

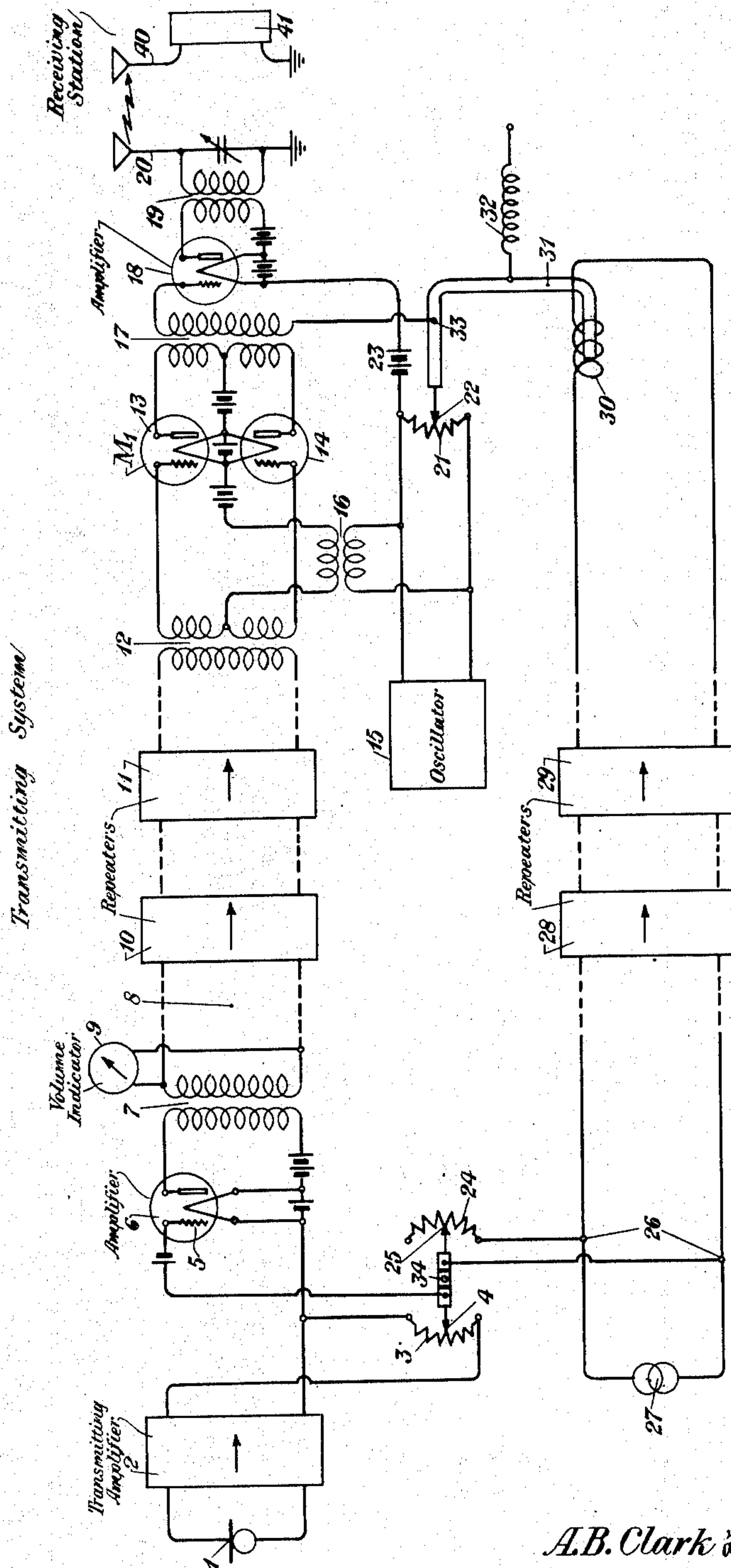
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A. B. CLARK ET AL

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VOLUME RANGE CONTROL SYSTEM

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VOLUME-RANGE-CONTROL SYSTEM.

