

Sept. 13, 1932.

H. C. FORBES

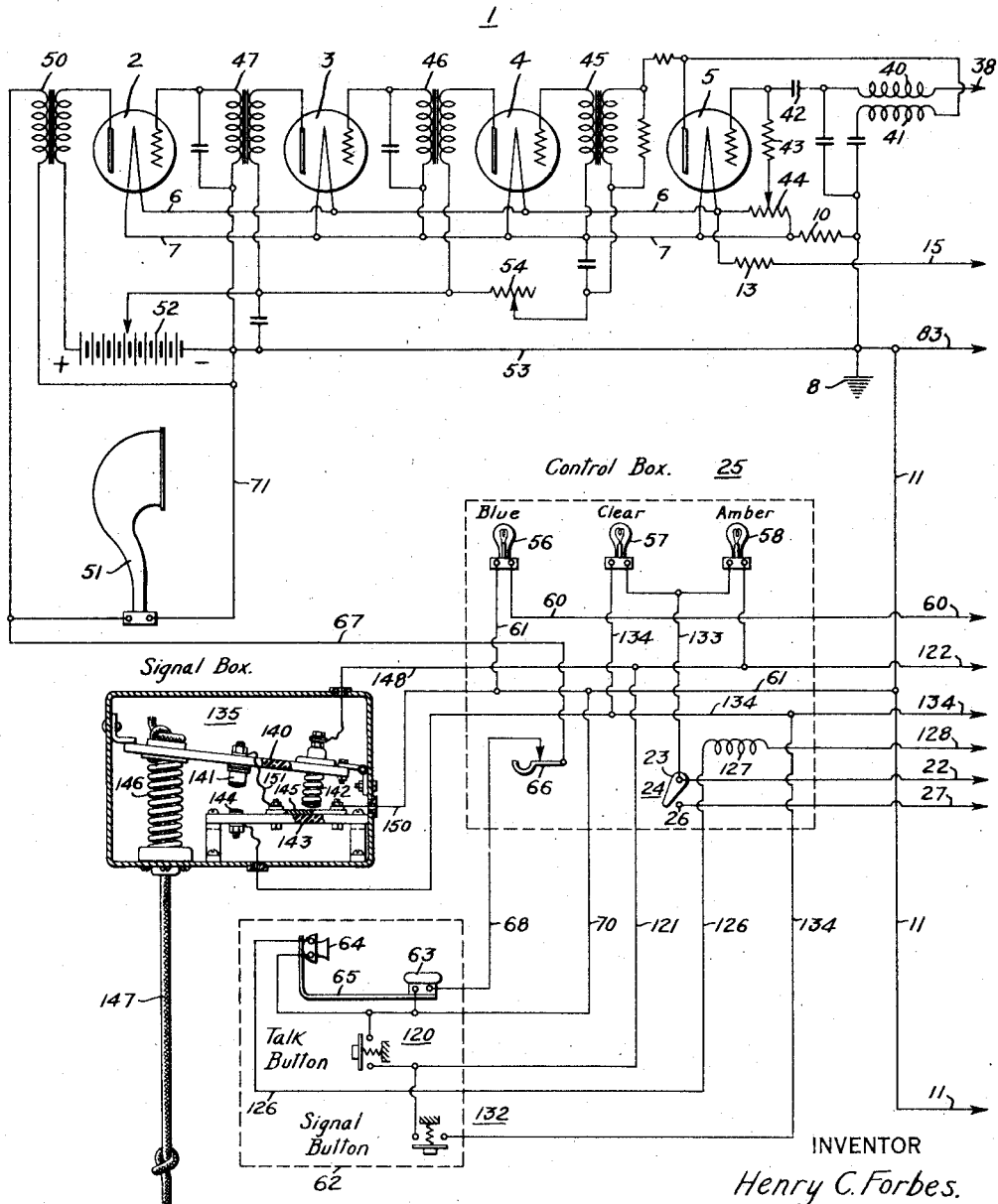
1,877,571

SIGNALING SYSTEM

Filed April 5, 1928

2 Sheets-Sheet 1

Fig. 1.



