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TELEGRAPH CORRECTION SYSTEM

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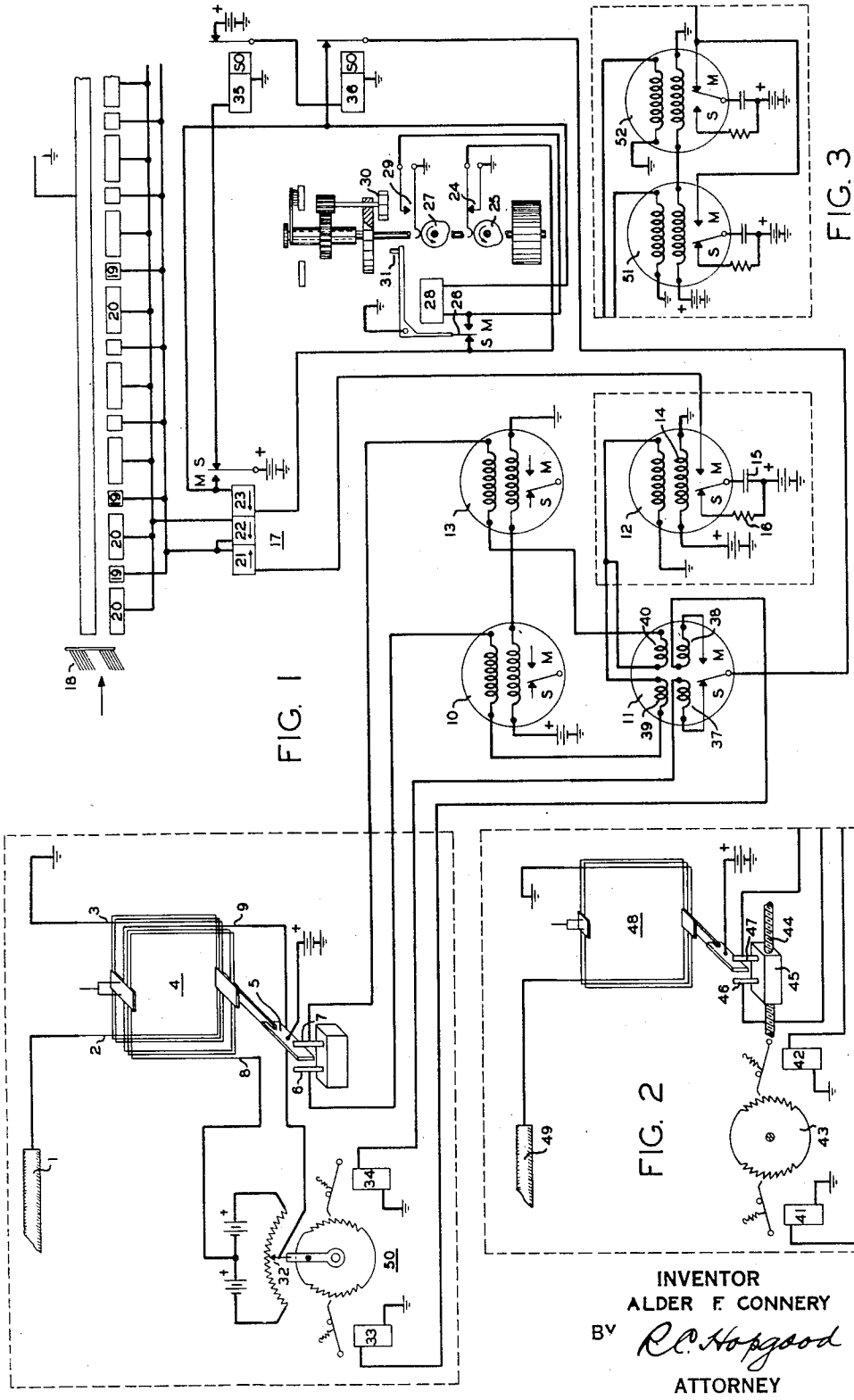


FIG. 1

FIG. 2

FIG. 3

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TELEGRAPH CORRECTION SYSTEM

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My invention relates to telegraph and like signalling systems, and particularly to submarine cable telegraph systems and means whereby automatic correction of bias distortion is accomplished.

