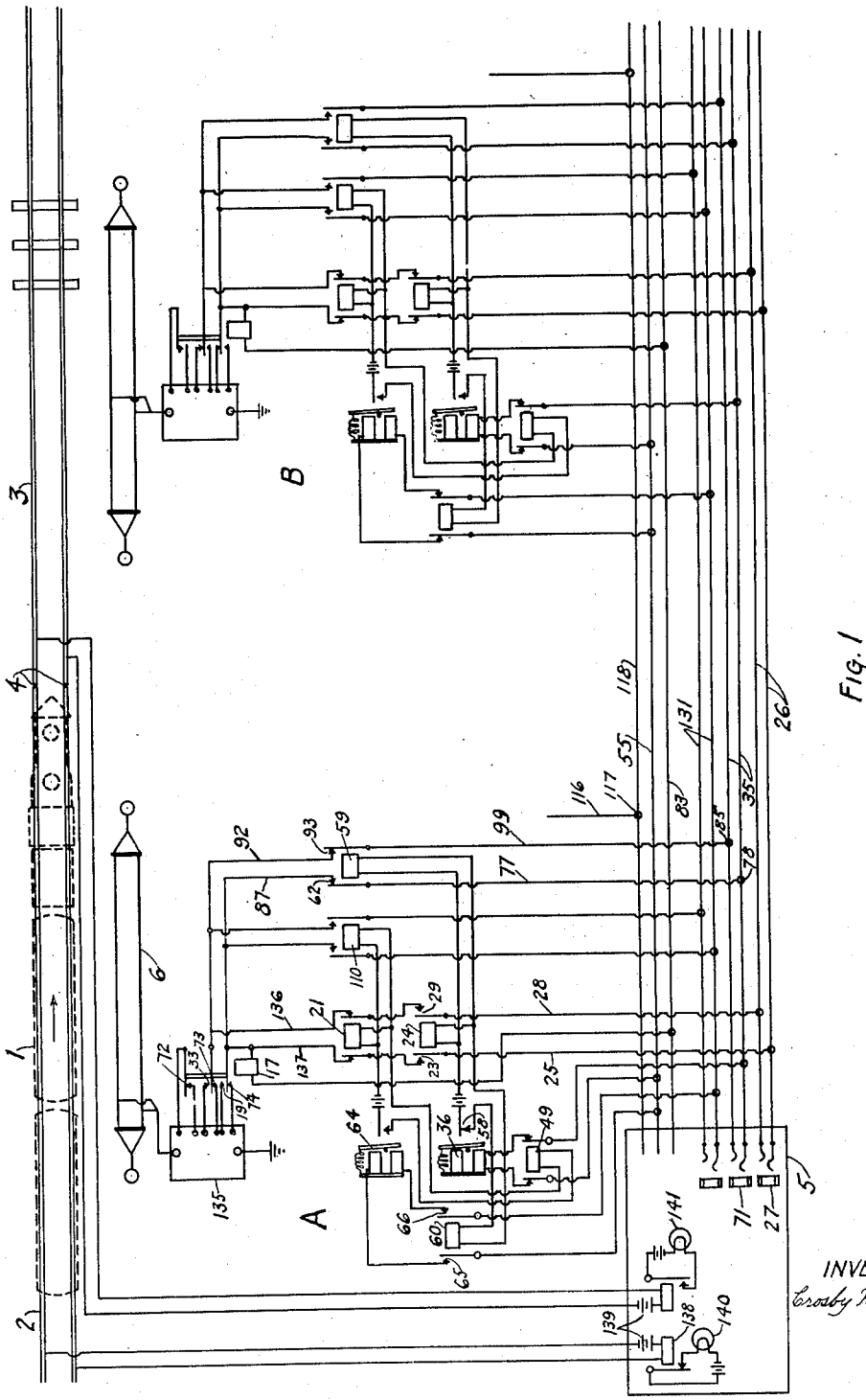

FIG. 1

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Filed Nov. 22, 1919 4 Sheets-Sheet 2

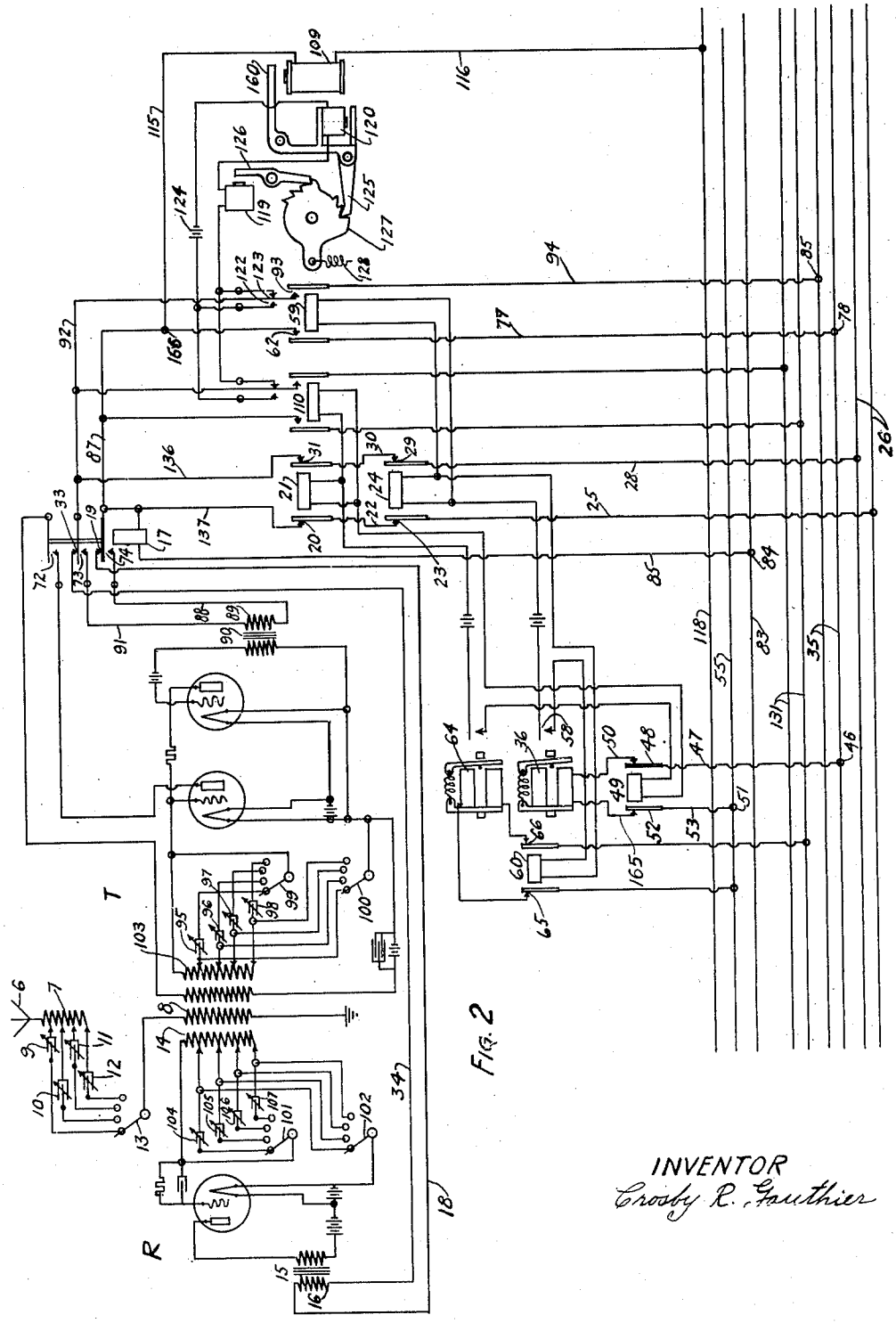

FIG. 2

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ELECTRICAL COMMUNICATING SYSTEM

