July 26, 1938. F. W. BRIXNER 2,124,847

POLAR IMPULSE REPEATING SYSTEM

Filed Sept. 11, 1935 2 Sheets-Sheet 1

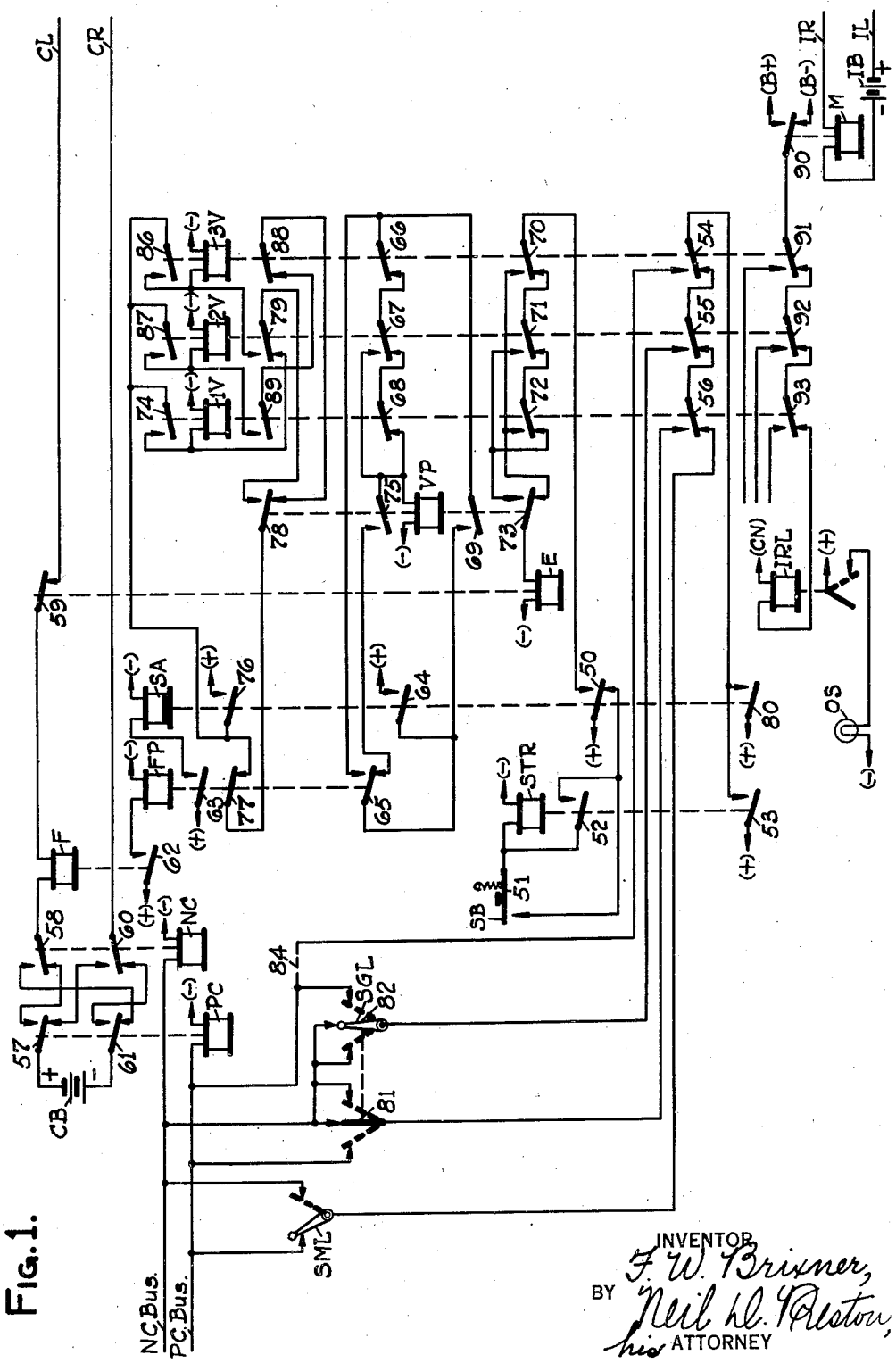


FIG. 1.

