G. M. YORKE & G. R. BENJAMIN.

MEANS FOR SYNCHRONIZING ROTARY DEVICES.

APPLICATION FILED AUG. 21, 1915.

1,215,605.

Patented Feb. 13, 1917.

2 SHEETS—SHEET 1.

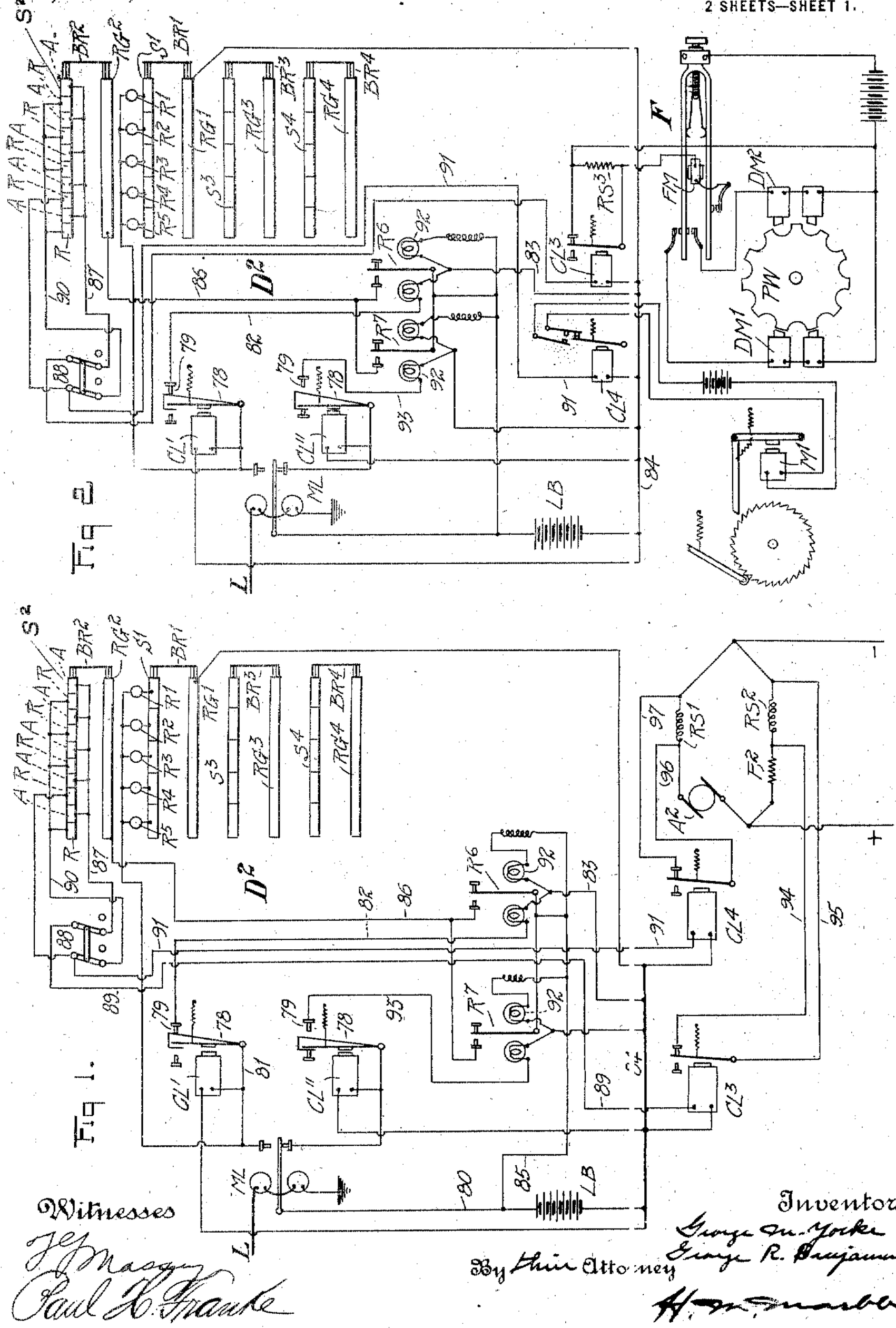

Fig 2

Fig 1.