Long submarine telegraph cables are subject to a flow of current which is caused by differences in the earth potential between the grounding points of the system. These earth currents vary in direction and amplitude from time to time and will interfere with the reception of signals unless means are applied to counteract them. When the receiving instrument is in the form of a relay, the action of these earth currents causes the zero position of the relay armature to move to one side or the other of its proper position, resulting in the output signals from the relay being biased, and this may result in errors in transmission.

Various methods have been adopted in order to overcome the interfering effects produced by earth currents. One of the commonest methods is to insulate the receiving instrument from the cable, by means of a blocking condenser or transformer, so as to prevent a flow of steady current from the cable into the receiving instrument, or, in other words, to prevent the very low frequency components of the received current from flowing from the cable through the receiver. The necessary low frequency components are then supplied to an auxiliary coil of the relay through a local shaping network from the receiving relay contacts. While the method just described is effective in preventing earth currents causing a persistent bias on the receiving instrument, the difficulties in shaping the received signal are very much increased and any irregularities or faults in the contact of the receiving relay will result in a detrimental effect on the shape of the relay signal. Furthermore, this method does not entirely eliminate biased signals from the relay because the relay, due to its mechanical instability, may in itself create a bias and, if there is an amplifier or magnifier between the cable and the relay, the difficulties due to local biasing, which is not caused by earth currents, are very much increased. It is customary, when this method is used, to provide a manually controlled counter-biasing effect which an attendant may adjust from time to time.

Another method of automatically correcting bias is to have an auxiliary receiving relay controlled by the received signals, which has its contacts so adjusted that the armature will, under normal conditions, just fail to touch either of these contacts; and, when an earth current results in a greater amplitude of the armature in one direction or the other, a circuit is completed through one of the relay contacts and a correcting means is brought into action which tends to neutralize the effect of the earth current so the armature relay will again just fail to make contact. The objection to this method is in its lack of sensitivity to bias and the difficulty in keeping the added relay in suitable adjustment. It is obvious that, if for any reason the size or overall amplitude of the signals should increase, the relay armature will be constantly operating the correcting means and this may bring in a biased condition. On the other hand, if the overall amplitude of the signals should be reduced, then it will be necessary for the received signals to assume a considerable bias before any bias correction is made.

Among the principal advantages of my method of correcting bias is its sensitivity or ability to correct for an extremely small amount of bias and the fact that it will correct biased signals regardless of whether they are caused by earth currents or local apparatus variations. Furthermore, my method is not dependent upon signal amplitude, the bias correction being effected by relative phase shift, and no delicate apparatus is required to detect and control bias.

My method of automatically correcting signal bias is not only applicable to the various codes and signalling methods used in submarine cable telegraphy, but may also be used to control bias in land line direct current telegraphy. Another application of my invention is, in connection with carrier current telegraphy, to automatically control the amount of gain or amplification. Another important application is in connection with operation of synchronous telegraph systems over radio circuits. One of the difficulties of working synchronous systems over radio circuits has been the type of distortion known as fading, which has a biasing effect on relay signals. By the use of my invention it will be possible to automatically control the amplification of the radio receiver so that when the signals become too strong the amplification will be automatically reduced, and vice versa, the signals from the relay, therefore, remaining unbiased.

