July 26, 1927. 1,636,784

L. F. PARKER ET AL

PHASE CORRECTION IN SYNCHRONOUS TELEGRAPH SYSTEMS

Filed Jan. 6, 1926

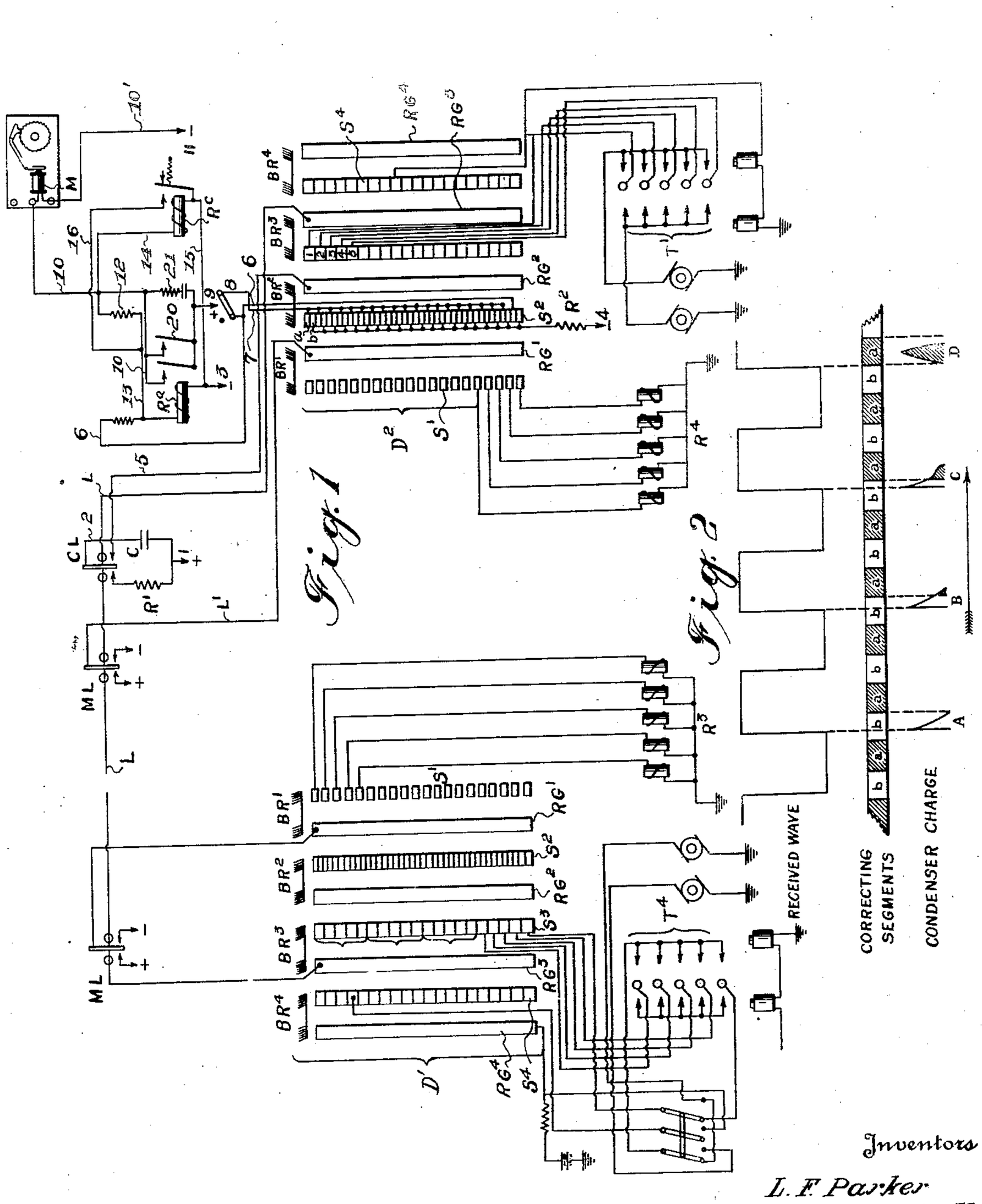

Fig. 1

Fig. 2

Inventors

L. F. Parker

F. B. Bramhall

By Eugene C. Brown

Attorney

Patented July 26, 1927. 1,636,784

UNITED STATES PATENT OFFICE.

