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MEANS TO CONTROL CROSS TALK

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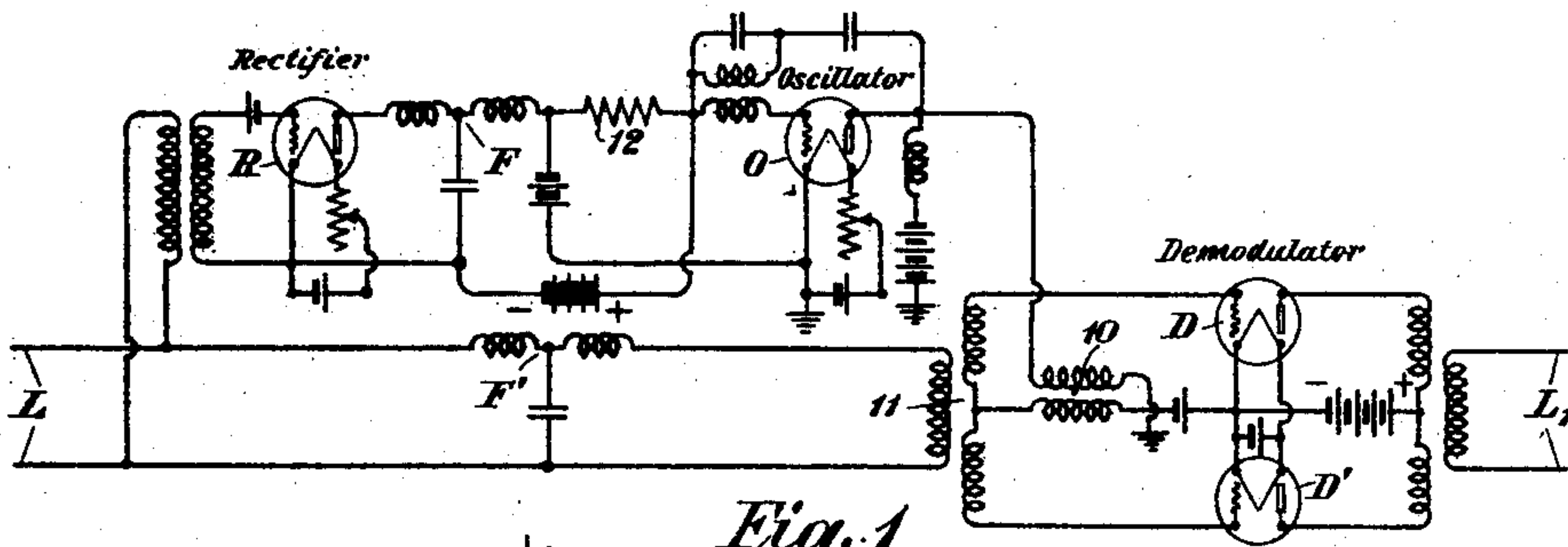


