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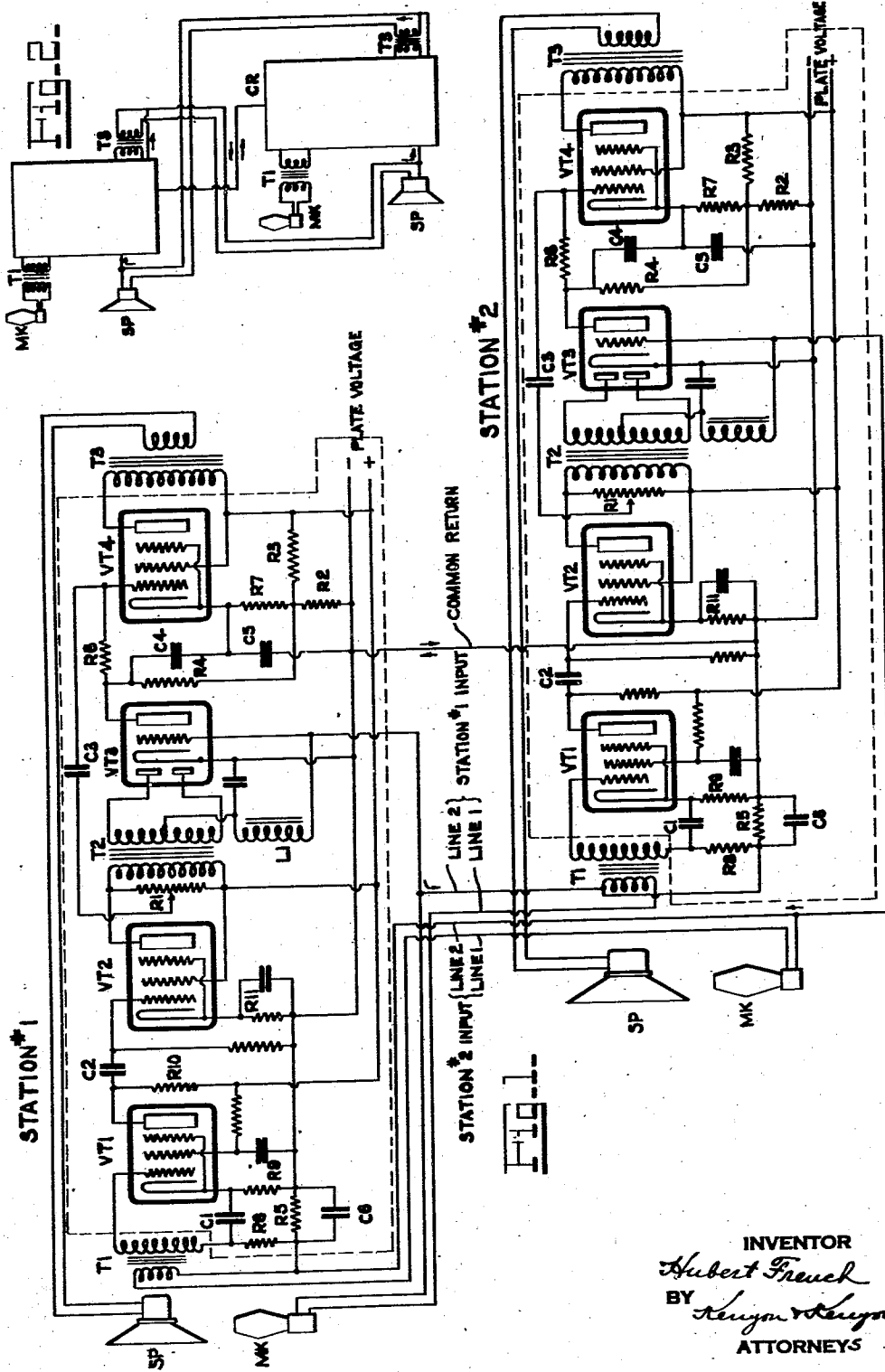
H. FRENCH

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INTERSTATION COMMUNICATION SYSTEM

