Nov. 9, 1937. R. A. McCANN 2,098,829

RAILWAY SIGNALING

Filed June 10, 1933 2 Sheets-Sheet 1

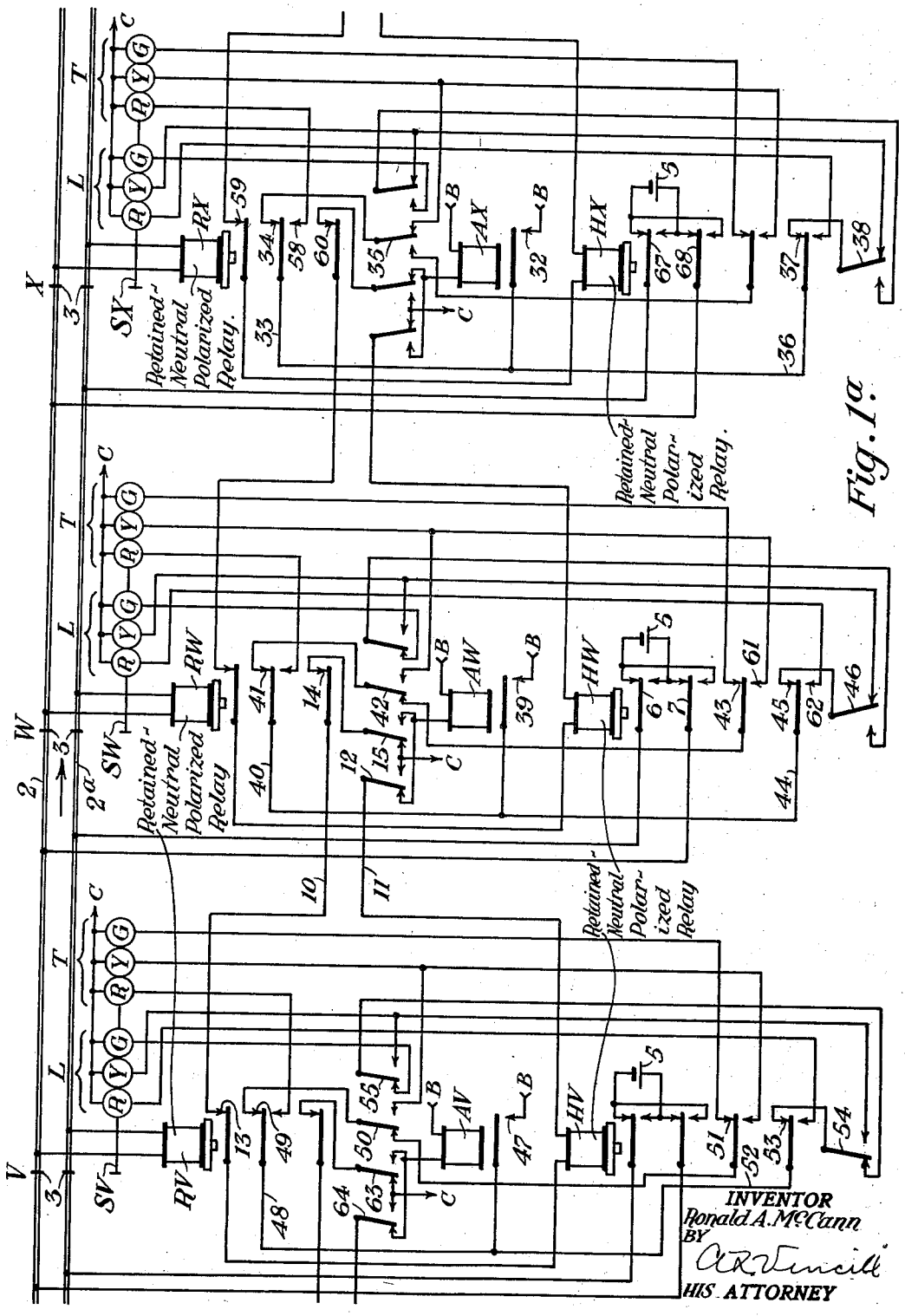


Fig. 1a.

