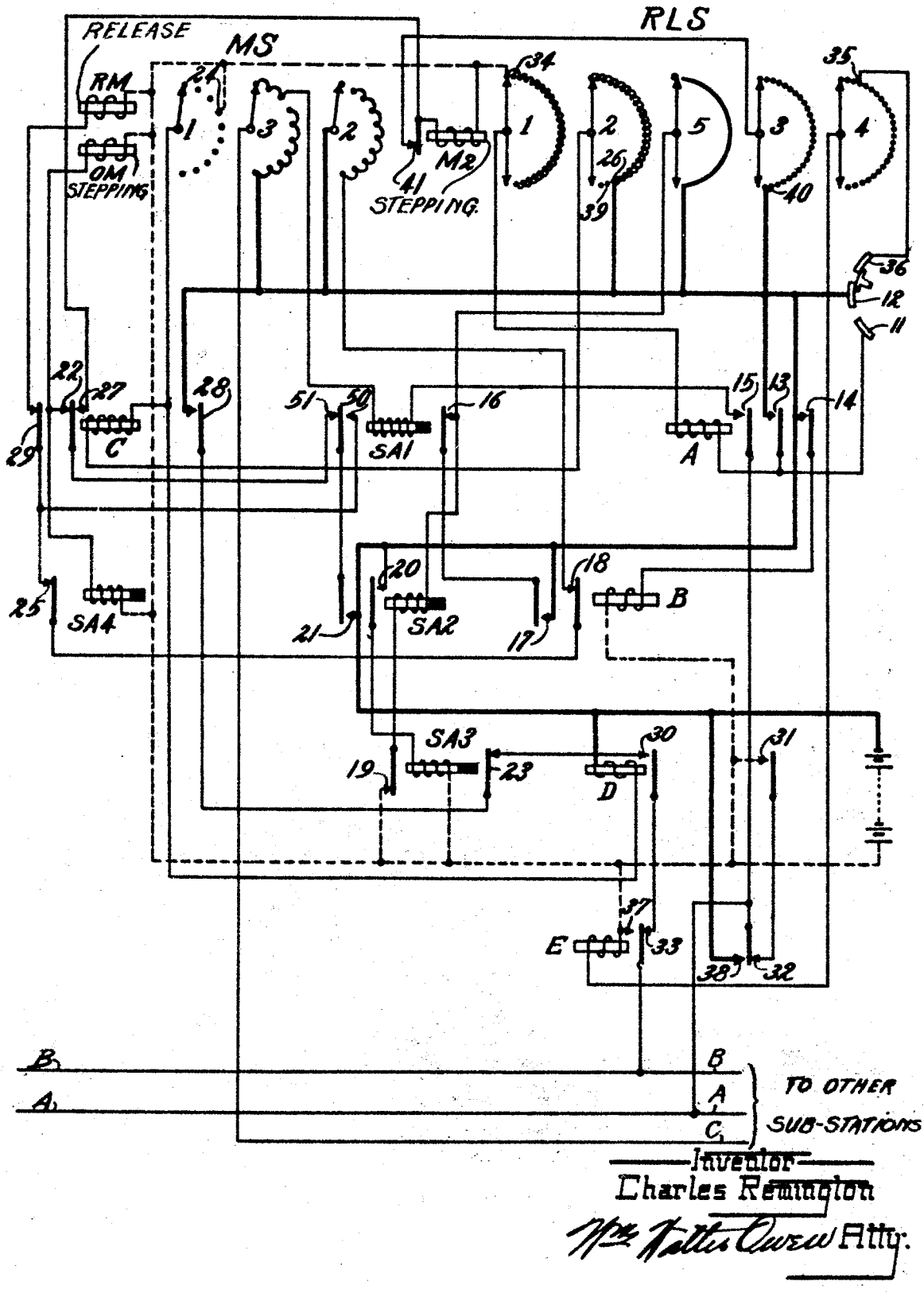
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SELECTIVE SIGNALING SYSTEM