Filed July 18, 1939

2 Sheets-Sheet 1



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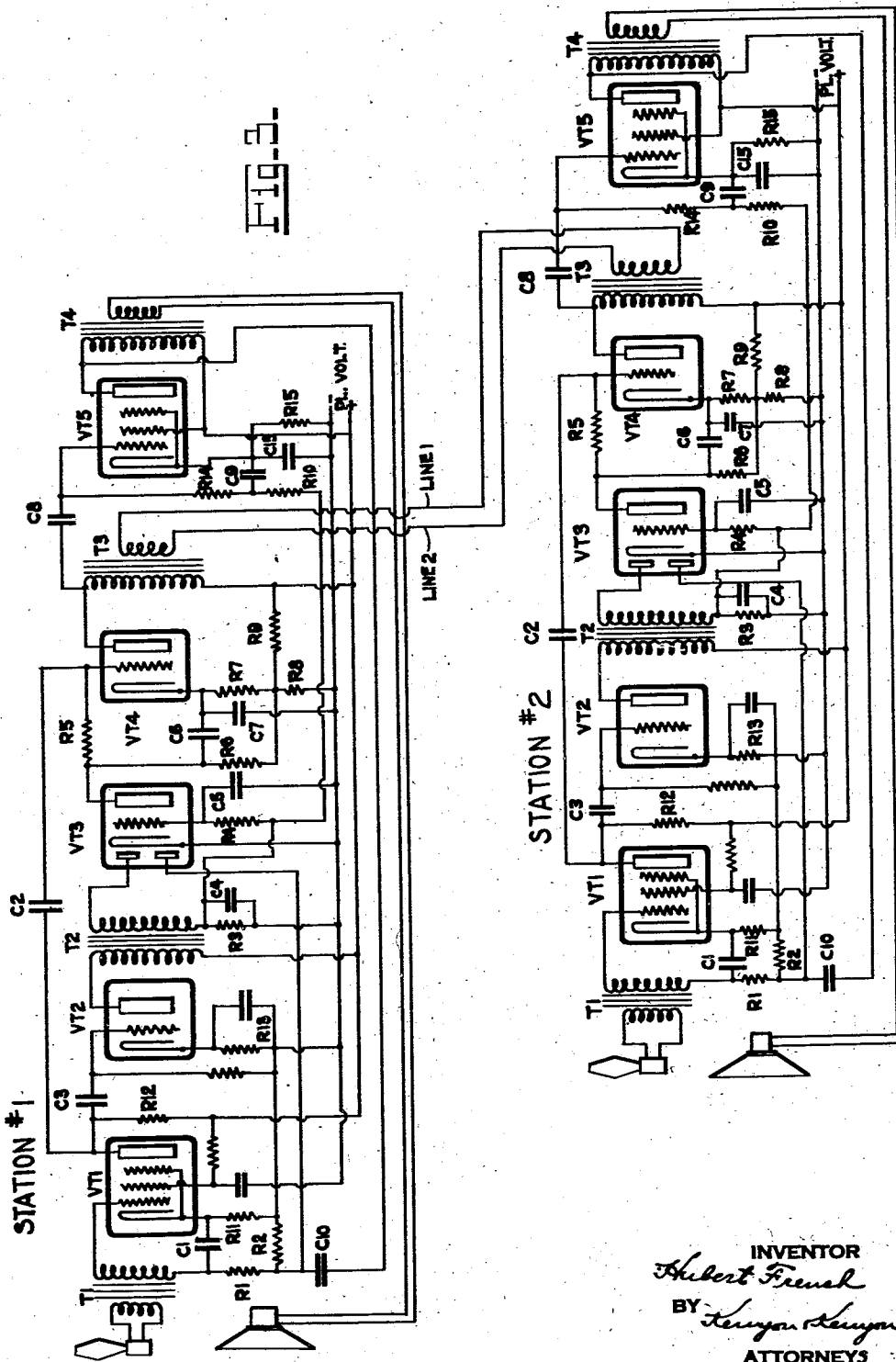
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UNITED STATES PATENT OFFICE

2,199,220

INTERSTATION COMMUNICATION SYSTEM

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13 Claims. (Cl. 179-1)

This invention relates to interstation communication systems.

