July 2, 1929. J. C. FIELD 1,719,506

SUPERVISORY SYSTEM

Filed Nov. 13, 1925 2 Sheets-Sheet 1

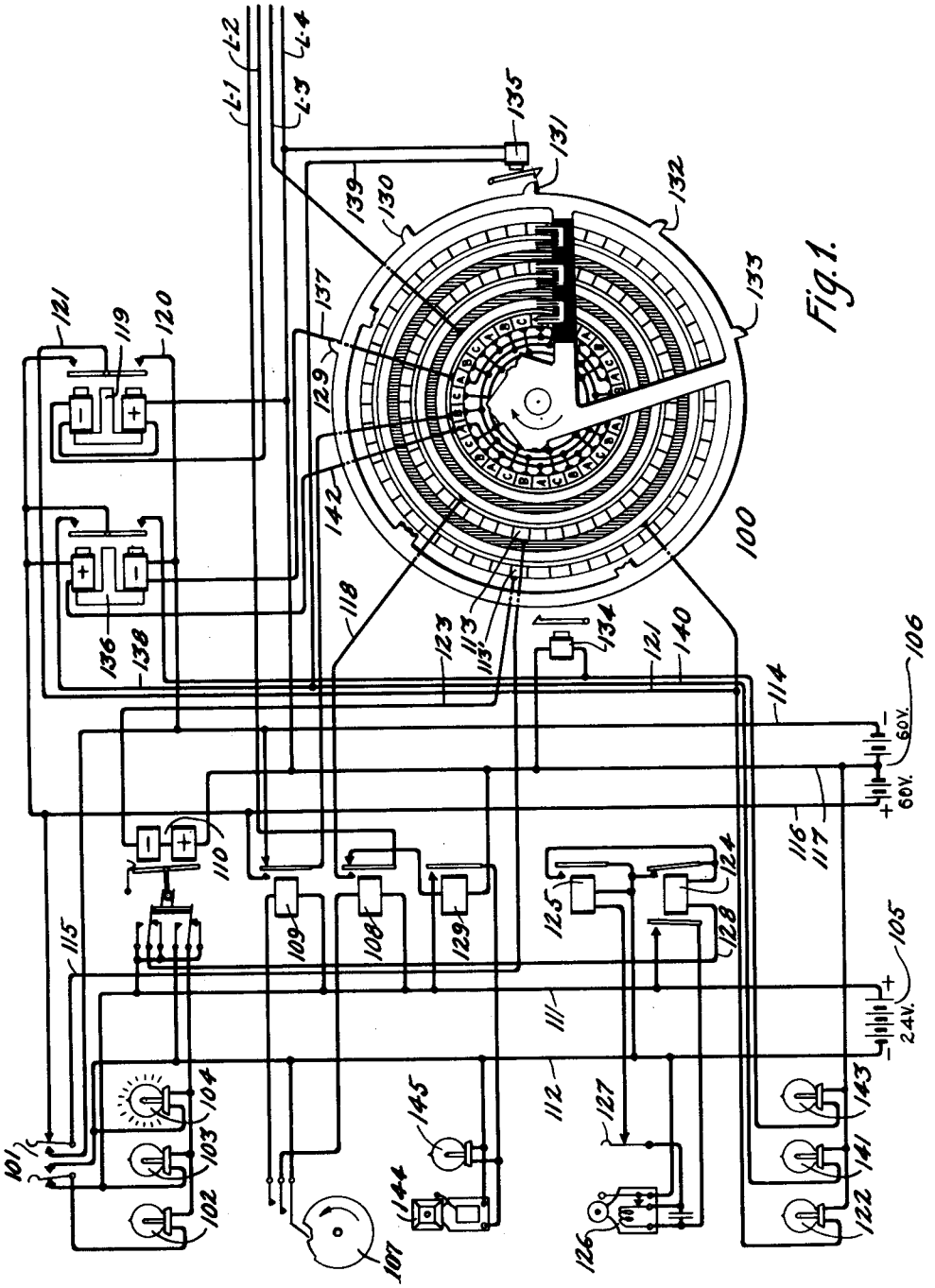


Fig. 1.