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This invention relates to a combined wire and radio signaling system, and particularly to means for minimizing the effects of interference in both the wire and radio portions of the said combined signaling system.

In the patent to A. B. Clark No. 1,565,548 which issued on December 15, 1925, is disclosed an arrangement for compressing the range of volume of waves transmitted over a telephone line in order to avoid, on one hand, the overloading of the line repeaters or causing undue cross-talk in paralleling circuits, and, on the other hand, to minimize interference during periods of low volume. In the arrangement shown and described in that application, the volume range is expanded at the receiving end of the line to the same extent to which it is compressed at the sending end of the line, so that the volume range at the receiving end will be the same as that impressed upon the transmitting apparatus.

This invention resides in the application of the broad principle disclosed in the said patent to A. B. Clark to a signaling system comprising a wire line and a radio circuit in combination.

Other objects of this invention will be apparent from the following description when read in connection with the attached drawing showing schematically a form of embodiment of the invention, comprising a combined wire and radio transmitting system co-operating with one or more receiving stations.

In the drawing the transmitter 1 represents symbolically any form of pick-up device by means of which speech, music, or other sounds may be picked up and carried to a transmitting device, such as the amplifier 2, for amplification prior to impression upon the wire line. Bridged across the output side of the amplifier 2 is a potentiometer comprising the resistance 3 and the contact point 4, which is arranged to apply different potentials to the grid 5 of the amplifier 6. This potentiometer is a compressor, and when employed in connection with the amplifier 6, serves to keep the volume range within the limits of the line 8. The output side of the amplifier 6 is coupled by the transformer 7 with the line 8 which has a volume indicator 9 bridged across the sides thereof. This line may have any number of repeaters there-

in, such as 10 and 11, in order to raise the volume level at the points wherein the repeaters are inserted. The line 8 is coupled with a radio transmitting station by means of the transformer 12. This station comprises a modulator M_1 including the tubes 13 and 14, which modulator is of the well-known carrier suppression type disclosed in the patent to Carson, No. 1,449,382, dated March 27, 1923. A source of carrier frequency 15 is connected by means of the transformer 16 with the common conductor of the tubes 13 and 14. The output circuit of the modulator is coupled by the transformer 17 with the input side of the radio-frequency amplifier 18 whose output side is coupled by the transformer 19 with the antenna 20. The source of carrier frequency 15 has bridged across it not only the primary winding of the transformer 16, but also the resistance 21 of a potentiometer whose contact point 22 is connected with the grid of the amplifier 18. A source of biasing potential 23 is also connected with the grid.

The movable arm that carries the contact 4 at the transmitting station also carries the contact point 25 which co-operates with the resistance 24, all or part of which would be effectively bridged across the output of the oscillator 27 at the points 26, depending upon the setting of the contact point 25. The oscillator 27 is connected with the radio station by means of the circuit 35 which may contain one or more repeaters, such as 28 and 29, and comprises also a solenoid winding 30 located at the radio station. This solenoid co-operates with the arm 31 which is pivoted at 33 and carries the contact point 22 of the carrier potentiometer. A spring 32, or equivalent device, serves to pull the contact point toward the position giving the largest carrier voltage. From the foregoing description it will be seen that the oscillator 15 not only applies oscillations of the carrier frequency to the input side of the modulator M_1 to be modulated by the signal received by the modulator from the wire line 8, but the said oscillator also applies oscillations of the carrier frequency directly to the input of the radio-frequency amplifier 18, which oscillations are rendered controllable as to amplitude by varying the setting of the potentiometer 21-22. It is desirable to note that since the modulator is of the carrier sup-

pression type, oscillations impressed upon the transformer 16 do not pass to the radio-frequency amplifier, but only the side bands of that carrier frequency pass thereto.

