July 23, 1929. R. K. POTTER 1,721,574

TRANSMISSION LEVEL REGULATION

Filed Nov. 20, 1925

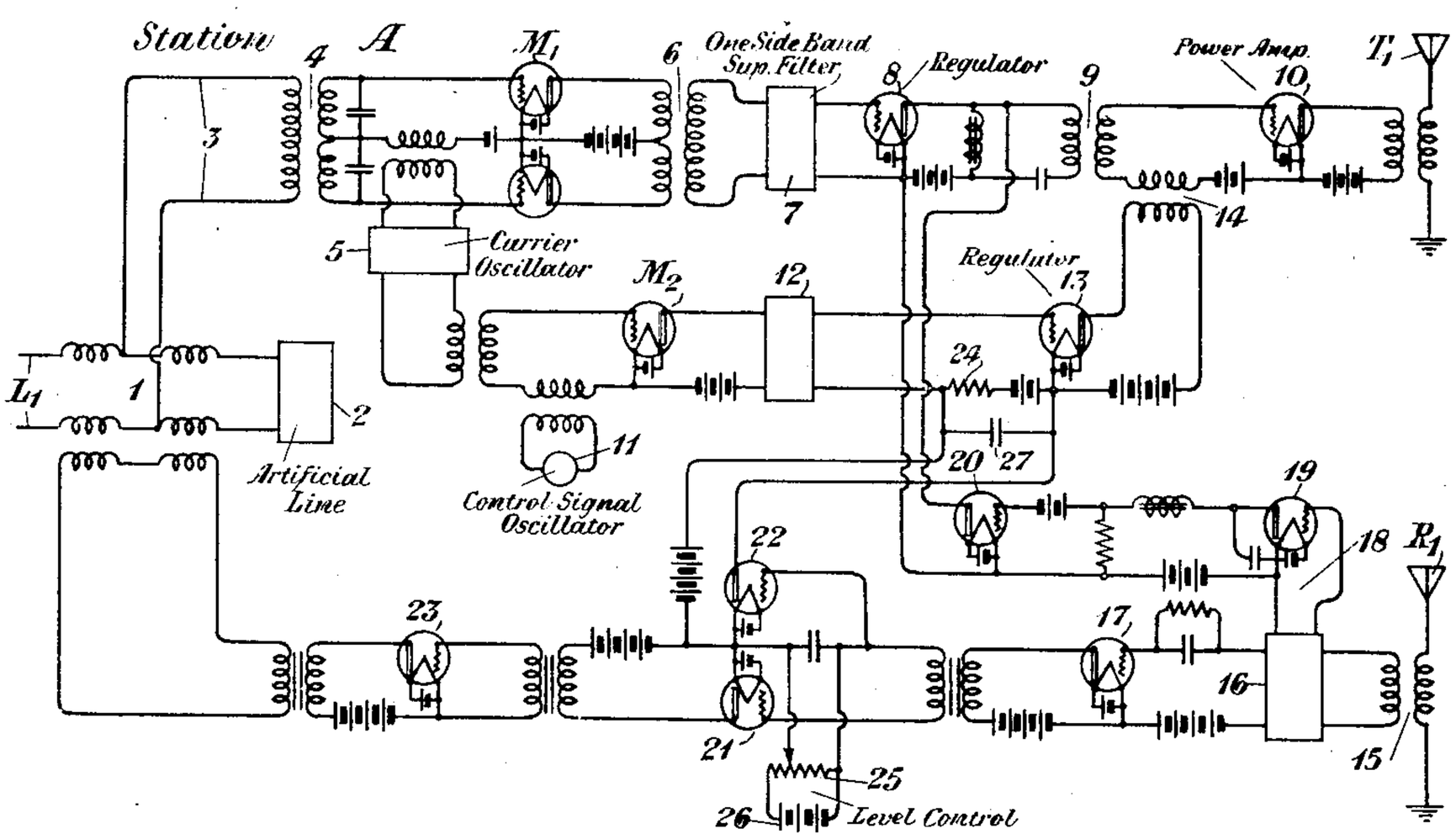

Fig. 1

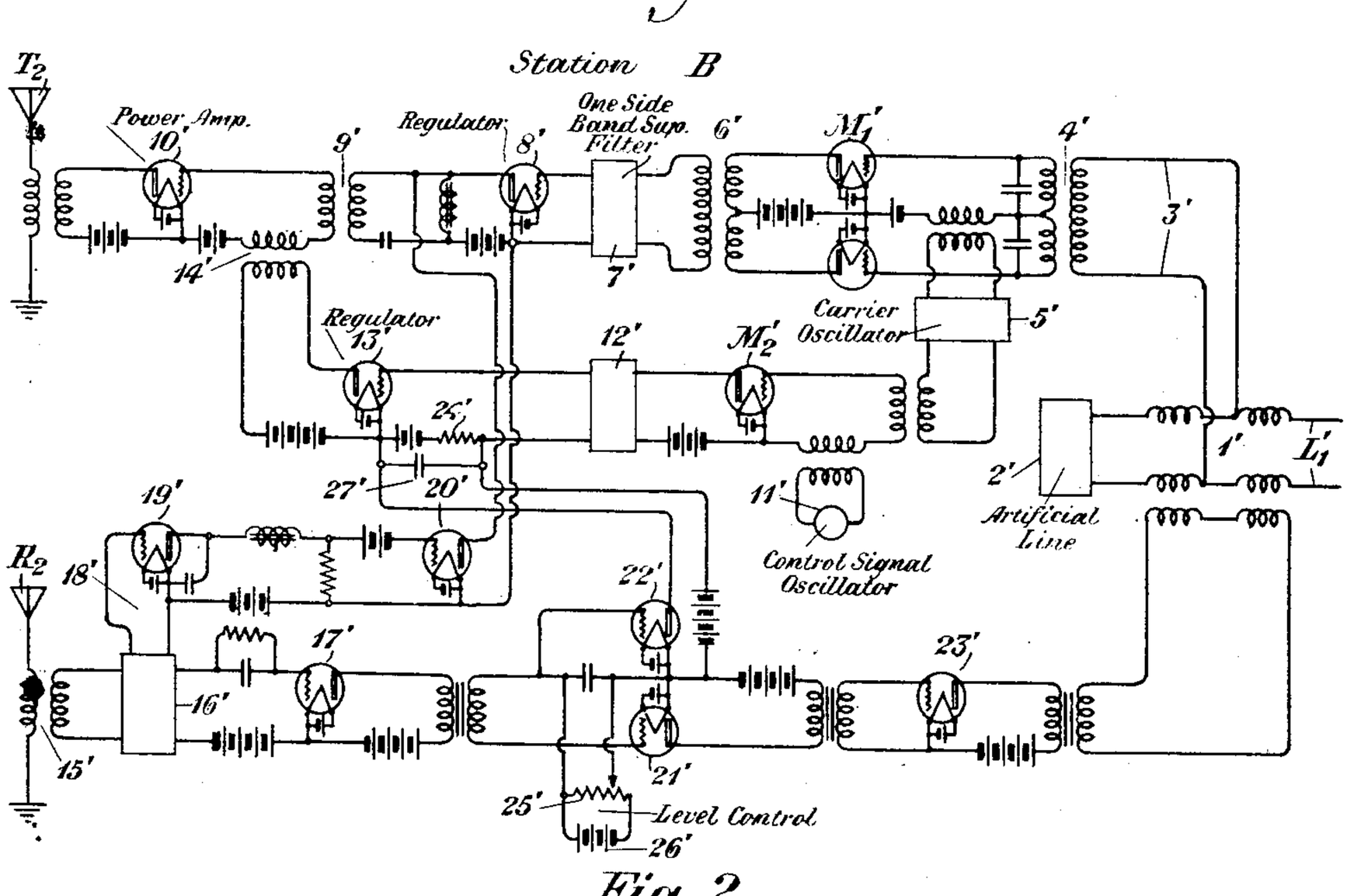

Fig. 2

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TRANSMISSION LEVEL REGULATION.

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This invention relates to radio signaling systems, and particularly to means for regulating the transmission level of a two-way system in order to render the overall equivalent of the system substantially constant.

In radio signaling systems, it is desirable to maintain a substantially fixed ratio between the signal strength and noise strength throughout the system so that at the receiving end the signal will be sufficiently stronger than the noise, to render the signal readily selectable. This ratio may be maintained constant by controlling the transmitter output at the sending station. If the attenuation is high, it will require a stronger output to maintain the required signal to noise ratio. If the attenuation diminishes, a smaller amount of energy need be transmitted to maintain the required signal to noise ratio.

One of the objects of this invention is to control the transmitter output by means of a control signal sent out from the receiving station, which control signal will be subjected to the same degree of attenuation as the communication wave which is being transmitted in the opposite direction.

Other objects of this invention will be apparent from the following description when read in connection with the attached drawing, of which Figures 1 and 2 represent two stations A and B, of a system of communication, each station preferably employing the same type of circuit, which circuit shows schematically one form of the invention.