Such systems comprise a microphone and a loudspeaker with connections for transmitting audio frequency electrical signals from each microphone to the other station loudspeaker. The microphone and loudspeaker at each station are located so close to each other that provision must be made to prevent acoustical feed back from each loudspeaker through its associated microphone to the other station loudspeaker. Heretofore, such provision has been in the nature of manually or electromagnetically actuated means for rendering one transmission line inoperative whenever the other transmission line is operative or has been in the nature of acoustical insulation between each loudspeaker and the associated microphone.

An object of this invention is the provision in an interstation communication system of electronically controlled means for automatically preventing transmission of signals from one microphone to the loudspeaker connected thereto whenever signals are being transmitted from the other microphone to the loudspeaker connected to it and for preventing transmission of signals of less than a given intensity from either microphone to the loudspeaker at the other station.

Other objects, novel features and advantages of this invention will become apparent from the following specification and accompanying drawings, wherein:

Fig. 1 is a circuit diagram of one embodiment of the invention;

Fig. 2 is a circuit diagram of a modified embodiment of the invention, and

Fig. 3 is a circuit diagram of still another embodiment of the invention.

Referring now to Fig. 1 wherein a two-station apparatus is illustrated, a microphone M and a speaker S are provided at each station in juxtaposition, it being common practice to have the microphone and speaker in effect a unitary arrangement. The circuit arrangement at the two stations are identical and the same reference characters are used for corresponding elements at the two stations.

The microphone M at each station has its coil series connected through transmission lines 1 and 2 with the primary winding of a transformer T₁ at the other station. One terminal of the secondary of each transformer T₁ is connected to the control electrode of a vacuum tube VT₁, while the other terminal of said secondary is connected to the cathode of said tube through

a decoupling resistor R₈, a resistor R₉ and the cathode biasing resistor R₆ and a condenser C₁ is bridged between said last-named terminal and the cathode of said tube. The cathode of each tube VT₁ is connected through said cathode biasing resistor R₆ to the negative side of a voltage source while the anode of said tube is connected through the usual plate load resistor R₁₀ to the positive side of said source. Each tube VT₁ has a suppressor electrode bridged to the cathode and a screen electrode connected to the positive side of the voltage source in the usual manner through a dropping resistor and by-pass condenser. The output circuit of each tube VT₁ is coupled by means of the condenser C₂ to the control electrode of a vacuum tube VT₂. The cathode of each tube VT₂ is connected to the negative side of the voltage source through the cathode biasing resistor R₁₁.

In the output circuit of each vacuum tube VT₂ is contained the primary winding of a transformer T₂ which is bridged by a variable voltage divider R₁. Each tube VT₂ has a suppressor electrode bridged to the cathode and a screen electrode connected to the positive side of said voltage source. The terminals of the secondary of each transformer T₂ are connected to a pair of rectifier anodes of a combination diode and triode vacuum tube VT₃. The midpoint of the secondary of each transformer T₂ is connected to the cathode of the associated vacuum tube VT₃ through a choke coil L₁, input line 2 of the opposite station, the resistor R₅ at the opposite station and a common return line connecting the negative sides of the voltage sources at the two stations. The cathode of each tube VT₃ is connected to the negative side of the voltage source and the control electrode of the triode section is connected to the load end of the choke coil L₁. Four resistors R₂, R₃, R₄ and R₇ are interconnected at a common junction and the anode of each tube VT₃ is connected through the resistors R₄ and R₃ to the positive side of the potential source.

The slider of each voltage divider R₁ is coupled through a condenser C₃ to the control electrode of a vacuum tube VT₄, such control electrode also being connected through the resistance R₅ to the anode of tube VT₃. The anode of each tube VT₄ is connected through the primary of a transformer T₃ to the positive side of the voltage source and the coil of the speaker is connected in series with the secondary of said transformer T₃. The tube VT₄ has a suppressor electrode bridged to the cathode of said tube and a

screen electrode connected to the positive side of said voltage source. The cathode of each tube VT₄ is connected through the cathode biasing resistors R₇ and R₈ to the negative side of said voltage source. A by-pass condenser C₅ is provided from the cathode to the negative side of the voltage source in shunt to the cathode biasing resistors and a condenser C₄ is connected in shunt to the resistors R₄ and R₇.

