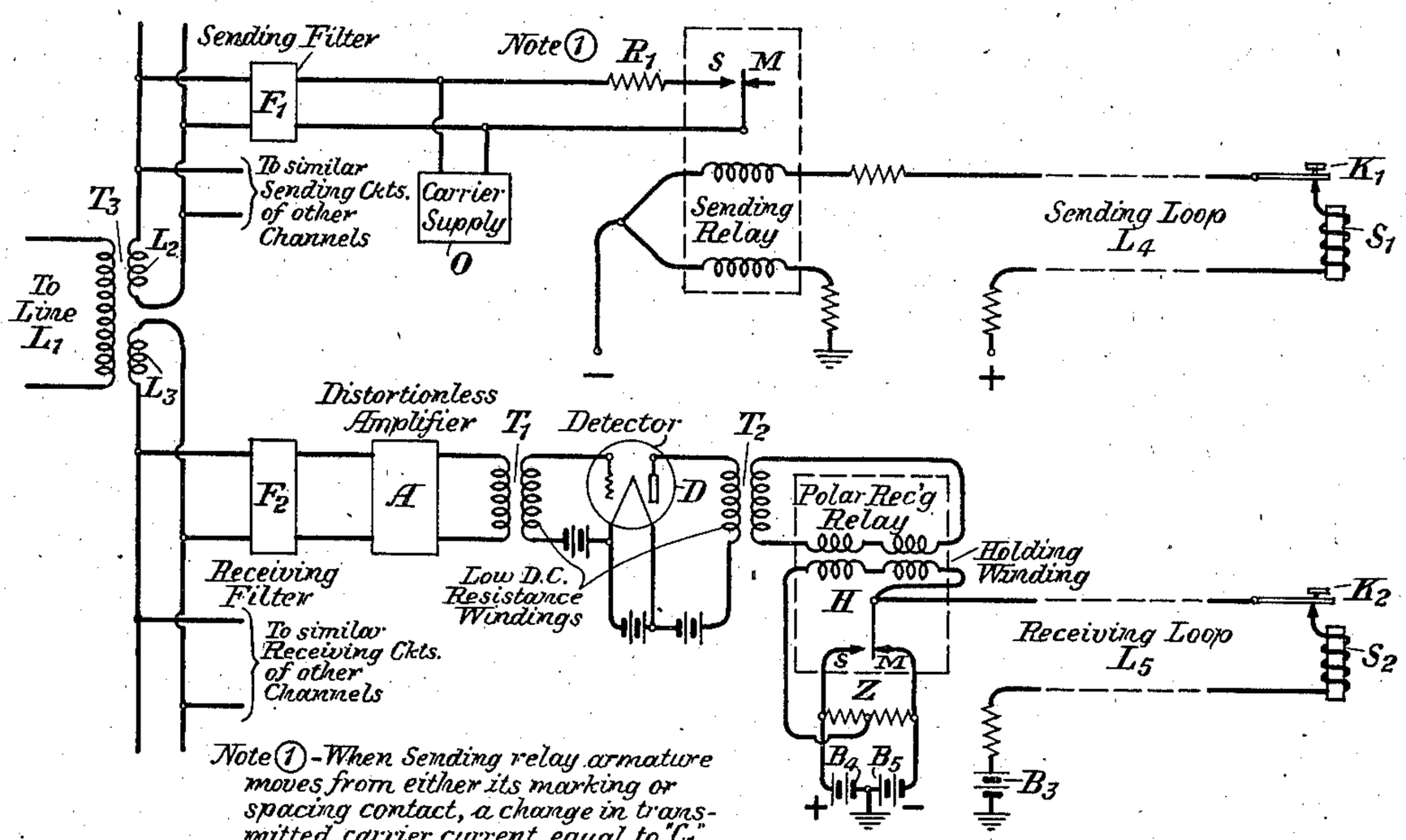
May 25, 1937. V. P. THORP 2,081,312

CARRIER TELEGRAPH SYSTEM

Filed June 5, 1934 2 Sheets-Sheet 1



Note (1) - When Sending relay armature moves from either its marking or spacing contact, a change in transmitted carrier current equal to "C_1" is made as indicated on Fig. 2.

