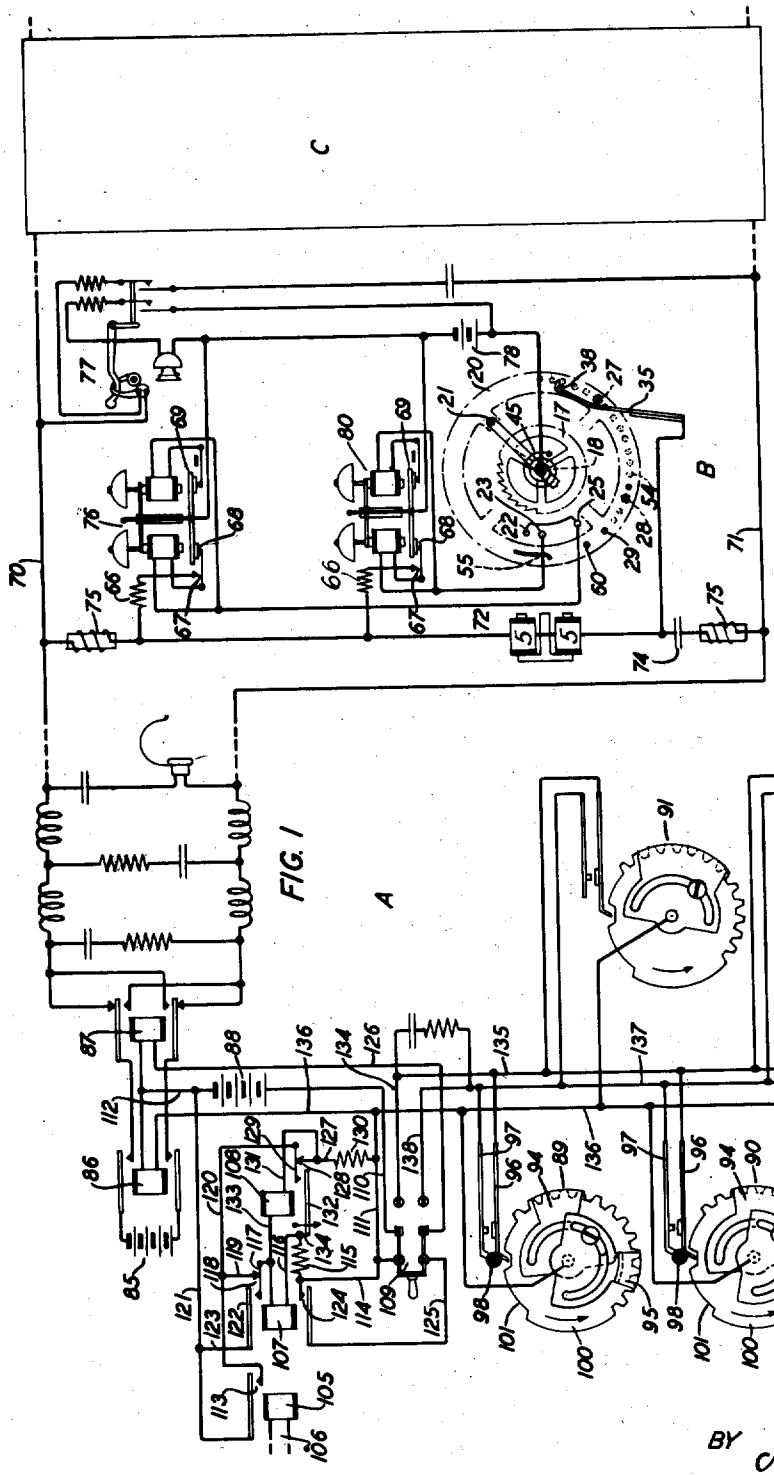
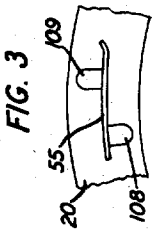
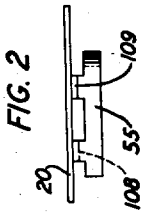
Feb. 4, 1936. J. C. FIELD 2,029,710

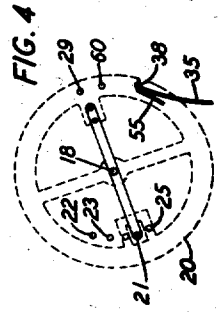
SELECTIVE SIGNALING SYSTEM

Filed April 25, 1934









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Patented Feb. 4, 1936

2,029,710

UNITED STATES PATENT OFFICE

2,029,710

SELECTIVE SIGNALING SYSTEM

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Application April 25, 1934, Serial No. 722,308

3 Claims. (Cl. 175—352)

This invention relates to signaling systems and more particularly to selective signaling systems in which each of a plurality of stations connected with a pair of line wires is provided with a selectively operated signal-controlled device.

