

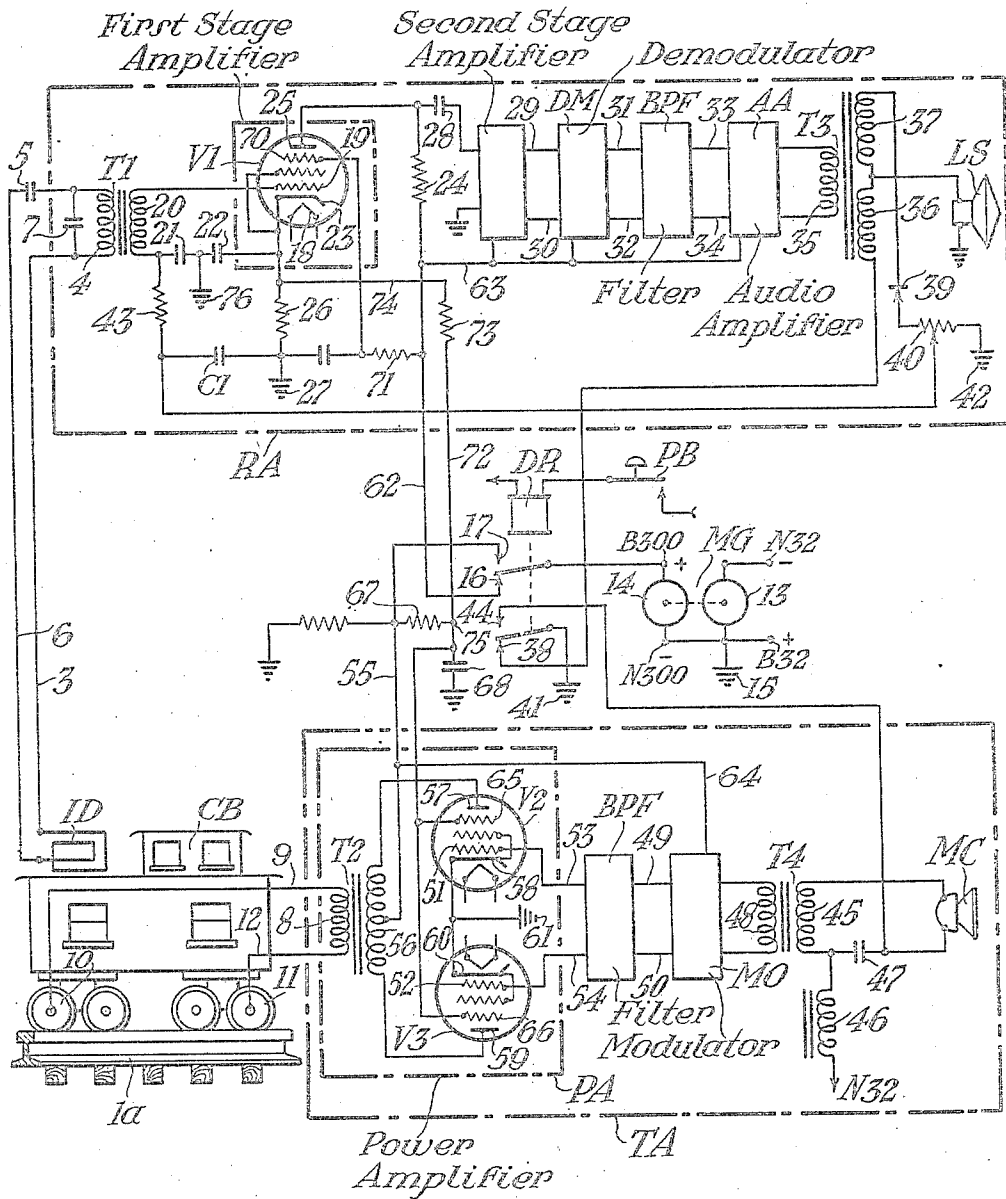
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APPARATUS FOR COMMUNICATION SYSTEMS

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APPARATUS FOR COMMUNICATION
SYSTEMS

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My invention relates to apparatus for communication systems, and more particularly to two-way apparatus for such systems.