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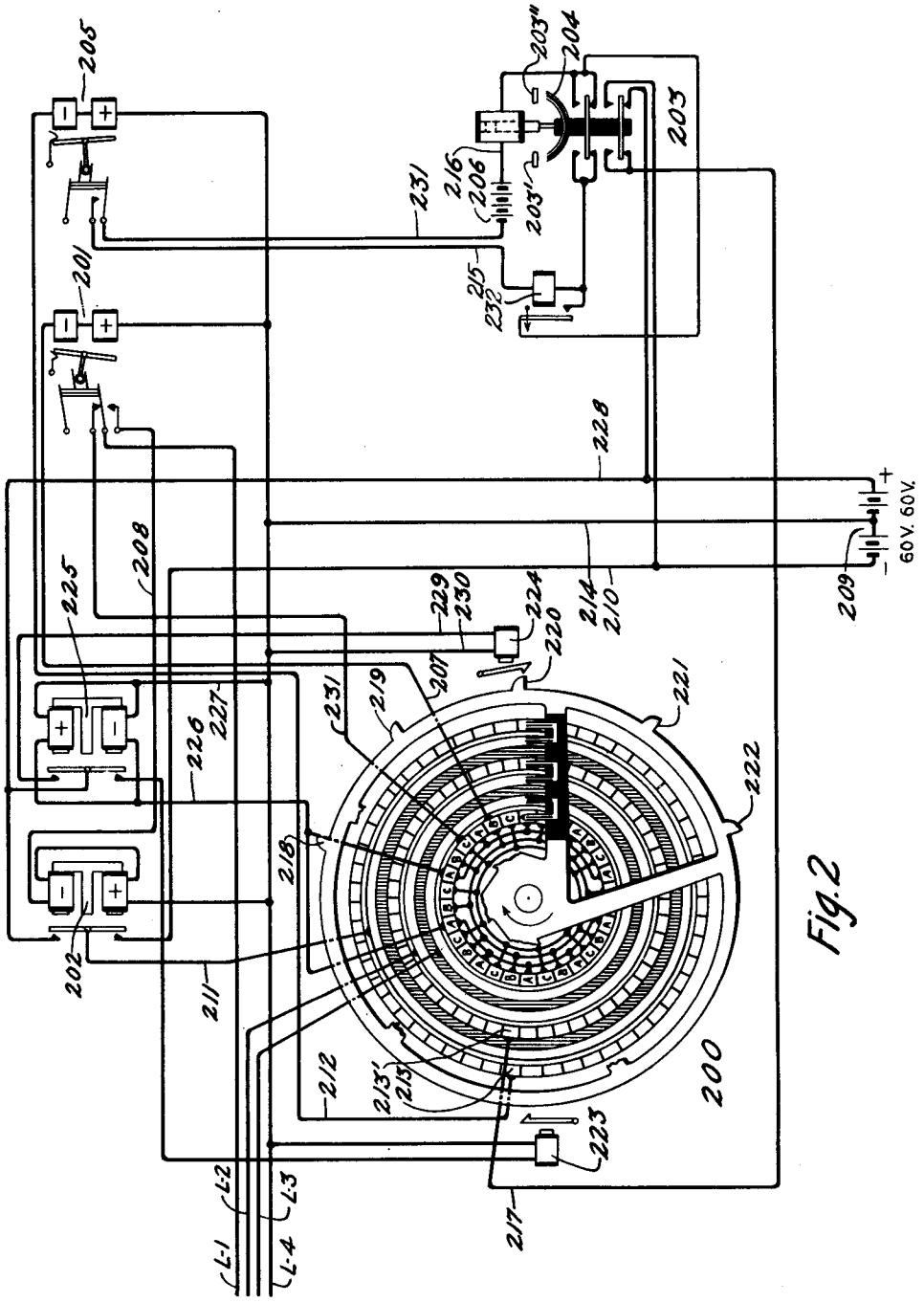


Fig. 2

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Patented July 2, 1929. 1,719,506

UNITED STATES PATENT OFFICE.

