This invention relates to railway signalling systems, and more particularly pertains to a block signalling system adapted to govern traffic in both directions over a stretch of single track.

It often happens that two spaced interlocking areas are connected by a stretch of single track over which it is expedient to have traffic pass in opposite directions at different times. The traffic over such a stretch may be jointly governed by the operators at the two interlocking areas, or may be governed by a single operator at some central point. In any event, the system must be organized to govern the signals in such a manner that traffic can enter only at one end of the stretch at any one time. Also, when such a single track stretch extends for a considerable distance, it is often desirable to provide intermediate signals to allow for following train movements. Regardless of whether the stretch is occupied by one or more trains, the system must be organized to prevent the establishment of an opposing train movement until the stretch is entirely unoccupied.

In view of the above considerations in connection with a stretch of single track between two spaced interlocking areas, it is proposed in accordance with the present invention to provide a novel circuit organization for controlling the entering and intermediate signals of such a single track stretch in a manner to provide four indication block signalling in both directions by the use of a minimum number of line wires.

Generally speaking, it is proposed that the system of the present invention provide two line wires between each signal location which may be used for clearing signals in either direction and at the same time provide sufficient control conditions thereover to effect the desired four indication block signalling. The four control conditions on the line are positive or negative steady energization, positive and negative pulses alternately, and the deenergization of the line. Also, apparatus is associated with the ends of the line wires at each signal location in such a manner that each pair of line wires can be used to transmit the control conditions in either direction. In the present embodiment, a regular three indication signal mechanism is proposed to be employed giving the usual green, yellow and red indications, which mechanism is caused to give a fourth indication by flashing the yellow indication.

Another feature of the present invention is to provide a system organization which remains in the condition for the direction of traffic last established, but which can be controlled at either end by the operator to establish traffic conditions for train movements entering the single track stretch from that end. However, if the signalling for the single track stretch is controlled by the operators at the opposite ends of the stretch their joint cooperation is required either over a telephone or telegph system, or by a separate traffic locking circuit. On the other hand, if the signalling system is controlled by a single operator at a central point, then suitable means is provided either at the central control office or in the field to assure that the operator will endeavor to establish traffic in one direction only at any particular time.

Other objects, purposes and characteristic features of the present invention will be part obvious from the accompanying drawings, and in part pointed out as the description of the invention progresses.

In describing the invention in detail, reference will be made to the accompanying drawings, in which like letter references characters have been provided to designate similar parts throughout the several views with these letter reference characters being given distinctive preceding numerals characteristic of the signal locations with which such parts are associated, and in which:

Fig. 1 illustrates by suitable symbols the track layout and signal arrangement contemplated as having the present invention applied thereto;

Fig. 2 is a representation of the signal indications given during the presence of a train in the stretch of single track;

Figs. 3A, 3B, 3C, 3D, and 3E, when placed end to end, illustrate diagrammatically one form of signalling system embodying the present invention.

For the purpose of simplifying the illustration and explanation, the various parts and circuits constituting the embodiment of the invention have been shown diagrammatically and certain conventional illustrations have been employed, the drawings having been made more with the purpose in mind of making it easy to understand the principles and mode of operation, than with the idea of illustrating the specific construction and arrangement of parts that would be employed in practice. Thus, the relays and contacts are illustrated in a conventional manner and symbols are used to indicate the connections to the terminals of batteries, or other 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. In the drawings, equipment is located at several different points along the trackway, and it is assumed that suitable sources of direct current, as represented by the symbols, are provided at each of these different spaced points as required.

Referring to Fig. 1, it will be seen that a stretch of single track extends between an interlocking area adjacent "Tower A" and another interlocking area adjacent "Tower B". Signals 6, 8, 10, 12 and 14 are provided for governing traffic in an east bound direction, while signals 7, 9, 11, 13 and 15 are provided for governing traffic in a west bound direction. Each of these signals is assumed to be of the search light type such as shown, for example, in the prior patent to O. S. Field, Pat. No. 1,835,150, dated December 8, 1913. Each such signal, such as signal 6 of Fig. 3A, has an operating mechanism including an electro-magnet M for moving a spectacle SP from its normal biased position where a red indication is displayed to either of two other positions in which yellow and green indications are respectively given. A lamp L supplies the light for the light projecting organization of the signal. The mechanism also includes contacts which are operated to different positions depending upon the indications given by the signal. For example, contacts 98 and 99 assume their solid line positions while the signal indicates stop; contact 98 moves to the right when the signal indicates yellow; and contact 99 moves to the left when the signal indicates green. However, it is to be understood that other types of signals might well be employed.

These signals, regardless of their type are commonly constructed to give three indications such as red, yellow and green; but, in order to provide for closer spacing of traffic when the traffic is dense, it is desirable to have a
fourth indication which in accordance with the present invention is given by flashing the yellow indication of the regular three indication signal mechanism. This has been indicated on the drawings by a suitable legend in Fig. 1 as follows: "Signals Give Fourth Indication by Flashing Yellow."
The fourth indication is not represented in the signal symbols to avoid the erroneous impression that each signal is mechanically constructed to give four indications. This diagram of Fig. 1 also indicates by legend that two line wires are provided between each pair of signal locations and that these line wires are controlled by the track circuits of the respective track section.
All of the signals are normally dark except the entering signals 6 and 15, as well as the leaving signals 7 and 14. All intermediate signals are illuminated upon the approach of a train. Since the condition of the system for the last direction of traffic remains until the traffic direction is reversed, the system may assume any one of several different normal conditions. As shown, the last direction of traffic is assumed to have been from west to east so that the signals 10 and 12 are controlled to the yellow indicating positions and the signal 8 is controlled to its green indicating position. The signals 9, 11, and 13 are of course controlled to their stop or red indicating positions and the position of the signals are indicated by solid line signal arms; and those signal arms and those signals which are illuminated, have such solid lines made heavy.

