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INTERFERENCE NEUTRALIZER FOR ALTERNATING CURRENT TELEGRAPH SYSTEMS

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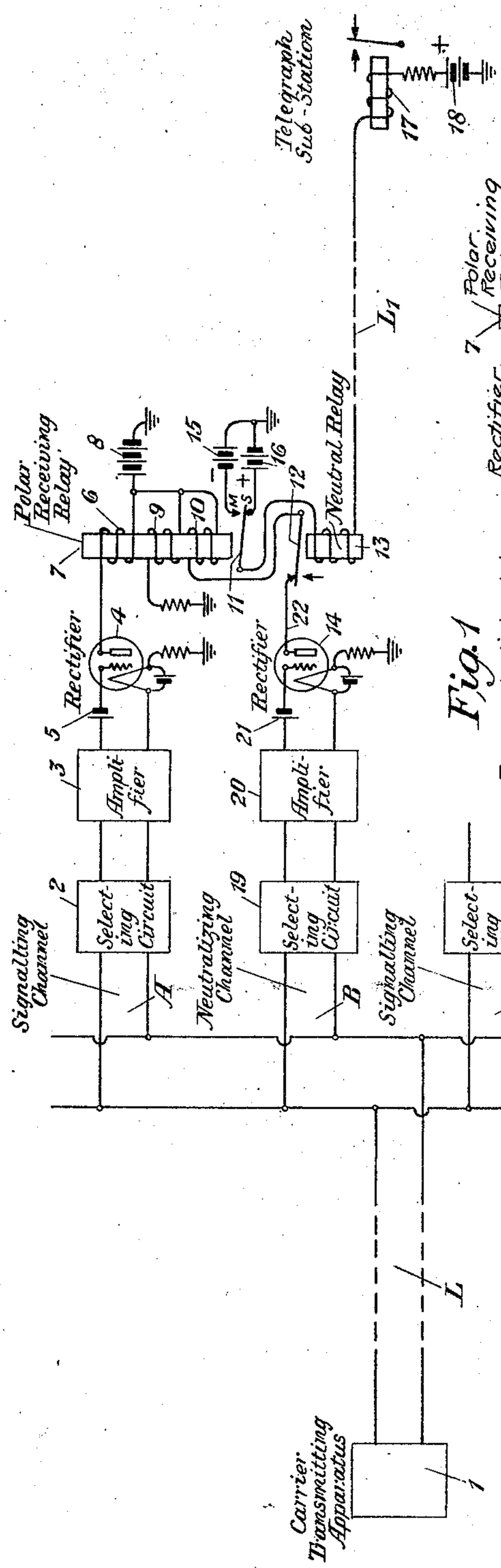

Fig. 1

For neutralizing interference during reception of spacing impulses.