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Filed Sept. 11, 1935 2 Sheets-Sheet 2

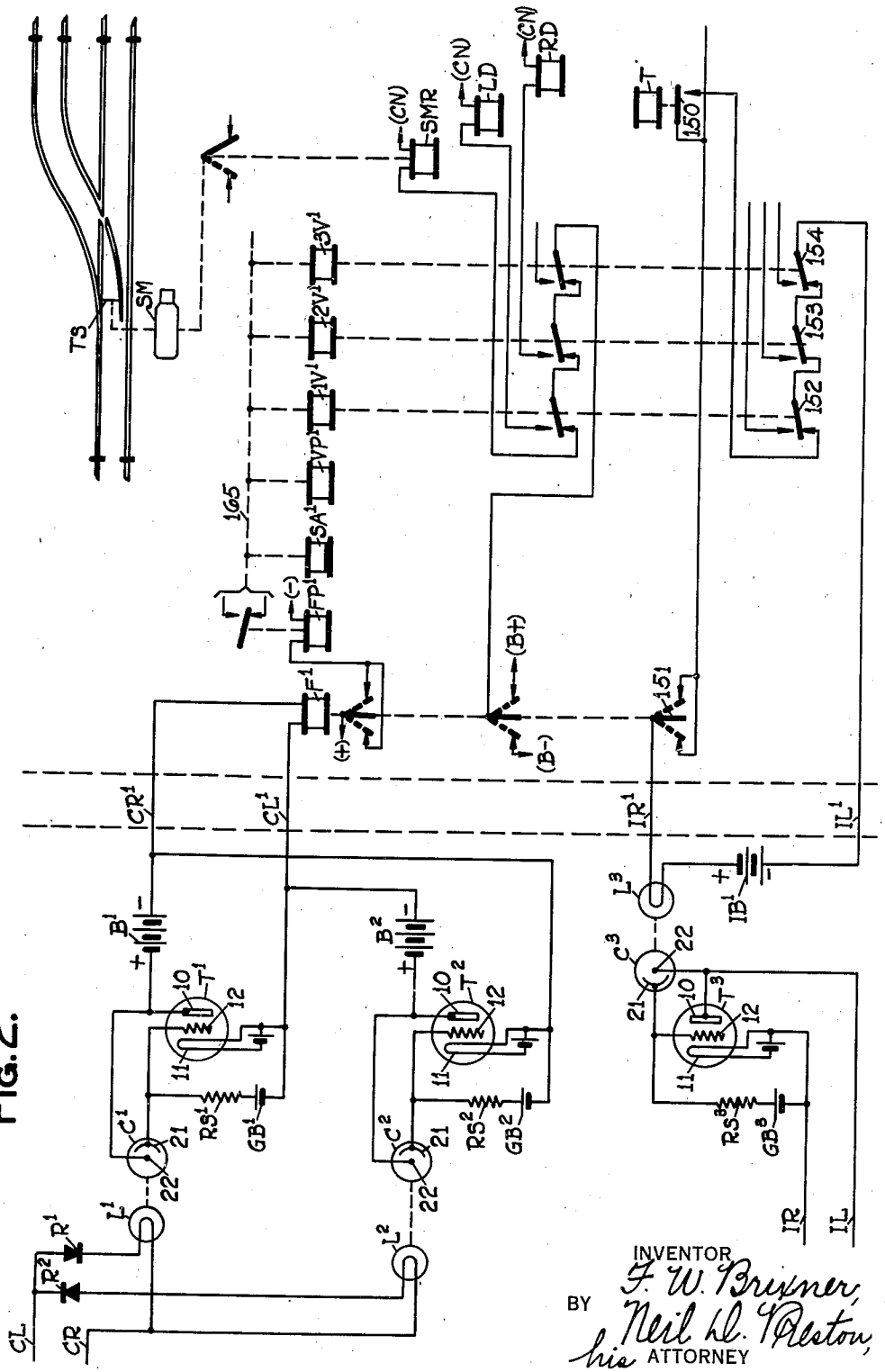


FIG. 2.

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Patented July 26, 1938 2,124,847

UNITED STATES PATENT OFFICE

2,124,847

POLAR IMPULSE REPEATING SYSTEM

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Application September 11, 1935, Serial No. 40,124

2 Claims. (Cl. 177—353)

This invention relates to centralized traffic controlling systems for railroads and it more particularly pertains to the communication part of such systems.

By means of the centralized traffic controlling system contemplated by the present invention, switches and signals at field stations along a railroad system are under the supervision and control of an operator at a central control office so that they can be positioned in accordance with the required traffic over the stretch of track equipped with the system. Likewise, the condition of the various traffic controlling devices, such as the switch positions, the unoccupied and occupied condition of the track sections and the like, are transmitted to the control office to provide the operator with such information as may be necessary for the proper governing of train movements.

While the present invention is adapted for use in a system having a plurality of field stations, in order to simplify the drawings and description, it is shown as operating in connection with a single field station connected to the control office by means of a control line circuit and an indication line circuit.

The present invention is more particularly directed to a traffic controlling system in which the distance between the control office and certain field stations is such that it is not practical to transmit impulses from the office to these distant field stations and from the distant field stations back to the control office because of the length of the line circuit.

The present invention contemplates the use of one or more repeater stations for repeating the impulses both ways over the communication system. In addition to the repeater station or stations, regular stations (not shown) may be connected to the communication system either between the control office and the repeater station or beyond the repeater station.

The apparatus at the control office and at such field station is arranged to be responsive to different series of impulses applied to the line circuits in distinctive combinations in accordance with the character of the messages desired to be transmitted outward from the control office and inward to the control office. Each series of impulses causes step-by-step apparatus at the office and at the field stations to operate through a cycle of operations in synchronism.

