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LEVEL CONTROL FOR CARRIER TRANSMISSION SYSTEMS

Filed Dec. 24, 1925 2 Sheets-Sheet 1

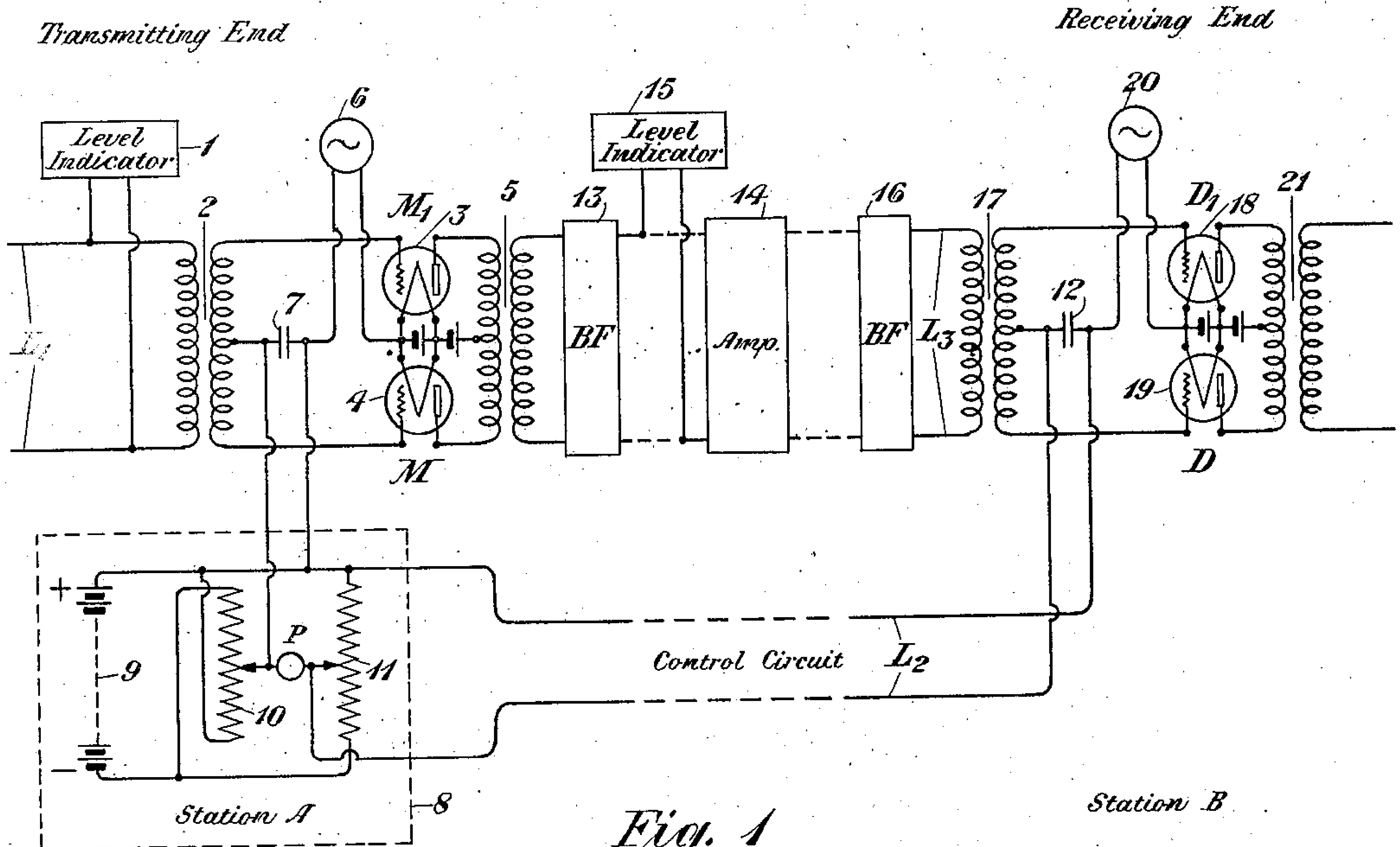

Fig. 1

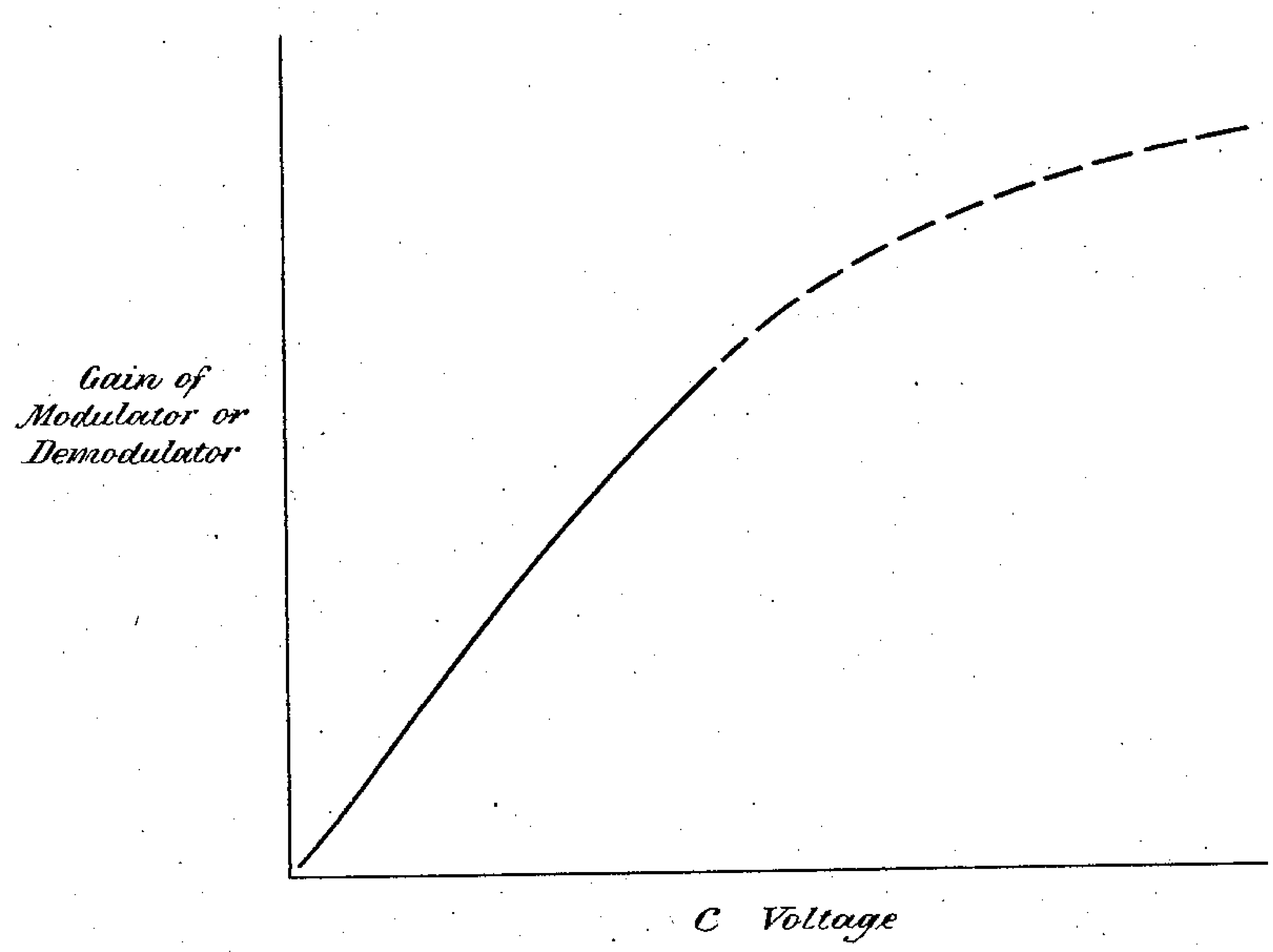