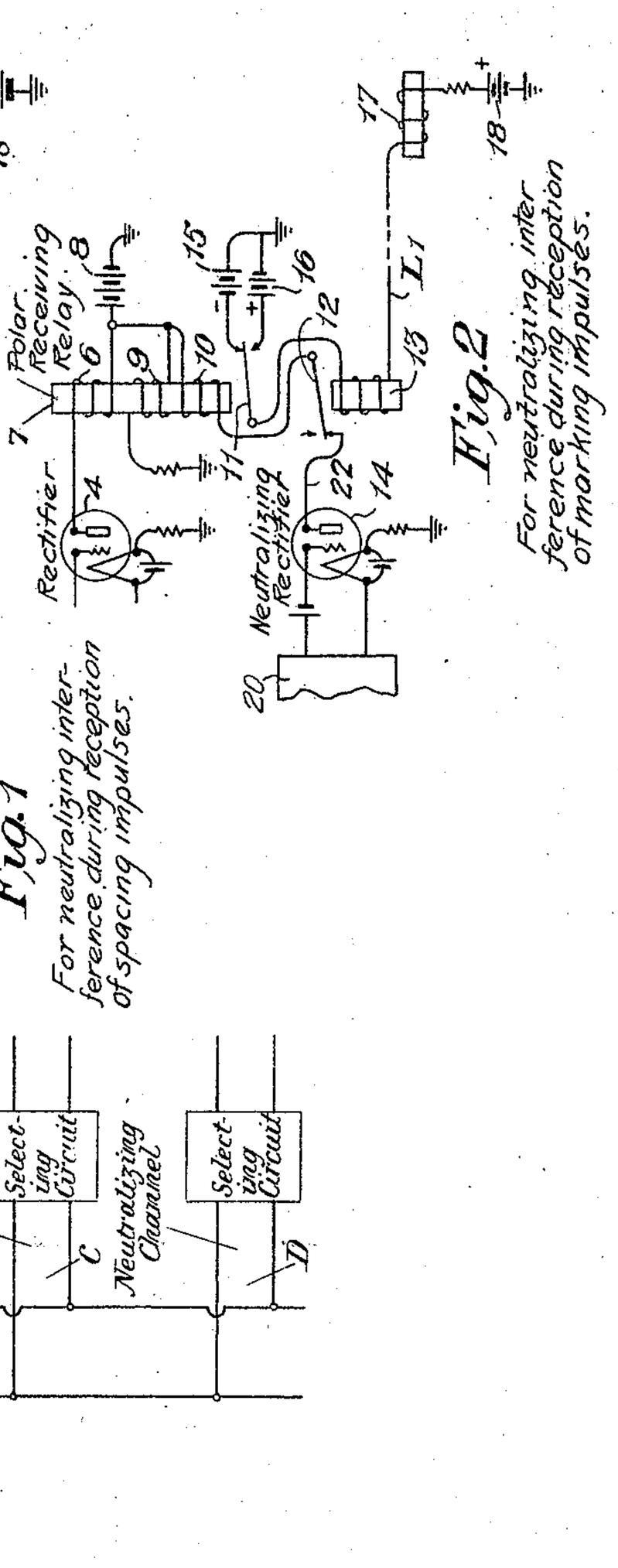

Fig. 2

For neutralizing interference during reception of marking impulses.

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UNITED STATES PATENT OFFICE

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INTERFERENCE NEUTRALIZER FOR ALTERNATING-CURRENT TELEGRAPH SYSTEMS

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This invention relates to alternating current telegraph systems, and particularly to means for neutralizing the effect of extraneous interference upon the receiving apparatus of such systems.

In the carrier telegraph systems of the types that are well-known in the art, the carrier currents received from the line circuit are rectified, and the rectified current is used to operate a polar relay. This relay normally has a biasing winding through which a current flows steadily of such a value that it neutralizes approximately one-half of the effect of the normal operating current when both currents are flowing. This causes the armature to be moved from one contact to the other with equal force in either direction, as the operating current is alternately on and off. Interfering currents set up in the line circuit by sources extraneous to the system itself often cause false operation of the relay, and also produce distortion of the carrier current signals being transmitted over the line by such interference with the operation of the receiving relay.

My invention resides in a system for neutralizing interference in an alternating current telegraph system by a method that consists in applying to the polar receiving relay a neutralizing impulse whose magnitude is equal to or greater than the disturbance in the signaling channel, and controlling the time and the direction of application of the said neutralizing impulse so that it will be effective to prevent the disturbance in th signaling channel from moving the armature of the receiving relay from one of the contacts, for example, the spacing contact of the said relay if it is desired to protect against interruptions to spacing signals. Protection against interruptions to marking signals may be effected by slightly changing the circuit connections in a manner that will be set forth hereinafter. The arrangement disclosed in the copending application of Kelley, Monk and Thorp, Serial No. 336,884, filed February 1, 1929, provides for the automatic control of the application of the neutralizing impulse, by and in accordance with the received signaling impulses, so as to automatically neutralize the effect upon said relay of interference received in the signaling channel during the reception of marking impulses as well as during the reception of spacing impulses, and, to that extent constitutes an improvement upon my invention which will now be fully described.