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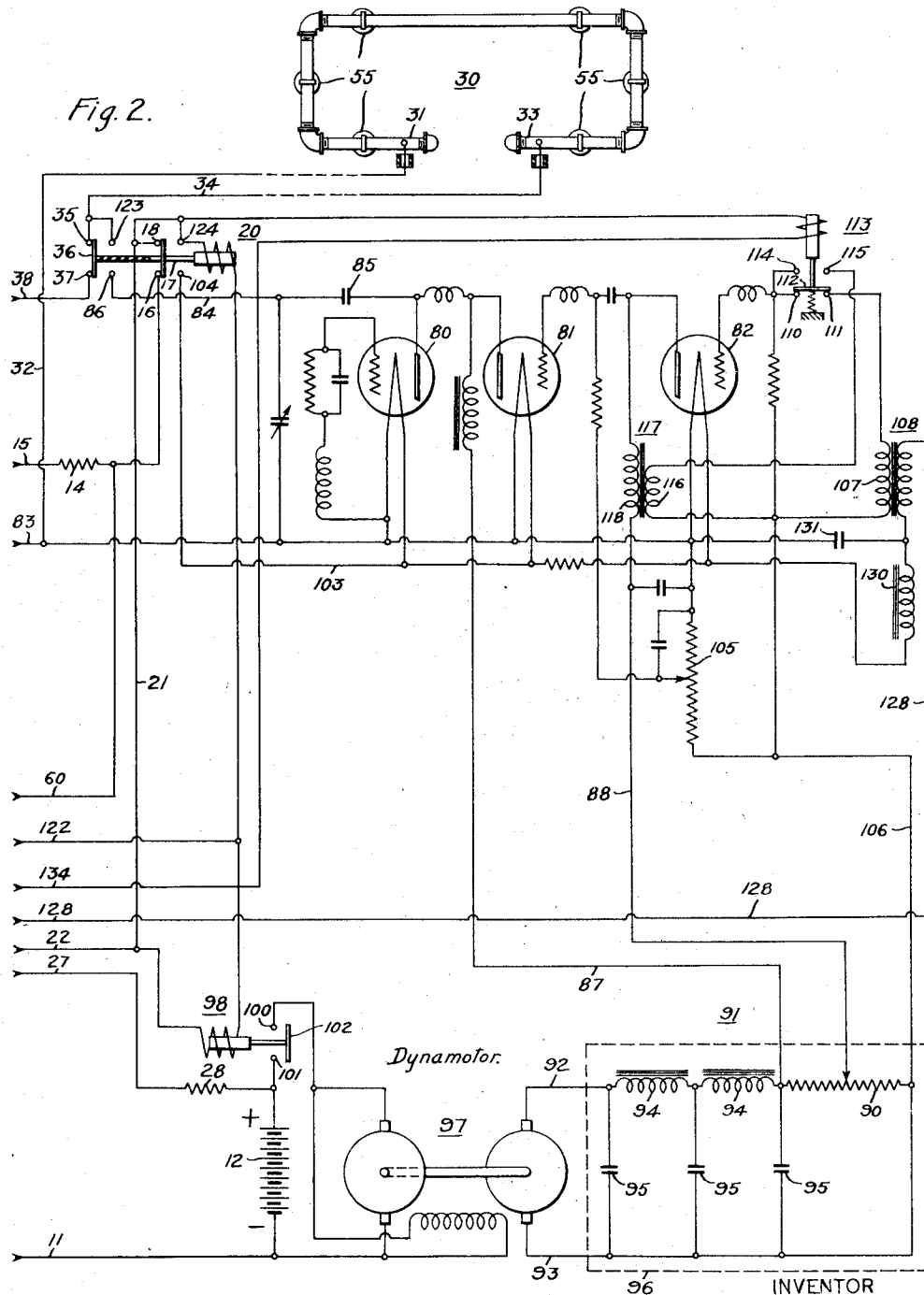
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

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SIGNALING SYSTEM

Application filed April 5, 1928. Serial No. 267,585.