Fig. 1

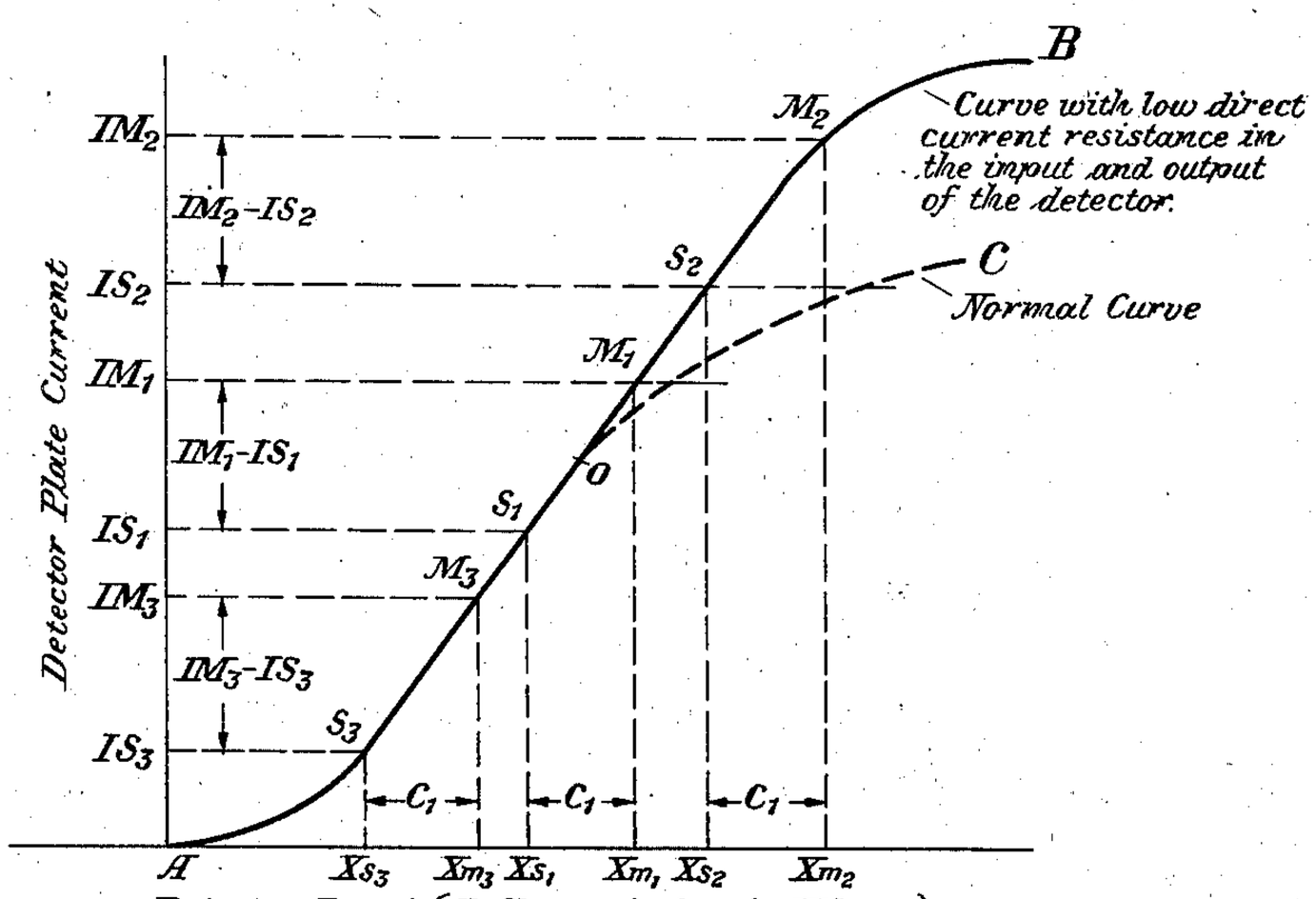


Fig. 2

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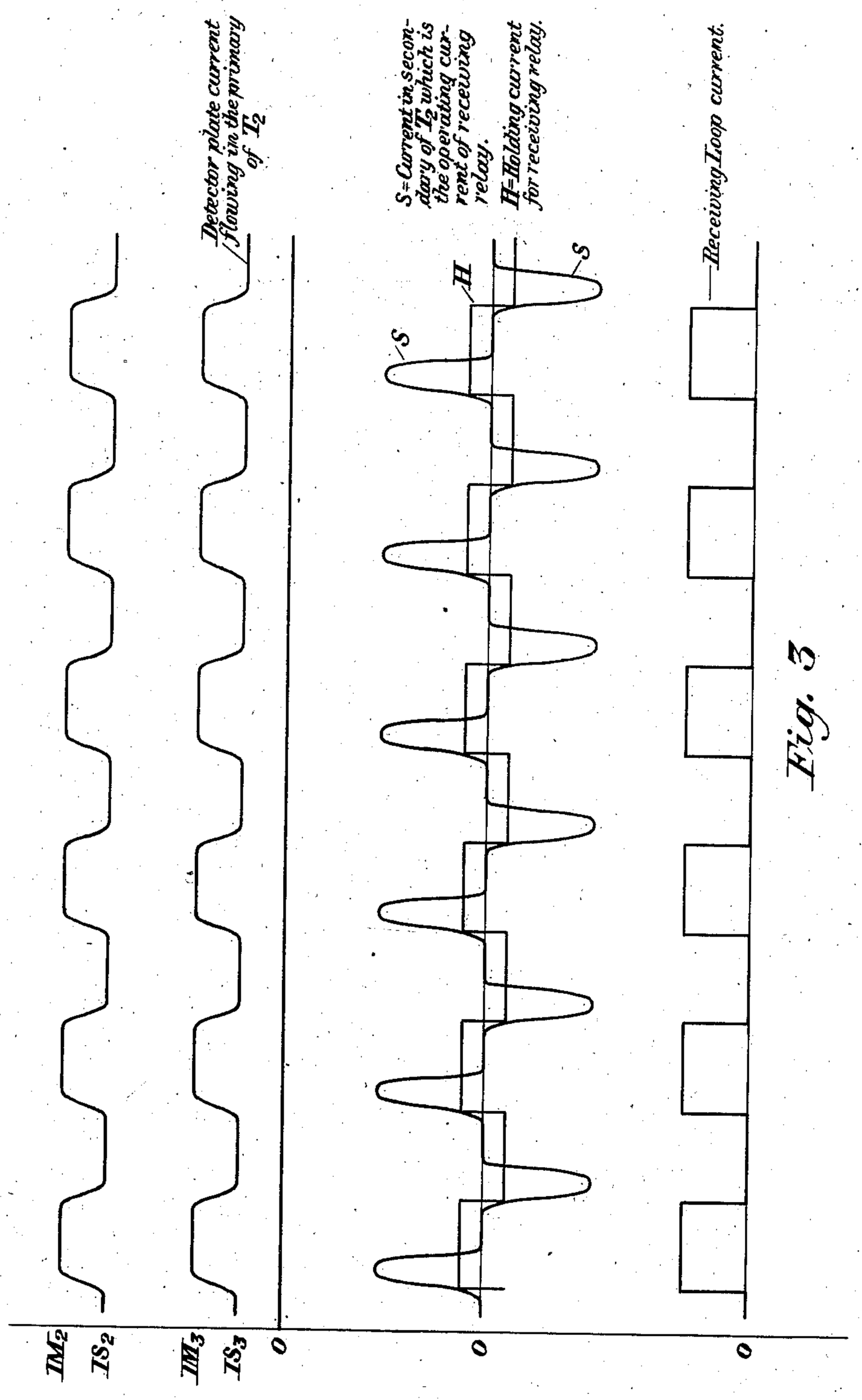

Fig. 3

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CARRIER TELEGRAPH SYSTEM

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6 Claims. (Cl. 178—66)

This invention relates to carrier telegraph systems and, more particularly, to arrangements for reducing the distortion of the telegraph signals received over such systems.

In carrier telegraph systems of the usual type any changes in the received currents are apt to cause distortion in the telegraph signals. These changes in received current are due to a number of causes and primarily to variations in line attenuation with weather conditions. It is the practice in certain types of carrier telegraph systems to utilize sensitive receiving relays, which are biased to spacing by a current which has a magnetic effect on the armature of the relay of one half that of the marking or received rectified current. This biasing current is substantially constant and is independent of the line characteristics since it is supplied from a local battery. It is evident, therefore, that any change in the received current from the distant end will cause bias or distortion in the telegraph signals in the receiving loop circuit. In certain types of service, such as high speed teletypewriter service, this may be sufficiently large to cause trouble. Accordingly, it is one of the primary objects of the invention to provide arrangements whereby variations in the received currents due to changes in line attenuation or to other causes will not cause bias or distortion in the signals in the receiving loop circuit.

While this invention will be pointed out with particularity in the appended claims, the invention itself, both as to its further objects and features, will be better understood from the detailed description hereinafter following, when read in connection with the accompanying drawings in which Figure 1 shows an embodiment of the invention given merely for the purpose of illustration, this figure showing the sending and receiving circuits of each of a plurality of carrier channel terminals; Fig. 2 shows a detector characteristic on which are indicated the various operating ranges of the carrier current detector of this invention and Fig. 3 shows the current magnitudes in various parts of the arrangement illustrated in Fig. 1.

