

Jan. 16, 1934.

J. HERMAN

1,943,478

TRANSMISSION LEVEL CONTROL IN TELEGRAPH SIGNALING SYSTEMS

Filed Aug. 23, 1930

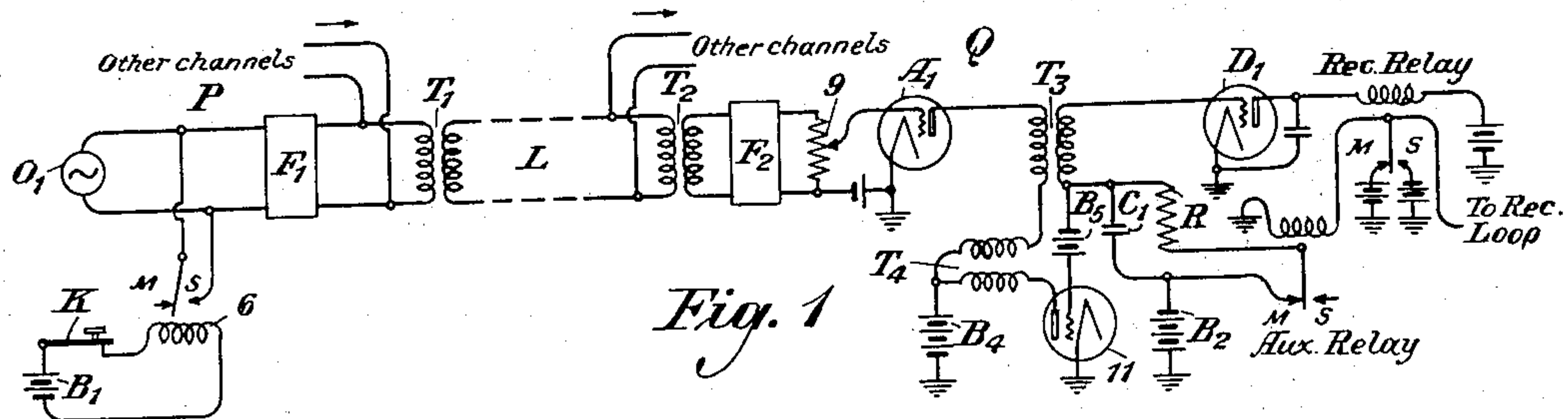


Fig. 1

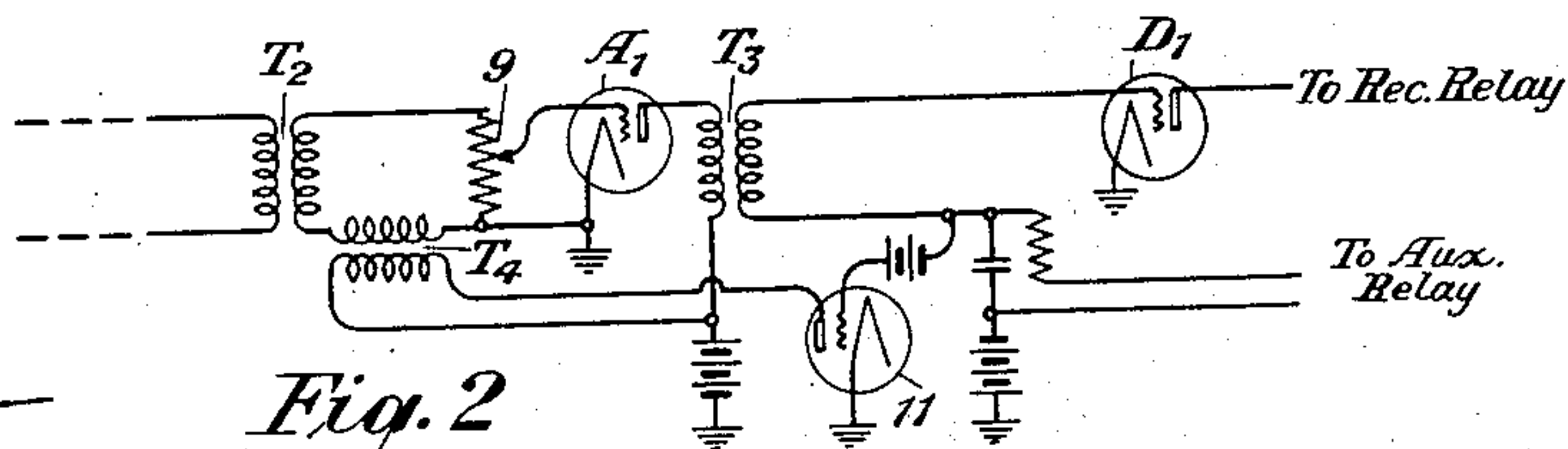


Fig. 2

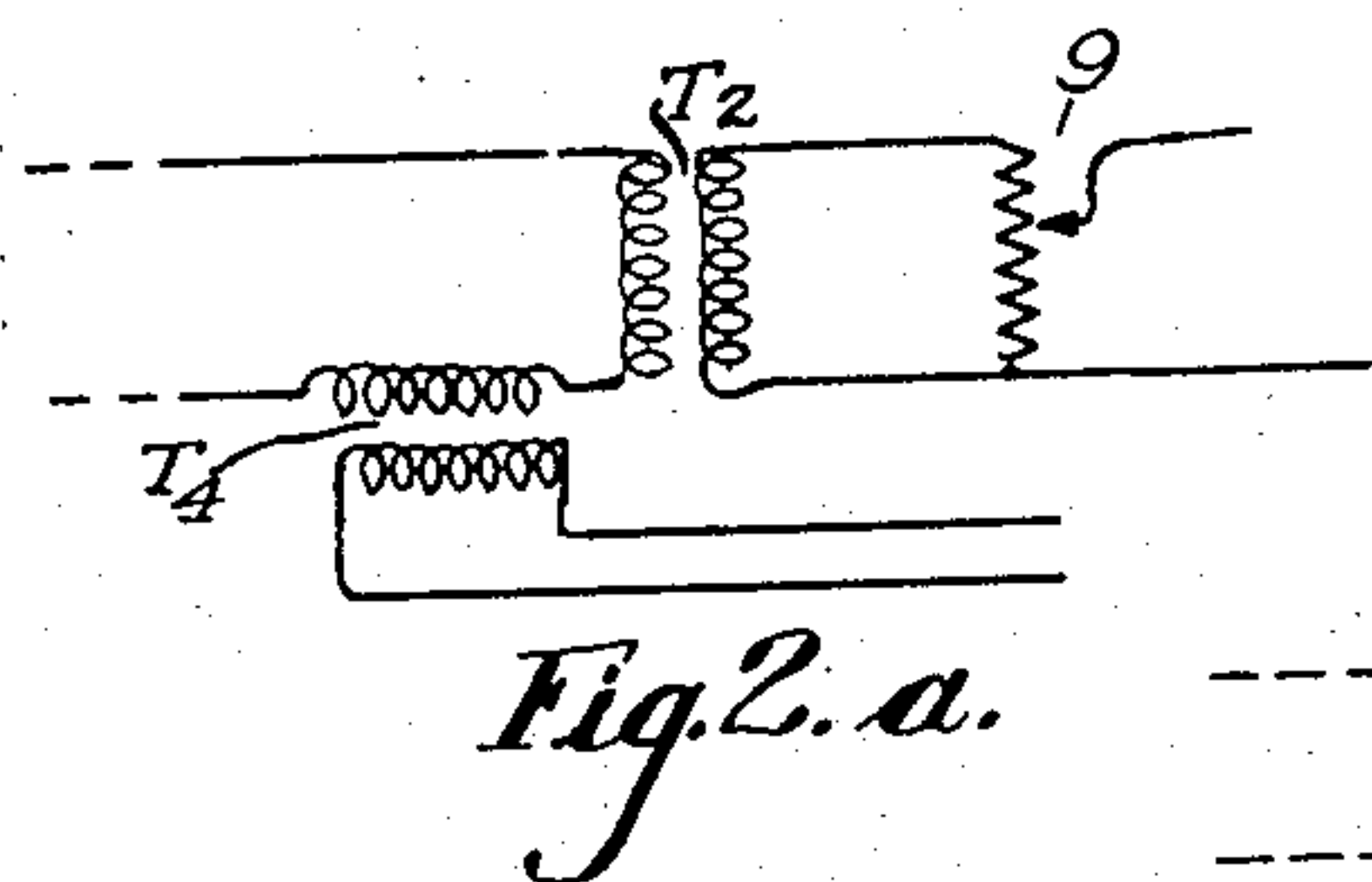


Fig. 2.a.