My invention relates to signaling systems, and it has particular relation to radio signaling systems intended to be utilized for communication between the front and rear ends of long railway trains, or between trains and nearby way-stations.

Radio apparatus for railway application differs materially from that designed for other services, in that simplicity, ruggedness and reliability are of paramount importance. The apparatus must, of necessity, be operated and maintained by a personnel unfamiliar with radio engineering, and often by persons having only slight knowledge of the simplest electrical phenomena. The transmitter and receiver must, therefore, be substantially automatic, or semi-automatic, in operation, requiring no more technical knowledge on the part of the user than is required in manipulating an ordinary telephone.

Another requirement is that the antenna, or radiating structure, if mounted exteriorly of the train, shall, at all times, clear the walls of tunnels through which the train passes. Tunnel, and other, clearances, on the great majority of the railroads that handle heavy freight traffic, are often reduced to a matter of a few inches, and the problem of devising a satisfactory antenna has hitherto been difficult of solution.

Electric power for the operation of the transmitting portion of the system is not usually available in the locomotive, and never available in the caboose, or in other cars of a freight train. Batteries are, therefore, necessary and they may be charged from the headlight generator, or from an axle-driven generator carried beneath the caboose.

It is, accordingly, one object of my invention to provide a signaling system that shall be particularly adaptable for use on railway trains.

Another object of my invention is to provide a signaling system of the aforesaid type

that shall be substantially automatic in operation, and one which requires minimum skilled attention.

Another object of my invention is to provide, in a signaling system of the aforesaid type, means for giving visual indications to the operator of the momentary state of the system, whereby he will know whether it is in condition to transmit or to receive signals.

Another object of my invention is to provide, in a signaling system of the aforesaid type, means for visually indicating to the operator each code-signal as he transmits it, whereby signaling is facilitated for those who are unfamiliar with radio apparatus in general.

Another object of my invention is to provide, in a signaling system of the aforesaid type, an improved arrangement of the operating controls therefor, whereby all of such controls may be manipulated by the operator with minimum effort, and with substantially no chance for error.

Another object of my invention is to provide, in a signaling system of the aforesaid type, automatic means for changing the state of the system from transmitting to receiving, and vice-versa, interconnected with means for visually indicating the momentary state thereof.

Another object of my invention is to provide, in a signaling system of the aforesaid type, an improved antenna structure particularly adaptable for mounting on the upper exterior portion of a locomotive or railway car.

In one embodiment of my invention, I attain the aforementioned objects by providing a compact combined radio-transmitter and radio-receiver suitable for use in situations where only limited space is available, and by arranging a power-supply system for the transmitting portion thereof comprising a storage battery and a motor-generator driven thereby.

I further provide means comprising a plurality of relays controlled by push-buttons mounted in convenient positions on a hand-set, for causing the system to be shifted from the transmitting to the receiving condition. In addition, I provide a plurality of vari-colored lamps that are so inter-connected with the relay-control circuits that the momentary condition of the system is at all times visually indicated to the operator.

I prefer also to incorporate into my improved signaling system the invention disclosed in a copending application in the name of W. E. Brindley, Serial No. 110,363, filed May 20, 1926, and assigned to the Westinghouse Electric & Manufacturing Company, by providing a pull-cord-controlled sequential-switch having contact-members connected in parallel with the push-buttons mounted on the hand-set, for use when it is desired to transmit code-signals only.

The novel features that I consider characteristic of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood by reference to the following description of a specific embodiment, taken in connection with the accompanying drawings, in which—

Figure 1 is a diagrammatic view of the receiving portion of a railway signaling-system comprising a preferred embodiment of my invention, showing the hand-set, the pull-cord switching device, and the visual indicators, and

Fig. 2 is a diagrammatic view of the transmitting portion of the same system, showing the relays previously mentioned, and the arrangement of the power-supply.

