Sept. 5, 1944. C. W. LATIMER 2,357,671

PHASE CORRECTION CIRCUIT

Filed May 29, 1943 2 Sheets-Sheet 1

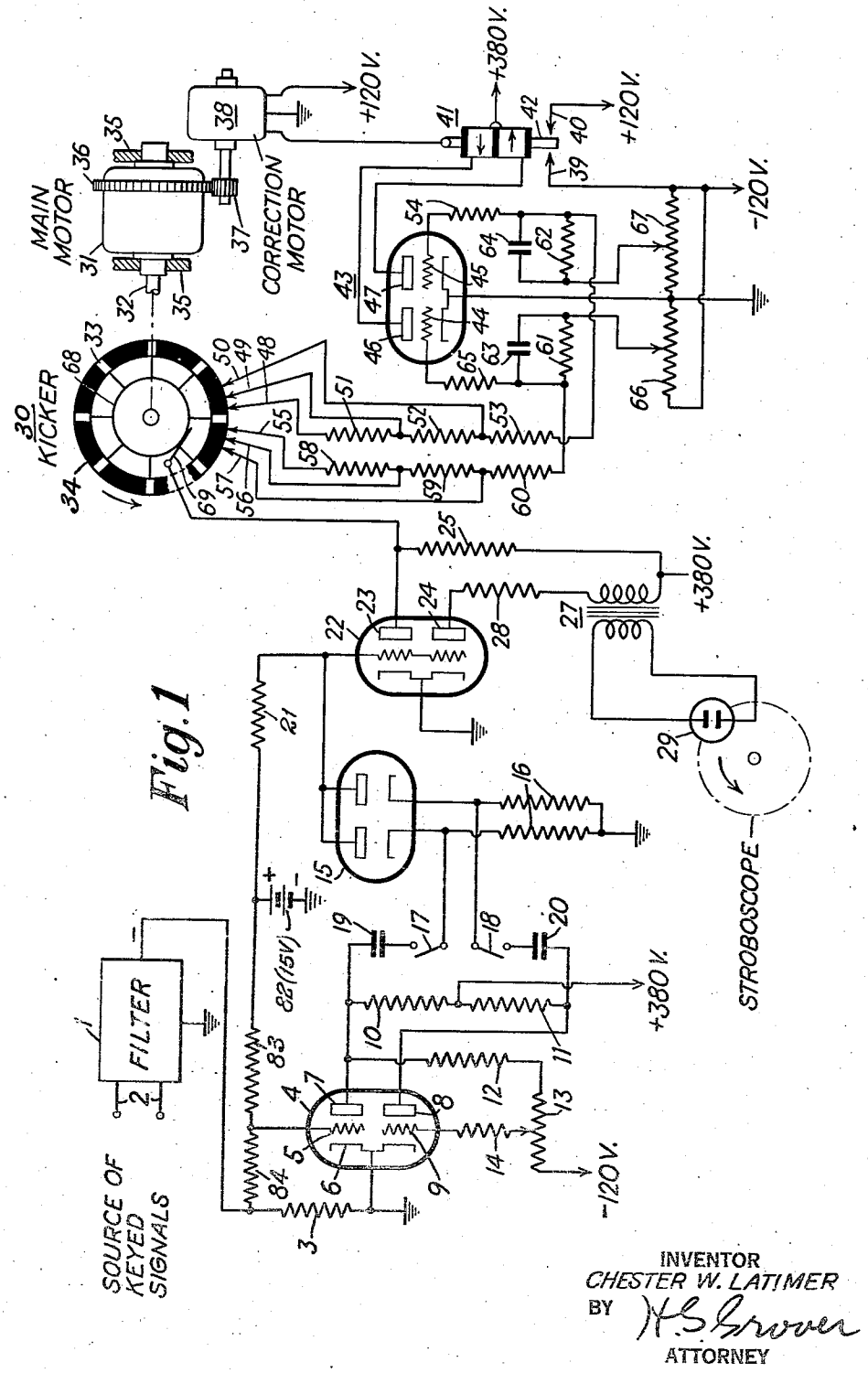


Fig. 1

INVENTOR
CHESTER W. LATIMER
BY H. S. Grover
ATTORNEY

Sept. 5, 1944. C. W. LATIMER 2,357,671

PHASE CORRECTION CIRCUIT

Filed May 29, 1943 2 Sheets-Sheet 2

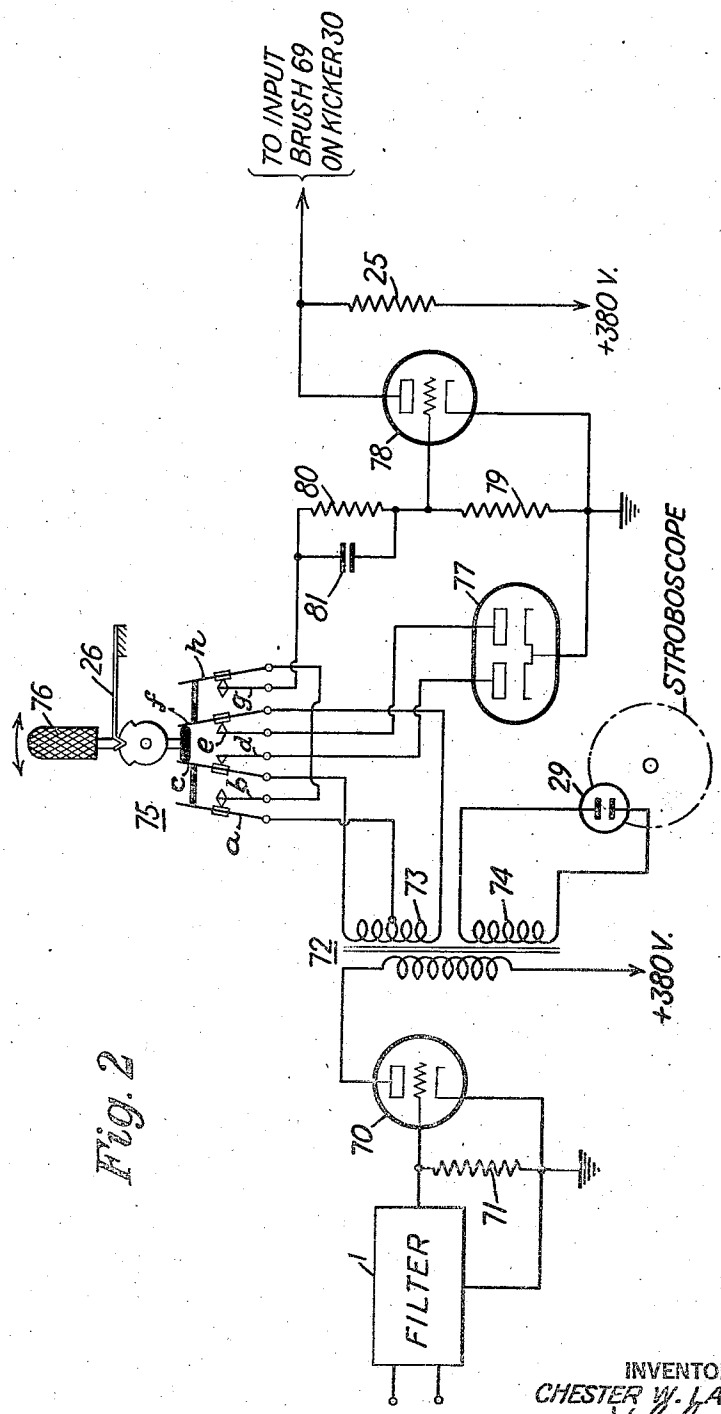


Fig. 2

INVENTOR
CHESTER W. LATIMER
BY H. S. Brown
ATTORNEY

Patented Sept. 5, 1944 2,357,671

UNITED STATES PATENT OFFICE

2,357,671

PHASE CORRECTION CIRCUIT

Chester W. Latimer, West Orange, N. J., assignor to Radio Corporation of America, a corporation of Delaware

Application May 29, 1943, Serial No. 488,988

11 Claims. (Cl. 178—53)

This invention relates to improvements in phase correction circuits, particularly for synchronizing the operating equipment of a telegraph receiver with transmitting equipment at a telegraph signal sending station. I am aware that many devices have been utilized in the past for the maintenance of a receiving distributor in phase synchronism with the incoming telegraph signals. It is an object of my invention to improve upon devices heretofore used.

A more specific object of my invention is to provide phase correction apparatus including a simplified electronic circuit arrangement in combination with rotative switching mechanism such that departures from synchronous phase in a rotating distributor shall be corrected more rapidly when such departures are excessive, and less rapidly when such departures are slight.