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Fig. 1



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Fig: 2

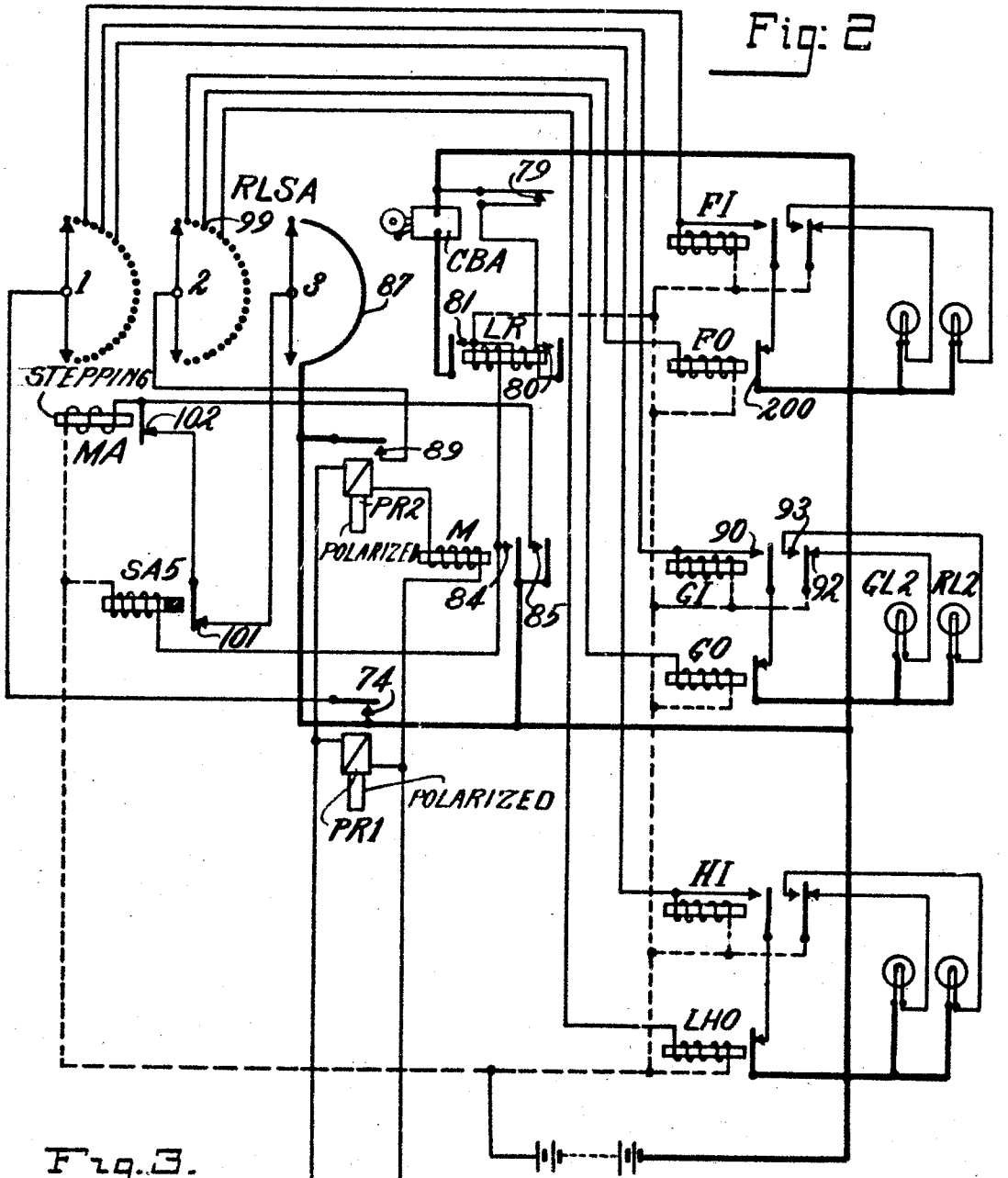
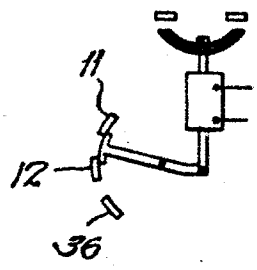


Fig. 3.