Witnesses

J. J. Magee

Paul K. Franke

Inventors

George M. Yorke

George R. Benjamin

By their Attorney

H. M. Munn

G. M. YORKE & G. R. BENJAMIN.

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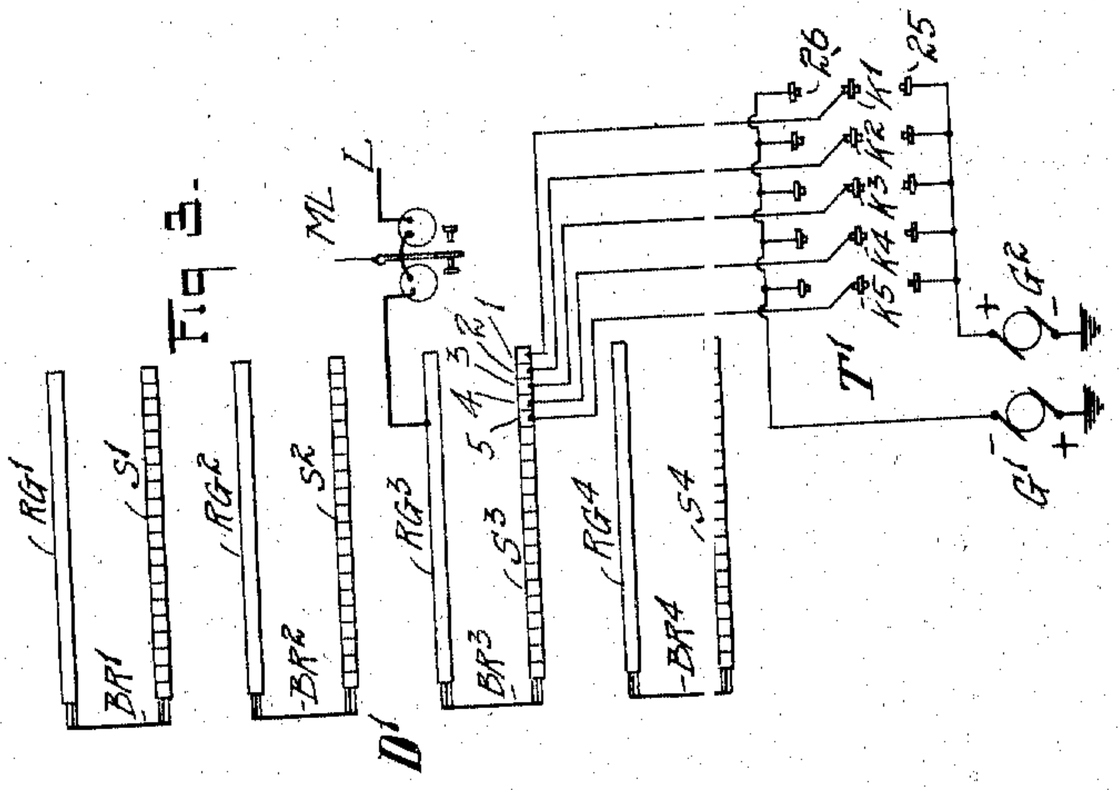
2 SHEETS—SHEET 2.

Fig. 2.



Witnesses

J. J. Massey

Paul K. Franke

Inventor

George M. Yorke

George R. Benjamin

By their Attorney

H. M. Marble

UNITED STATES PATENT OFFICE.

GEORGE M. YORKE, OF NEW YORK, N. Y., AND GEORGE R. BENJAMIN OF JERSEY CITY, NEW JERSEY, ASSIGNORS TO THE WESTERN UNION TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

MEANS FOR SYNCHRONIZING ROTARY DEVICES.

1,215,605. Specification of Letters Patent. Patented Feb. 13, 1917.

Original application filed January 5, 1915, Serial No. 654. Divided and this application filed August 21, 1915. Serial No. 46,641.

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 radiotelegraphy, 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 obviating 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 transmitting 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 of comprehension and to avoid opportunity for derangement.

We will now proceed to describe our invention with reference to the accompanying drawings, and will then point out the novel features in claims. In said drawings:

Figure 1 illustrates 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.

Fig. 2 is a view similar to Fig. 1, but illustrates certain alternatives which may be employed in the correction apparatus.

Fig. 3 is a diagrammatic view illustrating schematically transmitting means which may be employed in connection with the receiving and correcting apparatus of Figs. 1 and 2.

Referring first to Figs. 1 and 3: D^1 (Fig. 3) and D^2 (Fig. 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 accessary 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 comprise 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, in Fig. 3, 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 designate main line relays of which there is one at each end of line L.