5 A receiving station is represented symbolically by the antenna 40 and a receiving set 41 which is capable of detecting the signal by beating together the received carrier and side bands in a detector operating upon the
10 square law. In such detecting systems, which are well known in the art, constancy of the signal is assured when the side band amplitude is decreased if the carrier amplitude is increased proportionately, and vice
15 versa.

The nature of the invention will be quite apparent from the description of the mode of operation of this circuit. Let it be assumed that speech, music or other sound of moderate
20 intensity is being produced at the transmitter 1 and also let it be assumed that the potentiometer arm 34, at what may be termed the wire transmitting station (to distinguish it from the radio transmitting station) is in its
25 midpoint position, as shown in the drawing, and furthermore that the arm 31 of the potentiometer at the radio station is likewise at its midpoint, as shown on the drawing. Under such conditions the potentiometer 3 and the
30 amplifier 5 adjust the volume so that it is within the range of transmission which the wire system is capable of handling, and with the potentiometer 21—22 at the radio station likewise set at the midpoint, the oscillations
35 impressed upon the amplifier 18 will have an amplitude that bears a definite relation to the amplitude of the side bands resulting from the modulation of the carrier oscillations by the signal impressed by the wire line 8 upon
40 the modulator M_1 .

If the sound applied to the transmitter 1 becomes so loud that the volume is too great for the wire and the radio system to carry, the control knob 34 is operated to the right,
45 which reduces the volume applied to the wire line 8 by reducing the potential applied by the contact point 4 to the grid 5 of the amplifier 6. The operation of the control knob 34 to the right moves the contact point 25 downwardly, thereby decreasing the shunt resistance across the source 27 and in that way reducing the current that flows through the solenoid 30. This permits the spring 32 to rotate the arm 31 in a counter-clockwise direction about the point 33, which increases the
55 volume of the oscillations of the carrier frequency applied by the source 15 to the input circuit of the radio amplifier 18. Since the volume of the signal, that is, speech or music, has been reduced by the action of the potentiometer 3—4 and the amplifier 6 at the wire transmitting station, the amplitude of the side bands produced by the modulator M_1 will likewise be reduced. The amplitude of the
60 carrier oscillations has been increased, so that

the signal as detected at a distant receiving station, which is the product of the carrier and the side band amplitudes, remains constant.

If the intensity of the sound that is being
70 impressed upon the transmitter 1 falls to such a low level that when transmitted over the line 8 it would be below the level of the noise on the line, it then becomes necessary to raise the level of the sound before transmitting it
75 over the line. This is done by moving the arm 34 in a counter-clockwise direction, which increases the alternating grid potential of the amplifier 6 and thereby increases the outgoing current. Such movement of the arm
80 34 increases the resistance bridged across the points 26 of the control circuit and thereby permits a stronger current to flow over that circuit and through the winding of the solenoid 30. This causes a rotation of the arm
85 about the point 33 in a clockwise direction. The effect of this is to reduce the amplitude of the carrier oscillations applied by the source 15 to the radio-frequency amplifier 18. Accordingly the outgoing carrier frequency
90 will have a smaller amplitude than normal, but since the volume of the signal has been increased, the amplitude of each side band will be greater than normal, and consequently, the intensity of the sound at a receiving station will be substantially that produced in the vicinity of the transmitter 1, inasmuch as the detected signal depends upon the product of the amplitudes of the side band and the carrier frequencies.
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It is desirable to point out that not only does this invention provide for changing the volume range for transmission over a wire system in order to keep the volume of the signal above the noise level of the line and below
105 the overload point of repeaters, and below the point where interference would be created in adjacent lines, but the invention also effects the control of the signal over the radio path in substantially the same manner. Thus, if
110 the volume of sound is above normal, the amplitude of the side band is diminished and that of the carrier is increased, and vice versa, if the magnitude of the sound is below normal, the amplitude of each side band is increased and the amplitude of the carrier is reduced. In such a system, if there is a cessation of sound, the amplitude of the carrier will be reduced substantially to zero, so that the interference effect of static will be
120 reduced at the receiving stations during intervals of quietness which tends to render reception of the signal much clearer. In this way the system is made less sensitive to extraneous disturbances both in the wire line
125 and in the radio part of the system during periods when the sound is weak or absent, while, on the other hand, distortion due to overloading the repeaters of the wire lines during the transmission of loud sounds or the
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production of undue cross-talk in paralleling circuits is avoided. Furthermore, the power required by the radio transmitter to deliver a given volume range at the radio receiving stations without experiencing interference trouble is materially reduced.