In Fig. 2 the operated conditions of the various signals are illustrated for train X in the track section 1ST which is being followed by a train Y that has not entered the single track stretch. Although the signals to the rear of the train are not shown as being illuminated, the indications which would be given by these signals upon the approach of the train Y have been indicated by suitable letters such as R, Y, F, and G for red, yellow, flashing yellow, and green respectively. The line wires leading from signal 14 have positive and negative energy applied thereto alternately, but this energy is not repeated at the signal 12 because the track relay associated with the track section 1ST opens the line circuit, which deenergized condition of the line circuit for signal 12 is indicated by (0). The line wires extending to signal 10 have steady negative energy supplied thereto as indicated by (—). The line wires leading to signal 8 have positive energy applied to them as indicated by (+). The line wires extending to signal 6 are supplied with positive and negative energy alternately as indicated by (—++—), which causes the signal 6 to indicate green. The signals 7, 9, 11, 13, and 15 are all in their biased stop positions and would give a red indication if illuminated as indicated by R adjacent each of the symbols.

Referring to Figs. 3A-3E, it will be seen that the tower A is shown in Fig. 3A as governing a signal control relay 6RD while the tower B of Fig. 3E is shown as governing a signal control relay 15LD. The relay 6RD is for controlling traffic to the right and effecting the clearing of signal 6, while the relay 15LD is for controlling traffic to the left and clearing the signal 15. It is contemplated that these relays are independently controlled from their respective towers by suitable manually operable levers in any conventional manner. However, it is to be understood that this control might be provided over any suitable type of communication system, either of the direct line wire or indirect or of the control type. It is also contemplated that the present invention might well be applied to stretches of single track between passing sidings and that these relays represented as being controlled from separate towers might both be controlled by the same operator over a suitable centralized traffic controlling system to establish a controlled direction of traffic.

Referring to Figs. 3A-3E, it will be noted that each signal has associated therewith polarized line relays HR and DR which are so constructed as to respond to only a particular polarity. Although any suitable polarized relay may be employed, one such a relay is shown, for example, in the Willing et al., Pat. No. 2,502,811 dated April 4, 1950. Each pair of these relays HR and DR is so connected in the line circuit for their respective signal that one relay responds only when the line circuit is supplied with energy of one polarity and the other relay responds only when the line circuit is supplied with energy of the opposite polarity.

A slow releasing relay HD is associated with each pair of line relays HR and DR, and is controlled by them so as to be energized when either of these relays is picked up providing the HD relay for the responding signal is deenergized. Each relay HD is sufficiently slow acting as to remain picked up when its energization is dependent upon the alternate picking up of the associated relays HR and DR.

Two slow acting relays DP and DPP are associated with each pair of line relays HR and DR, and are controlled by such line relays to distinctively respond to alternate energization of the line circuit with opposite polarities. Each signal also has a green-yellow repeater relay GYP connected in the usual way to be energized when that signal is indicating green or yellow. A flashing relay FL is associated with each signal to operate at a suitable rate under proper conditions. This flashing relay FL serves the purpose of controlling the lamp of the associated signal to give a flashing yellow indication under the proper traffic conditions, and also serves to control the code circuit for that signal to cause it to be energized with opposite polarities alternately in a manner later to be described. Each flashing relay FL may be of any suitable type, or may be a code oscillator, but for convenience in the present disclosure, it is assumed that this relay is of the self-interrupting type, as shown, for example, in the prior patent to O. S. Field, Pat. No. 2,097,786 dated November 2, 1937. Since such a flashing relay FL does not ordinarily have a sufficient number of contacts, a repeater relay FLP is associated with each signal to control the line circuit to the rear.

Because the system organization is of the so-called tumble-down type, it is necessary that each intermediate signal be provided with a directional stick relay S, such as relay 8S, for example, in Fig. 3B. These directional stick relays are for the purpose of controlling the line circuits to the rear of their respective signals upon the passage of a train.

All of the line circuits are controlled by the respective track relays of the associated track sections. In addition, an approach relay A is located at each signal and is included in the line circuit connection when energy is supplied to it at that signal location. An approach relay in which the associated approach relay A, as later discussed. By the use of such approach relays associated with the line circuits which are track circuit controlled, it is possible to approach light the intermediate signals.

It is believed that the various other features of the present invention as well as the underlying principles thereof may be best understood by further description being set forth from the standpoint of operation.

Operation

As above mentioned, the system is left in the condition established for the last direction of traffic with the exception, of course, that the manually controlled entering signals 6 and 15 are at stop. Also, all of the signals except the entering signals 6 and 15 as well as the leaving signals 7 and 14, are normally dark. These signals adjacent the respective interlocking areas are manually controlled and are normally illuminated so as to provide the proper signal indications for local switching train movements. More specifically, the lamp L of signal 6 is energized through a circuit including back contact 16 of relay 6DP (see Fig. 3A). A similar circuit is, of course, present in Fig. 3E for signal 15. The controls for signals 7 and 14 have not been shown, since they relate
more particularly to the track layouts and signalling conditions of the respective interlocking areas.