Fig. 1

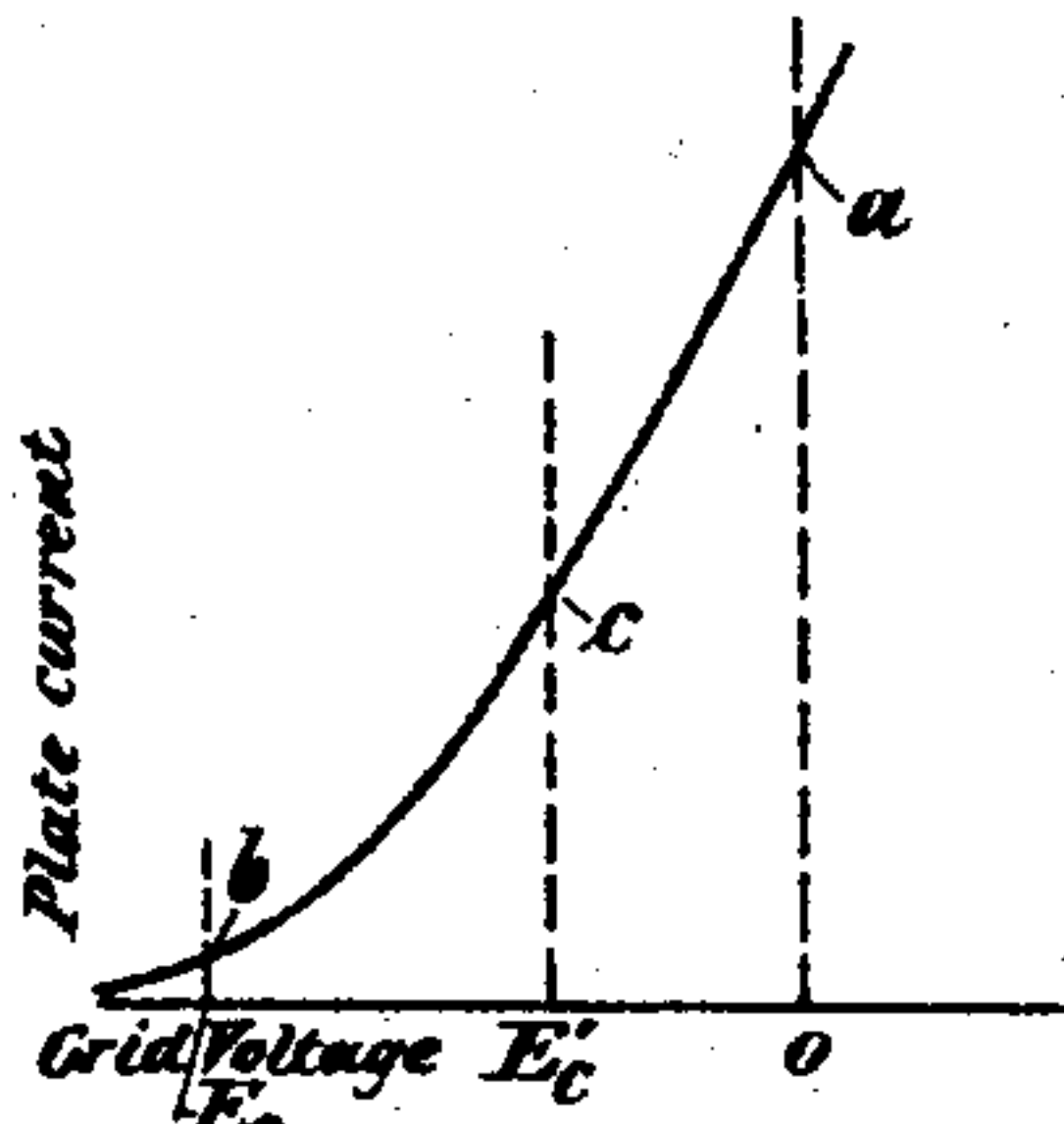


Fig. 1a

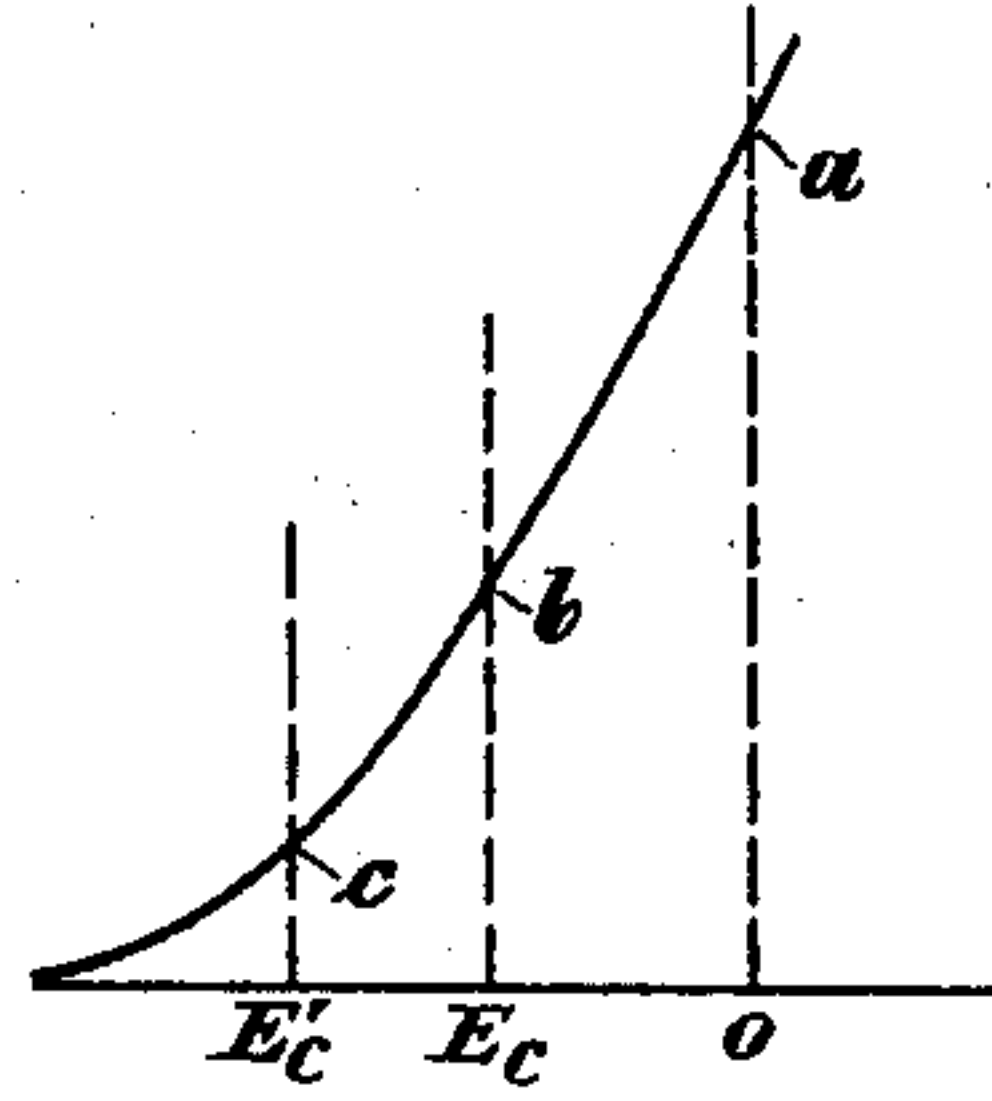


Fig. 2a

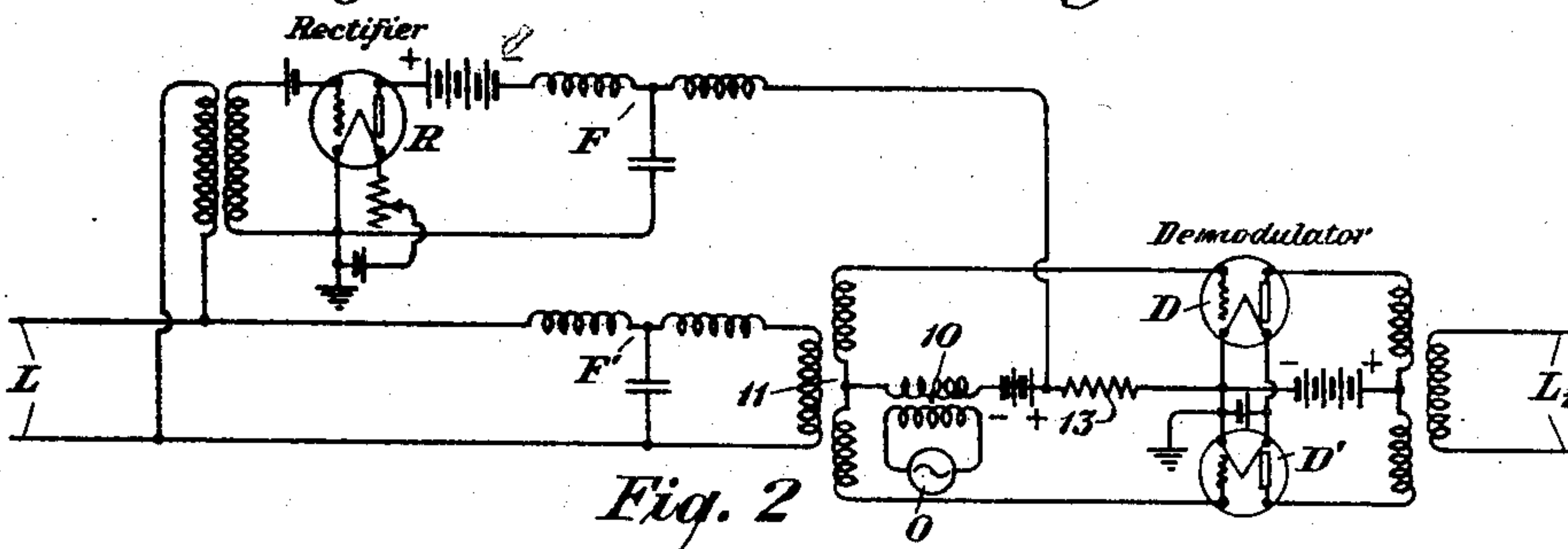