It is desirable to point out that the form in which the invention has been disclosed is purely schematic and constitutes no limitations upon the invention. Various equivalents for the means shown upon the drawing will readily occur to those skilled in the art. The method embodied in this invention can be equally well applied to any system of compressed range transmission over wires in which the level of transmission in the wire system is varied either manually or automatically in accordance with the amplitude of the original sound. It is merely necessary that the range expanding apparatus at the receiving end of the wire line be arranged to vary the amplitude of the radio carrier, without varying the amplitudes of the side bands which are controlled directly by the signal waves in the wire line.

The invention, therefore, is not limited to the particular form shown, inasmuch as 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 an arrangement for controlling the volumes throughout a transmission system comprising a wire circuit connected with a radio circuit, the combination with a wire line having a transmitting device connected therewith of a radio transmitter also connected with the wire line and having a source of carrier current, means connected with the wire line to control the volume range transmitted thereby, and means connected with the said radio transmitter and controlled by the said volume range controlling means to vary the amplitude of the carrier inversely with changes produced by said volume range control means connected with said line.

2. In an arrangement for controlling the volumes throughout a transmission system comprising a wire circuit connected with a radio circuit, the combination with a transmitting station of a radio station, a wire line connecting the said transmitting station and the said radio station, the said transmitting station comprising a potentiometer to control the volume range impressed upon the said line, the said radio station having a source of carrier frequency and a potentiometer to control the amplitude of the carrier radiated from the said station, and means connecting the said stations to vary the said carrier potentiometer inversely with changes in the potentiometer at the transmitting station.

3. In an arrangement for controlling the volumes throughout a transmission system

comprising a wire circuit connected with a radio circuit, the combination with a transmitting station of a radio station, a wire line connecting said stations, the said transmitting station having means to control the volume range of the energy applied to the said line in order to keep it within the limits that the line is capable of transmitting, and means connected with the said radio station and controlled by the said volume range controlling device at the transmitting station to vary the amplitude of the carrier frequency transmitted by the said radio station in inverse proportion to the change made in the volume of the energy applied to the wire line.

4. In an arrangement for controlling the volumes throughout a transmission system comprising a wire circuit connected with a radio circuit, the combination with a transmitter of a transmitting amplifier, a line, means to compress the volume range of the said transmitting amplifier to bring the said range within the limits of the said line, a radio transmitter comprising a modulator connected with the said line, an amplifier, a source of oscillations connected with the said modulator and the said amplifier, and means controlled by the said volume range compressor to vary the amplitude of the oscillations applied to the said amplifier of the radio transmitter inversely with the changes made by the said compressor upon energy applied by the transmitting amplifier to the said line.

5. In an arrangement for controlling the volumes throughout a transmission system comprising a wire circuit connected with a radio circuit, the combination with a line of means to apply energy thereto, means to control the volume range of the said energy, a radio transmitter connected with the said line comprising a modulator, an amplifier connected with the output of the modulator, a source of oscillations connected with the said modulator and the said amplifier, and means connected with the output of the said oscillator and controlled by the said volume range controlling means to vary the amplitude of the oscillations applied to the said amplifier inversely with the changes made upon the energy applied to the said line by the said volume range controlling means.