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UNITED STATES PATENT OFFICE

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SELECTIVE SIGNALING SYSTEM

Application filed May 28, 1927, Serial No. 195,024, and in Great Britain June 3, 1926.

The present invention relates in general to selective signaling systems, but is concerned more particularly to such systems in which devices in a plurality of remotely situated substations are supervised at a central station over trunk conductors extending to the substations in tandem, and the principal object of the invention, briefly stated, is the provision of a new and improved supervisory system of the tandem type, the improvements tending to make the system cheaper to install and maintain, and to make it more reliable in its operation.

In a power distribution system, in which a high voltage transmission line extends through a plurality of communities, each of which may be switched onto the transmission line to draw current therefrom, it is highly desirous that the despatcher at the central or generating station be apprised at all times of the number of circuits closed onto that particular transmission line. Since the stations drawing current from this line are disposed along it, supervisory equipment must parallel the line, and unless separate conductors are provided for each station on the line, the supervisory equipment must be of tandem type, that is the various stations are connected in multiple onto a common set of supervisory conductors. It is to such a system that this invention relates specifically. In such a system, if the signaling and indicating devices through which the despatcher is apprised of the condition of the line at all times, are to function properly, provision must be made to prevent interference between two signals if devices at two or more substations change their position at the same time. If for example the circuit breakers at the first and second substation on the transmission line were to open simultaneously, each would attempt to send in the signal characteristic of it, to apprise the dispatcher that it has opened. If no special means were provided, these two signals would attempt to traverse the common circuit at the same time with the result that the supervisory equipment at the control station would be improperly set, if, it is set at all. Accordingly, as a further object of my invention, I provide a new and improved method of preventing interference between signals transmitted from two or more substations, in case circuit breakers or the devices therein operate simultaneously.

According to another object of my invention, I provide a new and improved selective signaling system, employing step-by-step switches, engaging contacts so arranged that the circuits controlled through them completely supervise all the switching equipments in the substation whenever a device in the substations changes its position.

Further objects of my invention, not specifically referred to here, will be best understood from the accompanying description and drawings, and while I have chosen to show my invention in connection with a particular type of apparatus, I have done so by way of example only, as there are many modifications and adaptations which can be made by one skilled in the art without departing from the scope of the invention.

Fig. 1 of the drawings shows the apparatus at one substation of a group connected to three lines A, B and C, while Fig. 2 shows the apparatus at the central station. Fig. 3 shows a schematic representation of a circuit breaker such as might be employed in a substation to which this system be applied. This figure shows the manner in which the arm engaging segments 36, 12, and 11 is actuated by the circuit breaker mechanism. The lines A and B extend to the central station, while C extends between the various substations without returning to the central station. The apparatus shown is for the purpose of indicating the position of circuit breakers and changes of position and is not concerned with any selecting operations. The apparatus at the central station for receiving supervisory signals is similar to that shown in the drawings of my copending applications Serial Nos. 86,383 filed Feb. 26, 1926, and 109,325, filed May 15, 1926, with the necessary removal of all connections with the selecting equipment which is shown in those applications. As there are a number of substations on a common line it is necessary that when one is transmitting a signal,

or signals, all the others should be barred. Referring to Fig. 1, it will be noted that there are two switches, a rotary line switch RLS and a minor switch MS. The minor switch differs from the rotary line switch in that the rotary line switch is of the type in which the wipers move in a continuously forward direction having two diametrically opposite arms, so that when one arm ceases to wipe over the bank of contacts, the other wiper begins to engage the bank of contacts, which are arranged in a semi-cylindrical manner, there usually being 25 contacts in the bank as shown. The minor switch is of the type which moves forward on operating against spring pressure, and on the energization of a release magnet to remove a holding pawl, restores to normal. In the minor switch shown, only ten contacts are provided. It should be mentioned that there is nothing specially important in the distinetion between these two types of switches, the reason that these switches are of the two types described and not of the same type, is that it is usual to make a ten point switch of the type having a release magnet and a switch having twenty-five contacts of the continuously moving forward type, the capacity of these two switches being most suitable for their particular purpose as will be understood later. In addition to the two rotary switches there are provided five relays A, B, C, D and E of the ordinary quick acting type and four slow to release relays SA^1, SA^2, SA^3 and SA^4. The quick acting relays include a relay A which controls the initiation of the transmission of the position of circuit breakers, and is energized by a momentary circuit closed when a circuit breaker changes its position. The second quick acting relay B is an auxiliary relay to the first relay A and is energized and deenergized in accordance with the relay A with, however, a slight delay for a purpose which will be clear later.