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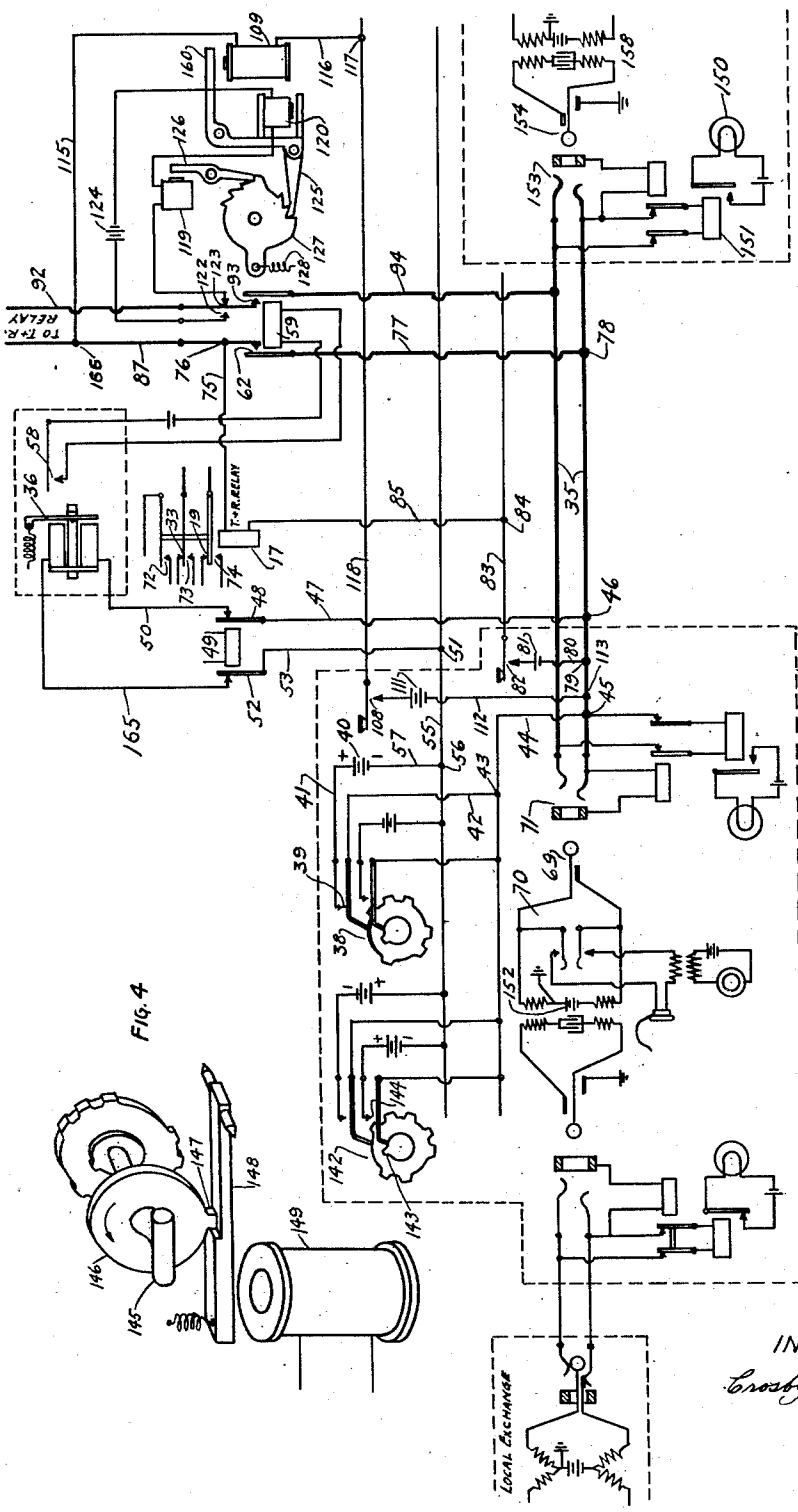

FIG. 3

FIG. 4

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ELECTRICAL COMMUNICATING SYSTEM

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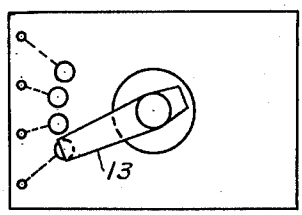

FIG. 5

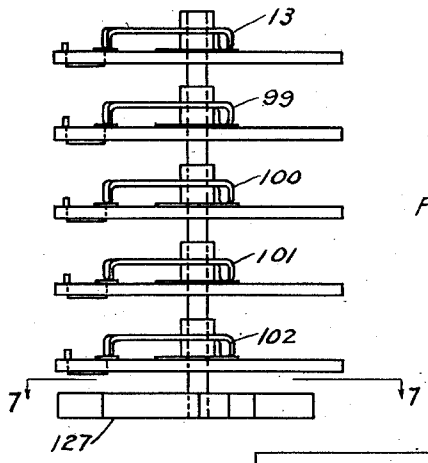

FIG. 6.

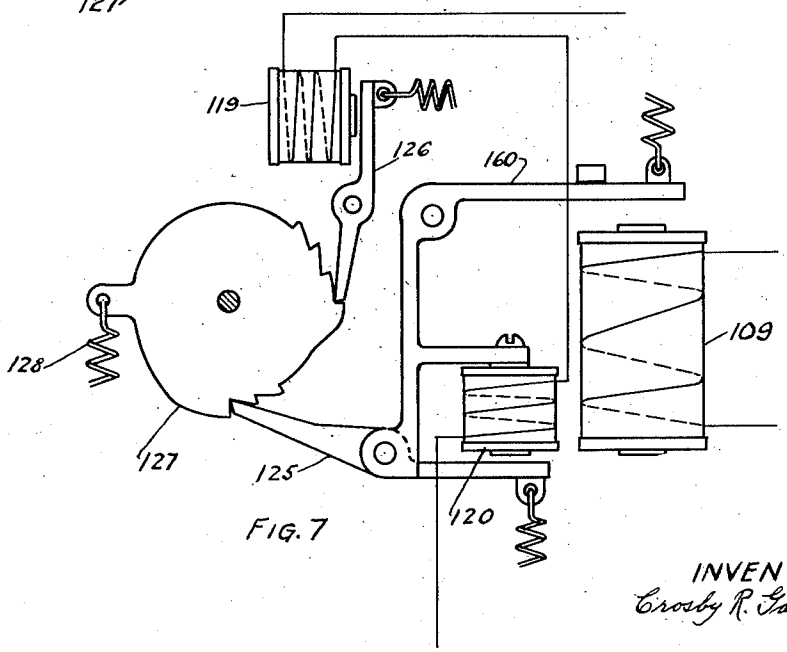

FIG. 7

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Patented Sept. 8, 1925. 1,552,919

UNITED STATES PATENT OFFICE.

CROSBY R. GAUTHIER, OF NEW YORK, N. Y., ASSIGNOR TO WIRED RADIO, INC., OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

ELECTRICAL COMMUNICATING SYSTEM.

Application filed November 22, 1919. Serial No. 340,020.

To all whom it may concern:

Be it known that I, CROSBY R. GAUTHIER, a citizen of the United States, residing at New York city, in the county of New York, State of New York, have invented certain new and useful Improvements in Electrical Communicating Systems, of which the following is a specification.

This invention relates, in general, to electrical signaling systems such as telephone and telegraph systems, and is directed more particularly to such a system wherein both radio and metallic line transmission are employed.

One object of the invention is the provision of an economical and reliable system whereby telephone or telegraph communication can be established and maintained between moving vehicles and distant stationary points or between distantly separated moving vehicles, as for example, two railroad trains.