The apparatus shown in Fig. 1 comprises a radio-receiving set 1 comprising a plurality of thermionic devices 2, 3, 4 and 5, the filaments of which are connected in parallel to two conductors 6 and 7. The conductor 7 is connected to a grounded portion 8 of the apparatus through a resistor 10, the grounded end of the resistor being, in turn, connected, by a conductor 11, to the negative terminal of a 24-volt battery 12 shown in Fig. 2. The filament-supply conductor 6 is connected to the other terminal of the battery 12 over a circuit including two resistors 13 and 14, a conductor 15, a fixed contact member 16, a movable contact member 17, a fixed contact member 18 of a relay 20, a conductor 21, a conductor 22, the movable member 23 of a master-switch 24 mounted in a control box 25, the fixed contact member 26 of the master-switch, and a conductor 27 in which is serially included an additional resistor 28. The total voltage drop in the resistors 13, 14 and 28, when the filaments of the receiving tubes are energized, is 18 volts,

the difference between this drop and the potential of the battery, i. e., 6 volts, being consumed in the various conductors and in the filaments of the said receiving tubes.

The input circuit for the receiving set comprises a loop 30, one terminal 31 of which is connected to ground through a conductor 32, and the other terminal 33 of which is connected to the grid of the thermionic device 5 over a circuit including a conductor 34, a fixed contact member 35, a movable contact member 36 actuated by the relay 20, a second fixed contact 37, a conductor 38, an inductor 40 to which is coupled a feed-back inductor 41, and a grid-condenser 42. The thermionic device 5 is provided with a grid-leak 43, which connects the grid to an intermediate point on a potentiometer 44 that shunts the filament supply conductors 6 and 7.

The movable member 36 is normally in contact with the members 35 and 37 thus maintaining the receiving set in condition for the reception of signals whenever the filaments of the thermionic devices are energized, and potential is applied to the anodes thereof.

The thermionic devices 5, 4, 3 and 2 are connected in cascade by means of audio-frequency transformers 45, 46 and 47, and the device 2 is provided with an output-transformer 50, the secondary of which is connected in series with a loud-speaker 51.

Anode potential for the several thermionic devices is supplied from a battery 52, the negative terminal of which is connected to ground through a conductor 53. The battery 52 preferably delivers 135 volts to the anode of the device 2, 90 volts to the anodes of the devices 3 and 4, and a variable potential determined by a resistor 54, to the anode of the detector device 5.

Neither the specific manner in which the several thermionic devices constituting the receiving set are inter-connected, nor the specific tubes utilized is material to the operation of my invention, it being perfectly feasible to utilize a more complicated and sensitive set if it is desired to receive from distances greater than a few miles.

The loop-antenna 30 is preferably a single turn of one-inch brass pipe assembled with standard pipe fittings, and is mounted horizontally on a plurality of insulators 55 affixed to the roof of the locomotive cab, or the roof of the caboose. Such an antenna is particularly well suited to railway service, for it is non-directional, and its transmission range is limited to only a few miles.

A plurality of vari-colored signal-lamps 56, 57 and 58, are mounted on the exterior of the control box 25, and are, at all times, visible to the operator. The lamp 56, which is blue in color, has one terminal connected, over a conductor 60, to the fixed contact member 16 previously referred to in tracing the

filament-supply circuit for the receiving thermionic devices, and the other terminal thereof is connected, over a conductor 61 and the conductor 11, to the negative terminal of the battery 12. Upon closing the master-switch 24, therefore, in order to energize the filaments of the receiving tubes, potential is, at the same time, applied to the blue signal-light, which, so long as it is illuminated, indicates to the operator that the set is in the receiving condition.

The potential supply circuit for the signal-lamp 56 may be traced from the positive pole of the battery 12, over the conductor 27, the closed master-switch 24, the conductor 22, the conductor 21, the closed contact members 16, 17 and 18, the conductors 15 and 60, through the lamp, the conductor 61, and the conductor 11 which is connected to the negative pole of the battery 12.