Fig. 2

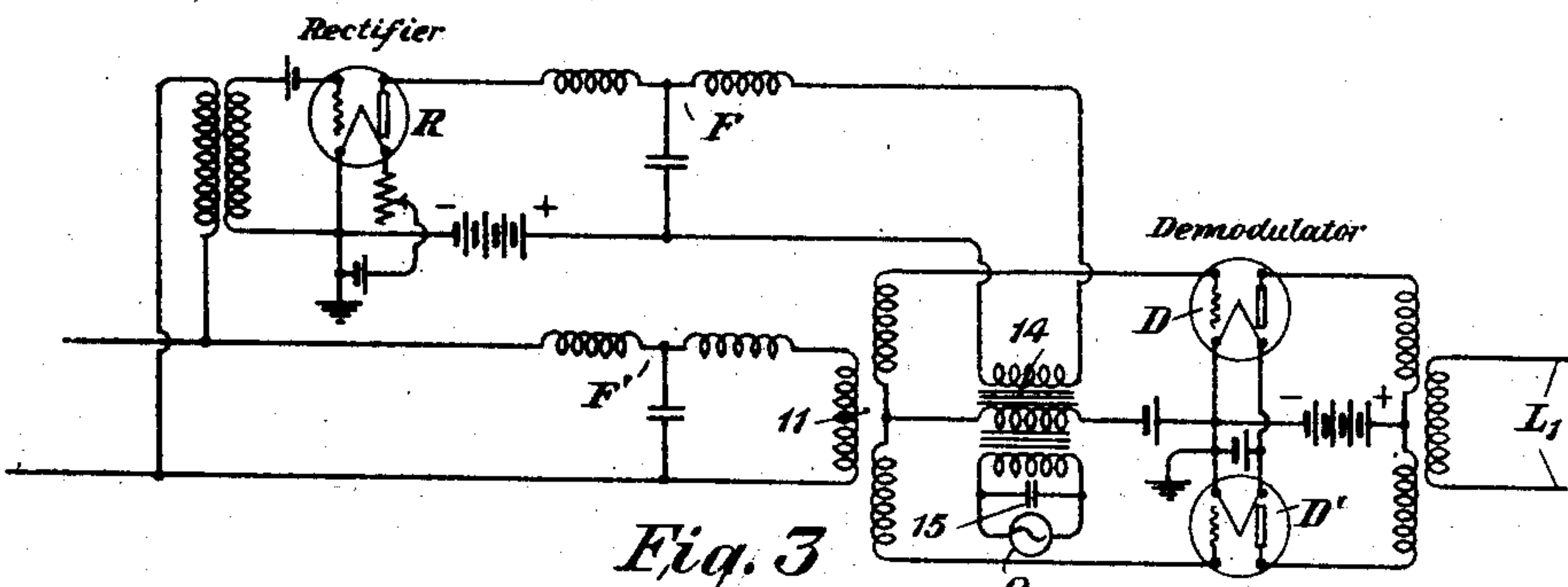


Fig. 3

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UNITED STATES PATENT OFFICE

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MEANS TO CONTROL CROSS TALK

Application filed June 26, 1928. Serial No. 288,467.