Another object of the invention is the provision in a telephone or telegraph system of means whereby a radio station can be selectively and operatively connected to a metallic transmission line under the control of a distant operator.

Still another object of the invention is the provision of a telephone system which will permit telephone subscribers in distantly separated localities to transmit speech and the like through the medium of a plurality of distantly separated radio stations simultaneously.

One of the principal features of the invention relates to the provision of a telephone system wherein a plurality of radio stations and a plurality of telephone exchanges are situated at intervals along and operatively associated with a metallic transmission line and wherein means are provided for transmitting signals over the transmission line and into the ether from any of the telephone exchanges through the medium of all the radio stations simultaneously.

Another of the principal features of the invention consists in the provision of a system for transmitting signals to and from moving vehicles, as for example, between distantly separated trains, or between a train and a distant station. According to this feature of the invention there is preferably provided one or more metallic transmission lines along the route of the vehicle, as for instance, along a railroad track. A source of high frequency current on the vehicle or vehicles, means for suitably modulating the high frequency current in accordance with the voice or other signals also on the vehicle or vehicles, and means for impressing the modulated high frequency current on the transmission line whereby the signals are transmitted over the transmission line to the other vehicle or distant station. By such an arrangement it is practicable to provide long distance telephone or telegraph service for passengers and operators on moving trains and other vehicles without employing long distance radio transmission, thus securing at least semi-private communication and eliminating to a large extent the uncertainties inherent in long distance radio transmission.

Still another of the principal features of the invention relates to an arrangement whereby a radio station or stations can be selectively connected to a metallic transmission line or lines under the control of a distant operator. This is accomplished, preferably, by providing at each radio station a suitable selecting device or devices which is or are operable over a circuit extending to a distant control station, as for instance, a telephone exchange.

A still further feature relates to the provision of an arrangement whereby the operative frequency or wave length of a radio station or the frequency of a source of carrier current can be controlled over a metallic circuit extending to a distant control station.

There are still other features which will be readily understood from the detailed description hereinafter.

The many novel features embraced in this invention are far-reaching in their scope and are applicable in many embodiments other than that which will be described, and I therefore do not wish to be limited except as indicated by the appended claims.

The embodiment of the invention which has been chosen for a detailed description is a telephone system particularly adapted for use on railroads and which may be connected with the usual telephone systems such as the Bell system, thereby providing telephone service for passengers and trainmen on moving trains. Incidentally the invention is also adapted for train dispatching service.

This specific embodiment of the invention comprises a plurality of radio stations distributed along a railroad at relatively short intervals, each radio station being equipped with radio transmitting and receiving apparatus; one or more trunk lines extending along the railroad, at least one end of which connects with an operating or control station (which may conveniently be a telephone exchange) and means under the control of an operator at the control station whereby the radio apparatus at each of the radio stations can be connected to and disconnected from the trunk line as required. The trains on the railroad are equipped with radio transmitting and receiving apparatus and the control station is equipped with essential telephone apparatus.

Telephone communication is established between parties on the trains and the operator at the control station through the medium of the operator's telephone apparatus, the trunk line, the transmitting and receiving apparatus at the radio stations and the transmitting and receiving apparatus on the trains.

The transmitting range of each radio station is preferably quite short. It need be only a trifle more than half the distance between radio stations. In other words, if the radio stations are spaced five miles apart, the transmitting range of each radio station need be and is preferably only a trifle over two and one-half miles in each direction.

Communication is established through the medium of any one radio station, only while a train is within the range of that station. When a train passes out of the range of one radio station and into the range of a succeeding radio station, the first radio station is disconnected from the trunk line and the second radio station is connected thereto, etc.

The advantage of using a plurality of radio stations equipped with short range transmitting apparatus will be obvious to those skilled in the art. Interference is largely eliminated by this system and communication can be established over long distances. The possibility of meassages being intercepted by stations for which they are not intended is also reduced to a minimum by the use of short range apparatus. The transmitting apparatus carried by the trains is of course, also of the short range variety.

Another feature of this system comprises the use in connection with the aforementioned parts of the system, of a listening-in line extending along the railroad, at least one end of which connects with a control station. The receiving apparatus at each idle radio station is normally connected to the listening-in line and the controlling operator's telephone set can be connected thereto. The object of the listening in line is to provide means whereby parties on trains on the railroad can call the controlling operator, and whereby the controlling operator can talk through the medium of several radio stations simultaneously whenever it becomes necessary to locate a train. Upon receiving a call from a train the controlling operator selects an idle trunk line and connects thereto, the radio station nearest the train. The provision of a listening-in line reduces the number of trunk lines necessary on a railroad where there are a large number of trains travelling at the same time. For example, if there were a maximum of say twenty trains travelling at one time over a certain railroad, in order to provide communicating means for every train, without using the listening-in line it would be necessary to provide twenty trunk-lines. But the probabilities are that not more than five of these trains would require a connection at any one time and therefore five trunk lines and a listening-in line would be sufficient.

Another feature of this system is a wave-length changing device. The radio apparatus is preferably arranged to operate on a number of different wave lengths. In the drawings accompanying this specification, the radio circuits are shown arranged for operating on four different wave lengths. Of course, any desired number of wave lengths can be provided for. The wave length changing device comprises an electromagnetic step by step mechanism co-operating with a number of movable switch members, the energizing circuit of the step by step mechanism being operable by the operator at the control station. In the particular arrangement described herein, this mechanism is operable only when the radio station with which it is associated is connected to a trunk line. When a radio station is disconnected from a trunk-line it is thereupon automatically connected to a listening-in line and the wave-length changing mechanism is automatically restored to its first or normal position. Thus, every "idle" radio station is set to operate on the same wave-length. This is designated the listening-in wave length. The radio apparatus at each radio station is preferably adjusted to operate on a corresponding wave-length for each corresponding position of the wave length mechanisms.

As previously stated, means are employed whereby the various radio stations can be connected to and disconnected from a trunk-line as required.

Assuming that communication has been established with a train, as it proceeds along the road, one radio station after another will be successively connected to and disconnected from a trunk line. The preferred means whereby these connections and disconnections are accomplished comprises the use of electro-magnetic selector mechanisms, the operation of which is under the control

of an operator at the control station. The selector mechanisms or, briefly, selectors operate on combinations of electrical impulses and in the circuit herein described the selectors are of the biased polarized type, that is they operate only on combinations of unidirectional electrical impulses and each selector will respond effectively only to impulses flowing in a definite direction through its coils. Currents flowing in opposite directions through a circuit are sometimes designated, for convenience, as positive and negative currents and this designation will be used hereinafter. Each selector, then, will respond only to current impulses of a definite polarity, that is, positive or negative, and will not be affected by impulses of opposite polarity.

The selectors at every alternate radio station operate on impulses of like polarity. For example, considering four succeeding radio stations A, B, C and D, the selectors at A and C will respond to impulses of like polarity, say positive impulses, and the selectors at stations B and D will respond to impulses of like polarity, but of the polarity opposite to that to which A and C respond, that is B and D will respond to negative impulses. If it is desired to connect radio station A to a trunk line, a definite combination of positive impulses are sent over the selector circuit and the selector at A will operate and close its local circuit, thereby connecting the radio apparatus at A to the trunk-line and simultaneously disconnecting the radio apparatus from the listening-in line. As soon as a communicating train has passed out of the normal range of A, it is necessary to connect B to the trunk line and disconnect A therefrom. The selector at B is operated by sending out a definite combination of negative impulses and as stated before the negative impulses will have no effect on the selector at A. Therefore B is connected to the trunk line before A is disconnected therefrom. Immediately after the requisite combination of negative impulses to operate the selector at B have been sent out, one additional positive impulse is sent out and this operates the selector at A to restore it to normal. Upon the restoration to normal of the selector at A, that station is disconnected from the trunk-line and connected to the listening-in line. By this arrangement it will be seen, a continuous connection is maintained, there being no interruption due to transferring from station to station.