For the purposes of the present disclosure, it has been assumed that traffic was last established from west to east. It follows later explained, this leaves the system in a condition controlling signals 10 and 12 to yellow indicating positions and signal 8 to a green indicating position in spite of the fact that energy is applied to both ends of the line circuit organization. The conflict between the application of energy in opposite directions ordinarily occurs in the line wires for the end track sections and although it may not be absolutely true, it is sufficiently predominant as to assume this condition for the purposes of the disclosure. Also assuming the signal 14 is manually controlled to stop, the line circuit organization is energized at signal 14 with steady negative energy which controls the signal 12 to a yellow indicating position. The line circuit for signal 10 is thus energized with steady positive energy by the apparatus at signal 12, so that this signal 10 also assumes a yellow indicating position and in turn controls the line circuit to signal 8 with positive and negative potential alternately applied at intervals. This causes the signal 8 to be controlled to a green indicating position and to endeavor to simply the circuit extending to signal 6, but due to the fact that energy is also applied to the line circuit at signal 6, no control is effected.

More specifically, with the traffic direction relay WFR of Fig. 3E deenergized, the line wires 19 and 20 are energized from (+). through a circuit including back contact 21 of relay 14GYP (see Fig. 3E), back contact 22 of relay 14FLP, back contact 18 of relay WFR, front contact 79 of relay 15TR, line wire 20, front contact 33 of relay 12TR, back contact 24 of relay 13FLP, back contact 25 of relay 13S, back contact 26 of relay 13GYP, windings of relay 12DR and 12HR in series, back contact 27 of relay 13GYP, back contact 28 of relay 13S, back contact 29 of relay 13FLP, front contact 30 of relay 12TR, line wire 19, front contact 103 of relay 15TR, back contact 17 of relay WFR, back contact 31 of relay 14FLP, back contact 32 of relay 14GYP, to (-). The steady energy which flows in this circuit is in such a direction as to be characterized as a negative energization and cause the contacts of relay 12HR to be manually picked up. This negative energization of the line circuit is steady due to the fact that relay 14FLP is steadily deenergized while the signal 14 is at stop.

Referring to Fig. 3D, it will be seen that the steady energization of relay 12HR closes its front contact 33 to energize the relay 12HD because back contact 42 of 13HR contact 52 might be noted that the closed condition of front contact 134 does not affect the energization of its associated relays at this time. The relay 12HD completes an energizing circuit for the mechanism of signal 12 from (-), through a circuit including front contact 34 of relay 12TR, back contact 35 of relay 12DPF, mechanism of signal 12, back contact 36 of relay 12S, front contact 37 of relay 12HD, back contact 38 of relay 12DPF, to (-). The energy which flows in this circuit is in such a direction as to cause the signal 12 to be operated to its yellow indicating position.

With the signal 12 mechanism operated, its contact 43 is operated to the right to energize the relay 12GYP that energizes the signal 12. The picked up condition of this relay 12GYP connects steady positive energy to the line circuit for the next section to the rear.

More specifically, a circuit is closed from (-) through contact 44 and 45 of signal 13 (see Fig. 3D) in a stop position, back contact 46 of relay 13FLP, back contact 47 of relay 13S, back contact 48 of relay 13GYP, windings of relay 12A, front contact 49 of relay 12GYP, back contact 50 of relay 12S, back contact 51 of relay 12FLP, front contact 52 of track relay 15TR, line wire 53, front contact 54 of relay 10TR, back contact 55 of relay 75 11FLP, back contact 56 of relay 11S, back contact 57 of relay 11GYP, windings of relay 10HR and 10DR in series, back contact 58 of relay 11GYP, back contact 59 of relay 11S, back contact 60 of relay 11FLP, front contact 61 of relay 10TR, line wire 62, front contact 63 of relay 13TR, back contact 64 of relay 12FLP, back contact 65 of relay 12S, front contact 66 of relay 12GYP, to (-). The steady energy which flows in this circuit is in such a direction as to characterize a positive energization for the line relays and causes the relay 10DR to be steadily picked up.

It should be noted at this point that the steady application of positive energy to the line wire 53 and 62 includes the approach relay 12A in series, so that this approach relay 12A is picked up closing its front contact 81 to energize its repeater relay 12AP. The open condition of back contact 39 of relay 12AP removes energy from the lighting circuit of the lamp of signal 12, and contact 39 is not again closed until a train approaches this signal.

The steady closure of front contact 67 of relay 10DR (see Fig. 3C) energizes relay 10HD which completes the energizing circuit for the signal 10 mechanism at front contact 68. The remaining portion of the circuit will be understood by analogy to the circuit point out in detail for signal 12. Also, the direction of current flow in this circuit is the same as for signal 12 and actuates the signal 10 to a yellow indicating position.

The steady picked up condition of relay 10DR closes its front contact 69 to energize the relay 10DP through a circuit also including back contact 70 of relay 10HR. This energized condition of relay 10DP closes its front contact 71, but the relay 10DDP is not energized since the relay 10HR is steadily deenergized and from contact 70 is open. However, the closure of front contact 72 of relay 10DP completes an energizing circuit for the flashing relay 10FL. More specifically, contact 73 of signal 10 is, of course, moved to its right hand position with the signal 10 controlled to its caution indicating position which energizes the relay 10GYP and also supplies energy through front contact 72 of relay 10DP, winding of relay 10FL, back contact 74 of flashing relay 10FL, to (-). The flashing relay 10FL, thus energized, is intermittently interrupted by its own back contact 74 so as to be intermittently operated in the usual fashion of a flashing relay. Its front contact 75 is the one intermittently closed to directly energize its repeater relay 10FL.

