April 1, 1930. L. A. KELLEY 1,752,345

REDUCTION OF ATMOSPHERIC DISTURBANCE

Filed Nov. 26, 1928

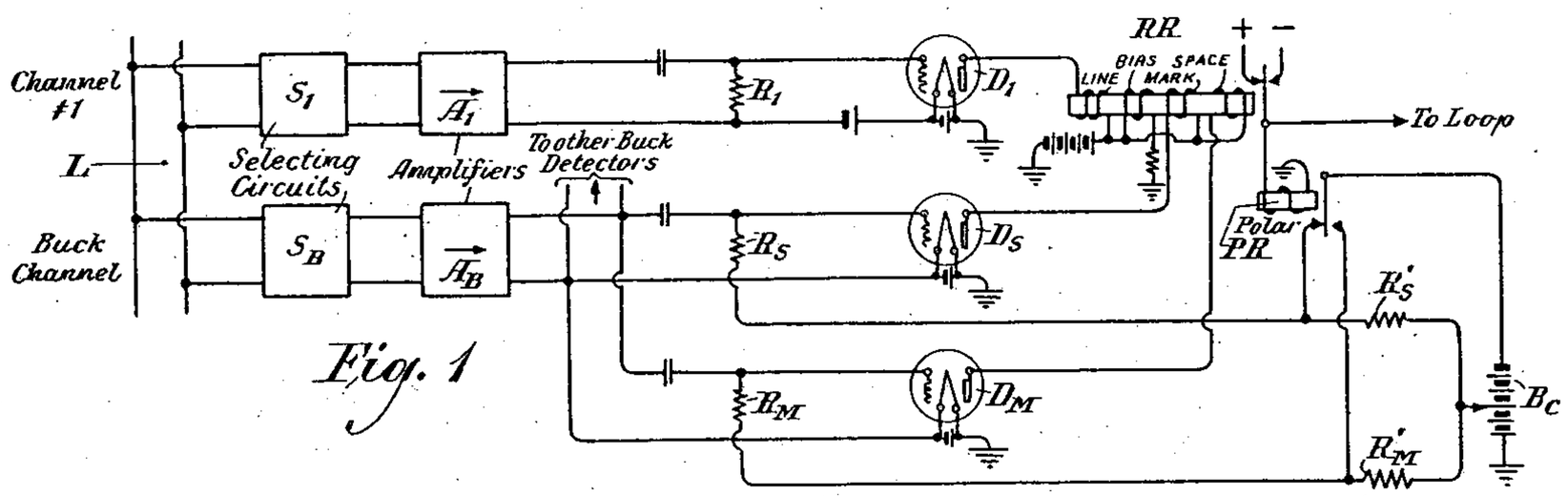

Fig. 1

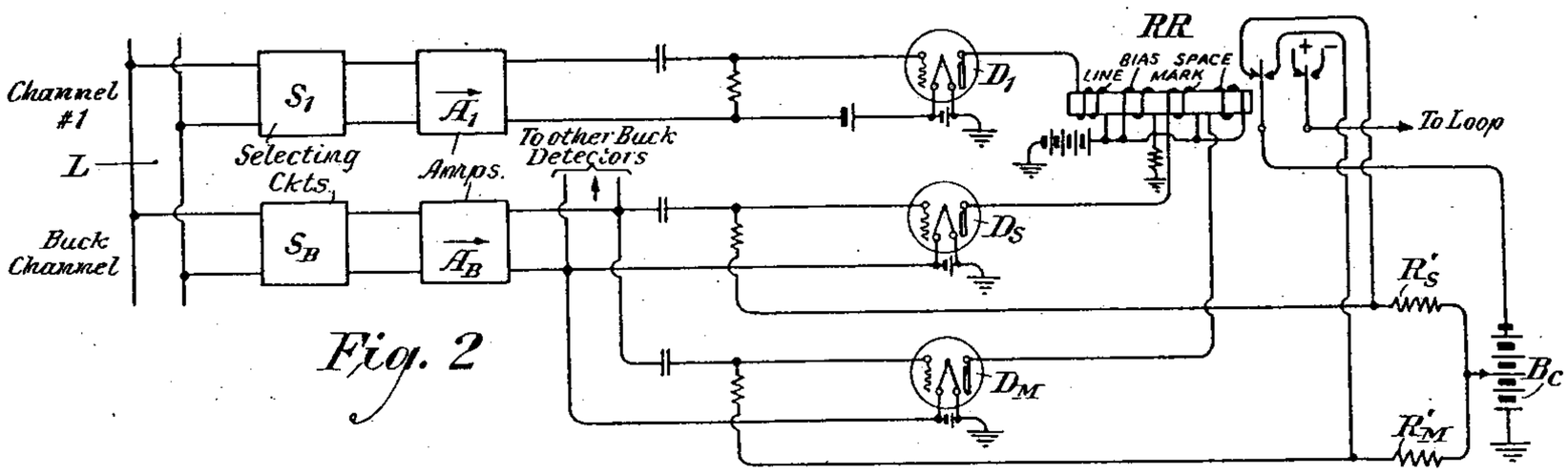

Fig. 2

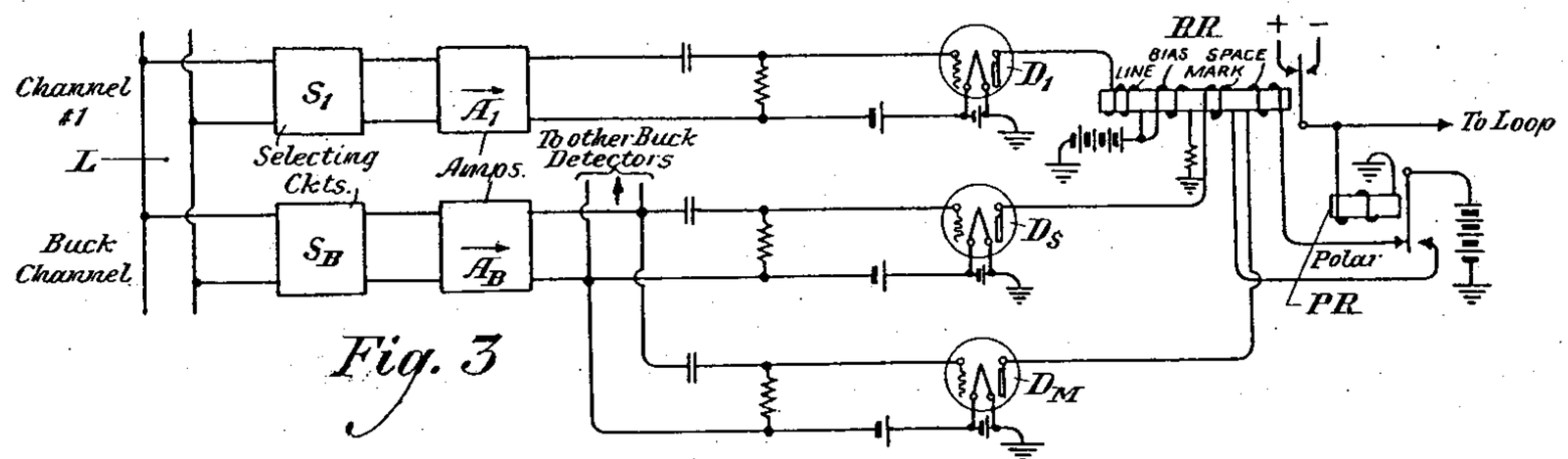

Fig. 3

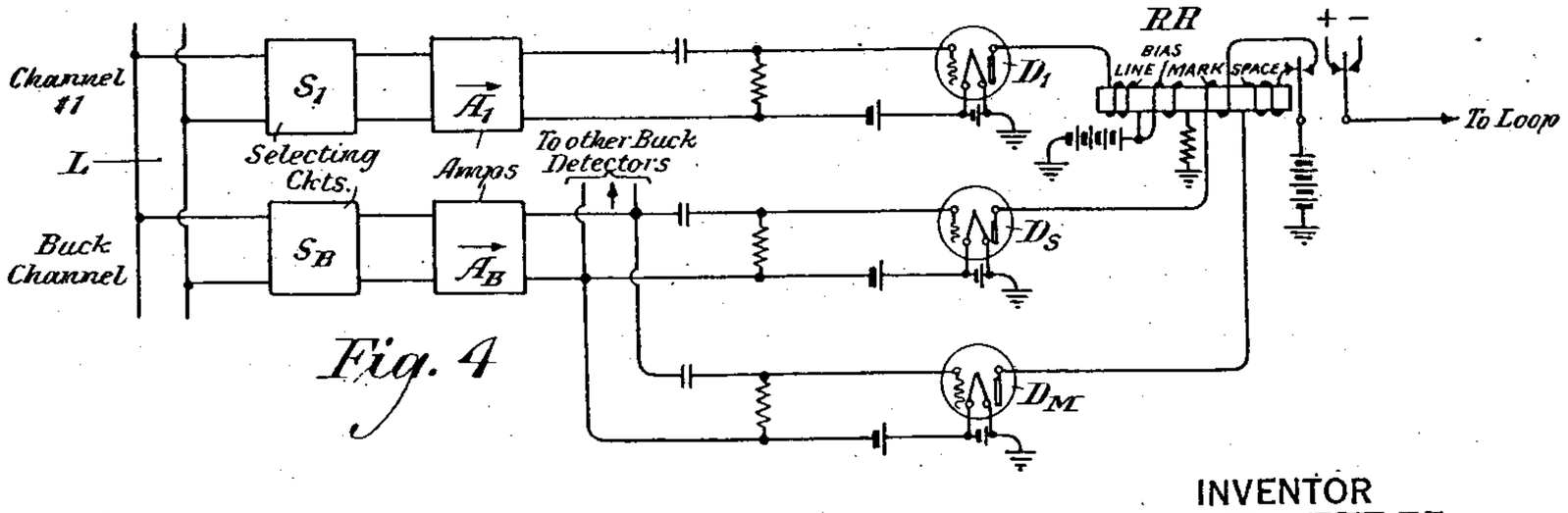

Fig. 4

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UNITED STATES PATENT OFFICE

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REDUCTION OF ATMOSPHERIC DISTURBANCE

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This invention relates to carrier telegraph systems, either radio or on wires and more particularly to arrangements for suppressing false telegraph signals caused by atmospheric disturbances.

In order to suppress false telegraph signals of the type above referred to, it has been proposed to associate with a carrier telegraph system at the terminal station an additional channel, known as a buck channel, which is so arranged as to be receptive to a frequency band which is not used for telegraph signaling but which is adjacent to the bands assigned to the several signaling channels. By means of the buck channel, a unidirectional pulse of current is produced each time an atmospheric disturbance occurs, and this impulse is employed to hold the armature of the receiving relay of the protected telegraph