A hand-set 62, which comprises a receiver 63 and a transmitter 64 mounted on a handle 65, is normally supported by a switching-device 66 positioned in the control-box, maintaining the contacts thereof open. In such case, the output from the receiving set 1 is applied solely to the voice-winding of the loud-speaker 51. When, however, the hand-set is removed from the switching-device, the said receiver is then, by reason of the closing of the contacts of the switching device, connected in shunt to the loud speaker by a conductor 67, a conductor 68, a conductor 70, the conductors 61, 11 and 53, and a conductor 71. The impedance of the receiver 63 is preferably made much less than that of the loud-speaker, in order that the former shall receive substantially all of the received signal when it is removed from the control-box, this being the desirable condition when the hand-set alone is being used for communication.

The transmitting portion of the system comprises a thermionic oscillator 80, a thermionic modulator 81 operatively connected thereto, and a thermionic device 82, the latter having the functions of both a speech amplifier and of a generator of audio-frequency oscillations.

Normally, the transmitting portion of the system is de-energized, and the output circuit thereof, comprising a conductor 83 connected to the filament of the oscillator, and grounded, and a conductor 84 connected to the anode of the oscillator through a condenser 85, and terminating in a fixed contact member 86, is disassociated from the loop-antenna by the relay 20.

High potentials for the transmitting thermionic devices 80, 81 and 82 are supplied over conductors 87 and 88, leading from a resistor 90 which is bridged across the output terminals of a filter-chain 91. The input terminals 92 and 93 of the filter-chain, which chain comprises a plurality of series chokes 94, and a plurality of shunt condensers 95,

which is preferably housed in a separate, shielded container 96, are connected to the high-voltage side of a dynamotor 97.

The dynamotor 97 is energized from the battery 12 under the control of a relay 98 having fixed contacts 100 and 101 and a movable contact 102, which contacts are normally open.

The filaments of the transmitting thermionic devices 80, 81 and 82 are connected across the conductor 83 and a conductor 103, the conductor 83 being connected to the negative terminal of the battery 12 through the conductor 11, while the conductor 103 terminates in a fixed contact 104 normally disengaged from the movable contact 17. The filament supply conductor 83 is connected to the negative terminal of the high-voltage source through a resistor 105 and a conductor 106, the potential drop across the said resistor caused by the space current in the transmitting tubes being utilized to negatively bias the grids of the speech-amplifier and modulator tubes 82 and 81.

The secondary winding 107 of an audio-frequency transformer 108 is normally comprised in the input circuit of the speech-amplifier 82, one terminal of the said winding being connected to the grid of the amplifier through the fixed contacts 110 and 111 and the movable contact 112 of a relay 113. The relay is provided with two back contacts 114 and 115, the contact 114 being connected to the contact 110, and the contact 115 being connected to one terminal of the primary winding 116 of a transformer 117, the secondary winding 118 of which constitutes the coupling-inductor between the speech-amplifier 82 and the modulator 81. The remaining terminal of the primary winding 116 is connected to the filament of the speech amplifier through the resistor 105.

Just so long, therefore, as the contacts of the relay 113 remain as shown in the drawings, the thermionic device 82 is so connected to the secondary of the transformer 108 that it has its ordinary, or normal, function of a speech-amplifier. When the relay 113 is energized, however, in a manner to be later described, the secondary of the transformer 108 is disconnected from the thermionic device, and the input and output circuits thereof are caused to be closely coupled through the transformer 117, giving rise to the generation of oscillations at audio-frequency, which oscillations may be applied to the modulator at intervals, and for periods, determined by the actuation of the relay.

In order to energize the transmitter, to connect it to the antenna, and to simultaneously de-energize the receiver, and to disconnect the latter from the antenna, a control circuit is provided which includes the winding of the dynamotor-control relay 98 and the winding of the relay 20 which actuates the movable

members 17 and 36 previously referred to as being interposed in the filament-supply circuit and input-circuit of the receiving set, respectively. The control-circuit may be traced from the negative terminal of the battery 12, over the conductor 11, the conductors 61 and 70, the normally open contacts of a "talk-button" 120 mounted on the hand-set 62, a conductor 121, a conductor 122, the windings of the relays 20 and 98 in parallel, the conductors 21 and 22, the master-switch 24, and over the conductor 27 to the positive terminal of the battery 12. Upon energization of the relay 20, by depressing the "talk-button", after closing the switch 24, the armature 36 moves to the right to connect the grid of the oscillator 80 to the loop-antenna by way of the contact 86 and a back contact 123 and at the same time the armature 17, by disengaging the fixed contacts 16 and 18, deprives the filaments of the receiving tubes from potential, and completes a filament-supply circuit for the transmitting tubes by engaging the back contacts 124 and 104. The amber light 58 in the control-box is simultaneously supplied with potential, thus indicating to the operator that the transmitter is energized and ready for signaling, and that the receiver is disconnected from the antenna and de-energized.