Referring to the drawings, Fig. 1 shows one terminal of a carrier telegraph channel at which there is a branch line L_2 over which carrier signals may be transmitted to line L_1 and a branch line L_3 over which carrier telegraph signals may be received from line L_1. Line L_1 in this particular case is a two-wire line and different frequencies are used for sending to and receiving from the distant station. The same frequency can be and often is used for transmission and reception but in the latter case a 4-wire circuit is used, the two pairs being connected respectively to L_2 and L_3 through suitable transformers. This will be apparent to those skilled in this art.

For purposes of illustration of the invention the local loop circuit is shown full-duplex, that is, separate loops are used for transmission and reception of signals. Half duplex arrangements may be used equally well in the practice of this invention but these are not shown on the drawings since that is not necessary for an understanding of the invention. For transmission of the telegraph signals, the well known balanced loop is used for actuating the sending relay. This will not be described in detail as it does not constitute an important part of the invention. I am concerned here particularly in any arrangement for actuating the sending relay by means of the operation of the subscriber's sending key K_1.

When key K_1 is closed, the armature of the sending relay will rest against its M contact and the carrier current from the carrier supply O will flow freely into the sending filter F_1, branch line L_2, through transformer T_3 to line L_1 and to the distant station. When key K_1 is opened, the armature of the sending relay will move to its S contact, which connects resistance R_1 in shunt with the carrier supply O and this will reduce the input to the sending filter F_1 by a predetermined amount but not to zero. When resistance R_1 shunts the carrier supply O, a substantial current will still be supplied to the filter F_1. Other arrangements may be used for accomplishing this purpose, and these will occur to those skilled in this art, but it will be necessary always to keep in mind that the fundamental method of transmitting signals in accordance with this invention is by means of varying the transmitted current over a relatively small range rather than by changing it from zero up to a certain value as is ordinarily done. This is an important objective of this invention.

The receiving means for signals transmitted in the above manner are shown in the lower part of Fig. 1. Carrier signals are received from the distant station over line L_1, then pass hrough transformer T_3 to line L_3, where they are selected from other signals of other frequencies by the receiving filter F_2 and pass into the amplifier A and from there go through transformer T_1 to the detector tube D. The output of the detector tube D includes one winding, i. e., the primary winding of the transformer T_2, the other winding, i. e., the secondary winding of which connects to the

operating windings of the polar receiving relay. This relay is provided with holding windings H which serve to hold the armature on whichever contact it happens to be resting when there is no current in the operating windings. It is evident that, when either a steady carrier current or zero current is applied to the input to the detector, there will be no current in the operating winding of the receiving relay since the direct current component is kept out of the operating windings of this relay by the transformer T_2. However, when a change of current occurs in the plate circuit of the detector tube, a current will be induced in the secondary of T_2 which will flow in the operating windings of the receiving relay and its magnitude will be such as to overpower the holding current, thus moving the armature of the relay to the opposite contact. The windings of the relay are so poled that an increase of current in the detector plate circuit will move the relay armature to its M contact and a decrease in detector plate current will move the relay armature to its S contact. Movement of the receiving relay armature from one contact to the other connects alternately positive and negative batteries B4 and B5 to the receiving loop L_5 which actuates the subscriber's receiving mechanism S_2.

It will be noted that the polar receiving relay is arranged to operate on changes in received carrier current. There is no local bias current supply for this relay, although there is a holding circuit to keep the relay armature on the contact to which it has been moved by the pulse of current, either marking or spacing from the transformer T_2 in the detector output circuit. The holding circuit is unbiased regardless of inequality in the receiving leg battery voltages and this is because the return circuit from the relay armature is brought to the center tap of a resistance Z connected across batteries B4 and B5, as shown.

A further feature of the invention is the arrangement of the detector input and output circuits so that the detector characteristic will have a large range over which the output has a linear relation to the input. The direct current resistance of both the input and output of the detector is kept as low as possible for this purpose. This improvement is indicated more clearly upon a consideration of curve B especially if compared with curve C in Fig. 2 which is a normal characteristic for a detector circuit.