Nov. 9, 1937. R. A. McCANN 2,098,829

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Filed June 10, 1933 2 Sheets-Sheet 2

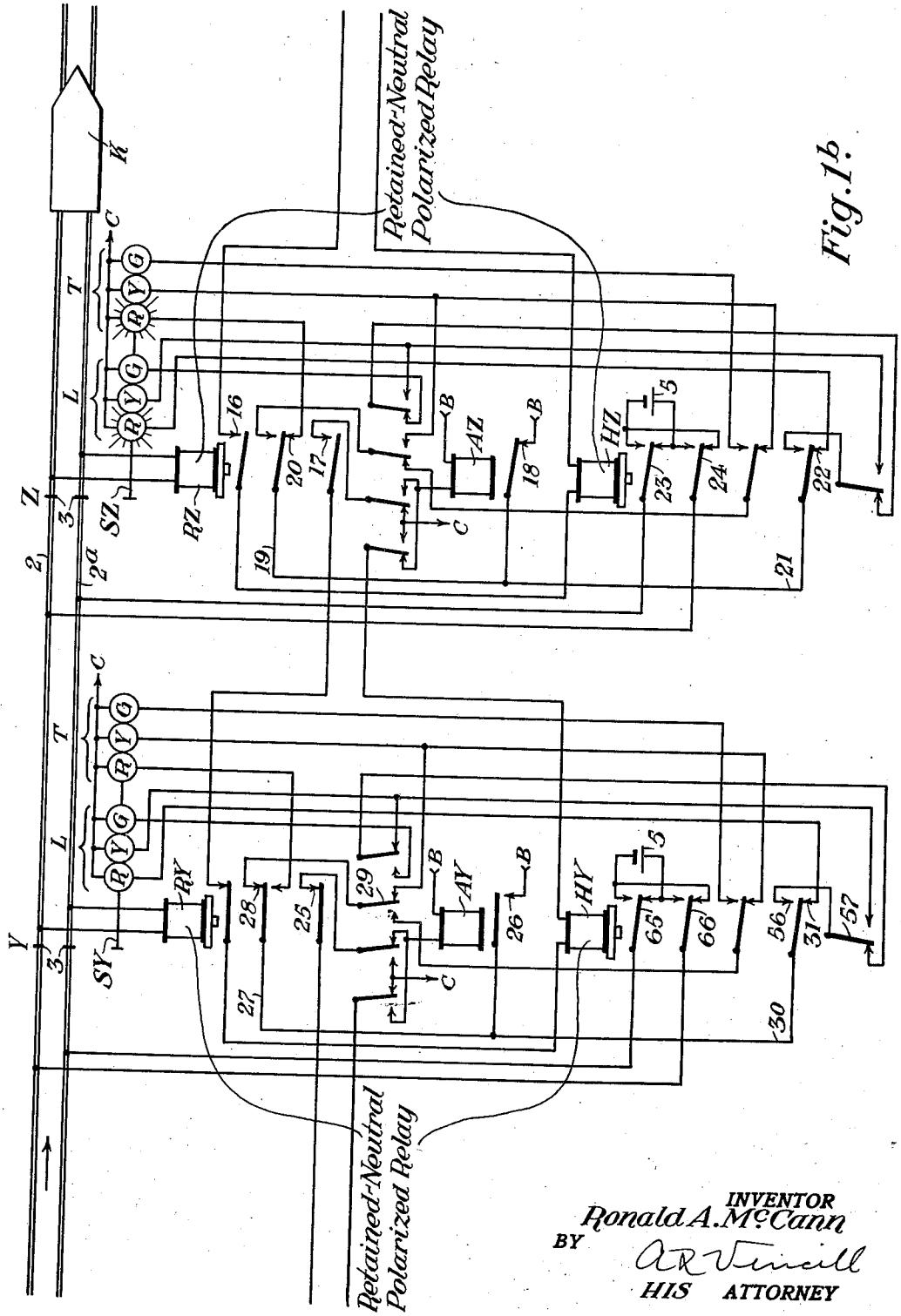


Fig. 1b.