Selectors operating on combinations of electrical impulses are well known in the art. For a description of such a selector reference is made to United States Patent 1,244,544 to Charles S. Rhoades, Jr.

Impulse sending devices are also well known in the art and require no description.

A modification for an impulse sender for use with this invention will be described in the detailed description hereinafter. This modification affords a means whereby a spring operated impulse sender can be wound up and restrained from operating until released by an electromagnetically operated catch. By this provision when an operator has established a connection with a train, she can wind up the impulse senders corresponding with several succeeding radio stations and they will be released automatically when the train enters the range of the respective radio stations. Thereby, the operator is relieved of the necessity of watching signal lamps indicating the passage of the train from section to section.

An installation in accordance with this invention would ordinarily include a number of control stations. For example, an installation between Albany and Buffalo would be likely to include control stations at Albany, Utica, Syracuse, Rochester and Buffalo. Assuming that a train is proceeding from Albany to Buffalo, from the time it leaves Albany until it reaches Utica, conversations with that train can be handled by the operators either at Albany or Utica as required. If, for instance, a passenger on the train wishes to talk with a telephone subscriber in New York, the call will be handled by an Albany operator, but if the passenger wishes to talk with a telephone subscriber in Buffalo, the call will be handled by a Utica operator. Considering the first case, that is a connection between the train and a New York telephone subscriber, the call will be handled by an Albany operator as long as the train remains in the division between Albany and Utica, but if the communication continues after the train passes Utica, then the control of the operation will be transferred from Albany to Utica and the latter operator will continue to handle the call until the train reaches the next control station, namely, Syracuse, when an operator at the latter station will take it up.

To establish communication between two trains in the same division, that is located between succeeding control stations, the operator appropriates two idle trunks in that division and connects the two together by means of a suitable cord circuit. The radio station nearest one of the trains is then connected with one of the trunks, and the radio station nearest the other train is connected to the other trunk. Where the trains are in different divisions, the trunks are extended through the control station or stations, as the case may be, by means of the cord circuits. Where the trains are in adjacent divisions, the operations involved in connecting the radio stations to the trunks and changing connections as the trains pro-

ceed may be controlled by one operator, but where the trains are in distantly separated divisions, the operators at each of two control stations will be required to establish and maintain the connections.

Any suitable radio transmitting and receiving circuits can be used with this invention. The transmitting circuit shown in the drawings accompanying this specification is based on that shown in United States Patent No. 1,273,789 to William C. White and the receiving circuit is one well known in the art. No detailed description, therefore, will be required for an understanding of these circuits.

Substantially the same radio circuits as are provided at the radio stations would also be provided on the trains except for obvious modifications, as, for instance, the remote control wave length changing arrangement would not be provided on the train. It is therefore thought that there is no necessity for showing the radio circuits for use on the trains. No provision is shown for amplifying the received signals, but it will be obvious that amplifiers can be used if required.

Provisions are shown in the circuits for operating the radio transmitting apparatus and the radio receiving apparatus, alternately. This provision comprises a transmitting and receiving relay, one at each radio station, the energizing circuits of which are controlled by the operators at the control stations. The transmitting and receiving apparatus is arranged to operate alternately in order to prevent the well known howling effect which might otherwise result. The transmitting and receiving relay will be hereinafter referred to as the T & R relay.

Referring to the drawings—Fig. 1 is a fragmentary general arrangement showing two radio stations, with associated antennæ and selector apparati; two trunk-lines; a listening-in line; a control station connecting with the lines; a railroad track with a passing train indicated thereon in dotted lines; and lamp signals at the control station for indicating the positions of trains. Many of the details are omitted from this figure.

Fig. 2 is a circuit diagram of a complete radio station with connections to trunk lines, listening-in lines and lines serving the T & R relays, selectors and wave length changing mechanisms.

Fig. 3 is a fragmentary circuit diagram showing a trunk line connecting two control stations and impulse sending devices associated with one of the control stations together with a circuit arrangement illustrating the operation of one selector at a radio station. The operating circuit for a wave length mechanism and a T & R relay are here shown. Jacks forming terminals of the trunk and signal lamps for indicating the operative condition of the trunk line and a talking cord circuit at one of the control stations are shown. A trunk leading from one of the control stations to a local telephone office and part of a cord circuit at the local telephone office are also shown.

Figure 4, illustrates the modification for the impulse sender hereinbefore referred to.

Figures 5, 6 and 7 show the wave-length changing mechanism of which Figure 5 is a plan view of one of the radial switches.

Figure 6 is a side elevation showing five radial switches, arranged in superposed relation to each other.

Figure 7 is a sectional view on line 7—7 of Figure 6, showing the electro-magnetic step by step mechanism whereby the rotatable ratchet member is driven.

Before embarking upon a description of the operation of the system, a brief description of the mechanisms illustrated in Figs. 4, 5, 6 and 7 will be given.

There is represented in Fig. 4 an ordinary impulse sending key of the type employed in train dispatching systems except that a simple provision is shown for rendering the operation of the key semi-automatic. The disc 146 is integral with the winding handle 145, and is provided with a lug 147, which bears against a shoulder of armature 148 and is thereby prevented from unwinding. The key is wound by turning in the direction indicated by the arrow, and in unwinding turns in the opposite direction. It will be quite clear from the drawing that when electromagnet 149 is energized, armature 148 is attracted, and the key is thereupon free to unwind. The impulses are sent while the key is unwinding.

The wave length changing switch of Figs. 5, 6 and 7 comprises five contact wiper arms 13, 99, 100, 101 and 102, each of which is operatively and individually associated with a set of four fixed contact points. All the contact wiper arms are insulatively mounted on a common rotatable shaft, to the end of which is secured a ratchet member 127. The mechanism for operating the ratchet member comprises a stepping pawl 125, which is pivotally attached to the armature 160 of the stepping magnet 109. 126 is a holding pawl, and 119, 120 are releasing magnets. Each energization of stepping magnet 109 will effect a forward movement of stepping pawl 125, and will accordingly step ratchet member 127 forward. The latter is held in any of its forward positions by holding pawl 126, and may be released by energization of electromagnets 119 and 120, whereupon it is restored to normal, together with the contact wiper arms, by the restoring spring 128. It will be understood that the several contact wiper arms engage successive fixed contacts

for each successive forward step of the ratchet member.

In the following description of operation of this invention, it will be assumed that a calling party on a train running from Albany to Buffalo wishes to communicate with a telephone subscriber in Albany. The train is situated somewhere between Albany and Utica and proceeding toward the latter city. Referring to Figure 1 of the drawings, 1 is the train; 2 and 3 are sections of track insulated at point 4; 5 is the control station at Albany; 6 is the antenna associated with radio station A. Radio station B is similar in all respects to radio station A and will therefore require no separate description. 135 is the radio apparatus at radio station A. 17 is the T & R relay the contacts of which are shown in transmitting position. 35 and 131 are two trunk lines and 26 is a listening-in-line, terminating in jack 27. 21 and 24 are relays controlling the connection of the radio apparatus with the listening-in line. 59 and 110 are relays controlling the connection of the radio apparatus with the trunk-lines 35 and 131 respectively. 49 is a relay for cutting off selector 36 and 60 is a relay for cutting off selector 64. All the above relays except relay 17 are in local circuits controlled by selectors 36 and 64 respectively.