Since the impulses to be transmitted from a transmitting field station are applied to the indication line circuit in response to the receipt and registration of stepping impulses applied to the stepping line circuit in the control office, it will be obvious that, when the transmitting field station is at the end of an extremely long line, considerable delay is introduced between the application of the stepping impulse in the control office and the receipt of the associated indication impulse for that step in the control office if the impulses are repeated by relay or mechanical repeaters.

In view of the above, one of the objects of the present invention is to reduce this delay by introducing one or more repeater stations which receive and re-transmit the control impulses from the office and the indication impulses from a transmitting station without appreciable delay.

In carrying the invention into effect, a pair of lamps are placed at the repeater station and connected to the control line circuit through rectifier units, so that these lamps are selectively energized in accordance with the polar impulses applied to the control line circuit. A similar lamp is connected to the indication line circuit at the repeater station, which line circuit leads to the distant field stations. This lamp is energized when the indication line circuit is energized and since the impulses in the indication line circuit are not of variable polarity a single lamp is sufficient for repeating impulses over this circuit.

The energization of each of these lamps controls an associated light sensitive cell which is placed adjacent the lamp in such a way as to be effected by its illumination. It will be understood that the lamps may be of the filament type but, in order to accomplish the maximum speed of operation of the repeating arrangement, it is proposed that they be of the gas-filled type, such as the well known neon lamps which are substantially instantaneous in their response to current and no current.

Since the present invention relates more particularly to an impulse transmitting and repeating arrangement, it is not believed necessary to complicate the drawings by illustrating the manner of station selection and station registration by the impulses applied to the control and the indication line circuits respectively. All of this has been disclosed in numerous prior applications such, for example, as Ser. No. 455,304 filed May 24, 1930, corresponding to Australian patent 1501 of 1931.

A control line battery, or other suitable source of current, is located in the control office and arranged to be variably connected to the control line circuit for the transmission of controls. Ir-

respective of the particular polarity of energization of the control line circuit, the impulses applied thereto are effective to cause the stepping relay banks in the control office and at the field station to operate through a cycle of operations in synchronism.

Similarly, an indication line battery, or other suitable source of current, is located in the control office for the purpose of energizing the indication line circuit when messages are transmitted from the field station.

Numerous applications for my invention will naturally suggest themselves to those skilled in the art and it will be understood that I do not wish to limit myself to railways, the form of apparatus disclosed in the accompanying drawings being applicable to many places where the invention may be used.

Referring to the drawings, Fig. 1 illustrates the apparatus in the control office and Fig. 2 illustrates the apparatus at a repeater station and at a field station. In order to conveniently follow the operation of the system, to be later described, Fig. 2 should be placed to the right of Fig. 1 with correspondingly lettered lines in alinement.

For convenience in describing the operation of the present invention it is assumed that the field station illustrated to the right of the dotted lines in Fig. 2 is at such a distance from the control office that it is impractical to transmit impulses between these locations and maintain the fidelity of operation required. It is therefore assumed that a repeater location is connected to the control office by a control line circuit comprising control line conductor CL and control return conductor CR. The repeater location is also connected to the control office by an indication line circuit comprising indication line conductor IL and indication return conductor IR. The repeater station is connected to the field station by a control line circuit comprising control line conductor CL^1 and control return conductor CR^1. Likewise, an indication line circuit connects the repeater location with the illustrated field station, which line circuit comprises indication line conductor IL^1 and indication return conductor IR^1.

Although the present embodiment illustrates the field station as having only a single track switch, it will be understood that the invention is not so limited, since any desired number of switches and associated signals may be arranged to meet the requirements of practice.

For the purpose of simplifying the illustrations and description, various parts and circuits have been shown diagrammatically and certain conventional illustrations have been employed, the drawings have been made more with the purpose in mind of making it easier to understand the principles and mode of operation of such a system rather than attempting to illustrate the particular construction and arrangement of parts actually employed in practice. The relays and their contacts are illustrated in a conventional manner and symbols are used to indicate connections to the terminals of batteries or other suitable sources of electric current, instead of showing all of the wiring connections to these terminals. The symbols (+) and (—) are employed to indicate the positive and negative terminals respectively of suitable batteries or other sources of direct current. The symbol (CN) is employed to indicate a center or intermediate tap of a battery or other source of direct current, the terminals of which are indicated by (B+) and (B—).

Control office equipment.—Referring to Fig. 1, the reference character F illustrates a neutral line relay which repeats the impulses applied to the control line circuit from control battery CB in the office. Neutral line repeating relay FP repeats the operations of relay F and slow acting line repeating relay SA is picked up at the beginning of a cycle of operations, maintained in its picked up position throughout the cycle and dropped at the end of a cycle after the series of impulses have been transmitted.

