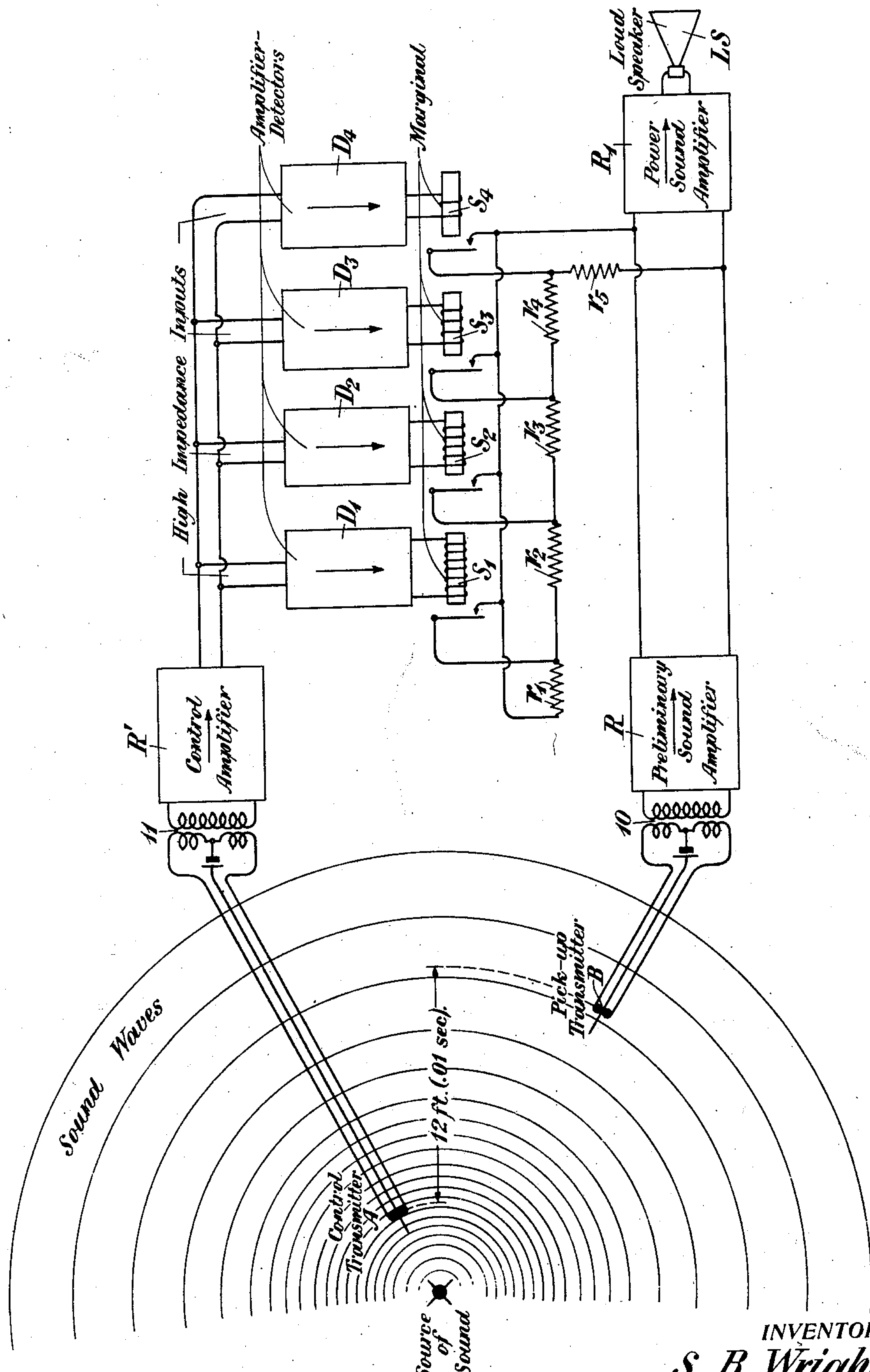
Dec. 15, 1925. **1,565,540**

S. B. WRIGHT

AUTOMATIC VOLUME REGULATION OF TRANSMISSION SYSTEMS

Filed Sept. 3, 1924



INVENTOR
S. B. Wright
BY
G. E. Folk
ATTORNEY

Patented Dec. 15, 1925. **1,565,540**

UNITED STATES PATENT OFFICE.