Another object of my invention is to provide improvements in a phase corrector such as to preserve the effectiveness of correcting pulses locally derived at the receiving station despite the unavoidable occurrence of wide variations in the time ratio between marking and spacing signal code elements. The attainment of this object is particularly desirable in radio telegraph systems because of multipath signal reception and consequent elongation of the marking pulses in varying degree.

Still another object of my invention is to provide electronic equipment for controlling a phase corrector, and, in combination therewith, means for choosing whether the front edges, the back edges, or both front and back edges of the marking signals shall be used as reference points in the derivation of correcting pulses.

In telegraph signalling, it is well known that the original rectangularly shaped signal envelope becomes more or less distorted when transmitted over a given channel. In particular, the build-up time at the front edges and decay time at the trailing edges of marking signals may be quite appreciable, and the effective time duration of received marking signals may be thereby appreciably increased beyond the duration of the transmitted marking signals, with the result that a spacing signal element immediately following a marking element is partially overlapped by the latter, and the overlapped portions of the signal elements are thereby rendered unusable for communication. This is especially the case over a radio channel in which multipath effects from time to time cause wide variations in the effective time duration of received marking signals. Although wave shaping circuits are frequently interposed between the signalling channel and the recording or printing apparatus, such circuits are generally complicated, more costly than is warranted for certain channels of communication, and not capable of automatically dealing with wide variations in the effective length of received marking signals as well as other forms of distortion. It is desirable, therefore, that a phase corrector be so designed that it will operate successfully notwithstanding the presence of a high degree of signal distortion. This condition is met in accordance with my invention by providing means whereby, as a matter of choice, the phase corrector may be controlled either by the front edge, the back edge, or both edges of the marking signal elements. This choice is exercised in accordance with the relative steepness of the wave slope during a mark-space shift and during a space-mark shift, and in accordance with the constancy of increase in the effective time duration of marking signals received over the particular circuit.

The technique of phase correction as heretofore employed in radio circuits is illustrated by Patent No. 2,038,375, dated April 21, 1936, and Patent No. 2,062,009, dated November 24, 1936, both granted to Richard E. Mathes.

My invention will now be described in more detail, reference being made to the accompanying drawings, in which:

Fig. 1 shows diagrammatically a circuit arrangement and associated apparatus units for carrying out the invention; and

Fig. 2 shows an alternative circuit arrangement which may be substituted as a portion of the complete circuit arrangement shown in Fig. 1.

Referring first to Fig. 1, I show therein a filter 1 having input terminals 2 which may be connected to a source of rectangular wave telegraph signals. Usually these signals before rectification are transmitted as a keyed tone envelope over a wire line from a radio receiving station (located in a convenient outlying district) to a commercial communications office in a metropolis. The filter 1 follows an amplifier-rectifier in order to eliminate a residual line tone component from the rectified D. C. signal. Other provisions for receiving the incoming signals may, however, be made, if desired. The output from the filter 1 may be considered as a keyed train of rectangular waves varying between ground potential and a potential which is negative with respect to ground. Such signals are preferably applied across an impedance 3 in the input circuit of an amplifier tube 4 having a grid 5 in one of its twin sections. The common cathode 6 of this

tube supplies emission to both sections. The tube also contains two anodes 7 and 8 and a control grid 9 for the second section of this twin arrangement. The anodes 7 and 8 are supplied through resistors 10 and 11 with positive D. C. potential, illustratively indicated as +380 volts. The common cathode 6 is grounded.

In order to obtain a thresholding action in the tube 4, for the purpose of rejecting line and other electrical noise and portions of marking signal envelopes of lower level than some predetermined fraction of full marking level, it is preferable to maintain a somewhat positive normal bias on the grid 5. This grid is thus connected through resistor 83 to the positive terminal of source 82, while the negative terminal of said source is grounded. Resistor 84 in the input circuit also contributes to the thresholding action. Satisfactory ohmic values for resistors 83 and 84 are 1½ megohms and ½ megohm respectively, when the source 82 is rated at about 15 volts. A limiting action in tube 4 for the purpose of obtaining full marking output, notwithstanding variations in marking signal amplitude below peak amplitude not greater than some predetermined fraction of peak marking amplitude, is obtained by applying to grid 5 marking voltage which is appropriately more negative than is needed to cut off current from plate 7 to cathode 6.