Code sending relay PC is provided for selecting a (+) impulse to be applied to the control line circuit and code sending relay NC is provided for selecting a (—) impulse to be applied to the control line circuit. Relay E is for the purpose of marking off the impulses of a cycle, that is, it is picked up to deenergize the control line circuit and dropped to energize this line circuit.

A suitable stepping relay bank comprising relays VP, 1V, 2V and 3V is employed to mark off the successive steps of each cycle. Relays 1V, 2V and 3V take their steps (pick up) during the time spaces or "off" periods of the cycle and relay VP shifts its position during the energized or "on" periods of the cycle. When the stepping relays are picked up they are stuck up until the end of the cycle. Relay VP is picked up and dropped during alternate "on" periods of the cycle.

For the purpose of indicating how the system may be initiated from the control office, a starting button SB and an associated starting relay STR are provided. Message relay M is shown connected in the indication line circuit and is for the purpose of receiving indications during any cycle of operations. For the purpose of illustrating the registration of the messages received over the indication line circuit a single indication receiving relay IRL is shown, this relay being controlled by the track relay at the field station for giving an OS indication. As typical of the controls transmitted from the office to the station, switch machine lever SML and signal lever SGL are illustrated as being selectively connected to the PC and NC buses for applying polar impulses to the control line circuit.

Field station equipment.—The field station illustrated in Fig. 2 includes a biased-to-neutral polar line relay F^1 and its repeating relays FP^1 and SA^1. Relay F^1 actuates its polar contacts to the right in response to a (+) impulse applied to the control line circuit and to the left in response to a (—) impulse applied to the control line circuit. Relay FP^1 repeats the impulses received by relay F^1 irrespective of their polarity and relay SA^1 operates in a manner similar to the corresponding SA relay in the control office. Likewise the stepping relay bank comprising relays VP^1, $1V^1$, $2V^1$ and $3V^1$ operate substantially in synchronism with corresponding relays in the control office.

For the purpose of illustrating the reception of controls switch machine control relay SMR, left direction relay LD and right direction relay RD are shown selectively operated at various steps of the cycle in accordance with the polar controls received. For the purpose of indicating the transmission of indications track relay T is illustrated in its energized position. It will be understood that this track relay is connected to the illustrated track section in the usual manner and that it is deenergized in response to the occupancy of this track section.

The repeater station (located at any point desired) is shown in the left hand portion of Fig. 2. Since it is assumed that there is no field station at this location, only the apparatus required for impulse receiving and repeating is illustrated.

The repeater station includes lamps L^1 and L^2 connected in the control line circuit and responsive to (+) and (−) impulses respectively applied to control line conductor CL. These impulses selectively energize the proper lamps because of rectifier units R^1 and R^2. Lamp L^3 is connected in the indication line circuit leading from the repeater station to a more distant station (or stations) and is energized in accordance with indications transmitted from an indication battery IB^1.

It will be obvious that rectifiers R^1 and R^2 may be entirely separate or a single device with a center tap may be used as shown.

The lamps and the light sensitive cells at the repeater station are so located with respect to each other that the light beams from the lamps are directed onto the associated light sensitive cells upon the energization of the lamps. Three electric discharge devices or vacuum tubes T^1, T^2 and T^3 are controlled by the associated light sensitive cells in a manner which will appear in the following description. These electric discharge devices may take different forms, such as the cold cathode, grid glow tubes or other types of gas-filled tubes. The well known grid controlled electron discharge device or vacuum tube is illustrated in the drawings.

In the form here shown each electron discharge device comprises an anode 10, a cathode 11 and a grid 12 enclosed in a suitable envelope which, if desirable, may contain a small amount of inert gas.

The plate battery for tube T^3 is indicated as battery IB located in the control office. The output circuit of tube T^2 includes plate battery B^2 and the line circuit CL^1—CR^1. The output circuit of tube T^1 includes plate battery B^1 and line circuit CR^1—CL^1.

The light sensitive cells C^1, C^2 and C^3 are connected to the input circuits of the associated vacuum tubes, the input circuit of each tube being negatively biased by means of a circuit extending from the (−) terminal of grid bias battery GB (with suitable exponent) and resistance RS (with suitable exponent).

As above mentioned, rectifiers R^1 and R^2 permit current to flow through lamps L^1 and L^2 in response to (+) and (−) impulses respectively applied to the control line circuit.

It is believed that the invention will best be understood by setting forth in the following description various typical operations in detail.

Normal conditions.—With the system in its normal condition the control and indication line circuits and their associated repeated line circuits are normally deenergized. All of the relays illustrated in the drawings are deenergized with the exception of track relay T which is illustrated as being picked up because it will be assumed that the associated track section is unoccupied.

Manual start.—It will first be assumed that the operator in the control office desires to actuate track switch TS at the illustrated station to its normal locked position. It will be assumed that the track switch is in its reverse position and is operated to its normal position in response to a first (+) impulse applied to the control line circuit.

