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AUTOMATIC VOLUME CONTROL FOR TELEPHONE LINES

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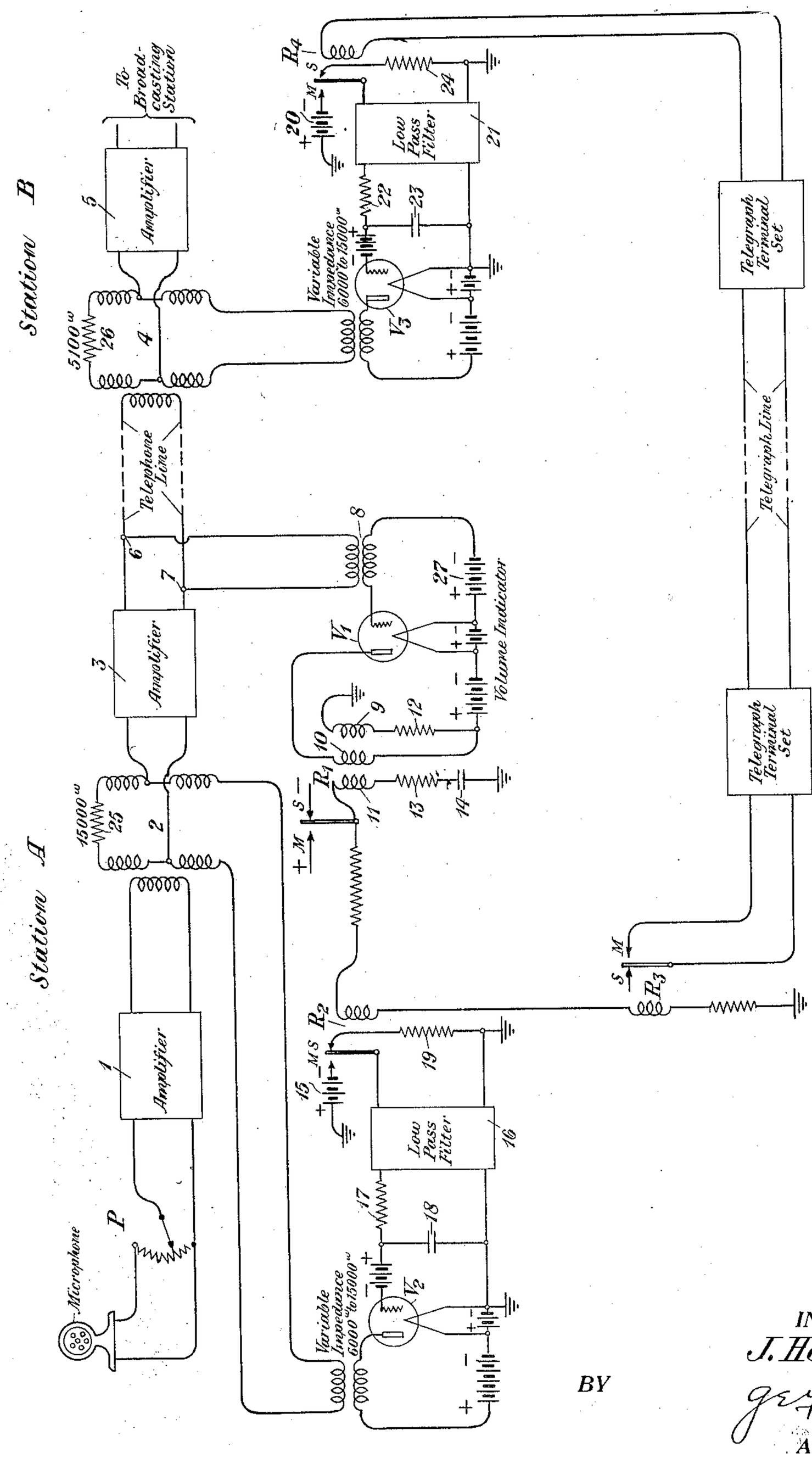

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AUTOMATIC VOLUME CONTROL FOR TELEPHONE LINES.

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This invention relates to telephone transmission systems, and more particularly to methods of and means for effecting current volume control in such systems.

The invention is particularly applicable to telephone transmission systems connecting microphones to distant radio broadcasting stations.

It is the object of applicant's invention to limit automatically the volume of the telephone currents transmitted over the line without changing the volume at the receiving end.

The above stated object is attained in general as follows: At the sending station the peaks of the telephone currents, when these currents exceed a predetermined safe value, are automatically converted into direct current suitable for transmission over an ordinary telegraph circuit. The direct current impulses are caused to effect automatically a reduction of the telephone current volume at the sending station input to the line. Simultaneously, the direct current impulses are transmitted over a telegraph circuit to the receiving station, where they automatically effect an increase of the current volume at the output from the line, thereby compensating for the volume reduction effected at the sending station.

