Oct. 7, 1924. 1,511,015

H. A. AFFEL

TRANSMISSION REGULATION

Filed May 4, 1922

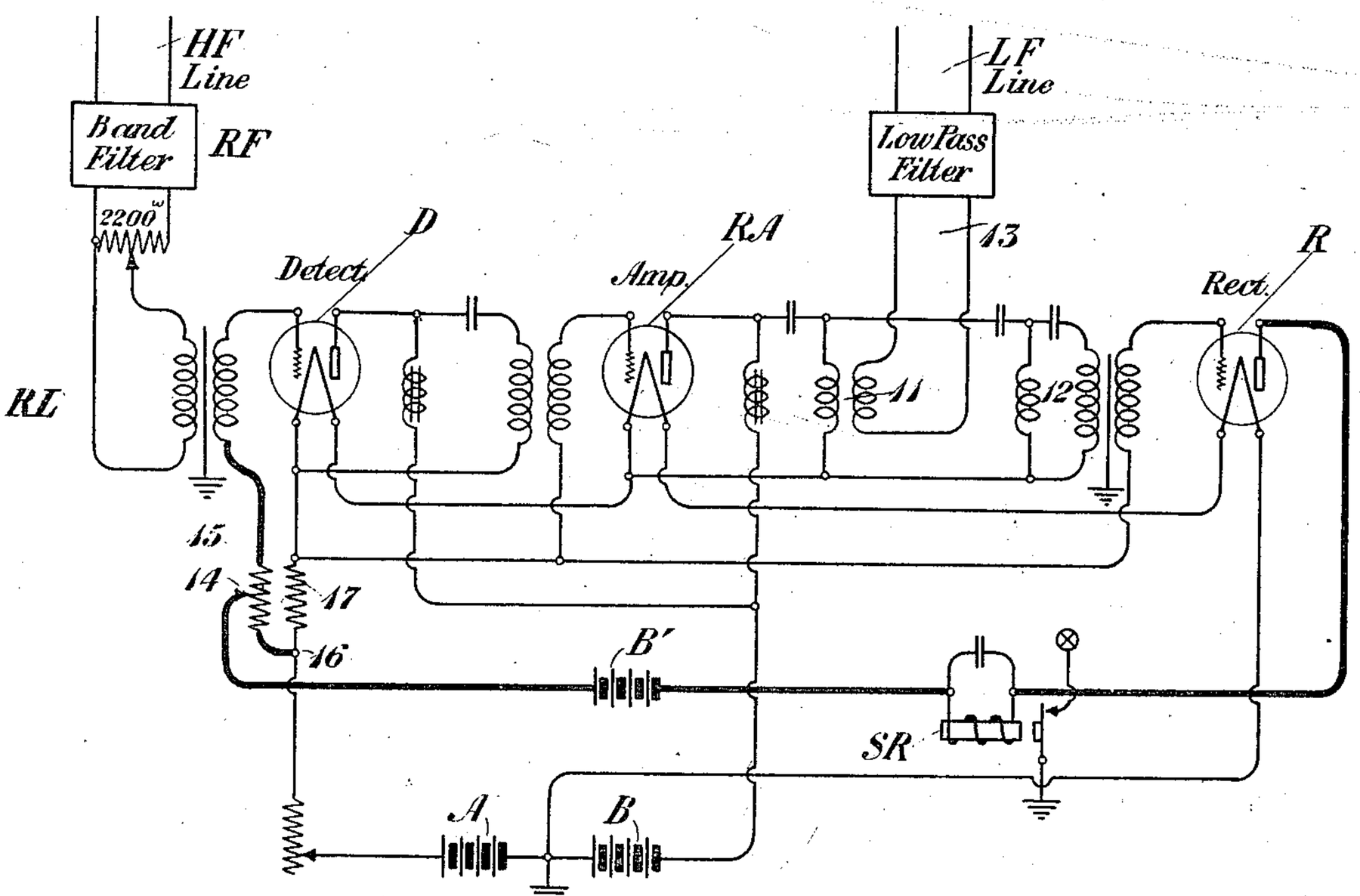

Fig. 1

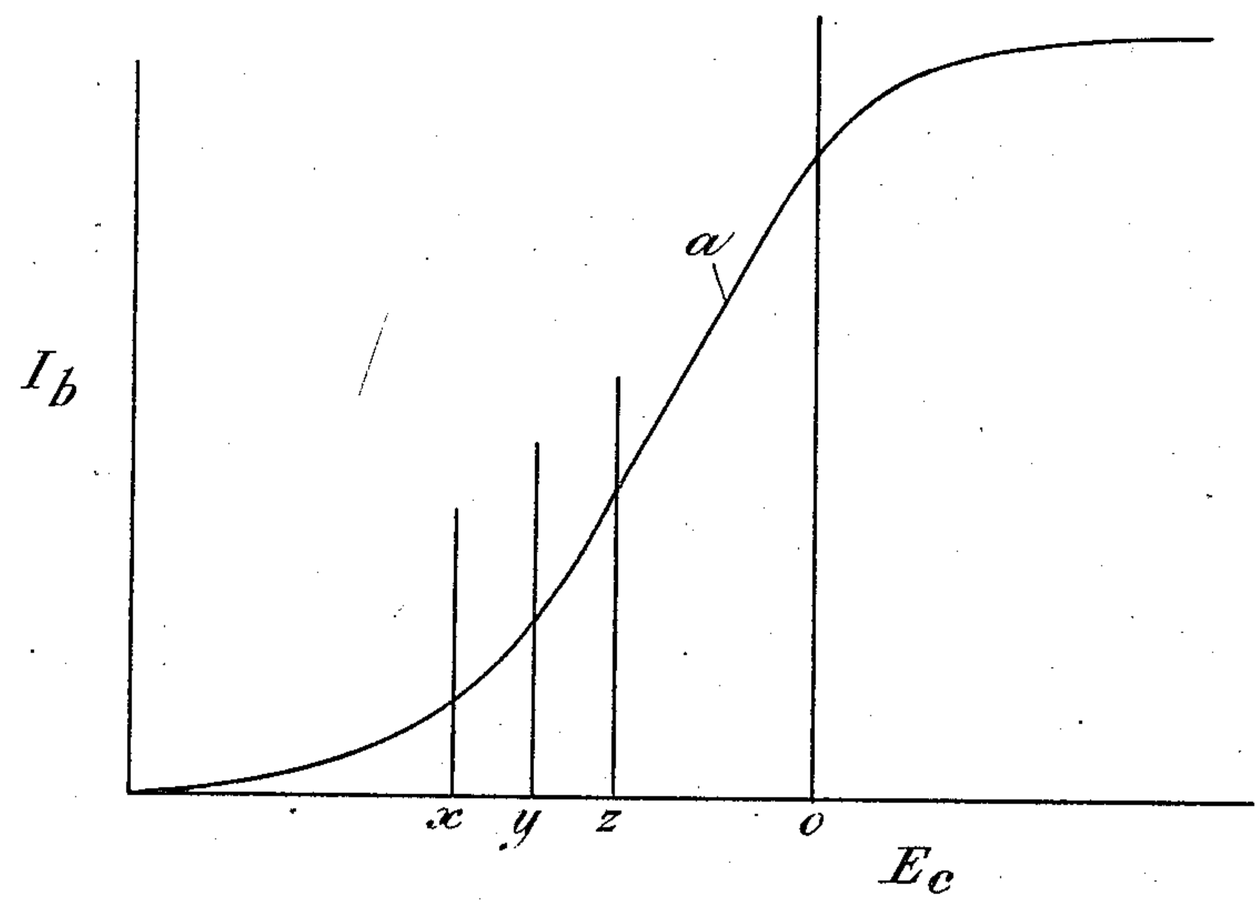

Fig. 2

INVENTOR.
H. A. Affel
BY
ATTORNEY.

Patented Oct. 7, 1924. 1,511,015

UNITED STATES PATENT OFFICE.

HERMAN A. AFFEL, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TRANSMISSION REGULATION.

Application filed May 4, 1922. Serial No. 558,446.

To all whom it may concern:

Be it known that I, HERMAN A. AFFEL, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Transmission Regulations, of which the following is a specification.

This invention relates to multiplex signaling circuits, and more particularly to methods and arrangements for controlling the transmission over such circuits.