With the system in its normal condition the actuation of starting button SB (see Fig. 1) closes a circuit for picking up relay STR which extends from (+), back contact 50 of relay SA, contact 51 of button SB and winding of relay STR to (−). Relay STR closes a stick circuit for itself extending from (+), back contact 50 of relay SA, front contact 52 and winding of relay STR to (−). Since the pick up circuit for relay STR extends through back contact 50 of relay SA and since this relay is picked up in response to the initiation of the system, it will be seen that relay STR is dropped as soon as the system is initiated, but as will be later pointed out the circuit extending through front contact 50 of relay SA is effective to maintain the system in operation throughout a complete cycle.

Impulsing and stepping operation.—The picking up of relay STR closes a circuit for picking up relay PC which extends from (+), front contact 53 of relay STR, back contacts 54, 55 and 56 of relays 3V, 2V and 1V respectively, contact of lever SML in its left hand position and winding of relay PC to (−).

The picking up of relay PC energizes the control line circuit with a (+) impulse over a circuit extending from the (+) terminal of battery CB, front contact 57 of relay PC, back contact 58 of relay NC, winding of relay F, back contact 59 of relay E, control line conductor CL, rectifier R^1, lamp L^1, control return conductor CR, back contact 60 of relay NC and front contact 61 of relay PC to the (−) terminal of battery CB. It will be obvious that current flowing over the control line circuit in this direction is ineffective to light lamp L^2 because of rectifier R^2.

The energization of the control line circuit picks up relay F which closes an obvious circuit at its front contact 62 for picking up relay FP. Relay FP closes an obvious circuit at its front contact 63 for picking up relay SA. Relay SA closes a circuit for picking up relay VP which extends from (+), front contact 64 of relay SA, front contact 65 of relay FP, back contacts 66, 67 and 68 of relays 3V, 2V and 1V respectively and winding of relay VP to (−). Relay VP establishes a first stick circuit for itself extending from (+), front contact 64 of relay SA, front contact 69 of relay VP and over the remainder of the previously described circuit to the winding of relay VP.

In response to the operation of relay VP a circuit is closed for picking up relay E, which extends from (+), front contact 50 of relay SA, back contacts 70, 71 and 72 of relays 3V, 2V and 1V respectively, front contact 73 of relay VP and winding of relay E to (−). The picking up of relay E opens its back contact 59 to deenergize the control line circuit which marks the end of the first "on" period.

In response to the deenergization of the control line circuit, relays F and FP are dropped and a second stick circuit is closed for relay VP which extends from (+) front contact 64 of relay SA, back contact 65 of relay FP, front contact 75 and winding of relay VP to (−). The dropping of relay FP closes a circuit for picking up relay 1V which extends from (+), front contact 76 of relay SA, back contact 77 of relay FP, front contact 78 of relay VP, back contact 79 of relay 2V and winding of relay 1V to (−). Relay 1V closes an obvious stick circuit for itself at its front contact 74.

In response to the picking up of relay 1V, relay E is deenergized by the opening of back contact 72 to again energize the control line circuit by

the closure of back contact 59, which marks the end of the first "off" period and the beginning of the second "on" period.

The control line circuit is energized with a (—) impulse over the above described circuit except that it now extends through back contact 57 of relay PC, front contact 60 of relay NC, front contact 58 of relay NC and back contact 61 of relay PC. Relay NC is energized at this time because of a circuit which extends from (+), front contact 80 of relay SA, back contacts 54 and 55 of relays 3V and 2V respectively, front contact 56 of relay 1V, contact 81 of lever SGL in its mid position and winding of relay NC to (—), which circuit was established when relay 1V was picked up during the first "off" period.

In response to the energization of the control line circuit, relays F and FP are again picked up and relay VP is deenergized because its first stick circuit is open at back contact 68 of relay 1V and its second stick circuit is open at back contact 65 of relay FP. The dropping of relay VP energizes relay E over a circuit extending from (+), front contact 50 of relay SA, back contacts 70 and 71 of relays 3V and 2V respectively, front contact 72 of relay 1V, back contact 73 of relay VP and winding of relay E to (—). The energization of relay E deenergizes the control line circuit at back contact 59 to mark the end of the second "on" period and the beginning of the second "off" period.

In response to the deenergization of the control line circuit, relays F and FP are dropped and a circuit is closed for picking up relay 2V which extends from (+), front contact 76 of relay SA, back contact 77 of relay FP, back contact 78 of relay VP, back contact 88 of relay 3V, front contact 89 of relay 1V and winding of relay 2V to (—). Relay 2V closes an obvious stick circuit for itself at its front contact 87.