This invention relates to transmission circuits, and more particularly to arrangements for reducing cross-talk or interference upon such circuits.

5 In designing telephone transmission circuits with respect to cross-talk limitations, there are two factors to be taken into consideration,—first, the effect of cross-talk upon the intelligibility of the conversation while
10 talking is taking place, and, second, the absence of secrecy or the annoying effect of the cross-talk during gaps in the conversation. The latter factor determines the limiting condition, for the reason that the maximum cross-
15 talk current which would be permissible without rendering the conversation unintelligible will be greater than the maximum cross-talk which may be permitted without rendering such cross-talk understandable or
20 objectionable during gaps in the conversation.

It has heretofore been proposed to eliminate or reduce cross-talk or noise currents from external sources, during such intervals
25 as conversation is not taking place, by providing switching arrangements for normally disabling the circuit for transmission purposes, such disabling means being removed, however, under the control of voice currents
30 when conversation takes place.

It is proposed, in accordance with the present invention, to arrange the receiving apparatus of the carrier channels so that the receiving gain will be appreciably less at small
35 inputs than at normal speech loads. This results in the receiving apparatus discriminating against cross-talk during non-talking intervals, while permitting of proper transmission of the relatively large talking currents.

40 The invention may now be more fully understood from the following description, when read in connection with the accompanying drawings, in which Figures 1, 2 and 3 illustrate three forms of circuit arrangements
45 embodying the invention, and Figs. 1a and 2a are curves illustrating the operation of the circuits of Figs. 1 and 2, respectively.

Referring to Fig. 1, L designates the connection extending from the carrier receiving
50 apparatus of one channel of the carrier sys-

tem to the main line upon which the carrier channels are superposed. Included in the circuit L is a demodulator of the balanced type, comprising vacuum tubes D and D',
55 having their circuits connected in the usual push-pull arrangement and connected to the output circuit L₁. In the arrangement disclosed in Fig. 1, it is assumed that at the distant transmitting station the carrier is
60 suppressed and only the side band is transmitted. Consequently, an oscillator, comprising the vacuum tube O and its associated circuits, is connected to the common branch of the input of the demodulator through the
65 transformer 10. The oscillator supplies to the demodulator a frequency corresponding to the original carrier frequency, and the side band is applied to the modulator through the
input transformer 11.

The output signal impressed by the modu-
70 lator upon the circuit L₁ will be a function of the amplitudes of both the locally supplied carrier and the side band. Consequently, by controlling the amplitude of the oscillations
75 supplied to the demodulator, the output to the circuit L₁ may be controlled in any desired manner. In order to effect such control, some of the energy from the input circuit L is applied to a rectifier, comprising a
80 tube R having its grid poled sufficiently negative so that normally no space current flows, but when the signal is applied, a direct current will flow in the output circuit, said direct
current having an amplitude corresponding to the amplitude of the applied signal. The
85 positive pole of the plate battery of the tube R is connected to the grid of the oscillator O and to one terminal of resistance 12, and the filament of tube O is connected (through the
90 grid battery E_c) to the other terminal of resistance 12. The resistance 12 is connected as shown, with the result that when current flows in the plate circuit of the tube R, the
potential drop due to the flow of current through the resistance 12 will be applied to
95 the grid of the oscillator O. A normal potential of high negative value is applied to the grid of the oscillator O by means of the battery E_c, as indicated.

The operation of the circuit will be clear 100

from the curve of Fig. 1a, which is the characteristic curve of the oscillator O. As is well known, the oscillator will be most effective in generating oscillations when it is operating on the straight part of its characteristic between the lower knee and the upper bend of the curve. If no potential were applied to the grid, the tube would operate about the point in its characteristic designated *a*. At this point, the amplifying effect of the tube would be distorted due to the grid going positive during positive half waves of an applied signal current. For proper generation of oscillations, the grid should be biased further in a negative direction so as to operate somewhere in the neighborhood of point *c*, which is on the straight part of the characteristic.