When no signals are being transmitted from one station to the other, the potential on the control electrode of the triode section of each tube VT₃ is such that plate current flows through said triode section and the voltage drop across resistor R₄ biases the control electrode of the associated tube VT₄ sufficiently negative with respect to the cathode of such tube to suppress plate current flow in said tube VT₄ thereby insuring that noise level of less than a predetermined intensity at either station will not be reproduced in the speaker at the other station. Upon excitation of either microphone by audible signals of a given intensity, such signals will be reproduced in the speaker at the opposite station. The audible signals are translated into electrical impulses by the microphone and are impressed upon the transformer T₁ of the receiving station. The voltage thus induced in the secondary of the receiving station transformer T₁ is amplified by vacuum tubes VT₁, VT₂ in the usual manner and a portion of the output of the tube VT₂ is impressed upon the control electrode of the receiving station tube VT₄. Simultaneously, a portion of the output of said tube VT₂ is rectified by the diode section of the receiving station tube VT₃ and causes current flow through the transmitting station input line 2, the transmitting station resistor R₅ and back through the common return line to the cathode of said diode section. The voltage drop across the transmitting station resistor R₅ biases the control electrode of the receiving station tube VT₃ sufficiently negative relative to the cathode to suppress current flow in the tube VT₃. As a result of the suppression of the plate current flow in tube VT₃, the voltage drop across resistor R₄ disappears, leaving a voltage drop created by the resistor R₇ as the only bias for the control electrode of the receiving station tube VT₄. Thereupon, the plate current flows in said tube VT₄ and such tube reproduces signals from the receiving station tube VT₂. Such signals are impressed by the output of the tube VT₄ on the receiving station speaker S and the audible signals impressed upon the transmitting station microphone are reproduced by the receiving station speaker. The voltage drop across the transmitting station resistor R₅ likewise biases the control electrode of the transmitting station tube VT₁ relative to its cathode sufficiently negative to suppress plate current flow in said tube, thereby preventing operation of the amplifier whereby the transmitting station speaker is prevented from reproducing signals picked up by the receiving station microphone from the same station speaker.

The modification disclosed in Fig. 2 differs from that disclosed in Fig. 1 in that in Fig. 2, the amplifying and controlling equipment for the station 2 speaker is located at station 1 while the amplifying and controlling equipment for station 1 is located at station 2 with the result that amplified signals are transmitted from one station to the other. In this modification, the coil of each microphone is series connected with

the primary of the transformer T₁ at the same station, while the coil of each speaker is series connected with the secondary of the transformer T₃ at the opposite station. The operation of Fig. 2 modification, however, is identical with that of the Fig. 1 modification.