The train 1 being in section 2 of the track and therefore within the range of radio station A, the call from the train is picked up by the antenna 6 and receiving apparatus R at radio station A. Referring to Fig. 2, the antenna circuit for the listening-in position consists of antenna 6, inductance 7, condenser 9, switch 13, inductance coil 8 and ground. The received signal is induced into the coil 14 of the receiver circuit R rectified and somewhat amplified by said receiver circuit and induced in the form of voice modulated current into the secondary 16 of transformer 15 which transformer may or may not be provided with a core of magnetic material. The circuit from secondary coil 16 to the listening in line 26 comprises conductors 18 and 34, contacts 19 and 33 of the T & R relay 17, this relay being at the time de-energized, conductors 136 and 137, contacts 20 and 31 of relay 21, conductors 22 and 30, contacts 23 and 29 of relay 24 and conductors 25 and 28. The listening in line 26 terminates in jack 27 and the controlling operator's telephone is connected to that jack.

The operator upon hearing the call and determining the location of the train, selects idle trunk line 35, and plugs into jack 71 with plug 69 of cord circuit 70 (see Fig. 3). She then winds the impulse sender 38 and releases it. The contact 39 of the impulse sender 38 is thereupon operated to send out a definite combination of positive impulses operating selector 36 at radio station A. The circuit from impulse sender 38 to selector 36 comprises contact 39, conductor 41, battery 40, conductor 57 to point 56, conductor 55 to point 51, conductor 53, armature 52 of relay 49 and its contact, conductor 165, winding of selector 36, conductor 50, armature 48 of relay 49 and its contact, conductor 47 to point 46, ring side of trunk line 35 to point 45, conductor 44 to point 43, conductor 42 to contact 39. Contact 58 is closed by the operation of selector 36, and relays 24, 59 and 60 are thereupon energized, their circuits being closed by contact 58.

Energizing relay 60 breaks contacts 65 and 66 thus disconnecting selector 64, thereby preventing its operation. Energizing relay 24 breaks contacts 23 and 29, disconnecting the radio apparatus from the listening in line and energizing relay 59, closes contacts 62 and 93 connecting the radio apparatus to the trunk line. Contact 62 is in the circuit of step by step magnet 109 of the wave length mechanism, and since that contact is now closed the wave length mechanism can be operated by the controlling operator.

The circuit whereby the controlling operator operates the wave length mechanism comprises switch contact 108 at the Albany control station, conductor 118 to point 117, conductor 116, electromagnet 109, conductor 115 to point 166, conductor 87, contact 62 of relay 59, conductor 77 to point 78, ring side of trunk line 35 to point 113, conductor 112, battery 111, and contact 108. Each time contact 108 is closed, electromagnet 109 is energized and the wave length switches are advanced one step. A suitable switching mechanism would ordinarily be provided for operating contact 108 the required number of times for any desired wave length.

The circuit for operating the T & R relay is controlled by switch contact 82 and comprises battery 81, conductor 80 to point 79, ring side of trunk line 35 to point 78, conductor 77, contact 62 of relay 59, conductor 87 to point 76, conductor 75, T & R relay 17, conductor 85 to point 84, conductor 83 to contact 82. Closing contact 82 energizes T & R relay 17 which closes contacts 72, 73 and 74, thus connecting the transmitting circuit T to the trunk line 35. With T & R relay 17 energized, the circuit from primary coil 89 of transformer 90 to trunk line 35 comprises conductor 88, contact 74, conductor 87 contact 62 of relay 59, conductor 77 to point 78 on the ring side of the trunk line, point 85 on tip side of trunk line, conductor 94, contact 93 of relay 59, conductor 92, contact 73 of T & R relay 17, conductor 91 to primary coil 89 of transformer 90. A circuit such as that just described for the T & R relay is associated with each of the trunks and the listening-in line.

Referring to the radio transmitting circuit T shown in Fig. 2, it will be noted that condenser 95 is connected in circuit by virtue of switch member 99 being in the first or listening in position. When switch member 99 is shifted to second, third, and fourth positions, condensers 96, 97 and 98 respectively are connected into the circuit. Only one of the condensers is in circuit at a time. Likewise, a different number of turns of coil 103 are connected in circuit for each position of switch member 100. Coil 103 and the condensers 95, 96, 97, and 98 constitute the oscillating circuit of the transmitter and by the use of condensers of various capacities together with various numbers of turns of the coil 103, the natural frequency of this oscillating circuit, and consequently the wave length, is varied. The wave length of the receiving circuit is likewise varied through the medium of the condensers 104, 105, 106 and 107 and the wave length of the antenna is varied by means of condensers 9, 10, 11 and 12. The wave length of the transmitting circuit, receiving circuit and antenna circuit is of course varied simultaneously.

The train being in track section 2, relay 138 is energized by battery 139 and the local circuit of signal lamp 140 is closed thus lighting that lamp. Signal lamp 140 indicates to the operator the location of the train. When the train passes out of section 2, into section 3, and therefore out of the range of radio station A, and into the range of radio station B, signal lamp 141 will be lighted and lamp 140 will be extinguished. The operator is thus notified to transfer the connection from radio station A to radio station B, and this is accomplished by operating impulse sender 142, sending out a combination of negative impulses. Negative impulses will not affect the selector of radio station A, as it is designed to operate only on positive impulses, and consequently the radio apparatus at radio station B will be connected to trunk line 35, while that at radio station A still remains connected thereto. However, after impulse sender 142 has finished sending its combination of negative impulses, the lug 143 will cause the operation of contact 144, thereby sending out one positive impulse which will operate to return selector 36 at radio station A to its normal position. Radio station A will thereupon be disconnected from trunk line 35 and connected to listening in line 26. Relay 59 being deenergized by the opening of its circuit, its armatures will be restored to normal breaking contacts 62, 93 and 122. But before contact 122 breaks, contact 123 will make thus momentarily establishing a circuit through release magnets 119 and 120 of the wave length mechanism, and battery 124. The holding pawl 126 and stepping pawl 125 will be thereby released, and the ratchet 127 together with switch members 13, 99, 100, 101 and 102 will be restored to normal, that is the listening in position.

The electromagnets 149 of the impulse sender release mechanisms Fig. 4 would ordinarily be connected in the circuits of signal lamps 140 and 141, and would be energized upon a train entering the corresponding sections of the track. Referring to Fig. 3 it is seen that trunk line 35 interconnects two control stations and terminates in a jack at each end. Signal lamps and associated relays are shown for indicating busy lines. When plug 69 is inserted in jack 71 a circuit will be established from battery 152 of cord circuit 70, at Albany through relay 151, at Utica, energizing that relay; causing its armature to be pulled up closing the circuit of signal lamp 150. Lighting of signal lamp 150 will indicate to the Utica operator that trunk line 35 is busy. When the train approaches Utica the Albany operator will call the Utica operator on an order wire or by other means not shown and ask the Utica operator to take over control of the connection. The Utica operator will insert plug 154 into jack 153 and the plug at the other end of the cord circuit 158, into the jack of a succeeding trunk line extending to Syracuse, the next control station. The operation is then a repetition of that which has been previously described.

No flash back signal is shown for indicating to the Albany operator that the conversation has been completed, and the connection may be taken down, but such signalling arrangements are old in the art and will be obvious. In the circuits described only one radio station is connected to the same trunk line at one time, but if desired the circuits can be readily modified so that more than one radio station can be connected at one time to the same trunk line.

In the event that an operator wishes to communicate with a train in her division the position of which she does not know, she will plug her telephone set into the listening-in line jack and operate the T & R key associated therewith, thereby connecting the transmitting apparatus at all the radio stations in her division or one of her divisions, as the case may be, to the listening-in line, and she may then speak through the medium of all the so-called radio stations simultaneously and ask for the position of the desired train. Upon receiving the necessary information from an operator on the wanted train, she will transfer the connection to an idle trunk and proceed as previously described.