Fig. 2

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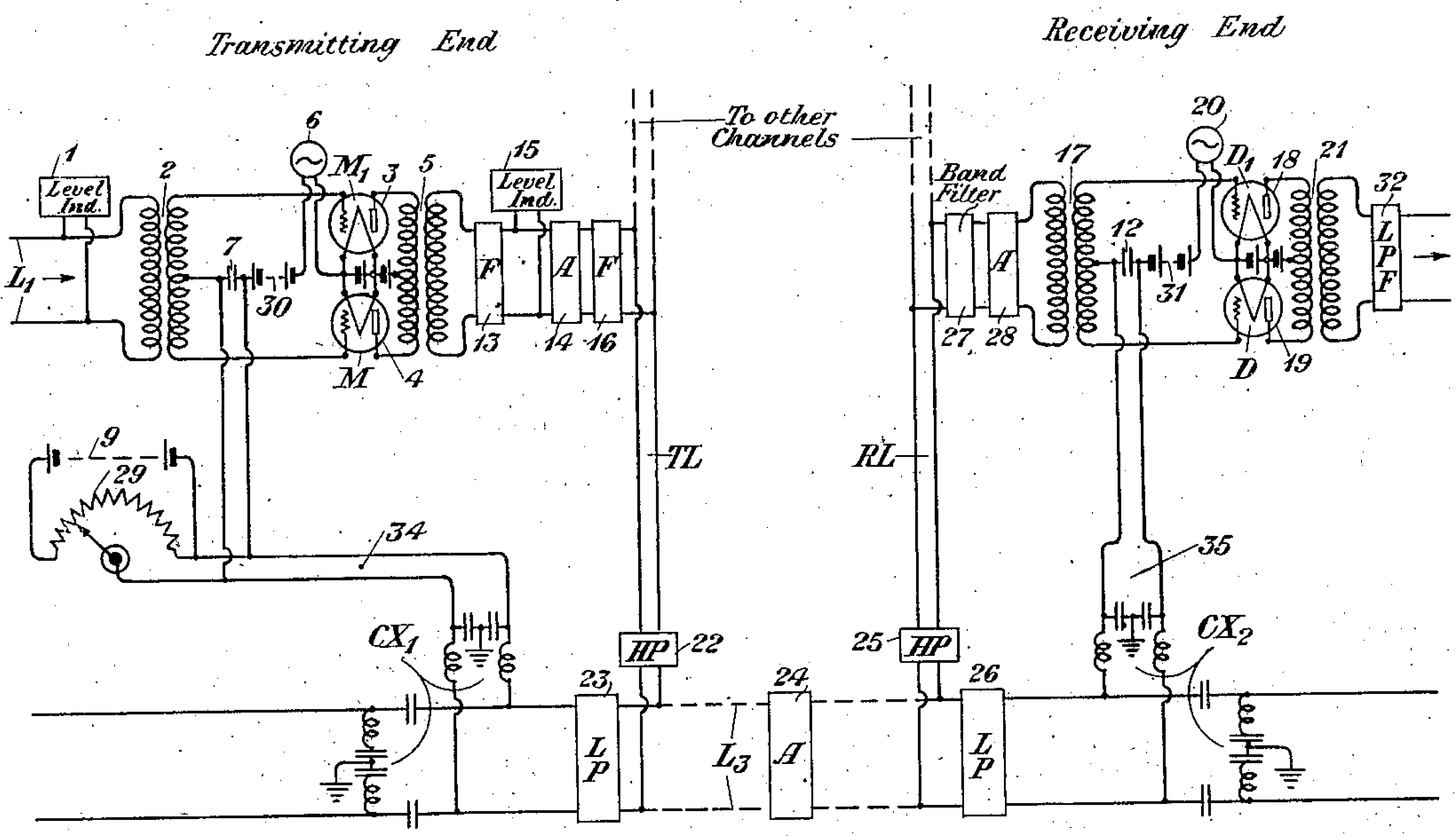