In the modification disclosed in Fig. 3, the coil of the microphone at each station is series connected to the primary of the transformer T₁ at the same station. One terminal of the secondary of each transformer T₁ is connected to the control electrode of a vacuum tube VT₁, while the other terminal of said secondary is connected to the cathode of said tube through a decoupling resistor R₁, resistor R₂ and cathode biasing resistor R₁₁, and a condenser C₁ is bridged between said last-named terminal and the cathode of said tube. The cathode of each tube VT₁ is connected through said cathode biasing resistor R₁₁ to the negative side of a voltage source, while the anode of said tube is connected through the usual plate load resistor R₁₂ to the positive side of said source. Each tube VT₁ has a suppressor electrode bridged to the cathode and a screen electrode connected to the positive side of the voltage source, in the usual manner through a dropping resistance and by-pass condenser. The output circuit of each tube VT₁ is coupled by means of the condenser C₃ to the control electrode of a vacuum tube VT₂. The cathode of each tube VT₂ is connected to the negative side of the voltage source through the cathode biasing resistor R₁₃ and by-pass condenser. In the output circuit of each vacuum tube VT₂ is contained the primary winding of a transformer T₂. One terminal of the secondary of each transformer T₂ is connected to one of a pair of rectified anodes of a combination diode and triode vacuum tube VT₃. The anode of the tube VT₁ is coupled through the condenser C₂ to the control electrode of the vacuum tube VT₄ and the anode of the tube VT₃ is coupled to said control electrode through the resistor R₅. In the output circuit of the vacuum tube VT₄ is included the primary of the transformer T₃, the secondary of which is connected in series with the secondary of the transformer T₃ at the opposite station. Also, the output circuit of each tube VT₄ is coupled through the condenser C₈ to the control electrode of a vacuum tube VT₅, the output circuit of which includes the primary winding of a transformer T₄, the secondary of which is connected in series with the coil of the speaker S. The remaining anode plate of the diode section of VT₃ is coupled through the condenser C₁₀ to the anode of the same station tube VT₅. The control electrode of the triode section of each tube VT₃ is connected through a resistor R₄, resistor R₁₀, and resistor R₁₄ to the control electrode of vacuum tube VT₅. The remaining end of the secondary of each transformer T₂ is connected through the resistor R₃ bridged by the condenser C₄ to the negative side of the voltage source. A condenser C₅ bridges the control electrode of the vacuum tube VT₃ to the negative side of the voltage source. Four resistors R₆, R₇, R₈ and R₉ are interconnected at a common junction and the anode of each tube VT₃ is connected through the resistors R₆ and R₉ to the positive side of the voltage source. The cathode of each vacuum tube VT₄ is connected through cathode biasing resistors R₇ and R₈ to the negative side of the voltage source. A condenser C₆ bridges the resistors R₆ and R₇ and a condenser C₇ bridges the cathode of the tube VT₄ to the negative side of

the voltage source. The tube VT_1 is provided with a suppressor electrode bridged to the cathode and the cathode is connected through a resistor R_{15} bridged by a condenser C_{15} to the negative side of the plate source. A condenser C_2 is bridged from the cathode of the vacuum tube VT_4 to the connection between the resistors R_{10} and R_{14} .

In the modification of Fig. 3, the transmission between stations 1 and 2 takes place over two conductors only which makes it necessary to generate locally at each station all the biasing voltages which may be necessary for the prevention of acoustical feed back between a speaker and a microphone during transmitting, receiving and silent periods. When neither station is transmitting, the control electrodes of tube VT_4 is biased negatively with respect to its cathode sufficiently to prevent plate current flow in the tube VT_4 . Such biasing of the control electrode of the tube VT_4 is produced by the voltage drop across the resistor R_3 in the output circuit of the triode section of the tube VT_3 , the control electrode of which is of proper bias with respect to its cathode as to permit plate current flow. When the station 1 is a transmitting station, the audible signals actuate the station 1 microphone and their electrical equivalents are transmitted by induction through transformer T_1 to the control electrode of the tube VT_1 . A part of the amplified output of the tube VT_1 is impressed through the coupling condenser C_3 on the grid of VT_2 which tube further amplifies the signals. From the output of the vacuum tube VT_2 , the signal is induced into the secondary winding of the transformer T_2 from whence it is fed to one of the diode anodes in the tube VT_3 . A voltage of one polarity is developed across the condenser C_4 which negatively biases the control electrode of the triode section of the vacuum tube VT_3 and also negatively biases the control electrode of the tube VT_5 . Such biasing of the control electrodes just referred to is sufficient to prevent the flow of plate current in the triode section of the tube VT_3 and also to prevent plate current flow in the tube VT_5 . As a result of the interruption of the plate current flow in the triode section of the tube VT_3 , the voltage drop across the resistor R_3 is eliminated and the high negative bias previously existing on the control electrode of tube VT_4 and which previously had prevented flow of plate current in the tube VT_4 is removed thereupon permitting such tube to become operative. The remaining signal output of the tube VT_1 is impressed through the condenser C_2 on the control electrode of the tube VT_4 which has now as above described been rendered operative. The output of the tube VT_4 is induced into the secondary winding of the transformer T_3 and is transmitted through the lines 1 and 2 to the receiving station. The output of the tube VT_4 is prevented from operating the tube VT_5 by the application to the control electrode of the tube VT_5 of a high negative biasing voltage obtained through the decoupling resistor R_{10} from resistor R_3 . From the secondary of the receiving station transformer T_3 , the signal is impressed through the coupling condenser C_6 on the control electrode of the tube VT_5 and the output of the tube VT_5 is impressed upon the receiving station speaker from the transformer T_4 . In order that the sound output of the receiving station speaker can produce no input to the control electrode of the receiving station tube VT_1 , a small portion