Tube 4 is operated as a push-pull device, the anode 7 being connected through resistor 12 and potentiometer 13 to a terminal of the power supply source which is more negative than a grounded intermediate tap thereof. This more negative potential is indicated illustratively as —120 volts. The grid 9 is biased by means of a resistor 14 connected to a tap on the potentiometer 13. When the tube section controlled by grid 5 becomes conductive, a reduced positive potential on the anode 7 causes a reduction in the potential drop through resistor 12 and potentiometer 13, whereby the grid 9 is driven more negative and preferably is biased to cut-off. Consequently, the conductive states in the two sections of the twin triode tube are alternate. That is to say, the upper section becomes conductive during a spacing impulse and the lower section becomes conductive during a marking impulse.

A twin diode discharge tube 15 has its two independent cathodes connected to ground through cathode resistors 16. These cathodes are also connected individually to two switches 17 and 18 which are respectively in circuit with capacitors 19 and 20, by which the anodes 7 and 8 may be selectively coupled to the cathodes in tube 15. The anodes in tube 15 are both connected to ground through a resistor 21 and source 82.

Unidirectional mark-space and space-mark transition pulse potentials passed by the twin diode tube 15 are applied as negative control voltages to the control grids in a twin triode amplifier tube 22. The common cathode in this tube is grounded. The anode 23 is supplied with positive D. C. potential through resistor 25. Source 82 and resistor 21 provide a thresholding action. Limiting action is obtained by causing the transition pulse voltages to drive the grids of tube 22 more negative with respect to ground than is required to cut off current through the tube from plate to cathode.

The anode 24 is likewise supplied with a positive D. C. potential by connection thereto through the primary winding of a transformer 27 and through a resistor 28. The secondary winding of transformer 27 is connected to an indicating lamp 29 which is of the gaseous discharge type. This lamp being mounted on a rotating member integrally with the shaft of the distributor can be used as a stroboscope for indicating the phase relation between the marking impulses and the orientation of the distributor kicker.

The distributor proper is not shown in the drawings, but will be understood to be driven by a main motor 31 whose shaft 32 also drives a kicker mechanism 30. This kicker mechanism is illustrated diagrammatically as having a rotor consisting of a plurality of uniformly spaced conductive segments 33 interspersed with insulating segments 34. The number of conductive segments 33 around the periphery of the rotor is determined by the number of channels in the multiplex system but may be a multiple or submultiple of the number of channels, if desired. For example, in a four-channel multiplex system, in which the distributor proper passes two signal elements in each channel during one revolution, the kicker 30 is arranged to have eight conductive segments 33. This same kicker may, however, be used in a two-channel multiplex system.

The motor 31 has its housing mounted in bearings 35, and about the periphery of the motor housing is mounted a gear 36 which meshes with a pinion 37 (or worm, if desired,) driven by a correction motor 38.

While the motor 31 is driven continuously, the correction motor 38 is operated in either direction intermittently in order to provide phase correction of the distributor and kicker. The correction motor 38 is, therefore, preferably a D. C. motor having field and armature windings such that current reversals in one of them will drive the motor reversibly. Hence, the control circuit for motor 38 may include contacts 39 and 40 on a three-position relay 41. The armature 42 on this relay is connected to the armature winding in the correction motor 38.

Relay 41 has two windings which respectively actuate the armature 42 in opposite directions. Well-known biasing means (not shown) are used to hold the armature 42 in a neutral position when no energy is supplied to either of the relay windings.

The circuit for controlling relay 41 will now be described. This circuit includes the space discharge paths in a twin triode tube 43. This tube has a grounded cathode, two grids 44 and 45, and two anodes 46 and 47. The grid 45 may be variably excited with respect to the cathode by means of impulses applied thereto through different brushes 48, 49, and 50 depending upon which of these brushes is in contact with a conductive segment 33 at the instant of mark-space or space-mark transition. Transition pulses when fed through any of the brushes 55, 56, or 57 are used to apply a graduated excitation to the grid 44.

The brushes 48, 49, and 50 which bear on the periphery of the rotor in the kicker 30 are used to complete a circuit from the anode 23 in tube 22 to the input circuits of the aforementioned twin triode tube 43. The control potentials occur only at the instant of mark-space or space-mark transition and are operative only when phase correction is to be applied. If, therefore, a contacting segment 33 is positioned midway between brushes 48 and 55 at the instant of signal element transition, no correction is required, and the correction pulse which is derived from the signals will be ineffective. When, however, the

grid in tube 22 is biased to cut off by a mark-space or space-mark transition pulse, the voltage rises on anode 23 and, if correction is necessary, this more positive potential is fed to one or another of two timing circuits consisting of capacitors 63 and 64 which are respectively in parallel with resistors 61 and 62.

