Nov. 3, 1931. J. HERMAN 1,829,830

PILOT CHANNEL FOR TELEGRAPH SYSTEMS

Filed Feb. 25, 1930

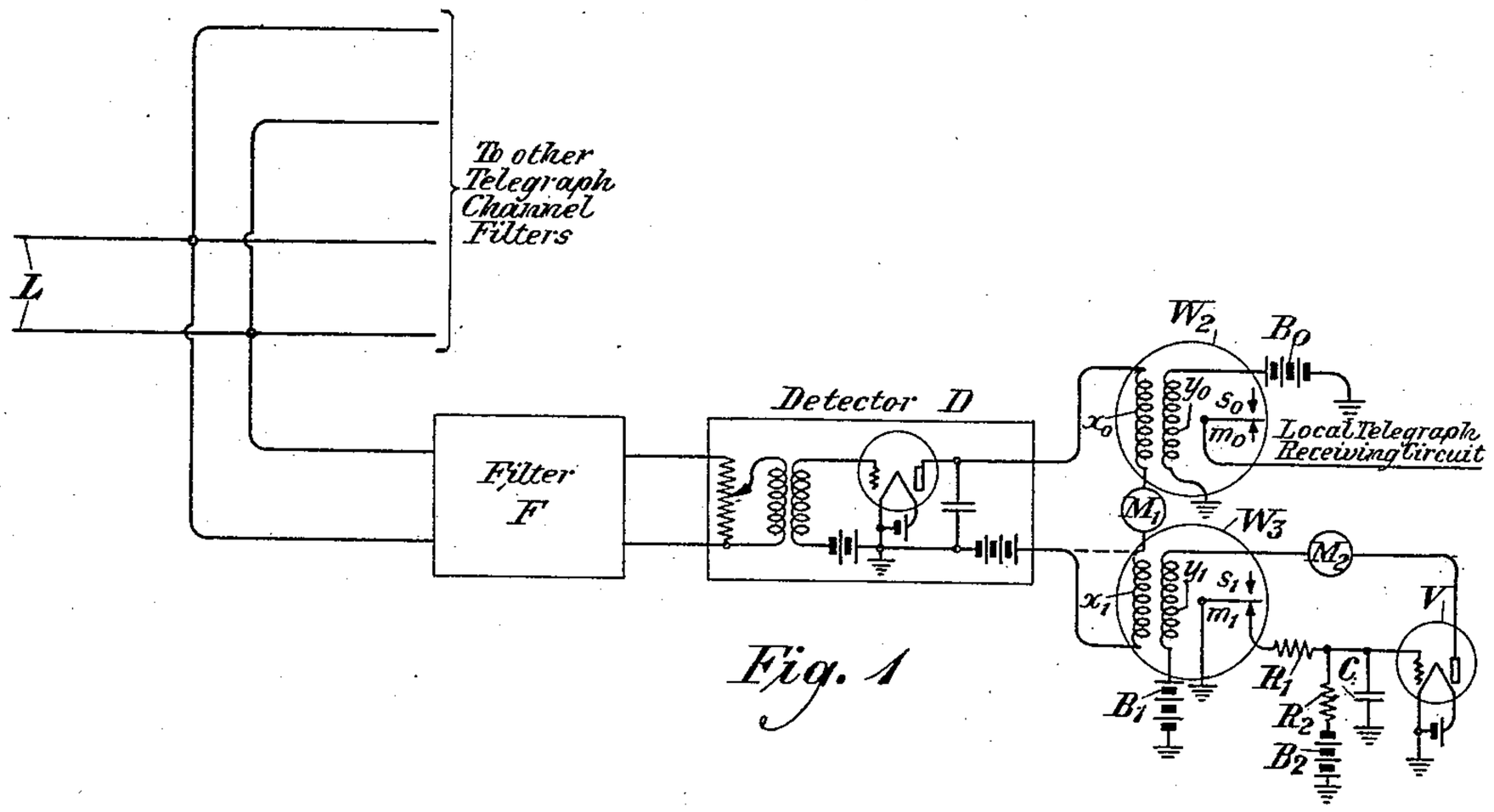

Fig. 1

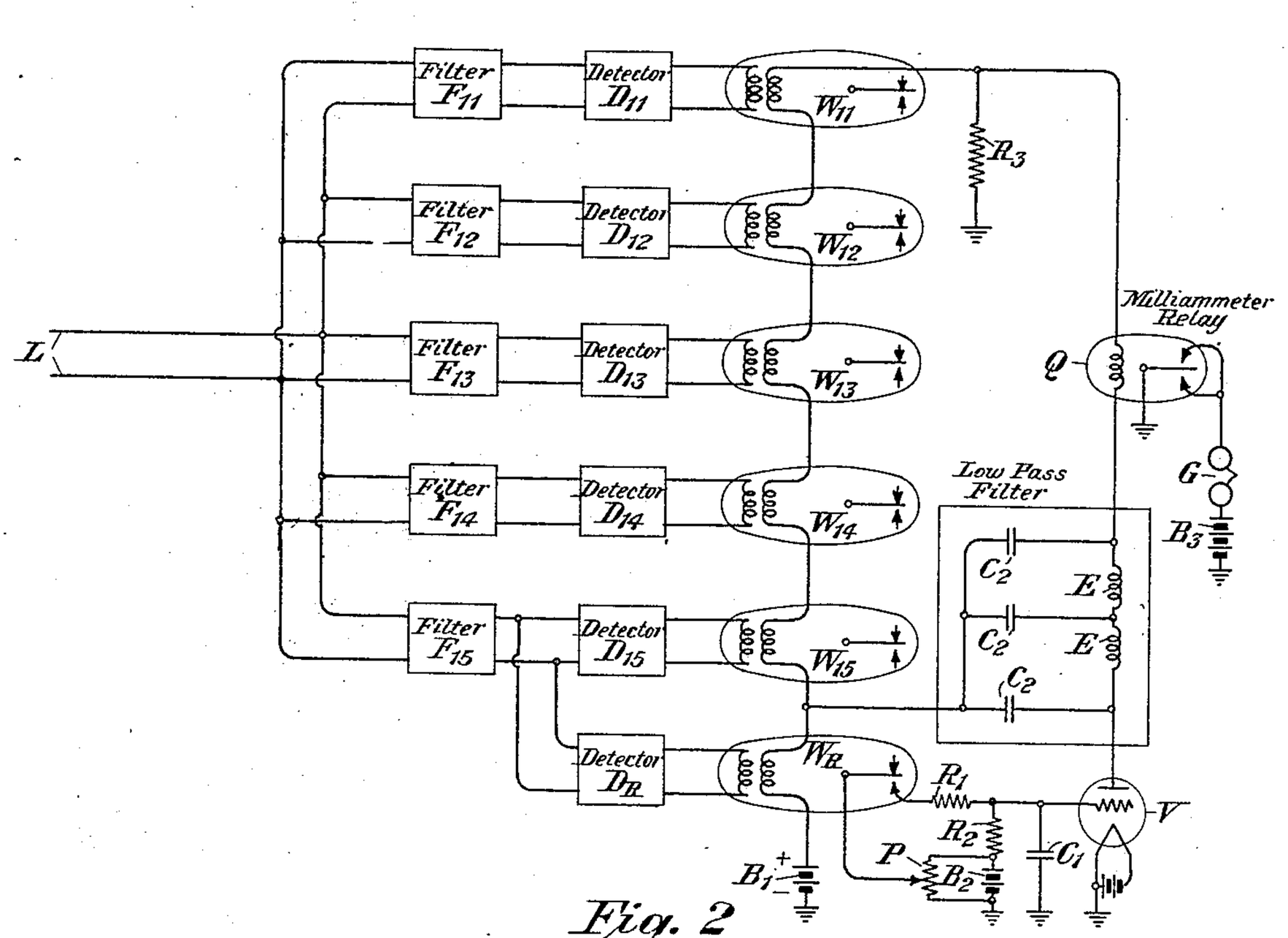

Fig. 2

INVENTOR
J. Herman

BY

ATTORNEY

Patented Nov. 3, 1931 1,829,830

UNITED STATES PATENT OFFICE

JOSEPH HERMAN, OF WESTFIELD, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

PILOT CHANNEL FOR TELEGRAPH SYSTEMS

Application filed February 25, 1930. Serial No. 431,192.