channel or channels against the contact (marking or spacing, as the case may be) upon which it happens to rest at the time the disturbance occurs. In order that the pulse may be so applied as to hold the armature in either position of the relay armature, a reversing arrangement is provided. In the form previously used, this reversing arrangement (which is, in effect, a double-throw reversing switch) involves two armatures and four contacts. As the usual polar relay commonly used in connection with telegraph circuits has but a single armature with but two contacts, in the circuit above referred to it was necessary to use two polar relays to accomplish the necessary reversing.

In accordance with the present invention a circuit arrangement is provided whereby the reversing operation may be performed by a single relay having an armature and two contacts. This is accomplished by providing the receiving relay of the protected channel with two buck windings, one for use in connection with disturbances occurring during the marking interval and the other for use in connection with disturbances occurring during the spacing interval. These windings are to be actuated by current supplied through two separate detectors or rectifying tubes associated with the buck channel, and the reversing armature renders the two tubes alternately effective as the signals change from marking to spacing, and vice versa. The reversing armature may comprise either an extra armature upon the receiving relay or it may comprise the armature of a single polar relay associated with the loop circuit and controlled by the receiving relay. In the former case the system has the advantage that the reversal is effected instantaneously with the shift of the armature of the receiving relay, since the vacuum tubes have no mechanical or electrical inertia.

It will be noted that the system involves one less polar relay for each protected channel, but requires an additional vacuum tube rectifier or detector for each channel. This represents an economic advantage as the tubes are, in general, cheaper than relays. Furthermore, the partial or complete elimination of the inductance of polar reversing relays from the loop (when they are connected in series with the loop) is a desirable feature as the inductance tends to round off or distort the signals and thus cause a less snappy action of the sounders.

The invention will now be more fully understood from the following description when read in connection with the accompanying drawing, Figures 1, 2, 3 and 4 of which illustrate schematically four different circuit arrangements embodying the principles of the invention.