Fig. 3

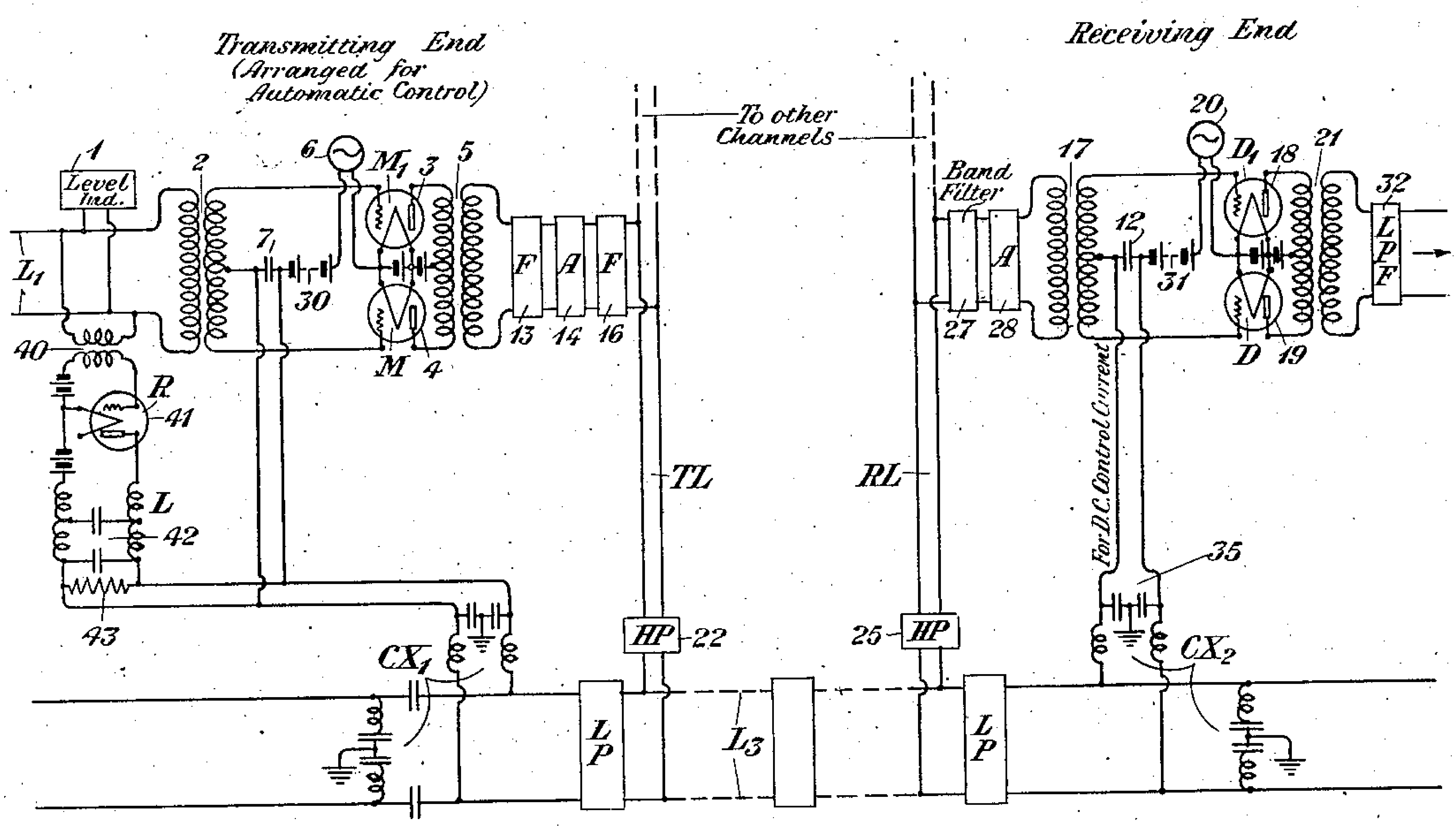

Fig. 4

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UNITED STATES PATENT OFFICE.

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LEVEL CONTROL FOR CARRIER-TRANSMISSION SYSTEMS.

Application filed December 24, 1925. Serial No. 77,607.

This invention relates to carrier transmission systems and particularly to means for controlling the transmission level of such system either manually or automatically in such manner that the over-all equivalent of the circuit remains constant at all times.

In radio broadcasting systems it is frequently desirable to connect a plurality of broadcasting stations by means of wire circuits over which the broadcast program is transmitted to each of the said stations by means of a carrier channel from a central distributing point. While the transmission of certain programs, particularly those involving high grade music, renders it necessary to transmit a wide range of volume, it is desirable to reduce the volume range in transmitting over the line itself to a relatively narrow range of levels by controlling the input circuit, and to control the output circuit so that the level range may be expanded to its original proportions.