Two trunk lines 35 and 131 respectively are shown in Figs. 1 and 2. Two selectors 36 and 64 are shown at radio station A,

co-operating with trunk lines 35 and 131 respectively and two relays 49 and 60 are shown co-operating with the selectors. When selector 36 is operated and contact 58 is closed, it will be seen that the circuit of relay 60 will be energized, and contacts 65 and 66 will be open cutting off selector 64. Likewise if selector 64 were operated, relay 49 would be energized cutting off selector 36. It is obvious that the functions of relays 21, 49 and 110 can be performed by a single relay and likewise the functions of relays 24, 59 and 60 can be performed by a single relay. Greater simplicity of illustration is accomplished, however, by showing three relays instead of one. Furthermore it is obvious that these relays can be entirely eliminated by the use of a selector designed to directly operate the contacts operated by these relays.

Where a system in accordance with this invention is utilized as a broadcasting system, the automatic selectors at the radio stations may, if desired, be eliminated, and the radio apparatus can be connected directly to a transmission line or through the medium of plugs and jacks or the like. But it is preferable to retain the selectors, as it may be desirable at times to broadcast through only one or two stations at a time. Where the specific arrangement shown and described herein is used for broadcasting purposes, either the listening-in line or a trunk may be employed as the medium for transmitting the signals from the control stations to the radio stations. The signals to be broadcasted may be transmitted from any of the control stations and into the ether through the medium of all the radio stations simultaneously.

The system herein described in detail is equally applicable with perhaps slight modifications for use in communicating with ships at sea and particularly ships running coastwise. If used in such a connection, the radio stations would obviously be located along the coast. It is also applicable, of course, for communicating with river-going vessels.

What is claimed is:

1. A signaling system comprising a plurality of radio stations situated at intervals, a transmission line multiply associated with said radio stations and means remotely operable whereby said radio stations can be selectively connected with said transmission line.

2. A signaling system comprising a plurality of radio stations situated at intervals, a control station, a transmission line multiply associated with said radio stations and connected with said control station, and means operable from said control station whereby said radio stations can be individually connected to said line.

3. A signaling system comprising a plurality of radio stations situated at intervals, a control station, a line multiply associated with said radio stations and connected with said control station and selective means operable from said control station whereby said radio stations can be individually connected to said line.

4. A signaling system comprising a plurality of radio stations situated at intervals, a plurality of transmission lines multiply associated with said radio stations and automatic selective means whereby said radio stations can be individually connected to any of said lines.

5. In a signaling system, a radio station comprising radio apparatus, a transmission line associated with said radio station and automatic selective means at said radio station whereby a terminal of said line can be connected to and disconnected from said radio apparatus.

6. A signaling system comprising a plurality of radio stations situated at intervals, a transmission line multiply associated with said radio stations, automatic means for selectively putting said radio stations into communicative relation to said line and means whereby a signal may be transmitted over said line to a selected radio station and re-transmitted from said selected radio station into the ether through the medium of electromagnetic waves.

7. A signaling system comprising a plurality of radio stations situated at intervals, a transmission line multiply associated with said radio stations, a control station associated with said line, means operable from said control station whereby any of said radio stations can be selectively put into communicative relation to said line, and means whereby signals can be transmitted from said control station over said line to any of said radio stations which may be in communicative relation thereto, and retransmitted into the ether through the medium of electromagnetic waves.

8. A signaling system comprising a plurality of radio stations situated at intervals, a plurality of transmission lines multiply associated with said radio stations, said radio stations normally connected with one of said lines and disconnected from the other or others and selective means operable to disconnect any of said radio stations individually from the line to which it is normally connected and connect it to another of said lines.

9. In a signaling system, a radio station comprising radio apparatus, a transmission line associated with said radio station and selective means remotely operable whereby said radio apparatus can be connected to and disconnected from a terminal of said transmission line.

10. In a signaling system, a radio station comprising radio apparatus, a transmission line associated with said radio station, a control station associated with said line, selective means at said radio station operable from said control station whereby said radio apparatus can be connected to a terminal of said line.

11. In a signaling system, a radio station comprising radio apparatus, a plurality of transmission circuits associated with said radio station and automatic selective means at said radio station whereby said radio apparatus can be put into communicative relation with any of said lines.

12. In a signaling system, a radio station comprising radio apparatus, a transmission line associated with said radio station, a control station connected with said line, electromagnetic tuning means at said radio station adapted to change the operating wave length of said radio apparatus, said tuning means operable from said control station, and a circuit for said tuning means including said transmission line.

13. In a signaling system, a radio station, comprising radio apparatus; means remotely operable, whereby said radio apparatus can be connected to and disconnected from a trunk line, and means remotely operable when said radio apparatus is connected to said trunk line, whereby the operating wave length of said radio apparatus can be varied.

14. In a signaling system, a radio station, comprising radio apparatus, means remotely operable, whereby said radio apparatus can be connected to and disconnected from a trunk line, an electro-magnetic switching mechanism, remotely operable whereby the operating wave length of said radio apparatus can be varied, a circuit and a source of current for said electro-magnetic switching mechanism and means for interrupting said circuit.

15. In a signalling system, a radio station comprising radio apparatus, a selector responsive to a combination of electrical impulses and a relay controlled by said selector, two transmission lines associated with said radio station and means including said relay for connecting said radio apparatus to said transmission lines alternately.

16. In a signalling system, a radio station comprising radio apparatus, a plurality of selectors at said radio station, a relay for and controlled by each selector, each of said selectors adapted to close a circuit for operating its respective relay in response to a definite combination of electrical impulses, a plurality of transmission lines associated with said radio station, each of said transmission lines associated with one of said selectors and a plurality of means each including one of said relays for connecting said radio apparatus to the transmission line associated with an operated selector.

17. In a signaling system, a radio station comprising radio apparatus, a biased polarized selector at said radio station, said selector responsive to a definite combination of electrical impulses of a definite polarity, two transmission lines associated with said radio station, said radio apparatus being normally connected to one of said transmission lines, said selector operable to disconnect said radio apparatus from said first mentioned transmission line and to connect said radio apparatus to the other of said transmission lines.

18. In a telephone system-comprising a plurality of radio stations, each of said radio stations, comprising radio apparatus, and selective means whereby said radio apparatus can be connected to and disconnected from a trunk line, said means comprising a selector responsive to a definite combination of electrical impulses of a definite polarity, alternate radio stations being equipped with selectors responsive to positive impulses, and intermediate radio stations with selectors responsive to negative impulses.

19. In a telephone system, a plurality of radio stations, a selector for each of said radio stations, whereby the radio apparatus can be connected to a trunk line, said selectors at alternate radio stations responsive to definite combinations of electrical impulses of positive polarity, and said selectors at intermediate radio stations responsive to definite combinations of electrical impulses of negative polarity; a control station connected tc said trunk line, comprising impulse sending devices for operating said selectors, each of said impulse sending devices being arranged to send out a definite combination of impulses of one polarity followed by an impulse of opposite polarity.

20. In a telephone system, comprising a plurality of radio stations, a trunk line, a control station, means operable from said control station, whereby radio apparatus at said radio stations can be connected to and disconnected from said trunk line; a relay at each of said radio stations operable from said control station, whereby the transmitting apparatus and receiving apparatus at said radio stations can be alternately connected to and disconnected from said trunk line.

21. A signalling system comprising a plurality of way stations situated at intervals, a transmission line multiply associated with said way stations, but normally out of communicative relation therewith, a listening-in circuit multiply associated with said way stations and normally in communicative relation therewith, and selective means whereby said way stations can be individually put out of communicative relation to said

listening-in line and into communicative relation with said transmission line.