Railway train communication systems of the type here contemplated use the track rails in the transmitting channel and a station on a train is provided with a receiving circuit and a transmitting circuit coupled to the rails. In a preferred form of two-way apparatus for such systems, the train carried receiving circuit includes an inductor mounted in inductive relation to the rails and the train carried transmitting circuit is connected to two spaced pairs of wheels of the train to include in the circuit a given length of the rails in multiple. The equipment of such a station is switched from a receiving condition to a sending condition, and vice versa, through a circuit controller operable to a first position where a current source is connected to the plate circuits of the electron tubes of the receiving portion of the apparatus, and to a second position where this current source is disconnected from the receiving tubes and is connected to the plate circuits of the tubes of the transmitting portion of the apparatus. The grid and heater circuits of the tubes of such two-way apparatus, as well as the receiving and transmitting circuits, are normally closed so that the equipment is in a condition to either immediately receive or send as determined by the position of the circuit controller. Under such an arrangement of the circuits, the control grid circuit of the first stage tube of the receiving apparatus is connected at all times to the receiving circuit, and a field created about the receiving inductor when the transmitting circuit is supplying current to the rails induces in the inductor an electromotive force that is applied to the control grid of the first stage receiving tube although the receiving apparatus as a whole is inactive due to its plate circuits being deenergized. This electromotive force applied to the grid of the first stage receiving tube during transmission periods of the same station, may cause current to flow in the grid circuit of this first stage tube because of the relatively strong field created by the local transmitting circuit. Condensers, such as a condenser of an automatic volume control device, connected to the grid circuit of this first stage receiving tube, become charged when grid current flows, and such condenser charge in turn acts as an unwanted negative grid bias voltage when the equipment is next switched to the receiving condition, with the result that the sensitivity of the receiving apparatus may be reduced until this

charge has had time to leak off. In other words, subsequent to a period of transmitting from a station, there may be a period of a few seconds during which the sensitivity of the receiving apparatus of that station is reduced, with the result the first few words or phrase of a message from a remote station may be not satisfactorily received.

Accordingly, an object of my invention is the provision of improved two-way communication apparatus, the receiving amplifier of which is unaffected by the field created by the transmitting apparatus of the same station.

Another object of my invention is the provision of improved two-way communication apparatus wherewith a reduction in the sensitivity of the receiving amplifier, due to a transfer of energy from the transmitting circuit to the receiving circuit for the station, is avoided.

Again, an object of my invention is the provision of novel means to bias the receiving amplifier tubes of two-way communication apparatus of a station with a voltage derived from the transmitting apparatus at the same station during transmitting periods.

Other objects, features and advantages of my invention will appear as the specification progresses.

The foregoing objects and advantages embodying my invention are accomplished by providing two-way communication apparatus which includes novel means to apply a relatively high negative grid bias voltage to the first stage receiving amplifier tube during transmitting periods. Such two-way equipment is switched either to a receiving condition or to a transmitting condition by connecting the plate current source either to the plate circuits of the receiving tubes or to the plate circuits of the transmitting tubes. Preferably a directional relay is employed as the switching means and the connection to the receiving tubes is completed through back contacts of this relay and the connection to the transmitting tubes is completed through front contacts of the relay. A preselected point in the connection of this plate current source to the transmitting tubes is connected by a circuit preferably including a resistor, to the cathode of the first stage receiving amplifier tube. In this way, the cathode of the first stage receiving tube is made positive in potential with respect to the control grid of that tube by a voltage corresponding to that existing at the preselected point of the connection to the plate circuits of the transmitting tubes, and such

bias voltage is effective only during periods of transmission. With the first stage receiving tube thus biased with its cathode highly positive in potential with respect to the control grid, any electromotive force picked up by the receiving circuit due to a field created by the transmitting circuit of that station is insufficient to cause grid current to flow in the first stage receiving tube, whereas a flow of grid current at this time would charge any associated condenser, such as a condenser of an automatic volume control device. A charge on a condenser associated with the grid circuit of the first stage receiving tube would cause an unwanted negative grid bias voltage subsequent to a period of transmission until the charge had had time to leak off. During the discharge period of such a condenser, the sensitivity of the first stage receiving tube and of the entire receiving apparatus would be materially reduced with the result that the first few words of an incoming message might be lost. This relatively high negative bias voltage for the first stage tube of the receiving apparatus is withdrawn whenever the apparatus is switched to the receiving condition, and hence the receiving apparatus is operative at its usual amplifying gain for any received message.