It is the object of this invention to provide, in a carrier system employed in broadcast transmission, means to simultaneously and variably control the input and the output levels of such a system, which control may be effected either manually or automatically, whereby the over-all equivalent of the circuit is rendered constant.

This invention will be clearly understood from the following description when read in connection with the attached drawing, of which Figure 1 shows a form of embodiment of the invention in which the level control is effected manually and by means of a separate control circuit between the transmitting and the receiving circuits of the system; Fig. 2 is a curve showing the relation between the grid voltage and the gain of a modulator or demodulator; Fig. 3 is another form of embodiment of the invention employing manual control, but utilizing the transmission circuit for effecting the control at the receiving end of the line, and Fig. 4 shows the use of an automatic control system in a transmitting system substantially like Fig. 3.

In Fig. 1, the line L_1 represents an input circuit having any form of transmitting apparatus connected therewith for picking up the program that is to be transmitted by means of the carrier system to the distant end of the circuit. This line has connected therewith a level indicator 1 which shows the energy level at the input of the carrier transmission system. The line L_1 is connected by means of the transformer 2 with the input circuit of the modulator M_1, which is preferably of the carrier suppression type shown in the patent to J. R. Carson, No. 1,449,382 which issued on March 27, 1923.

This modulator employs the vacuum tubes 3 and 4, the grids of which are connected with the terminals of the secondary winding of the transformer 2, and the plates of which are connected with the terminals of the primary winding of the transformer 5. The input circuit of the modulator also includes a connection between the midpoint of the secondary winding of the transformer 2 and the filaments of the tubes 3 and 4. This connection embraces a source of carrier current 6 and a condenser 7 across which is connected the level control device comprising the apparatus within the dotted line 8. This level control device includes a source of direct current voltage 9 for negatively biasing the grids of the tubes and potentiometers 10 and 11. This level control device is connected by means of the control circuit L_2 with the receiving circuit of the carrier system being bridged across the condenser 12 of the demodulator D_1, which will be fully described hereinafter.

The secondary winding of the transformer 5 is connected with the band filter 13, which in turn is connected with an amplifier 14, the connection having bridged across it a level indicator 15. The output side of the amplifier is connected with a band filter 16 which in turn is connected with the line L_3 which connects the transmitting station of the carrier system with the receiving station. The line L_3 is connected with the receiving circuit by the transformer 17. This receiving circuit comprises the balanced tubes 18 and 19, and the circuit is substantially like the modulating circuit at the transmitting station having a source of carrier frequency 20 connected with it in order to effect demodulation of the modulated carrier currents. The output of the demodulating circuit is connected by the transformer 21 with an output circuit which may be connected with the input circuit of the radio broadcasting station.

It will be seen that the source of direct current potential 9 provides the grid potential not only for the tubes of the modulator M_1, but also for the tubes of the demodulator D_1, being connected with the latter tubes by the control circuit L_2. It will further be seen that this grid potential is rendered variable by the potentiometer 10—11, one of which resistances is connected with the grid circuit of the modulator M_1, and the other resistance with the grids of the demodulator D_1. As will be seen from the curve shown in Fig. 2, the gain of a modulator or demodulator is a function of the grid voltage. This curve shows that as the grid voltage increases, the gain of a modulator or demodulator is likewise increased, and a decrease of grid voltage produces an opposite effect upon the modulator or demodulator. The circuit of the level control device 8 is so arranged that a movement of the potentiometer 10—11 in the direction for increasing the grid potential of the modulator M_1 at the transmitting end effects also a variation in the grid potential of the demodulator D_1 at the receiving end, the latter change being in opposite direction to the former. It is, of course, desirable that the normal grid voltage upon the tubes shall be such that the variation upwards and downwards of the said voltage may be made along the straight part of the curve shown in Fig. 2.