Referring to Fig. 1, L designates bus bars associated with the receiving terminal of a carrier system (either wire or wireless) upon upon which the frequencies corresponding to a plurality of signaling channels are impressed at a receiving point. In practice the system will usually be multiplex, but for purposes of illustration the apparatus of but a single receiving channel of a multiplex system is shown. This includes a selecting circuit S_1 which may be a tuned circuit, or a filter, or other known selecting device for admitting to the channel the band of frequencies assigned thereto. An amplifier A_1 is connected beyond the selecting circuit, this amplifier being of any known type such, for example, as a vacuum tube amplifier. To the output of the amplifier a vacuum tube de-

tector D_1 is connected. The plate circuit of the detector includes the line winding of a receiving relay RR. The grid circuit is biased by means of the usual "C" battery so that in the absence of the received carrier no plate current will flow. In signaling, the carrier is usually transmitted during the marking interval and no current is transmitted during the spacing interval, so that pulses of current will flow in the plate circuit corresponding to the marking signals, while the spacing signals will be represented by no-current intervals in the plate circuit. The receiving relay RR also includes a biasing winding, the current through which is adjusted by means of a suitable resistance to such value that the biasing current will produce a pull upon the armature of the relay in the opposite direction to and about half as strong as the pull produced by the plate current flowing through the line winding during a marking interval.

In order to reduce the effect of the atmospheric disturbance an auxiliary or buck channel is provided which includes a selecting circuit S_B. This selecting circuit may be similar to the selecting circuit S_1 but is selective of a frequency or a narrow band of frequencies which is not used for signaling but is in the neighborhood of the bands actually employed for the transmission of signals. An amplifier A_B, similar to the amplifier A_1, is connected in the buck channel beyond the selecting circuit. In the output of this amplifier are connected detectors associated with the various receiving channels. In the case of the receiving channel illustrated two such detectors, D_S and D_M, are provided, the former being effective during spacing signals and the latter during marking signals. The plate of the spacing detector D_S is connected to the plate battery through the space winding of the relay RR, and this winding is so poled as to produce a pull on the armature in the same direction as that produced by the biasing winding; in other words, a pull opposite to that due to a marking signal. Similarly, the plate of the marking detector D_M is connected to the plate battery through the marking winding of the relay RR which is so poled as to assist the line winding, and therefore, to tend to hold the armature of the receiving relay upon its marking contact.

In order to render the two detectors effective, the one during the reception of marking signals and the other during the reception of spacing signals, a circuit arrangement is provided for controlling the bias of the grids of the two detectors. For this purpose a polar relay PR is associated with the loop circuit so that its armature will be shifted as the armature of the receiving relay shifts from marking to spacing, and vice versa. A grid battery B_C has certain of its cells connected to the grid of the detector D_S through the resistances R_S and R_S', these cells being similarly connected to the grid of the detector D_M through the resistances R_M and R_M'. These connections are such as to apply to the detectors a normal grid bias whereby no space current flows in the absence of alternating current applied to the grid, but a rectified plate current is permitted to flow in response to the application of such alternating current. The armature of the polar relay PR is so connected that as it shifts back and forth it short-circuits the resistance R_S' or R_M', as the case may be, of one or the other of the detectors D_S and D_M, and includes extra cells of the battery B_C in the corresponding grid circuit, thereby rendering one or the other of the grids of the two tubes so negative that no plate current will flow in response to any disturbing current received by the selecting circuit S_B.

The operation is as follows: When a train of carrier waves is transmitted corresponding to a marking signal and having the frequency assigned to the channel illustrated, a rectified current flows in the plate circuit of the detector D_1 and through the line winding of the receiving relay RR. As this current has a value about twice as great as the normal biasing current through the biasing winding of the relay, the armature is pulled from the spacing contact to its marking contact, and a signal is sent to the loop. At the same time the polar relay PR shifts its armature to its left-hand contact, thereby short-circuiting the resistance R_S' and increasing the negative potential upon the grid of the space detector D_S of the bucking channel. The short-circuit is, of course, at the same time removed from the resistance R_M' so that the normal grid potential is applied to the marking detector D_M, rendering said detector responsive to an alternating current flowing in the selecting circuit S_B. As the selecting circuit S_B does not select the carrier frequency used for signaling, no rectified current flows in the plate circuit of the detector tube D_M in the absence of an atmospheric disturbance, and the grid of the tube D_S is rendered so negative that no plate current can flow in its circuit, in any event.