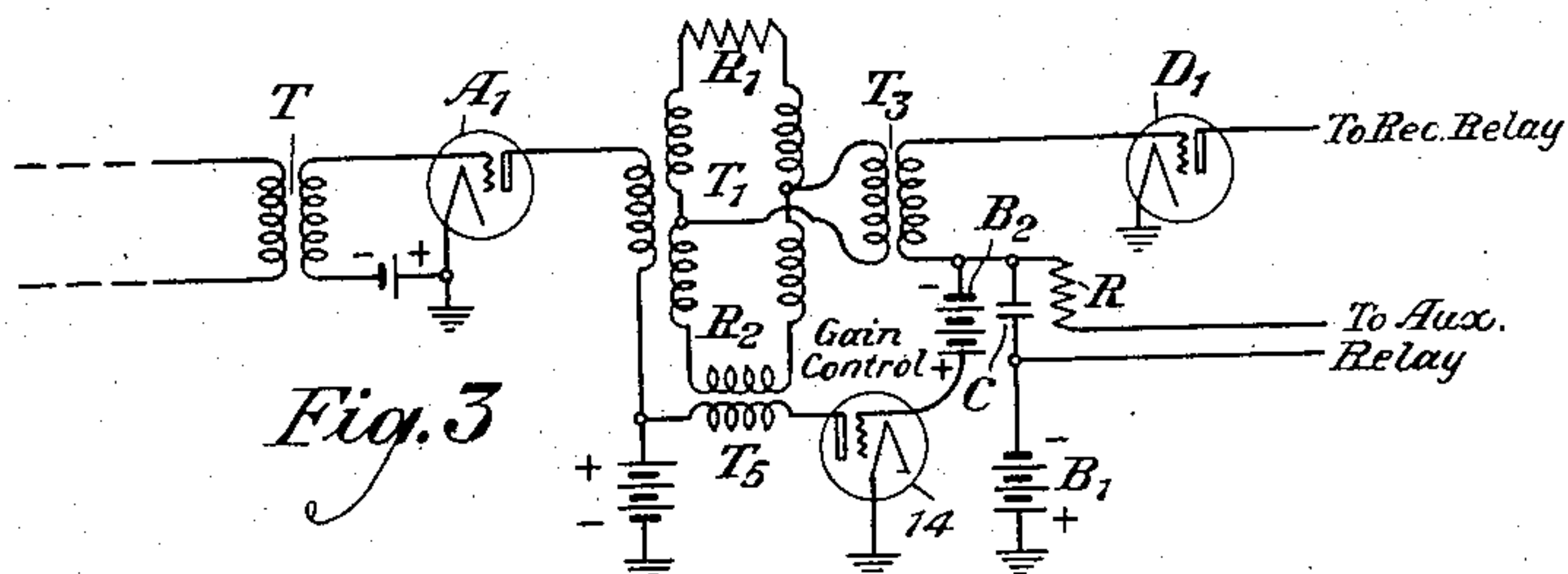


Fig. 3

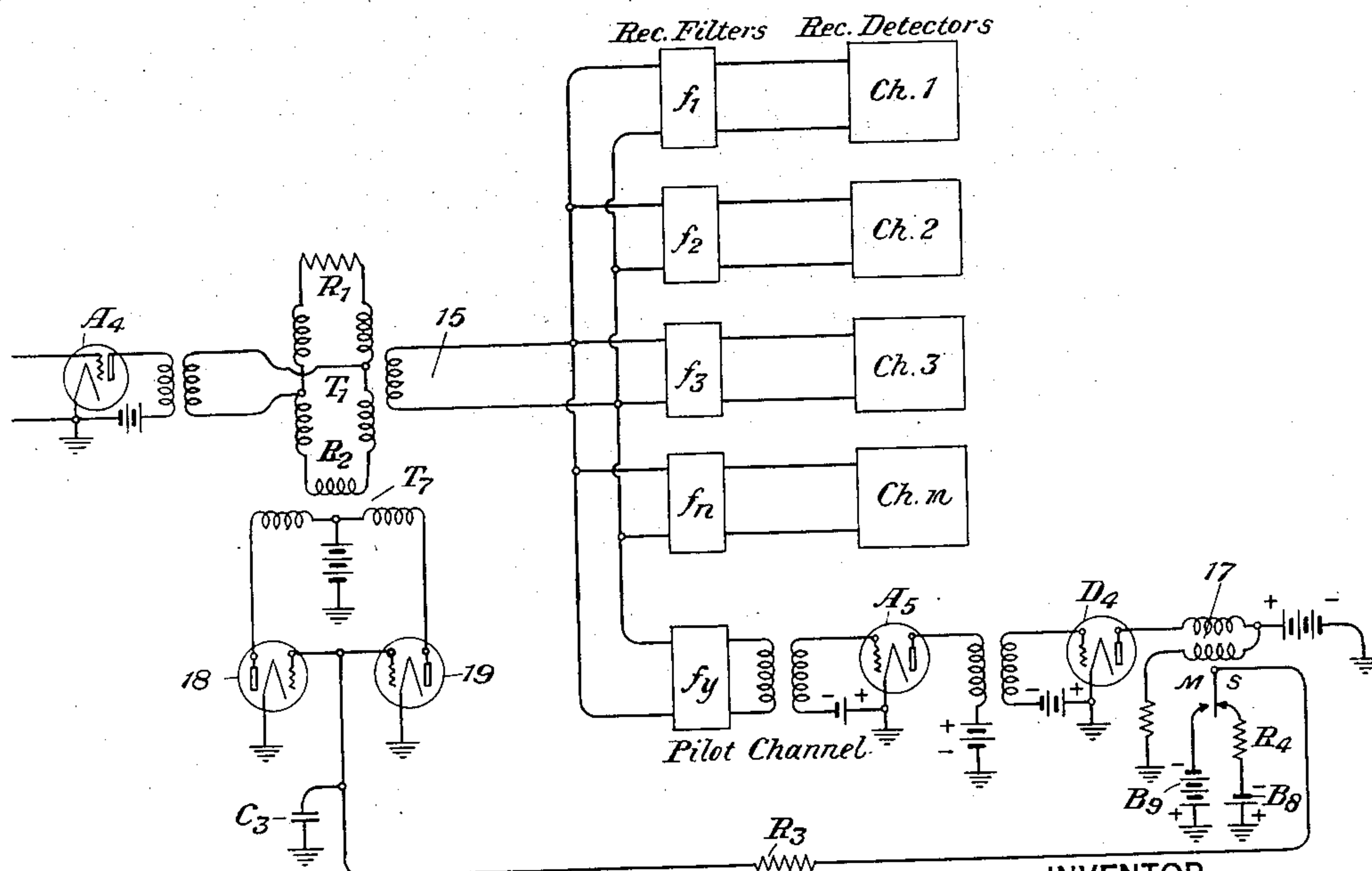


Fig. 4

INVENTOR
J. Herman
BY
ATTORNEY

UNITED STATES PATENT OFFICE

1,943,478

TRANSMISSION LEVEL CONTROL IN
TELEGRAPH SIGNALING SYSTEMSJoseph Herman, Westfield, N. J., assignor to
American Telephone and Telegraph Company,
a corporation of New York

Application August 23, 1930. Serial No. 477,366

8 Claims. (Cl. 178—44)

This invention relates to transmission level control in telegraph signaling systems, and more particularly in those systems in which signaling is carried on by a carrier frequency wave. It has for its object that of reducing the effects in the receiving apparatus of changes in transmission level, such changes being primarily due to changes in transmission level of the transmission line but also arising from other causes in any portion of the apparatus at the transmitting station or the receiving station.

I accomplish this purpose in a number of ways but essentially by controlling the impedance of one or more vacuum tubes in accordance with the intensity of received signals and transferring this varied impedance to a circuit which thus has its output modified in such a direction as to give a substantially constant signal intensity at the final receiving apparatus.