The foregoing explained the operation of the circuits for sending and receiving signals by means of small changes in the transmitted and received currents. For an understanding of the performance of such a system under various line equivalent conditions, reference is made to Fig. 2 of which curve B shows the detector plate current plotted against detector input level. Assume, for example, that the normal equivalent of the line is such that the input level to the detector for a marking signal is Xm_1 and for a spacing signal is Xs_1. The corresponding detector plate currents will be IM_1 and IS_1. The change in input level from marking to spacing is independent of line conditions since it is determined by the resistance R_1 and the position of the sending relay armature. This charge in input level is indicated in Fig. 2 by C_1. The change in detector plate current for this level is from IM_1 to IS_1, or vice versa, and this change in current through the primary of T_1 in Fig. 1 induces the operating current in the receiving relay windings as shown by curve S in Fig. 3. If the line equivalent changes so that the input level to the detector for a marking signal is now Xm_2 and for a spacing signal Xs_2, the change in detector plate current will be IM_2—IS_2 when going from the marking to the spacing condition. This change is substantially equal to IM_1—IM_2 so that the effect on the receiving relay is the same as for the normal level case. The same conditions obtain when the line level drops to such a value that the input level for a marking signal is Xm_3 and for a spacing signal Xs_3. It is thus evident that over a considerable range of line equivalents, the telegraph signals will be received free from bias which would ordinarily be present in the ordinary sending and receiving means.

In addition to compensating for line attenuation changes, the circuit arrangements of this invention take care to some extent of the change in battery voltages at the terminal stations. At the sending station, for example, the oscillator and sending amplifier which together supply the carrier current will vary in output with charges in battery potentials and at the receiving station the gain of the receiving amplifier will likewise vary with changes in battery potentials. In any case involving the features of this invention, the pulse of current which operates the relay to its M contact will be the same in magnitude as that which operates it to its S contact and signals will be repeated unbiased.

In Fig. 3, the two upper curves are practically the same. They show that the plate current flowing through the primary winding of the transformer T_2 is independent of large changes in, for example, the line equivalent of the transmission circuit. Curve S shows the current in the secondary winding of transformer T_2. The square cornered curve H shows the holding current flowing through the holding windings H of the receiving relay. The lowermost curve shows the current in the receiving loop L_5.

While the invention has been disclosed as embodied in certain specific arrangements which are deemed desirable, it is understood that it is capable of embodiment in many and other widely varied forms without departing from the spirit of the invention as defined by the appended claims.

What is claimed is:

1. The method of transmitting carrier telegraph signals which consists in continuously and uninterruptedly transmitting a carrier current during signaling, changing the magnitude of the carrier current during its transmission by a small predetermined amount in accordance with marking and spacing signals and maintaining the said changes in magnitude of the said carrier current at the transmitting and receiving terminals substantially free of bias independently of variations in the transmitting medium within predetermined limits.

2. In a carrier telegraph system, a source of carrier current which is uninterruptedly emitted for conveying signals to a distant point, means for varying the magnitude of the uninterrupted current emitted by said source by a small, predetermined amount corresponding to telegraph signals, and means for maintaining the said changes in magnitude of the said carrier current at the transmitting and receiving terminals substantially free of bias independently of variations in the transmitting medium within predetermined limits.

3. In a carrier telegraph system, the method of reducing the effect of line equivalent changes

which consists in transmitting uninterruptedly a carrier current the amplitude of which varies by a predetermined amount in accordance with signals and maintaining in the uninterrupted carrier current a fixed amplitude change during reception independent of variations in the conditions of transmission.

4. The method of signaling which consists in generating a carrier current, varying the magnitude of said carrier current by a small amount in accordance with telegraph signals without interrupting said carrier current, transmitting said modulated carrier current, receiving said modulated carrier current, rectifying it into current pulses corresponding to the original signals, and maintaining said pulses of a magnitude which is always independent of the medium of transmission.

5. The combination of a source of alternating current of large amplitude, means for tranmitting said alternating current and varying its magnitude by a small amount in accordance with signals, the transmitted signal bearing current always being of substantial magnitude, a vacuum tube detector upon which said alternating current is impressed, and a circuit coupled to said detector to which the detected current is transmitted, said detector having input and output circuits of low resistance so that the characteristic of the detector will have a large range over which the output circuit current bears a linear relation to the input circuit current.

6. In a carrier telegraph system, a line having a transmission characteristic which is highly variable and transmitting current of large but slightly variable amplitude corresponding to telegraph signals, a detector having low resistance input and output circuits, the input circuit of said detector being coupled to said line, a circuit coupled to the output circuit of said detector in which pulses of detected current flow, and means including said detector and the circuit coupled to the output circuit of the detector whereby said pulses will maintain an amplitude variation in said circuit coupled to the output circuit which is always independent of the variations in the transmission characteristic of said line.

VAUGHN P. THORP.