This invention relates generally to telegraph systems, and more particularly to telegraph systems which employ carrier waves for the transmission of signals. Still more particularly, this invention relates to arrangements for providing a pilot channel in a carrier telegraph system suitable for determining the magnitude of the current transmitted to the receiving relay of the system.

In certain arrangements of carrier telegraph circuits, particularly those of the open wire type, it is desirable to provide a pilot channel in order to observe and correct for frequent variations in the transmission equivalent of the circuit. It has been the practice in the past either to establish a separate channel for this purpose or to interrupt the transmission of signals on a working channel for a brief interval whenever it was desired to observe the transmission equivalent of the circuit. Both of these practices have certain disadvantages, the former being uneconomical and the latter interfering with the normal operation of the circuit. This invention relates to arrangements for overcoming these disadvantages so that one or more suitable pilot channels may be obtained by simple additions to the receiving apparatus of the working channels.

This invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawings in which Figure 1 represents an arrangement for obtaining a pilot channel in a carrier telegraph system, and Fig. 2 shows an arrangement for preventing bias of the telegraph signals transmitted by the system which would result from changes in the transmission equivalent of the circuit.

In Fig. 1 of the drawings, line L is one which is employed for the transmission of a plurality of currents of different frequencies, each of which is interrupted in accordance with signals. One of the channels connected with the line L is shown in some detail, and this includes the usual receiving filter F, which may be of the band-pass type, and a detector D. The detector may include a three-element vacuum tube, the grid electrode of which may be connected to the filament electrode through the secondary winding of a transformer, and a battery for suitably biasing that grid electrode with respect to the filament electrode, as shown. The primary of this transformer may be connected to the filter through a potentiometer for the purpose of controlling the input voltage to the detector. The plate electrode of the tube included in the detector may be connected to the filament electrode through a condenser, which is employed for the purpose of bypassing such alternating currents as may become super-imposed upon the direct current resulting from rectification. This plate electrode is also connected to the filament electrode through the winding x_0 of a relay W_2, a meter M_1, the winding x_1 of a relay W_3 and a battery, this battery being employed for the purpose of providing proper positive potential for the plate electrode.

The relay W_2 represents the usual form of polar receiving relay which is biased by means of a current flowing continually through its winding y_0 from a battery B_0. When no current is present in the winding x_0, then the flux produced by the winding y_0 will be sufficient to cause the armature of this relay to move to its spacing contact s_0 and remain closed against that spacing contact. The fixed terminal of the armature of relay W_2 may be connected to a local telegraph receiving circuit, and when the armature of this relay is closed against contact s_0, the positive terminal of a battery (not shown) may be connected to the receiving circuit. When the key at the distant station becomes closed, a substantial current will flow through the winding x_0 and the magnetic field produced

by the winding x_0 will then be greater than that produced by the winding y_0, causing the armature of the relay W_2 to close its contact m_0. In that event the negative terminal of a battery may be connected to the local telegraph receiving circuit. If the windings x_0 and y_0 have the same number of turns, and if the armature of the relay W_2 is mechanically unbiased, then it is the practice in the art to arrange the circuit so that twice as much current will flow through winding x_0 as flows through winding y_0, when the key at the distant station is closed. The dotted line shows how the lower terminal of the winding x_0 may be connected to the positive side of the battery used in the detector D for the purpose of receiving signals without the aid of a pilot channel.