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SUPERVISORY SYSTEM.

Application filed November 13, 1925. Serial No. 68,824.

This invention relates to remote control power systems using rotary distributors. In such systems it is essential that these distributors be kept in synchronism. Heretofore in such systems, the distributors have been automatically synchronized a certain number of times per revolution.

An object of this invention is to provide means for notifying the load dispatcher at the control station when the distributors are out of synchronism by an amount less than that required to operate the automatic synchronizing means. To accomplish this result the distributors are provided, in addition to the automatic synchronizing mechanism, with additional means, which operates when the distributors are out of step an amount less than that required to operate the automatic synchronizing means, to actuate a signal to notify the dispatcher who may then take steps to correct this condition.

Another object of this invention is to prevent false operation of switches due to cross wires or extraneous currents. This is accomplished by having the main controlling line wire open at both stations except when the switches are being operated. In the present embodiment the line is open at contacts of a pair of relays one at each station, one of which relays is operated through the medium of the distributors.

These and other features of the invention will be better understood from the following description in connection with the attached drawings in which Fig. 1 represents a control station while Fig. 2 represents the remote or outlying station. When the figures are placed end to end with Fig. 1 at the left, a preferred form of a switch supervisory system, according to this invention, is shown.

In the system illustrated only one key and associated signal lamps are shown at the control station and only one power switch is shown at the remote station. The system is limited, however only by the number of segments on the rotary distributors and is shown in connection with one key and one switch to avoid duplication.

Two continuously operating rotary distributors are used, the one at the control station being designated by 100 and the one at the remote station being designated by 200. These distributors are of the type disclosed in Patent No. 1,496,875 to J. C. Field, dated June 10, 1924.

At the control station is a key 101 having two sets of contacts actuated simultaneously and arranged to remain in the position to which they may be moved. The left-hand group of contacts in conjunction with a polarized relay 110 controls the circuits for the 24-volt indicating lamps 102, 103, and 104 from a source of current 105. Lamp 102 is white and is lighted during the period of operating the remote switch until the answer back signal is received. Lamp 103 is red and when lighted indicates that the corresponding switch at the remote station is closed, and lamp 104 is green and when lighted indicates that the switch is open. The right-hand group of contacts of key 101 controls the polarity of the current applied to a segment in the middle group of distributor 100 from source 106. A relay similar to 110 is required for each key, such as 101, and the associated lamps.

A rotating key 107 equipped with three contact springs is manually operated to make one complete revolution after any key, such as 101, is changed. This key, which is of the type disclosed in Patent No. 1,155,640 to G. Brown October 5, 1915, takes a slightly longer time to complete a revolution than the rotary distributors which are arranged to make a complete revolution in five seconds. This is to insure a complete operation of the system as will appear in the following description. The middle and lower contacts of this key close a circuit from source 105 through relay 108. Relay 108 when energized connects the collector ring of the middle group of distributor 100 to line conductor L—1. The upper and lower contacts of the key close a circuit from source 105 through relay 109. This relay, when energized, changes the polarity on the segments marked "B", which are all strapped together, of the inner group of distributor 100 from negative to positive. This positive current is transmitted through the cooperating brush to the inner collector ring, thence over line L—3 to inner collector ring of distributor 200 at the remote station through the cooperating brush to the B segments which also are strapped together, thence to relay 201 to line conductor L—4, back to the source 106 at the control station. The operation of relay

201 by positive current attracts its armature toward the lower winding, changing the associated contacts to connect L—1 to relay 202 for a purpose to appear later.

At the remote station the power switch is designated by 203 and is arranged to control a power circuit, one branch of which terminates at contact blocks 203′ and 203″. Brush 204 connects these contact blocks to close the circuit. Switch 203 is also equipped with two sets of auxiliary contacts, the purpose of which will appear later. A mechanically locking polarized relay 205 controls the circuit through the actuating solenoid of the power switch from source 206. A similar relay is required for each power switch. There is also included in the circuit for actuating the power switch solenoid a slow release relay 232 having its armature and associated contact connected in the circuit to bridge the auxiliary contacts when the power switch opens or closes.