The object of this invention is to provide in a system of this kind improved means for communicating the correct time simultaneously to the stations connected with the line wires.

A feature of this invention resides in a set of sequentially operated relays which control the operation of an impulse controlling relay for the system in place of the step-by-step selector required in the system disclosed in my Patent No. 1,367,774, issued February 8, 1921, thus simplifying the system of said patent, and cheapening its cost.

In the drawing:

Fig. 1 shows a selective signaling system including a central station, a plurality of way stations connected to the line wires, a portion of a telegraph circuit through which time signals are transmitted to the central station and means at the central station for controlling the repeating of time signals to the way stations;

Figs. 2 and 3 are side plan plant views respectively of a fragmentary portion of a selector; and

Fig. 4 is a view of a step-by-step operated element of a selector.

In simultaneously communicating the correct time to way stations on the line, signal pulses are sent from the central station to advance the selectors at the way stations to a predetermined position for the reception of time signals. These selectors are preferably of the type disclosed in my Patent No. 1,343,256. When the selectors at the way stations have been advanced to the required positions to receive time signals, the central station apparatus is placed under the control of a time signaling device which may be, for instance, a time repeating relay in a telegraph circuit controlled from a central time observatory station.

In Fig. 1, A is a central station and B and C are way stations on the line. There may be a comparatively large number of way stations connected to the line, but in order to simplify the description of the invention only two way stations are shown. Since the apparatus at way station C is identical in construction to the apparatus at way station B, the details of the way station apparatus are only shown at B. At each way station there is a selector 72 comprising a polarized electromagnet, the windings 5—5 of which are connected in bridge of the line wires 70 and 71, and in series with a condenser 74 and two impedance coils 75—75, and a step-by-step contact carrying element 20 adapted to be advanced step-by-step against the action of a spring 45, in response to succeeding current impulses of opposite polarity through the windings of the polarized electromagnet. Each way station is also equipped with a signaling bell 76 under the control of the selector thereat and a telephone set 77 included in a normally open bridge of the line wires. A signal battery 78 at each way station may serve for operating the signal bell 76 and for furnishing current for talking purposes. At each way station there may be an additional signaling device 80 which may be, exactly like the signaling bell 76, controlled by the selector and operated from the local battery 78 thereat. The operating circuit of the signaling bell 76 is closed upon the engagement of the contact arm 21 of the step-by-step element with the contact 22. The operating circuit of the signaling device 80 is closed when the contact arm 21 engages contact 23. Holding pin 29 corresponds to the contact 22, and holding pin 60 to contact 23. Upon the cessation of the last stepping impulse, projection 38 of the holding spring 35 at the proper station engages one of the holding pins 29 or 60 to hold the element in the proper contact engaging position.

At the transmitting station A there is a main battery 85 for supplying current for operating the selectors at the way stations. This battery is normally disconnected from the line wires, but may be connected therewith by the operation of a relay 86. A pole changing relay 87, which serves as an impulse controlling relay for the system, is provided for reversing the connections from battery 85 to the line wires 70 and 71. The relays 86 and 87 are connected in parallel and in circuit with a local battery 88, and are normally controlled by the impulse transmitters 89, 90, 91, 92, and 93. The transmitter 89 is for calling way station B, 90 for calling way station C, 91 for calling a group of stations, 92 for calling all of the stations and 93 for preparing the apparatus at all stations for the simultaneous reception of time signals. The transmitters are provided with teeth, certain ones of which may be blocked out by one or both adjustable cams 94 and 95 to obtain the particular number and combination of effective teeth for calling purposes. Each transmitter is adapted to rotate in the direction of the arrow, and the teeth thereof are adapted to control contact springs 96 and 97 in circuit with the pole-changing relay 87. The free end of contact spring 97 of transmitters 89 and 90 is bent downward, and carries at the extremity thereof an insulating roller 98, which, as the transmitter rotates, is adapted to ride on top of the cam 95 and separate contacts 96 and 97 during the time of the passage of cam 95.

