March 10, 1931. A. C. DICKIESON 1,795,479

WAVE TRANSMISSION SYSTEM

Filed Oct. 30, 1926

Fig. 1.

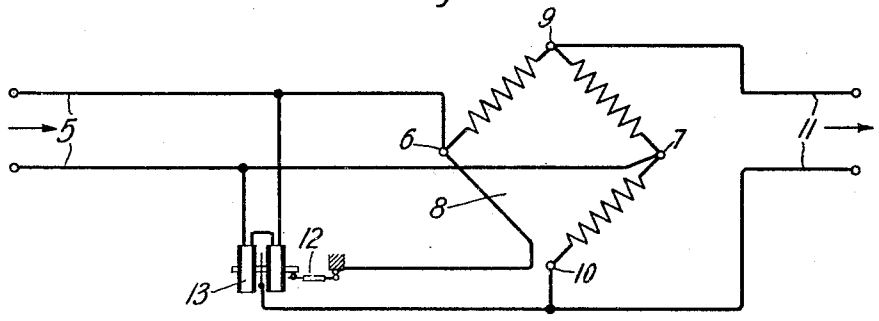


Fig. 2.

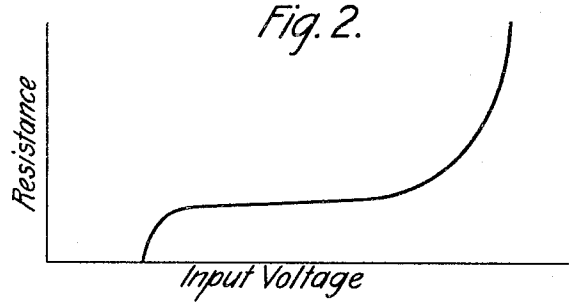
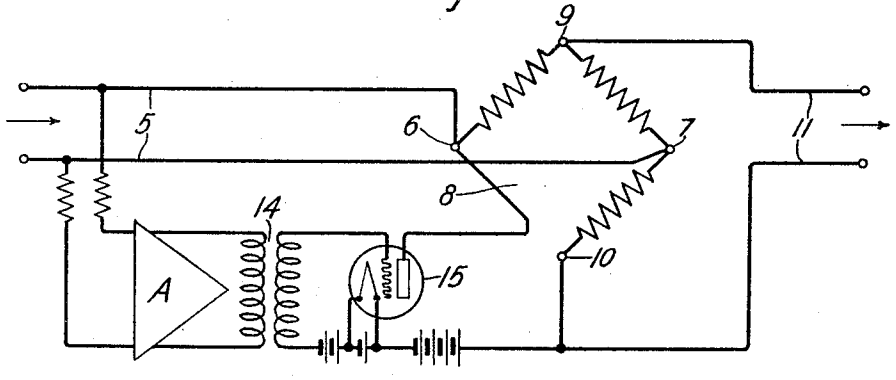


Fig. 3.



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UNITED STATES PATENT OFFICE

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WAVE-TRANSMISSION SYSTEM

Application filed October 30, 1926. Serial No. 145,171.

This invention relates to wave transmission systems and particularly to means for controlling the energy level of transmission in such systems.

An object of the invention is to control the energy level in a signaling system in response to changes in the intensity of the transmitted waves.

Other objects of the invention are to increase the sensitivity and precision of volume control systems.

The invention is especially applicable to radio broadcasting, public address and similar systems, where music and speech are transmitted over telephone or other transmission circuits. A feature of the invention is a simple and efficient circuit for automatically regulating the energy level.

Heretofore, this has usually been accomplished by connecting a volume indicator across the outgoing line to indicate changes in the energy level of the transmitted waves. An operator observes the deflection of the volume indicator and manually adjusts the gain of an amplifier in the outgoing line to obtain the desired energy level.