Under normal conditions, therefore, with no signal transmitted to the circuit L, the grid of the oscillator O should be biased sufficiently negative to operate about the point *b*, so that a carrier or beating frequency of very small amplitude is applied to the demodulator. If a strong signal, such as the side band corresponding to a voice signal, should be transmitted to the circuit L, some of the energy would be rectified by the rectifier R, and a direct current would flow in the output circuit of the rectifier, thereby causing a drop through resistance 12. This drop will be in such a direction as to bias the grid less negative and thereby shift the operation of the oscillator to the straight part of its characteristic, so that oscillations of large amplitude will be generated and supplied to the demodulator. The signal entering the demodulator through the transformer 11 beats with the applied carrier to produce a voice frequency current in the circuit L₁ of large amplitude.

If, however, a side band corresponding to a small signal current, such, for example, as a noise or cross-talk current is transmitted to the circuit L, the rectified direct current in the output circuit of the tube R produces a very small drop through the resistance 12, so that the grid of the oscillator O is biased but very little less negative than indicated at the point *b* of Fig. 1a. Under these conditions, the oscillations supplied to the demodulator will be of very small amplitude, and hence the noise current produced in the circuit L₁ will be of very small amplitude. In other words, the system discriminates against noise and other weak currents, but it is very effective for the transmission of signal currents of normal amplitude.

It is, of course, undesirable that the current flowing through the resistance 12 should fluctuate at frequencies normally occurring in the audio frequency band, and consequently a filter F is provided in the output circuit of the rectifier R to suppress all alternating current components except those of

relatively low frequency, so that the fluctuations of current through the resistance 12 will correspond to the envelope of the applied wave, or, in other words, to the gradual change in amplitude of the signal with intensity of sound rather than with the change in amplitude corresponding to individual oscillations. The filter F also serves to prevent any possible modulation of the voice band with the carrier in the oscillator O. Since the presence of the filter F introduces a slight delay in the operation of changing the effectiveness of the demodulator, a corresponding filter F' may be provided between the circuit L and the input transformer 11 of the demodulator to correspondingly delay the application of the signal current to the remodulator, thus permitting the demodulator to be changed in effectiveness by the time the signal producing the change arrives.

It is obvious, of course, that the arrangement, as above described, will have the effect of discriminating against noise currents and cross-talk between idle intervals of speech transmission. Furthermore, by varying the adjustment, the degree of discrimination may be varied from an absolute suppression of weak noise currents corresponding to a normal operation of the oscillator O on the extreme lower part of the curve to any partial degree of suppression of the noise currents corresponding to a normal operation of the oscillator in that part of its characteristic curve between *a* and *c* of Fig. 1a. By varying the potential and poling of the normal C battery applied to the grid of the oscillator, the oscillator may be made to operate normally at any desired point on its characteristic, and, by properly choosing the value of the resistance 12 with respect to the plate impedance of the rectifier R, the bias of the grid of the oscillator may be shifted from its normal bias any desired amount, thereby determining the degree of discrimination as between a given weak current, such as a cross-talk current, and a given strong current, such as a normal voice current.

A modified arrangement is illustrated in Fig. 2, in which the discrimination is effected by adjusting the operation of the modulator itself. Here, the oscillations are supplied to the demodulator from the source O, as before, but in this instance, the rectifier R exercises no control over the amplitude of the oscillations. On the contrary, the rectifier is so connected that its output circuit controls the biasing of the grids of the demodulator tubes D and D'. The normal bias of the grids of the demodulator tubes may be determined by the usual C battery, as illustrated. A resistance 13 is, however, included in the common branch of the grid circuit, as shown, and the negative terminal of the B or plate battery of the rectifier R is connected to one terminal of the resistance 13, so that

