June 16, 1959 R. STEENECK 2,891,109

PRINTING TELEGRAPH SIGNAL NORMALIZER

Filed June 22, 1956

3 Sheets-Sheet 1

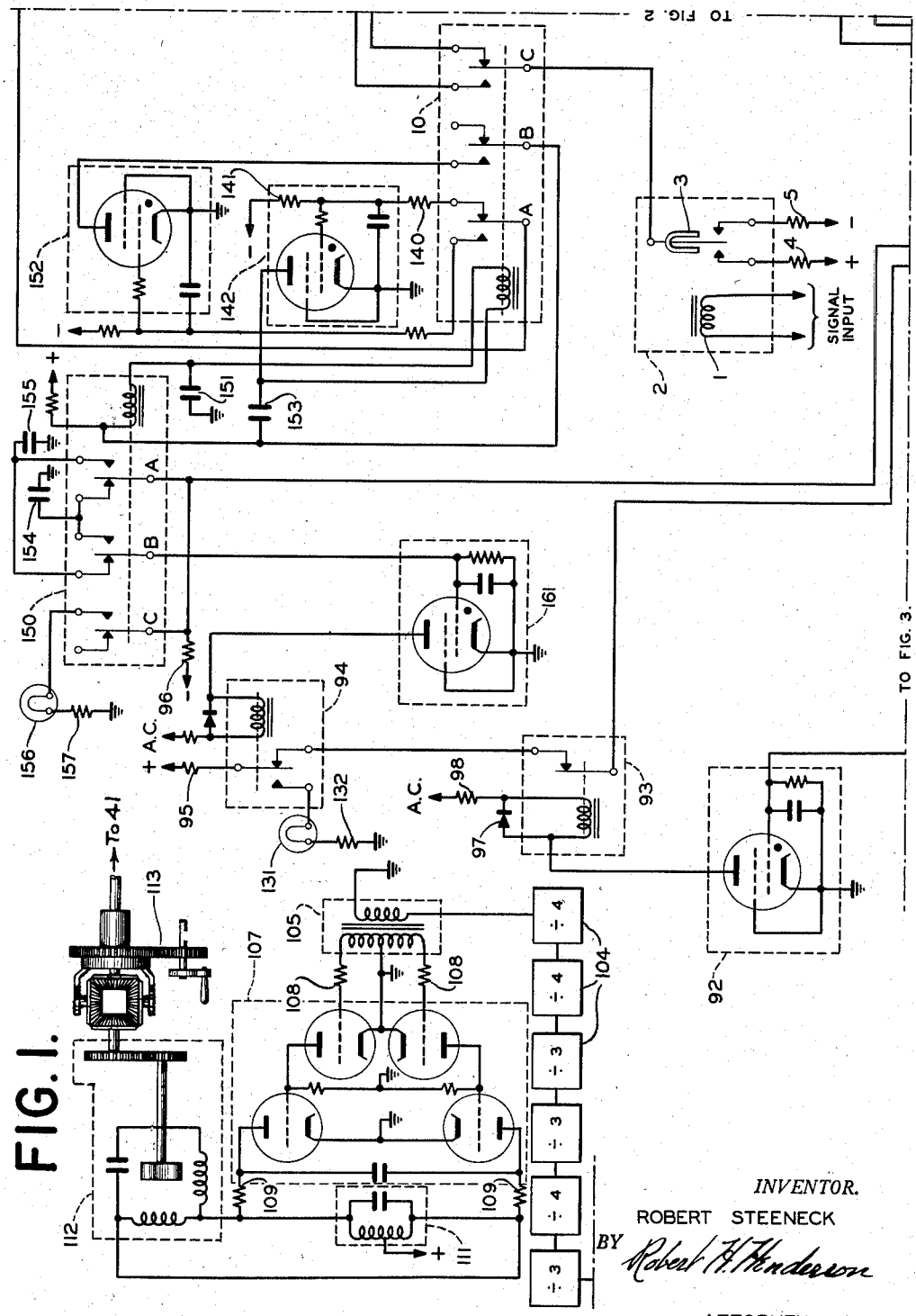


FIG. 1.