For a fuller understanding of my invention, reference may be had to the accompanying drawing, which is a diagrammatic view showing one form of apparatus embodying my invention when used with a two-way communication system for railway trains. It is to be understood that my invention is not limited to communication systems for railway trains, and this one application illustrates the many places where the apparatus is useful.

I shall describe this one form of apparatus embodying my invention, and shall then point out the novel features thereof in claims.

Referring to the drawing, the reference character CB designates a car of a railway train, such as, for example, a caboose of a freight train, and which caboose is provided with two-way communication equipment, the receiving apparatus of such equipment being indicated as a whole by a dash-dot rectangle RA, and the transmitting apparatus of the equipment being indicated as a whole by a dash-dot rectangle TA.

The caboose CB is provided with a receiving circuit and a transmitting circuit to couple the receiving apparatus RA and the transmitting apparatus TA, respectively, to the rails of the track over which the caboose operates, and of which track only the one rail 1a is shown, it being understood that the track is of the well-known construction. The receiving circuit includes an inductor ID mounted on the caboose in inductive relation to the rails, and the circuit can be traced from the top terminal of inductor ID through wire 3, primary winding 4 of an input transformer T1 of the receiving apparatus RA, condenser 5 and wire 6 to the lower terminal of inductor ID. A condenser 7 is connected across winding 4 of transformer T1, and the parts are proportioned to tune this receiving circuit to the frequency band of the communication current that is to be used. The transmitting circuit can be traced from the top terminal of winding 8 of an output transformer T2 of the transmitting apparatus TA through wire 9, a first pair of wheels 10 of the caboose, the track rails in multiple to a second pair of wheels 11 of the caboose, and wire 12 to the lower terminal of transformer winding 8, connection with the

wheels being made through the medium of any of the several well-known arrangements. It is to be seen, therefore, that the receiving apparatus RA is inductively coupled to the rails through inductor ID of the receiving circuit, and electromotive forces corresponding to communication current flowing in the rails are picked up and applied to the receiving apparatus. Also, communication current created in the transmitting apparatus TA is supplied to the transmitting circuit through transformer T2, and such current flows in the rails between the spaced pairs of wheels 10 and 11 to create a voltage drop across this length of the rails, and which voltage drop causes in turn communication current to flow in the rails to each side of the caboose in the well-known manner.

As an aid in the understanding of my invention, I shall assume by way of illustration that the communication current is a single side band carrier telephone current, the carrier being of 5700 cycles per second, the voice frequencies used to modulate the carrier being of the range of 400 to 2500 cycles per second, and the upper side band of 6100 to 8200 cycles per second, being the side band transmitted. Also, the same carrier frequency is used in both directions. It is to be understood, of course, that my invention is not limited to such single side band carrier telephone current, and a communication current of other frequencies can be used.

The caboose CB is further provided with a source of current for energizing the communication equipment, such current source being preferably at 32 volt battery of the type commonly used in train lighting systems and the positive and negative terminals of which are indicated in the drawing at B32 and N32, respectively. Current from this relatively low 32 volt source is converted into a relatively high voltage current of the order of 300 volts for use in the plate circuits of the electron tubes of the equipment by a motor generator MG, the motor 13 of which is connected across terminals B32 and N32, and the generator 14 of which is provided with positive and negative terminals B300 and N300, respectively. The positive terminal B32 and the negative terminal N300 are preferably connected to a common ground electrode 15.