In response to the energization of relay 2V, relay E is deenergized by the opening of back contact 71, which in turn energizes the control line circuit with an impulse determined in accordance with the position of lever SGL, as selected by the picking up of relay 2V. This impulse is (—) because relay NC is picked up over a circuit extending from (+), front contact 80 of relay SA, back contact 54 of relay 3V, front contact 55 of relay 2V, contact 82 of lever SGL in its mid position and winding of relay NC to (—).

The energization of the control line circuit causes relays F and FP to pick up, after which relay VP is picked up over a circuit extending from (+), front contact 64 of relay SA, front contact 65 of relay FP, back contact 66 of relay 3V, front contact 67 of relay 2V and winding of relay VP to (—). Relay VP is stuck up as previously described and relay E is energized over a circuit extending from (+), front contact 50 of relay SA, back contact 70 of relay 3V, front contact 71 of relay 2V, front contact 73 of relay VP and winding of relay E to (—).

The energization of relay E deenergizes the control line circuit at back contact 59 which results in the dropping of relays F and FP and the picking up of relay 3V over a circuit extending from (+), front contact 76 of relay SA, back contact 77 of relay FP, front contact 78 of relay VP, front contact 79 of relay 2V and winding of relay 3V to (—). Relay 3V closes an obvious stick circuit for itself at front contact 86.

In response to the energization of relay 3V, relay E is deenergized by open back contact 70 for again energizing the control line circuit. It is assumed that the control line circuit is energized with a (+) impulse at this step because of the circuit extending through front contact 64 of relay 3V and dotted line conductor 84 to relay PC. With relay PC energized and relay NC deenergized the impulse at this step is marked (+).

In response to this energization of the control line circuit, relays F and FP are picked up and relay VP is dropped in a manner described for the second "on" period. In response to the dropping of relay VP, relay E is energized over a circuit extending from (+), front contact 50 of relay SA, front contact 70 of relay 3V, back contact 73 of relay VP and winding of relay E to (—).

The energization of relay E deenergizes the control line circuit at back contact 59 which results in the dropping of relays F and FP. Since there are no more stepping relays to be picked up, relay E remains energized to keep the control line circuit deenergized for a sufficient time to permit relay SA to drop. In response to the dropping of relay SA the stick circuits of the stepping relays are deenergized at front contact 76, relay E is deenergized at front contact 50 and the code sending relay PC is deenergized at front contact 80.

The above describes the detailed operation of the stepping bank and the impulse relay operation in the control office for applying a series of impulses to the control line circuit in response to a manual start. It will be understood that the system may be initiated in response to a field start for causing the step-by-step operation already described, but since this feature forms no part of the present invention it has been omitted from the present disclosure. It is merely assumed that indications will be transmitted from the illustrated field station each time the operator initiates the system in the control office and that it is unnecessary to show the initiation of the system for the transmission of indications at any other time.

The stepping operations at the field stations are controlled by relay FP1 in the same manner that the stepping in the office is controlled by relay FP. The detailed circuits of the station stepping relays are not shown but, as indicated by dotted line 165, these circuits are like similar circuits in the office.

It will now be explained how the polar impulses are transmitted in accordance with the controls to be governed, after which a description of the operation relating to the receiving and repeating of these polar impulses at the repeater station will be given.

Transmission of Controls.—In the above explanation it was assumed that the control lever SML was in its left normal position for transmitting a first (+) impulse over the control line circuit. It will be obvious that this first impulse would be (—) in the event that lever SML is in its right hand dotted reverse position, because in this case relay NC would be energized for energizing the control line circuit with a (—) impulse. Similarly, in the event that lever SGL is in its left hand dotted position, then the second impulse would be (+) instead of (—) because contact 81 in this position connects to relay PC. In this event the third impulse would be (—) because the left hand contact 82 of lever SGL connects to relay NC.

Similarly, if lever SGL is in its right hand dotted position the second impulse would be (—) because contact 81 of lever SGL in its right hand

dotted position connects to relay NC and the third impulse would be (+) because contact 82 in its right hand dotted position connects to relay PC.

It is believed that the above example indicates how a selection of two controls, (+) or (—), are transmitted at each step of the system.

Repeating Operation.—Referring to Fig. 2, each light sensitive cell C^1, C^2 and C^3 comprises a cathode 21 and an anode 22. The arrangement shown comprises a single stage DC unit for repeating (+) impulses in the control line, a single stage DC unit for repeating (—) impulses in the control line and a single stage DC unit for repeating impulses in the indication line.

The same B battery is used for a light sensitive cell and the associated electric discharge device, the cathode 21 of each cell being directly connected to the grid, with the anode of each cell being directly connected to the plate. Each electric discharge device has its cathode heated by means of the usual A battery or other source of current supply. The grid 12 of each electric discharge device is maintained at a normal (—) potential with respect to its filament by means of a C battery or the like, such as GB^1, GB^2 and GB^3 connected to the grids of the three tubes through resistances RS^1, RS^2 and RS^3.