The invention will be better understood by reference to the following specification and the accompanying drawing in which Figure 1 is a diagrammatic sketch of a carrier frequency signaling system incorporating one form of my invention; Fig. 2 is a modification of the circuit of Fig. 1; Fig. 2a shows a modification of one feature of Fig. 2; Fig. 3 is a still further modification as applied to one signaling channel; and Fig. 4 is a further modification in which use is made of a pilot channel to control the gain for a plurality of signaling channels.

Referring more particularly to Fig. 1, there is shown at a transmitting station P an oscillator O_1 which is normally sending out to the line a carrier wave of a definite frequency. A local circuit containing a key K, a battery B_1 and a relay 6 controls this signal by placing a short circuit across the oscillator or removing such short circuit, by moving the relay armature from marking to spacing position, and the reverse. The signals are impressed on the transmission line L through a transformer T_1 . Other channels may be associated in parallel to impress their respective carrier waves on the line, each of the transmitting oscillator circuits being rendered independent by means of filters, such as F_1 . At the receiving station Q a signal wave from O_1 may be separated from other channels by means of a transformer T_2 and a filter F_2 . It is then impressed on the amplifier A_1 , the output thereof passing through transformer T_3 to a detector D_1 . The output of this detector may go directly to a telegraph sounder or may in turn control a receiving loop, as shown in the figure.

In order to reduce changes in telegraph bias

due to changes in received current, I have found it desirable to place in series in the grid circuit of the detector a resistance R, and in parallel thereto a condenser C_1 . A negative grid battery B_2 is also supplied, and finally an auxiliary relay circuit for opening the branch containing the resistance R when no signaling current is arriving. This particular combination of elements with its utility, is described in my copending application Serial No. 477,365, filed August 23, 1930, and as explained therein, gives a controlled negative voltage to the grid of the detector tube which is highly effective in reducing changes in telegraph bias.

In addition, however, to such control of the detector grid voltage, I find it desirable to provide means for changing the transmission level at the input to the detector in order to further increase the effectiveness of the arrangement. This may be done manually by altering the gain of the amplifier A_1 through the potentiometer 9, but I find it desirable to have an automatic control of this gain. I accomplish this by automatically changing the impedance of the output circuit of amplifier A_1 in accordance with the potential of the grid of the detector, this potential in turn being controlled by the intensity of the incoming signal. To this end I have shown in Fig. 1 a thermionic vacuum tube 11 in the output of which there is included the primary of a transformer T_4 , the secondary of said transformer being in series in the output of the amplifier A_1 . The plate circuits of both amplifier A_1 and vacuum tube 11 are supplied with battery from B_4 . The apparent impedance of the secondary of the transformer T_4 as seen from the output of amplifier A_1 will be determined by the impedance of the vacuum tube 11 so that, in effect, the impedance of this tube is transferred to the output circuit of the amplifier A_1 . Any alteration in the impedance of this tube 11 will correspondingly change the impedance of the amplifier A_1 . If the transmission level of the line rises, then the increased intensity of signals passing to the detector D_1 will increase the negative bias of the grid of said detector, as explained in my copending application referred to above. This increase in negative bias will also be transferred to the grid of tube 11, thus increasing its plate impedance and in turn reducing the gain of the amplifier A_1 . In view of the rather large negative bias of the detector, I find it desirable to introduce into the grid circuit of the tube 11 a battery B_5 so poled as to decrease the negative bias of

this tube and thus bring its plate impedance to a more appropriate value.

While in Fig. 1 I have shown the variable impedance of the tube 11 as being transferred to the output circuit of amplifier A₁, it should be apparent that this variable impedance might be introduced in a number of other places with equal effectiveness for controlling the intensity of the received signals. Thus, in Fig. 2 I have shown the transformer T₄ placed in the input circuit of amplifier A₁ where it functions in a similar manner. It is also apparent that instead of introducing it immediately in the input circuit of the amplifier in series with the secondary of the transformer T₂, it might have been placed in series with the primary of said transformer, as shown in Fig. 2a, thus introducing into the line itself a greater or smaller loss, depending upon the transmission level of the line proper.