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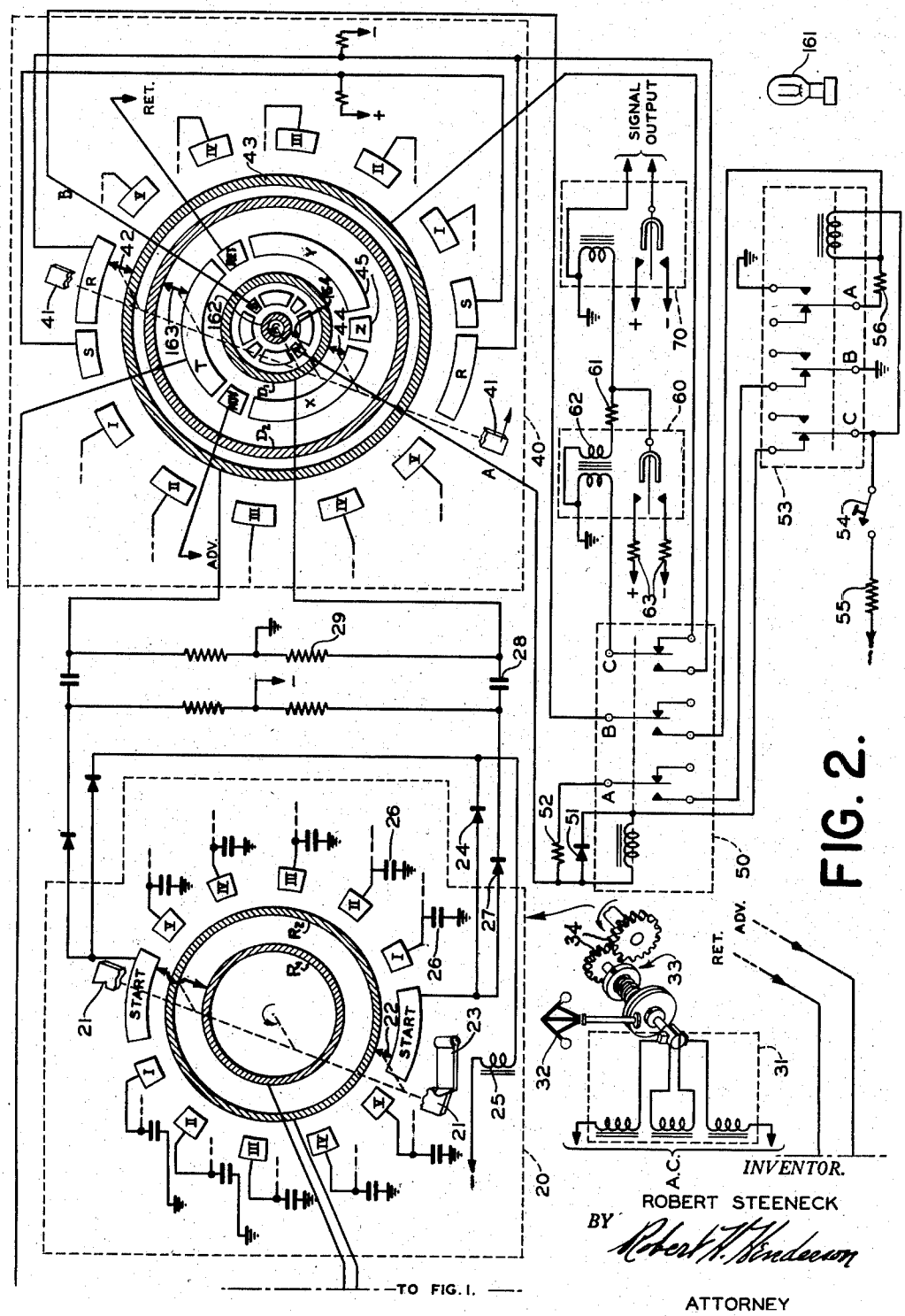


FIG. 2.