SUMNER B. WRIGHT, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

AUTOMATIC VOLUME REGULATION OF TRANSMISSION SYSTEMS.

Application filed September 3, 1924. Serial No. 735,661.

To all whom it may concern:

Be it known that I, SUMNER B. WRIGHT, residing at East Orange, in the county of Essex and State of New Jersey, have invented certain Improvements in Automatic Volume Regulation of Transmission Systems, of which the following is a specification.

This invention relates to transmission circuits and more particularly to arrangements to automatically change the volume of the currents transmitted as the intensity of the signal varies.

In transmission systems such as are used in connection with radio broadcasting, public address and other similar systems it is frequently desirable to change the range of volume transmitted. For example, in transmitting musical productions the volume of the signal may vary from instant to instant over a range, the maximum power of which bears a ratio of as high as 100,000 to the minimum power. In many instances, it is impractical to transmit such a wide range of variation in volume either because of some limitation in the transmission medium or because of some limitation in a translating device in the transmission system.

It has heretofore been necessary to change the volume to be transmitted from time to time in case it became too great or too small, this change being effected by some manual manipulation. This involved obvious difficulties, for the attendant must not only make the change at the proper instant but will have to depend upon his own individual judgment as to how great a change in volume to make at any given time. In accordance with the present invention, therefore, it is proposed to arrange the circuit so that the regulation of the volume of the transmission will be accomplished automatically with change in volume of the original signal.

The invention may now be more fully understood from the following description thereof when read in connection with the accompanying drawing, the figure of which illustrates a preferred embodiment of the invention.

In the figure, a typical transmission circuit is illustrated conventionally, the particular circuit shown being of the type known as a public address system. The system involves a source of sound X in the vicinity of which a sensitive pick-up transmitter B is located, the pick-up transmitter being connected through an amplifier R and a power amplifier R_1 to a loud speaker LS. The pick-up transmitter as illustrated is of the well known push-pull type and is connected through the usual balanced transformer arrangement 10 to the amplifier R. The amplifiers R and R_1 may be of any well known type, such, for example, as vacuum tube amplifiers.

In order to control the volume transmitted to the loud speaker LS from the transmitter B a variable shunt comprising resistances r_1, r_2, r_3, r_4 and r_5 is bridged across the circuit at a point intermediate between the amplifiers R and R_1. The total shunt resistance across the circuit may be varied by cutting in a greater or lesser number of the resistances r_1 to r_5 in a manner about to be described, thereby varying the volume transmitted to the power amplifier R_1 and consequently to the loud speaker LS.

In order to automatically control the volume, an auxiliary or control transmitter A, which may be of the same type as the transmitter B, is associated with an auxiliary control amplifier R′, which may be similar to the amplifier R, already described, the circuit connections comprising a transformer 11 and other elements similar to those associated with the pick-up transmitter. The output circuit of the amplifier R′ has associated therewith a number of amplifier detector arrangements such as D_1, D_2, D_3 and D_4. These amplifier detector arrangements are schematically illustrated, but may comprise any known type of device for amplifying the alternating voice currents and rectifying or detecting the voice currents so as to translate them into direct current components having amplitudes corresponding to the intensity of the alterating currents.

Each of the amplifier detector units has a sensitive relay connected therewith, as illustrated at S_1, S_2, S_3 and S_4. These relays are marginal so that they will respond to different current values. The relay S_1, for example, may respond to very minute currents and the relay S_4 to only the very largest currents resulting from signal transmission, while the relays S_2 and S_3 may respond to intermediate current values. Each of the relays S_1 to S_4 inclusive, by means of a contact, short-circuits one or more of the resistances r_1 to r_4 inclusive. In order that the amplifier detector circuits shall not produce an undue shunting effect upon each other their input circuits may preferably be of high impedance.