The system is shown with the switch 203 open at the remote station and the green light 104 lighted at the control station.

To describe the operation of the system, let it be assumed that power switch 203 is to be closed. Key 101 at the control station, is changed in position so that the middle or main contact spring of each group contacts with the inside spring of the corresponding groups, that is, the middle spring of the left group contacts with the right spring of the group and the middle spring of the right group contacts with the left spring of the group. The green lamp remains lighted since no change has occurred in its circuit which extends from battery 105, through conductor 111, lower and middle contact springs of lower group of relay 110, lamp 104, conductor 112 to battery 105. The white lamp 102 becomes lighted over a circuit from battery 105, conductor 111, lower and middle contact springs of lower group of relay 110, lamp 102, middle and right contact springs of left group of key 101, conductor 112 to battery.

The change in the contact springs in the right-hand group changes the polarity on segment 113 in the middle group of distributor 100 from positive to negative over a circuit from battery 106, conductor 114, left and middle contact springs of right group of key 101, conductor 115 to segment 113.

After key 101 is operated, rotating key 107 is started. This key connects its three associated contact springs, the middle and lower springs closing an obvious circuit from battery 105, through relay 108, the upper and lower springs closing a circuit from the same source through relay 109. As pointed out above relay 108 in energizing attracts its armature to close its front contact and connect collector ring of the middle group of distributor 100 to line L—1. At the same time, relay 109 attracts its armature to open its back contact and close its front contact. The back contact of relay 109 is connected to the negative pole of battery 106, through conductor 114 while the front contact is connected to the positive pole of battery 106 through conductor 116. The armature is connected to the segments marked B on the inner group of distributor 100. Since the B segments are strapped together, when the inner brush of the distributor 100 bridges one of the B segments with the corresponding collector ring, a positive current is transmitted over line L—3 to the collector ring of the inner group of distributor 200 at the remote station and since the distributors are in synchronism, the inner brush of this distributor will bridge the collector ring to a B segment, then over conductor 207, through relay 201 to line conductor L—4, conductor 117 at the control station to battery 106. The armature of relay 201 is thereby attracted to the lower winding connecting line L—1 to relay 202.

When the middle brush of distributor 100 bridges segment 113 with its collector ring, current of negative polarity is impressed on relay 202 at the remote station over a circuit from negative pole of battery 106, conductor 114, left and middle springs of right group of key 101, conductor 115, segment 113, middle collector ring, conductor 118, front contact and armature of relay 108, line conductor L—1, middle and lower contacts of lower group of relay 201 at the remote station, conductor 208, relay 202 to line conductor L—4, conductor 117 at the control station to battery 106. The armature of relay 202 at the remote station is thereby attracted to its upper winding closing a circuit from the negative pole of battery 209 to conductor 210, lower contact and armature of relay 202, conductor 211, outer collector ring and outer brush of distributor 200, segment 213, conductor 212, relay 205, conductor 214 to battery 209.

Negative current through relay 205 attracts its armature toward the upper winding thereby closing the associated contact. This closes a circuit from battery 206, through conductor 231, contacts of relay 205, conductor 215, winding of slow release relay 232, lower contacts of upper auxiliary group of power switch 203, solenoid of switch 203, conductor 216, to battery 206. Current through the solenoid draws the plunger into it thereby closing the power circuit. Upon energization the armature of relay 232 closes a shunt circuit around the upper auxiliary contacts of switch 203. As the power switch closes, the upper auxiliary group of contacts is momentarily opened. However, the armature and associated contact of relay 232 maintain the circuit through the solenoid during this period.

The left contacts of the lower auxiliary contacts are strapped and connected by conductor 217 to segment 213′ of the middle group of distributor 200 the right contacts being connected to opposite poles of battery 209. When the power switch closes, the lower auxiliary contacts change the polarity on segment 213′ from the positive to negative.