Recent inventors have provided automatic systems of volume control which require little or no maintenance and also eliminate the element of inaccuracy which usually exists in manually controlled systems. A system which is typical of the recent advance in the art is disclosed in a United States Patent 1,690,224 to E. W. Gent, patented November 6, 1928, in which the gain of a thermionic amplifier is varied in response to changes in the amplitude of the transmitted currents. The present invention is a result of attempts to simplify the construction and operation of automatic volume control systems.

The volume control circuit of this invention includes a Wheatstone bridge having a pair of opposite terminals connected to an incoming line and the other pair of opposite terminals connected to an outgoing line. One arm of the bridge includes a device which responds to variations in the strength of the incoming currents to control the condition of the bridge. The bridge is normally unbalanced so that it passes comparatively weak currents with little or no attenuation. When the amplitude of the incoming currents increases, however, the bridge becomes more nearly balanced and hence introduces an increasing loss into the circuit. Variations in the amplitude of the incoming currents thus effect a compensating change in the transmission loss of the circuit and the energy level is maintained substantially constant.

A feature of the invention resides in a highly sensitive bridge circuit which may be employed as a volume compressor, but may also be used for other purposes. One arm of this bridge includes the contacts of a voice operated relay, the resistance characteristics of which are such that the resistance remains substantially constant for input amplitudes within a certain definite range, while beyond this range the contact resistance increases rapidly.

The invention will be described in connection with the accompanying drawing in which similar reference characters represent corresponding parts in the different figures, and in which:

Fig. 1 is a diagrammatic illustration of a volume control system employing the sensitive bridge circuit of the invention;

Fig. 2 shows a curve illustrating the contact resistance characteristics of the relay shown in Fig. 1; and

Fig. 3 is a diagrammatic illustration of a modified volume control system.

In Fig. 1, an incoming circuit 5 is connected to the opposite terminals 6 and 7 of a Wheatstone bridge 8. The other two opposite terminals 9 and 10 of the bridge are connected to an outgoing circuit 11. One arm of the Wheatstone bridge includes the contact device 12 of a low frequency vibrating relay 13 having its windings connected across the incoming circuit 5. This relay is preferably of the type disclosed in U. S. Patent No. 1,579,887 to E. J. Pratt, issued April 6, 1926.

The contact resistance characteristics of the relay 13 are illustrated graphically by the curve of Fig. 2, in which the ordinates represent the contact resistance and the ab-

scissæ represent the voltage impressed upon the windings of the relay from the circuit 5. It will be seen from this curve that the contact resistance is negligible up to a certain desired low input voltage, and then increases and remains substantially constant over a fairly wide range of voltages, and beyond the upper limit of this range the resistance increases rapidly.

The circuit is so adjusted that the Wheatstone bridge is completely unbalanced when no signals are impressed upon the windings of the relay 13. Comparatively weak signal voltages produce no effect upon the contact resistance, as shown by the curve of Fig. 2, and are therefore practically unattenuated in passing through the bridge. When the impressed voltage increases above a predetermined limiting value, however, the relay 13 begins to operate and the contact resistance increases. This increase in resistance tends to make the Wheatstone bridge more nearly balanced and limits the voltage impressed upon the outgoing circuit 11. As a result of this action, excessive voltages in the incoming circuit 5 are prevented from reaching the outgoing circuit 11 and the outgoing signals are maintained at a substantially constant energy level.

The modified volume control system shown in Fig. 3 includes a sensitive response circuit of the type disclosed in my copending application Serial No. 145,170, filed October 30, 1926, which was issued as Patent 1,762,768, June 10, 1930. This circuit includes an amplifier A having its input connected across the circuit 5 and its output coupled by means of transformer 14 to the grid circuit of a three-electrode space discharge tube rectifier 15. The plate circuit of the rectifier 15 is included in one arm of the Wheatstone bridge between the terminals 6 and 10. The grid of the rectifier 15 is given a negative bias such that small changes in the biasing potential produce large changes in the resistance of the plate circuit. The constants of the circuit are so chosen that the bridge is normally unbalanced and offers little resistance to the passage of weak signals. As the voltage impressed upon the grid circuit of the rectifier 15 increases, however, the resistance of the plate circuit increases greatly and tends to make the bridge more nearly balanced, the operation being substantially the same as that of the system of Fig. 1.