The winding x_1 of an additional polar relay W_3 is in series with the winding x_0 of the relay W_2, and the plate current of the tube of the detector D flows equally through both of these windings. The winding y_1 of relay W_3 is connected in the plate circuit of a vacuum tube designated V, this plate circuit including battery B_1, winding y_1, a meter M_2, the plate and filament electrodes of tube V and ground. Winding y_0 is so arranged that the current flowing in the plate circuit of the tube V will cause it to produce a magnetic effect upon the armature of the relay W_3 which opposes the magnetic effect produced by the winding x_1, when current flows in the plate circuit of the tube of the detector D. The armature and marking contact m_1 of the relay W_3 are employed for the purpose of controlling the potential of the grid electrode of the vacuum tube V in a manner which will be described in greater detail hereinafter.

When the telegraph key at the distant sending station corresponding to the channel under consideration is held in its closed position, a substantially steady current will flow through the plate circuit of the tube forming detector D and this current may be read on the meter M_1. When the telegraph key at the distant station is so held, the value of the current flowing through meter M_1 may be changed to any desired extent by the adjustment of the potentiometer shown associated with the detector D. When the telegraph key is being operated for the transmission of signals, the meter M_1 will no longer indicate the actual value of the current in the plate circuit of the tube forming detector D, but the pointer of this meter will follow the signals and it will tend to give an intergraded reading of the current impulses in the circuit.

One of the principal features of this invention lies in the provision of the meter M_2 for the purpose of indicating the maximum value of the current in the plate circuit of the tube of the detector D, even when telegraph signals are being transmitted. If the telegraph key at the distant station is kept closed, the current in the plate circuit of the tube V above described, which includes the winding y_1, will be less than the steady current in the plate circuit of the detector tube which flows through winding x_1, and therefore the armature of the relay W_3 will be operated so as to close the marking contact m_1. In that event ground will be connected to the grid electrode of the tube V through the armature and marking contact m_1 of relay W_3 and a resistance R_1, which may have a value of, for example, 100,000 ohms. Before the closure of contact m_1 a condenser C, which may have a capacity of about 4 microfarads, was charged to a negative potential by a battery B_2 through a resistance R_2, which may have a value of, for example, 2 megohms. But upon the closure of contact m_1 the condenser C becomes gradually discharged through resistance R_1, the armature and contacts m_1 of relay W_3 and ground.

When the condenser C is charged to the full voltage of battery B_2, it will so bias the grid electrode of the vacuum tube V with respect to the filament electrode that practically no current will flow in the plate circuit of the vacuum tube B. But upon reduction of the charge upon condenser C, the grid electrode will become less negatively biased and substantially greater current will flow in the plate circuit of the vacuum tube V. Upon the closure of the contact m_1 of the relay W_3 the condenser C does become discharged, and hence the flow of current from the battery B_1 in the plate circuit of the vacuum tube V will increase and will continue to increase, while the contact m_1 remains closed, until the magnetic effect of winding y_1 becomes sufficient to overcome the corresponding effect produced by the winding x_1. The armature of the relay W_3 will then move to the s_1 contact. As soon as this occurs, the discharging circuit of condenser C, which includes the resistance R_1, will be opened and the battery B_2 will further increase the charge on condenser C through resistance R_2. As the condenser C becomes charged to a greater negative voltage, less current will flow through winding y_1 of relay W_3 and the current in winding y_1 will decrease and continue to decrease until the magnetic effect produced by winding y_1 becomes less than that produced by winding x_1. The armature of relay W_3 will then again operate so as to close contact m_1 in order to decrease the charge of condenser C. This process will be repeated and the armature of the relay W_3 will move back and forth between its contacts as a result of only slight changes in the current in the plate circuit of the tube V.

It will be evident that if the windings x_1 and y_1 have an equal number of turns, and if the armature of the relay W_3 is not me-

chanically biased, the operation of the arrangement will result in a fairly steady value of current through the winding y_1, and this current will be substantially equal to that flowing through winding x_1. If the ratio of the numbers of turns in the windings x_1 and y_1 is not unity, then the values of the currents in these two windings will be inversely proportional to their respective numbers of turns. The value of the current in the plate circuit of the tube of the detector D may readily be determined from the value of the current in the plate circuit of the tube V as indicated by the meter M_2, and the latter current will be substantially constant.