If, under these conditions, an atmospheric disturbance should occur, its effect upon the signal receiving channel may be either to increase the plate current through the line winding of the receiving relay or to decrease it, depending upon the magnitude of the disturbance. An increase in the plate current is without any effect to produce false signals, but if the plate current should be sufficiently decreased a false spacing signal would occur, permitting the armature to be shifted to its spacing contact under the control of the biasing winding. This is prevented, however, by the action of the buck circuit. The atmospheric disturbance usually assumes the form of an impulse having a wide range of fre-

quencies. A narrow band of these frequencies passes through the selecting circuit S_B of the buck channel and upon being amplified is applied to the grids of the various detectors, such as D_S and D_M. This is without effect upon the plate circuit of the detectors such as D_S, whose grids are rendered abnormally negative. Detectors such as D_M, however, respond to produce a pulse of rectified plate current corresponding to the atmospheric disturbance. This pulse of current, in the case of the signaling channel illustrated, flows through the marking winding of the relay RR, which is poled in such a direction as to tend to hold the armature of the receiving relay upon its marking contact, so that no false signal occurs.

When the carrier current corresponding to the signaling channel illustrated in interrupted in accordance with a space signal, the plate current of the detector D_1 ceases flowing through the line winding of the relay RR and the biasing winding comes into play to shift the armature to its spacing contact, thus sending a space signal to the loop. This causes the polar relay PR to shift its armature to its right-hand contact, thereby removing the short-circuit from the resistance R_S' and applying it to the resistance R_M' with the result that the marking detector D_M is now poled to such an extreme negative potential as to be inoperative, while the grid potential of the spacing detector D_S is reduced to normal value. Under these conditions, the effect of an atmospheric disturbance is to permit the selecting circuit S_1 to select from the disturbing wave a frequency corresponding to the signaling channel illustrated. This causes a pulse of rectified current to flow in the plate circuit of the detector D_1 and through the line winding of the relay RR, thus tending to produce a false marking signal. This is prevented, however, by the fact that the selecting circuit S_B of the buck channel selects a component of the disturbing wave which is amplified and applied to the grids of the various detectors. This selected component is without effect upon the marking detector D_M, but causes a rectified pulse of current to flow in the plate circuit of the space detector D_S so that the pulse of current flows through the space winding of the receiving relay in such a direction as to assist the biasing winding in holding the armature against the spacing contact.

In the foregoing arrangement it will be observed that the reversing of the holding pulse supplied by the buck channel is controlled by a single armature of a single polar relay included in the loop circuit. This is an advantage over the prior arrangements which require two armatures with two contacts, and hence, two polar relays in the loop circuit. While the elimination of one of the polar relays is obtained at the expense of an additional detector tube, this represents an economic saving, due to the fact that, in general, the tube will be less expensive than the polar relay.

A modified arrangement is shown in Fig. 2 which differs from that of Fig. 1 in that, instead of providing a polar relay PR in the loop circuit to control the grid potentials of the detectors D_S and D_M, this control is effected directly by an additional armature of the receiving relay RR. As shown in Fig. 2, the left-hand armature of the relay RR controls the connections of the grid battery B_C and determines the short-circuiting of the resistances R_S' and R_M', the signals being transmitted to the loop over the right-hand armature of said relay. In this case, the reversal is instantaneous with the shifting of the armature of the receiving relay, due to the fact that the vacuum tube rectifiers D_S and D_M have no inertia.

A modified arrangement is shown in Fig. 3 which is similar to that of Fig. 1 in that it requires a single polar relay with a single armature to determine the reversing action, but it differs therefrom in that the reversing action is effected through a control of the plate circuits of the detectors D_S and D_M instead of through their grid circuits. In this case the grid circuits of the detectors D_S and D_M are provided with the normal "C" battery connections so that their grids will be poled sufficiently negative to prevent a flow of plate current in the absence of applied signal currents but permitting the detectors to respond to applied signaling currents to produce corresponding rectified plate currents. The plate circuits of the detectors D_S and D_M are connected through the spacing and marking windings of the receiving relay RR over the front or back contact, as the case may be, of the polar relay PR. When a marking signal is being received the space winding of the receiving relay and the plate circuit of the space detector D_S are both open-circuited by reason of the armature of the polar relay being shifted to its right-hand contact. This completes the plate circuit of the detector D_M through the marking winding of the relay RR so that, if during marking the current through the line winding should be reduced as a result of an atmospheric disturbance, the detector D_M would send a pulse through the marking winding in such a direction as to assist the line winding, thereby preventing a false spacing signal. During spacing the polar relay PR shifts its armature to the right, thereby rendering the plate circuit of the spacing tube D_S effective and disabling the marking detector D_M. If, under these conditions, an atmospheric disturbance should cause a detector current in the line winding, tending to shift the armature of the receiving relay from its spacing contact and thereby