The operation is as follows: Assuming that the intensity of the signal at X has a minimum value, the control transmitter A and the pick-up transmitter B will both operate to generate alternating currents of small amplitude. The alternating currents generated by the transmitter A are amplified by the amplifiers R′ and impressed upon the amplifier detectors D_1 to D_4 inclusive so that rectified currents flow through the windings of the relays S_1 to S_4 inclusive. These rectified currents will be of such small amplitude that none of the relays S_1 to S_4 inclusive will be sufficiently energized to attract its armature; consequently, the shunt circuit bridged across the input side of the repeater R_1 will include all of the resistances r_1 to r_5 inclusive. As these resistances will be in series with each other the resistance of the shunt will be very large so that substantially the entire alternating current generated by the pick-up transmitter B and amplified by the amplifier R will be transmitted to the input circuit of the power amplifier R_1. If an instant later the intensity of the signal at the source X should increase, the rectified currents flowing through the relays S_1 to S_4 inclusive will be increased so that one or more of the relays S_1 to S_4 will be operated, depending upon the intensity of the signal. If only the relay S_1 is operated the resistance r_1 will be short-circuited and the shunt circuit bridged across the input side of the amplifier R_1 will be reduced, with a corresponding reduction in the amplitude of the currents impressed upon the amplifier. If the rectified currents are sufficient in intensity to operate both relays S_1 and S_2, resistances r_1 and r_2 will both be short-circuited and the shunt will only include the resistances r_3, r_4 and r_5 in series. The amplitude of the currents transmitted to the repeater R_1 will accordingly be further decreased. Similarly, if the signal is of maximum intensity the rectified currents will be of such amplitude that all of the relays S_1 to S_4 inclusive are operated so that the resistances r_1 to r_4 will be short-circuited and the shunt connection will only include the resistance r_5. The currents transmitted to the amplifier R_1 will therefore be correspondingly reduced.

The effect of the variation in intensity of the signal upon the loud speaker LS may be varied by properly choosing the values of the resistances r_1 to r_5 inclusive. For example, it will be obvious that these resistances may be so proportioned that as the signal at X increases in intensity the amount of resistance shunted across the input of the amplifier R_1 will be just sufficient to maintain the actual value of the current impressed upon the power amplifier R_1 of minimum value, with the result that although the intensity of the signal at the source may change, the signal emitted by the loud speaker will be of constant volume. If the resistance r_5 be made very small, or even zero, and the other resistances be progressively larger, it will be apparent that as the intensity of the sound increases a greater proportion of the energy transmitted from the amplifier R will be by-passed through the shunt, with the result that the sound emitted by the loud speaker will decrease in volume as the sound at the source increases in volume. On the other hand, if the resistances r_1 to r_5 inclusive are all made fairly large and properly related to each other, the effect may be made such that for a signal of minimum amplitude no change in the volume of current emitted by the loud speaker will be produced, but as the signal increases in volume a sufficient amount of resistance will be included in the shunt circuit so that the signal emitted by the loud speaker, while increased in volume, will not be increased as much as the original source itself.

Inasmuch as a certain time will be required for the relays such as S_1 to S_4 inclusive to operate in response to a change in volume, some provision must be made to enable the relays to operate and change the value of the resistance of the shunt circuit just at the instant, or just before the instant, that the currents from the pick-up transmitter B arrive at the shunt. This may be readily accomplished by arranging the control transmitter A somewhat nearer to the source of sound than the pick-up transmitter B. Sound travels through the air slower than the electric currents are transmitted over the circuits and consequently, by properly locating the transmitter B, sufficient time may elapse while the sound is being transmitted through the air to enable the transmitter A to actuate the relays S_1 to S_4 inclusive. For example, on the assumption that sound travels 1180 feet per second in air, if the transmitter B is 12 feet further away from the source of sound X than the transmitter A, one one-hundredth of a second will elapse after the sound strikes the transmitter A before it will actuate the transmitter B, thus giving the relays S_1 to S_4 inclusive sufficient time to operate and regulate the loss in the transmission circuit between the amplifiers R and R_1.