An appreciable time is required to charge the condenser 63 or the condenser 64 by a succession of signal transition pulses before the associated one of the grids 44 or 45 is driven sufficiently positive to cause conduction in its respective section of the tube 43, or sufficiently more positive than the other to make its respective section of the tube 43 more conducting than the other section.

The following will explain the purpose of the resistors 58, 59, 60 which are interposed between the brushes 55, 56, 57 and the input circuit of grid 44 in tube 43 and also resistors 51, 52, 53 which are interposed between the brush group 48, 49, 50 and the input circuit including grid 45 in tube 43. Assume that the kicker 30 is running slightly fast with respect to the incoming signal. One of the segments 33 may be in contact with brush 48 at the time of occurrence of a transition pulse and current will flow through resistors 51, 52, and 53 thereby to cause a positive increment of charge on capacitor 64. The sensitivity of response of the tube 43 in either of its triode space paths is determined by the values of resistance and capacitance in the time-constant circuits. It is not desired that the tube 43 shall immediately respond to a single transition pulse. However, by storing successive transition pulses in the time-constant circuit, a charge is gradually built up until a grid voltage adequate to produce conduction in the tube 43 is obtained, after which the correction relay 41 will function to operate the correction motor 38 in the proper direction.

If, now, the kicker 30 is running faster than in the case just previously described, one of the segments 33 may be in contact with brush 49, or even with brush 50 at the occurrence of a transition pulse. If the pulse is picked up by brush 49, then resistor 51 will not be included in the charging circuit of capacitor 64. Furthermore, if the transition pulse is picked up by brush 50, then neither resistor 51 nor resistor 52 will be included. Removal of resistance from this circuit will decrease the time required to charge capacitor 64 to a potential sufficient to make the tube 43 conductive.

The same explanation holds when the speed of the kicker is slow with respect to the incoming signal. At such time, the brushes 55, 56, or 57 will be brought into play. Consequently, the amount of resistance in the chain of resistors 58, 59, 60 will determine the rapidity at which capacitor 63 is charged by the transition pulse. The grid 44 in its triode section of tube 43 will thus be variably controlled by the transition pulse in dependence upon the required amount of retardation of the kicker 30 with respect to the incoming signals.

A negative D. C. bias for grids 44 and 45 in tube 43 is derived from a −120 v. terminal of the power source. This negative bias is applied to grid 44 through potentiometer 66 and resistors 61 and 65. Likewise the D. C. bias is applied to grid 45 through potentiometer 67 and resistors 62 and 54. Potentiometers 66 and 67 are each connected at one end to the grounded cathode in tube 43.

In the operation of the circuit arrangement and associated movable elements shown in Fig. 1, the tube 4 operates substantially as a D. C. signal amplifier and reverser having two input circuits from which both make and break transition pulses of substantially equal amplitude and correct polarity may be derived through coupling condensers 19 and 20. This arrangement is a substitute for transformer coupling and has proven to be more desirable than transformer coupling.

The twin diode tube 15 operates in dependence upon the changes of sense of the signals as amplified and reversed by the tube 4. If both switches 17 and 18 are closed, then unidirectional conduction takes place in tube 15 both at the front edge and at the back edge of each signal. If, however, switch 18 is opened while switch 17 is closed, then tube 15 delivers only the transition pulses which are developed at the back edge of the marking signal. Contrariwise, if switch 18 is closed, while switch 17 is opened, then the tube 15 delivers transition pulses which occur only at the front edge of each marking signal. In all cases only those pulses which make the grids of tube 22 negative with respect to its cathode are passed by tube 15.

The negative signal transition pulses derived from the plates of tube 4 and passed with correct polarity for conduction through tube 15 are caused to vary the potential drop through resistor 21. Such pulses control the discharge in tube 22. One section of this twin triode tube, as has been previously mentioned, is used for actuating a stroboscope indicator 29. The other triode section, which includes anode 23, feeds positive control potentials through the kicker 30 and through any of the conductive segments 33 which may at that instant be moving under one of the brushes of this kicker. Application of the control pulses to the segments 33 is made through a collector ring 68 and a brush 69 in contact therewith. Any suitable means for connecting the collector ring with all of the segments 33 may be employed.

Assuming that switch 17 is closed and switch 18 is opened, then the pulses produced by mark-space transitions of signal will be passed through the correction kicker 30 and through the upper section of tube 22. Similarly, if switch 18 is closed and switch 17 is opened, then pulses produced by space-mark transitions of signal will be passed to the correction kicker 30. If both switches are closed, all pulses will be passed through.