produce a false marking signal, the space detector D_S comes into play and responds to a component of the disturbance to cause rectified plate current through the space winding of the receiving relay. This rectified current is in such a direction as to assist the biasing winding but to oppose the line winding, and hence tends to maintain the armature upon the spacing contact to prevent a false marking signal.

An arrangement is shown in Fig. 4 which is similar to the arrangement of Fig. 3 except that a contact for controlling the plate circuits of the detectors D_S and D_M is provided by an extra armature upon the receiving relay RR, as described in connection with Fig. 2. The operation of this arrangement will be apparent without further description.

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 carrier telegraph system, a receiving channel including means to select a carrier frequency, means to detect therefrom a telegraph signal and a receiving relay, an auxiliary channel including means to select from an interfering wave a component having a frequency in the neighborhood of that of the receiving channel, means to translate said component into a pulse of current, a pair of oppositely poled auxiliary windings on said receiving relay, and means controlled by said relay to transmit said pulse through one of said windings during receipt of a marking signal and through the other of said windings during receipt of a spacing signal.

2. In a carrier telegraph system, a receiving channel including means to select a carrier frequency, means to detect therefrom a telegraph signal and a receiving relay, an auxiliary channel including means to select from an interfering wave a component having a frequency in the neighborhood of that of the receiving channel, a pair of oppositely poled auxiliary windings on said receiving relay, a pair of detectors associated with said auxiliary channel and individual to said windings to supply a pulse of current thereto in response to the component selected by said auxiliary channel, and means controlled by said receiving relay to render one of said detectors and the corresponding winding effective during receipt of a marking signal and to render the other of said detectors and the other winding effective during receipt of a spacing signal.

3. In a carrier telegraph system, a receiving channel including means to select a carrier frequency, means to detect therefrom a telegraph signal and a receiving relay, an auxiliary channel including means to select from an interfering wave a component having a frequency in the neighborhood of that of the receiving channel, a pair of oppositely poled auxiliary windings on said receiving relay, a pair of detectors associated with said auxiliary channel and individual to said windings to supply a pulse of current thereto in response to the component selected by said auxiliary channel, and means controlled by said relay to render one of said detectors operative during receipt of a marking signal and to render the other of said detectors operative during receipt of a spacing signal.

4. In a carrier telegraph system, a receiving channel including means to select a carrier frequency, means to detect therefrom a telegraph signal and a receiving relay, an auxiliary channel including means to select from an interfering wave a component having a frequency in the neighborhood of that of the receiving channel, a pair of oppositely poled auxiliary windings on said receiving relay, a pair of detectors associated with said auxiliary channel and individual to said windings to supply a pulse of current thereto in response to the component selected by said auxiliary channel, and means controlled by said receiving relay for so biasing the grid of one of said detectors as to render it inoperative during receipt of a spacing signal and for so biasing the grid of the other detector as to render it inoperative during receipt of a marking signal.

5. In a carrier telegraph system, a receiving channel including means to select a carrier frequency, means to detect therefrom a telegraph signal and a receiving relay, an auxiliary channel including means to select from an interfering wave a component having a frequency in the neighborhood of that of the receiving channel, a pair of oppositely poled auxiliary windings on said receiving relay, a pair of detectors associated with said auxiliary channel and individual to said windings to supply a pulse of current thereto in response to the component selected by said auxiliary channel, an armature for said receiving relay for transmitting marking and spacing signals to a receiving circuit, and an additional armature for said receiving relay having front and back contacts over which circuits of said detectors may be completed.

In testimony whereof, I have signed my name to this specification this 24th day of November 1928.

LEO A. KELLEY.