22. A signalling system comprising a plurality of radio stations situated at intervals, a transmission line multiply associated with said radio stations and normally out of communicative relation therewith, a listening-in line multiply associated with said radio stations and normally in communicative relation therewith, a control station jointly associated with said transmission line and said listening-in line, and means operable from said control station whereby said radio stations, individually, can be put into communicative relation to said transmission line and out of communicative relation with said listening-in line.

23. In a signaling system, a plurality of radio stations situated at intervals, a transmission line multiply associated with said radio stations, a control station associated with said line, means whereby a signal can be propagated from said control station over said line to any of said radio stations, selectively, and means including electromagnetic waves whereby said signal can be further propagated into the ether.

24. In a signaling system, a plurality of radio stations, a transmission line multiply associated with said radio stations, a control station associated with said line, means including said line whereby said control station can be put into communicative relation with said radio stations individually and means whereby signals can be transmitted from all of said radio stations to said control station simultaneously.

25. A signaling system comprising a plurality of radio stations situated at intervals in operable relation to a railroad, a transmission line multiply associated with said radio stations, radio apparatus carried by a vehicle on the tracks of said railroad, adapted to communicate with said radio stations, and means responsive to the relative position of said vehicle on said tracks whereby said radio stations can be individually put into and out of communicative relation to said line.

26. A signaling system comprising signal propagating means, a plurality of transmission lines associated with said signal propagating means, a plurality of selectors each associated with one of said transmission lines and operable to connect said transmission line to said signal propagating means and when so operated to preclude the other of said selectors being operated.

27. In a signaling system, a plurality of signal stations, each comprising signaling apparatus and a plurality of selectors, a plurality of transmission circuits multiply associated with said signal stations, each selector at each signal station operable to connect one of said transmission circuits to the signaling apparatus associated with said selector and when so operated to prevent the operation of the other of said selectors associated with said last mentioned signaling apparatus.

28. A signaling system comprising a plurality of radio stations situated at intervals, a transmission line multiply associated with said radio stations, a control station associated with said line, means whereby messages may be transmitted in both directions over said line between any of said radio stations and said control station, selective means operable from said control station whereby said radio stations can be individually put into and out of communicative relation to said line and means associated with said radio stations and said control station jointly whereby an operator at said control station can receive signals from all of said radio stations, simultaneously.

29. A signaling system comprising a plurality of radio stations situated at intervals, a line multiply associated with said radio stations, a control station associated with said line, selective means operable from said control station whereby said radio stations can be individually put into and out of communicative relation to said line, means whereby an operator at said control station can receive signals from said radio stations both individually and collectively, and means operable from said control station whereby the operating wave length of said radio stations can be varied.

30. In a signaling system, a plurality of radio stations each comprising radio transmitting and receiving apparatus, a line multiply associated with said radio stations, a control station associated with said line, selective means operable from said control station whereby said radio stations can be individually put into and out of communicative relation to said line, means jointly associated with said radio stations and said control station whereby an operator at said control station can receive signals from all of said radio stations simultaneously, means operable from said control station whereby the transmitting and receiving apparatus at said radio stations can be alternately put into and out of communicative relation to said line, and means operable from said control station whereby the operating wave length of said radio stations can be varied.

31. In a signaling system, a plurality of radio stations situated at intervals in operable relation to a railroad, a line multiply associated with said radio stations, a control station associated with said line, selective means whereby said radio stations can be individually put into and out of communicative relation to said line, radio apparatus carried by a vehicle on the track of said

railroad, means responsive to the position of said vehicle for controlling said selective means whereby said radio stations can be progressively connected to said line as said vehicle progresses, to the end that the radio apparatus carried by said vehicle may be constantly in communicative relation with one of the two of said radio stations with which it is in closest propinquity at any point on the railroad at which the vehicle may be momentarily situated.

32. In a signaling system, a plurality of radio stations, a line multiply associated with said radio stations, an electromagnetic selector at each of said radio stations whereby said radio stations can be put into and out of communicative relation to said line, a control station associated with said line, impulse sending means for controlling said selectors, means for operating said impulse sending means, locking means for restraining said impulse sending means, electromagnetic means for releasing said locking means, and means for energizing said electromagnetic means.

33. In a system comprising a metallic transmission line and a plurality of radio stations situated along said line, the method of signaling which consists in transmitting electrical signals over the metallic circuit and thence into the ether from each of a plurality of radio stations progressively.

34. The method of signaling which consists in transmitting electrical signals over a metallic circuit to a radio transmitting station, propagating the signals from the radio transmitting station into the ether and subsequently transmitting other signals over the metallic circuit to another radio transmitting station, and propagating the last mentioned signals into the ether from the last mentioned radio transmitting station.

35. The method of signaling which consists in selectively connecting one of a plurality of radio stations to a metallic circuit, transmitting electrical signals over said circuit to said radio station and thence into the ether by electromagnetic waves and subsequently selectively connecting another of said radio stations to said circuit, transmitting other signals over the circuit to the last mentioned radio station and thence into the ether by electromagnetic waves.

36. The method of signaling between two vehicles which consists in transmitting a signal from one of said vehicles through the ether to a radio station, thence propagating the signal over a metallic circuit to a second radio station and thence propagating the signal through the ether to the other of said vehicles.

37. The method of signaling which consists in selectively connecting each of a plurality of radio stations, one after another to a metallic circuit and transmitting electrical signals over the metallic circuit and into the ether through the medium of said radio stations.

38. A signaling system comprising a radio station, a plurality of transmission lines associated with said radio station, said radio station normally connected with one of said lines and disconnected from the other or others of said lines, and automatic selective means operable to disconnect said radio station from the line to which it is normally connected and connect it to another of said lines.

39. In a signaling system, a plurality of radio stations, a transmission line, a control station, means operable from said control station whereby radio apparatus at said radio stations can be connected to and disconnected from said transmission line, a relay at each of said radio stations operable from said control station whereby the transmitting apparatus and receiving apparatus at said radio stations can be alternately connected to and disconnected from said transmission line.

40. In a system for signaling between moving vehicles, a transmission line situated along the vehicular route, means for transmitting signals over said line from one vehicle to another, said means including a source of high frequency carrier current on one vehicle, and means on the other vehicle for receiving the signals from said transmission line, a control station associated with said transmission line and means at said control station whereby an operator thereat can selectively establish channels of communication between the said vehicles.

41. A telephone system comprising a transmission line, a plurality of distantly separated radio transmitting stations situated along said line and operatively associated therewith, a plurality of control stations situated at intervals along said line, and means whereby voice signals and the like may be transmitted from any of said control stations over said line and thence into the ether from all said radio stations simultaneously.

42. In a telephone system, a plurality of distantly separated telephone exchanges, a transmission line interconnecting said telephone exchanges, means at certain of said telephone exchanges for connecting telephone subscribers' lines to said transmission line, and a plurality of radio transmitting stations situated along said line and operatively associated therewith.

43. In a telephone system, a transmission line, a plurality of stations situated at distantly separated points along said line, a plurality of said stations each comprising a generator of high frequency continuous wave oscillatory current, and means for modulating said oscillatory current in ac-

cordance with the voice signals transmitted over said line, and means at each of a plurality of said stations for transmitting voice signals over said line.

44. In a telephone system, a calling subscriber's station, a called subscriber's station, a line connected with at least one of said stations, a source of high frequency carrier current, automatic means operable over said line for selectively associating said source of carrier current with said line, and means including said source of carrier current and said line for transmitting speech between said subscribers' stations.

45. In a signaling system, a plurality of radio stations, a plurality of control stations, a metallic transmission line or lines interconnecting said radio stations and said control stations, and means whereby signals can be transmitted from any of said control stations over said transmission line or lines and into the ether from all said radio stations simultaneously.

