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MEANS FOR SYNCHRONIZING ROTARY DEVICES.

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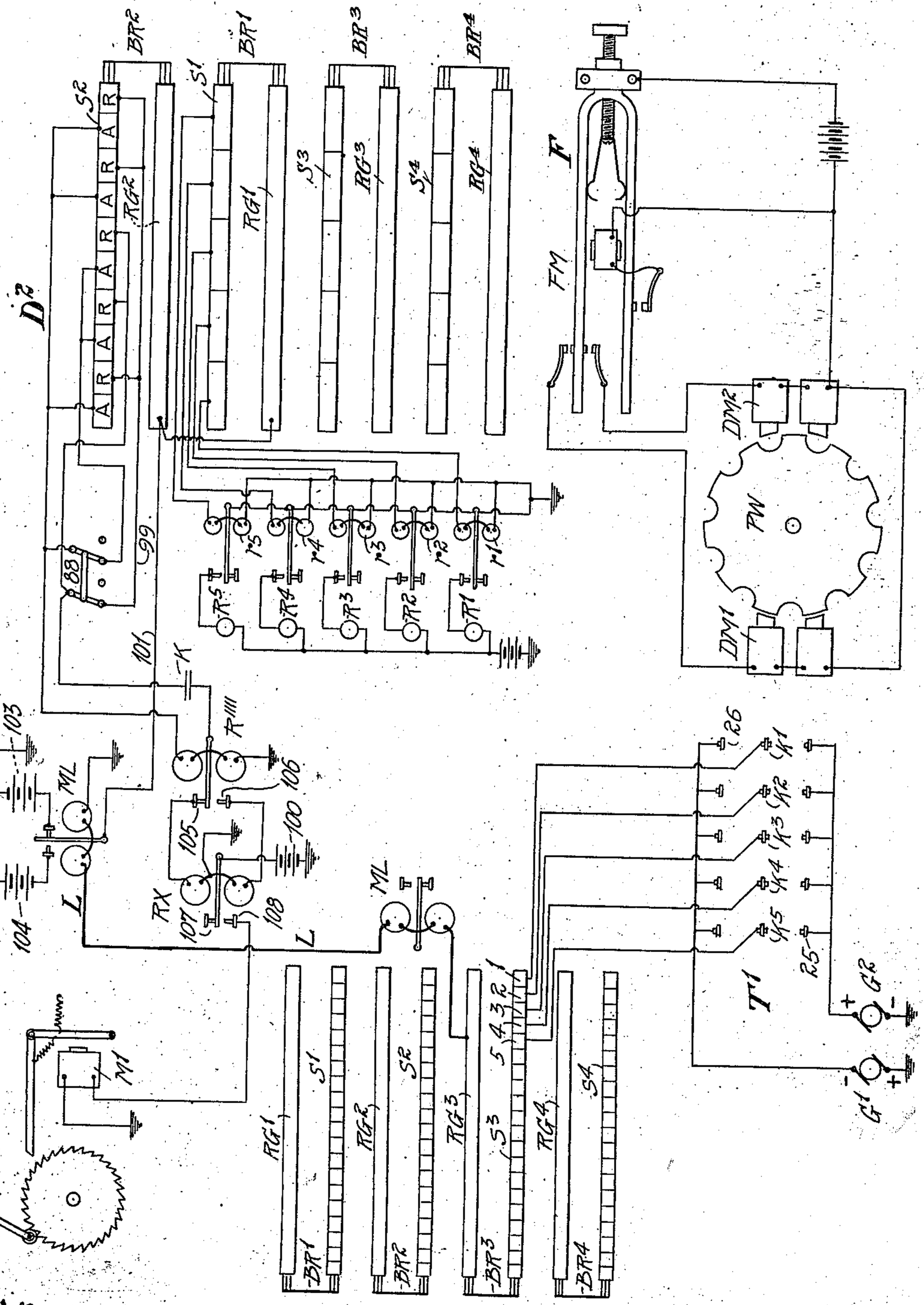

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MEANS FOR SYNCHRONIZING ROTARY DEVICES.