In Fig. 1, which represents station A, the line L_1 serves to connect the radio terminal circuit shown in the figure with a distant station or subscriber. This line is connected in a well-known manner with certain of the windings of the hybrid coil 1 which has also connected therewith an artificial line 2 serving to balance the real line L_1. Also connected with the hybrid coil is the transmitting branch circuit 3, by means of which the communication signals are impressed upon the transmitting apparatus of the radio station. This circuit is connected by the transformer 4 with the modulator M_1 which may be of any well-known type, but preferably is of that type in which the carrier current is suppressed. This modulating circuit has connected therewith a source of carrier oscillations 5, which oscillations are modulated in the device M_1 by the incoming communication currents. The output side of the modulator is connected by the transformer 6 with a band filter 7, which is preferably of the type adapted to suppress one of the bands resulting from modulation and to transmit the other. This band filter is connected with a regulator 8, which in turn is connected by the transformer 9 with the power amplifier 10, and this is connected with the antenna T_1 from which waves will be radiated to a distant station such as B shown in Fig. 2, where they will be received by the receiving antenna R_2. The oscillator 5 of Fig. 1 is also connected with the input side of another modulator, M_2, to which is connected an oscillator 11, producing a control signal intended to modulate the oscillations produced by 5. These carrier frequency oscillations as modulated by the control signal are transmitted through the filter 12 and, when regulated as to amplitude by the regulator 13, will be impressed upon the power amplifier 10 and transmitted to the distant station B of Fig. 2 for the purpose of controlling transmission from that station to station A shown in Fig. 1. The manner in which this result is attained will be described later.

The receiving branch of station A comprises a receiving antenna R_1 which is coupled by the transformer 15 to the filter 16, which has a two fold function, one to select the received communication band and impress it upon the circuit of the detector 17, and the other to separate out the control signal band produced at the distant station B by the circuit containing the modulator M_2', and transmitted therefrom for the purpose of controlling the amplitude of the communication signal sent from the antenna T_1 to the said distant station. This control signaling band passes into the branch circuit 18, with which is connected a rectifier con-

sisting of the tubes 19 and 20, which serves to determine the amplitude of the communication side band that will be passed by the regulator 8 and impressed upon the power-amplifier 10. The communication wave is impressed upon the detector 17 and the resultant current is impressed upon the level control circuit comprising the tubes 21 and 22. The output side of the tube 21 is connected with the amplifier 23. The tube 22 is connected with the input circuit of the regulator 13 and thus effects a control of the amplitude of the control signal sent out from the modulator M_2. The output side of the amplifier 23 is connected with the line L_1 through the hybrid coil 1.

The manner in which the circuit works will perhaps, be best understood if we consider first how a communication signal is transmitted from Station A to station B, and is received at station B and translated by the receiving branch of that station, which is similar to the receiving branch of station A. Let it be assumed that a communication signal, such as a speech band, is transmitted over the line L_1 from apparatus connected therewith, and is received at the radio terminal station A for transmission to a subscriber connected with the line L_1' which connects with the distant radio station B. The speech band will pass into the circuit 3 and be impressed by the transformer 4 upon the input side of the modulator M_1, wherein it serves to modulate the carrier oscillations produced by the source 5, and the two resultant bands will be impressed by the transformer 6 upon the band filter 7. One of the bands, as, for example, the upper side band, will be selected and transmitted through the filter, and the other band will be suppressed. The selected band will pass through the regulator 8, which is normally adjusted to produce a predetermined amplitude. The resultant wave when given the required degree of amplification by the power amplifier 10, will be radiated by the antenna T_1 to the distant radio station B. The received band will be impressed by the receiving antenna R_2 upon the receiving circuit, and after being passed by the filter 16', will be impressed upon the detector 17'. This detected signal then passes through the tube 21' and when amplified by the tube 23', will be impressed upon the line L_2 for transmission to the distant station. The transmission of a communication signal from station B to station A is likewise effected in the manner described above.