The picking up of relay 18GYP (see Fig. 3C) applies energy to the line circuit to the rear. More specifically, energy is applied from (-), through a circuit including contact 150 in its left hand position, contact 151 in its right hand position, back contact 152 of relay 11FLP, back contact 153 of relay 11S, back contact 154 of relay 11GYP, windings of approach relay 10A, front contact 155 of relay 10GYP, back contact 156 of relay 10S, back contact 157 of relay 10FLP, front contact 157 of relay 11TR, line wire 84, front contact 156 of track relay 8TR (see Fig. 3B), back contact 158 of relay 9GYP, back contact 159 of relay 9S, back contact 160 of relay 8GYP, windings of relays 8HR and 8DR in series, back contact 161 of relay 9GYP, back contact 162 of relay 9S, back contact 163 of relay 9FLP, front contact 164 of relay 8TR, line wire 85, front contact 164 of relay 11TR, back contact 82 of relay 10FLP, back contact 165 of relay 10S, front contact 166 of relay 10GYP, to (-).

This positive energization of the line wires 84 and 85 is intermittently reversed to a negative energization by the relay 10FLP. For example, the energy which is connected to line wire 84 through front contact 155 is applied to line wire 85 through front contact 165 of relay 10FLP, while the line wire 84 is connected to (-) through front contact 83. This intermittent reversal of energization occurs at some suitable rate so that positive and negative energizations are caused to occur alter-
nately. It should be noted that both the positive and the negative energization of the line wires 84 and 85 is by the supply of energy in the same direction through the approach relay 10A in series. For this reason, the relay 10A remains steadily picked up during the intermittent and alternate energization of the line circuits. However, if the contacts between the front and back points of the contacts of the relay 10FLP is too long for the relay 10A to remain picked up, its actual control is made continuous by reason of its slow acting repeater relay 10AP being directly controlled through front contact 170. However, if desired, the relay 10A might be made slow acting and a resulting signal contact of the relay 10AP steadily picked up, the flashing circuit for lamp L of signal 10 is open at back contact 76, and signal 10 is dark.

Referring to Fig. 3B, it will be seen that the alternate positive and negative energizations of the line wires 84 and 85 is contact 114 of relay 8DR and 8HR to be alternately picked up. During the positive energizations of the line, relay 8DR is picked up and relay 8HR is dropped away so that relay 8DP is energized through back contact 87 and front contact 86. During negative energizations of the line relay 8HR is picked up and relay 8DR is dropped away so that relay 8DP is energized through front contact 87, back contact 88, front contact 89. Since these relays 8DP and 8DPP both have slow releasing characteristics, they remain picked up between the successive energizations which close their respective pick up circuits.

The intermittent operation of relays 8DR and 8HR is alternately effective to energize the relay 8HD through front contacts 91 and 92, so that relay 8HD remains steadily picked up. Thus, the signal 8 mechanism is energized through a circuit closed from (++) and including front contact 93 of relay 8TR, front contact 94 of relay 8DPP, front contact 95 of relay 8HD, back contact 96 of relay 8S, signal 8 mechanism, front contact 97 of relay 8DPP, to (---). The energy which flows in this circuit is such a direction as to cause the signal 8 mechanism to be actuated to its clear indicating position. For this reason, relay 8GYP is energized from (++) through a circuit including contact 105 in a left contact position, contact 106 in a left hand position, windings of relay 8GY, to (---). Energy is also fed through these contacts 105 and 106, through the flashing relay 8FL through contact 104 of relay 8DP.

Under these conditions, energy is applied to the line wires 110 and 111 through a circuit distinguished from (---) and includes signal contact 171 in a left hand position, signal contact 172 in a right hand position, back contact 173 of relay 9FLP, back contact 174 of relay 9S, back contact 175 of relay 9GY, windings of approach relay 8A, front contact 176 of relay 8GY, back contact 120 of relay 8S, back contact 177 of relay 8FLP, front contact 178 of relay 9TR, to line wire 110. The return line wire 111 is connected through front contact 115 of relay 9TR, back contact 178 of relay 8FLP, back contact 121 of relay 8S, and front contact 179 of relay 8GY, to (---). This application of energy is in such a direction as to characterize a positive energization of the line wires 110 and 111, but since the flashing relay 8FLP is operating, its repeater relay 8FLP intermittently picks up closing its front contacts 177 and 178 to reverse the energization to characterize a negative energization of the line wires.

As mentioned above, under normal conditions with signal 6 manually controlled to stop, energy is also applied at such signal location to the line wires 110 and 111. More specifically, a connection is made from (++) through back contact 180 of relay 7GY, back contact 181 of relay 7FLP, back contact 182 of relay 7EF, front contact 113 of relay 6TR, to line wire 111. The return connection from wire 110 is through front contact 112 of relay 6TR, back contact 183 of relay 7EF, back contact 184 of relay 7FLP, back contact 185 of relay 7GY, to (---).

It can thus be seen that when the positive energy is applied to the line wire 110 at the signal 6, its battery is in series with the battery at the signal 6 location so that an added loop through the line circuit which energizes the relay 8A; but, when the energization of the line wires is reversed at the signal 6, the two batteries are in opposition and no energy flows. Thus, the relay 8A is intermittently picked up and dropped. However, its front contact 186 intermittently energizes the slow acting repeater relay 8AP, which is continuously slow acting as to remain picked up between successive energizations. This maintains back contact 100 open and keeps the lamp of signal 8 deenergized until a train approaches, as later explained.