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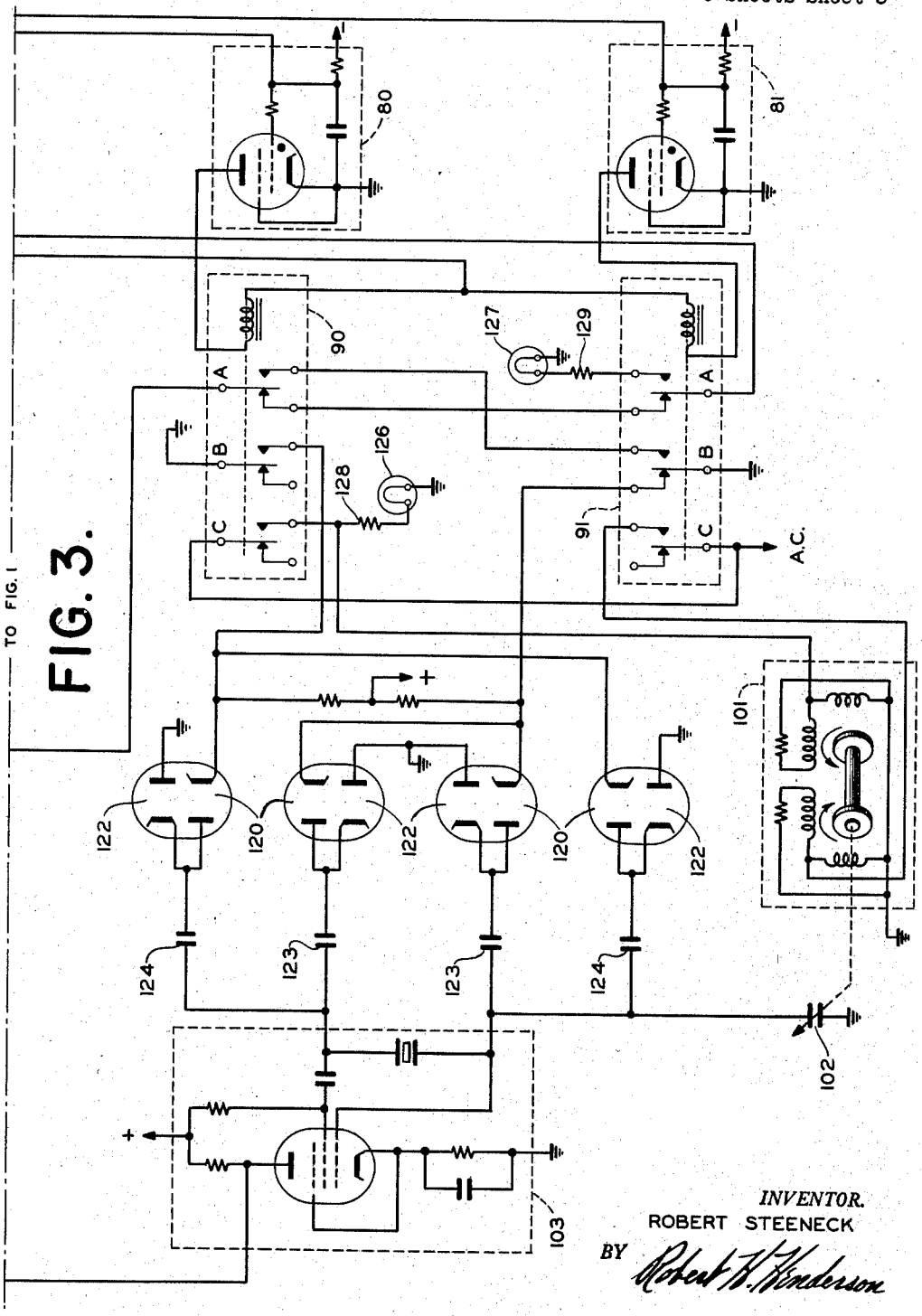


FIG. 3.

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2,891,109

PRINTING TELEGRAPH SIGNAL NORMALIZER

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Application June 22, 1956, Serial No. 593,173

11 Claims. (Cl. 178—70)

This invention relates to the production of signals for the printing telegraph, and more particularly to a device for producing an even flow of character signals from a source providing character signals which are interspersed with rest periods.

Printing telegraph signals originating in the start-stop code as a solid succession of characters by distributors accurately timed to an arbitrary speed are gathered at a distant point for multiplex transmission on distributors which are operated at a constant and precisely established speed. To conveniently avoid synchronization problems, the speed of these latter distributors is maintained at a value slightly higher than that of the first. As a necessary consequence of this, each multiplex transmission is necessarily interspersed with rest periods of one character duration, which are generated each time the multiplex distributors, because of their higher speed, advance by a distance of one character beyond the position of the originating start-stop distributors.

By means of the instant invention, such a transmission is converted into a continuous steady flow of characters at the originating rate and having the artifically introduced rest periods expunged without leaving any gaps in the transmission of the received signal. This is accomplished entirely from the receiving end of the telegraph channel; that is to say, without the need for any synchronizing information to be transmitted.

One of the objects of this invention is to detect and correct at the receiving end of a printing telegraph circuit any drift in phase relationship that may occur between an original steady rate transmission of signals and the receiving end steady rate retransmission of said signals, thus establishing a circuit where the transmission and the retransmission of characters occur in synchronism.

Another object of the instant invention is to adjust the speed of a telegraph retransmitting device to closely match the steady rate speed of a transmitting device connected thereto, in order to reduce the number of phase corrections required in a given time interval.

A further object of the instant invention is to detect the presence of an abnormal phase condition on a telegraph circuit and to avoid the application of phase or speed corrections to a repeater while such a condition exists.

Another object of the instant invention is to provide visual means for observing and monitoring the phase relationship between a transmitting and a retransmitting device in a telegraph channel.

A further object of the instant invention is to provide convenient manual means for quickly bringing the retransmitting end of a telegraph circuit into correct phase relationship with the transmitting device thereof.

Another object of this invention is to detect and correct any phase difference in the amount of one full character in a transmission when due to circuit faults and to effect said phase correction within a time short enough to enable correctly phased retransmission of the character arriving out of proper phase.