LEIGHLAND F. PARKER, OF BURLINGTON, VERMONT, AND FAY B. BRAMHALL, OF METUCHEN, NEW JERSEY, ASSIGNORS TO THE WESTERN UNION TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

PHASE CORRECTION IN SYNCHRONOUS TELEGRAPH SYSTEMS.

Application filed January 6, 1926. Serial No. 79,586.

Our invention relates to phase correction of two remotely disposed rotating members and more particularly to synchronous telegraph or signalling systems.

An object of our invention is to provide simple and reliable means for maintaining two remotely disposed rotating members in phase with each other.

Another object of our invention is to provide means having a "constant" characteristic for maintaining two rotating members in phase.

Another object of our invention is to provide means requiring no maintenance for keeping two members in phase.

Still another object of our invention is to provide means for replacing a relay by a condenser to maintain two members in phase.

There are other objects of our invention which with the foregoing will become apparent.

Telegraph systems such as that herein illustrated and described, comprise rotating distributors remotely disposed with respect to each other, and connected by a signalling conductor. The segments of the distributors at one end of the conductor are connected to transmitter contacts and at the other end the distributor segments are connected to relays of an automatic telegraph printer.

A uniform five unit code known as Baudot code and comprising combinations of positive and negative impulses is used. As the distributor brush rotates over the segments, a code of five impulses is transmitted, the position of the five transmitter contacts determining the polarity of these implses. At the receiver these impulses are distributed to five receiving relays as the brush thereat rotates over the segments.

By this well-known use of the distributor, each transmitter contact is in succession brought into electrical connection with its associated receiving relay over a single line and this principle can, of course, as illustrated in the drawing be extended to multiplexing, using each group of five segments per channel.

It is obvious, however, that for correct operation, the two distributors must be maintained in synchronism and in phase. Otherwise the transmitter contact will be connected to the wrong relay over the line resulting in a false signal.

It has been found best in practice to rotate one of these two distributors slightly faster than the other and then provide means for restoring the phase relation of the two distributors whenever they fall out a predetermined degree. Heretofore this means has been a relay, as illustrated in the patent to Rothermel, No. 1,253,889, of which this is an improvement.

The relay R^b in Rothermel, however, requires very delicate adjustment and considerable maintenance. Since the distributors are rotating at comparative high speed the circuit closing must be timed just right and always occur at the same time. A relay is not constant in operation; its moment of contacts shifts continuously due to changes in residual magnetisms and the natural period of the armature at certain frequencies. Relays in general are subjected to the usual mechanical difficulties which make their elimination in systems desirable.

In practicing our invention, we provide an all electrical means, namely a condenser to operate the phase correcting circuits, so redesigning these circuits as to make this possible.

Referring now to the drawings, Figure 1 shows the circuits of a multiplex telegraph system embodying our invention.

Fig. 2 illustrates the electrical effects with the brushes of the distributors in three conditions, namely, in phase, partially out of phase and entirely out of phase.

Referring first to Fig. 1: D^1 and D^2 designate rotary distributers or commutators of the general Baudot type, located at opposite ends of a line wire L. Such distributors comprise a plurality of commutator rings alternate rings being plain and segmented respectively, and suitable brushes being provided for connecting each plain ring electrically with its corresponding segmented ring. Corresponding rings of the two distributors shown are designated by the same reference characters, viz, S^1, RG^1, S^2, RG^2, S^3, RG^3 and S^4, RG^4; and the brushes are designated by characters BR^1, BR^2, BR^3 and BR^4.

The distributors shown in Fig. 1 are adapted each for four "channels of communication"; but for simplicity we have shown transmitting and receiving means for one "channel of communication" only in

each direction. The distributer rings are shown "developed", and we have shown no means for driving the brushes, the mounting of the brushes with reference to the various distributer rings and the methods of rotating such brushes, being well known and disclosed in the patent to Yorke and Benjamin, No. 1,298,622.

T^1 and T^4 designate automatic transmitters, one at each end of the line and each adapted to transmit, through its corresponding distributer, to receiving apparatus R^3 or R^4, at the opposite end of the line, and through the distributer at that end of the line. Since such transmitting and receiving apparatus are well known and disclosed in the above-named patent, detailed description thereof is not necessary here.