It will be noted that variations in the time intervals between the control pulses which are applied to the storage capacitors 63 and 64 will occur in practice due to the occasional elongation or contraction of the marking elements with respect to the spacing elements of the signals. Thus, conditions may arise in which correction pulses may be picked up concurrently both by brush 48 and brush 55. These correction pulses would, however, accumulate opposingly on the capacitors 63 and 64, and if both sections of the twin triode tube 43 become simultaneously conductive, then the energization of the windings in relay 41 will be in an opposing sense.

So long as phase correction is unnecessary, the elongation of a marking signal has no effect except to produce balanced excitation of the coils in relay 41. Furthermore, elongation of the mark element has no adverse effect upon the correc-

tive function when correction is required. This can be explained by an example:

When a phase deviation develops such as to require retardation of the receiving distributor, elongation of the marking signals being assumed, the transition pulse at the front edge of the marking signal occurs while one of the segments 33 contacts a brush of the retarding group 48, 49, 50. The transition pulse at the back end of the marking signal subsequently occurs while a segment 33 traverses either the space between brushes 48 and 55 or while it contacts one of the brushes of the accelerating brush group 55, 56, 57 nearer the neutral point than the front edge position of segment 33. The resultant retardation effect is to unbalance the charging of condensers 63 and 64 and to render the two sides of the twin triode tube 43 unequal in their conductivity. The path of greater conductivity will be in circuit with the particular winding on the relay 41 which will throw its armature 42 to the proper side for driving the correction motor 38 so as to retard the phase of the main motor 31.

Obviously my system operates equally well when unbalancing of potentials applied to the grids 44 and 45 in tube 43 takes place under the condition of contraction of the marking elements.

Despite the elongation of the mark intervals with simultaneous contraction of the space intervals, it is always a differential between the values of the correction pulses applied as energy storage components in the capacitors 63 and 64 that causes correction, whether to retard or to accelerate the distributor.

Referring now to Fig. 2, I show therein a substitute circuit arrangement which may be inserted between the filter 1 and the brush 69 of the kicker 30 as shown in Fig. 1. The circuit arrangement of Fig. 2 is described as follows:

Signal impulses as filtered by the unit 1 are fed to the grid of an amplifier tube 70 and control that grid by variations in the potential drop across the resistor 71 leading to the grounded cathode. The output circuit of tube 70 includes a D. C. source, illustratively indicated as of +380 volts, fed through the primary winding of a transformer 72 and thence to the anode in tube 70. Transformer 72 has preferably two secondaries 73 and 74. The secondary 74 is used in connection with the gaseous indicator tube 29 forming part of a stroboscope referred to in the description of Fig. 1. Thresholding action in tube 70 may be obtained by applying positive bias to its grid in the same manner as to the grid tube 4 in Fig. 1. Such arrangement is entirely clear in view of Fig. 1 and, therefore, needs no further illustration.

The transformer secondary 73 has a center-tap connected to contact *a* in a three-position toggle switch 75. The terminals of the secondary 73 are connected to contacts *c* and *f* respectively. The toggle switch is shown in a neutral position, in which connections are suitably made to the input circuit of an amplifier tube 78 and to a rectifier tube 77, whereby both mark-space and space-mark transitions develop useful pulses for phase correction. These pulses being negative in sense cause the tube 78 to block and hence to apply positive control pulses through the kicker 30 to the grids 44 and 45 in tube 43 (Fig. 1).

In the toggle switch 75 are two movable contacts *a* and *c* which cooperate with stationary contacts *b* and *d* and which are controlled by movement of the lever handle 76 to the right. Likewise, the switch 75 includes movable contacts *f* and *h* which cooperate with stationary contacts *e* and *g*, and which are controlled by moving the lever handle 76 to the left. If desired, the mechanism of the switch may be provided with a locked spring 26 which engages with a notched cam such that the switch may be locked in any one of its three positions.

The anodes of the rectifier tube 77 are connected to the switch contacts *d* and *e*. The common cathode of tube 77 is grounded.