A further object of the instant invention is to provide a telegraph signal normalizer wherein all operating mechanical components except distributors of proven reliability have been eliminated.

In the instant invention, printing telegraph signals of the start-stop type arriving at the receiving end of a circuit in groups separated by rest periods of one character duration as previously described are, after conversion by a relay to polarized form, analyzed by a distributor having double the usual number of segments, sufficient to accommodate two complete characters, and the component impulses (except the start pulses) are led to corresponding segments of a retransmitting distributor. Storage condensers associated with each segment enable the received pulses to be available for retransmission for as long as an entire character period. A pickup brush on the retransmitting distributor is rotated at such constant speed as to cause the retransmission to lag behind the input signals by a progressively greater amount.

When the rotating brush of the receiving distributor after having responded to a long series of characters during which the retransmitter has lagged behind to the extent of somewhat more than a whole character, encounters the distinctive signal of a rest period, the said rest period is deleted from the retransmission because of the inherent properties of the circuitry already described, but which is hereinafter described with greater particularity. As a consequence of the deletion of each periodic said rest period signal, the retransmitter is thereby advanced in phase the necessary extent of one character period to nullify the accumulated phase lags of the retransmitter.

When the speed of the synchronous motor driving the retransmitting distributor happens to correspond precisely with the net rate of arrival of meaningful characters the distribtuors will repeat continuously this pattern of progressive lagging and instantaneous advance. Any variations which occur in this arrival rate, however, must be matched by a change in rate of the transmitting distributor, and this is accomplished by employing as a frequency source for the synchronous driving motor thereof, a variable crystal oscillator. The oscillator is so constructed that its frequency may be instantaneously shifted by a predetermined amount for a fixed time, in order to produce an immediate phase shift, in either direction as required, and it is also so constructed that its normal operating frequency may be continuously and slowly altered in either direction by energizing an appropriate motor drive, geared to a frequency determining element of the circuit.

Starting pulse signals received on the two starting segments of the receiving distributor are separately differentiated and led respectively to two opposed brushes on the rotating arm of the retransmitting distributor for commutation. If synchronization between distributors were to occur, all such pulses from the rotating brushes would fall at a single spot on the retransmitting distributor face plate. Under the conditions of operation described, however, the pulses fall in a zone which travels in an arc of about 180° around the face plate, then snaps back to a starting position, repeating the process continuously. Neon glow lamps connected to each said brush and to ground, and revolving on opposite ends of the brush arm of the retransmitter distributor, show this pattern of operation clearly and are useful as well in making manual adjustment of phase by means of a differential gearing mechanism attached to the retransmitter distributor rotor shaft.

When the speed of the retransmitter distributor differs from that corresponding to the average incoming character rate, the differentiated start pulse pattern above described, creeps or revolves around the retransmitter face

plate in a forward or reverse direction according to whether the retransmitter is operating at more or less than the desired speed. Conductive segments are appropriately located on the face plate of the retransmitter distributor to collect the differentiated start pulses when they have lagged or advanced beyond the normal 180 degree zone, and they are then led to the grids of appropriate thyratrons for operating relays to add or remove capacity from the crystal oscillator circuit for a definite time in order to shift its phase in the required direction by an amount sufficient to provide immediate correction of the drift. In addition thereto, the differentiated start pulses, in falling on the "advance" or "retard" segments, energize further circuitry for operating slow speed reduction-geared motors to turn a variable capacitor in the crystal circuit ahead or backward for slowly producing a small change in the normal frequency of the oscillator, in the desired direction. It is evident that by this means the necessity for operating the above described phase-shifting circuitry is minimized, enabling the device to operate for relatively long periods of time in substantial synchronism with the average arrival rate of incoming signals, during any period in which the said average is constant or nearly constant.

The remainder of the circle swept out by the said brushes defines a zone in which differentiated start pulses do not fall during normal operation. A segment on the retransmitter face plate located in the said zone is connected to circuitry for shifting the telegraph input when pulses are so received, from one brush on the receiving distributor to another one diametrically opposed thereto. This restores the pulses to the correct zone of impingement by introducing a phase reversal therein, and prevents the phase and speed control malfunction which would otherwise occur when such pulses encountered the "Advance" or "Retard" segment. It is a feature of this arrangement that during the operation of the said phase reversal circuitry and for definite period of time thereafter, the equipment previously described for both phase and frequency adjustment of the oscillator is disabled. Such a provision is advantageous because circumstances requiring such phase reversal are usually caused by occasional adventitious mulfunction of the signal originating equipment, or else by transmission difficulties, neither of which implies any need for oscillator adjustment. If such deletion were not provided, the changes in oscillator frequency resulting would usually constitute the misadjustment of an oscillator already properly set, at a time when the difficulty of synchronization may be much greater than normally exists.