1,191,933. Specification of Letters Patent. **Patented July 18, 1916.**

Original application filed January 5, 1915, Serial No. 654. Divided and this application filed August 21, 1915. Serial No. 46,642.

To all whom it may concern:

Be it known that we, GEORGE M. YORKE, of the city, county, and State of New York, and GEORGE R. BENJAMIN, of Jersey City, Hudson county, and State of New Jersey, citizens of the United States of America, have invented certain new and useful Means for Synchronizing Rotary Devices, of which the following is a specification.

Our invention relates to means for synchronizing a plurality of rotary members, and is particularly intended and adapted for use in so-called synchronous telegraph or signaling systems, though also applicable for other purposes, as, for example, the synchronizing of electric generators and motors. However, since our invention is primarily intended for the synchronizing of distributers or commutators of multiplex telegraph systems, it will be described herein as embodied in such a system, but without any intention on our part of thereby limiting our invention to use in multiplex telegraph systems; and while we describe hereinafter our invention as applied to a multiplex telegraph system of the so-called Baudot type, and to a system wherein one conductor of the line circuit is a metallic conductor, we do not intend thereby to limit our invention either to telegraph systems of the so-called Baudot type, or to telegraph systems wherein one conductor of the line circuit is a metallic conductor; the invention being equally applicable to so-called radio-telegraphy, wherein current waves are transmitted through the air or ether or other agent than a telegraph wire.

Telegraph systems such as that in connection with which our invention is herein illustrated and described, comprise two or more distributers or commutators with means for maintaining synchronism. Each telegraph character consists of a plurality of current impulses (five impulses for each character, in the particular system herein described), the necessary distinctions between the several characters being obtained by causing one or more of the current impulses of each character to be of opposite "sign" or direction or polarity from the other impulses of that character; the resulting reversals of current sign affording the number of permutations necessary for the distinction of the several letters of the alphabet, punctuation signs, and special signals for the operation of the various parts of the transmitting and receiving apparatus. In some telegraph systems, a greater number of impulses per character than five are employed, and it is conceivable that there might be a telegraph or signaling system wherein a less number of current impulses than five for each character might suffice. With the particular number of current impulses for each character, our invention has nothing to do, being equally applicable to systems wherein the current impulses for each character are greater or less in number than five.

In systems such as referred to it is essential that the distributers or commutators shall rotate or move in substantial synchronism; and heretofore, at least in the Baudot system, it has been the common practice to provide special divisions of the commutators for effecting synchronization, the transmitting and receiving apparatus being synchronized once in each complete rotation, provided synchronization is required. According to our invention, we dispense with the separate divisions of the commutators, heretofore provided, particularly in the Baudot system, for effecting synchronization, and instead we employ means whereby each reversal of current sign, employed in the transmission of characters or other signals, is available for synchronization or "correction" (the term "correction" being the term commonly employed in the art, and being the term hereinafter employed, with reference to the establishment or reëstablishment of synchronism between the transmitting and receiving apparatus). Thereby we materially increase the effective speed of transmission, and also materially simplify the apparatus besides ob-

viating the otherwise numerous opportunities for errors in transmission and making it possible to maintain constantly very accurate synchronism and to bring the transmitting and receiving apparatus into accurate synchronism, both as to speed and as to phase, very quickly, when the apparatus is started up.

Our invention consists, therefore, in improved synchronizing means; particularly synchronizing means wherein each reversal of line current or polarity is available for "correction"; though various portions of the apparatus embodying our invention are adaptable for use in systems wherein synchronization is effected otherwise than by each current reversal or reversal of polarity.

This improved correcting means affords the following important advantages: 1. Every change of sign of the signaling impulses, or, in systems operating by current pulses of one direction only, every change of current strength, provides a possible correction moment. 2. At this correction moment the correcting devices will be operated if the correction is required, and will not be operated if the correction is not required. 3. As the telegraph signals consist of various combinations of positive and negative impulses, or, in systems operating by current impulses of one direction only, of various combinations of impulses of different strength, or of impulses and spaces, many correction moments are available during each revolution of the distributer brushes. 4. Because of the foregoing characteristics of our system, no special correcting impulses are required.