The generator 14 is connected either to the receiving apparatus RA or to the transmitting apparatus TA through contacts of a directional relay DR, which relay is controlled by an obvious circuit including a push button PB. When push button PB is released, relay DR is deenergized to close its back contact 16 and generator 14 is connected to the plate circuits of the tubes of the receiving apparatus RA in a manner to appear shortly, but when push button PB is depressed, relay DR is energized to close front contact 17 and generator 14 is connected to the plate circuit of the tubes of the transmitting apparatus TA.

The receiving apparatus RA may be any one of several well-known arrangements, and is shown as including a first and a second stage amplifier, a demodulator DM, a band pass filter BPF, an audio frequency amplifier AA and a loud speaker LS.

The first stage amplifier includes an indirectly heated pentode tube V1, the filament 18 of which is constantly heated. Tube V1 is provided with a control grid circuit that includes control grid 19 of tube V1, winding 20 of transformer T1, condensers 21 and 22 in series, and cathode 23 of

the tube, the junction terminals of condensers 21 and 22 being connected to a ground electrode 76. The plate circuit for tube V1 extends from terminal B300 of generator 14 through back contact 16 of directional relay DR, wire 62, resistor 24, plate 25 and intervening tube space to cathode 23 of tube V1, resistor 26 and ground electrodes 27 and 15 to negative terminal N300 of generator 14. Screen grid 70 of tube V1 is provided with a suitable voltage through resistor 71 connected to the plate circuit of the tube.

It is to be seen, therefore, that the control grid circuit of tube V1 is permanently coupled to the receiving circuit through transformer T1, and the plate circuit is energized only when the directional relay DR is released. Consequently, electromotive forces picked up by inductor ID due to communication current flowing in the rails are applied to tube V1 and appear in the plate circuit of the tube in an amplified form when directional relay DR is released. Furthermore, when directional relay DR is picked up to open back contact 16 and disconnect generator 14 from the plate circuit of tube V1, tube V1 remains heated and its grid circuit remains coupled to the receiving circuit.

The plate circuit of the first stage tube V1 is coupled to the input side of the second stage amplifier through a condenser 28. The second stage amplifier is shown conventionally for the sake of simplicity since its specific structure is not required for a full understanding of my invention, and this amplifier can be of any standard form. It is sufficient for this application to point out that the communication current applied to the input of the second stage amplifier is further amplified whenever the directional relay DR is released to close back contact 16 and connect generator 14 to the plate circuit of the tube of the second stage amplifier through wires 62 and 63, and the amplified current is in turn applied through wires 29 and 30 to the input side of demodulator DM.

Demodulator DM is also shown conventionally since it may be any one of several well-known forms, and it is sufficient to state that on the assumption the communication current is an upper side band carrier telephone current, the demodulator includes a source of carrier frequency current to mix with the incoming current and one of the products of demodulation passed through wires 31 and 32 to the band pass filter BPF comprises the voice frequencies.

Band pass filter BPF is proportioned to pass the voice frequencies and to substantially suppress the remaining products of demodulation, the output side of the band pass filter being connected through wires 33 and 34 to the input side of the audio amplifier AA, which may be of well-known construction and is shown conventionally only. After amplification of the voice frequency at amplifier AA, the telephone current is supplied to winding 35 of an output transformer T3, and which transformer is provided with two secondary windings 36 and 37 connected in series. An operating winding of the loud speaker LS is connected across secondary winding 36, through back contact 38 of the directional relay DR to reproduce the voice frequencies appearing at the transformer T3, as will be readily understood by an inspection of the drawing.

The receiving apparatus also includes an automatic volume control device, comprising an asymmetric unit 39, a resistor 40 and a condenser C1. One half cycle of the voice frequency current ap-

pearing across secondary windings 36 and 37 of transformer T3 causes current to flow from the lower terminal of winding 36, through back contact 38 of directional relay DR, ground electrodes 41 and 42, resistor 40, asymmetric unit 39, and to the top terminal of winding 37 of transformer T3. Condenser C1 is connected between a mid terminal of resistor 40 and ground, and is charged at a voltage proportional to the voltage drop across a preselected portion of resistor 40, and hence is charged at a voltage the magnitude of which depends upon the energy level of the voice frequency current. The charge on condenser C1 is applied to control grid 19 of the first stage tube V1 through a resistor 43 and serves as an automatic volume control bias voltage in the well-known manner.