The contact spring 96 of each transmitter is normally out of engagement with the rotatable disc thereof. During the revolution of the disc of each transmitter, contact spring 96 is in engagement with the disc, maintaining the circuit of re-

lay 86 closed to connect battery 85 to the line wires 70 and 71. Assuming that transmitter 89 is operated and that the double-pole, double-throw switch 109 is thrown to the right, as the disc of the transmitter starts to rotate, the circuit of relay 86 is completed, operating this relay and connecting battery 85 to the line wires. As contact spring 96 rides upon the first tooth, it also engages spring 97 to actuate the pole changing relay 87 by current from battery 88 to reverse the connection of battery 85 to the line wires. When spring 96 drops between two teeth, relay 87 will be deenergized, and during the time that spring 96 is passing over the cam 94, relay 87 will be energized to furnish a prolonged impulse of one polarity, for example, negative. As the disc continues to rotate, alternating impulses are sent over the line. When the cam 95 is reached, the insulating roller 98 on spring 97 rides thereon, and raises spring 97 to keep it out of reach of spring 96, so that during the time the insulating roller 98 is riding over the cam 95, a prolonged impulse of opposite or positive polarity is sent over the line wires. As the disc continues to rotate, additional alternating impulses are sent over the line wires, and when the spring 96 rides on the cam surface 100, a prolonged negative impulse is sent over the line wires to provide a ringing period. When the spring 96 drops onto the cam surface 101, a prolonged positive impulse is sent over the line wires to release the selector at the selected station. When spring 96 is out of engagement with the toothed wheel, relay 86 is released and battery 85 is removed from the line.

Assuming that the selector at way station B is arranged to respond to a code of impulses represented by 3—9—3, when the transmitter 89 is operated, it will send out the first set of three impulses of alternate polarity. The third impulse is of sufficient duration to permit the magnets of all selectors on the line to release before the first impulse of the second set is sent. It is to be understood that when potential of either polarity is applied to the line for a sufficient interval, the condensers 74 at the way stations become charged, whereupon the flow of current through the selector magnets ceases and the selector magnets release. Those selectors, including the one at station B, which are arranged to respond to codes of impulses, the first set of which is made up of three impulses, will, in releasing, cause the curved end 38 of the contact spring 35 to engage the holding pin 27 in the contact-carrying member 20, so that the contact-carrying member 20 at these stations will be held in advanced position. All other selectors on the line including the one at station C requiring a different number of current impulses to bring their pins 27 into engagement with the projections 38 will be dropped back to normal position. Nine impulses will next be transmitted over the line to step the ratchet wheels 17 around to a position where when the selector magnets are deenergized, due to the extended duration of the ninth impulse, projection 38 will engage the pin 28 at station B, thus holding the selector thereat in advanced position, while the selector at station C will return to normal position. The selectors at all stations connected to the line which are arranged to respond to a code of impulses, the sum of the impulses in the first two sets of which totals nine and those arranged to respond to a code of impulses, the first set of which is of nine impulses, will also be held in advanced positions, while all other selectors, which were held in the advanced positions at the end of the first set of impulses transmitted will be returned to normal position. Three impulses now sent over the line circuit will cause the engagement of contact 21 with the contact 22 at station B to close an energizing circuit for the signaling bell 76, but no other station on the line will have its contact 21 in engagement with its contact 22. When the contact arm 21 engages contact 22 at station B, and upon the cessation of the last of this set of three impulses, the projection 38 engages the pin 29 to hold the element 20 of the selector in contact engaging position. The signaling device 80 at station B may be operated by a proper number of impulses sent over the line, after the selector thereat has been moved into its second holding position.