On the following revolution of the brushes of the distributor, segment 213′ is bridged to its collector ring by the middle brush, thus closing a circuit from negative pole of battery 209, upper contacts of lower auxiliary group of power switch 203, conductor 217, segment 213′, middle brush, middle collector ring of distributor 200, line conductor L—2, relay 119 at the control station, line L—4, conductor 214 to battery 209.

Relay 119 when energized with a negative current attracts its armature to the upper winding. This closes a circuit from negative pole of battery 106, conductor 114, conductor 120, lower contact and armature of relay 119, conductor 121, then in parallel, one branch through white lamp 122 to battery 106, the other branch to outer collector ring of distributor 100, outer brush, segment 113′, conductor 123, relay 110, conductor 117 to battery 106.

White lamp 122 is lighted only momentarily, since the circuit is closed only while armature and lower contact of relay 119 are in contact, to indicate an answer back signal. The negative current through relay 110 causes its armature to be attracted toward the upper winding, changing the contacts of the upper group, which extinguish the white and green lamps 102 and 104, respectively, and lights red lamp 103. Circuits for the white and green lamps have already been traced. The red lamp is lighted over a circuit from battery 105, conductor 111, red lamp 103, middle and upper contacts of lower group of relay 110, conductor 112 to battery 105.

The upper group of contacts of relay 110 controls a normally energized relay 124, which in turn controls a relay 125, which again controls an audible signal 126 when an indication is given. A key 127 associated with the audible signal or bell 126 controls its operation to permit it to ring continuously or to give but one stroke.

With the system as shown, relay 124 is energized over a circuit from battery 105, conductor 111, lower and middle contacts of upper group of relay 110, conductor 128, winding of relay 124, right armature and front contact of relay 124, conductor 112 to battery 105. The upper and lower contacts of the upper group of relay 110 are strapped and connected to conductor 111 from battery 105. However, when relay 110 changes its position, the circuit of relay 124 is momentarily broken permitting both of its armatures to fall back. The right armature breaks the holding circuit while the left armature closes a circuit with its back contact for bell 126 from battery 105, conductor 111, back contact and left armature of relay 124, bell 126, then in parallel, one branch to conductor 112 to battery, the other branch to key 127, relay 125 to conductor 112 to battery. Relay 125 is thereby energized and attracts its armature which closes a circuit with its front contact to energize relay 124. This circuit may be traced from battery 105, conductor 111, upper and middle contacts of upper group of relay 110, conductor 128, relay 124, front contact and armature of relay 125, conductor 112 to battery 105. Relay 124 is therefore immediately energized closing its holding circuit at its right armature and breaking the bell circuit at its left armature. This permits the bell to give but one tap. If, however, key 127 is open, relay 125 will not be energized to restore relay 124 and the bell will continue to ring until key 127 is closed.

As mentioned above, rotary key 107 takes slightly longer to complete a revolution than the distributors. Soon after the distributors have completed a revolution, transmitting the switch changing impulses, the upper spring of key 107 breaks contact with the others and one second later the middle spring breaks with the lower spring. The upper spring breaks a circuit for relay 109 permitting its armature to fall back to the back contact thereby changing the polarity of the current impressed on the B segments of the inner group of distributor 100 and through conductor L—3 on the B segments of distributor 200 and hence through relay 201 at the remote station thus restoring it to its original position over the circuit previously traced. In changing its contact, relay 201 disconnects line L—1 from relay 202 at the remote station. When the middle and lower springs of key 107 open the energizing circuit for relay 108, line L—1 is disconnected from the middle collector ring of distributor 100 and at the same time connected through relay 129 to the return conductor 117 of battery 106, leaving the system as before.

If it is desired to open switch 203 at the remote station, key 101 and rotary key 107 are operated as before. The polarity of the current now transmitted through segment 113 of distributor 100 is positive instead of negative, thereby operating the armature of relay 202 at the remote station toward the lower winding. This puts positive current from battery 209 through the outer collector ring and brush to segment 213 of distributor 200 to energize relay 205. The armature of relay 205 is therefore attracted toward its lower winding breaking the circuit through the solenoid of the power switch

203 permitting the plunger to drop thereby opening the power switch.