Transmitting apparatus TA may be of any one of several well-known arrangements, and as shown it comprises a microphone MC, a modulator MO, a band pass filter BPF and a power amplifier PA. The microphone MC is preferably included in an energizing circuit receiving power from the 32 volt source of current, and which energizing circuit extends from terminal B32, through ground electrodes 15 and 41, front contact 44 of directional relay DR, microphone MC, winding 45 of a transformer T4, and inductance 46 to terminal N32, a condenser 47 being connected across the circuit. Thus voice frequencies produced by speaking into the microphone MC are transferred through transformer T4 to its secondary winding 48, and are applied in turn to the input side of modulator MO of standard construction and shown conventionally only in order to not unduly complicate the drawing. Plate voltage is provided for modulator MO from the generator 14 through front contact 17 of the directional relay DR and wires 55 and 64, and the modulator MO would also include a generator of carrier frequency current which is modulated by the voice frequencies. The side bands of such modulated current are passed from the output side of modulator MO through wires 49 and 50 to band pass filter BPF of the transmitting apparatus, and which filter is proportioned to pass a preselected one of the side bands and which is here assumed to be the upper side band, and to suppress the other products of modulation. The output of the band pass filter is applied to the tubes of the power amplifier PA.

The power amplifier PA includes two pentodes V2 and V3 connected in multiple. The filaments of these tubes are constantly heated and their control grids 51 and 52, respectively, are connected to the output side of the band pass filter by wires 53 and 54. The plate circuits of tubes V2 and V3 can be traced from the positive terminal B300 of generator 14, through front contact 17 of relay DR, wire 55, either top portion of winding 56 of output transformer T2, plate 57 and intervening tube space to cathode 58 of tube V2, or lower portion of winding 56, plate 59 and intervening tube space to cathode 60 of tube V3, and thence through ground electrodes 61 and 15 to negative terminal N300. A desired voltage for screen grids 65 and 66 of tubes V2 and V3, respectively, is derived from generator 14 through resistor 67 when the directional relay DR is picked up to close front contact 17, a condenser 68 being preferably connected between terminal 75 of resistor 67 and ground.

Thus the communication current passed by the band pass filter of the transmitting apparatus is amplified to a relatively high energy level and is

passed through transformer T2 to the transmitting circuit connected to the rails through the wheels 10 and 11 of the caboose. It follows that the transmitting apparatus is normally inactive, but the tubes of the apparatus are conditioned to be immediately active for transmission of current whenever the directional relay is picked up.

According to my invention, the first stage tube V1 of the receiving apparatus is provided with a bias voltage derived from the transmitting apparatus through a circuit which extends from terminal 75 of resistor 67 through wire 72, resistor 73 and wire 74 to cathode 23 of the tube V1. Hence when directional relay DR is picked up to render the transmitting apparatus active, a voltage corresponding to that appearing at terminal 75 of resistor 67 is applied to the cathode 23 of tube V1 and causes cathode 23 to be positive in potential with respect to the control grid 19, such voltage being predetermined by the proportioning of the parts of the circuit.