of the output signal of the receiving station tube VT_5 is fed through the coupling condenser C_{10} to the diode section of the receiving station tube VT_3 for rectification. The resulting rectified voltage appears across the receiving station resistor R_2 , the negative side of which is connected to the control electrode of the tube VT_1 through the decoupling resistor R_1 , thereby negatively biasing the control electrode of the tube VT_1 sufficiently to prevent plate current flow in said tube, thereby preventing such tube from amplifying any signal which the microphone reproduces from the speaker output.

The vacuum tubes VT_1 and VT_2 of Figs. 1 and 2 amplify the signals sufficiently to provide the voltage necessary properly to bias the control electrode of the opposite station tube VT_1 and the control electrode of the same station tube VT_3 to interrupt plate current flow in such tubes. The tube VT_4 constitutes a normally inoperative repeater which is rendered operative by reduction of its negative bias when the plate current flow is interrupted in the tube VT_3 and may also act as an amplifier if additional amplification is desired. The action is the same in the system of Fig. 3 except that the negative bias for the tube VT_1 is developed at the same station at which the tube is located.

I claim:

1. In an interstation communication system having a microphone and a speaker at each station, connections between the microphone at each station and the speaker at an opposite station including a vacuum tube amplifier and a vacuum tube repeater between each amplifier and its associated speaker, a triode electron discharge device for each repeater having a resistor in its output circuit, connections for negatively biasing the control electrode of the associated repeater by the potential drop across said resistor, a rectifier for each amplifier connected to the output thereof and having a resistor in series, and connections for negatively biasing the control electrodes of an amplifier and a triode by the potential drop across one of said last-named resistors.
2. In an interstation communication system having a microphone and a speaker at each station, connections between the microphone at each station and the speaker at an opposite station including a vacuum tube amplifier and a vacuum tube repeater between each amplifier and its associated speaker, a triode electron discharge device for each repeater having a resistor in its output circuit, connections for negatively biasing the control electrode of the associated repeater by the potential drop across said resistor, a rectifier for each amplifier connected to the output thereof and having a resistor in series, and connections for negatively biasing the control electrodes of each amplifier and the triode associated with the opposite amplifier by the voltage drop across the resistor in series with the rectifier associated with said opposite amplifier.
3. In an interstation communication system having a microphone and a speaker at each station, connections between the microphone at each station and the speaker at an opposite station including a vacuum tube amplifier and a vacuum tube repeater between each amplifier and its associated speaker, a triode electron discharge device for each repeater having a resistor in its output circuit, connections for negatively biasing the control electrode of the associated repeater by the potential drop across said resistor, a rectifier for each amplifier connected to the output

thereof and having a resistor in series, and connections for negatively biasing the control electrodes of each station amplifier and the other station triode by the resistor in series with the rectifier associated with such amplifier.

4. In an interstation communication system having a microphone and a speaker at each station, connections between the microphone at each station and the opposite station speaker including a vacuum tube amplifier and a vacuum tube repeater at each station with transmission lines leading from each repeater to the opposite station speaker; a triode vacuum tube at each station having a resistor in its output circuit, connections for negatively biasing the control electrode of the same station repeater by the potential drop across said resistor, a rectifier at each station connected to the output of the same station amplifier and having a resistor in series, and connections for negatively biasing the control electrodes of each amplifier and the opposite station triode by the voltage drop across the resistor in series with the rectifier associated with the opposite station amplifier.

5. In an interstation communication system having a microphone and a speaker at each station, connections between the microphone at each station and the opposite station speaker including a vacuum tube amplifier and a vacuum tube repeater at each station with transmission lines leading from each microphone to the opposite station amplifier, a triode vacuum tube at each station having a resistor in its output circuit, connections for negatively biasing the control electrode of the same station repeater by the potential drop across said resistor, a rectifier at each station connected to the output of the same station amplifier and having a resistor in series, and connections for negatively biasing the control electrode of each amplifier and the control electrode of the opposite station triode by the voltage drop across the resistor in series with the rectifier associated with the opposite station amplifier.