The objects of our invention are to maintain accurate synchronism constantly; to avoid errors in transmission or in operation of the apparatus due to lack of perfect synchronism; to bring the transmitter and receiving apparatus into synchronism and proper phase relation very quickly, when the apparatus is started up; to increase the effective speed of transmission; to simplify the apparatus employed; to make it very easy to operate the apparatus; and in general to make the apparatus relatively simple and easy to comprehension and to avoid opportunity for derangement.

We will now proceed to describe our invention with reference to the accompanying drawing, illustrating diagrammatically one arrangement of receiving apparatus which may be employed in accordance with our invention, including one form of correction apparatus which may be employed.

In said drawing, D^1 and D^2 designate transmitting and receiving distributers located at opposite ends of a line circuit L. The two distributers are similar and, in general, are each divided into four similar quadrants, each of which quadrants may be, and commonly is, employed for the simultaneous transmission and reception of messages, constituting, with its circuits and accessory apparatus, a single "channel of communication." For simplicity of illustration, we have shown transmitting means connected to one quadrant only of the distributer D^1 and we have shown one quadrant only of the distributer D^2; and we have omitted the signal receiving connections of distributer D^1 and the signal transmitting connections of distributer D^2. Both distributers are shown "developed."

Each of the distributers D^1 and D^2 comprises a plurality of rings (eight rings in the construction shown) which are connected in pairs by suitable brushes, one ring of each pair being segmented and one ring of each pair being plain or continuous. Rings S^1 and RG^1 form one pair of rings, of which ring S^1 is segmented, these rings being connected by brushes BR^1; these two rings and their brushes being employed for receiving. Rings S^2 and RG^2 form another pair of rings of which ring S^2 is segmented, these two rings being employed for synchronization or correction, and being connected by brushes BR^2. Rings S^3 and RG^3 form another pair of rings, employed for transmission, and are connected by brushes BR^3; ring S^3 being segmented as shown; and rings S^4 and RG^4 form another pair of rings employed for the control of the automatic transmitting apparatus, and other local purposes, and are connected by brushes BR^4.

T^1 designates a transmitter, which may be either a hand operated transmitter or may be a mechanically operated and mechanically controlled transmitter, such for example, as a transmitter controlled by a suitable perforated tape. Such transmitter, in the construction shown, comprises five sets of current reversing transmitting contacts K^1, K^2, K^3, K^4 and K^5, of which the middle contacts are movable, and the outer contacts are connected to one or the other of two generators G^1 and G^2, oppositely connected so that positive or negative impulses are transmitted according as each middle contact of the transmitter is in contact with the one or the other of the corresponding outer contacts. However, the particular means for supplying current to the line is unimportant as is the particular means for supplying current of the one sign or the other to the line, as desired. One complete set of synchronizing apparatus is all that is required for one circuit, however many transmitting and receiving sets may be operated over that circuit.

L designates the line conductor, connecting the two distributers, and ML designates main line relays of which there is one at each end of line L.

Referring now to the distributer D^2 and the apparatus shown in connection therewith: The ring S^2 of the distributer D^2 is divided into segments lettered alternately A and R. The main line relay ML associated with distributer D^2 controls, through distributer ring RG^2 and brush BR^2 and the A segments of ring S^2, a relay R''''; while from the R segments of ring S^2 a circuit conductor 99 leads through switch 88 to a condenser K connected to the armature of relay R''''. The two contact stops of relay R'''' are connected, the one to one magnet and the other to the other magnet of a polar relay R^x, and thence to ground. The armature of relay R^x is connected to a generator 100 and thence to ground, while one contact stop of relay R^x is connected to the magnet M^1 of a ratchet mechanism, well known in the art, which, when operated, steps back the generator D^2 with reference to the generator D^1.