Applicant's invention will be more clearly understood when the following detailed description is read with reference to the accompanying drawing, which shows diagrammatically one desirable form of the circuit arrangements for volume control as applied to a telephone transmission system connecting a microphone to a distant broadcasting station.

With reference to the details of the drawing, the telephone currents from the microphone at the sending station A pass through the potentiometer P and the amplifier 1 to a gain-controlling circuit including the hybrid coil 2. This gain-controlling circuit has in it a fixed resistance 25. A variable gain control is obtained through the variable balance of the hybrid coil 2, which variable balance is obtained by varying the plate circuit impedance of the vacuum tube V_2, as will be more fully discussed below. From the hybrid coil 2 the telephone currents pass through the amplifier 3 over the telephone line to a gain-controlling circuit at the receiving station B. This second gain-controlling circuit includes the hybrid coil 4 and a fixed resistance 26. The variable gain control is obtained through the variable balance of the hybrid coil 4, which variable balance in turn is obtained by varying the plate circuit impedance of the vacuum tube V_3, as will be more fully discussed below. From the hybrid coil 4 the telephone currents pass through the amplifier 5 to the broadcasting station.

Across the telephone line at the points 6 and 7 in the output of amplifier 3, there is connected through the coil 8 a volume indicator, including the vacuum tube V_1. The grid circuit of this vacuum tube includes a battery 27, this battery impressing on the grid a negative voltage of such value that normally little or no plate current flows. This vacuum tube permits a direct current to flow in its plate circuit when an alternating wave of sufficient amplitude is applied to the grid circuit. Applicant's volume indicator differs from the common type merely in that in place of the usual milliammeter there is connected in the plate circuit a polar relay R_1, which, as will appear more clearly below, is in effect slow operating and slow releasing. This polar relay R_1 has three windings, 9, 10 and 11. The winding 9 serves as a biasing winding, and is operated from a local battery through the resistance 12, in the drawing the plate battery of the volume indicator being utilized for this purpose. Winding 10 is connected into the plate circuit of the vacuum tube V_1 and serves as the main operating winding of the relay. Winding 11 serves as an auxiliary holding winding and is operated from the positive and negative batteries connected to the contacts of relay R_1, as indicated in the drawing. This winding 11 is connected from the armature of the relay to ground in series with the resistance 13 and the capacity 14. It will hold the relay armature temporarily on either contact for a period of time depending upon the values of resistance 13 and capacity 14. It thus prevents the relay armature from chattering rapidly in response to rapid fluctuations of the voice currents, and consequently, the action of the armature will be sufficiently slow to produce

impulses suitable for transmission over an ordinary telegraph circuit.

To the armature of relay R_1 there are connected the windings of two additional polar relays, R_2 and R_3. As will appear more clearly below in the discussion of the operation of applicant's system, the relay R_2 controls the volume reduction at the sending station by varying the plate circuit impedance of the vacuum tube V_2, and relay R_3 transmits the direct current impulses over the telegraph line to the receiving station B, where these impulses are caused to effect a compensating volume increase by varying the plate circuit impedance of the vacuum tube V_3.

The operation of the volume control system will now be described in detail. For the purpose of illustration, the value of the resistance 25 is chosen as 15,000 ohms, and the value of the impedance of the tube V_2 as from 6,000 ohms to 15,000 ohms. While these values are arbitrarily chosen, they indicate the difference in values which is suitable. Likewise, at the receiving station B, the value of the resistance 26 is chosen as 5,100 ohms, and the value of the variable impedance of the tube V_3 as 6,000 ohms to 15,000 ohms, as is the case with the tube V_2. When the armatures of relays R_1 and R_2 are on their spacing contacts S, the plate impedance of the tube V_2 at one end of the circuit including the hybrid coil 2, differs widely in value from the balancing resistance 25 at the other end of the circuit. It is well understood in the art that, given this difference, the hybrid coil 2 will offer only a small loss to the telephone currents passing through it from amplifier 1 to amplifier 3.

If the volume level of the telephone currents at the input to the telephone line exceeds a predetermined value, the peaks of these currents are automatically converted in the volume indicator into pulsating direct current in the plate circuit. This occurs because the voice waves of amplitude greater than the predetermined value which are impressed upon the grid circuit make the grid potential so much less negative that a substantial amount of current is permitted to flow in the plate circuit. Consequently, the plate current of the volume indicator will increase sufficiently to throw the armature of relay R_1 from its spacing contact S to its marking contact M. This operation of the relay results in the operation of relays R_2 and R_3 to their marking contacts M. Upon the operation of relay R_2 to its contact M the negative pole of the battery 15 is connected to the grid circuit of the vacuum tube V_2. Current from this battery 15 flows through the low-pass filter 16 and the resistance 17, and as will be clearly understood in the art, gradually establishes a negative voltage across the condenser 18. The increasing of the amount of negative voltage on the grid of the tube V_2 increases the plate circuit impedance of that tube, as is well understood, and consequently, this plate circuit impedance will be nearer to balancing the 15,000 ohm resistance 25 at the other end of the circuit including the hybrid coil 2. It follows that there is an increase of the transmission loss in the hybrid coil 2, and this increase will continue until the level of the telephone currents at the input to the line has become low enough to result in the release of the relay R_1 in the volume indicator circuit. The armature of relay R_1 of course is returned to its spacing contact S, and likewise the armature of relay R_2 is returned to its contact S. The result is the gradual discharge of the condenser 18 through the resistance 19. The level of the telephone currents at the input to the line will then rise again until relay R_2 is again operated, and the above described process will be repeated. It will be evident to those skilled in the art that the relay operations responsive to the peaks of the voice currents, as described above, will establish an average voltage on condenser 18 of such value that the proper input level to the telephone line will be maintained.