6. In an interstation communication system having a microphone and a speaker at each station, connections between the microphone at each station and the speaker at an opposite station including a vacuum tube amplifier and a vacuum tube repeater between each amplifier and its associated speaker, a triode electron discharge device for each repeater having a resistor in its output circuit, connections for negatively biasing the control electrode of the associated repeater by the potential drop across said resistor, a rectifier for each amplifier connected to the output thereof and having a resistor in series, and connections for negatively biasing the control electrode of one triode by the potential drop across one of said last-named resistors.

7. In an interstation communication system having a microphone and a speaker at each station, connections between the microphone at each station and the speaker at an opposite station including a vacuum tube amplifier and a vacuum tube repeater between each amplifier and its associated speaker, a triode electron discharge device for each repeater having a resistor in its output circuit, connections for negatively biasing the control electrode of the associated repeater by the potential drop across said resistor, a rectifier for each amplifier connected to the output thereof and having a resistor in series, and connections for negatively biasing the control electrode of

each triode by the voltage drop across the resistor in series with the same station rectifier.

8. In an interstation communication system having a microphone and a speaker at each station, connections between the microphone at each station and the opposite station speaker including a vacuum tube amplifier and a vacuum tube repeater at each station with transmission lines leading from each repeater to the opposite station speaker, a triode vacuum tube at each station having a resistor in its output circuit, connections for negatively biasing the control electrode of the same station repeater by the potential drop across said resistor, a rectifier at each station connected to the output of the same station amplifier and having a resistor in series, and connections for negatively biasing the control electrode of each triode by the voltage drop across the resistor in series with the rectifier associated with the same station amplifier.

9. In an interstation communication system having a microphone and a speaker at each station, connections between the microphone at each station and the speaker at an opposite station including a vacuum tube amplifier and a normally inoperative vacuum tube repeater between each amplifier and its associated speaker, and means responsive to the output voltage of the amplifier for rendering said repeater operative.

10. In an interstation communication system having a microphone and a speaker at each station, connections between the microphone at each station and the speaker at an opposite station including a vacuum tube amplifier and a normally inoperative vacuum tube repeater between each amplifier and its associated speaker, and means responsive to the output voltage of each amplifier for rendering operative the same station repeater and rendering the opposite station amplifier inoperative.

11. In combination, an amplifier, a vacuum tube repeater connected to the output of said amplifier, a triode electron discharge device having a resistor in its output circuit, connections for negatively biasing the control electrode of said repeater by the potential drop across said resistor, a rectifier connected to the output of said amplifier and having a resistor in series, and connections for negatively biasing the control electrode of said triode by the potential drop across said last-named resistor.

12. In an interstation communication system having a microphone and a speaker at each station, connections between the microphone at each station and the opposite station speaker including a vacuum tube amplifier and a first vacuum tube repeater at each station with transmission lines leading between the outputs of said first repeaters and a second repeater at each station coupling the first repeater to the speaker, a triode vacuum tube at each station having a resistor in its output circuit, connections for negatively biasing the control electrode of each first repeater by the potential drop across said resistor, means including a rectifier for negatively biasing the control electrode of the same station triode and the control electrode of the same station second repeater by said amplifier output voltage, and means for negatively biasing the control electrode of each station amplifier by the output voltage of the same station second repeater.

13. In combination, an amplifier, a vacuum tube repeater connected to the output of said amplifier, a resistor in the anode-cathode circuit of said repeater, connections for negatively biasing the

control electrode of said repeater by the potential drop across said resistor, a triode electron discharge device having a resistor in its output circuit, connections for negatively biasing the control electrode of said repeater by the potential drop across the resistor in the triode output cir-

cuit, a rectifier connected to the output of said amplifier and having a resistor in series, and connections for negatively biasing the control electrode of said triode by the potential drop across said last-named resistor.

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