46. A signaling system comprising a transmission line, a plurality of radio stations each including a high frequency generator for propagating electromagnetic waves into the ether, said radio stations being situated at intervals along said line, and means remotely operable whereby said radio stations can be selectively connected with said transmission line.

47. A signaling system comprising a transmission line, a plurality of radio stations situated at intervals along said line, a control station connected with said line, and means operable from said control station whereby said radio stations can be selectively connected with said transmission line.

48. A signaling system comprising a plurality of transmission lines, a plurality of radio stations situated at intervals along said line, and remotely operable selective means whereby said radio stations can be individually connected to any of said lines.

49. A signaling system comprising a transmission line, a plurality of radio stations situated at intervals along said line, each of said radio stations including a high frequency generator for the propagation of electromagnetic waves into the ether, automatic means for selectively putting said radio stations into operative relation to said line, and means whereby signals can be transmtted over said line to a selected radio station and retransmitted from said selected radio station into the ether through the medium of electromagnetic waves.

50. The combination in a telephone system, of a source of high frequency carrier current for the propagation of speech, a telephone transmission line, and automatic switching means for operatively associating said source of carrier current with said line.

51. The combination in a telephone system, of a plurality of sources of high frequency carrier current for the propagation of speech, a telephone transmission line, and automatic means for selectively and operatively associating said sources of carrier current with said line.

52. The combination in a telephone system, of a plurality of sources of high frequency carrier current for the propagation of speech, a plurality of transmission lines, and automatic selecting means for operatively associating any of said sources of carrier current with any of said lines.

53. In a signaling system, a transmission line, a plurality of sources of high frequency carrier current operatively associated with said line, and means operable over said line for varying the frequency of operation of any of said sources.

54. In a telephone system, an operator's position, an incoming line at said position, outgoing lines terminating at said position, means at said position for interconnecting said incoming line with any of said outgoing lines, a plurality of carrier current channels, a called subscriber's station, and automatic means under the control of an operator at said position for extending a talking path from said incoming line to said called subscriber's station, said talking path including one of said outgoing lines, said automatic means being operable to selectively and operably associate one of said carrier current channels with the outgoing line included in the talking path.

55. In a telephone system, a calling subscriber's station, a called subscriber's station, a line connected with at least one of said stations, a plurality of sources of high frequency carrier current, automatic means for selectively associating said sources of carrier current with said line, and means including said line and a selected one of said sources of carrier current for transmitting speech between said subscribers' stations.

56. In a telephone system, a calling station, a called station, a line connected with at least one of said stations, a source of high frequency carrier current, automatic means controllable from said calling station for selectively associating said source of carrier current with said line, and means including said line and said source of carrier current for transmitting speech between said stations.

57. In a signaling system, a transmission line, a plurality of sources of high frequency carrier current operatively associated with said line, and means operable over said line for varying the frequency of operation of any of said sources.

58. In a telephone system, a calling station, a called station, a line connected with at least one of said stations, a source of high

frequency carrier current, an impulse sending device at said calling station, automatic means operable under the control of said impulse sending device for extending a signaling path including said line between said stations, and means including said source of carrier current and said line for propagating speech between said stations.

59. In a telephone system, a calling station, a called station, a line connected with at least one of said stations, an impulse sending device at said calling station, a plurality of sources of high frequency carrier current, automatic means operable under the control of said impulse sending device for extending a signaling path including said line between said stations, said automatic means being operable for selectively associating any of said sources of carrier current with said line, and means including said line and the selected source of carrier current for propagating speech between said stations.

60. In a telephone system, a calling subscriber's station, an operator's position, a line from said calling subscriber's station to said operator's position, a called subscriber's station, a trunk terminating at said operator's position, means at said operator's position for connecting said calling subscriber's line with said trunk, a source of high frequency carrier current, and automatic means operable under the control of an operator at said position for operatively associating said source of carrier current with said trunk, and means including said line, said trunk, and said source of carrier current for propagating speech between said subscribers' stations.

61. In a signaling system, the combination with a metallic transmission line of a source of high frequency waves, means operable over said line for connecting the terminals of said line with said source, means for propagating signals over said line to said high frequency source, and means for modulating the high frequency waves in accordance with said signals.

62. A signaling system comprising a transmission line, a plurality of radio stations each including a high frequency generator for propagating electro-magnetic waves into the ether, said radio stations being situated at intervals along said line, and means remotely operable whereby said radio stations can be selectively controlled.

63. A signaling system comprising a transmission line, a plurality of radio stations situated at intervals along said line, a control station connected with said line, and means operable from said control station whereby said radio stations can be selectively controlled.

64. In a signaling system, a transmission line, means for transmitting signals over said line, a plurality of stations situated along said line, means at each of said stations for propagating high frequency signal waves, means for modifying said high frequency waves in accordance with signals transmitted over said line, and means remotely operable for individually selecting said stations.

65. In a signaling system, a transmission line, means for transmitting signals over said line, a plurality of stations situated at intervals along said line, radio transmitting apparatus at each of said stations operable to transmit electromagnetic waves in accordance with signals transmitted over said line, and means remotely operable for individually selecting said stations.

66. In a signaling system, a transmission line, a plurality of stations situated along said line, radio transmitting apparatus at each of said stations, a control station associated with said line, means operable for transmitting signals from said control station over said line and thence into the ether from any of said first-mentioned stations individually, and means operable from said control station for individually selecting said first-mentioned stations whereby communication may be established through the medium of said transmission line and the radio apparatus at the selected station.

67. In a signaling system for railroads, means for radiating high frequency electromagnetic waves at a plurality of points along a railroad track, an electromagnetic wave responsive device carried by a train on said railroad track, and means responsive to the position of said train on said track for controlling the actuation of said first means.

68. In a signaling system for railroads, a plurality of sources of high frequency electromagnetic waves situated at intervals along a railroad track, a train moving along said track, apparatus carried by said train, said apparatus being operable to receive and respond to said electromagnetic waves and controlling means for said sources of electromagnetic wave, said controlling means being dependent in operation upon the position of said train.

69. A telephone system comprising telephone exchanges, subscribers' stations, metallic transmission lines, means at said telephone exchanges for selectively effecting connections between said subscribers' stations through the medium of said metallic transmission lines, a plurality of separated radio transmitting stations operatively associated with said telephone exchanges and means whereby a signal may be transmitted through the medium of any of said telephone exchanges and a plurality of said radio stations conjointly and simultaneously.

70. The combination in a telephone system of a plurality of telephone exchanges, telephone subscribers' stations, telephone

subscribers' lines connected with subscribers' stations and associated with each of said telephone exchanges, means for interconnecting said subscribers' stations through the medium of said telephone exchanges and subscribers' lines, a plurality of radio receiving stations, means whereby operators at said telephone exchanges may establish telephone connections with a plurality of said radio receiving stations contemporaneously whereby radio signals may be received at said telephone exchanges, and means whereby connections may be established at said telephone exchanges between said plurality of radio receiving stations and any of said subscribers' lines whereby received radio signals may be transmitted to the subscribers' stations.

71. A radio transmitting station, a remote control station, a metallic transmission line interconnecting said stations, means whereby signals may be propagated from said control station over said transmission lines and then into the ether through said radio station, and means whereby an operator at said control station can control the operating frequency of said radio station.

72. In a system of communication, a plurality of telephone subscribers' stations, a plurality of radio receivers, a telephone exchange, transmission lines, said subscribers' stations, telephone exchange and radio receivers being interconnected by means of said transmission lines, and means whereby said subscribers' stations may be connected with said radio receivers individually and collectively.

In witness whereof, I hereunto subscribe my name this 20th day of November, A. D. 1919.

CROSBY R. GAUTHIER.