As stated above, the operation of relay R_1 results in the operation of relay R_3. When the armature of the latter relay is thrown to its marking contact M, direct current impulses are transmitted over the telegraph circuit to the relay R_4 at the receiving station B. This relay acts on the circuits of the vacuum tube V_3 just as the relay R_2 at the sending station A acts on the circuits of the tube V_2. When, in response to the impulses transmitted over the telegraph line, the armature of relay R_4 is thrown to its marking contact M, the negative pole of the battery 20 is connected to the grid circuit of the tube V_3. Current from the battery 20 flows through the low-pass filter 21 and the resistance 22 and gradually establishes a negative voltage across the condenser 23. The increase of the amount of negative voltage on the grid of the tube V_3 raises the plate circuit impedance of the tube from 6,000 ohms (arbitrarily chosen) toward 15,000 ohms. Since, as stated above, the value of the fixed resistance 26 in the receiving station gain-controlling circuit is 5,100 ohms, the increase of plate circuit impedance in the tube V_3 in response to the operation of relay R_4 results in the further unbalancing of the hybrid coil 4. Consequently, the transmission loss through the hybrid coil is decreased, and the volume output from the line is increased.

It should be evident from the above description that applicant's arrangement responds to excess of current volume at the station A by reducing the current volume

at the input to the line and by causing a compensating increase of the current volume at the output from the line at the receiving station. Furthermore, it should be evident that this operation is rapid and entirely automatic.

In connection with applicant's arrangement for volume control, there have been described gain-controlling circuits of a particular type. It is to be understood that such specification is merely for the purpose of illustration and that any suitable gain-controlling means may be substituted. Also, it is to be understood that many other changes from the arrangement shown may be made without a departure from the spirit and scope of applicant's invention as defined in the appended claims.

What is claimed is:

1. In a system for the transmission of telephone signals over wires, the method of limiting the current volume in the line, which consists in automatically converting at the sending station the peaks of the telephone currents, when said currents exceed a predetermined value and only at such times, into direct currents, and causing the direct current impulses automatically to effect a reduction of the volume at the sending station input to the line and a compensating increase of the volume at the receiving station output from the line.

2. In a system for the transmission of telephone signals over wires, the method of limiting the current volume in the line, which consists in automatically converting at the sending station the peaks of the telephone currents, when said currents exceed a predetermined value and only at such times, into direct currents, causing the direct current impulses automatically to effect a reduction of the volume at the sending station input to the line, transmitting said impulses to the receiving station over a separate path, and causing said impulses automatically to effect a compensating increase of the volume at the receiving station output from the line.

3. In a system for the transmission of telephone signals, said system including a sending station, a receiving station, and a transmission line connecting said stations, automatic means at the sending station for converting the peaks of the telephone currents, when said currents exceed a predetermined value and only at such times, into direct currents, automatic means at the sending station controlled by the direct current impulses for reducing the input volume to the transmission line, and automatic means at the receiving station controlled by said impulses for effecting a compensating increase of the volume at the output from the transmission line.

4. In a system for the transmission of telephone signals, said system including a sending station, a receiving station, and a telephone line connecting said stations, automatic means at the sending station for converting the peaks of the telephone currents, when said currents exceed a predetermined value and only at such times, into direct currents, automatic means at the sending station controlled by the direct current impulses for reducing the input volume to the telephone line, a telegraph circuit for carrying the direct current impulses to the receiving station, and automatic means at the receiving station controlled by said impulses for effecting a compensating increase of the volume of the telephone currents at the output from the telephone line.

5. In a system for the transmission of telephone signals, said system including a sending station, a receiving station, and a telephone line connecting said stations, a vacuum tube volume indicator connected across the input to the telephone line at the sending station, an effectively slow operating and slow releasing relay in the plate circuit of said volume indicator, said relay operating when the telephone currents exceed a predetermined value, automatic means controlled by said relay for reducing the input volume to the telephone line, a telegraph circuit between the sending station and the receiving station, automatic means controlled by the relay for sending impulses over said telegraph circuit, and automatic means at the receiving station controlled by said impulses for effecting at the output from the telephone line an increase of the volume equal to the reduction thereof effected at the sending station.

In testimony whereof, I have signed my name to this specification this 30th day of December, 1925.

JOSEPH HERMAN.