One embodiment of my invention, described here, is in connection with a synchronous submarine telegraph system in which the rotary receiving instrument is provided with phase correcting means of the so-called "clock hand" type. In other words, the brushes of the receiving distributor are normally set so they revolve a trifle

too fast and are from time to time retarded in order to maintain them in synchronism with the received signals. The operation of a phase correcting system of this type has been described in U. S. Letters Patent No. 1,927,707, issued to M. B. Kerr. One important detail in which the phase correcting system described herein and that described in the Kerr patent differ is in the method of generating corrector impulses. In my invention these corrector impulses are generated at the beginning of the received signals of both positive and negative polarity, instead of by signals of only one polarity. In the phase correcting system used in connection with my invention, the means of determining whether the distributor brush has advanced beyond its true position by an amount requiring it to be corrected backward is to compare the moment of cross-over of received signals of plus to minus, or vice versa, with the position that the brush should occupy with respect to definitely located conductive segments on the distributor, the edges of which segments represent the points at which the brush should be when the received signal changes polarity, if the brush is to be in phase with the brush of the sending distributor. This determination is made with the aid of relays and magnets associated with the receiving distributor.

When signals are received over a long submarine cable, the moment of arrival of the various signal impulses will not have the regularity of the impulses transmitted into the cable at the distant end. The moment of arrival will be determined, to a large extent, by so-called "history" effects. For example, in the three-element cable code, in which dots and dashes are represented by impulses of equal length but of opposite polarity and spacing signals by zero impulses, the moment of arrival of a dot following a dash or of a dash following a dot will be appreciably later than if the dot or dash had followed a zero impulse. Since the correcting segments of the receiving distributor are equally spaced, it will be obvious that it will not be possible to have the moment of cross-over of all the various signals coincide with the distributor corrector segments. In actual operation a phase corrector system of the type which we are now considering will maintain the distributor brushes with respect to the corrector segments so that phase corrections will be generated only from those signals which have the greatest lag with respect to the transmitted signal. In other words, the brushes and equally spaced segments may be considered as a phase discriminating means, since they choose to initiate phase corrections only from those signals which have certain phase distortion characteristics.

In a phase correction system of this type, which is arranged to operate on signal changes both from plus to minus and from minus to plus, it will be obvious that, when unbiased signals are being received on properly adjusted apparatus, the phase correction of the brush as it gradually creeps ahead will be caused indiscriminately by signal changes in either direction. On the average there will be as many phase corrections originated by the received signals when they are crossing from plus to minus as when they are crossing from minus to plus. When a bias is introduced into the received signal, in any way causing the signals to be heavier or of longer duration for unit impulses of one polarity than for those of the other polarity, the moment of cross-over of received signals in going from plus to minus occurs when the brush is in a different position relative to the correcting segment than when the cross-over is from minus to plus. Thus, when there is a bias toward the dash side, the moment of cross-over of the received signal from dash to dot is delayed with respect to the moment of cross-over from dot to dash, and therefore the distributor brush will be farther ahead at the moment of cross-over from dash to dot than it is at the moment of cross-over from dot to dash. As corrections are originated when the distributor brush advances on to the correcting segment at the moment of cross-over, continued bias on the dash side would result in all of the correcting impulses originating from cross-overs from dash to dot, and, vice versa, if there were a dot bias the cross-over from dot to dash would be delayed with respect to the cross-over from dash to dot and all of the correcting impulses would originate from cross-overs from dot to dash.

The predominance of phase corrections originating on cross-overs from dot to dash, or from dash to dot, is the basis of my invention. My invention is based on the assumption that, whenever a phase correction occurs in going from dash to dot, there exists a dash bias, or, vice versa, whenever a phase correction occurs in going from dot to dash there exists a dot bias and, therefore, this bias should be instantly corrected. These steps of bias correction are very small with respect to operating current of the relays so that, if a bias does not exist, the actual bias put on the relay by the bias corrector is extremely small. However, it has been found that the phase shift of the signal in time, as determined by its moment of cross-over, is very sensitive to the displacement of the zero current axis of the signalling current, which results in causing biased signals, and even a very small bias put on the signal in this way is sufficient to be indicated immediately by the next correction taking place in the opposite sense and, thereby, immediately restoring the unbiased condition.

One method which I use, to correct the bias in the received signal, is to apply the proper amount of current through an auxiliary winding on the main line relay coil. This biasing current is controlled by a potentiometer, the resistance of which is controlled by stepping a contacting device in one direction when corrections are caused by cross-overs from dashes to dots and stepping it in the other direction when corrections are caused by cross-overs from dots to dashes. Various other means of producing a correcting bias on the main line relay in accordance with either one of the two types of phase correction may be used.