A fuller understanding of the invention may be gained by reference to the accompanying drawings of a specific illustrative example thereof, wherein:

Fig. 1 is a schematic diagram of a portion of a telegraph signal normalizer constructed in accordance with the present invention;

Fig. 2 is a continuation of Fig. 1; and

Fig. 3 is a continuation of Fig. 1.

Referring now to the drawings, in Fig. 1 is seen an input winding **1** of a polar telegraph relay **2** wherein through the polarizing effect of a constant magnetic field such as that produced by the movable magnet **3**, but which may in fact be either a permanent magnet field or an electromagnetic field, the incoming printing telegraph signals are converted to polarized form on the tongue of the relay **2**. Reinforcement of the signals occurs from contact of the tongue with positive and negative local battery supplied through current limiting resistors **4** and **5**. Polar signals therefrom are led through tongue and back contact C of relay **10** (later to be described) and thence to contact ring R_2 on the face plate of receiving distributor **20** shown in Fig. 2. Rotatable brush arm **21** bearing brush **22** is held by magnetic sprag **23** over the face plate segment designated "start" until a characteristic starting pulse traverses the segment and a dry disc rectifier **24** for operating electromagnet **25** to attract sprag **23** and release arm **21**. Motor **35**, speed controlled by governor **32**, then drives brush arm **21** through slip clutch **33** and reduction gears **34** for one half revolution in conventional start-stop manner. Signals incoming over ring R_2 are thereupon distributed by brush **22** to face plate segments I to V, where they are retained by the storage condensers **26** connected to each segment. Segments I to V on each side of receiving distributor **20** are also connected to corresponding segments on the face plate of retransmitting distributor **40**, as indicated merely by broken lines on the drawing for the sake of clarity. Brush arm **41** is rotated at an appropriate speed by means later to be described, and carries brush **42** for contacting each said segment to the sending ring **43**, which is connected through back contact C and tongue of relay **50** and thence through the coil of latching relay **60** to ground. Full polar signals developed on the tongue of relay **60** because of the latching effect of a small current, limited by resistor **61**, flowing through the relay coil **62**, occur at a low power level because of the current limiting effect of resistors **63**. They are amplified in relay **70** to provide an output signal of suitable power. When a rest period occurs in the incoming telegraph signals, it comprises a continuous positive charge throughout the character period, which is blocked by rectifier **24**, and therefore does not release sprag **23**. Consequently, no new signals are stored on the segments of distributors **20** or **40**, but since the brush **42** of distributor **40** is, at the start of the rest period, more than a full character behind the incoming signals, it continues to transmit those signals previously stored. Arrival of further character signals at the end of the rest period causes distribuor **20** to start, and to store them on the segments of both distributors, just ahead of the brush of distributor **40**. In this way, the rest period signal is deleted without interrupting the continuity of the retransmitted signal.

Start signals received on the segment designated "start" of distributor **20** are passed through dry disc rectifier **27** and differentiated to pulses by capacitor **28** and resistor **29**, then applied to the ring D_1 of distributor **40** which is contacted by the rotating brush **44** to the ring of segments **45**. In normal operation, these pulses fall on the segments *x*, *y*, and *z* thereof, and are unused. If distributor **40** is rotating too rapidly, pulses will ultimately impinge on segment "RET" of ring **45** whence they are led to the grid circuit of conventional thyratron circuit **80** where they cause to be locked to ground the coil circuit of relay **90** which is supplied through the back contact of relay **93** and the front contact of (normally energized) relay **94** through current limiting resistor **95** from positive battery supply. Thyratron timing circuit **92**, which has held the coil circuit of relay **93** cut off from ground return because of negative battery applied to its grid through back contacts A of relays **90** and **91** and current limiting resistor **96**, finds this source of negative potential removed from its grid by the opening of back contact A of relay **90**, the grid begins to approach cathode potential due to the discharge of its grid circuit capacitor through its grid leak resistor. Relay **90** is thus locked up for at least the predetermined time before which thyratron **92** will fire due to decay of the negative charge on its grid, which firing grounds the coil return of relay **93**, permitting flow through the coil of half cycles of alternating current supply, limited by resistor **98** and reenforced in the coil by discharge, during the remaining half cycles of coil induced current throught the rectifier **97**. Pulling in of relay **93** by thyratron **92** at the conclusion of the timing period, as described, opens its contact supplying positive potential to the coil of relay **90**, and therethrough to thyratron **80**, which promptly reverts to the nonconducting condition before back contacts A of relay **90** could again fall closed and thyratron **92** and relay **93** again operate to reenergize relay **90**.