The lower auxiliary contacts of the power switch change the polarity on segment 213' of distributor 200 from negative to positive to energize relay 119 at the control station with positive current. Relay 119 attracts its armature toward the lower winding closing a circuit at its upper contact to light white lamp 122 and through the outer collector ring, outer brush and segment 113' of distributor 100 to energize relay 110 with positive current from battery 106. Relay 110 upon energizing assumes the position shown. As pointed out above, the white lamp 102 and red lamp 103 are extinguished and green lamp 102 is lighted. The action of relays 124 and 125 in controlling bell 126 is the same as described above.

In case power switch 203 actuates automatically, that is, if it is in the closed position and opens automatically, the operation just described occurs for the answer back signal causing the white lamp 102 and green lamp 104 to become lighted and the red lamp 103 to be extinguished by the operation of relay 110.

The dispatcher is notified of this automatic action by the lighting of the white lamp and the ringing of the bell. He thereupon operates keys 101 and 107 to actuate relay 205 at the remote station to the position corresponding to the condition of the power switch.

In systems of this type using two independent rotary distributors, it is essential that means be provided for checking these distributors as to synchronism. The present invention provides two means, one of which synchronizes the distributors every tenth of a revolution, the other means being a signal given when the distributors are out of synchronism by an amount less than that required for the first means.

On the outer rim of the rotating parts of each distributor are five projections or catches 129, 130, etc., and 218, 219, etc., evenly spaced over one half the circumference. Each distributor is provided with two magnets, 134—135 and 223—224 located at diametrically opposite points having catches which cooperate with the projections on the rims.

On distributor 100, one half of the A segments on the inner group are strapped together and a conductor leads from one section to the upper winding of relay 136, the other section being connected to the lower winding of this relay. On distributor 200 the A segments are connected in the same way, the leads from the two sections, however, join outside the distributors and then connect in parallel through both windings of relay 225. The A segments are located on the distributors so as to actuate the release magnets 134 etc., to attract the catches and hence permit the brush arms to continue to rotate.

In the position of the distributors illustrated, the inner brush of each distributor bridges an A segment and the associated collector ring. In this position a circuit is closed at the control station from the negative side of battery 106, conductor 114, conductor 120, lower winding of relay 136, conductor 137, right-hand A segment of distributor 100, associated collector ring, line conductor L—3, inner collector ring and A segment of distributor 200, conductor 226, in parallel through the windings of relay 225, conductor 227, line conductor L—4, conductor 117 at the control station to battery 106.

The armature of relay 136 is thereby attracted to the lower winding closing at its upper contact a circuit from the positive side of battery 106, conductor 116, armature and upper contact of relay 136, conductor 138, then in parallel, one branch through conductor 139, magnet 135, line conductor L—4, conductor 117 to battery 106, the other branch being through conductor 140, red lamp 141 to battery 106. Relay 135 in energizing attracts its catch just before the projection 131 would have engaged with it, thus permitting the brush arm to continue to rotate. The other branch through the red lamp lights it momentarily as an indication of the operation of the magnet.

At the remote station relay 225 being energized by negative current attracts its armature to the lower winding which closes a circuit at its upper contact from the positive side of battery 209, conductor 228, armature and upper contact of relay 225, conductor 229, magnet 224, conductor 230, line conductor L—4, conductor 214 to battery 209. The catch of magnet 224 is therefore withdrawn at the same time as the catch of magnet 135 and for the same reason. On the other half of the revolution the A segements of distributor 100 are connected by conductor 142 through the upper winding of relay 136 to positive lead 116 of battery 106 and as before traced through relay 225 at the remote station. Both relays 136 and 225 close circuits at their lower contacts through magnets 134 and 223 to attract their catches. At the control station the green lamp 143 is in parallel with magnet 134 and it flashes when the magnet energizes.