The third relay C is energized to cut off the operating magent OM of the minor switch MS after a certain predetermined number of impulses have been sent; the fourth relay D is also energized after a certain number of impulses have been sent and serves to provide an impulsing circuit over the B line over which impulses are sent corresponding to the steps taken by the rotary line switch RLS. The fifth relay E is provided for the purpose of reversing the polarity of the direction of current flow over the A and B lines, when a wiper of the rotary line switch RLS passes over contacts marked with negative potential due to circuit breakers being in. The first slow acting relay SA^1 is provided for the purpose of preventing the transmission of impulses if signals are being transmitted from another substation over the line, the slow-acting relays SA^2 and SA^3 interact for the purpose of generating impulses to operate the magnets M^2, OM and RM of the switches and to send impulses to line, while the relay SA^4 is energized throughout the series of impulses operating the magnet OM of the minor switch and slightly after to maintain the circuit of the release magnet RM open until the third quick-acting relay C has energized.

Having now briefly described the apparatus employed a description will be given of the operation of the system, in the first case assuming that no other substation is transmitting supervisory signals, and a circuit breaker has been put in as shown on the right of the figure at the substation indicated in Fig. 1 of the drawing. The circuit breaker in moving connected a momentary circuit between segments 11 and 12 for the first quick acting relay A as follows: from positive pole of battery over the first contact engaged by wiper 1 of rotary line switch RLS, wiper 1, relay A, segment 11, segment 12, negative pole of battery. Relay A energizes and locks energized independently of the circuit breaker contacts over the following circuit:—positive pole of battery, wiper 1 of rotary line switch RLS, relay A, contact 13, negative pole of battery. Relay A at contact 14 completes a circuit for relay B which also energizes, while over contact 15 it connects the C lead over wiper 3 and minor switch MS, normal contact engaged thereby, slow-acting relay SA^1, contact 15 to the A line. If another substation is transmitting supervisory signals a circuit will accordingly be completed for slow-acting relay SA^1 which will accordingly open contacts 16 and 51 and close contact 50. This will be appreciated from the later description.

However, in the present case it is assumed that no other substation is sending supervisory signals and accordingly slow-acting relay SA^1 is not energized. The second quick-acting relay B at contact 18 opens a point in the circuit of the release operating magnet RM of the minor switch MS, while at contact 17 it completes the following circuit for slow-acting relay SA^2, negative pole of battery, contact 17, contact 16, slow-acting relay SA^2, contact 19 to positive pole of battery. Slow acting relay SA^2 accordingly energizes and at contact 20 completes a circuit for slow-acting relay SA^3 while at contact 21 a circuit is completed as follows: negative pole of battery, contacts 21, 51 and 22, operating magnet OM of the minor switch MS to positive pole of battery. A branch of this circuit extends also from contact 22 through the slow-acting relay SA^4 to positive pole of battery, the operating magnet OM and slow acting relay SA^4 energizing. Magnet OM advances the wipers of the switch MS one step. Slow-acting relay SA^3 in energizing opens contact 19 and thereby permits slow-acting relay SA^2 to de-energize.