This invention will be clearly understood from the following description when read in connection with the attached drawing, of which Fig. 1 shows schematically a simple form of embodiment of the invention for neutralizing interference during the reception of a spacing impulse; and Fig. 2 shows the manner in which a portion of the circuit of Fig. 1 is modified in order to effect neutralization of interference during the reception of marking impulses.

In the drawing the line L represents a transmission circuit or medium over or through which a plurality of carrier frequencies such as f_1, f_2, etc., may be transmitted from the carrier transmitting apparatus 1 to the carrier receiving apparatus connected with the other end of the said line. The receiving station comprises a plurality of branch circuits A, B, C, and D. Circuits A and C are intended to receive the signaling channels based upon the carrier frequencies f_1 and f_2, respectively. Circuit B serves as a neutralizing channel in connection with circuit A, and in like manner circuit D serves as a neutralizing channel in connection with circuit C. Only two of the branch circuits, namely, A and B, are shown in their entirety since the other pairs of signaling and neutralizing circuits are preferably similar to A and B. The circuit A has connected therewith a selecting circuit or network 2 which may be a tuned circuit, filter, or other selective device to permit the passage of the frequency f_1 or a band based upon that frequency. The output of the selecting circuit 2 is connected with an amplifier 3 which may be of any well known type, and the latter is connected with the rectifier 4, shown as of the vacuum tube type. The grid circuit of the rectifier contains a battery 5 that is designed to apply a negative bias to the grid of such magnitude as to suppress the space

current when signals are not being received. The plate circuit of the rectifier is connected with the winding 6 of the polar receiving relay 7, which winding is also connected with the source of plate voltage 8. The polar receiving relay has also two other windings 9 and 10. Winding 9, which is the biasing winding is so poled and the magnitude of the current flowing therethrough from the source 8 is such as to tend to keep the armature 11 upon its spacing contact when current is not flowing through winding 6. Winding 10, which constitutes the neutralizing winding of the relay, is connected between the source of voltage 8 and the armature 12 of relay 13. The upper contact of relay 13 is connected with the plate of the rectifier 14 associated with the neutralizing circuit B. The mode of connection of the plate of rectifier 14 and the contact of relay 13, and the direction of flow of current through the winding 10, as shown in the drawing, will neutralize interference that occurs during the reception of a spacing impulse; that is to say, the circuit arrangement shown in the figure will prevent the movement of the armature 11 from its spacing contact in the event that an interfering impulse comes into the circuit A during the time interval representing the reception of a spacing impulse. Later, I will show the manner in which the circuit connections should be made to prevent the movement of the armature 11 from its marking contact when interference enters the circuit A during the reception of a marking impulse.

The contacts of the polar relay 7 are connected with the marking and spacing batteries 15 and 16, respectively. The armature 11 is connected with the winding of relay 13 which is in turn connected with the loop circuit L_1 having a telegraph substation connected therewith, represented diagrammatically by the relay 17 and the battery 18. The polarity of the said batteries is as indicated upon the drawing. The neutralizing circuit B contains a selecting circuit 19, an amplifier 20, and the rectifier 14, the latter having a negative biasing source 21 connected with the grid, the magnitude of which is such as to suppress space current in the rectifier 14 when no disturbing impulses are being passed by the network 19 from the line to the rectifier 14.

In carrier telegraph systems, a marking impulse consists of a train of oscillations of the carrier frequency, and a spacing impulse represents the absence or suppression of such oscillations during the spacing interval. For the purpose of describing the principle of the invention let it be assumed that a spacing impulse is being transmitted over the line L by the channel represented by the frequency f_1, and also that there is no disturbance to create any interfering currents in the said line. Since the carrier current is not transmitted during the spacing interval, no space current will flow in the rectifier 4 because the negative bias produced upon the grid by the battery 5 is sufficient to suppress such space current. Accordingly, current will not flow in the winding 6 of relay 7, and the armature 11 of that relay will be held against its spacing contact by virtue of the current flowing through the biasing winding 9. Furthermore, since battery 16 is equal to, and opposes battery 18, no current will flow through the winding of relay 13 which is connected in series with batteries 16 and 18 and the loop L_1. Consequently, relay 13 will be deenergized and its armature 12 will rest against its upper contact, which will establish a connection from the grounded battery 8, through winding 10, armature 12, and upper contact of relay 13, to the plate of rectifier 14, but no current will flow through the neutralizing winding 10, because the negative bias maintained upon the grid of 14 by the battery 21 is sufficient to prevent the flow of current from the plate to the filament of 14, when no interfering currents exist in the line, which was the condition assumed just above.