Another modification of my invention is shown in Fig. 3. In this case I have introduced between the amplifier A₁ and the detector D₁ a hybrid coil of well-known structure, the input terminals of which are connected in the plate circuit of amplifier A₁ and the output terminals of which are connected to the primary of transformer T₃. As commonly used in many places, this hybrid coil would have impedances R₁ and R₂ associated with it and of equal values to give a so-called balanced hybrid coil. In that event, impulses impressed on the input terminals produce no effect at the output terminals. In this circuit, however, the hybrid coil circuit is not balanced, but there is a certain amount of unbalance between the two sides R₁ and R₂ and of a magnitude to transmit to the transformer T₃ telegraph signals of appropriate intensity. If, now, the amount of unbalance of this hybrid coil is modified, there will be a change in efficiency of this circuit for passing signals through to the transformer T₃. Such unbalance might be changed by hand to suit the periodic changes in transmission level of the line as a whole, but in this invention I accomplish the control automatically by means of a variable impedance which in turn is controlled by the intensity of the incoming signals. Thus, in Fig. 3 there is shown on the one side of the hybrid coil a fixed impedance R₁, preferably a resistance, and on the other side an impedance R₂, which is the impedance of a vacuum tube 14 transferred to the hybrid coil circuit by means of transformer T₅, all in a manner similar to that described in the transfer of the impedance of the tube 11 to the output circuit of amplifier A₁. In other respects the circuit of Fig. 3 is the same as that described in connection with Fig. 1. It will be apparent that if the transmission level of the line rises, the signals coming through to the detector will be of greater intensity. This will gradually bring about a larger negative bias of the detector D₁, which negative bias will also be transferred to the grid of tube 14, increasing its impedance. This increase in impedance of tube 14 will cause a corresponding increase of impedance R₂ as seen from the hybrid coil and this in such a direction that it reduces the amount of unbalance and thus decreases the intensity of the signals passed through to transformer T₃.

In each of the above modifications the control has been for each individual signaling channel. It may, however, be desirable to control the gain for all the channels simultaneously. Such an arrangement is shown in Fig. 4 in which one transmission channel is set aside as a pilot channel. In that figure the transmission line is con-

nected directly to the input terminals of a hybrid coil or passes first through an amplifier A₄. The output terminals 15 then lead to the various receiving circuits, one for each transmission channel, the various receiving circuits being electrically separated by means of filters f_1 , f_2 , etc. On one channel, however, corresponding to a definite carrier frequency, no signals are impressed but that channel is used for pilot purposes only. As shown in the figure, the filter f_y separates the frequency corresponding to the pilot channel. Thereupon it may be passed through an amplifier A₅ and then impressed on a detector D₄, the output circuit of which contains a relay 17. The hybrid coil has on its two sides, respectively, the impedances R₁ and R₂, the first of these being a fixed resistance and the second being the variable impedance of one or more vacuum tubes transferred by a transformer T₇ to the hybrid coil and thus constituting the impedance R₂. Normally R₁ and R₂ are of such different values that the amount of unbalance permits signals of desired intensity to pass through to the terminals 15. The unbalance, however, is controlled by changing the grid potential of the one or more vacuum tubes 18 and 19. More specifically, this is accomplished in the following manner.

The relay 17 in its spacing position impresses on the grids of the tubes 18 and 19 the negative voltage due to battery B₈ and in marking position impresses the voltage of battery B₉. If, now, the transmission level of the line is comparatively low, the detected output of D₄ is such that relay 17 is on spacing position, whereupon a negative voltage of comparatively small value is impressed on the grids of the two tubes 18 and 19. The impedances R₁ and R₂ are so adjusted that this results in a large unbalance of the hybrid coil. If, now, the transmission level of the line rises, the relay will move to marking position and impress on the grids of the tubes 18 and 19 a relatively large potential from battery B₉. The corresponding increase of impedance of 18 and 19 will be transferred to the hybrid coil, reducing the amount of unbalance and thus reducing the intensity of signals coming through. The relay 17 may be of any appropriate form but might very well take the form of a voltmeter relay, and normally the contacting device would be at some intermediate position and only when the transmission level of the line changes substantially in the one direction or the other will the pointer of the voltmeter move to make contact at the one side or the other. In order to remove sudden fluctuations of the grid potential of tubes 18 and 19, it will be desirable to have a resistance such as R₃ connected in circuit. For a similar purpose condenser C₃ is connected from the grids to ground, this condenser acting as a reservoir to maintain potential on the grids for a longer period while the contact of relay 17 may be at an intermediate or floating position. Finally, additional resistances, such as R₄, of a suitable value, may be introduced to reduce the suddenness with which the voltage of any battery, such as B₈, shall make itself effective on the grids of 18 and 19, all for the purpose of causing the variable impedance to change at a comparatively slow rate only.