Differentiated start pulses falling on segment ADV of ring **45** indicate a need for advancement in retrans-

mitter phase and are led to thyratron **81** which operates relay **91** in the same manner above described by which thyratron **80** operates relay **90**. When pulses fall on both ADV and RET segments simultaneously, or within the predetermined delay period, tongue B of relay **91** applies ground through tongue A of relay **90** to the timing circuit of thyratron **92** to fire it and thus open relay **92**, quenching both thyratrons **80** and **81** in this ambiguous situation, and reopening relays **90** and **91**.

Tongues C of relays **90** and **91** are supplied with A.C., and their front contacts connect respectively to forward and backward motors in the reduction geared motor assembly **101** which is fastened to the rotatable shaft of variable condenser **102**. Pulses on the RET segment of ring **45** thus cause the condenser to be turned slowly in one direction and pulses on the ADV segment cause rotation in the opposite direction. Numeral **103** represents a signal generator comprising a pentode vacuum tube in a quartz crystal oscillator circuit with the crystal operating at the frequency of equivalent parallel circuit resonance. In this mode of operation, a crystal is subject to having its operating frequency varied by a variation of the circuit capacitance across it and such a change is produced by adjustment of condenser **102**, since the capacity of each side of the crystal to ground is a part of the capacity thereacross. Sinusoidal output from signal generator **103** is conveniently reduced in frequency by conventional dividers **104** to energize push-pull transformer **105**. Output signal therefrom drives amplifier **107** through coupling resistors **108**, whose output is coupled by resistors **109** to the tuned circuit **111**, resonant at a frequency in the neighborhood of the operating frequencies expected and suffiiently broadly tuned to provide substantially resonant loading to the amplifier **107** at all such frequencies. A synchronous motor having speed reduction gears **112** is connected to and driven by the sinusoidal output of circuit **111** and turns the brush arm **41** of the retransmitter distributor **40** through the differential gear and hand crank mechanism **113**, which is used for adjusting by hand the phase of the said distributor **40** when, because of failure of the equipment or for other reasons, it becomes desirable so to do.

Actuation of relay **90** or **91** as above described to effect oscillator frequency change in a desired direction is also effective to close a front or open a back contact B thereof respectively to apply or remove ground from the cathodes of an outer or inner pair of diodes **120** respectively.

Since these cathodes, when ungrounded, are biased through resistors **121** to a potential which makes conduction through them impossible, they then represent an open circuit in both directions. A further diode **122** associated with each and oppositely poled, thereupon rectifies sufficient of the signal current to elevate the signal circuit to such positive potential as will cause cutoff of further direct current flow through it and thus isolates the signal circuit from ground.

When grounded, the said cathodes merely comprise parts of oppositely poled rectifiers in parallel, providing conduction to ground for the pairs of tuning condensers **123** and **124** whereby they can increase or decrease oscillator frequency by being thus switched out of or into the oscillator circuit. The advantage of this method of switching lies in the fact that when the cathodes are biased positively and the diodes therefore open, the capacity to ground of the remaining oscillator circuitry is increased but little, and it is therefore feasible to approach rather closely the series resonant frequency of the crystal in order to provide for a substantial change in frequency by tuning, since the mere addition of more capacity beyond a certain point soon reached, is relatively ineffective to cause frequency change.

Since the duration of closure of relays **90** and **91** is determined at a fixed value by thyratron **92**, as previously explained, the change of oscillator frequency caused by the removal of condensers **123** or the insertion of **124** persists for a fixed time, and results in a definite phase change of the oscillator output in the desired corrective direction. Indicator lamps **126** and **127**, operated through resistors **128** and **129** conveniently demonstrate the operation of relays **90** and **91** respectively for monitoring purposes. Lamp **131** operated through resistor **132** likewise shows the operation of relay **94**, as will be explained hereafter.

Impingement of differentiated start pulses on the segment T of distributor **40** indicates an incorrect phase relationship between distributors **20** and **40** by an amount in excess of a complete character period. Such positive pulses are led through the tongue and back contact A of relay **10** through limiting resistor **140** and load resistor **141** to negative battery supply. Conventional thyratron circuit **142** which normally remains in the cut off condition because of negative battery applied to its grid through resistor **141** is triggered by these positive pulses to apply ground to one side of the coil of relay **10**, the other side of which coil is connected to positive battery through the coil of relay **150**. Condenser **151**, also connected between the said other side and ground, and therefore bearing positive charge, provides immediate current flow through the coil of relay **10** under these conditions. Relay **10** thus pulls in and holds in because thyratron circuit **192** remains conductive, changing the signal input over relay **2** from ring R_1 to ring R_2 of distributor **20** by motion of the tongue C of relay **10**, which is the effect desired because said signals are then distributed to the segments of distributor **20** by a diametrically opposed brush, and when picked up by brush **42** of distributor **40**, will contain the start pulses located on the opposite and correct side of the distributor.