During the operation of the signaling bell 76 which results from the closure of its energizing circuit, a local circuit through the windings of the selector magnets 5—5 is intermittently established. This circuit may be traced in Fig. 1 from the upper pole of battery 78, through armature 69, contacts 68, and 67, answer-back resistance 66, windings of the magnets 5—5, contact spring 35, holding pin 29, and the contact carrying element 20 to the lower pole of battery 78. The closure of this circuit is of such short duration, the resistance of the answer-back resistance 66 and the windings of the selector magnets 5—5 so high and the voltage of the battery 78 so low, that the closure of this circuit does not affect the operation of the selector.

By selecting 15 as the number of steps required to close the first signaling contact of any selector, there are fifty-five different combinations possible and with a selector responsive to each of these combinations, it is possible to equip a line with fifty-five selectors and operate them successfully without interference. With a total number of thirty holes 54 in the contact-carrying member 20, as shown in Fig. 1, it is possible to choose thirty-two as the number of steps required to close the first signaling contact 22, 21 of any selector. This may be done by merely shifting the position of the contact-carrying member 20 on the shaft 18 so that the contact 21 is moved farther to the right. If thirty-two be chosen as the number of steps required to close the first signaling contacts 22, 21 of any selector, there are three hundred seventy-eight different combinations possible, and with a selector responsive to each of these combinations, it is possible to equip a line with three hundred seventy-eight selectors and operate them successfully without interference.

When fifteen is chosen as the number of steps required to close the first signaling contact 22 of any selector, the following table represents the different combination or code of impulses for the total number of fifty-five separate stations:

2— 2—11	3— 3—9	4—5—6	5—8—2	7—6—2
2— 3—10	3— 4—8	4—6—5	6—2—7	8—2—5
2— 4— 9	3— 5—7	4—7—4	6—3—6	8—3—4
2— 5— 8	3— 6—6	4—8—3	6—4—5	8—4—3
2— 6— 7	3— 7—5	4—9—2	6—5—4	8—5—2
2— 7— 6	3— 8—4	5—2—8	6—6—3	9—2—4
2— 8— 5	3— 9—3	5—3—7	6—7—2	9—3—3
2— 9— 4	3—10—2	5—4—6	7—2—6	9—4—2
2—10— 3	4— 2—9	5—5—5	7—3—5	10—2—3
2—11— 2	4— 3—8	5—6—4	7—4—4	10—3—2
3— 2—10	4— 4—7	5—7—3	7—5—3	11—2—2

It will be seen that the second signaling contact 23 of any selector may be engaged by contact 21 by sending, as the third or last set of im-

pulses, two more than is enumerated in the above table.

It will also be seen that if it is desired to select any group of stations (the first signaling contacts thereof) in which the first set of impulses is of the same number, for example, the group containing station B, this may be done by sending a code of impulses represented by 3—12, the second group of twelve impulses being obtained by adding together the impulses of the second and third sets. In the selecting of a group of stations, only the first removable holding pin 27 is used. The transmitter 91 at the transmitting station A is arranged to send this code of impulses 3—12, and may be used to select this group of way stations, which includes B. Station B may also be included in another group in which the last set of impulses is of the same number, responsive to a code of impulses represented by 12—3, the first group of twelve impulses being obtained by adding together the first two sets of impulses. In this case, only the second removable holding pin 28 will be used.

For the purpose of providing for the simultaneous reception of time signals at all way stations, the contact carrying member or step-by-step element 20 of each selector is provided with a holding member 55 so positioned that its curved end will be engaged by the curved projection 38 of the holding spring 35 (as shown in Fig. 4) when the element 20 has been advanced in response to twenty impulses of current through the magnet windings 5—5.