These various modifications have been described as being alternative methods for accomplishing a definite result and this is as intended, but it should also be appreciated that they may be used to supplement each other. Thus, the

pilot channel method of Fig. 4 may be used to compensate for the chief changes in transmission level of the transmission line, but in addition there may be associated with each one of the individual channels of Fig. 4 further control or compensation of the form shown in Figs. 1, 2 and 3, and in addition, there may or may not be associated with each one of these circuits the bias control due to condenser C_1 , R and auxiliary relay, as mentioned in connection with Fig. 1 and as described more fully in my copending application to which reference has been made.

While this invention has been described particularly in connection with carrier frequency telegraphy, it is to be understood that the methods of level control described will apply equally well in many other systems of communication, such, for example, as so-called d. c. telegraphy, or for numerous telephone circuits.

What is claimed is:

1. In a carrier current signaling system, a transmission line equipped for signaling on a plurality of transmission channels, a receiving station therefor comprising a detector for detecting the carrier frequency wave on one channel, an unbalanced hybrid coil associated with the line and transmitting signal impulses of amplitude proportional to its unbalance, and means for changing the unbalance as the transmission level of the line changes to reduce changes in the level of the received signals, said means being controlled by the slowly changing bias of the detector grid due to change in transmission level.

2. In a carrier current signaling system, a transmission line, a receiving station associated therewith comprising an amplifier and a detector in tandem in the direct transmission channel, a vacuum tube whose impedance is controlled by the biasing grid potential of the detector, and a transformer for transferring the controlled impedance into the circuit of the amplifier.

3. In a carrier current signaling system, a transmission line, a receiving station associated therewith comprising an amplifier and a detector in tandem, a vacuum tube the plate circuit of which is associated with the circuit of the amplifier whereby the gain of the amplifier is varied in accordance with the impedance of the vacuum tube, means for giving the grid of the

detector a potential depending upon the intensity of the incoming signal, and a conductive connection from the grid circuit of the detector to the grid circuit of the vacuum tube whereby the impedance of the vacuum tube is changed in accordance with changes in the grid potential of the detector.

4. In a carrier current signaling system, a transmission line, a receiving station comprising two three-electrode vacuum tubes in tandem, and means associated with the tubes for controlling the output impedance of the first tube in accordance with the biasing grid potential of the second tube.

5. In a carrier current signaling system, a transmission line, a receiving station comprising an amplifier and a detector in tandem, and means associated with the amplifier and the detector for controlling the output impedance of the amplifier in accordance with the biasing grid potential of the detector.

6. In a carrier current signaling system, two vacuum tubes in tandem, a variable impedance the magnitude of which is controlled by the bias condition of the input circuit of the second vacuum tube, and means for introducing this impedance into the output circuit of the first tube.

7. In a carrier current signaling system, a transmission line equipped for signaling on a plurality of transmission channels, a receiving station therefor comprising a detector for detecting the carrier current on one channel, and means preceding the detector to reduce the effect of changes in transmission level of said channel, said means controlled by the slowly changing bias of the detector grid due to change in transmission level.

8. In a carrier current signaling system, a transmission line equipped for signaling on a plurality of transmission channels, a receiving station therefor comprising a detector for detecting the carrier frequency wave on one channel, and an electrical circuit in series with the line and preceding the detector to reduce the effect of changes in the transmission level of said channel, said circuit being controlled by the slowly changing bias of the detector grid due to change in transmission level.

JOSEPH HERMAN.