It also opens contact 23 but as relay D is not energized, this is without effect at this time. Slow-acting relay SA^2 on de-energizing opens the circuit of the operating magnet OM at contact 21 but does not open sufficiently long to permit slow-acting relay SA^4 to de-energize, as it is again energized over its original energizing circuit immediately slow-acting relay SA^3 de-energizes following the falling away of armature of slow-acting relay SA^2 on its de-energization. It will be appreciated that slow-acting relays SA^2 and SA^3 will intermittently and alternately energize without cessation as long as the negative pole of battery is connected to the upper side of the winding of relay SA^2. Accordingly the operating magnet OM advances step by step until after the third step it reaches the fourth contact 24. It should be mentioned that on the third step of the magnet wiper 3 of the minor switch MS connects negative pole of battery to the C wire, thereby preparing a circuit to prevent another substation sending impulses. It should also be mentioned at this time that wiper 2 of minor switch MS at the first step prepared a circuit for the release magnet RM which is opened at contact 18, and contact 25. When the operating magnet OM has made three steps and wiper 1 of minor switch MS has reached contact 24, a circuit is completed for quick-acting relays C and D as follows: for relay C, over positive pole of battery, contact 24, wiper 1 of the minor switch MS, relay C, wiper 2 of rotary line switch RLS, normal contact 26 to negative pole of battery. For relay D, positive pole of battery, contact 24, wiper 1 of minor switch MS, relay D to negative pole of battery. Quick-acting relays C and D accordingly energize, relay C at contact 22 opens a point in the circuits of the operating magnet OM, and relay SA^4, and also opens the contact 29 thereby opening a point in the circuit of the release magnet RM while it closes contacts 27 and 28. At contact 27 it extends the impulsing circuit controlled by relay SA^2 to the magnet M^2 of the rotary line switch RLS. Relay D on energizing closes contacts 30 and 31. At contact 31 positive pole of battery is connected over contact 32 of relay E to the A lead thereby completing a circuit for the relay SA^1 of any substation which may have its relay A energized preparatory to transmitting supervisory signals. Accordingly contact 16 will be opened at that station and the transmission of impulses therefrom cannot accordingly proceed. At contact 30 the circuit is completed as follows to line B:—negative pole of battery, contact 28, contact 23, contact 30, contact 33 to B line. If the A line is connected to positive pole of battery, it will thus be appreciated that battery is connected across the A and B lines and that impulses are transmitted in this circuit as the contact 23 of relay SA^3 opens. Accordingly when contact 24 is reached impulses are transmitted to the magnet M^2 and corresponding impulses are sent over the A and B lines. The rotary line switch therefore commences to step. On the first step the wiper 1 disconnects itself from the normal contact to an open contact 34, thereby opening the locking circuit of relay A which accordingly de-energizes. At wiper 5 however the contact 16 is connected to negative pole of battery and thereby maintains the negative pole of battery to the upper side of the winding of relay SA^2 so that SA^2 and SA^3 continue to pulse step by step. Wiper 2 of rotary line switch RLS continues to engage the contacts connected to negative pole of battery so that the circuit of relay C is maintained. While this is going on the wiper 4 is connected successively with contacts which may or may not have negative pole of battery connected to them due to circuit breakers to which they correspond being in. For the sake of the present description it will be sufficient to assume that the only circuit breaker in is that which we are describing although if others were in the operation would be in every way similar. When wiper 4 reaches a fourth contact 35, a circuit is completed as follows: negative pole of battery, segments 12 and 36 of the circuit breaker contacts, contact 35, wiper 4 of rotary line switch RLS, relay E to positive pole of battery. Relay E accordingly energizes and reverses the direction of current flow over the A and B line by connecting positive pole of battery to the B line at contact 37 and negative pole of battery to the A line at contact 38, thereby sending a reversal of current each time that relay E is energized, that is each time the wiper 4 passes over contacts corresponding to a circuit breaker which is in. Eventually wiper 2 reaches the disconnect contact 39 thereby opening the circuit of relay C which accordingly de-energizes, thereby opening the impulsing circuit to the B line, at contact 29 completing a circuit for the release magnet RM of the minor switch MS as follows:—release magnet RM, contact 29, contact 25, contact 18, wiper 2 in the off normal position to negative pole of battery. The release magnet accordingly energizes and the minor switch MS restores to normal. At wiper 3 of rotary line switch RLS and the contact 40 corresponding in position to the contact 39, a circuit is completed for the magnet M^2 of the rotary line switch RLS as follows:—negative pole of battery, contact 40, wiper 3, interrupter contacts 41, magnet M^2 to positive pole of battery. Magnet M^2 therefore steps the wipers 1, 2, 3, 4 and 5 of the rotary line switch RLS to normal. If another circuit breaker should have come out after relay A has deenergized, relay A will energize again, thereby locking energized, re-energize relay B to open contact 18, and