The signals for west bound traffic do not have their respective approach relays energized, but the circuits for the respective lamps are taken through the back contacts of the HD relays for the opposing direction, which maintain these lamps deenergized. More particularly, referring to Fig. 3B it will be seen that the lamp L of signal 9 has its circuit taken through back contact 187 which is open under the conditions above described. A similar circuit is provided through the other signals 11 and 13.

Let us assume that the operator at tower A desires to send an east bound train through the single track stretch. First, he communicates with the operator at tower B via telephone, telegraph, or other communication means, and consults with the operator at tower B to determine whether or not the operator at tower B can receive east bound traffic.

If the operator at tower B finds that east bound traffic will be received by the operator at tower B, it is agreed between the two operators that east bound traffic may be established. The operator at tower A then actuates the control lever for signal 6 when suitable means are not shown effects the energization of relay 6RD. This closes front contact 188 to energize the direction relay EFR through an obvious circuit. The signal 6 cannot be cleared immediately until it is determined whether or not energy is being supplied to the line circuits from the signal 15 location. The picking up of relay EFR and the opening of back contacts 182 and 183 disconnects the source of energy at the signal 6 location and the closure of these front contacts connects the line relays 6DR and 6HR to the line wires 110 and 111.

Assuming that the single track stretch is unoccupied and that the operator at the east end of tower B has nothing in his way, the relay 6RD being energized, the application of alternate polarities to the line wires 110 and 111 causes the relay 6HD to be energized through front contacts 190 and 191. Also, this operation of the line relays causes the relays 6DP and 6DPP to be energized through circuits that will be understood by analogy to the above description. Thus, a circuit is closed for the signal 6 mechanism from (---), through a circuit including front contact 192 of relay 6RD, front contact 193 of relay 6HD, front contact 194 of relay 6DPP, windings of mechanism 8 of signal 6, front contact 195 of relay 6DPP, to (---). The energy through this circuit is in such a direction as to actuate the spectacle SP to a green indicating position in which the green roundel G is in the light projecting path. The lamp L is steadily illuminated by reason of the closure of front contact 112 of relay 6DPP. The flashing relay 6FL is not in operation due to open contact 196.

In brief, the tumble-down line circuits have actuated section by section to be built up to the signal 6, since energy is applied at the signal 15, and since there is no other traffic in the stretch of single track. If there were a west bound train in the stretch of single track, there would be no energy feeding to the relays 6DR and 6HR so that signal 6 could not be cleared in spite of action by the operator to energize relay 6RD. However, the picking up of the relay 6RD followed by the picking up
of relay EFR would remove energy from this end of the line circuits and would place all intermediate signals at stop preventing any westbound train from proceeding further. This is not done under proper procedure because the operators at towers A and B cooperate by a suitable communication method and signals with the trains to expect. However, if desired, a traffic locking circuit or other suitable expedient might be employed to prevent such erroneous operation of the lever for signal 6 and the corresponding lever at tower B for signal 10. The present invention relates more particularly in the signal control circuits for four section signals over a single track stretch having signals for both directions, such features have not been disclosed herein.

Let us assume that the clearing of signal 6 is accepted by an east-bound train which proceeds into the track section 6T. This deenergizes the track relay 6TR opening front contacts 112 and 113 to deenergize the line circuit including line wires 110 and 111. The relays 6DR and 6HR are therefore deenergized which results in the deenergization of relays 6DP and 6DDP. This restores the signal 6 to stop.

The opening of the line circuit also deenergizes the approach relay 8A which in turn opens front contact 186 and deenergizes its repeater relay 8AP to close back contact 100. This completes the energizing circuit for the lamp L for signal 8 from (+), through a circuit including back contact 100 of relay 8AP, back contact 101 of relay 9HR, front contact 102 of relay 8DP, Lamp L, to (-). Thus, as the east-bound train proceeds into the track section 9T it finds the signal 8 giving a green indication so that it can proceed at authorized speed toward the signal 10.

As the train passes the signal 8 into track section 8T, the track relay 8TR is deenergized opening front contacts 116 and 117 to deenergize relay 8LR and 8IR. These relays in ceasing their intermittent operation, previously described, causes the release of relays 8DP and 8DDP as well as relay 8HD. This controls the signal 8 to stop by deenergizing the mechanism of the signal. Also, the directional stick relay 8S is picked up by reason of a circuit closed from (+), and including back contact 93 of track relay 8TR, front contact 118 of relay 8HD, windings of relay 8S, to (-). This pick-up circuit for the relay 8S is completed as soon as the track relay 8TR releases and during the release time of the relay 8HD. As soon as the relay 8S picks up, it closes front contact 119 to shunt the front contact 118 of relay 8HD so that upon the closure of back contact 118 a holding stick circuit is closed for the relay 8S. The picking up of the directional stick relay opens its back contact 96 to assure that the signal 8 cannot be energized. Also, the closure of its front contacts 120 and 121 effects the connection of the source of this signal at this location to the line wires 110 and 111 in a direction to characterize a negative energization of the line wires. This causes the relay 6HR at signal 6 to be steadily energized and pick up the relay 6HD, assuming that the operator at tower A has kept relay 6RD picked up for east-bound traffic. Such energization of the relay 6HD would permit an east-bound train to proceed on a caution indication. This is because under such circumstances the relay 6DDP is energized. However, if such following trains are permitted to proceed into the single track stretch, the operator at tower B is advised that he knows what trains to expect.