The holding member 55 has a tail piece having two lugs 108 and 109, bent at substantially right angles thereto, by means of which the holding member 55 is secured to the lower side of the element 20, as clearly shown in Figs. 2 and 3. The curved end of the holding member 55 corresponds to any of the pins 27, 28, 29, and 60 positioned in the element 20, that is, insofar as its function of holding the step-by-step element in advanced position is concerned. The tail piece of the holding member 55 is provided so that after the projection 38 of the holding spring 35 engages the curved end of the holding member 55, the advancement of the element 20 in response to only one or two impulses through the magnet windings 5—5 followed by the deenergization of the selector magnets will not permit the return of the element 20 to normal position; for the projection 38 of the holding spring 35 in moving in toward the element 20 will strike the tail piece of the holding member 55 which due to the action of the spring 45 will be rotated with the element 20 until the curved end of the holding member 55 engages the projection 38. The element 20 will therefore be held in advanced position with the movable contact 21 thereof within one step of the stationary contact 25 or five steps beyond the station contact 22 as shown in Fig. 4. The length of the tail piece of the holding member 55 is such that after the curved end thereof is engaged by the projection 38, the element 20 must be advanced at least four steps more before the projection 38, in moving toward the element 20, will clear the end of the tail piece and permit the spring 45 to return the element 20 to normal position. Contact 25, which may be considered as the time receiving contact, is electrically connected with the station contact 22.

All of the fifty-five stations (the first signaling contacts thereof) may be called simultaneously by sending over the line wires fifteen impulses. It will be seen that neither of the removable holding pins 27 and 28 will be used in calling all stations simultaneously. The transmitter 92 at transmitting station A, as previously mentioned, is arranged to send out a single set of fifteen impulses for calling all stations. All stations may be prepared for receiving time signals over the line wires 70 and 71. For this purpose the transmitting station A is equipped with a transmitter 93, provided with a series of teeth, arranged so that when the transmitter is set in operation, an uninterrupted set of twenty impulses of current of alternate polarity will be transmitted over the line wires. These impulses in traversing the magnet windings 5—5 energize the selector magnets causing the advancement of each element 20 to a position where upon the cessation of the twentieth impulse, the deenergization of the selector magnets permits the projection 38 of the holding spring 35 to engage the curved end of the holding member 55, thereby to hold the element in such advanced position. When the projection 38 and the curved end of the holding member 55 are in engagement, the contact 21 on member 20 is within one step of the contact 25, so that an additional one-step advancement of the ratchet wheel, in response to a single impulse of current through the windings of the selector magnets, will advance contact 21, one step into engagement with contact 5. Upon the deenergization of the selector magnets following their energization by the single impulse of current, the projection 38 will again engage the curved end of holding member 55, and contact 21 will be out of engagement with contact 25. During the time of engagement of contacts 21 and 25, the signaling bells 76 at all stations will be ringing.

The one-step advancement of the ratchet wheels of the selectors at all way stations in receiving time signals is controlled by a time repeating relay 105 in a telegraph circuit 106 through a pair of relays 107 and 108. The relays 107 and 108 operate in sequence and control the operation of the pole-changer relay 87. When the correct time is to be communicated to the way stations, and the selectors at the way stations have been advanced to the required position for receiving the time signals, the double-pole double-throw switch 109 is manually moved to the left-hand position as shown in Fig. 1 by the operator at the central station A. This removes the control of the pole-changer relay 87 from the code sending transmitters 89, 90, 91, 92, and 93 and places the pole-changer relay 87 under the control of the relays 107, 108 and the time repeating relay 105. Relay 86 is held energized when the switch 109 is in the left-hand position and holds the battery 85 connected to the line wires 70 and 71. The circuit for the relay 86 when the switch 109 is in the left-hand position may be traced as follows: Positive terminal of local battery 88, conductor 110, upper center pole of switch 109, upper arm and upper left-hand pole of switch 109, conductor 111, conductor 136, winding of relay 86, conductor 112, to negative terminal of local battery 88.

Upon the first closure of the contacts 113 by the time repeating relay 105, relay 107 operates over the folowing circuit, positive pole of local battery 88, conductor 110, upper central pole of switch 109, upper arm and upper left-hand pole of switch 109, conductor 114, resistance 115, conductor 116, winding of relay 107, spring contact 117 and back contact 118 of relay 107, conductor 119, conductor 120, contacts 113 of the time repeating relay 105, conductor 121, to the negative