I will now explain the operation of the circuit as shown in Fig. 2 when transition pulses both at the front and at the back edges of the marking signal are to be utilized. Unidirectional conduction takes place in tube 77 such that the potentials generated in the secondary 73 and passed by tube 77 are negative with respect to ground. This can be seen from the fact that the anodes of tube 77 are connected to the terminals of the secondary 73 through closure of contacts *c* and *d* and also through closure of contacts *e* and *f*. The negative pulses are fed out of the center-tap and through contacts *a*, *b*, *h*, and *g* of the switch 75 and thence through resistors 80 and 79 to ground. The grid of tube 78, being connected to the junction of resistors 80 and 79, is biased to cut off by the signal pulse. The grid circuit capacitor 81 introduces a desirable pulse shaping factor.

Next I will explain the operation of the circuit of Fig. 2 when only mark-space transitions are to be utilized for phase correction. In this case, the lever handle 76 is moved to the right in order to open-circuit the contacts *a* and *b*, as well as contacts *c* and *d* while closing a circuit from the upper terminal of the secondary 73 through contacts *c* and *b* and thence through contacts *h* and *g* to the input circuit of tube 78. Now the left hand rectifier section of tube 77 is open-circuited and stands ineffective, while the right hand section provides a unilateral conductance from the lower end of the secondary 73 to ground. The pulses generated in the secondary 73 are applied negatively to the grid in tube 78, since the tube 77 is conductive only when the lower end of the secondary 73 is positive; that is, at the moment of mark-space transition.

By setting the switch handle 76 to the left, the space-mark transition times are denoted by effective pulses which appear negatively at the lower end of the secondary 73. These pulses are transmitted to the input circuit of tube 78 by closure of contact *f* against contact *g*, while the upper end of the secondary 73 remains connected through contacts *c* and *d* to the left hand anode in tube 77. The right hand section of tube 77 becomes inactive due to the break between contacts *e* and *f*. Furthermore, the mid-tap of the secondary 73 becomes disconnected from the input circuit for tube 78 whenever the toggle switch lever 76 is moved in either direction from its neutral position, since the center-tap connection may be open-circuited either by breaking contacts *a* and *b* or by breaking contacts *g* and *h*.

The operation of the circuit arrangement of Fig. 2 as alternatively substituted for part of Fig. 1 will be clearly understood in view of the foregoing description.

Modifications of my invention other than those herein shown and described may readily be made by those skilled in the art, but without depart-

ing from the spirit and scope of my invention.

I claim:

1. In a phase correction system, a distributor, the cyclic operation of which is to be maintained in phase with the periodicity of received code signals, a motor for driving said distributor, means for deriving surge pulses from the mark-space and space-mark code element transitions, means including a commutator the segments of which are arranged to be progressively contacted by each single one of two series of brushes, one series having an advancing phase adjusting function and the other series having a retarding phase adjusting function, for utilizing said pulses to sense the direction and degree of departure of said distributor from phase adjustment, and correction means operable upon said distributor driving motor to shift the phase of its rotor sooner in the case of a major departure than in the case of a minor departure from synchronous phase adjustment.

2. The combination according to claim 1 and including switching means for selecting one of three modes of utilization of said surge pulses, to wit, (1) the pulses derived only from space-mark transitions, (2) the pulses derived only from mark-space transitions, and (3) the pulses derived from transitions in both senses.

3. A system for phase correction of a signal distributor comprising a segmented rotor arranged to be driven in unison with said distributor, a group of brushes having a distributor-accelerating function and a second group of brushes having a distributor-retarding function, said brushes being arranged to be sequentially contacted by each segment in said rotor, continuously operable driving means for said distributor and said rotor, means including an intermittently operable reversible motor for applying phase correction to said driving means in dependence upon departures from a given phase relation thereof with respect to the periodicity of reception of a train of code signal elements, means for deriving correction pulses from the mark-space, and the space-mark transitions occurring in said train, and means differentially responsive to said correction pulses according as they are applied thereto through different ones of said brushes for determining the direction of rotation of said reversible motor, the speed with which the last said means is rendered effective being determined by the particular brush which conducts the correction pulses.

4. A system for phase correction of a signal distributor comprising a segmented rotor arranged to be driven in unison with said distributor, a plurality of stationary brushes arranged to be sequentially contacted by each segment in said rotor, means controlled by incoming telegraph code signals for producing pulses at the instant of transition from one sense of signaling to another, a pair of time-constant circuits having ground connections on one side thereof, and on the other side connections through impedances of differing values to different ones of said brushes, the brushes being separately grouped with respect to their connections to one or the other of said time-constant circuits, means including circuit connections from ground through said pulse producing means, also through said rotor segments and an automatically selected brush for feeding the transitionary pulses to said time constant circuits, an electronic device having twin discharge paths and separate input and output circuits for each path, each input circuit being individually under control of charges accumulated in a respective one of said time constant circuits, a differential relay having opposing windings each included in a respective one of the output circuits of said electronic device, and means operable by said relay for effecting phase correction of said distributor.