The light sensitive cells are adapted to receive the light beams projected from the associated light units L^1, L^2 and L^3. These light sensitive cells C^1, C^2 and C^3 may take different forms such, for example, as the well known photo-electric cell whose conduction depends upon illumination, or the well known selenium cell whose resistance depends upon illumination of a photo-voltaic cell in which light produces an electro-motive force. In the form shown in the present embodiment, cells C^1, C^2 and C^3 are photo-electric cells each comprising an anode 22 and a cathode 21 enclosed in a suitable envelope. Each of these cells will of cource comprise an enclosing tube which is open only at the end or side toward the cooperating light beam in order to prevent the light sensitive element of the cell from being influenced by light other than the associated light beam.

When the potential of the anode 22 is rendered sufficiently positive with respect to the cathode 21 and the cell is illuminated, current is passed from the anode to the cathode. Although not shown in the present drawings it may be found desirable to couple the light sensitive cell to the input circuit of the amplifier by means of a large resistance, because of the extremely high internal impedance of the cell and the very small value of current flowing therein. It is also within the scope of the present invention to take other special steps to obtain the maximum operating efficiency of the arrangement, such as enclosing the cell and amplifier in a shielded container, reducing or neutralizing the inherent capacity across the light sensitive cell elements and the like, but since these arrangements have no bearing on the features and method of operation of the present invention for the purpose of repeating direct current impulses they are not shown in the drawings.

It is clear from the foregoing discussion that each of the vacuum tubes associated with the control line circuit CL and CR comprise an output circuit including a B battery in series with the control line circuit CL^1 and CR^1 to which the line relays such as relay F^1 are connected. Referring back to the energization of the control line circuit extending from the office to the repeater station, it will be recalled that this line was energized with a first impulse of (+) polarity for lighting lamp L^1.

Assuming that lamp L^1 is of the neon type, it will be substantially instantaneously illuminated to project a light beam onto cell C^1. This renders cell C^1 conducting so that a positive potential from the (+) terminal of battery B^1 is applied to grid 12 of tube T^1 which renders this grid positive with respect to its filament. Tube T^1 now becomes conducting and current flows in its plate circuit from the (+) terminal of battery B^1, through the plate filament circuit of tube T^1, control line conductor CL^1, winding of relay F^1 and control return conductor CR^1 to the (—) terminal of battery B^1.

Since this current flows from left to right through the winding of relay F^1 its polar contacts are positioned to the right in response to the (+) impulse applied to the control line circuit in the control office.

It will be recalled that the second impulse applied to the control line circuit in the control office was (—) in character. This causes current to flow from the (+) terminal of battery CB, back contact 57 of relay PC, front contact 60 of relay NC, control return conductor CR, lamp L^2, rectifier R^2, control line conductor CL, back contact 59 of relay E, winding of relay F, front contact 58 of relay NC and back contact 61 of relay PC to the (—) terminal of battery CB.

This (—) impulse is effective to light lamp L^2 which projects a beam of light onto cell C^2 for rendering the grid circuit of tube T^2 positive so that this tube becomes conducting. Current now flows over the control line circuit CR^1 from the (+) terminal of battery B^2, plate filament circuit of tube T^2, control return conductor CR^1, winding of relay F^1 and control line conductor CL^1 to the (—) terminal of battery B^2. Since current flows from right to left through the winding of relay F^1 its polar contacts are operated to the left in response to the (—) impulse applied to the control line in the control office.

During the step-by-step operations at the station the indication line circuit, including conductors IL^1 and IR^1, are energized or not energized as determined by the particular indication to be transmitted. For example, with the track section unoccupied, track relay T remains energized and when relay F^1 at the field station is actuated to either its right or left position in response to the first impulse applied to the control line circuit, lamp L^3 remains deenergized and no current is transmitted over the indication line circuit comprising conductors IL and IR.

In the event that relay T is deenergized because the track section is occupied its back contact 150 is closed. When relay F^1 actuates its contact 151 either to the right or to the left in response to the first impulse applied to the control line circuit, lamp L^3 is illuminated over a circuit extending from the (+) terminal of battery IB^1, lamp L^3, indication return conductor IR^1, contact 151 of relay F^1 in either actuated position, back contact 150 of relay T, back contacts 152, 153 and 154 of relay $1V^1$, $2V^1$ and $3V^1$ respectively and indication line conductor IL^1 to the (—) terminal of battery IB^1.

The illumination of lamp L^3 renders cell C^3 conducting which applies a positive potential to the grid of tube T^3 from the (+) terminal of battery IB. Tube T^3 is therefore rendered conductive and current flows over the indication line circuit

for energizing relay M from the (+) terminal of battery IB, indication line IL, plate filament circuit of tube T^3, indication return line IR and winding of relay M to the (—) terminal of battery IB.