pole of local battery 88. Relay 107 in operating pulls its upper armature 122 against spring contact 117 and separates spring contact 117 from back contact 118 and locks up over a circuit including the winding of relay 107, spring contact 117, armature 122, conductor 123 and conductor 121. The operation of relay 107 prepares a circuit for relay 108. When relay 107 is energized, it also closes its lower armature against contact 124 to close a circuit to the pole-changer relay 87 which may be traced as follows: Positive pole of local battery 88, conductor 110, upper central pole of switch 109, upper arm and upper left-hand pole of switch 109, conductor 114, lower armature and contact 124 of relay 107, conductor 125, left-hand lower pole, lower arm and lower central pole of switch 109, conductor 126, winding of pole-changer relay 87, conductor 112 to the negative pole of local battery 88. Pole-changer relay 87 is then energized and reverses the battery connections to the line wires 70 and 71, which causes the selector 72 at each of the way stations to move the movable contact 21, one step into engagement with the stationary contact 25. The bell 76 at each way station then rings to indicate the first of a series of time signals.

Upon the first closure of the contacts 113 of the time repeating relay 105, a short circuit is provided around the winding of relay 108. The short circuit includes conductor 127, back contact 128 and spring contact 129 of relay 108, conductor 120, closed contacts 113 of time repeating relay 105 to conductor 121 through conductor 123, armature 122, contact spring 117, conductor 133 to coil winding of relay 108. Relay 108 is not energized upon the first closure of contacts 113. When the time repeating relay 105 is deenergized and contacts 113 open, the short circuit around the winding of relay 108 is opened and relay 108 operates over the circuit prepared by relay 107. The circuit for operating relay 108 may be traced as follows: Positive pole of local battery 88, conductor 110, upper central pole, upper arm, upper left-hand pole of switch 109, conductor 111, resistance 130, conductor 127, conductor 131, winding of relay 108, conductor 133, upper spring contact 117 and armature 122 of relay 107, conductor 123, conductor 121 to negative pole of local battery 88. Relay 108 when energized, pulls its armature 132 against the contact spring 129 and separates contact spring 129 from the back contact 128 and partially prepares a short circuit around the winding of relay 107. This short circuit is completed when the next energization of the time repeating relay 105 occurs. Assuming that relay 107 is energized over its locking circuit and that relay 108 is held energized over the circuit including armature 122 and contact spring 117 of relay 107, when the time repeating relay 105 closes its contacts 113 a second time, the short circuit partially prepared around the winding of relay 107 by relay 108 is completed. The short circuit around the winding of relay 107 may be traced as follows: From conductor 116, conductor 134, armature 132 and spring contact 129 of relay 108, conductor 120, contacts 113 to conductor 121, conductor 123, armature 122, contact 117 to winding of relay 107. Relay 107 therefore becomes deenergized and releases its lower armature from contact 124 thereby opening the circuit of the pole-changer relay 87. The resistances 115 and 130 are provided as protective elements in the short circuits around the windings of relays 107 and 108. Relay 108 is sufficiently slow to release to keep its armature 132 against spring contact 129 until the upper spring contact 117 of relay 107 has moved into engagement with back contact 118. This provides a holding circuit for relay 108 by way of conductor 133, upper spring contact 117, and back contact 118 of relay 107, conductor 119, conductor 120 and closed contacts 113 of the time repeating relay 105. When contacts 113 open again, relay 108 is deenergized. Relay 108 is also sufficiently slow to release to prevent the time sending apparatus from pulsing fast enough to cause the selectors to step off the time signal receiving position, while telegraph message impulses are being sent over the telegraph circuit 106 and the time repeating relay 105 is being affected by the message impulses, if the time sending apparatus is connected momentarily to the transmitting apparatus. The time signal impulses sent over the telegraph lines are transmited at a much slower rate of speed than the telegraph message impulses.

When the pole-changer relay 87 releases its armatures, the battery connections to the line wires 70 and 71 are reversed and the selector 72 at each way station is again operated to move contact 21 into engagement with contact 25 to close the circuit to the signal bell 76. The bell 76 therefore rings again. It will be seen therefore that relays 107 and 108 operate in sequence and control the operation of the pole-changer relay 87 in the sending of time signal impulses and that these time signal impulses sent to the selectors at the way stations coincide in number to the number of times the contacts 113 of the time repeating relay 105 are closed. If the sequentially operated relays 107 and 108 were not provided between the time repeating relay contacts 113 and the pole-changer relay 87, the selector 72 at each way station would advance its contact 21 to a ringing position once for each closure of the contacts 113 and once again for each opening of these contacts. This would make the signal bell 76 ring twice for each time signal repeated by the time repeating relay 105 and there would not be a sufficient pause between signals at the way station to readily detect the number of signals sent over the line wires.