It will be obvious that the general principles herein disclosed may be embodied in many other organizations widely different from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In a signaling system, means to translate signaling energy into electrical energy having variations of volume, a transmission circuit upon which said electrical energy may be impressed, and means automatically responsive to a change in the volume of said electrical energy to so change the volume of the energy transmitted that it will vary through a range different from that of the impressed energy, the variations in volume of the transmitted energy remaining proportional to the variations in volume of the impressed electrical energy.

2. In a signaling system, means to generate signaling energy having variations of volume extending over a wide range, a transmission circuit over which a lesser range of volume is to be transmitted, means to impress said energy upon such transmission circuit, and means automatically responsive to changes in the volume of the generated energy to reduce the volume of the energy transmitted so that the range of volume transmitted will be less than the range of volume generated, the variations in volume of the transmitted energy remaining proportional to the variations in volume of the generated energy.

3. In a signaling system, means to generate signaling energy having variations of volume, a transmission circuit including a pick-up means responsive to said energy, a variable loss element included in said transmission circuit, and means to automatically vary the loss introduced by said element as the volume of the generated energy varies, so that the volume of the energy transmitted will vary through a range different from that generated, the variations in volume of the transmitted energy remaining proportional to the variations in volume of the generated energy.

4. In a signaling system, means to generate signaling energy having variations of volume, a transmission circuit including a pick-up means responsive to said energy, a variable shunt bridged across the transmission circuit, and means to vary the electrical values of said shunt automatically in response to variations of the energy generated, so that the volume of the energy transmitted will vary through a range different from that generated, the variations in volume of the transmitted energy remaining proportional to the variations in volume of the generated energy

5. In a signaling system, means to generate signaling energy having variations of volume, a transmission circuit including a pick-up transmitter responsive to said energy, a variable loss element included in said transmission circuit, an auxiliary transmission circuit over which currents corresponding to the signaling energy generated may be transmitted, and means associated with said auxiliary circuit for automatically operating in response to variations in the amplitude of the current transmitted over said auxiliary circuit to variably adjust the loss element in said first mentioned transmission circuit.

6. In a signaling system, means to generate signaling energy having variations of volume, a main transmission circuit including a pick-up transmitter responsive to said energy, a variable loss element associated with said circuit, an auxiliary transmission circuit including a second transmitter responsive to said energy, and means associated with said second circuit and responsive to currents generated by said second transmitter to variably control the loss introduced into said first circuit by said loss element as the volume of the generated energy varies.

7. In a signaling system, means to generate signaling energy having variations of volume, a main transmission circuit including a pick-up transmitter responsive to said energy, a variable loss element associated with said circuit, an auxiliary transmission circuit including a second transmitter responsive to said energy, and means associated with said second circuit and responsive to currents generated by said second transmitter to variably control the loss introduced into said first circuit by said loss element as the volume of the generated energy varies, said second transmitter being located nearer the source of sound than the said first transmitter to enable the variable loss element to be adjusted in response to a change in the volume of the energy generated before the corresponding currents have been transmitted from said first transmitter to said loss element.

8. In a signaling system, means to generate signaling energy having variations of volume, a transmission circuit upon which the energy may be impressed, means associated with said circuit for automatically varying its transmission efficiency as the energy generated varies in volume, and means to introduce a sufficient delay in transmission over said circuit to enable said automatic varying means to operate in response to a given change in volume before the corresponding currents arrive.

9. In a signaling system, means to gener-

ate signaling energy having variations in volume, a transmission circuit upon which said energy may be impressed, a variable transmission element in said circuit, means automatically responsive to changes in the volume of the energy generated to adjust said variable transmission elements, and means to delay the transmission of currents over said transmission circuit by a sufficient amount to enable said automatically responsive means to adjust said variable transmission element before said currents arrive at said variable transmission element.

In testimony whereof, I have signed my name to this specification this 2nd day of September 1924.

SUMNER B. WRIGHT.