While a communication wave is passing from station A to station B, control signal waves are being sent from both stations, but we need be concerned only with that sent from station B to station A, because this wave controls the level of the communication wave from A to B. At station B there is created a control signal band represented by the modulation by M_2' of the carrier oscillations from the source 5' by a control signal from the source 11'. This high frequency control signal passes through the filter 12' and the regulator 13', and when amplified by the power amplifier 10', will be transmitted to the receiving antenna R_1 of station A, from which station the communication signal is then being transmitted to the distant station B. It is important that the frequency of the control signal produced by the generators 11 and 11' shall lie just outside the range of communication frequencies, as, for example, outside the range of voice frequencies so that the filters 16 and 16' may separate the control signal and the communication signal and send each into its proper paths. The control signal received by the antenna R_1 of station A will be impressed upon the filter 16, and will be in turn impressed upon the circuit 18. The tube 19 rectifies the received control signal, that is to say, the carrier frequency modulated by the control frequency from the source 11'. The amplitude of the rectified voltage will, of course, depend upon the amplitude of the control signal which may vary from time to time, depending upon its attenuation during the course of its transmission from the antenna T_2 to the antenna R_1. Since this rectified voltage is impressed upon the grid of the tube 20, the plate voltage of the regulator 8 may be varied and amplitude of the communication wave may be proportioned to meet changing conditions in its path of transmission.

In practice, the attendant at station B observes the level of the communication signal incoming from station A and adjusts in the following manner the amplitude of the control signal sent out from station B to station A. By manipulating the potentiometer 25' he varies the grid potential of the tubes 21' and 22'. The variation of the grid potential of tube 21' varies the amplification of the communication signal that is passing over the receiving branch of station B to the line L_1'. Any variation of the grid potential of tube 22' causes a corresponding variation of its plate current, and since this current flows through the resistance 24' connected with the grid circuit of the regulator 13' corresponding changes of potential will be produced on the grid of 13'. The amplitude of the control signal wave produced by the modulation of the carrier oscillations of source 5' by the control signal of source 11' is controlled by the grid voltage of the regulator 13'. The attendant at station B will therefore vary the potentiometer 25' in such way as to effect the transmission from station B of a control signal of such amplitude as to effect the proper adjustment of the regulator 8 in the communication transmit-

ting branch at station A. If the attenuation of the communication signal between station A and station B is high, the level of the control signal will accordingly be adjusted by the operator at station B so that when the control signal is received and rectified at station A, the voltage of the plate circuit of the regulator 8 will be so increased as to raise the amplitude of the side band passing through the said regulator. In this way, the side band representing the communication signal transmitted from station A, will be adjusted to meet changes in the attenuating characteristics of its path, which has produced a similar effect upon the control signal transmitted from the distant station B to the station A shown in Fig. 1.

Now let it be assumed that a communication signal is transmitted from antenna T_2 of station B to the receiving antenna R_1 at station A. This signal will be passed by the filter 16 to the detector 17, and the detected signal will be impressed upon the level control circuit comprising the tubes 20 and 21. If the energy level of this received signal is low, which would be determined by the attendant at station A, he would effect an adjustment of the level control by varying the potentiometer 25 and thus would vary the magnitude of the plate current produced by the tube 22. The voltage produced by this current flowing through the resistance 24, which is connected in the input side of the tube 13, controls the grid potential of that tube and thus controls the magnitude of the control signal transmitted to the distant station. Assuming, as stated, that the level of the received communication signal was low, the adjustment of the level control device 25—26 would be made in such way as to increase the amplitude of the outgoing control signal from the modulator M_2. This would be transmitted by the antenna T_1 to the distant receiving antenna R_2, and passing there into the branch circuit 18′, would serve in the manner similar to that hereinbefore described to increase the amplitude of the communication signal wave being transmitted from the antenna T_2, which increase would be effected by the variation of the plate potential of the regulator 8′.

It will therefore be seen that by means of the arrangements shown in the figures just described, the regulation of the transmission level of the communication wave between two stations would be effected from the receiving station by means of a control signal transmitted from the latter station to the sending station.

For the purpose of simplifying the description the invention has been described in connection with a system characterized by carrier suppression and transmission of a single side band, but the invention is not so limited but may be employed in other systems, such as for example, those in which the carrier and one side band, or the carrier and both side bands are transmitted.

While this invention has been disclosed as embodied in a particular form, it is obvious that it is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. The method of controlling the transmission level in a two-way radio signaling system which consists in transmitting a communication signal from one station to a second station of the said system and simultaneously transmitting a control signal from the said second station to the said first station, varying the amplitude of the control signal sent from the second station to the said first station, rectifying the control signal received by the said first station and controlling the amplitude of the communication signal transmitted from the first station by the rectified control signal.

2. The method of controlling the transmission level in a two-way radio signaling system which consists in transmitting a communication signal from one station to a second station of the said system and simultaneously transmitting a control signal from the said second station to the said first station, varying the magnitude of the control signal in accordance with the magnitude of the communication signal transmitted from the first station as received at the said second station.