thereby prevent the release magnet RM from energizing when the cycle of impulses caused by the first circuit breaker has been completed. What happens in that case is that the minor switch MS remains in the position in which it has been set, namely with wiper 1 on contact 24, relays SA^2 and SA^3 continue to pulse, rotary line switch steps automatically to normal, relay C remains energized so that after M^2 has stepped automatically under the control of its own contact 40, it begins to pulse under the control of relays SA^2 and SA^3 for a second cycle, relay A de-energizing when contact 34 is reached by wiper 1. It will thus be appreciated that the second cycle of impulses follows the first automatically when two circuit breakers come out in comparatively rapid succession at a single substation before any other signals can be sent from other substations. It should be mentioned that the minor switch MS may be set to any arbitrary position, either the position corresponding to the particular substation, or the position being the same for each substation as may be desired. By making the conditions different for each substation the tendency would be to give certain substations preference in the case of two circuit breakers changing their positions simultaneously at two different substations. If two circuit breakers should come out at any substation while the minor switch is operating, both changes will be recorded by the rotary line switch moving through its complete cycle and the relay A therefore need not in such an event cause a second revolution, for that reason it is only energized after the rotary line switch has moved with the wiper 1 past contact 34.

It may happen that circuit breakers at two or more stations come out during the transmission of a supervisory signal or signals from another station so that when the common line A—B becomes free the relays SA^1 at each of the waiting stations de-energize simultaneously and the minor switches MS commence to operate. By marking the contacts in the banks of the various minor switches differently at the different stations however, it is clear that the relays C and D at one station will operate before the relays C and D at the other stations, completing the guarding circuit and thus operating the test relay SA^1 at the other station and connecting the impulsing circuit to the A and B lines. This station can then transmit its signals uninterrupted. When this signal has been transmitted to the control room, the minor switch returns to normal, and the next station to reach its marked contact guards the A and C lines and sends impulses over the A and B lines. Relay SA^1 on energizing at contact 50 completes a circuit as follows: battery through contacts 21 of slow-releasing relay SA^2, contacts 50, and contacts 29 for the release magnet RM if the minor switch is in off normal condition so that all stations start equally from normal. It will be noted that by this arrangement the testing period is of variable duration, i. e., the period during which relay SA^1 is connected between A and C leads, while the guarding, i. e., the connection of battery between A and C lines immediately follows it. Certain alternatives suggest themselves which might be employed in place of the arrangement described. The guarding circuit over A and C lines could be completed immediately relay A or relay B energizes to test or preferably immediately the minor switch steps off normal.

If a circuit breaker in one of the substations moves when the trunk line AB is occupied, the energization of relay A closes at springs 15 a circuit from positive battery on the A lead of the trunk, through the relay SA^1, normal position and the wiper 3 of the minor switch MS to the C lead which is connected to the negative battery at the substation which has the exclusive use of the trunk line. Relay SA^1 energizes, and at spring 16 opens a point in the circuit of relay SA^2, to prevent that relay energizing. As long as relay SA^2 is in its normal position, pulsing cannot be started, and the signal corresponding to the new position of the device which moved is held until the trunk line is free. In the substation containing this device whose signal is held, relays A, B, and SA^1 are energized. As soon as the trunk line becomes free, SA^1 deenergizes, and pulsing is started in the hereinbefore explained manner.