5. A telegraph distributor phase corrector comprising a conductively segmented rotor arranged to be driven in unison with the distributor, a plurality of brushes arranged to be sequentially contacted by each segment of the rotor, an electronic device having two discharge paths, two input circuits and two output circuits, each input circuit including a resistively shunted capacitor for delaying its action, a multisection impedance having taps individually connected to different ones of said brushes which form a lagging phase detector group, another multisection impedance having taps likewise connected to the remaining brushes which form a leading phase detector group, each said impedance in association with the brushes connected thereto constituting a variable bias-controlling means effective upon an appropriate grid in said electronic device, signal responsive means for applying corrective pulses to one or the other of said grids in dependence upon the occurrence of a leading or lagging departure of said distributor from a proper phase relation to the received signals, a differential relay having coils individually serially connected in the respective output circuits of said electronic device, and means operable by said relay for sometimes advancing the phase of said distributor and at other times for retarding the phase thereof, depending upon the sense of the needed correction.

6. In a phase correction system, a distributor having a driving motor the frame of which is journaled for orientation of its field, a reversible correction motor having a shaft geared to said frame thereby to adjust the phase of said distributor, a three-position relay having differential windings each individually in circuit with a different discharge path in an electronic switch, a potential source selectively connectable to one or the other of said windings in dependence upon the conductivity of an appropriate one of said discharge paths, a controlling circuit for each said discharge path, a delay circuit operatively connected to each said controlling circuit, switching means comprising arcuately disposed stationary contact elements and a contacting rotor driven in unison with said distributor for feeding a control potential to one of said controlling circuits and to the delay circuit associated therewith, graduated impedance means interposed between each said delay circuit and different ones of said stationary contact elements, thereby to variably determine the speed of response of said electronic switch, means for deriving correcting pulses from a train of incoming code signals to be applied through said switching means and to be variably channelled through said impedance means to an appropriate controlling circuit, thereby to perform a phase correcting function, and means to restore said relay to its neutral position upon completion of said performance.

7. A system for phase correction of a rotating device with respect to a train of incoming code signals, comprising means for deriving correcting pulses from mark-space, and space-mark transitions occurring in said train, switching means operable to select for use in the phase correcting function either the mark-space pulses alone, the

space-mark pulses alone, or all of the derived correcting pulses, and means having graduated delay circuit parameters whereby the selected pulses are utilized to produce an accelerative, retardative or null effect upon said rotating device in dependence upon the phase relation of said device to the correcting pulses, the last said means including an electron discharge device having two discharge paths, two control grids, an individual input circuit connecting each grid to a cathode in said discharge device, and a plurality of conductive paths to said grids which paths traverse differing portions of an impedance element appropriate to each grid.

8. A system according to claim 7 and including a differential relay reversibly operable in dependence upon the discharge path in said electron device which is rendered conductive.

9. In a synchronous telegraph receiving system, means responsive to changes in polarity of received signal elements to produce correcting pulses of alternately reversed polarity, means for inverting alternate pulses so that all are of the same polarity, a rotary element the speed of which is to be synchronized with the periodic reception rate of said signal elements, contact members movable with said rotary element into successive circuit closing engagement with each of a plurality of brushes which are arranged in two groups, an impedance terminally connected to one brush and having at least one tap connected to another brush of the same group, a second impedance similarly connected to brushes of the other group, a differential three-position relay having an armature movable between two fixed contacts and having two windings arranged to be selectively energized in response to said correcting pulses, electronic switching means having two output circuits, each including a winding of said relay, input circuits for said electronic means arranged to normally block the same, means for applying said correcting pulses through said movable contact members, through selected ones of said brushes, and through different portions of said impedances, whereby one or another of said output circuits of the switching means is caused to be conductive and to actuate said relay, and means responsive to the operation of said relay for accelerating or retarding said rotary element.

10. The combination according to claim 9 and including means optionally operable in the derivation of correcting pulses for suppressing the effects of signal element polarity changes in one direction while utilizing such changes in the other direction.

11. The combination according to claim 9 and including reversible motor means under control of said relay for effecting phase correction of said rotary element.

CHESTER W. LATIMER.