In a wire carrier or radio telephone system, the fluctuations in attenuation of the transmission medium or line produce corresponding variations in the over-all transmission equivalent of the voice circuit. In one well known type of carrier system, the carrier frequency itself is suppressed at the modulator end in connection with each channel, and the fundamental frequency, which is relatively low, is transmitted to the receiving end of the circuit, and by harmonic regeneration, caused to produce a synchronous carrier supply for the respective demodulators. The carrier supply in this case is transmitted at a frequency which is substantially independent of ordinary line attenuation fluctuations and the variation in line attenuation at the side band frequency causes a directly proportional variation in the over-all equivalent, there being substantially no fluctuation of the equivalent of the circuit due to the carrier component itself.

With the type of carrier system, however, in which a carrier frequency is transmitted along with the side band of each individual channel, the transmission fluctuations may be even more serious, since in demodulation the resultant voice output may, for normal operation of the demodulator, be proportional to the product of the carrier and the modulated side band. If, therefore, the attenuation of the intervening line or other transmission medium varies, approximately the same variation will take place for both the carrier and the modulated side band, and the resultant voice circuit variation, being proportional to the product of these two factors, will be approximately double that of the line attenuation itself.

In accordance with the present invention, it is proposed to overcome the difficulties encountered in connection with transmission fluctuations in the type of circuit in which the carrier frequency is transmitted along with the side band, by controlling some element of the transmission channel or circuit to vary the transmission of such element in accordance with the amplitude of the carrier frequency of the channel. Preferably, the control thus exercised will be applied to an element in the receiving channel at a receiving station by selecting the carrier frequency component, rectifying the selected component to produce a direct current whose amplitude will depend on the transmission conditions to which the carrier has been subjected, and controlling the transmission element by the rectified current. The control exercised by the rectified current may be effected either electrically or mechanically, but in the preferred form herein disclosed, an electrical system of control is illustrated.

The invention may now be more fully understood by reference to the following description, when read in connection with the accompanying drawing, Figure 1 of which shows a circuit diagram embodying the principles of the invention, and Fig. 2 is a curve illustrating the operation of one of the vacuum tube circuits shown in Fig. 1.

Referring to Fig. 1, so much of the carrier system is shown as is necessary to an understanding of the present invention. In this figure, RL designates the receiving channel of one transmission circuit of a carrier telegraph system, said channel being connected, together with other similar channels (not shown), to a common transmission line (not shown), over which carrier frequencies are transmitted. The corresponding transmitting channel is not illustrated, as it is not involved in the present invention. The receiving channel RL includes a band filter RF for selecting the desired side band and the corresponding carrier, a detector D and a receiving amplifier RA. The detector D may be of any well known type, such as a vacuum tube detector, and is adapted to detect the voice currents corresponding to the side band by beating the side band with the carrier. The receiving amplifier RA may be any well known type of amplifier, but is illustrated as being a vacuum tube amplifier and is arranged to amplify the detected voice currents as well as the unmodulated carrier component appearing in the output circuit of the detector. The output circuit of the receiving am-

plifier RA includes a transformer 11 by which the low frequency circuit 13 (which may be associated with a low frequency transmission line) is connected to the receiving channel.

The circuit 13 includes a low-pass filter by which the voice frequency currents are selected into said circuit to the exclusion of the higher frequency components, such as the unmodulated carrier. The carrier frequency component may be selected by means of a tuned circuit or filter 12 through which the carrier frequency is impressed upon a rectifier R. The rectifier R may be of any well known type but is illustrated as a vacuum tube arrangement adapted to translate the selected carrier component into a direct current. In systems of this type, this direct current is primarily used to control the operation of a signal relay SR, which is illustrated as being included in the output circuit of the rectifier. This signal relay is adapted to operate a ringing signal when the carrier is interrupted at the sending station, the interruption of the carrier (which is normally transmitted) resulting in the cessation of the flow of direct current in the output circuit of the rectifier.

In the present invention, this circuit is also utilized to control the transmission efficiency of the detector D, and for this purpose the output circuit of the rectifier may be traced from ground to the filament of the rectifier, through the space in the tube to the plate of the rectifier and then through the winding of the relay SR, battery B′ to point 14 of resistance 15, thence to junction point 16 of resistances 15 and 17, through the resistance 17 and through the series connected filaments of the detector D, amplifier RA and rectifier R to ground. A connection also extends from the point 14, through the upper half of resistance 15 to the grid of the detector D. It will be seen, therefore, that the potential of the grid D is made to depend upon the amplitude of the rectified current flowing in the plate circuit of the rectifier R.