In practice, in these distributers, the brushes of each distributer are mounted upon a rotatable shaft, driven by a motor of very constant speed, the brush shaft of one distributer being usually driven at a normal speed very slightly greater or very slightly less, as preferred, than the brush shaft of the other distributer; and the function of the corrector is to step back or to step forward, as the case may be, the brushes of the one distributer with reference to the brush shaft of that distributer, in order to restore proper phase relation between the two distributers when such restoration is necessary. The distributer provided with such correction mechanism is termed the "corrected distributer", while the other distributer, which commonly has no correction mechanism, is termed the "correcting distributer." In Fig. 1, D^1 is the "correcting distributer" and D^2 is the "corrected distributer"; correcting mechanism being shown only in connection with distributer D^2.

Commonly, a line relay is interposed between each distributer and the line, and commonly the "corrected distributer" is provided with a "correcting relay" in the main line, by which correcting relay the correction mechanism of that distributer is directly controlled. In Fig. 1, ML designates the two main line relays, and CL the correcting relay employed in connection with distributer D^2.

According to the Yorke-Benjamin correction method, each current reversal affecting the correcting relay CL affords an opportunity for correction; but the correction mechanism operates only when, at the time of one or more of such reversals, one distributer is sufficiently out of phase with respect to the other distributer, to require correction.

In considering the operation of our improved corrector, we will consider that telegraphic characters are being transmitted from distributer D^1 to distributer D^2. It will be noted that contacts of transmitter T^4 are connected by suitable conductors to five segments of rings S^3 of distributer D^1, and that, supposing various contact combinations to be set up in transmitter T^4, when brush BR^3 passes over the segments of rings S^3, to which said contacts of transmitter T^4 are connected, corresponding current impulses will pass through the left hand main line relay ML through line wire L and then through the right hand main line relay ML, and relay CL, to ground or other return. Signals from distributer D^1, repeated by the right hand relay ML, pass through local line wire L′ into ring RG^1 of distributer D^2 and thence, through brush BR^1 of that distributer, into ring S^1, and so into signal receiving device R^4. It is not thought necessary to describe in detail this signal receiving device; or the method of its operation.

Ring S^2 consists of segments, alternate ones of which are connected to relay R^a over conductor 6 and negative battery over resistance R^2.

The armature of relay CL vibrates, as stated above, in unison with the vibration of the armature of the right hand relay ML. If the received impulse is of such a nature as to move to close its left hand contact, any charge in condenser C will be dissipated over the resistance R^1 and the armature contacts of relay CL.

If now the line current polarity is reversed, the armature of relay CL will move to close its right hand contact. If the distributers are in phase at this instant, the brush BR^2 should be on one of the contacts *b* and the condenser C will be charged over a circuit from positive battery condenser C, armature CL and its right hand contact, conductor 5, ring RG^2, brush BR^2, segment *b*, resistance R^2 to negative battery at 4. As a result, nothing will happen and condenser C will be discharged upon some subsequent reversal of current as heretofore described.

If the distributors are not in phase at the instant the armature of relay CL closes its right hand contact, brush BR^2 will be on one of the segments *a*. As a result, a circuit will be completed from positive battery at 1, condenser C, armature of relay CL and its right hand contact, conductor 5, ring RG^2, brush BR^2, segment *a*, conductors 7 and 6, winding of relay R^a to negative battery at 3. Relay R^a is energized over this circuit and closes its armature contact.

As a result of this a locking circuit for relay R^a and energizing circuits for relay R^c and magnet M are completed. The locking circuit for relay R^a extends from negative battery, winding of relay R^a, conductor 13, resistance 12 contact and armature of relay R^a to positive battery at 9. A parallel circuit for energizing relay R^c is also completed from negative battery at 3, winding of relay R^c, contact and armature of relay R^a to positive battery at 9. The energizing circuit for magnet M is completed from

negative battery at 11, conductor 10′, winding of magnet M, conductor 10, contact and armature of relay R^a to positive battery at 9.

Relay R^a and magnet M are designed as quick-to-operate relays while relay R^c has a slower characteristic. As a result, both relay R^a and magnet M will have been completely energized before the armature of relay R^c closes its front contact. The energization of magnet M operates the pawl through its armature rotating the ratchet wheel one step and brings the two distributers back into phase.