The claims to my invention apply not only to cable signals having three elements or polarities, namely, positive, negative and zero, but also to signalling codes having only two elements or polarities such as positive and negative or positive and zero signals, etc., as well as other signalling codes composed of various combinations of current strengths or polarities.

Other objects of this invention will be apparent from the following description when read in connection with the attached drawing of which:

Fig. 1 shows the invention applied to a regenerative repeater used in connection with a long submarine cable system.

An automatic method of disconnecting and reconnecting the automatic bias corrector circuit is also shown in Fig. 1.

Fig. 2 illustrates an alternative method of bias-

ing the main cable relay by adjusting the position of the relay contact pins.

Fig. 3 shows a modified arrangement of the corrector relay.

The signals received over the cable 1 flow through one winding 2 to 3 of cable relay 4, and thence to ground. This coil is suspended in a magnetic field and may be deflected one way or the other from its zero position, depending upon the polarity of the received signal. During the reception of a dot, the cable relay tongue 5 will remain against the dot contact 6, and during the reception of a dash, the tongue will make contact with contact 7. During the reception of a zero interval, the tongue will remain midway between contacts 6 and 7. The cable relay coil also carries an auxiliary or correcting winding 8—9, which is automatically controlled in a manner which will be described later. The tongue 5 is connected to positive battery; and when the tongue is touching dot contact 6, current will flow through the dot relay 10 and winding 39 of the bias correcting relay 11, through the winding of the corrector relay 12, and thence to ground. The bias correcting relay 11 will move its spacing contact. When the tongue 5 makes contact with dash contact 7, the dash relay 13 will be operated and current will also flow through winding 40 of bias correcting relay 11 which will move to its marking contact and corrector relay 12 will also operate and move to its marking contact. The dot relay 10 and dash relay 13 may be used in connection with regenerator circuits which can be operated from the same distributor, shown in this figure, but, since regenerator circuits are well known and form no part of this invention, they will not be described here.

Reviewing again the operation of relays 11 and 12, it should be noted that the tongue of relay 11 will move to its spacing contact S whenever a dot is received, and it will move its tongue to the marking contact M whenever a dash is received. Relay 12 will move its tongue to the marking contact M when either a dot or dash is being received, but the tongue of this relay will move to its spacing contact S during the intervals when a zero signal is being received, and, furthermore, in case a dot or a dash directly follow one another, corrector relay 12 will move its tongue to the spacing contact during the brief interval that the tongue 5 of the cable relay is in transit between contacts 6 and 7. Corrector relay 12 moves its tongue to the spacing contact when no signal is being received, by virtue of the current in the biasing winding 14. Each time the tongue of corrector relay 12 moves to its spacing contact, condenser 15 will discharge through resistance 16. Whenever a dot or a dash is received, the tongue of relay 12 will move to its marking contact, and the charge of the condenser will flow through the marking contact of relay 12, and through either one or two windings of correcting relay 17, depending upon whether the brushes 18 are at that instant upon segments 19 or segments 20. If the brushes are on segments 20, the condenser charge will flow through windings 21 and 22 in a series opposing direction, and, therefore, the correcting relay will have no tendency to operate. If, on the other hand, the brushes are slightly out of phase with respect to the signal, the brushes 18 will be on segments 19 when the condenser charge occurs, and, therefore, this charge will only pass through winding 21 of relay 17, which will lock itself up through its locking winding 23. The path of this locking circuit is from plus battery through the tongue of the correcting relay 17, through the marking contact M, through winding 23, and thence through contacts 24 which are controlled by cam 25. In the event that relay 17 should attempt to lock up at the instant that contacts 24 are opened, then the locking circuit will be maintained by the spacing contact of tongue 26. When the contact 29 is closed by cam 27, a circuit is completed from the tongue of correcting relay 17, marking contact M, winding of corrector magnet 28, and through contacts 29 to ground. Corrector magnet 28 will operate and lock itself up through its marking contact M, the armature will move pin 51 into the path of the star wheel 30, and at a certain point in the revolution this star wheel will engage with the pin 31 and cause the brushes to be stepped back a definite amount with respect to the phonic motor. When contacts 24 are opened by cam 25, the locking circuit of corrector relay 17 will be deenergized and the return to normal of relay 17 will also deenergize corrector magnet 28. This stepping back of the brushes from time to time will keep them in proper phase with respect to the received signals, and as previously explained, in the case of a dash bias on the incoming signals the corrections will be generated only on dot signals, and in the case of a dot bias will be generated only on dash signals.