Disregarding for the moment the connection of this plate circuit to the grid of the detector D through the point 14, it will be seen that the grid of the detector D may be made normally negative with respect to the filament, by reason of the fact that the battery A, which supplies the filament heating current through the resistance 17, is connected to the grid of the detector D through the resistance 15, and by properly proportioning the resistance 15 with respect to the resistance 17, the grid may be made more negative than the filament. The connection of the plate circuit of the rectifier R to the point 14, however, results in superposing a negative potential (depending upon the value of the rectified current) upon the grid of the detector D, in addition to the negative potential supplied from the battery A. Under normal transmission conditions, the rectified current flowing in the plate circuit of the rectifier R will have a definite negative potential, so that the resultant potential upon the grid of the detector D may be made to correspond to the point *y* of the characteristic curve *a* of Fig. 2, this curve representing the variation in the plate current of the detector with variation in the grid potential of the detector.

The point *x* of the characteristic curve may be taken as the point at which the greatest curvature occurs, and consequently, the detector will be most efficient at this point. The point *z* of the characteristic curve is a point at which the curvature is much less than at the point *x*, and this may be considered the point at which the detector will be least efficient over its practical operating range. The point *y* is chosen at an intermediate point between the points *x* and *z*, so that under average transmission conditions, the detector will be working at the point *y*. Consequently, if the transmission efficiency of the carrier circuit or medium is decreased, so that the amplitude of the carrier current is decreased, the rectified direct current flowing in the output circuit of the rectifier R will be correspondingly decreased and the grid of the detector will become more positive, so that the operating point of the detector will be shifted toward the point *x*, thereby increasing the efficiency of the detector. This increased efficiency will obviously manifest itself not only in an increased detection efficiency, but since the operation is now taking place on a portion of the characteristic curve which has greater slope, it will also manifest itself in greater amplification for the currents which pass through the tube substantially undistorted, such as the carrier current itself. By a proper adjustment, this increase in efficiency may be made to compensate for the decreased amplitude of the carrier and side band, so that the resultant detected voice currents will be the same as under average conditions.

Likewise, if the efficiency of the transmission medium be increased above the average condition, the amplitude of the carrier current will be increased, with a corresponding increase in the amplitude of the direct current flowing in the output circuit of the rectifier R. Consequently, the grid of the detector D will be made more negative than before, and its operating point will be shifted toward *z* with a corresponding decrease in the operating efficiency of the detector. This decrease may be so regulated in any given case as to compensate for the increased amplitude of the

carrier and side band, with the result that the detected voice frequency will be substantially no greater than under the average condition. It will be evident that the effective amplification of the detector will also be decreased because the operation will take place over a portion of the characteristic curve which is less steep.

In this manner, the change in transmission conditions in the carrier circuit may be automatically compensated for electrically and this compensation automatically takes place regardless of whether the circuit is being used for signaling purposes or not. In other words, the carrier current being transmitted at all times regardless of whether or not there is an accompanying side band, and the control of the efficiency of the detector depending upon the amplitude of the carrier frequency, the regulation of transmission will take place whether or not the side band is transmitted.

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. The method of controlling transmission in a carrier system in which the carrier is transmitted along with the side band and in which a detector is employed to detect the signal, which consists in transmitting the carrier and side band over a medium whose transmission is variable under different conditions, combining the carrier together with the side band in the detector to detect the low frequency signaling wave represented by the side band, selecting the unmodulated carrier from the output current of the detector, producing from the selected carrier a current having characteristics depending upon the transmission conditions to which the carrier has been subjected, and controlling the efficiency of the detector in accordance with the characteristics of the current thus produced to compensate for the change in efficiency of the transmitting medium.

2. The method of controlling transmission in a carrier system in which the carrier is transmitted along with the side band and in which a detector is employed to detect the signal, which consists in transmitting the carrier and side band over a medium whose transmission is variable under different conditions, combining the carrier together with the side band in the detector to detect the low frequency signaling wave represented by the side band, selecting the unmodulated carrier from the output current of the detector, producing from the selected carrier a direct current whose amplitude depends upon the transmission conditions to which the carrier has been subjected, and controlling the efficiency of the detector in accordance with the amplitude of the direct current thus produced to compensate for the change in efficiency of the transmitting medium.