After the time signals have been sent to the way stations, the operator at the central station moves the switch 109 to the right-hand position. This will disconnect the time sending apparatus including the sequentially operated relays 107 and 108 from the pole-changer relay 87 and will place the pole-changer relay 87 under the control of the code signal transmitters 89, 90, 91, 92, and 93. When the switch 109 is in the right-hand position, the circuit of the relay 86 is as follows: Positive pole of local battery 88, conductor 110, upper central pole, upper arm and upper right-hand pole of switch 109, conductor 134, conductor 135, lower spring contact 96 and the code disc of the transmitter, conductor 136, winding of relay 86, conductor 112 to the negative pole of local battery 88. The circuit to the pole-changer relay 87 when the switch 109 is in the right-hand position is as follows: Positive pole of local battery 88, conductor 110, upper central pole, upper arm and upper right-hand pole of switch 109, conductor 134, conductor 135, spring contacts 96 and 97 of the code transmitter, conductor 137, conductor 138, lower right-hand pole, lower arm and lower central pole of switch 109, conductor 126, winding of pole-changer relay 87, conductor 112 to negative pole of local battery 88.

What is claimed is:

1. In a signaling system in combination, a pole changing relay, an energizing circuit for said pole changing relay, contacts in said energizing circuit, a pair of relays comprising a first relay and a second relay, an operating circuit for said relays, contacts, in said operating circuit, means to close said contacts in said operating circuit, said first relay operating to close the contacts in said energizing circuit, a second set of contacts closed by said first relay, said second set of contacts completing a locking circuit for said first relay and closing the operating circuit for energization of said second relay, a shunt around said second relay, said shunt being normally open at said contacts in said operating circuit, make-before-break contacts controlled by said second relay, the break contacts being in said shunt, and make-before-break contacts in the second set of contacts controlled by said first relay, the make contacts being in the locking circuit for said first relay and preparing the operating circuit for energization of said second relay, the make contacts of said second relay completing a shunt circuit for said first relay and the break contacts of said second relay removing the short-circuit from said second relay, said pair of relays operating in sequence to control the operation of said pole changing relay in accordance with closures only of said contacts in said operating circuit.

2. In a signaling system in combination, a pole changing relay, an energizing circuit for said pole changing relay, normally open contacts in said energizing circuit, a relay to control said contacts, an operating circuit for said relay, normally open contacts in said operating circuit, means to close the normally open contacts in said operating circuit, make-before-break contacts operated by said relay, the break contacts being utilized in the energization of said relay when the normally open contacts in said operating circuit are first closed by said closing means, the make contacts being utilized to hold the circuit of said relay closed when the normally open contacts in said operating circuit are released after a first closing movement, a second relay connected to said operating circuit, make-before-break contacts controlled by said second relay, a shunt around said second relay, said shunt including the break contacts of said second relay and the normally open contacts in said operating circuit, said second relay operating through the make contacts of the make-before-break contacts of said first relay when the normally open contacts in said operating circuit open after a first closing movement, and a second shunt including make contacts of said second relay, said second shunt being completed around said first relay when said second relay operates its make contacts and said normally open contacts in said operating circuit are closed.

3. In a signaling system in combination, a pole changing relay, an energizing circuit for said pole changing relay, contacts in said energizing circuit, a relay to close said contacts in said energizing circuit, an operating circuit for said relay, contacts in said operating circuit, means to close said contacts in said operating circuit, a second relay connected to said operating circuit, make-before-break contacts operated by said first relay, said make contacts operating to hold said first relay energized when the contacts in said operating circuit are opened after a first closing movement, the break contacts of said first relay being in the energizing circuit of said second relay, make-before-break contacts operated by said second relay and a shunt for said first relay including the make contacts of said second relay and the contacts of said operating circuit, said relays operating in sequence to control the energization of said pole changing relay so that said pole changing relay will be energized upon a first closure of said contacts in said operating circuit and held operated upon a subsequent opening of said contacts in said operating circuit and deenergized upon a second closure of said contacts in said operating circuit.

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