If it is desired to communicate by voice, the microphone 64 mounted on the hand-set may be spoken into by the operator. The microphone is supplied with operating current over a circuit which is completed at the same time the relay 20 is energized to throw the system from the receiving to the transmitting condition. The microphone direct-current supply circuit may be traced from the negative pole of the battery 12, over the conductors 11, 61 and 70, through the microphone 64, a conductor 126, a radio-frequency choke-coil 127, a conductor 128, the primary of the audio-frequency transformer 108, a choke-coil 130, the filament conductor 103, the fixed contacts 124 and 104 and the movable armature 17 of the relay 20, the conductors 21 and 22, the master-switch 24, and the conductor 27 connected to the positive pole of the battery. The alternating component of the microphone current is bypassed around the choke-coil 130 by a large condenser 131, preferably having a capacity of 4 microfarads.

If it is desired to communicate by code-signals, the operator, while maintaining the talk-button depressed, manipulates a signal-button 132, which button is also mounted on the hand-set. Upon depression of the signal-button, an energizing circuit is completed for the relay 113 associated with the input circuit of the speech-amplifier 82, which causes the movable armature 112 thereof to disengage the fixed contacts 110 and 111 and to engage the contacts 114 and 115, thus coupling the

input and output circuits of the speech-amplifier together through the transformer 117, and causing the said amplifier to function as an audio-frequency oscillator, as hereinbefore explained. Each time, therefore, that the signal-button 132 is depressed, audio-frequency oscillations are generated and are impressed on the input of the modulator, causing the radio-frequency oscillations generated by the thermionic device 80 to be modulated by an audio-frequency that is interrupted according to the manipulation of the said signal button.

In order that the operator shall be visually apprised of the signals he is sending out, it is advisable to so arrange the interconnecting circuits that the clear light in the signal box is illuminated each time the signal button is depressed. One terminal of the clear lamp is accordingly directly connected to the positive pole of the battery 12 through conductor 133, the master-switch 24, and the conductor 27, while the remaining terminal is connected to the negative pole of the battery over a circuit which may be traced through a conductor 134, the signal-button 132, the talk-button 120, and the conductors 70, 61 and 11.

The clear lamp accordingly flashes each time the signal button is depressed, provided the talk-button is held down, and remains illuminated just so long as pressure on the signal-button is maintained. This is a very decided advantage under certain operating conditions.

In the event that it is desired to signal by code alone, it has been found desirable to retain the signal-cord with which the majority of railway operatives are already familiar. To that end, I have provided a sequence-switch 135, analogous to the switch disclosed in the application of W. E. Brindley, previously referred to, and have connected the contacts of the said switch in parallel with the talk-button and the signal-button, respectively.

The sequence-switch comprises a pivotally mounted member 140 of insulating material, on which are secured a rigid contact device 141 and a resilient contact device 142. A bridge-member 143 is supported in proximity to the pivotally mounted member 140, and carries thereon a plurality of fixed contact devices 144 and 145, which contact devices lie in the path of travel of the contact devices carried by the member 140. The member 140 is maintained in normal raised position by a coiled spring 146, through the axis of which extends a pull-cord 147 by which the member 140 may be pulled downward.

The resilient contact device 142 and the fixed contact 145 are connected in parallel with the talk-button 120 by means of a conductor 148 which connects with the conductor 121, and a conductor 150 which connects with

the conductor 70 while the contact devices 141 and 144 are connected in parallel with the signal-button 132 by a circuit which includes the contacts of the talk-button.