When the east-bound train enters track section 8T and proceeds toward the signal 10, as before mentioned, the line circuits are opened deenergizing the relay 10A and approach lighting the signal 10. The signal 10 is controlled to a yellow indicating position by the steady positive energization of the line circuit including line wires 53 and 62. This causes the relay 10DR to be steadily picked up resulting in the steady energization of relay 10DP and the open condition of back contact 80. Thus, the flashing relay 10FL is in operation so that the lamp L of signal 10 is intermittently energized by a circuit closed from (+), and including back contact 76 of relay 10AP, back contact 77 of relay 11HD, back contact 78 of flashing relay 10FL, lamp L, to (-). This flashing yellow indication of signal 10 advises the trainman that the second signal in advance is at stop and that he should govern his train accordingly.

As the train passes the signal 10, the directional stick relay 10S is picked up in a manner which will be readily understood by analogy to the description for directional stick relay 8S. Such energization of the directional stick relay 10S causes the closure of front contacts 156 and 165 to apply a steady negative energization to the line wires 84 and 85. This effects the steady energization of the relay 8HR and in turn picks up the relay 8HD. This releases the directional stick relay 8S and permits the operation of the signal 8 to a yellow indicating position, which in turn causes a steady positive energization of the line wires 110 and 111. If the operator has maintained relay 6RD picked up for east-bound traffic this would pick up the relay 6DP and allow the signal 6 to give a flashing yellow indication by reason of the front contact 16 causing the flashing relay 6FL to operate. Since both the contacts 16 and 112 would be open, the front contact 197 of the flashing relay 6FL could apply energy intermittently to the lamp L of signal 6.

As the east-bound train proceeds and approaches signal 12, it, of course, is approached lighted by reason of a circuit closed from (+), and including back contact 39 of relay 12AP, back contact 40 of relay 13HD, back contact 41 of relay 12DP, Lamp L of signal 12, to (-). This steady yellow illumination of the signal 12 advises the trainman that the next signal in advance is at stop. As the train proceeds past the signal 12 at the proper speed, the directional stick relay 12S is picked up. This applies a steady negative energization to the line wires 53 and 62 which is effective at signal 10 to release the directional stick relay 10S and cause a steady positive energization to be applied to the line wires 84 and 85 extending to signal 8. At signal 8 the line wires 110 and 111 are now supplied with opposite polarities alternately so that the signal 6 could be operated to a clear indicating position, if desired.

In the above description, it is assumed that the signal 14 is standing at stop so that the east-bound train approaches prepared to stop. Such east-bound train will, of course, await the orders of the tower B. The operator at tower B may hold the train at signal 14 until traffic conditions within his area are proper. Traffic illumination in the vicinity of the signal 14 may be illuminated in such a manner to distinctly clear the signal 14 to allow the train to proceed into its interlocking area. On the other hand, the operator at tower B may clear the signal 14 in anticipation of the arrival of the train so that as the train leaves the interlocking area at tower A it will receive all green high speed proceed indications.

In any event, when the train proceeds into the interlocking area at tower B, the signal 14 is placed at stop by the release of suitable track relays or by the manual restoration of the associated signal lever. In either case, the relay WFR is deenergized so that energy is applied to the line wires 19 and 20 in the manner previously described which results in the picking up of the relay 12HD and the release of the directional relay 12S.

In the above description, it will be noted that if the east-bound train proceeds past the signal 8, the directional stick relay 8S picks up and applies energy to the line wires 110 and 111. If manual manual or automatic means restores the relay 6RD to a deenergized position, the directional relay EFR is released and energy is also applied to the line wires at this location. These two energies oppose each other or add together as above described. But it should be noted that the energized condition of the relay 8S prevents any response of the relays 9HR and 9DR. Upon the continued passage of the train, energy is restored to the line wires 84 and 85 which picks
up the relay 8HD. This releases the directional stick relay 8S by opening back contact 118. Also, the closure of back contact 96 of the directional stick relay permits the signal 8 mechanism to be operated to the caution position in which the relay 8GP is energized. There is a short interval of time between the closure of back contact 96 and the picking up of the relay 8GYP during which the energy applied to the line wires 110 and 111 at the location of signal 6 can feed through back contacts 120 and 121 to the relays 9HR and 9DR. The picking up of either of these relays cannot energize the relay 9HD because of the open back contact 198 of relay 8HD. In this way, the signal 9 is prevented from being controlled during such a transition. As soon as the signal 8 responds and relay 8GYP picks up, then a positive steady energization is applied to the line wires 110 and 111 and the energy conflict takes place in such wires, as previously described.

In this way each directional stick relay applies energy to the line wires for the section in the rear of an occupied section and as the train progresses such energy is applied section by section and holds the condition thus established behind the train. For this reason it is apparent that the conditions for the last direction of traffic are maintained in spite of the fact that the operator at the entrance end, or automatic means, causes the restoration of the direction control relay at that end.

In connection with the above transition period just described, it is to be understood that the response of a signal followed by the energization of its green-yellow repeater relay 8YP is shorter than the release times for the HD relays and for this reason the progress of the train from section to section does not interrupt the control established behind it.

Although the above description is given more particularly from the standpoint of east bound train movements, it is to be understood that west bound train movements may be made in a similar way following an agreement between the operators at the towers A and B upon the establishment of west bound traffic. The operator at tower B by manipulation of his signal control lever for signal 15 effects the energization of the relay 15LD. This in turn closes its front contact 122 to energize the direction control relay WFR. The opening of back contacts 17 and 18 removes energy from the line wires 19 and 20 and causes the tumble-down of the circuit conditions previously established. This permits the energy applied at signal 6 to cause the circuits to build up section by section from that end and effect the energization of the line relays 15HR and 15DR in a manner analogous to that previously described for the opposite direction. This response of the line relays to the proper control in accordance with the existing conditions allows the signal 15 to clear and traffic to proceed in the usual way.