Referring now to the receiving and correcting apparatus of Fig. 1: There are two correcting relays CL′ and CL″ which, in

the arrangement shown, are both non-polar delay-action relays, one or the other being operated according as the armature of the corresponding main line relay ML makes contact with its upper or lower stop. Relay ML controls selecting relays R^1—R^5 inclusive, through distributer rings RG^1 and S^1 of the distributer D^2. Supposing a current pulse in the line wire L to reverse the position of the armature of relay ML, the magnet of correcting relay CL′ will be energized, but, since this relay is a delay action relay, before the contact spring 78 has broken contact with the rear stop 79, a circuit will have been completed from main battery LB through conductor 80, the armature and upper stop of relay ML, conductor 81, armature contact spring 78, rear stop 79, and conductor 82 through one winding of the differential polar relay R^6, conductor 83 and the main return conductor 84 back to battery. This current impulse, in passing through relay R^6, moves the armature of that relay to the left, thereby completing another circuit from battery LB through conductor 85, the armature of relay R^6, and conductor 86 to distributer ring RG^2 and thence, through brushes BR^2 to one or another of the alternated segments R and A of ring 82. If the brush BR^2 is in contact with one of segments A the circuit will then continue through conductor 87, switch 88 and conductor 89, the magnet of relay CL^3 and back to the opposite pole of battery LB. Should brush BR^2 be in contact with an R segment of ring S^2 at the instant, the circuit will be, instead, through conductor 90, switch 88, conductor 91 and the magnet of relay CL^4, back to the opposite pole of battery LB. It will be seen that the circuit path from ring S^2 is to relay CL^3 or relay CL^4, according as the brush BR^2 is in contact with an A (advance) segment, of ring S^2, or with an R (retard) segment of ring S^2; and if, (as will be the case, if the distributer is in perfect phase relation with the distributer at the transmitting end of the line) the brush BR^2 is over one of the insulating divisions between an A segment and an R segment of ring S^2 at the instant of actuation of relays CL′ and R^6, no circuit will be completed to either relay CL^3 or CL^4. The circuit through the armature of relay CL′ to one magnet coil of relay R^6 continues for an instant only, as the armature 78 of that relay CL′ almost immediately breaks contact between spring 78 and stop 79, whereupon the armature of relay R^6 is drawn back to the position shown in Fig. 1, by the relatively weak holding coil 92 of that relay, to which coil current is supplied from battery LB through conductors 85, 83 and 84.

Upon the return of the armature of relay M′ to its lower stop, a circuit is completed through the magnet of relay CL″ and also, for an instant, through the armature spring 78 of that relay, the back stop 79 of that relay, and conductor 93 and through the stronger of the coils of polar relay R^7 back to battery; and thereby a circuit is completed from battery LB through conductor 85, the armature of relay R^7, and conductor 86 and thence through RG^2, brush BR^2 and one of the A or R segments of ring S^2 to one of the relays CL^3 or CL^4, and thence back to battery; or, should brush BR^2 be on one of the insulation divisions of ring S^2 at the moment of actuation of relays CL^2 and R^7, neither relay CL^3 or relay CL^4 will be actuated. It will be seen that whether relay CL′ or relay CL″ is actuated, depends simply upon whether the armature of relay ML moves in one direction or the other; that relay CL″ controls relay R^7 just as relay CL′ controls relay R^6; and that when either relay R^6 or R^7 is actuated to close circuit to ring RG^2, circuit is completed to relay CL^3 or relay CL^4, according as brush BR^2 is in contact at the moment with an A segment or an R segment of ring S^2; while if brush BR^2 is on an insulation division of that ring S^2 neither relay CL^3 or relay CL^4 will be actuated.

A^2 designates an electric motor driving distributer D^2. When the magnet of relay CL^3 is energized, that relay opens a shunt circuit 94—95 around a resistance RS^2 in series with the field F^2 of the motor A^2; and the field resistance of the motor being thereby increased, the speed of the motor A^2 is increased. When the magnet of relay CL^4 is energized that relay breaks the shunt 97—97 around resistance RS^1 in series with the armature of motor A^2 the breaking of which shunt 96—97 throws resistance RS^1 in series with the armature thereby decreasing the speed of the motor A^2. It will be obvious that control of the resistances RS^2 and RS^1 by relays CL^3 and CL^4, themselves controlled in the manner described, will keep distributer D^2 in synchronism with the distributer at the transmitting end of the line.