With relay M deenergized because track relay T is energized, relay IRL maintains its polar contact in its left hand position by means of a circuit extending from (B—), back contact 90 of relay M, back contacts 91, 92 and 93 of relays 3V, 2V and 1V respectively and winding of relay IRL to (CN). With track relay T deenergized, relay M is picked up as described and the circuit for energizing relay IRL extends from (B+) at front contact 90 of relay M, which positions the contact of relay IRL to the right for energizing lamp OS as an indication that the track section is occupied.

It will be obvious that other indications, such as the position of the track switch, the clear and stop signal indications and the like, may be transmitted on additional steps of the cycle in the manner described for the transmission of the track occupancy indication.

As above mentioned it is believed unnecessary to illustrate or to describe the station selection, station registration or the lock out features of the system to which this invention may be applied. These features may take many forms to meet the requirements of practice and the scope of the present invention is such as to embrace any particular form of station selection, station registration, lockout or initiation features to which the present impulse repeating arrangement may be applied.

Having thus described one specific embodiment of an impulse repeater system it is desired to be understood that the particular arrangement illustrated is merely typical of applicant's invention and is not intended to show the exact circuit design necessary to carry out the features of the invention, but has been selected to facilitate in the disclosure rather than to limit its scope and it is further to be understood that various modifications may be made and various adaptations and alterations may be applied to the specific form disclosed in order to meet the various problems encountered in practice and that the system may be varied in the amount of apparatus installed, all without in any manner departing from the spirit or scope of the invention except as limited by the appended claims.

What I claim is:—

1. In a code type communication system; a first line circuit connecting a control office with a repeater station; a second line circuit connecting the repeater station with a field station; a code transmitter at the control office and including a step-by-step mechanism for impressing different series of time spaced positive and/or negative impulses upon said first line circuit; repeater means at the repeater station comprising one light producing means responsive to only said positive impulses in said first line circuit; a second light producing means responsive only to said negative impulses in said first line circuit; a first light sensitive cell controlled by said first light producing means; a second light sensitive cell controlled by said second light producing means; two battery sources of electric energy, two electronic means controlled by said first and second light sensitive cells respectively so as to impress positive impulses on said second line circuit from a first one of said battery sources and to impress negative impulses on said second line circuit from the other of said battery sources, said impulses being of the same polar characteristics as those impressed on said first line circuit and also being substantially coexistent therewith; code receiving means at the field station including a step-by-step mechanism operated step-by-step in response to impulses on said second line circuit and distinctively responsive to the different codes; indication line circuit means connecting said control office with the field station; code transmitting means at the field station effective to condition said indication line circuit means on each step of said step-by-step mechanism at the field station; and indication receiving means at the control office controlled on each step of said step-by-step mechanism at said control office in accordance with the condition of said indication line circuit means as conditioned by said code transmitting means at the field station on that step; whereby code messages are transmitted from the control office to a distant location with substantially no delay incurred by the repeating of the impulses so that the step-by-step mechanisms controlled thereby operate in synchronism to allow the simultaneous transmission of indication impulses from the distant location to the control office on corresponding steps.

2. In a code type communication system; a control office and a distant field station; a first control line circuit extending from the control office to an intermediate repeater station; a second control line extending from the repeater station to the field station; a code transmitter at the control office including a step-by-step mechanism for impressing different series of time spaced positive and/or negative impulses upon said first control line circuit; repeating means at the repeater station including one light producing means responsive to only said positive impulses on said first line circuit, a second light producing means responsive to only said negative impulses on said first line circuit, a first light sensitive cell controlled by said light producing means, a second light producing cell controlled by said second light producing means, two battery sources, two electronic means controlled by said first and second light sensitive cells respectively so as to impress positive impulses on a second line circuit from a first one of said battery sources and to impress negative impulses on the second line circuit from the other of said battery sources with said impulses being of the same polar characteristics as those impressed on said first line circuit and also being substantially coexistent therewith; code receiving means at said field station controlled by said different series of impulses on said second control line circuit and including a step-by-step mechanism operated step-by-step in synchronism with said step-by-step mechanism at the control office in response to such impulses; a first indication line circuit connecting said control office with said repeater station; a second indication line circuit connecting said repeater station with said field station; means at said distant field station for transmitting a code element on each step of said step-by-step mechanism at that station over said second indication line circuit; indication repeating means at said repeater station including a light producing means responsive to said code elements in said second indication line circuit, a light sensitive cell controlled by said light producing means, electronic means controlled by said light sensitive cell so as to impress code elements on said first indication line circuit from said battery source, said code elements being

of the same characteristics as said elements on said second indication line circuit and also being substantially coexistent therewith; code receiving means at said control office responsive on each step of said step-by-step mechanism at the control office to be conditioned in accordance with the element on said first indication line circuit as transmitted at the field station on that step and repeated into said first line circuit at the repeater station; whereby control messages are transmitted from the control office to the distant field station in a manner that indication messages are transmitted synchronously therewith to the control office on the same steps by reason of the fact that the step-by-step mechanisms at the control office and at the field station are maintained in electrical synchronism.

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