The invention is also capable of other modifications and adaptations not specifically referred to but included within the scope of the appended claims.

What is claimed is:

1. A wave transmission system comprising an incoming circuit, a source of waves therein of varying volume, an outgoing circuit, a Wheatstone bridge having two opposite terminals connected to said incoming circuit and the other two opposite terminals connected to said outgoing circuit, said bridge being normally unbalanced to permit waves of low volume to pass freely from said incoming to said outgoing circuit, said bridge including a variable resistance in one arm and means connected to the incoming circuit and responding to volume variations in the incoming waves for continuously varying said resistance over a range of volume variations in said waves to control the degree of unbalance of said bridge circuit.

2. A wave transmission system comprising a circuit for transmitting electrical waves, a Wheatstone bridge for controlling the transmission of said waves through said circuit, an electromagnet responsive to changes in the amplitude of said waves, and a variable-resistance vibrating contact element controlled by said electromagnet and having its contact resistance included in one arm of said bridge, said contact resistance being a function of the response characteristic of said electromagnet and determining the degree of unbalance of said bridge.

3. A wave transmission system comprising a circuit for transmitting electrical waves, a Wheatstone bridge the degree of unbalance of which directly controls the volume of transmission of said waves through said circuit, and a vibrating relay responsive to changes in the amplitude of said waves, the the contact resistance of said relay directly controlling the condition of balance of said bridge.

4. A wave transmission system comprising an incoming circuit for receiving wave energy of varying volume, an outgoing circuit, a Wheatstone bridge having two opposite terminals connected to said incoming circuit and the other two opposite terminals connected to said outgoing circuit, and a relay quantitatively responsive to changes in the volume of said incoming wave energy, said relay controlling quantitatively the degree of unbalance of said bridge.

5. A wave transmission system comprising an incoming circuit for receiving wave energy of varying volume, an outgoing circuit, a Wheatstone bridge having two opposite terminals connected to said incoming circuit and the other two opposite terminals connected to said outgoing circuit, a relay responsive to changes in the volume of said incoming wave energy, and a vibratile contact element controlled by said relay and forming at least part of the resistance of one of the arms of said bridge, said relay quantitatively controlling the degree of unbalance of said bridge.

6. A sensitive response circuit comprising a Wheatstone bridge, means for applying variable voltage thereto, an electromagnet responsive to variations in said voltage, and means for varying the resistance of an arm of said bridge to vary the degree of unbalance of

the bridge, including a vibratile contact controlled by said electromagnet and having substantially constant resistance for applied voltages below a predetermined limit but the resistance of which rises rapidly above such limit.

7. In an electrical transmission system, a Wheatstone bridge comprising fixed resistance arms and a variable arm, the resistance of which is instantaneously variable under control of volume variations in transmitted energy, an input circuit and an output circuit connected respectively to opposite diagonals of said bridge, and means for utilizing a portion of the input for directly controlling the resistance of said variable arm.

8. A sensitive response circuit comprising a Wheatstone bridge, and a relay having a vibratile contact included in an arm of said bridge to control the balance thereof, the resistance of said vibratile contact being a continuous function of the response of the relay to changes in the voltage applied to said circuit.

9. A sensitive response circuit comprising a Wheatstone bridge which is normally unbalanced, an input and an output circuit connected respectively to the opposite diagonals of said bridge, and a relay having a vibratile contact connected in one arm of said bridge, the resistance of said vibratile contact being a continuous function of the response of the relay to changes in the voltage applied to said circuit.

In witness whereof, I hereunto subscribe my name this 22nd day of October, A. D., 1926.

ALTON C. DICKIESON.