Although it is believed that this operation of the system for the establishment of west bound traffic will be readily understood by analogy, it may be helpful to point out the operation especially with respect to signal 9 of Fig. 3B. Assuming that the signal 7 is at stop, a steady negative energization is applied to the line wires 110 and 111 which effects the picking up of the relay 9HR following the release of the relay 8GYP as a result of the tumble-down of the circuits for east bound traffic. This energization of relay 9HR closes its front contact 199 and energizes relay 9HD since contact 198 of relay 8HD is now closed. The picking up of relay 9HD closes an energizing circuit for the mechanism of signal 9 from (+), through a circuit including front contact 200 of relay 9TR, back contact 201 of relay 9DP, mechanism of signal 9, back contact 202 of relay 9S, front contact 203 of relay 9HD, back contact 204 of relay 9DP, to (-), energizing the operation of the signal 9 contact 171 to the right to energize relay 9GYP which effects the application of steady energy to the line wires 84 and 85. This energy is in such a direction as to characterize a positive energization and controls the signal 9 to a yellow indicating position. The signal 9 is not illuminated since its circuit is opened by the approach relay 9AP when the line circuit conditions have been stabilized. Since all of the double intermediate signal locations are organized in a similar way, it is believed that further operations for the establishment of west bound traffic will be unnecessary.

Referring to Fig. 3B it will be noted that various interlocks are provided to prevent apparatus for opposing directions to respond at the same time. For example, energy is not applied to the line wires 110 and 111 unless it is assured that the signal 9 is at stop as indicated by the closure of back contact 175 of relay 9GP. A similar check is provided by back contact 174 of directional stick relay 9S. Likewise, the back contact 173 of relay 9FL assures that the flashing relay 9FL and its associated control is at stop conditions.

It is to be understood that the usual protective features may be employed with the system of the present invention to prevent the reversal of traffic direction inadvertently in front of an approaching train by the use of suitable timing means which prevents the reversal of traffic for a limited time after an entering signal has once been cleared and then returned to stop.

From the above description, it is also apparent that the system of the present invention may be readily used with centralized traffic control systems of the code type and since it requires a minimum number of controls. For example, all that is required to establish any particular direction of traffic is to send a signal control to the entrance end of the single track stretch and the direction of traffic is automatically set up. This is due to the fact that energy is normally applied to the line wires at both ends of the single track stretch and therefore is immediately available to allow the circuits to build up section by section when the energy at the entrance end is removed. In such a system, however, it is also desirable to provide check locking which may be provided by a separate circuit organization or may be provided at the central office on the control machine all in accordance with conventional practice.

Having thus described a block signalling system as one specific embodiment of the present invention, it is desired to be understood that this form is selected to facilitate the disclosure of the invention rather than to limit the number of forms which it may assume; and, it is to be further understood that various modifications, adaptations, and alterations may be applied to the specific form shown to meet the requirements of practice, without in any manner departing from the spirit or scope of the present invention.

What we claim is:

1. In a signal system for railroads, a stretch of track having signals for both directions at a plurality of spaced locations to divide said stretch into a plurality of sections, a pair of line wires extending through each of said sections between the signal locations at the opposite ends thereof, relay means at each signal location for each pair of line wires terminating at that location, a source of energy at each signal location, circuit means at each signal location for connecting said relay means to their respective pair of line wires, other circuit means governed by such relay means at a signal location in response to the energization of one of the relay means for one pair of line wires effective to disconnect the relay means from the other pair of line wires and instead connect said source of energy thereto, whereby the application of energy to the pair of line wires extending to either end of said stretch effects the energization of each successive pair of line wires in turn, said signal means actuates its corresponding relay means at each said signal locations, said other circuit means at each signal location being effective for selectively steadily energizing its pair of line wires with one polarity or the other or intermittently energizing its pair
of line wires with both polarities alternately depending upon the character of energization of the line wires for the preceding track section, and signal control circuit means at each signal location for controlling the signal for one direction or the other depending upon which of the relay means at that location is energized to give a distinctive signal indication for each different condition of its line circuit energization for the section over which such signal governs traffic.

3. In a signal system for railroads having a stretch of track or signal locations for governing traffic in both directions, respective pairs of line wires connecting successive signal locations, relay means associated with the respective pairs of line wires terminating at each signal location, a source of energy at each signal location, circuit means at each signal location governed in accordance with the energization of said relay means associated with either pair of line wires terminating at that location for disconnecting said relay means associated with the other pair of line wires terminating at that location and connecting said source thereto, whereby the application of energy to the pair of line wires extending to either end of said stretch effects the energization of the corresponding relay means at each of said signal locations for governing traffic toward that end of said stretch having energy applied to the line wires, other circuit means at each signal location for selecting the character of energization of the pair of line wires in accordance with the character of energization of the preceding pair, said other means being capable of steadily energizing the then connected pair with one polarity or the other or intermittently energizing such pair with both polarities alternately at a predetermined rate, and signal control circuit means controlled by said relay means at a signal location for governing traffic in accordance with the energization of said signals to give four different indications in accordance with the selective energization of the associated pair of line wires.