Normally, that is, when the directional relay DR is released, the receiving apparatus RA is active and the transmitting apparatus TA is inactive, and communication current flowing in the rails from some remote station is picked up by the inductor ID, amplified, demodulated and reproduced at the loud speaker, the energy level of such reproduced current being governed by the automatic volume control device. When directional relay DR is picked up in response to operation of push button PB, the receiving apparatus is made inactive, and the transmitting apparatus TA is made active, and voice frequencies produced at the microphone MC are mixed with the carrier current at the modulator MO, and a single side band telephone current amplified to a relatively high energy level is applied to the rails through the transmitting circuit. The closed condition of the transmitting circuit causes the inductor ID to be in a strong field, and a relatively high electromotive force is induced therein due to the sending of the telephone current. This electromotive force picked up by inductor ID is applied to the receiving circuit, and in turn to the control grid circuit of the first stage tube V1, it being recalled that transmission in both directions is accomplished on the same carrier frequency. The grid cathode path of tube V1 acts to rectify this electromotive force and current flows from winding 20 through grid 19 to cathode 23 of tube V1, resistor 26, ground electrodes 27 and 42, a portion of resistor 40, resistor 43, and to winding 20 of the input transformer T1. Such current flowing through resistor 40 creates a voltage drop which is applied to condenser C1, and that condenser receives a charge with the ungrounded side negative in potential with respect to ground. Such a charge on condenser C1 would place an unwanted negative grid bias voltage on grid 19 of tube V1 when the apparatus is next switched to the receiving condition so that an incoming message from a remote station might not be amplified at the usual normal gain of the receiving apparatus until the charge on the condenser C1 has had time to leak off. That is, such unwanted charge on condenser C1 would tend to cause the first few words of an incoming message from a remote station to be lost. This undesirable charge on condenser C1 is avoided, however, due to the bias voltage applied to cathode 23 of tube V1 from the transmitting apparatus through the circuit including resistor 73. Such auxiliary bias voltage applied to the first stage tube V1 during periods of transmission serves to avoid the charge

on condenser C1, and hence the receiving apparatus is in a condition to amplify at once at full gain the incoming message received subsequent to a period of transmitting from the caboose.

Although I have herein shown and described but one form of apparatus for communication systems embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In communication apparatus using a receiving electron tube amplifier and a transmitting electron tube amplifier at a station and which tubes are coupled to the transmitting channel through a receiving circuit and a transmitting circuit respectively and the plate circuits of which tubes are excited from a common source of current connected either to the receiving tube through a first position of a circuit controller or to the transmitting tube through a second position of the circuit controller, the combination comprising, a normally closed control grid circuit for said receiving tube coupled to said receiving circuit to impress upon the receiving tube the electromotive forces picked up by the receiving circuit, an automatic volume control circuit including a condenser connected across said control grid circuit to at times provide a negative grid bias voltage for said receiving tube, and circuit means including a resistor and controlled by the second position of said circuit controller to connect said current source to said control grid circuit of the receiving tube to provide a predetermined negative grid bias voltage for the receiving tube to avoid the flow of grid current and charging of said condenser when the transmitting tube is active.

2. In communication apparatus using a receiving electron tube amplifier and a transmitting electron tube amplifier at a station and which tubes are coupled to a single two-conductor transmitting channel through a receiving circuit and a transmitting circuit respectively and the plate circuits of which tubes are excited from a common source of current connected either to the receiving tube through a first position of a circuit controller or to the transmitting tube through a second position of the circuit controller, the combination comprising, a normally closed control grid circuit for said receiving tube coupled to said receiving circuit to impress upon the receiving tube electromotive forces picked up by the receiving circuit, an automatic volume control circuit including a condenser receiving energy from the output of the receiving amplifier and connected to the control grid of said receiving tube to at times render said control grid negative in potential with respect to the cathode of the receiving tube, and a circuit including a first position contact of said circuit controller and a resistor to connect said current source across said control grid circuit of said receiving tube to avoid a charge on said condenser during transmission periods of said station due to a transfer of energy from the transmitting circuit to the receiving circuit because of their connections to said single transmitting channel.

3. In combination with a transmitting channel to convey communication current between remote stations, a station provided with a receiving amplifier tube having its control grid circuit normally coupled to said channel and with a

transmitting amplifier tube having its plate circuit normally coupled to said channel, a source of current connected to the plate circuit of said receiving tube through a first position contact of a manually controlled relay and to the plate circuit of said transmitting tube through a second position contact of the relay, an automatic volume control circuit including a condenser connected to the grid circuit of said receiving tube to at times provide a negative grid bias voltage 10

for the receiving tube, and a circuit closed at the second position of said relay to connect said current source to the control grid circuit of said receiving tube to render the cathode positive in potential with respect to the control grid of that tube to avoid a charge on said condenser when the transmitting tube is active to supply current to said channel.

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