If, therefore, it is desired to signal by code only, the hand-set is not removed from the switch-hook, but, by exerting a downward pull on the signal cord 147, the sequential action of the talk and signal buttons is simulated.

The apparatus thus far described, comprising one unit of a combined transmitting and receiving system, is of necessity duplicated on any one train. In other words, a transmitter-receiver, with the incidental apparatus, is positioned in the locomotive and a similar transmitter-receiver is positioned in the caboose. The separate units comprise a storage battery, a dynamotor, a filter box to contain the filter chain, the transmitter, a receiver, the signal switch, the loud speaker and the control box.

The control box is preferably mounted on the wall directly over the conductor's desk, with the signal box so positioned over the desk that the pull-cord is within easy reach of the conductor's hand. The loud speaker is preferably fastened to the wall of the cupola. The batteries, dynamotor and filter box are best placed on the floor of the locker space, and a charging block, with a cutout switch (not shown) is so provided as to permit the batteries to be charged without removing them.

At the front end of the train, the control box is preferably mounted on the rear bulkhead of the cab directly behind, and to the left of, the engineer. The loud speaker is mounted in any convenient manner at the top of the cab. The pull-cord switch is also so mounted as to be convenient to the engineer's hand. The storage batteries, dynamotor and filter box are preferably mounted in a locker in the tender, facing the cab, in order that they may be easily accessible. A charging block and a cutout switch (not shown) are also provided for charging the batteries in the locomotive without removing them from the locker. The transmitter and receiver units are best mounted under the overhand outside at the rear of the cab.

To operate the apparatus from either end, the control box is first unlocked, the door thereof opened and the master switch closed, which places the receiver in operation and lights the blue pilot-light in the manner previously described. The apparatus is then ready for the reception of signals. To signal the other end of the train, the hand microphone is lifted from the control box, permitting the hook switch to close, and the talk-button on the face of the handle is depressed. This disconnects the receiver, connects the transmitter and starts the dynamotor, as hereinbefore specifically described,

placing the transmitter in condition for talking. When it is desired to listen to a reply from the other end of the train, the talk-button is released, deenergizing the previously described relays, thus disconnecting the transmitting set from the antenna, stopping the dynamotor and connecting the receiving set to the antenna.

Should it be desired to call the attention of the crew at the other end of the train before starting to talk, the signal button may be depressed while holding down the talk-button, which causes the radiated carrier-frequency to be modulated at an audio-frequency determined largely by the constants of the transformer 108. As soon as the signal has been acknowledged, the conversation may proceed in the usual manner.

If it is merely desired to signal without carrying on a conversation, the pull-cord signal-switch may be utilized without the necessity of removing the hand-set from the control box. The cord is pulled down to the first notch, which is equivalent to depressing the talk-button and is then manipulated between the first and second notches against the resiliency of the contact 142 in the same manner that an ordinary whistle-cord is manipulated.

An amber colored light mounted on the top panel of the control box indicates, as previously pointed out, when the transmitter has been connected to the antenna and the dynamotor started. A white light flashes when the talk-button is depressed or when the signal cord is manipulated to the second notch, showing that a signal is being radiated.

The total power drawn from the storage batteries is about 30 watts while receiving and about 600 watts while transmitting. This power is the lowest that can be used and yet insure complete reliability of operation under service conditions, particularly on railroads operating in mountainous country where curves, hills, tunnels and cuts are of frequent occurrence. The power in the antenna circuit while transmitting is about 75 watts.

All parts of the apparatus are preferably so constructed that each unit is weather-proof and dirt-proof. Delicate parts of the transmitter and receiver are cushioned on heavy blocks of sponge rubber (not shown) to prevent damage thereto by vibration, and each unit of the transmitter-receiver should be spring-suspended.

A railway signaling system constructed and arranged according to my invention has many advantages, among which may be mentioned the fact that nothing but the control-box and the pull-cord switch need be mounted in accessible positions in the cab of a locomotive, or the caboose.