An automatic bias correcting unit is shown at 50. A contact arm 32 forms part of an adjustable potentiometer, which will cause a current to flow through the correcting winding 8 to 9 of the cable relay, the direction and strength of this current depending upon the position of contact 32. The position of the contact 32 is automatically controlled by the stepping magnets 33 and 34. Each operation of magnet 33 will alter the biasing effect on the cable relay a definite amount in one direction, and operation of magnet 34 will alter the bias a definite amount in the other direction. Each time corrector magnet 28 operates, magnet 33 or 34 will operate, and the decision as to which of these two magnets is to operate depends upon the bias correcting relay 11, which has been previously positioned by the received signals. If, for example, phase correction should occur on a dot signal, bias correcting relay 11 will be on its spacing contact when correcting relay 17 operates, and a current will flow through the following circuits: from plus battery through the tongue and marking contact of the correcting relay 17, through tongue and contact of relay 36, through the tongue of bias correcting relay 11, through the spacing contact, through locking winding 37, and through the winding of magnet 34 to ground. As long as current flows through this circuit, the bias correcting relay 11 will be held firmly to its spacing contact, because the effect of the current in winding 37 is greater than the current in windings 39 or 40, and the direction of the locking current is such as to hold the relay firmly upon the contact. If phase correction should occur on a dash signal, then bias correcting relay 11 will be on its marking contact when the tongue of correcting relay 17 operates, and the following circuits will be completed: from plus battery through tongue and marking contact of correcting relay 17, through tongue and contact of relay 36, through the tongue and marking contact of bias correcting relay 11, through locking winding 38, and thence to magnet 33 and ground. Bias correcting relay 11 will be held firmly to its marking contact as long as correcting relay 17 remains operated.

It is obvious from the foregoing that, if there

is a dot bias on the received signals, all the phase corrections will result from dash signals, and, therefore, each time a phase correction is made magnet 33 will operate, which will vary a neutralizing current through winding 8 to 9 of the cable relay 4 which will tend to compensate for the bias. When the bias has been compensated for, corrections will occur alternately on dot and dash signals, and therefore, magnets 33 and 34 will be operated alternately. The voltage of the batteries connected to the potentiometer are of such value that the amount of bias introduced in the cable relay by a single operation of magnet 33 or 34 will be small, and, therefore, the alternate operations of magnets 33 and 34 will have a negligible biasing effect.

When no signals are received over a long cable circuit containing one or more regenerative repeaters, the repeater apparatus will be unable to correct for phase shift, and when signals are finally received some time may elapse before the distributors pull into proper phase with the signals. While the distributor is coming into phase, it is desirable to disconnect the automatic bias correcting unit and re-connect it when the distributor is again properly correcting. This is to avoid the possibility of the automatic bias corrector pulling the signals into a bias when the distributor is correcting improperly.