A description will now be given of the manner in which the signals are received at the control station, reference being made to Fig. 2. When the apparatus at the substation is pulsing negative battery is connected to the C lead, but as this does not lead to the control station, it exerts no effect thereat. When relay D at the substation connects negative pole of battery to the B lead and positive pole of battery to the A lead, and pulses are sent over the B line the polarized relay PR^2 is energized over the following circuit: negative pole of battery, contact 28, contact 23, contact 30, contact 33, B lead, relay M, relay PR^2, A lead, contact 32, contact 31, to positive pole of battery. Relay M is energized over this circuit and at contact 84, connects negative pole of battery over left-hand winding of relay LR to positive pole of battery. This relay energizes and completes a locking circuit for itself as follows:—negative pole of battery, contact 79, contact 80, right-hand winding of relay LR to positive pole of battery, at the same time completes a circuit at contact 81 for the circuit breaker alarm bell CBA and this continues to ring until relay LR is de-energized and contact 81 opened by the attend-

ant breaking the circuit at contact 79. Relay M also at contact 85, completes a circuit for the operating magnet MA of the rotary line switch RLSA; thus magnet MA operates for every pulse over the A and B lines. When relay M energizes it also completes a circuit for relay SA^5 at contact 84; relay SA^5 being slow to release remains energized as long as impulses are being transmitted to keep open contact 101 in the circuit:—positive pole of battery, interrupter contacts 102, contact 101, wiper C^3 in off normal position to negative pole of battery. This circuit is provided for the purpose of restoring the switch RLSA to normal if the pulses should not return it to normal in the ordinary working. Relay PR^2 at contact 89 completes circuits for relays FO, GO and HO successively over wiper 2 of rotary line switch RLSA and second, fourth and sixth contacts respectively. Relay FO opens contact 200, which is however without effect if the corresponding circuit breaker is out, as relay FI is not energized similarly with relays GO and HO. For each circuit breaker that is in a current impulse is transmitted over the A and B lines in the opposite direction to that previously described. This circuit may be traced as follows:—negative pole of battery, contact 38, A line, relay M and relay PR^2 in parallel with relay PR^1, B line, contact 37 to positive pole of battery. Relay PR^1 is excited by this current but relay PR^2 does not energize with current in this direction. Relay M also energizes and therefore continues to send pulses over contact 85 to magnet MA.

Consider now for the purpose of the description that circuit breaker No. 2 has been put in, when the fourth contact of RLSA is reached, the relay GO is energized similarly to relay FO, but is also without effect. The next pulse is reversed as regards current over the A and B leads and while still permitting the energization of relay M and the consequent stepping of the wipers of RLSA, also energizes relay PR^1. Relay PR^1 completes a circuit for relay GI as follows:—negative pole of battery, contact 74, wiper 1 of RLSA in fifth position, relay GI to positive pole of battery. Relay GI energizes and at contact 90 locks energized in the following circuit:—negative pole of battery, contact 91, contact 90, relay GI to positive pole of battery, while at contact 92 it opens the circuit of the green lamp GL^2, which was lit indicating that circuit breaker was out, thereby extinguishing it and lighting the red lamp RL^2 over contact 93. The generation of impulses continues but no more signals will be transmitted unless other circuit breakers are in. If other circuit breakers should be in, for instance circuit breaker No. 3, then when the wiper reaches its seventh contact, the same operation over relays HO and HI will take place as already described. The change from a green to a red lamp indicates to the attendant that the circuit breaker has been replaced. It will be noted that relays FO, GO and HO are always energized every time the position of circuit breakers is being indicated, but by arranging that these are energized prior to the corresponding locking relays FI, GI and HI, if the locking circuit is momentarily opened when a circuit breaker is out, this (i. e., the locking circuit) is immediately restored due to the succeeding signal being such as to re-energize the locking relay and thereby restore the locking circuit.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In a selective signaling system, a control station containing signal receiving apparatus, a group of substations, a common trunk between said control station and said substations, signal sending apparatus and a counting switch at each substation, a guard circuit between said substations, means including a wiper of one of said counting switches for applying a distinctive potential to said circuit to designate a busy condition of said common trunk, switching devices at said substations, means responsive to the operation of one of said devices to preliminarily operate the associated signal sending device and counting switch to test for said potential, and means operated by said potential encountered on said guard circuit to stop said preliminary operation and to return said counting switch and said sending device to normal.