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the rectified direct current passed through the filter F will flow to ground through the resistance 13. This produces a drop which may be utilized to change the biasing of the grids of the demodulator tubes and thereby

change their effectiveness as demodulators. This feature of the operation may be understood from the curve of Fig. 2a which represents the characteristic curve of one of the demodulator tubes. With no grid bias, the tube will operate on that portion of its characteristic indicated at *a*, which is, in the case illustrated, near the upper part of the curve. By applying a proper bias through the C battery, the demodulator tube may be made to operate on that part of its characteristic represented at *c*, which is near the lower knee curve. At either *a* or *c*, the tube will be effective as a demodulator, because it introduces a distorting effect and produces a large second power term. If the tube operates in the neighborhood of the point *b*, which is on the straight part of the characteristic, the tube acts simply as an amplifier and has little or no effect as a demodulator, as the second power terms are either very weak or are absent entirely.

Now, with the grid normally biased by means of the C battery to operate in the neighborhood of *b*, the effect of the demodulator is to produce very little or no demodulated current in the output circuit L_1 in response to weak signal bands corresponding to noise or cross-talk. The effect of the drop through the resistance 13 may be such as to bias the grid more negative, and hence when signal currents, such as voice currents of large amplitude, are received, the rectified current flowing in the output of the rectifier R and through the resistance 13 may produce a drop sufficient to shift the operating point of the demodulator tubes to the point *c* which is at the lower knee of the curve. Consequently, the demodulators will be acting at their points of greatest efficiency as demodulators, thereby producing strong signal currents in the output circuit L_1 .

Obviously, by so connecting the resistance 13 and the plate battery of the rectifier R as to produce a drop in opposition to the normal bias due to the C battery, the effect of signal currents may be to shift the operating point of the tube to the upper bend or knee of the curve, at which point, also, the demodulator tubes will be effective as demodulators. It will also be noted that in Fig. 2 the filters F and F' are provided for the same reasons as stated in connection with Fig. 1.

A slightly different method of exercising control is illustrated in Fig. 3. Here, the carrier frequency is supplied from the fixed oscillator O, as in the case of Fig. 2, but the connection to the grid circuit of the demodulator tubes is effected through an iron core transformer 14. The input circuit of this

iron core coil is tuned by means of the condenser 15, as shown, so that when it is tuned to the same frequency as that of the currents supplied by the oscillator O, the carrier wave applied to the modulator will be most effective. The iron core coil is provided with an additional winding which is in circuit with the output of the rectifier tube R.

Changes in the rectified current will alter the saturation of the iron core, thereby changing the inductance of the winding in circuit with the oscillator, and hence changing the tuning. The tuning may be so adjusted that with no received current supplied to the rectifier, the current flowing through the controlling coil of the winding 14 will be such as to detune the circuit leading to the oscillator with respect to the carrier frequency. So, also, for weak received currents, such as noise or cross-talk currents, the coil may be sufficiently detuned to render the demodulating tubes D and D' relatively ineffective, due to the small amplitude of the beating carrier frequency supplied. If, however, strong signals, such as voice signals, are received, the rectified current will change the inductance so that the coil 14 will be substantially in tune with the frequency of the supplied carrier current, thereby producing maximum detected current in the output circuit L_1 .

In all the above arrangements, the control circuit is represented as being bridged across the input to the receiving device upon which the control is exercised. It should be understood that the control circuit may alternatively be connected to the output of the receiving device, and that certain advantages may result from so doing. It is essential in this case that the control circuit shall be relatively incapable of transmitting the frequencies normally transmitted by the signal receiving circuit, and vice versa, in order to avoid singing.

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 transmission system, a circuit to transmit carrier currents modulated in accordance with speech signals, a demodulating arrangement associated with said circuit, means to render said demodulating arrangement normally substantially ineffective to produce demodulated currents corresponding to signals of small volume, means to produce a direct current whose amplitude is determined by the amplitude of the received modulated currents, and means controlled by said direct current to control the effectiveness of said demodulating arrangement to produce demodulated currents in accordance with the amplitude of said direct current,

whereby the effectiveness of said demodulating arrangement to produce demodulated currents will be substantially less in response to induced cross-talk and other interfering currents than in response to carrier currents modulated by normal voice signals.