In the operation of the system, the operator watches the level indicator 1 during the time in which the audio frequencies representing the program are applied by the line L_1 to the modulator M_1. The carrier frequency of the source 6 which will be modulated by the audio frequencies will be impressed upon the circuit containing the band filter 13, the amplifier 14 and the band filter 16. A single side band would be passed by the filters 13 and 16 and amplified by the amplifier 14, and after transmission over the line L_3, would be detected by the demodulating circuit D_1. If the level of the input circuit L_1 increases above the desired point, the operator adjusts the potentiometer 10—11 in order to decrease the gain produced by the modulator M_1, and to increase the gain produced by the demodulator D_1. In this way, the transmission equivalent of the line as a whole is maintained constant.

The arrangement shown in Fig. 3, in which the same reference symbols have been used, as in Fig. 1, is also a manually controlled system, but differs from the arrangement shown in Fig. 1 in that it does not require a separate control circuit such as L_2 of Fig. 1 to effect the regulation of the grid voltage of the demodulator D_1 at the receiving end of the system. The output side of the transmitting circuit is connected with the branch transmission line TL to which a plurality of similar transmitting circuits of other channels may be connected. This transmitting branch has in it a high pass filter 22 in order to select the carrier channels and to discriminate against low frequency signals which also may be sent simultaneously over the line L_3. In similar manner, at the receiving end of the system, the branch receiving line RL is connected with the line L_3 and has in it a high pass filter 25. The input circuit of the modulator M_1 has a normal grid biasing battery 30, and similarly the demodulator D_1, a battery 31. The level control device consisting of the battery 9 and a potentiometer 29 is arranged so that its potential will vary in opposite ways the grid potential of the modulator tubes 3 and 4, and the demodulating tubes 18 and 19. This variation of the grid potential is effective over the branch circuits 34 and 35 connected by the line L_3. Transmission of the unmodulated carrier from the sources 6 and 20 is prevented by the employment of the composite sets CX_1 and CX_2, which permit the passage of the direct current potentials of the grid biasing battery 9, but suppress the high frequency carrier.

The method of operation is substantially the same as in Fig. 1, the operator watching the level indicator 1 and varying the potentiometer 29 to effect a reduction of the gain of the modulator M_1 and an increase in the gain of the demodulator D_1 whenever the level of the line L_1 increases above a predetermined amount. If the level of the line L_1 falls, the operator would, of course, produce an opposite effect, namely, increase the gain of the modulator M_1 and decrease that of the demodulator D_1.

The arrangement shown in Fig. 4 is structurally similar to that shown in Fig. 3, excepting that by means of the elements 40 to 43, inclusive, the level control is automatically effected. That is to say, as the level rises and falls in the line L_1 above or below a predetermined limit, a small portion of this energy is taken off by the branch circuit with which the regulation is connected, and is impressed by the transformer 40 upon the rectifier 41. The magnitude of the rectified energy will, of course, depend upon the level of the voltage in the line L_1. This rectified voltage, however, includes all the fluctuations in the speech energy, and therefore could not be used directly to vary the grid potential of the modulating and demodulating tubes without further smoothing out of the wave. This smoothing out is effected by means of the low pass filter 42 connected with the output side of the rectifier 41, and terminating in the resistance 43. This low pass filter is so proportioned as to substantially eliminate all the audio frequency ripples upon the rectified voltage and to render it substantially uni-directional. This voltage will be applied to the input circuits of the modulator and the demodulator across the condensers 7 and 12 in such way as to increase the grid potential of the modulator, and simultaneously to decrease the grid potential of the demodulator, or vice versa. This control voltage is transmitted over the line L^3 through the composite sets CX_1 and CX_2 in the manner in which the control voltage was transmitted in the arrangement of Fig. 3.

The low pass filter 42 will have to be adjusted in transmission characteristics so that the resultant gain control is neither too fast, that is to say, it should not follow all of the rapid fluctuations of the audio energy, or too slow, that is, not providing sufficiently responsive level control. If desirable, time lag circuits may be introduced in various parts of the arrangements to effect some improvement in its practical operation. It is possible to have the control channel transmitted at carrier frequency from the sending to the receiving end, and it is furthermore possible to have this control channel provided by the carrier current itself, since the effective gain of the modulator or demodulator is also dependent upon the amount of carrier energy supplied. In such a case, instead of having a constant carrier supplied, as illustrated in the figure, the grid potential might be made constant and the carrier supply transmitted to both terminals and caused to vary properly in relation to the input of the voice energy.