2. In a selective signaling system, a control station containing signal receiving apparatus, a group of substations, a common trunk between said control station and said substations, signal sending apparatus and a counting switch at each substation, a guard circuit between said substations, means including a wiper of one of said counting switches for applying a distinctive potential to said circuit to designate a busy condition of said common trunk, switching devices at said substations, means responsive to an operation of one of said devices to start the associated counting switch and said signal sender, means controlled through a wiper of said associated counting switch for testing for said potential on said circuit, said means stopping said associated counting switch and said sender or controlling it to transmit a signal over said trunk dependent upon the presence or absence of said potential on said circuit.

3. In a selective signaling system, a plurality of substations each containing switching devices, a central station containing supervisory signals corresponding thereto, a trunk connecting said stations, sending means

at each substation, means responsive to an operation of one of said switching devices for operating said sending means to first test the busy or idle condition of said trunk and second to transmit a fixed number of uniformly spaced impulses one of which is altered to designate the device which changed its position, and means at the central station, operated by said impulses to alter said signals to correspond with the new position of said device.

4. In a selective signaling system, a plurality of substations each containing switching devices, a central station containing supervisory signals corresponding thereto, a trunk connecting said stations, sending means at each substation, means responsive to an operation of one of said switching devices for operating said sending means to first test the busy or idle condition of said trunk and second to transmit a fixed number of impulses one of which is of opposite polarity from the rest, to designate the device which changed its position, and means at the central station, operated by said impulses to alter said signals to correspond with the new position of said device.

5. In a selective signaling system, a plurality of substations each containing switching devices, a central station containing supervisory signals corresponding thereto, a trunk connecting said stations, sending means at each substation, a test conductor between said substations, means for applying busy potential to that conductor when said trunk is energized, means responsive to an operation of one of said switching devices for operating said sending means to first test for the presence of busy potential on said conductor and second dependent upon the absence of said busy potential to transmit a fixed number of impulses, one of which is altered to designate the operated device, and means at the central station, operated by said impulses to alter said signals to correspond with the new position of said device.

6. In a selective signaling system, a plurality of substations each containing switching devices, a central station containing supervisory signals corresponding thereto, a trunk connecting said stations, sending means at each substation, means responsive to a simultaneous operation of devices in two or more substations to register the designations of those devices in their respective senders, a test conductor between said substations, means including a counting switch in each of said substations controlled over said conductor to allot said trunk to said respective senders in a prescribed order and to start said senders transmitting impulses over said trunk, and means at the central station operated by said impulses to alter said signals to correspond with the new position of said device.

7. In a selective signaling system, a central station and a plurality of substations, a trunk line extending between said stations, a plurality of multiposition devices in said substations, signals corresponding thereto at said control station, a counting switch in each of said substations, means responsive to a change in position of one of said devices for operating said counting switch to test the busy or idle condition of said trunk and if idle to seize it for the exclusive use of the substation containing that device, means operated in response to said seizure for transmitting codes over said trunk indicating the positions of the devices in that substation, and means responsive to said codes for setting said signals to correspond to the positions of the devices.

8. In a selective signaling system, a central station and a plurality of substations, a trunk line extending between said stations, a plurality of multiposition devices in said substations, signals corresponding thereto at said control station, a counting switch in each of said substations, means responsive to a change in position of one of said devices for operating said counting switch to test the busy or idle condition of said trunk and if idle to seize it for the exclusive use of the substation containing that device by applying a distinctive potential thereto, means for then transmitting codes over said trunk indicating the positions of the devices in that substation, and means for setting said signals in accordance with said codes.

9. In a selective signaling system, a central station and a plurality of substations, a trunk line extending between said stations, a plurality of multiposition devices in said substations, signals corresponding thereto at said control station, a sender in each substation, said senders each including a counting switch and a signal sending switch, means responsive to a change in position of one of said devices for operating said sender, means operated thereby for setting said counting switch to a predetermined position to allot said trunk line to the exclusive use of said sender, means operated by said sender after said counting switch has been set for transmitting a signal over said trunk line, and means responsive to said signal for operating said signals to correspond with the new position of said device.

In witness whereof, I hereunto subscribe my name this 9th day of May, A. D. 1927.

CHARLES REMINGTON.