Relay R^c now closes the front contact of its armature and as a result, shunts the energizing circuit of the relay R^a from negative battery at 3, armature of relay R^c and its front contact, conductor 16 to 13.

As a result of this shunt path, relay R^a is deenergized and opens its locking circuit. The energizing circuits of relay R^c and magnet M are also opened at the armature contact of relay R^a.

An analysis of the action is given in Figure 2 which shows the theoretical received wave, the relative position of the correcting segments and the condenser charging impulses. It should be noted that the time taken to traverse two correcting segments is slightly less than the length of one received impulse. This condition exists when the receiving distributer runs slightly faster than the sending distributer and the mechanical corrector steps the brushes backward.

Figure 2 shows the action at various brush positions. "A" shows the action directly following a correction when the correcting brush is on a "*b*" segment at the moment of current reversal. In this case as the tongue of the corrector relay touches its marking contact the condenser charge is entirely wasted through the resistance R^2. At position B the brushes of distributer D^2 have advanced slightly due to their greater speed and in this case the greater part of the condenser charge is through resistance R^2 and the remainder through the make relay. This small current through the make relay is not sufficient to operate it and the brushes continue to advance with respect to the received wave. At C a greater portion of the charge current passes through the "make" relay but still not enough to operate it. At D, however, the full charge current passes through the "*a*" segment and the "make" relay is operated. This in turn operates the mechanical corrector and the brushes are stepped back to the position shown at "A" and the process is repeated thus holding the brushes in synchronism with the received wave.

From this analysis, the importance of replacing the relay disclosed in Rothermel, by a condenser is evident. By using the condenser, a single instantaneous current surge is obtained. The period and measure of this surge can be definitely predetermined by condenser design. The selected constants will depend on the speed of the distributer and the size of segments *b*, so estimated that as soon as the distributers have fallen out of step the exact predetermined phase angle, a sufficient current surge for energizing relay R^a will be obtained. This degree of accuracy cannot be obtained with the relay R^b of Rothermel and its variably operating armature.

The same method will, of course, operate equally well for a system of correction in which the correcting distributer runs slower than the received wave and the brushes are stepped ahead.

Although we have disclosed our invention in connection with a multiplex telegraph system, it is understood, of course, that it has more general application as, for example, where continuously operating synchronous commutators or distributers are employed in a live circuit and applicants do not intend to limit themselves to the specific embodiment disclosed but only so far as set forth in the claims which follow.

We claim as our invention:

1. In a telegraph system, a correcting distributer, a corrected distributer rotating in approximate synchronism with said correcting distributer, a circuit connecting said distributers, means for transmitting impulses of two polarities over said circuit, a condenser, a phase correcting relay, mechanism controlled by said relay to shift the brushes of the distributor relative to their driving shaft, circuit arrangements whereby said condenser is charged on each reversal of polarity of said impulses and second circuit arrangements whereby said charging impulse also operates said phase correcting relay.

2. The method of phase correction between two members rotating in approximate synchronism which comprises reversing the polarity of impulses periodically, producing by said reversals a surge when said members are out of phase and operating a correcting mechanism with said surge to shift the brushes of one member relative to their driving shaft.

3. In a telegraph system, a correcting distributer, a corrected distributer rotating in approximate synchronism with said correcting distributer, a circuit connecting said distributers, means for transmitting impulses of two polarities over said circuit, electrostatic means, a phase correcting relay, mechanism controlled by said relay to shift the brushes of the distributor relative to their driving shaft, circuit arrangements whereby said condenser is charged on each reversal

of polarity of said impulses and second circuit arrangements whereby said charging impulse also operates said phase correcting relay.

4. The method of phase correction between impulses and a distributer which comprises producing surges by said impulses and operating a phase corrector by said surges to shift the distributor brushes relative to their driving shaft.

5. In combination, a correcting member, a corrected member, an electrical circuit connecting said members, means for transmitting impulses of two characteristics over said circuit, a condenser, circuit arrangement whereby said condenser is charged by a change of said received impulses, a correcting relay, mechanism controlled by said relay to shift the brushes of the distributor relative to their driving shaft, and circuit arrangements whereby said condenser discharges through said relay only when said distributers are out of phase.

In testimony whereof, we affix our signatures.

LEIGHLAND F. PARKER.
FAY B. BRAMHALL.