It will be noted that in the arrangement shown in the drawing the contact stops of the main line relay ML are connected, the one to a source of current 103 of one polarity, the other to a source of current 104 of the opposite polarity. The polarity of the armature of relay R'''' is such that a current impulse from battery 103 passing through the armature of relay ML, ring RG^2, brush BR^2, and any of the A segments of ring S^2 to the magnet coils of relay R'''', moves the armature of that relay into contact with the stop 105; while a current impulse from battery 104, passing through the armature of relay ML and the same circuit path to and through the magnet coils of relay R'''' moves the armature of that relay into contact with the contact stop 106.

The relay R^x is operated by batteries 103 and 104 through the armature of main line relay ML, conductor 101, ring RG^2, brush BR^2 and any of the R segments of ring S^2, condenser K, armature of relay R'''', and one or the other of contact stops of that relay to one or the other of the magnet coils of relay R^x. If the armature of relay R'''' is against contact stop 105 when the condenser K receives a charge from battery 103 through one of the R segments, the resulting current flow through the upper coil of relay R^x actuates the armature of that relay to move such armature against stop 107. If, however, the armature of relay R'''' is in contact with its stop 106, the charging of the condenser K as described, will energize the lower coil of relay R^x and move the armature of that relay into contact with stop 108. The magnet M^1 of the ratchet mechanism is energized only when contact is made between the armature of relay R^x and stop 108.

In describing the operation of the apparatus of this drawing we will first assume that the brushes of the distributer at the two ends of the line wire L are rotating in synchronism and in proper phase relation. When this condition exists the brush BR^2 will be just entering upon the beginning or left extreme of an A segment as the armature of main line relay ML changes from one position to the other, in response to a signaling impulse transmitted through line wire L. We will assume that the armature of relay ML has just moved to the right, and that brush BR^2 is just entering an A segment of ring S^2. As the brush moves over the A segment a circuit is established from battery 103 through the armature of relay ML, conductor 101, ring RG^2, brush BR^2, an A segment of ring S^2 and the coils of relay R'''' to ground, moving the armature of relay R'''' into contact with stop 105. This prepares a circuit path for the following operation: The brush BR^2 continues to move over the A segment of ring S^2 and on to the next succeeding R segment of that ring. The armature of relay ML being still against its right hand stop, and so in circuit with battery 103, when brush BR^2 makes contact with such succeeding R segment, a circuit is completed from battery 103 through the armature of relay ML and conductor 101 to the ring RG^2 as before, brush BR^2, and R segment of ring S^2 to one side of the condenser K, the other side of that condenser being connected through the armature of relay R'''', stop 105, and the upper coil of magnet R^x to ground, thereby holding the armature of relay R^x against its upper stop 107, so preventing any action of magnet ML; which is as it should be, for under the conditions assumed, the distributers at the two ends of the line are in perfect phase relation and no correction by the operation of magnet ML is required. But let us now suppose that the distributers at the two ends of the line are not in perfect phase relation; and that, at the moment the armature of main line relay ML moves to the right to establish a circuit connection with battery 103, the brush BR^2 instead of just entering an A segment as previously assumed, has advanced along an A segment until it is about to leave that segment. In such case the contact of brush BR^2 with such a segment, following the closing of connection between the armature of relay ML and battery 103, will be too brief to permit reversal of the armature of relay R'''', which armature, therefore, (having previously been against its stop 106 owing to previous transmission of an impulse from battery 104 through the coils of relay R'''') will remain in contact with stop 106; and when the brush BR^2 passes into contact with the next R segment, the condenser K will be charged from