Switch 88 is normally in the position shown in Fig. 1, but may be thrown to the opposite position, to facilitate bringing the distributers D^1 and D^2 into step when starting up. When first starting up, motor A^2 will drive distributer D^2 at a speed slightly in advance of the speed of the distributer at the transmitting end of the line. Switch 88 when thrown to the right or starting position disconnects all of the A segments of ring S^2 from conductor 89, and connects one R segment of distributer 82 to conductor 91. When first starting up, means, not illustrated in Fig. 3, is employed to cause the transmitting distributer to send the current impulses through the line once only in each rotation of that distributer. The receiving distribu-

ter D^2 being driven at a speed slightly greater than that of the transmitting distributer, it will soon happen that when the transmitting distributer is sending its current impulse, brush BR^2 of the receiving distributer D^2 will be in contact with that particular R segment of ring S^2 then in circuit, and thereupon relay CL^4 will be operated to retard the speed of the motor A^2; so bringing the two distributers into proper phase relation and synchronism as to speed.

The synchronizing arrangement shown in Fig. 2 is similar to that shown in Fig. 1, except that the distributer D^2 is driven by a La Cour wheel PW, the magnets DM^1 and DM^2 of which are alternately energized and deënergized by the action of an electrically driven tuning fork F. Relay CL^3 controls a shunt around resistance RS^3 in the circuit of the driving magnet FM of fork F, and when the magnet of relay CL^3 is energized the shunt around this resistance RS^3 is opened, the resistance RS^3 being thereby placed effectively in circuit with magnet FM, thereby increasing the speed of the fork F. Relay CL^4 operates a suitable ratchet mechanism, well known in the art, for stepping back the distributer D^2 with reference to the distributer D^1; whereby when the magnet of relay CL^4 is energized, the circuit of the ratchet magnet M^1 is closed and the ratchet mechanism operated to step the distributer D^2 backward slightly.

In many cases, correction may be effected by varying the speed of one of the distributers in one sense only. For example, the driving means for one of the distributers may be arranged to drive that distributer normally at a speed somewhat in excess of the speed at which the other distributer is driven, and correction may be effected by retarding the speed of the faster distributer, or by increasing the speed of the slower distributer. Since in Figs. 1 and 2 we have shown means for both increasing and decreasing the speed of the distributer D^2, it will be obvious that, if the distributer D^2 be arranged to be driven normally at a speed less than that of the distributer D^1, the correcting relay CL^4 and the means controlled thereby may be omitted, and correction effected as required by speeding up the motor A^2 (Fig. 1) by means of the relay CL^3 and the field resistance RS^2 controlled thereby, or the resistance RS^3 (Fig. 2) in the circuit of driving magnet FM. Or, if distributer D^2 be arranged to be driven normally at a speed greater than that of the distributer D^1, relay CL^3 and the means controlled thereby may be omitted and correction effected by means of the relay CL^4 and the resistance RS^1 (Fig. 1) controlled thereby; or ratchet mechanism MR (Fig. 2).

This application is a division of our application Serial No. 654, filed January 5, 1915, wherein we have claimed broadly means for maintaining correction mechanism arranged to be brought into operation by variation of the 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, two electrically controlled speed-varying means, one arranged when operated to increase the speed of such relative motion, the other arranged when operated to decrease the speed of such relative motion, one of such speed-varying means connected to alternate segments of the commutator and the other to the intermediate segments of the commutator, and means for applying current to said commutator brush, and for limiting the period of such application of current.

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, two electrically controlled speed-varying means, one arranged when operated to increase the speed of such relative motion, the other arranged when operated to decrease the speed of such relative motion, one of such speed-varying means connected to alternate segments of the commutator and the other to the intermediate segments of the commutator, and means for applying current to said commutator brush, and for limiting the period of such application of current, comprising a line relay and delay-action means controlled thereby.

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, two electrically controlled speed-varying means, one arranged when operated to increase the speed of such relative motion, the other arranged when operated to decrease the speed of such relative motion, one of such speed-varying means connected to alternate segments of the commutator and the other to the intermediate segments of the commutator, and means for applying current to said commutator brush, and for limiting the period of such application of current, comprising a line relay and two delay-action relays each controlling the supply of current to said commutator brush, said delay-action relays being actuated alternately by operation of said line relay.

4. 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, two electrically controlled speed-varying means, one arranged when operated to increase the speed of such relative motion, the other arranged when operated to decrease the speed of such relative motion, one of such speed-varying means connected to alternate segments of the commutator and the other to the intermediate segments of the commutator, and means for applying current to said commutator segments alternately, and for limiting the period of such application of current comprising a line relay, two delay-action relays operated alternately by said line relay, and two secondary relays, each controlled by one of said delay action relays; and each controlling the application of current to said commutator segments.