If a disturbance occurs in the vicinity of the line L, it will tend to produce therein an interfering current of a plurality of frequencies, some of which may be of the same frequencies as the carrier currents, or within the range of the bands based upon the said carrier frequencies f_1, f_2, etc., and another or others of said interfering frequencies may be outside said range of carrier frequencies. The interference of the frequency f_1 will pass into the circuit A and will be transmitted by the selecting circuit 2 to the amplifier 3 and the rectifier 4 wherein it will cause the flow of current through the plate circuit which includes the winding 6. The effect of that flow is to energize the said winding and to tend to cause the armature 11 to move from its spacing contact, which tendency, if unchecked, would interfere with the reception of the spacing impulse of the signal being transmitted. That effect is, however, prevented by utilizing the portion of the disturbance that lies in the frequency range of the selecting circuit 19 of the neutralizing circuit B, which frequency range may lie within the range of the group of channels employed in transmission over the system, or outside the range of said group. That portion of the disturbance that passes through 19, which will be designated the neutralizing impulse, will be amplified by 20 and impressed upon the grid of the rectifier 14, thereby overcoming the negative bias of 21. Accordingly, current will flow through the plate circuit of the rectifier 14 which includes the winding 10 of the polar relay, and the upper contact of relay 13, which contact

is closed by the deenergization of relay during the receipt of a spacing signal impulse. Since the effect of the flow of current through the winding 10, due to the neutralizing impulse, is opposite that of the flow of current through winding 6, due to the interfering impulse, that lies in the frequency range of the signaling channel, it will be apparent, that by controlling the magnitude of the space current of the rectifier 14, (by adjustment of the amplifier 20, or otherwise), so that the current in winding 10 may be made equal to or greater than the effect of the space current of rectifier 4 that flows through winding 6, the armature 11 of the polar receiving relay 7 will be prevented from leaving its spacing contact during the reception of a spacing impulse, regardless of the presence in the line of an interfering current of the same frequency as that employed in the signaling channel.

Fig. 2 shows the manner in which the circuit of Fig. 1 may be readily arranged to neutralize such interference as arises during the reception of a marking impulse. To accomplish that result the plate conductor 22 of the rectifier 14 is connected with the lower contact of relay 13; and, furthermore, winding 10 is so connected between armature 12 and the source of voltage 8 that the direction of flow of the current through the said winding is the reverse of that shown in Fig. 1. As arranged in Fig. 2, current will flow through winding 10 whenever interference occurs during the reception of a marking impulse, and the direction of flow of the current through winding 10 will be such as to assist in keeping the armature 11 of receiving relay 7 upon its marking contact.

I have described the mode of arranging the circuit to render the receiving relay unaffected by interference during the time of reception of either a spacing impulse or a marking impulse. From a practical standpoint it is more desirable to neutralize interference during the spacing interval because the circuit is more susceptible to interference during that interval than during the reception of marking impulses. Furthermore, the marking interference may be substantially reduced by designing the rectifier input circuit of the signal channel to make it less susceptible to such interference.