battery 103, and the lower coil of relay R^x will be energized and therefore the armature of that relay will be moved against its stop 108, causing the energization of magnet ML and the operation of the ratchet mechanism to retard or step back the distributer D^2; whereby that distributer is restored to proper phase relation with the distributer at the other end of the line. At the next change of polarity in main line L the armature of main line relay ML moves into connection with battery 104; but as the distributer D^2 has been stepped back to bring it into proper phase relation with the distributer at the other end of the line, the brush BR^2 remains in contact with the A segment of ring S^2 for a sufficient length of time for relay R'''' to be operated; though no operation of that relay R'''' occurs, because, although the current from battery 104 tends to move the armature of relay R'''' into contact with stop 106, that armature is already in contact with that stop 106, not having been moved from that stop 106 by the previous impulse from battery 103, since during such previous impulse contact of the brush BR^2 with an A segment continued for too brief a time for relay R'''' to operate. When brush BR^2 passes to the next succeeding R segment, a current impulse from battery 104 charges the condenser K and the resulting flow of current moves the armature of relay R^x into contact with its stop 107 thereby breaking the circuit through the ratchet mechanism M^1 and permitting the restoration of the armature and the pawl of that magnet to normal. The next reversal of current in line wire L moves the armature of relay ML into contact with battery 103, and just as the brush BR^2 passes over into contact with the next A segment, a current from battery 103 passes through the coils of relay R'''' for a sufficient time to move the armature of that relay against its stop 105, so that when the brush BR^2 reaches the following R segment of ring S^2, the latter portion of the current impulse from battery 103, charging the condenser K, does not change the position of the armature of relay R^x which is still held against stop 107. In other words, if the reversing relay R'''' is actuated by the first portion of the impulse, transmitted through the armature of the main line relay ML, whether that impulse be positive or negative, the correcting relay R^x is not actuated by the secondary portion of that impulse; but if the reversing relay R'''' is not actuated by the first portion of an impulse, by reason of such portion being too short, then the correcting relay R^x is actuated, magnet M^1 is energized, and correction of the distributer effected.

It will be obvious that the ratchet mechanism M^1 might be arranged to advance distributer D^2 with reference to distributer D^1 in the event that the distributer D^2 is arranged to be driven normally at a speed slightly less than that of distributer D^1, and that the correcting arrangement illustrated, and comprising the relays R'''' and R^x, would be arranged to cause the ratchet mechanism to advance the distributer D^2 with reference to distributer D^1, instead of stepping it back. The slight change in circuits required to accomplish this is obvious and is not believed to require illustration.

We have indicated diagrammatically, as means for driving distributer D^2, the well known La Cour motor comprising a toothed armature wheel PW, magneto DM^1 and DM^2, and a tuning fork contact device driven by a magnet FM for energizing magnets DM^1 and DM^2 in alternation. It may be understood that the distributer D^1 is driven by similar means. However, the distributers D^1 and D^2 may be driven by any suitable means, and we do not limit ourselves to any particular means for that purpose.

This application is a division of our application Serial No. 654, filed January 5, 1915, wherein we have claimed broadly means for maintaining synchronism between two distributers, comprising correction mechanism arranged to be brought into operation by variation of current impulses incident to the transmission of signals; therefore, such invention is not claimed herein.

What we claim is:

1. In a synchronous telegraph system the combination of a rotary distributer comprising a commutator divided into segments, and a brush for such commutator, means arranged to produce relative motion between said commutator and said brush, a line relay arranged to apply current of alternately opposite sign to said brush in response to signaling impulses in a line circuit, a polar relay having its operating magnet connected to alternate segments of said commutator, and its armature connected to the intermediate segments of said commutator and correcting means controlled by said polar relay and arranged to be operated or to be idle according as the first portion of an impulse transmitted through said commutator to the operating magnet of said polar relay is too brief or is of sufficient length to actuate said polar relay, said correcting means arranged to operate immediately upon failure of such polar relay to operate, the length of such impulses depending upon whether the commutator and brush are or are not in proper phase relation with respect to the operation of said line relay.

2. In a synchronous telegraph system the combination of a rotary distributer comprising a commutator divided into segments,

and a brush for such commutator, means arranged to produce relative motion between said commutator and said brush, a line relay arranged to apply current of alternately opposite sign to said brush in response to signaling impulses in a line circuit, a polar relay having its operating magnet connected to alternate segments of said commutator, and its armature connected to the intermediate segments of said commutator, and correcting means comprising a further relay having an armature and magnet coils arranged to move such armature in opposite directions, one such magnet coil connected to one contact stop of the polar relay, the other to an opposite stop of the polar relay, said further relay arranged to operate immediately upon failure of said polar relay to operate following a current reversal by the line relay.