Because of the large time constant of the charging circuit of condenser C established through resistance R_2, and because of the relatively small time constant of the discharge circuit established through resistance R_1 upon the closure of contact m_1, the arrangement functions practically the same when the telegraph key at the distant station is being operated as when it is kept closed. If the key is kept open for a length of time appreciably greater than that represented by the normal spaces between telegraph signals, then the current indicated by meter M_2 will gradually decrease to zero. Upon the operation of the key, however, the current through meter M_2 will quickly increase to its normal value.

In connection with a channel over which printers may be operated, the opening of the sending contacts for a length of time which may give a false indication of detector current, will occur only when the circuit may be in trouble. In connection with the channel operated by manual Morse the key may be held open for an appreciable length of time, and in that case the arrangement may occasionally give a false indication. Such a condition will be apparent to an experienced attendant and he will not be disturbed.

The characteristic of the detector which may be used in the operation of a carrier telegraph system of the type described is usually such that fairly large changes in the transmission equivalent of the circuit may produce only a small change in the normal value of the detector current. It may be advantageous to use separate detectors for the relays W_2 and W_3. Such detectors may be connected in parallel with each other across the output circuit of the filter F.

Fig. 2 of the drawings represents an arrangement by which the current provided in the pilot channel may be used to prevent bias in the signals resulting from changes in the transmission equivalent of the line. Here line L is bridged by a plurality of filters F_{11}, F_{12}, F_{13}, F_{14} and F_{15}, all connected in parallel relationship, and these are connected to detectors D_{11}, D_{12}, D_{13}, D_{14} and D_{15}, respectively. The detector D_R of the pilot channel is connected in parallel with the detector D_{15} across the output circuit of the filter F_{15}.

The pilot arrangement includes a relay W_R and the vacuum tube V which are interconnected the same as shown in Fig. 1 of the drawings. The battery B_2 is bridged by all of the resistance of the potentiometer P and the movable arm of this potentiometer extends to the axis of the armature of relay W_R. A low-pass filter is connected between the upper terminal of the biasing winding of relay W_R, and the plate electrode of the vacuum tube V, as shown, this filter including series inductances E, which may be of equal magnitude, and shunt condensers C_2, which may have equal capacities. This low-pass filter is intended to smooth out small variations in the plate current of the tube V resulting from the operation of the armature of relay W_R.

It is to be noted that the plate current of tube V flows through a circuit which includes the windings E of the low-pass filter, the winding of a milliammeter relay Q, the biasing windings of relays W_{11}, W_{12}, W_{13}, W_{14}, W_{15} and W_r, battery B_1 and ground. It will be apparent that upon adjustment of the gain of the detector D_R the proper value of the biasing current may be initially obtained for normal line conditions. When the transmission equivalent of the line changes, the current through the biasing windings of the various relays will be correspondingly changed and thereby will prevent bias in the telegraph signals.

The resistance R_3 forms a leak circuit which includes the battery B_1, the biasing winding of relay W_R, the biasing windings of relays W_{15}, W_{14}, W_{13}, W_{12} and W_{11}, resistance R_3 and ground. Since the channel to which detector D_R is connected may be held open for an appreciable length of time by local circuit troubles, current in the leak circuit will prevent the reduction in the flow of current through the biasing windings of the various relays to zero. The effect of the current in the leak circuit is such as to establish a minimum value for the current through these biasing windings, which the battery B_1 of the pilot circuit may supply. A similar effect may be obtained by reducing the voltage of the grid battery B_2 so that a small, though definite value of plate current will flow even when the armature of relay W_R closes its spacing contact *s*. A limit to the upper value of the current in the plate circuit of the tube V may be obtained by setting the movable arm of the potentiometer P at a suitable point.