2. In a transmission system, a circuit to transmit carrier currents modulated in accordance with speech signals, a demodulating arrangement associated with said circuit, means to render said demodulating arrangement normally substantially ineffective to produce demodulated currents corresponding to signals of small volume, a rectifier associated with said circuit to rectify a portion of the modulated carrier energy received from the circuit and thereby produce a direct current whose amplitude is determined by that of the received modulated currents, and means controlled by said direct current to control the effectiveness of said demodulating arrangement to produce demodulated currents in accordance with the amplitude of said direct current, whereby the effectiveness of said demodulating arrangement to produce demodulated currents will be substantially less in response to induced cross-talk and other interfering currents than in response to carrier currents modulated by normal voice signals.

3. In a transmission system, a circuit to transmit carrier currents modulated in accordance with speech signals, a demodulating arrangement associated with said circuit, means to render said demodulating arrangement normally substantially ineffective to produce demodulated currents corresponding to signals of small volume, means to produce a direct current whose amplitude is determined by the amplitude of the received modulated currents, means to supply a carrier current to said demodulating arrangement, and means controlled by said direct current to control the amount of carrier current supplied to said demodulating arrangement in accordance with the amplitude of said direct current, whereby the effectiveness of said demodulating arrangement to produce demodulated currents will be substantially less in response to induced cross-talk and other interfering currents than in response to carrier currents modulated by normal voice signals.

4. In a transmission system, a circuit to transmit carrier currents modulated in accordance with speech signals, a demodulating arrangement associated with said circuit, means to render said demodulating arrangement normally substantially ineffective to produce demodulated currents corresponding to signals of small volume, a rectifier associated with said circuit to rectify a portion of the modulated carrier energy received from the circuit and thereby produce a direct current whose amplitude is determined by

that of the received modulated currents, means to supply a carrier current to said demodulating arrangement, and means controlled by said direct current to control the amount of carrier current supplied to said demodulating arrangement in accordance with the amplitude of said direct current, whereby the effectiveness of said demodulating arrangement to produce demodulated currents will be substantially less in response to induced cross-talk and other interfering currents than in response to carrier currents modulated by normal voice signals.

5. In a system for discriminating between currents of different amplitudes, a space discharge transmission device having a control electrode associated with a source of signals to be transmitted therethrough, a source of biasing potential for said electrode for preventing the transmission of currents small in comparison with said signal currents and means for varying said biasing potential in accordance with the current transmitted through said device to make it readily transmit currents of signals magnitude.

6. The combination in a transmission system of a line for the transmission of signals, and means for the suppression of disturbing currents therein comprising an element normally opaque to currents of cross-talk amplitude but having means dependent upon the current transmitted through said element for rendering the gain thereof high for currents of signal amplitude.

7. The combination in a transmission system of a line for the transmission of signals, means for the suppression of disturbing currents therein comprising an element normally opaque to currents of cross-talk amplitude and means for rectifying a portion of the energy transmitted through said element and utilizing it for rendering the gain of said element high for currents of signal amplitude.

8. The combination in a transmission system of a line for the transmission of signals and means for the suppression of disturbing currents therein comprising a space discharge translating device therein having a control element, means for impressing a voltage upon said control element of value sufficient to prevent transmission therethrough of currents of cross-talk amplitude, and other means for reducing the effect of said voltage in response to increase of the currents transmitted through said translating device to permit readily the transmission of currents of signal amplitude.

9. The combination in a transmission system of a line for the transmission of signals and means for the suppression of disturbing currents therein comprising a space discharge translating device therein having an input circuit and an output circuit, means comprising a source of potential in said input circuit for rendering said device opaque to cur-

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rents of cross-talk amplitude, a resistance in
said input circuit, means for rectifying a
portion of current from said output circuit
and transmitting it through said resistance
5 to produce a potential to oppose said other
source of potential rendering said translating
device readily capable of transmitting cur-
rents of signal amplitude.

10 In testimony whereof we have signed our
names to this specification this 21st day of
June 1928.

HERMAN A. AFFEL.
ALLEN CARPE.

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