From the above it will be seen that the brushes of both distributors must be on an A segment to permit simultaneous operation of the corresponding release magnets. If, for instance, distributor 200 is slightly faster than distributor 100, the catch of magnet 224 will engage one of the projections 218, etc., and hold the ring stationary until the brush of distributor 100 comes to an A seg-

ment. If distributor 100 is faster than distributor 200 the rotating ring will be held by a catch of magnet 134 engaging projection 133 until release magnet 223 is energized. By using five projections on the rotating ring and two magnets, the rotating rings and hence the brushes are synchronized every tenth of a revolution.

One half of the A segments, as pointed out above, of distributor 100 has positive polarity while the other half has negative polarity. The B segments through the back contact and armature of relay 109 have negative polarity. The C segments are strapped but are not connected to any source of current. At the remote station the C segments of distributor 200 are all strapped and are connected through conductor 231, upper and middle contacts of lower group of relay 201 to line conductor L—1. In getting out of synchronism, either distributor may travel the faster. To describe the signaling means, assume that distributor 100 travels slightly faster than distributor 200. If the inner brush of distributor 100 is on a B segment then the inner brush on distributor 200 will be on an A segment. The brush of distributor 100 will then move to the C segment and that of distributor 200 to the B segment. Nothing will occur in this position since the C segments of distributor 100 are not connected to a source of current. In the next position the brush of distributor 100 will be on an A segment and the brush of distributor 200 will be on a C segment. In this condition either a positive or negative pulse will be transmitted through the A segment one of the windings of relay 136 from battery 106 over line L—3 to inner collector ring of distributor 200, segment C, conductor 231, upper and middle contacts of lower group of relay 201, line conductor L—1, armature and back contact of relay 108, winding of relay 129 to battery 106. Relay 129 in energizing closes at its front contact an obvious circuit from battery 105, through bell 144 and lamp 145. These signals notify the dispatcher that the distributors are out of synchronism one segment and he can then take the necessary steps to synchronize them. This is accomplished by adjusting the governor of one motor to make it correspond in speed with the other motor.

The other possibility is for distributor 200 to travel faster than distributor 100. In this case when the brush of distributor 200 is on an A segment the brush of distributor 100 will be on a C segment. Since no source of current is connected to either segment, nothing will occur. When the brush of distributor 200 is on a B segment the brush of distributor 100 will be on an A segment. In this case either a positive or negative current impulse will be transmitted from battery 106 through the A segment of distributor 100, the associated collector ring, line conductor L—3, inner collector ring and B segment of distributor 200, conductor 207, relay 201, line conductor L—4, conductor 117, to battery 106. Nothing will occur if the brush of distributor 100 is on an A segment which is connected to the negative pole of battery 106, since relay 201 was last energized by a negative current and remains operated in that position. If, however, the brush is on an A segment which is connected to the positive pole of battery 106, an impulse will be transmitted over the circuit just traced and will operate relay 201. This, however, will cause no interference and in a short time a negative pulse will be transmitted either by a subsequent A or B segment on distributor 100 or when the distributors are brought into synchronism a negative pulse will restore relay 201 to its normal idle position. When the brush of distributor 200 is on a C segment, the brush of distributor 100 will be on a B segment. Since the B segments of distributor 100 are connected to the negative pole of battery 106 through the armature and back contact of relay 109, a negative pulse will be transmitted from the B segments of distributor 100, the associated collector ring, line conductor L—3, collector ring and a C segment of distributor 200, conductor 231, upper and middle contacts of lower group of relay 201 to line conductor L—1, through armature and back contact of relay 108, winding of relay 129 to battery 106. As before, bell 144 and lamp 145 give the signal that the distributors are slightly out of synchronism and the dispatcher makes the necessary adjustments.

As mentioned above, the distributors make a complete revolution in five seconds and are synchronized by release magnets ten times per revolution, or every half second. As there are three segments on the inner group for each synchronizing action, the longest time that the distributors can be out of synchronism is one half a second and the shortest time one sixth of a second before a signal is given. This, of course, affords a means of keeping the distributors practically in constant synchronism.

It is understood that modifications may be made in this system as herein described and still be within the scope of this invention which is limited only by the appended claims.