3. In a synchronous telegraph system the combination of a rotary distributer comprising a commutator divided into segments, and a brush for such commutator, means arranged to produce relative motion between said commutator and said brush, a line relay arranged to apply current of alternately opposite sign to said brush in response to signaling impulses in a line circuit, a polar relay having its operating magnet connected to alternate segments of said commutator, and its armature connected to the intermediate segments of said commutator, and correcting means comprising a further relay having an armature and magnet coils arranged to move such armature in opposite directions, one such magnet coil connected to one contact stop of the polar relay, the other to an opposite stop of the polar relay, said further relay arranged to operate immediately upon failure of said polar relay to operate following a current reversal by the line relay, and a condenser interposed in the circuit connecting the armature of said polar relay and the commutator segments to which that armature is connected by such circuit.

4. In a synchronous telegraph system the combination of two rotary distributers to be operated in synchronism and a line circuit connecting the same, means for transmitting current impulses from the one distributer to the other and for varying such impulses for the transmission of signals, one of said distributers comprising a commutator divided into segments, and a brush for such commutator, and means for maintaining synchronism between said distributers, comprising a line relay arranged to apply current of alternately opposite sign to said brush in response to signaling impulses in the line circuit, a polar relay having its operating magnet connected to alternate segments of said commutator, and its armature connected to intermediate segments of said commutator, and correcting means controlled by said polar relay and arranged to be operated or to be idle according as the first portion of an impulse transmitted through said commutator to the operating magnet of said polar relay is too brief or is of sufficient length to actuate said polar relay, said correcting means arranged to operate immediately upon failure of such polar relay to operate, the length of impulses depending upon whether the commutator and brush are or are not in proper phase relation with respect to the other distributer.

5. In a synchronous telegraph system the combination of two rotary distributers to be operated in synchronism and a line circuit connecting the same, means for transmitting current impulses from the one distributer to the other and for varying such impulses for the transmission of signals, one of said distributers comprising a commutator divided into segments, and a brush for such commutator, and means for maintaining synchronism between said distributers, comprising a line relay arranged to apply current of alternately opposite sign to said brush in response to signaling impulses in the line circuit, a polar relay having its operating magnet connected to alternate segments of said commutator, and its armature connected to the intermediate segments of said commutator, and correcting means comprising a further relay having an armature and magnet coils arranged to move such armature in opposite directions, one such magnet coil connected to one contact stop of the polar relay, the other to the opposite stop of the polar relay, said further relay arranged to operate immediately upon failure of said polar relay to operate following a current reversal by the line relay.

6. In a synchronous telegraph system the combination of two rotary distributers to be operated in synchronism and a line circuit connecting the same, means for transmitting current impulses from the one distributer to the other and for varying such impulses for the transmission of signals, one of said distributers comprising a commutator divided into segments, and a brush for such commutator, and means for maintaining synchronism between said distributers, comprising a line relay arranged to apply current of alternately opposite sign to said brush in response to signaling impulses in the line circuit, a polar relay having its operating magnet connected to alternate segments of said commutator, and its armature connected to the intermediate segments of said commutator, and correcting means comprising a further relay having an armature and magnet coils arranged to move such armature in opposite directions, one such magnet coil connected to one contact stop of the polar relay, the other to an opposite

stop of the polar relay, said further relay arranged to operate immediately upon failure of said polar relay to operate following a current reversal by the line relay, and a condenser interposed in the circuit connecting the armature of said polar relay and the commutator segments to which that armature is connected by such circuit.

In testimony whereof we have signed this specification in the presence of two subscribing witnesses.

GEORGE M. YORKE.
GEORGE R. BENJAMIN.

Witnesses:
T. L. HUNT,
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