6. In an arrangement for controlling the volumes throughout a transmission system comprising a wire circuit connected with a radio circuit, the method which consists in varying the energy level of a signal at the input end of the wire circuit to bring it within the volume range of the said circuit, transmitting the signal to the radio circuit, modulating a carrier frequency by the signal simultaneously transmitting the modulated carrier frequency together with an unmodulated carrier frequency, and varying the amplitude of said unmodulated carrier frequency simultaneously and inversely with the

changes in the energy level of the signal applied to the wire circuit.

7. In an arrangement for controlling the volumes throughout a transmission system, comprising a wire circuit connected with a radio circuit, the method which consists in compressing the volume range of electrical energy resulting from speech, music or other sounds prior to transmitting the said energy over a medium to keep the level above that of interference and below the upper limit of transmission of the medium, modulating the carrier frequency by the said energy as transmitted and transmitting the products of said modulation over a different medium, simultaneously transmitting the unmodulated carrier frequency, and varying the amplitude simultaneously and inversely with the changes in the volume of the energy resulting from speech, music or other sound caused by the compression of the volume range.

8. In a transmission system comprising a wire circuit and a radio system, the combination with means for keeping the volume of the waves transmitted over the wire circuit within specified limits, of means for producing a carrier wave, means for producing side bands of said carrier under the control of the waves transmitted over the wire circuit without expanding their range of volume, means to radiate said side bands and said carrier and means for varying the volume of the carrier wave radiated by the radio transmitter in inverse proportion to the changes produced in the wave in the wire circuit by the first mentioned means.

9. A signal transmitting system comprising means for compressing the range of volume of the signals within specified limits and transmitting them over a wire line, a radio transmitter having its input connected with the said wire line, and containing means for radiating a carrier wave varied in amplitude in inverse ratio to the variations produced in the original signals by the said compressing means, and means for radiating side bands under the control of the signals in the wire line.

10. In a transmission system the combination with a transmitter of electrical signals, of means for compressing the range of volume of the signals, a wire circuit to convey the compressed signals to a radio transmitting station, means associated with said compressing means for transmitting signals indicating the condition of the compressing means over an auxiliary channel to the radio station, means at the radio station for radiating side bands under the control of the signals transmitted over the said wire circuit without expansion of their range, and means at the radio station for radiating a carrier whose volume varies in inverse ratio

with the changes produced in the volume of the original signals by the said compressing means, said carrier radiating means being under the control of the signals sent over the said auxiliary channel.

11. The method of transmitting signals over a system comprising a wire circuit and a radio system, which consists in compressing the range of volume of the waves transmitted over the wire circuit to bring the said range within the limits imposed by the wire circuit and the radio system, modulating at the radio transmitting station a carrier current by the said transmitted waves without expansion of the volume range, radiating the side bands resulting from such modulation together with a carrier current, and controlling the amplitude of said carrier current by the range-compressing means at the sending end of the wire whereby signals received from the radio transmitting station will be reproduced with their original range of volume.

12. The method of transmitting signals over a system comprising a wire circuit and a radio system, which consists in compressing the range of volume of the waves transmitted over the wire circuit to bring the said range within the limits imposed by the wire circuit and the radio system, modulating at the radio transmitting station a carrier current by the said transmitted waves without expansion of the volume range, radiating a side band resulting from such modulation together with a carrier current, and controlling the amplitude of said carrier current by the range-compressing means at the sending end of the wire whereby signals received from the radio transmitting station will be reproduced with their original range of volume.

13. The method of reducing the effects of extraneous disturbances and distortion due to excessive volume of signals in a transmission system, comprising a wire circuit and a radio system, which consists in compressing the range of volume of the signals before transmitting them over the wire line to the radio transmitter, modulating a carrier frequency by means of said signals and radiating the side bands without expansion of their volume range, simultaneously radiating a carrier, and varying the volume of said carrier in inverse ratio to the changes produced in compressing the original signal at the sending end of the wire line and receiving the combined carrier and side bands and reproducing the original signals with their original range of volume.

In testimony whereof we have signed our names to this specification this 30th day of December, 1925.

ALVA B. CLARK.
GEORGE CRISSON.