What is claimed is:

1. In a remote control system, a control station and a remote station, apparatus at said remote station to be controlled, a constantly rotating distributor at the control station having a ring of conducting segments corresponding to the controlled pieces of apparatus, keys at said control station, one for each piece of apparatus, a relay at said remote station for controlling the operation

of said apparatus, a circuit including one of said keys, one of said segments at the control station, said relay at the remote station, a pair of relays one at each station controlling said circuit and holding the same normally open, means at the central station to operate said relays to close said circuit prior to the transmission of signaling impulses thereover and for maintaining the same closed for a sufficient time to allow the impulses to be transmitted and for thereafter opening said circuit.

2. In a remote control system, a control station and a remote station, apparatus at said remote station to be controlled, a constantly rotating distributor at the control station having a ring of conducting segments, one of said segments corresponding to each piece of apparatus, keys at said control station, one for each piece of apparatus, a relay at said remote station for controlling the operation of said apparatus, a circuit including one of said keys, one of said segments at the control station and said relay at the remote station, a pair of relays, one at each station, controlling said circuit and holding the same normally open, a rotary switch at the control station, means controlled by said switch and actuated by rotating the same to operate said relays to close said circuit prior to the transmission of signaling impulses and to maintain the circuit closed for a sufficient time to allow the impulses to be transmitted, and thereafter to open said circuit.

3. In a supervisory system, a control and a remote station, a pair of rotary distributors, one at the control station and one at the remote station, adapted to operate in synchronism, conducting segments on the distributor at the control station, a polarized relay at the control station, a battery to the positive pole of which one-half of said segments are connected through one winding of said relay and to the negative pole of which the other half are connected through another winding of said relay, a conducting ring adjacent said segments, a rotating brush adapted to bridge said ring and segments, a conducting ring on the remote station distributor, a conductor joining said conducting rings, conducting segments on said latter distributor adjacent the conducting ring thereon, a rotating brush adapted to bridge said ring and segments, a polarized relay connected to said segments and to the mid-point of said battery, a pair of magnets for each distributor controlled by the corresponding relays, catches on said distributors, controlled by said magnets respectively, release latches controlled by said magnets to synchronize said brushes at a plurality of points in their revolution, conducting segments on the distributor at the remote station interposed between said segments thereon, a conductor connecting said latter segments together, a relay associated with said first distributor, a signal controlled thereby, and a conductor connecting said latter segments to said relay and the mid-point of said battery to close a circuit to operate said relay when said control station distributor is advancing faster than said remote control distributor.

4. In a supervisory system, a control and a remote station, a pair of rotary distributors, one at the control station and one at the remote station, adapted to operate in synchronism, conducting segments on the distributor at the control station, a polarized relay at the control station, a battery to the positive pole of which one half of said segments are connected through one winding of said relay and to the negative pole of which the other half are connected through another winding of said relay, a conducting ring adjacent said segments, a rotating brush adapted to bridge said ring and segments, a conducting ring on the remote station distributor, a conductor joining said conducting rings, conducting segments on said latter distributor adjacent the conducting ring thereon; a rotating brush adapted to bridge said ring and segments, a polarized relay connected to said segments and to the mid-point of said battery, a pair of magnets for each distributor controlled by the corresponding relays, catches on said distributors, controlled by said magnets respectively, release latches controlled by said magnets to synchronize said brushes at a plurality of points in their revolution, conducting segments on the distributor at the remote station interposed between said segments thereon, a conductor connecting said latter segments together, a relay associated with said first distributor, a signal controlled thereby, a conductor connecting said latter segments to said relay and the mid-point of said battery to close a circuit to operate said relay when said control station distributor is advancing faster than said remote control distributor, conducting segments on the distributor at the control station interposed between the segments thereon and all connected to one pole of said battery, said segments being adapted to be connected by the corresponding rotating brush to said ring which is connected to the ring of the distributor at the remote station to operate said signal control relay when said latter distributor is advancing faster than the other distributor.

In witness whereof, I hereunto subscribe my name this 12th day of November A. D., 1925.

JOSEPH C. FIELD.