Relays 35 and 36 are of the type which are slow to operate and quick to release. These relays should preferably be adjusted to require from 20 to 30 seconds to operate. An oil filled dashpot type has been found suitable. Relays 35 and 36 are shown in the position they would occupy when the distributor is properly correcting. Relay 35 tends to operate as long as relay 17 remains on its back contact. Under normal conditions, relay 17 will operate often enough to prevent relay 35 operating. If, however, no signals are received for a sufficient length of time, relay 35 will operate and release relay 36, which will interrupt the circuit to the tongue of bias correcting relay 11. When signals are received again and correcting relay 17 operates, relay 35 will be released and thus cause relay 36 to tend to operate. Relay 36 will finally operate and complete the circuit to bias correcting relay 11. Relay 35 should be adjusted so it will operate in the time required for the distributor to pull out of phase when no signals are received, and relay 36 should be adjusted so the time required for it to operate should be greater than the time required for the distributor to pull into phase and be correcting properly after a pause in the reception of signals.

Instead of establishing a neutralizing current in the auxiliary winding of the cable relay, it may be preferable to automatically make a mechanical adjustment on the cable relay. One method of doing this is shown in Fig. 2. The apparatus contained in Fig. 2 may be substituted for that contained within the dotted lines surrounding relay 4 and associated circuits.

Referring to Fig. 2, the magnets 41 and 42 are the equivalent of magnets 33 and 34 in Fig. 1 and are connected in the same manner, so that either one or the other of these magnets will be operated, depending upon the manner in which the signal is biased. Ratchet wheel 43 will be rotated in either direction, thus turning the spirally cut shaft 44, which in turn moves contact carrier 45. The movement of contact carrier 45 will move contact pins 46 and 47, which are equivalent to the pins 6 and 7 in Fig. 1. Relay 48 and cable 49 are equivalent to 4 and 1 in Fig. 1. The movement of the pins 46 and 47 will create a bias in the cable relay which will offset or neutralize the bias due to earth currents or other causes, so that the signal output from the relay will be unbiased.

To apply this invention to two-element signals in which the cross-over or transit of the tongue of the main receiving relay occurs very quickly, it may be found necessary to re-arrange the phase corrector circuit so that a condenser impulse will be generated on both dots and dashes, in spite of the brief transit interval on the main receiving relay.

The relays and circuits shown in Fig. 3 may be substituted in Fig. 1 for the relay and circuits contained within the dotted lines enclosing relay 12 in Fig. 1.

When this substitution has been made, it will be observed that relay 51 will be operated when the received signal is of one polarity, and relay 52 will be operated when the received signal is of opposite polarity, and, therefore, the condenser connected to one of these relays may be discharging while the condenser connected to the other relay is charging, and vice versa. This arrangement of circuits will result in the condenser impulses being properly generated from the received signals, regardless of how quickly the receiving relay 4 makes the transit from one contact to the other.

What is claimed is:

1. In a cable system, the method of correcting for zero displacement which consists in generating a counterbiasing effect on the received signals, said counterbiasing effect being controlled by the relative phase difference between signals of different polarity.

2. The method of eliminating earth current effect in a cable system which consists in producing, and controlling by the relative phase difference between signals of different polarity, a local current acting on the received signal impulses and neutralizing the distorting earth current effect.

3. In a signal receiving system, the method of automatically correcting bias which consists in comparing the phase of received signals of different polarities having similar phase distortion characteristics and controlling by said received signals a counterbiasing effect acting on said received signals to maintain them substantially unbiased.

4. In a signal receiving system, the method of correcting bias which consists in comparing the relative phase of received signals of different polarity and controlling a counterbiasing effect to maintain said signals unbiased, the direction of changes in said counterbiasing effect being controlled by relative phase of said received signals.

5. In a signal receiving system, the method of correcting bias in the received signals which consists in comparing the phase of those received signals of one polarity having the greatest phase distortion with those received signals of different polarity having the greatest phase distortion, and controlling a counterbiasing effect acting on the received signals, the direction of changes in said counterbiasing effect being determined by the relative phase of the compared received signals.

6. In a signal receiving system, the method of correcting bias in received signals which consists in generating impulses from received signals of different polarities, utilizing only those generated impulses having certain phase distortion characteristics for maintaining synchronous distributing apparatus in phase with the received signals

and for varying a counterbiasing effect acting on the received signals, the control of direction of each variation in said counterbiasing effect being subject to the polarity of the received signal from which the utilized impulse was generated.