3. The method of controlling transmission in a carrier system in which the carrier is transmitted along with the side band, which consists in transmitting the carrier and side band over a medium whose transmission is variable under different conditions, combining the carrier and side band in a receiving channel, selecting the carrier, producing from the selected carrier a current whose characteristics depend upon the transmission conditions to which the carrier has been subjected, and controlling the electrical characteristics of a transmission element of the receiving channel by means of the current thus produced to compensate for the change in efficiency of the transmitting medium.

4. The method of controlling transmission in a carrier system in which the carrier is transmitted along with the side band, which consists in transmitting the carrier and side band over a medium whose transmission is variable under different conditions, combining the carrier and side band in a receiving channel, selecting the carrier, rectifying the selected carrier to produce a direct current whose amplitude depends upon the transmission conditions to which the carrier has been subjected, and controlling the electrical characteristics of a circuit element of the receiving channel by means of the rectified carrier current to compensate for the change in efficiency of the transmitting medium.

5. The method of controlling transmission in a carrier system in which the carrier is transmitted along with the side band and in which the receiving channel includes a detector for detecting the signal, which consists in transmitting the carrier and side band over a medium whose transmission is variable under different conditions, combining the carrier and side band in the detector of the receiving channel, selecting the carrier, producing from the selected carrier a current whose characteristics depend upon the transmission conditions to which the carrier has been subjected, and controlling the efficiency of the detector in the receiving channel by means of the current thus produced to compensate for the change in efficiency of the transmitting medium.

6. The method of controlling transmission in a carrier system in which the carrier is transmitted along with the side band and in which the receiving channel includes a detector, which consists in transmitting the carrier and side band over a medium

whose transmission is variable under different conditions, combining the carrier and side band in the detector of the receiving channel, selecting the carrier, rectifying the selected carrier to produce a direct current whose amplitude depends upon the transmission conditions to which the carrier has been subjected, and controlling the efficiency of the detector in the receiving channel by means of the rectified carrier current to compensate for the change in efficiency of the transmitting medium.

7. The method of controlling transmission in a carrier system in which the carrier is transmitted along with the side band and in which the receiving channel includes a detector for detecting the signal, which consists in transmitting the carrier and side band over a medium whose transmission is variable under different conditions, combining the carrier together with the side band in the detector to produce low frequency signaling currents represented by the side band, selecting the unmodulated carrier component from the output current of the detector, producing from the selected carrier component a direct current whose amplitude varies in accordance with the transmission conditions to which the carrier has been subjected, and controlling the efficiency of the detector in accordance with the amplitude of said direct current to compensate for changes in the efficiency of the transmitting medium.

8. The method of controlling transmission in a carrier system in which the carrier is transmitted along with the side band and in which a vacuum tube detector having a controlling grid is employed to detect the signal, which consists in transmitting the carrier and side band over a medium whose transmission is variable under different conditions, combining the carrier together with the side band in the detector to produce low frequency signaling currents represented by the side band, selecting the unmodulated carrier component from the output current of the detector, rectifying the selected carrier component to produce a direct current whose amplitude varies in accordance with the transmission conditions to which the carrier has been subjected, and controlling the normal potential of the grid of the detector by said direct current to change its operating characteristics to compensate for changes in the efficiency of the transmitting medium.

9. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted together with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which the side band and carrier may be simultaneously impressed to detect the low frequency signaling currents represented by the side band, means to select from the output of the detector the unmodulated carrier frequency component, means to produce from the selected carrier component a current having characteristics depending upon the transmission conditions to which the carrier has been subjected, and means whereby a circuit element of said receiving channel may be controlled in accordance with the charactertistics of the current thus produced to compensate for the change in efficiency of the transmitting medium.

10. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted together with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which the side band and carrier may be simultaneously impressed to detect the low frequency signaling currents represented by the side band, means to select from the output of the detector the unmodulated carrier frequency component, means to produce from the selected carrier component a direct current whose amplitude depends upon the transmission conditions to which the carrier has been subjected, and means whereby a circuit element of the receiving channel may be controlled in accordance with the amplitude of said direct current to compensate for the change in efficiency of the transmitting medium.

11. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted along with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which the carrier and side band may be simultaneously impressed, means for selecting the carrier, means for producing from the carrier a current whose characteristics depend upon the transmission conditions to which the carrier has been subjected, a circuit element in said receiving channel, and means for controlling said element in accordance with the charactertistics of said current to compensate for the change in efficiency of the transmitting medium.

12. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted along with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel upon which the carrier and side band may be impressed, means for selecting the carrier, a rectifying device to rectify the selected carrier to produce a direct current having an amplitude depending upon the transmission conditions to which the carrier has been subjected, a circuit element in said receiving channel,

and means for controlling said element in accordance with the amplitude of the rectified current to compensate for the change in efficiency of the transmitting medium.

13. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted along with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which the carrier and side band may be impressed, means for selecting the carrier, means for producing from the selected carrier a current whose characteristics depend upon the transmission conditions to which the carrier has been subjected, and means for controlling the efficiency of said detector in accordance with the characteristics of the current thus produced to compensate for the change in transmission efficiency of the transmitting medium.

14. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted along with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which the carrier and side band may be impressed, means for selecting the carrier, a rectifying device to rectify the selected carrier to produce a direct current having an amplitude depending upon the transmission conditions to which the carrier has been subjected, and means to control the efficiency of said detector in accordance with the amplitude of the rectified current to compensate for the change in efficiency of the transmitting medium.

15. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted together with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which the side band may be impressed together with the carrier to detect the low frequency signaling currents represented by the side band, means to select the unmodulated carrier component from the output of said detector, means to produce from said selected carrier component a direct current whose amplitude depends upon the transmission conditions to which the carrier has been subjected, and means to control the efficiency of said detector in accordance with the amplitude of said direct current to compensate for the change in transmission efficiency of said transmitting medium.

16. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted together with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a detector upon which said side band may be impressed together with the carrier to detect the low frequency signaling currents represented by the side band, means to select the unmodulated carrier component from the output of said detector, means to produce from said selected carrier component a direct current whose amplitude depends upon the transmission conditions to which the carrier has been subjected, and means to control the normal potential of the grid of said detector by said direct current to compensate for the change in transmission efficiency of said transmitting medium.

17. The method of controlling transmission in a carrier system in which the carrier is transmitted along with the side band and in which an amplifier is employed at the receiving station, which consists in transmitting the carrier and side band over a medium whose transmission is variable under different conditions, combining the carrier with the side band to produce a low frequency signaling wave represented by the side band, selecting the unmodulated carrier, producing from the selected carrier a current having characteristics depending upon the transmission conditions to which the carrier has been subjected, and controlling the efficiency of the amplifier in accordance with the characteristics of the current thus produced to compensate for the change in efficiency of the transmitting medium.

18. The method of controlling transmission in a carrier system in which the carrier is transmitted along with the side band and in which a vacuum tube amplifier having a controlling grid is employed at the receiving station, which consists in transmitting the carrier and side band over a medium whose transmission is variable under different conditions, combining the carrier with the side band to produce low frequency signaling currents represented by the side band, selecting the unmodulated carrier component, rectifying the selected carrier component to produce a direct current whose amplitude varies in accordance with the transmission conditions to which the carrier has been subjected, and controlling the normal potential of the grid of the amplifier by said direct current to change its operating characteristics to compensate for the changes in the efficiency of the transmitting medium.

19. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted together with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including an amplifier, means to combine the side band with the carrier to produce low frequency signaling currents represented by the side band, means to select the unmodulated carrier frequency component, means to produce from the selected carrier component a current hav-

ing characteristics depending upon the transmission conditions to which the carrier has been subjected, and means whereby the efficiency of said amplifier may be controlled in accordance with the characteristics of the currents thus produced to compensate for the change in efficiency of the transmitting medium.

20. In a system for controlling transmission, a transmitting medium over which the carrier is transmitted together with the side band, the transmission efficiency of said medium being variable under different conditions, a receiving channel including a vacuum tube amplifier, means in said channel to combine the carrier with the side band to produce low frequency signaling currents represented by the side band, means to select the unmodulated carrier component, means to produce from said selected carrier component a direct current whose amplitude depends upon the transmission conditions to which the carrier has been subjected, and means to control the normal potential of the grid of the amplifier by said direct current to compensate for the changes in the effiency of the transmitting medium.

In testimony whereof, I have signed my name to this specification this 3rd day of May, 1922.

HERMAN A. AFFEL.