After pulling in as described, relay **10** is held in by conduction through thyratron **142** until an interruption occurs in its positive power supply. Tongue A of relay **10** switches the circuit over which said pulses arrive from back to front contact A thereof, and thus into a thyratron circuit **152** identical to that of **142**. Tongue B of relay **10** provides power thereto over a circuit which also has a capacitor **153** to the plate of thyratron **142**. Any pulse arriving at tongue A of relay **10** then fires thyratron **152**, which because of its connection through capacitor **153** to the former thyratron, momentarily depletes the plate potential thereof, causing it to extinguish and relay **10** to drop open.

Relay **150**, having its coil in series with that of relay **10**, operates simultaneously therewith, and a charge from minus battery is applied through resistor **96** to the tongue of contacts A thereof, whereby the capacitor **154** or **155** not then being connected by tongue B, is charged negatively. Upon a change in position of the relay occurring, the condenser so charged is connected by tongue B to the grid of thyratron circuit **161** which is operated by A.C. applied to the plate thereof, thus quenching it during the interval required for said capacitor to discharge, and allowing relay **94** to fall open, preventing the operation of relays **90** and **91** to affect the oscillator frequency during such period. An indicator light **156** is connected in series with resistor **157** and to front contact C of relay **150** for energization by tongue C thereof during operation of the relay to indicate correct operation.

Two neon indicator lamps such as **161** are provided at the opposite ends of rotating distributor arm **41** of distributor **40**, one connected between brush **44** and a brush not shown contacting the ground ring **162** and the other similarly connected to brush **163**. By this means, the arrival of differentiated start pulses is made visible, and the zone of their impingement clearly exhibited. This makes the operation of the phase reversal mechanism easy to monitor, and also shows by distinctive signals the presence of faults or malfunction in the transmission channel supplying the normalizer, so that manual readjustment of phase can be made.

As it is on some occasions desirable to delete one or more characters from the retransmission arbitrarily at the location of the signal normalizer, an arrangement for so doing is provided in the invention. Relay **50** has a rectifier **51** across its coil, making it slow to open, and is connected to a further segmented ring of distributor **40** at the segment A thereof, which is so located as to be connected by a rotating brush **164** to the ground ring **162** near the start of a character. The opposite side of the coil of relay **50** is connected through back contact and tongue C of relay **53** to a key **54** and thence through current limiting resistor **55** to negative battery. If key **54** is held depressed, relay **50** is therefore pulled in as soon as distributor **40** starts to traverse a next character. This switches the telegraph output of tongue C from sending ring **43** to negative battery. Tongue A, in pulling in, connects the coil of relay **50** through a suitable resistor **52** to a back contact and tongue B of relay **53** and thence to ground. Relay **50** thus remains energized although brush **163** travels beyond segment A and no longer provides a ground. When brush **163** reaches diametrically opposed segment B, however, as occurs after a complete character period has elapsed, ground is thereby applied to tongue B of relay **50**, which through its front contact B thus energizes relay **53**. Pulling in, relay **53** locks in over tongue and front contact A through resistor **56** for so long as segment B is contacted, provided key **54** is still depressed. In doing so, its back contacts C and B are broken, allowing relay **50** to fall open and again switch its output over tongue C to the sending ring **43**. If key **54** is released at any time between this event and the beginning of transmission of the character next following, a single character will have been deleted and replaced by a rest signal.

Although this invention has been described in terms of a device operated from the extremely stable basic frequency obtainable from an oscillating quartz crystal, it is to be understood that in any case where the instantaneous power supply frequencies at the start-stop signal originator and at the retransmitter are both very closely controlled, as they occasionally but rarely are, the local crystal becomes unnecessary, and when the described phase correction means and frequency correction means are then applied to a power line synchronous retransmitter motor by the use of a mechanical differential inserted in its shaft for each, or in some other convenient manner, the device is fully operative in these special circumstances without the use of a crystal or of circuitry therefor.

Although this invention has been described in terms of a specific illustrative example thereof, it is to be understood that to those skilled in the art various modifications and expedients will occur which do not, however, depart from the spirit of the invention disclosed. It is therefore intended that the instant invention shall be subject only to the limitations of the appended claims.

What is claimed is:

1. In a printing telegraph signal normalizer for character signals comprising permutation code bits in time sequence and having cyclic rest periods, which comprises multipath bit distribution means for plural characters, path connected bit storage means, and time sequential path collating retransmitter means, a source of variable speed power for said retransmitter means, character phase detecting means in said retransmitter means, means connected thereto and to said power source responsive only to excursions of character phase exceeding a predetermined minimum amount to correctingly vary the speed of said retransmitter means during said excursions, further such means to correctingly alter said retransmitter speed by a predetermined amount for a predetermined time upon each such excursion, and character phase controlled switching means connected to said bit distribution means for deletion of rest period signals received, without interruption of a continuous output of character signals at a steady rate.