The armature of the milliammeter relay Q may move between two contacts both of which are connected to a bell G and a battery B_3, which are in series with each other.

When the current through the winding of relay Q exceeds a predetermined value, one of its contacts will be closed, and its other contact will be closed when the value of the current drops below another predetermined value. In either case an alarm will be sounded by the bell G because of the flow of current from its associated battery B_3.

While this invention has been shown in certain particular arrangements merely for the purpose of illustration, it will be understood that the general principles of this invention may be employed in other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. The method of maintaining the amplitude of a direct current flowing through one winding of a polar relay substantially equal to the maximum amplitude of signaling current flowing through another winding of said relay which consists in progressively and gradually increasing the current periodically through the first of said windings until it exceeds the maximum amplitude of the signaling current flowing through the other of said windings, and progressively and gradually decreasing the current periodically through the first of said windings until it is less than the maximum amplitude of the signaling current flowing through the other of said windings.

2. The method of continuously maintaining the amplitude of a direct current flowing through the biasing winding of a polar relay substantially equal to the maximum amplitude of signaling current flowing through another winding of said relay, which consists in progressively and periodically decreasing the current through said biasing winding until its armature closes one of its contacts, and progressively and periodically increasing the current through said biasing winding until its armature closes the other of its contacts.

3. The combination of a relay having first and second windings both capable of operating its armature in mutually opposite directions, means for transmitting pulses of direct current representing signals through the first of said windings, a source of direct current individual to the second of the windings of said relay, and means associated with the armature of said relay for periodically increasing the flow of current through the second of said windings the amplitude of that current drops below the maximum amplitude of the current through the first of said windings and for periodically decreasing the flow of current through the second of said windings as it rises above said maximum amplitude.

4. The combination of a signaling source, a relay having two windings one of which is connected to said signaling source, means for transmitting direct current through the other winding of said relay, a circuit controlled by the armature of said relay, means associated with said circuit to change the magnitude of the current flowing through said other winding of said relay in accordance with changes in the maximum value of the current flowing from said signaling source.

5. The combination of a vacuum tube having plate, filament and grid electrodes, a first source of direct current potential, a polarized relay the winding of which is connected between the plate and filament electrodes of said vacuum tube through said first source of direct current, a condenser connected between the grid and filament electrodes of said vacuum tube, a second source of direct current potential, a first resistance connected in series with said second source of direct current potential between the grid and filament electrodes of said vacuum tube, and a second resistance connected in series with the armature and contact of said relay between the grid and filament electrodes of said vacuum tube.

6. The combination of a vacuum tube having plate, filament and grid electrodes, a first source of direct current potential, a polarized relay having two windings through one of which pulses of direct current flow, the other of the windings of said relay being connected between the plate and filament electrodes of said vacuum tube through said first source of direct current potential, means for indicating the magnitude of the current through the latter winding of said relay, a condenser connected between the grid and filament electrodes of said vacuum tube, a second source of direct current potential, a first resis ance connected in series with said second source of direct current between the grid and filament electrodes of said vacuum tube, and a second resistance connected in series with the armature and one contact of said relay between the grid and filament electrodes of the vacuum tube.

7. A system for the prevention of bias in signals transmitted over a line which result from changes in the transmission equivalent of the line comprising a polar relay having two windings, an auxiliary polar relay also having two windings, signals impressed on the line causing currents to flow through one of the windings of each of said relays, biasing current flowing through the other of the windings of each of said relays, and means associated with said auxiliary relay to change the biasing current in accordance with changes in the maximum amplitude of the signaling current.

8. A system for the prevention of bias in a multi-channel signaling system comprising a line, a plurality of polar relays each of

which has first and second windings, means whereby the signaling currents flowing over said line become impressed upon the first windings of said relays, a source of biasing current connected in series with the second windings of said relays, and means controlled by the armature of one of said relays to change the biasing current in accordance with variations in the maximum amplitude of the signaling current.

In testimony whereof, I have signed my name to this specification this 24th day of February, 1930.

JOSEPH HERMAN.