While this invention has been disclosed as embodied in certain forms, 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. In a signaling system in which a high frequency wave is modulated by a signal, the combination with a transmission circuit of a signal input circuit, a signal output circuit, a modulating circuit, having a source of carrier current connected therewith, effectively connecting said signal input circuit with said transmission circuit, a demodulating circuit, likewise having a source of carrier current, effectively connecting said transmission circuit with said signal output circuit, and means connected with said signal input circuit and with said modulating and demodulating circuits and regulated by the strength of the input signal to control the energy level at the input and output ends of said transmission circuit, thereby maintaining constant the over-all equivalent of said system.

2. In a signaling system in which a high frequency wave is modulated by a signal, the combination with a transmission circuit of a signal input circuit, a signal output circuit, a modulating circuit interposed between said input circuit and said transmission circuit to modulate a carrier current by said signal and to impress it upon said transmission circuit, a demodulating circuit interposed between said transmission circuit and said output circuit to demodulate the modulated carrier and to impress the resulting signal upon said output circuit and means controlled by the current of the signal input circuit to control the magnitude of the gain produced by said modulator and demodulator, thereby automatically maintaining constant the over-all transmission equivalent of said system.

3. In a signaling system in which a high frequency wave is modulated by a signal, the combination with a transmission circuit of a signal input circuit, a signal output circuit, a modulating circuit interposed between said input circuit and said transmission circuit to modulate a carrier current by said signal and to impress it upon said transmission circuit, a demodulating circuit interposed between said transmission circuit and said output circuit to demodulate the modulated carrier and to impress the resulting signal upon said output circuit, a rectifier having its input side connected with the said input circuit and its output side connected with said modulating and demodulating circuits, the latter connection including a low pass filter to smooth out the unidirectional current resulting from the rectification of the signal potential applied to said rectifier, thereby automatically maintaining constant the over-all transmission equivalent of said system.

4. In a signaling system in which a high frequency wave is modulated by a signal, the combination with a transmission circuit of a signal input circuit, a signal output circuit, a vacuum tube modulator interposed between said input circuit and said transmission circuit having a source of carrier oscillations adapted to be modulated by the singal, a vacuum tube demodulator interposed between the said transmission circuit and the said output circuit adapted to demodulate the said modulated carrier oscillations, and rectifying means having its input side connected with said input circuit and its output side connected with said vacuum tube modulator and demodulator adapted to vary the grid potential of the vacuum tubes in accordance with the variations in strength of the input signal.

5. In a signaling system in which a high frequency wave is modulated by a signal, the combination with a transmission circuit of a signal input circuit, a signal output circuit, a modulating circuit connecting said input circuit with said transmission circuit, a demodulating circuit connecting said transmission circuit with said output circuit, and means responsive to the strength of the input signal to automatically maintain constant the over-all transmission equivalent of the system.

6. In a signaling system in which a high

frequency wave is modulated by a signal, the combination with a transmission circuit of a signal input circuit, a signal output circuit, a modulating circuit connecting said input circuit with said transmission circuit, a demodulating circuit connecting the said transmission circuit with the said output circuit, and a rectifier having its input side connected with the signal input circuit and having its output side connected with said modulating circuit and said demodulating circuit, the said latter connection including a low pass filter to smooth out the rectified voltage.

7. In a signaling system in which a high frequency wave is modulated by a signal, the combination with a transmission circuit of a signal input circuit, a signal output circuit, a vacuum tube modulating circuit connecting said input circuit with the said transmission circuit, a vacuum tube demodulating circuit connecting the said transmission circuit with the said output circuit, and means connected with the signal input circuit and with said modulating circuit and demodulating circuits to automatically vary the grid potentials of each of the tubes of the said modulating circuit and said demodulating circuit to substantially the same degree but in opposite polar directions, the said variations corresponding to changes in the energy level of the signal input circuit.

In testimony whereof, I have signed my name to this specification this 23rd day of December, 1925.

HERMAN A. AFFEL.