7. In a signal receiving system, a synchronous distributing member, means for correcting phase between received signals and said synchronous distributing member, said phase correcting means being controlled by received signals of one polarity when received signals are biased in one direction, and by received signals of a different polarity when received signals are biased in the other direction, together with means for producing a counterbiasing effect acting on said received signals, the direction and strength of said counterbiasing effect being controlled by the polarity of the received signals which initiate phase corrections.

8. In a signal receiving system, receiving apparatus, a synchronous distributing member, means for generating phase correction impulses from received signals of different polarities, phase discriminating means for utilizing only those phase correction impulses generated by received signals of one or the other of two polarities depending upon the direction in which the received signals are biased from normal, means for producing a variable counterbiasing effect acting on the received signal, means for controlling the direction and strength of said counterbiasing effect by the polarity of the received signals from which the utilized phase correction impulses were generated.

9. In a telegraph system in which signals comprising combinations of different polarities are received, the combination of means for producing a counterbiasing effect acting on said received signals, phase controlled means for intermittently indicating the polarity of the received signals having the greatest time lag with respect to the transmitted signal, means for changing the strength of said counterbiasing effect, said counterbiasing effect being controlled by said phase controlled means and acting to change the counterbiasing effect in one direction or the other, depending upon the indicated polarity of the received signal.

10. In a signal receiving system, subject to disturbing voltages, a receiving instrument, a potentiometer connected thereto, and automatic means controlled by the relative phase of received signals of different polarity to vary the voltage applied from the potentiometer to the receiving instrument.

11. In a cable system comprising receiving apparatus which includes a member oscillatable about a zero position, the method of maintaining the zero position unaffected by disturbing potentials impressed across the receiving apparatus which consists in generating, and controlling by the relative phase of received signals of different polarity, a correcting effect equal and opposite to the disturbing effect.

12. In a signal receiving system, means for receiving signals of different polarities, a phase and bias correcting system for generating simultaneous phase and bias corrections from said received signals, the direction of said bias corrections being determined by the polarity of signals from which said phase and bias corrections were generated.

13. In a signal receiving system, signal receiving means, a synchronous distributor, phase correcting means acting on said distributor, bias correcting means acting on said receiving means, said phase and bias correcting means being both controlled by the relative phase of received signals and said distributor, said bias correcting means being also controlled by relative phase of signals of different polarity.

14. In a signal receiving system in which the received signals are subject to biasing, a bias corrector consisting, in combination, of phase discriminating means for utilizing, for correction purposes, received signals of one polarity when a bias exists in one direction, and for utilizing received signals of a different polarity when a bias exists in the other direction, together with means for controlling, in accordance with the polarity of said utilized received signals, a counterbiasing effect acting on the received signals to maintain them substantially unbiased.

15. In a signal receiving system, a phase controlled bias corrector comprising, in combination, received signals of different polarities, means for generating impulses from said received signals in such manner that the relative phase difference between impulses generated by signals of different polarities is an indication of the amount of bias in the received signal, synchronous means for detecting said phase difference between said impulses and for controlling counterbiasing means acting on said received signals to maintain them substantially unbiased.

16. In a system for receiving signals of different polarities, a synchronous distributing member, a counterbiasing device acting on the received signals, means for generating phase correction impulses from the received signals of different polarities, phase discriminating means for selecting only those phase correction impulses having certain phase characteristics to control means for correcting the relative phase between said received signals and said synchronous distributing member and also for controlling operations of said counterbiasing device, together with means for determining the polarity of signal from which was generated the utilized correction impulse and for controlling accordingly the direction of operations of said counterbiasing device.

17. In a signal receiving system in which the received signals are subject to biasing, receiving apparatus, a synchronous distributing member, means for correcting relative phase between said synchronous distributing member and said received signals, a phase controlled bias corrector acting on said received signals, means for rendering said bias corrector inoperative when no phase corrections occur for a predetermined time and means for again rendering said bias corrector operative when phase corrections again occur.

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