3. In a transmission level regulating system, the combination with a radio signaling station having transmitting and receiving circuits, of a second station likewise having transmitting and receiving circuits, each transmitting circuit of each station having means to effect the transmission of a communication signal and also of a control signal, and each receiving circuit having means to control the amplification of the communication signal transmitted from that station by virtue of the control signal as received from the said other station.

4. In a transmission level regulating system, the combination with a radio signaling station having transmitting and receiving circuits, of a second station likewise having transmitting and receiving circuits, each transmitting circuit of each station having means to effect the transmission of a communication signal and also of a control signal, and means at each station connecting the said receiving circuit and said transmitting circuit thereat adapted to rectify the control signal received thereat and to control the amplitude of the transmitted communication signal from that station by and in accordance with the amplitude of the rectified control signal.

5. The method of controlling the trans-

mission level in a two-way high frequency signaling system which consists in transmitting a communication signal from one station to a second station of the said system and simultaneously transmitting a control signal from the said second station to the first station, varying the level of the control signal in accordance with the level of the communication signal transmitted from the first station as received at the second station, and changing the level of the communication signal as transmitted from the first station in accordance with changes in level of the said control signal as received at the said first station.

6. The method of controlling the transmission level in a two-way high frequency signaling system which consists in transmitting a communication wave from one station of a system and simultaneously transmitting a control wave from another station, both of said waves traversing substantially the same path so as to be influenced to substantially the same degree of factors affecting transmission, varying the level of the said control wave as transmitted from the said other station according to changes in the level of the communication wave as received at the said other station, and utilizing the control wave as thus varied to govern the level of transmission of the said communication wave from the first mentioned station.

7. The method of controlling the transmission level in a two-way high frequency signaling system which consists in transmitting a communication wave from one station of a system and simultaneously transmitting a control wave from another station, both of said waves traversing substantially the same path so as to be influenced to substantially the same degree by factors affecting transmission, determining the level of the communication wave as received at the said other station, varying the level of the said wave as thus received and simultaneously varying the level of the control wave being transmitted from the said other station, and changing at the first mentioned station the level of the communication wave in accordance with changes in the control wave as received at the first mentioned station.

8. In a two-way signaling system, the combination with a plurality of stations of a transmission medium between them, each station having a transmitting and receiving branch, means connected with the transmitting branch to produce a high frequency communication wave, means also connected therewith to produce a high frequency control wave, the frequencies of the said waves being different, means connected with the receiving branch of each station to select the control waves transmitted from another station, and means responsive to the said selected control wave to govern the level of the communication wave as transmitted.

9. In a two-way signaling system, the combination with a plurality of stations of a transmission medium between them, each station having a transmitting and receiving branch, means connected with the transmitting branch to produce a high frequency communication wave, means also connected therewith to produce a high frequency control wave, the frequencies of the said waves being different, means connected with the receiving branch of each station to vary the level of the control wave being transmitted from each station to another station to control the level of the communication wave being transmitted from the said other station.

10. In a two-way signaling system, the combination with a plurality of stations of a transmission medium between them, each station having a transmitting and receiving branch, means connected with the transmitting branch to produce a high frequency communication wave, means also connected therewith to produce a high frequency control wave, means connected with the receiving branch of each station to vary not only the level of the communication wave received thereat, but also the level of the control wave being transmitted from the said receiving station to the station transmitting the said communication wave.

11. In a two-way signaling system, the combination with a plurality of stations of a transmission medium between them, each station having a transmitting and receiving branch, means connected with the transmitting branch to produce a high frequency communication wave, means also connected therewith to produce a high frequency control wave, the frequencies of the said waves being different, means connected with the receiving branch of each station to separate, by filtering, the received control wave from the received communication wave, means to detect the communication signal, means to amplify the communication signal and means connected with the said amplifying means to vary, at will, the level of the communication wave as received at each station and also to simultaneously vary, at will, the level of the control wave being transmitted from the same station.

12. In a two-way signaling system, the combination with a plurality of stations of a transmission medium connecting them, each station having a transmitting branch comprising a source of high frequency waves, a source of communication signals to modulate the said waves, a source of control signals to modulate the said waves, means to regulate the said modulated communication waves, means to regulate the modulated con-

trol waves, and a receiving branch comprising means to separate, by filtering, the communication waves and the control waves, means to detect the communication signal, means to amplify the communication signal, means to detect the control signal, means effectively connecting the latter detector with the means to regulate the communication waves in the transmitting branch of the same station and means connected with the amplifier of the communication signal to govern the operation of the regulating means of the control waves connected with the transmitting branch of the same station.

In testimony whereof, I have signed my name to this specification this 19th day of November, 1925.

RALPH K. POTTER.