3. In a signal system for railroads, a stretch of track having signals for both directions at spaced signal locations along the stretch to divide said stretch into a plurality of sections, a pair of line wires extending through each section, relay means at each signal location associated with each pair of line wires terminating at that location, a source of energy at each signal location, circuit means at each signal location governed by the energization of one relay means for causing the disconnection of the other relay means from its pair of line wires and connecting said source of energy thereto, other circuit means at each signal location governed by said other relay means at that location upon its energization to disconnect said one relay means from its pair of line wires and connect said source of energy thereto, whereby the application of energy to the line wires at one end of said stretch effects the energization of said line wires for the successive sections for energizing the corresponding relay means at each of the several signal locations, and whereby the application of energy to the line wires at the opposite end of said stretch effects the energization of the pair of line wires for successive sections to energize the corresponding relay means at the signal locations for the opposite direction, an intermittently operable relay means at each signal location, a signal control circuit means at each location for controlling the indications of said relay means at that location for one direction or the other depending upon which of the two relay means at that location is energized, said signal control circuit means acting in response to a particular condition of energization of said relay means for causing said intermittently operable relay means to effect the flashing of the corresponding signal and at the same time to cause said line circuit for the adjoining section to be energized with opposite polarities alternately.

4. In a signalling system for railroads, apparatus at a signal location having two control line wires extending thereto, polarized relay means connected in said line wires and distinctly responsive to the polarity of energization of said line wires, a three position light signal mechanism normally biased to a particular position indicating stop, a flashing relay, circuit means controlled by said polarized relay means when steady energized with either polarity to cause said signal mechanism to be operated to a different position indicating caution and when intermittently energized with opposite polarities alternately to cause said signal mechanism to be operated to a third position indicating clear, a control circuit means effective to cause operation of said flashing relay when said polarized relay means is steady energized with a particular polarity, and circuit means controlled by said flashing relay for causing said signal mechanism to operate when in said position indicating caution while said line circuit is steadily energized with said particular polarity.

5. In a signalling system for railroads, a line circuit having steady positive energy, steady negative energy or intermittent positive and negative energy alternately applied thereto in accordance with traffic conditions, relay means connected to said line circuit and distinctively controlled to either of three different conditions in accordance with the characteristic energization of said line circuit, a light signal mechanism controlled by said relay means to operate to a position when said line circuit is steadily energized and to operate to a different position when said line circuit is intermittently energized, a flashing relay controlled by said relay means to operate when said line circuit is steadily energized with one polarity, a lamp in said signal mechanism, and circuit means governed by said relay means and said flashing relay for intermittently energizing said lamp when said line circuit is steadily energized with said polarity and for steadily energizing said lamp when said line circuit is steadily energized with the opposite polarity or is intermittently energized with opposite polarities alternately.

6. In a signalling system for railroads, a signal mechanism operable to different indicating positions including clear, caution, and danger, a flashing relay operated while said signal indicates clear and caution, a lamp in said signal circuit means for at times causing said lamp to be intermittently energized by said flashing relay, a line circuit extending to the rear of said signal and having positive or negative energy applied thereto in accordance with the then existing indication of said signal, and a circuit means governed by said flashing relay to intermittently reverse the connections of said line circuit when said signal indicates caution with its said lamp flashing and also when said signal indicates danger.

7. In combination, a section of railway track, a signal for governing traffic of said section, a pair of conductors extending through said section and having steady energy of one polarity or the other applied thereto at the exit end of such section in accordance with traffic conditions and having both polarities applied alternately at recurring intervals in response to a third traffic condition, two polarized relays connected in series to said pair of conductors at said signal location, said relays being respectively responsive to opposite polarities, a slow acting relay energized when either of said polarized relays is picked up and effective to be maintained picked up when said polarized relays are alternately picked up at recurring intervals, a repeating relay energized when one of said polarized relays is energized, another repeating relay energized when the other polarized relay is picked up and said first repeating relay is picked up, and signal control circuits for actuating a three indication signal to indicate stop when said slow acting relay is deenergized and to indicate one proceed indication when said slow acting relay is energized and said repeater relays are deenergized, to indicate another proceed indication when said slow acting relay is deenergized and said repeater relays are energized, said signal control circuits including a flashing relay set into operation by the energization of said first repeating relay and being effective to cause the flashing of said signal in its first proceed indicating position.

8. In a railway signal system, a stretch of track hav-
ing signals at spaced intervals for governing traffic in a particular direction through said stretch, a pair of line wires extending through each section between signal locations, two signal control relays of the polarized type connected to the pair of line wires extending through the section governed by their associated signal circuit means governed by said signal control relays for causing its signal to indicate stop when both of said signal control relays are steadily deenergized, to actuate said signal to a first proceed indication position when one of said signal control relays is steadily energized, to actuate said signal to a second proceed indication when the other of said signal control relay is steadily energized and to actuate said signal to a second indicating position when said two signal control relays are energized alternately, a flasher relay at each signal location, circuit means for setting said flasher relay into operation whenever said other signal control relay is energized with said other polarity, said circuit means for controlling said signals causing said signal to flash said first proceed indication when said flashing relay is set into operation by said other polarity, and circuit means at each signal location for causing energy of one polarity to be applied to the pair of line wires extending to the rear of that signal location when that signal indicates stop, and causing the other polarity to be applied to said line wires when said signal is giving said first proceed indication, and causing said opposite polarities to be alternately applied at intervals to said such line wires when that signal is giving the first proceed indication but is being flashed, said means also acting to similarly apply said opposite polarities alternately when the signal at that location is giving said third proceed indication.

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