While this invention has been described as embodied in a particular form, it is to be understood that such showing is purely illustrative inasmuch as the invention is capable of embodiment in other forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. The method of neutralizing interference in an alternating current telegraph receiving system, in which the normal movement of the armature of a receiving relay from one contact to another is controlled by rectified signaling currents representing marking and spacing impulses, which consists in transmitting a signal over or through a medium by means of a carrier frequency, which signal is exposed to interference from a source of disturbances, selecting and rectifying the said carrier frequency, and impressing the rectified current upon the receiving relay, also selecting and rectifying a portion of the disturbance having a frequency different from that used for the said signal, applying said rectified disturbance to the said receiving relay, and controlling the application of the said rectified disturbance by the received signal impulse to be protected against interference, so that the rectified disturbance will prevent the interference existing in the signaling channel from moving the armature of the receiving relay from that contact to which it has been moved by the signal impulse to be protected against interference.

2. The method of neutralizing interference in an alternating current telegraph receiving system, in which the normal movement of the armature of a receiving relay from one contact to another is controlled by rectified signaling currents representing marking and spacing impulses, which consists in transmitting a signal over or through a medium by means of a carrier frequency, which signal is exposed to interference from a source of disturbances, selecting the current of the band based upon the said carrier, rectifying that current, likewise selecting the current resulting from interference whose frequency lies outside the said band, rectifying that current, applying both rectified currents to the receiving relay normally responsive to the signal being received, and controlling the time of application of the rectified interfering current of the said different frequency so that it will be effective to keep the armature of the receiving relay upon that contact to which it has been moved by the signal impulse to be protected against interference.

3. The method for neutralizing interference in an alternating telegraph receiving system, in which the normal movement of the armature of a receiving relay from one contact to another is controlled by rectified signaling currents representing marking and spacing impulses, which consists in transmitting signals over or through a medium by means of a plurality of carrier frequencies, the said medium being exposed to atmospheric disturbances capable of setting up therein interfering currents whose frequencies lie both within and without the range of the carrier frequencies, separating the carrier channels by the process of frequency selection, rectifying the selected carriers and the interference currents of the same frequencies as the said carriers, simultaneously selecting and rectifying an interference frequency or fre-

quencies, differing from the frequencies employed in the carrier channels, to form a neutralizing current to overcome the effect of any interference existing in the carrier channels, and controlling the application of the said neutralizing current to the receiving relay by that received signal impulse that is to be protected against interference, so that the neutralizing impulse will prevent the interfering impulse that lies within the range of a carrier channel from moving the armature of the receiving relay from that contact to which it has been moved by the particular signal impulse to be protected.

4. In a system for neutralizing interference in an alternating current telegraph receiving system, the combination with a source of signals of a plurality of carrier currents of different frequencies for transmitting the said signals over or through a medium that is exposed to atmospheric disturbances, a plurality of signal receiving circuits each having means to select from the said medium the current within a band based upon one of said frequencies, which current may result from either the signal or from disturbances whose frequency comes within that of the band, means to rectify the selected currents, one or more neutralizing circuits to pick up from said medium disturbances of a frequency or frequencies lying either between adjacent bands, or outside the range of the group of bands, a receiving relay effectively connected with two of said rectifiers, one associated with a signal receiving circuit and the other with a neutralizing circuit, and means controlled by the received signal impulses adapted to close the connection between the said rectifier of the neutralizing circuit, and the said receiving relay whenever the receiving relay is energized by the particular signal impulse that is to be protected against interference.

5. In a system for neutralizing interference in an alternating current telegraph receiving system, the combination with a source of signals of a source of current of a carrier frequency for transmitting the said signals over or through a medium that is exposed to atmospheric disturbances capable of setting up interfering frequencies lying within and also without the band of frequencies represented by the signal modulated carrier, a signal receiving circuit having means to select from the said medium the current of the frequencies within the said band, which current results from the signal and the interference whose frequency lies within the said band, means to rectify the currents of the selected band, a neutralizing circuit having means to select from the said medium a portion of the interference whose frequency lies outside the said band, means to rectify the selected interference, a receiving relay effectively connected with both of said rectifiers, and means controlled by the received signal impulses adapted to close the connection between the rectifier of the said neutralizing circuit and the said receiving relay whenever the receiving relay is energized by the particular signal impulse to be protected against interference.

In testimony whereof, I have signed my name to this specification this 23rd day of January, 1930.

LEO A. KELLEY.