2. In a printing telegraph signal normalizer for character signals comprising permutation code bits in time sequence and having cyclic rest intervals, which comprises multipath bit distribution means, path connected bit storage means, and time sequential path selecting retransmitter means, a stable source of variable speed power for said transmitter means, character phase detecting means in said retransmitter means, means connected thereto and to said power source responsive only to excursions of character phase exceeding a predetermined minimum amount to correctingly vary the speed of said retransmitter means during said excursions, further such means to correctingly alter said retransmitter speed by a predetermined amount for a predetermined time upon each such excursion, outphase detecting means in said retransmitter means and electronic phase advancing means operated thereby to instantaneously advance said distribution means one character.

3. The device in accordance with claim 2 wherein are relay means in circuit with said outphase detecting means coupled to said means to vary and to said means to alter the retransmitter speed, operative to overrule such variation and alteration during outphase.

4. In a permutation code signal normalizer comprising a start-stop receiving distributor electrically connected to a synchronous motor driven sending-on distributor by way of signal storage capacitors and having start pulse signal commutation brushes on the sending-on distributor for detecting abnormal pulse phase displacement in either direction, the combination comprising a first directionally sensitive starting pulse signal operated and reversible actuator control means wherein are ionizable gas operated thermionic trigger tubes for pulse signal detection and actuation control, a second such actuator control means, an oscillating quartz crystal controlled power supply for said synchronous motor having a first circuit element thereof mechanically movable for frequency variation and a second circuit element thereof alternatively switchable for frequency changing, a gear motor actuator for driving said first circuit element electrically connected to said first actuator control means to correctingly vary the frequency of said power supply at a relatively slow rate in response to an abnormal pulse phase displacement, time delay means, an actuator comprising a relay operatively connected to said second circuit element and electrically connected to said second actuator control means and said time delay means to correctingly alter the frequency of said power supply instantaneously in response to an abnormal pulse phase displacement for the duration of a predetermined fixed period of delay, whereby to produce a substantially immediate phase correction simultaneously with the start of a continuous frequency correction throughout a period of abnormal phase conditions.

5. A regenerative repeater and normalizer for permutation code signals comprising a start-stop receiving distributor, start segments and code segments therein for dissection of two consecutive code characters, two oppositely disposed commutation brush arms therein having separate input connections for alternative operation, character storage condenser banks connected to the code segments thereof, a sending-on distributor having code segments connected to the said storage banks, a rotating commutation brush arm and a brush thereon in said sending-on distributor for providing successive output connection to said code segments, two further and oppositely disposed brushes thereon and coupling means in circuit therewith and with said start segments of said receiving distributor, a further segment in said sending-on distributor, located for contact by said further brushes only within a zone of abnormal start pulse phase excursion, sliding contacts to said further brushes, and means in circuit therewith to transfer an input signal between

said separate input connections upon appearance of a signal from said start pulses at said further brushes, whereby abnormal phase excursion of the signals causes switching to an opposite input brush.

6. The device of claim 4 wherein there are gaseous discharge indicator tubes affixed to the said rotating commutation brush arm, each connected to a said brush, whereby phase indicating patterns are displayed.

7. Printing telegraph signal repeater and normalizer comprising a start-stop distributor having segments for reception of two characters on opposite sides thereof, a starting magnet thereon, a brush arm therein having identical opposite ends for alternate engagement by said starting magnet, a retransmitting distributor in circuit therewith controlled to run at a speed corresponding to the uninterrupted retransmission of information at the average rate of reception thereof and signal storage condensers in circuit therewith, whereby periodic rest periods in a telegraph signal are deleted from the retransmission and the retransmission caused to constitute a steady and uninterrupted flow of information.

8. The device of claim 7 wherein a synchronous motor operates said retransmitting distributor.

9. The device of claim 7 wherein an oscillating quartz crystal and a synchronous motor controlled thereby operates said retransmitting distributor.

10. The device of claim 7 wherein an oscillating quartz crystal and a synchronous motor controlled thereby operates said retransmitting distributor and wherein there are commutating brushes and zone segments for start pulses in the said retransmitting distributor for detecting lag and lead, and wherein there is means for varying the frequency of the said crystal, connected to the said zone segments and controlled thereby.

11. The device of claim 7 wherein a synchronous motor operates said retransmitting distributor and wherein there are commutating brushes and zone segments for start pulses in the said retransmitting distributor for detecting lag and lead, and wherein there is means for correcting the speed of said synchronous motor in circuit with and controlled by said zone segments.

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