5. 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, two electrically controlled speed-varying means, one arranged when operated to increase the speed of such relative motion, the other arranged when operated to decrease the speed of such relative motion, one of such speed-varying means connected to alternate segments of the commutator and the other to the intermediate segments of the commutator, and means for applying current to said commutator brush, and for limiting the period of such application of current comprising a line relay, two delay-action relays actuated alternately by said line relays, and two secondary relays, each comprising a magnet coil and a circuit therefor which is closed by the main line relay when that main line relay actuates the corresponding delay action relay, said circuit arranged to be broken by the corresponding delay action relay when it operates, each such secondary relay further comprising means for returning such secondary relay to normal condition upon the breaking of said circuit of said secondary relay by the corresponding delay-action relay.

6. 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, two electrically controlled speed-varying means, one arranged when operated to increase the speed of such relative motion, the other arranged when operated to decrease the speed of such relative motion, one of such speed-varying means connected to alternate segments of the commutator and the other to the intermediate segments of the commutator, and means for applying current to said commutator brush, and for limiting the period of such application of current comprising a line relay, two delay-action relays actuated alternately by said line relays, and two secondary relays, each comprising a magnet coil and a circuit therefor which is closed by the main line relay when that main line relay actuates the corresponding delay action relay, said circuit arranged to be broken by the corresponding delay action relay when it operates, each such secondary relay further comprising a holding coil relatively weaker than the said magnet coil, and normally energized, which holding coil returns such secondary relay to normal condition upon the breaking of the said circuit of said secondary relay by the corresponding delay-action relay.

7. 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 comprising an electric motor having an armature and a field, means for varying the resistance in the field circuit connected to alternate segments of the commutator, means for varying the resistance in the armature circuit connected to the intermediate segments of the commutator, and means for applying current to said commutator brush.

8. 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 comprising an electric motor having an armature and a field, means for varying the resistance in the field circuit connected to alternate segments of the commutator, means for varying the resistance in the armature circuit connected to the intermediate segments of the commutator, and means for applying current to said commutator brush, and for limiting the period of such application of current.

9. 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 comprising an electric motor having a field with a resistance in circuit therewith and an armature with a resistance adapted to be placed in circuit therewith, a relay connected to alternate segments of the commutator, and arranged when actuated, to cut in the field resistance, a relay connected to the intermediate segments of the commutator and

arranged when actuated to cut in the armature resistance, and means for applying current to said commutator brush.

10. 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 comprising an electric motor having a field with a resistance in circuit therewith and an armature with a resistance adapted to be placed in circuit therewith, a relay connected to alternate segments of the commutator, and arranged when actuated, to cut in the field resistance, a relay connected to the intermediate segments of the commutator and arranged when actuated to cut in the armature resistance, and means for applying current to said commutator brush, and for limiting the period of such application of current.

11. 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, and means for maintaining synchronism between said distributers, comprising electrically controlled means for varying the speed of one of said distributers, a line relay responsive to signaling impulses in said line circuit, and delay-action circuit controlling means controlled by that line relay, one of said distributers having a commutator and means controlled by said line relay and delay-action means for supplying current to that commutator, such speed varying means connected to certain of the segments of that commutator.

12. 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, and means for maintaining synchronism between said distributers, comprising two electrically controlled means, one arranged when actuated to increase the speed of one of said distributers, the other arranged when actuated, to decrease the speed of such distributer, a line relay responsive to signaling impulses in said line circuit, and delay action circuit controlling means controlled by that relay, one of said distributers having a commutator, and means controlled by said line relay and delay action means for supplying current to that commutator, one of said speed varying means connected to alternate segments of that commutator, and the other connected to intermediate segments of that commutator.

13. 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, a line relay responsive to signaling impulses in said line circuit, two delay-action relays actuated alternately by operation of said line relay, one of said distributers having a commutator and means controlled by said line relay and delay action relays for supplying current to that commutator, and speed varying means arranged to vary the speed of the distributer having such commutator, such speed varying means connected to certain of the segments of that commutator.

14. 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, a line relay responsive to signaling impulses in said line circuit, two delay action relays actuated alternately by operation of said line relay, one of said distributers having a commutator and means controlled by said line relay and delay-action relays for supplying current to that commutator, and two speed varying means arranged to vary the speed of the distributer having such commutator in opposite senses, one of said speed varying means connected to alternate segments of the commutator, the other speed varying means connected to intermediate segments of the commutator.

15. 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, and electrically controlled speed varying means connected to alternate segments of that commutator, and means for applying current to said commutator brush, and for limiting the period of such application, of current, comprising a line relay and delay action means controlled thereby.

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

GEORGE M. YORKE.
GEORGE R. BENJAMIN.

Witnesses:
T. S. HUNT,
R. J. MEIGS.