The operator may control the entire func-

tioning of the system without the necessity of manually throwing a large number of switches to shift from the talking to the listening condition. It is, accordingly, entirely possible for the engineer to be leaning out of the window of the cab, observing road conditions ahead, and at the same time carrying on a conversation with the conductor relative to the control of the train. The cord connecting the hand-set may be made sufficiently long to enable the engineer to carry the device with him to any part of the cab or tender, and in such event it would probably be preferable to provide a self-winding reel (not shown) in an elevated position, by which the slack of the cord would always be compensated.

The transmitting and receiving units need substantially no attention after they have once been adjusted by a skilled operator and, since the operation of the system is entirely automatic, there is but little likelihood that the user will cause any damage to them in service.

Railway operatives are, as a class, well accustomed to the use of lights for signaling purposes, and readily acquire a facility in interpreting the meaning of the three signal lamps mounted on the control box.

The novel manner in which I have provided for energizing the generator only during transmitting periods is another marked advantage, since the power saved thereby is a not inconsiderable item during the life of the apparatus, and wear and tear on the generator is also minimized thereby.

The antenna, being mounted close to the roof of the cab, does not interfere with the taking on of coal or water. The danger of shock to the engineer or fireman is also obviated by location of the antenna on the roof of the cab, since there is seldom any necessity for the men to climb thereon for repairs to the engine.

Although I have illustrated and described only one specific embodiment of my invention, many modifications thereof will be apparent to those skilled in the art. My invention, therefore, is not to be limited except insofar as is necessitated by the prior art or by the spirit of the appended claims.

I claim as my invention:

1. In a signaling system, an antenna, a radio receiving set comprising thermionic devices normally connected thereto, a radio transmitting set comprising thermionic devices, a common source of filament power for said devices, a source of anode potential for the thermionic devices in said transmitting set, means including a visual indicator for connecting said source to said receiving device, means for shifting the connection of said antenna from said receiving set to said transmitting set, a plurality of means functioning simultaneously with said shifting

means for transferring said filament power from said receiving set to said transmitting set, for connecting said anode potential source to said transmitting set, and for giving a visual indication that said transmitting set is in operative condition.

2. In a signaling system, radio transmitting apparatus including thermionic devices, a keying device, sources of filament and anode power for said thermionic devices, an antenna, a plurality of visual indicating devices, means for connecting said transmitting apparatus to said antenna and for simultaneously connecting said power sources to said apparatus, one of said visual indicating devices being energized upon the connection of said apparatus to said antenna, and means whereby the actuation of said keying device also causes the energization of another of said visual indicating devices.

3. In a signaling system, an antenna, a radio receiving set normally connected thereto, a radio transmitting set, a keying device for said transmitting set, a telephone hand-set, a plurality of switching devices mounted on and carried by said hand-set, means controllable by one of said switching devices for disconnecting said antenna from said receiving set and connecting it to said transmitting set, and means controllable by another of said switching devices for actuating said keying device.

4. In a signaling system, transmitting apparatus including a speech-amplifier and a modulator, a telephone hand-set including a microphone normally connected to said speech-amplifier, a switching device carried by said hand-set, and means controllable by said switching device for disconnecting said microphone from said speech-amplifier and for causing said speech-amplifier to generate oscillations at audio-frequency.

5. In a signaling system, energy radiating means, means comprising an oscillation generator for supplying energy to said radiating means, means for modulating the energy supplied, means for sequentially effecting the operation of the generator and the modulating means, and devices connected thereto for giving a visual indication of the condition of the generator and visual indications of the operation of said modulating means.

6. In a signaling system, an antenna, energizing means associated therewith, modulating means coupled to said energizing means, a switch for first actuating said energizing means and then controlling said modulating means, and additional devices under the control of said switch for giving a visual indication of the position thereof.

7. In a signaling system, an antenna, energizing means associated therewith, modulating means coupled to said energizing means, a telephone hand-set, and switching devices mounted on said hand-set for actuating said

energizing means and controlling said modulating means, and additional devices under the control of said switching devices for giving a visual indication of the condition of said energizing means and the operation of said modulating means.

In testimony whereof, I have hereunto subscribed my name this 29th day of March, 1928.

HENRY C. FORBES.