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RAILWAY SIGNALING

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Application June 10, 1933, Serial No. 675,246

32 Claims. (Cl. 246—46)

My invention relates to railway signaling, and particularly to signaling involving wayside signals located along a trackway for governing the passage of trains.

A feature of my invention is the provision of novel and improved apparatus for establishing a distinctive control for each of four track sections in the rear of an occupied section. Each distinctive control is effective to cause a corresponding aspect of the wayside signals, whereby there is produced a four block, five indication, system of signaling. A further feature of my invention is the provision of apparatus for controlling wayside signals in such a manner that trains are kept moving by signal indication in the event of broken line wires, and which apparatus will prevent an improper signal aspect resulting from a broken line wire. Other features and advantages of my invention will appear as the specification progresses.

I will describe one form of apparatus embodying my invention, and will then point out the novel features thereof in claims.

In the accompanying drawings, Figs. 1[a] and 1[b], are diagrammatic views which, when placed end to end in the order named, illustrate one form of apparatus embodying my invention.

Referring to the drawings, the reference characters 2 and 2[a] designate the traffic rails of a stretch of railway track along which traffic normally moves in the direction indicated by the arrows. These rails are divided by the usual insulated rail joints 3 into a plurality of track sections V—W, W—X, X—Y, Y—Z, etc.

Each track section is provided with a track circuit which comprises the traffic rails in series and which includes a track battery 5 connected across the track rails at one end of the section and a track relay R, with a suffix corresponding to the location, connected across the rails at the other end of the section. The winding of each track relay R is connected directly with the traffic rails as will be readily understood by an inspection of Figs. 1[a] and 1[b]. The track battery 5 for each section is reversibly connected with the track rails by pole-changing contacts of a line relay for the next section in advance. For example, the track battery 5 of the section V—W is normally connected with the traffic rails 2 and 2[a] over the front contacts of the neutral armatures 6 and 7 of a line relay HW, to be referred to later, to supply current of one polarity, and which polarity I shall refer to in the following description as being of normal polarity. At such time as the line relay HW is deenergized, the connection of the battery 5 with the traffic rails is reversed at the back contacts of the neutral armatures 6 and 7 to supply current of the opposite polarity, and which polarity I shall refer to as being of reverse polarity. The track relay RV for the section V—W, when energized with current of normal polarity, will shift its polar armatures 50, 55, 63 and 64 into engagement with their respective left-hand contacts, that is, to the position shown in Fig. 1[a]. When the relay RV is energized with current of reverse polarity, the polar armatures will be shifted into engagement with their respective right-hand contacts, that is, to the position opposite that shown in Fig. 1[a]. Each of the remaining track batteries of my system is connected with the rails of the associated section in the same manner as just described for battery 5 of section V—W, and each of the remaining track relays responds to the polarity of the current supplied to the associated track section in the same manner as just described for the track relay RV.

Each track section is also provided with a line circuit comprising a pair of line wires connected with a line relay located at one end of the section, and designated by the reference character H with a suffix corresponding to the location, and with a source of current located at the opposite end of the section. Again referring to the section V—W for illustration, the line circuit comprises the line wires 10 and 11 which are connected with the two terminals of the winding of the line relay HV at the entrance of this section, a front contact 13 of the associated track relay RV being interposed between the line wire 10 and the corresponding terminal of the winding of relay HV. At the exit end of the section V—W, the line wires 10 and 11 are reversibly connected with a current source through the medium of the track relay RW for the section next in advance. To be explicit, this line circuit normally extends from the B terminal of a convenient source of direct current, such as a battery not shown, through the winding of an approach lighting relay AW to be referred to later, left-hand contact of the polar armature 12 of relay RW, line wire 11, winding of relay HV, front contact 13 of relay RV, line wire 10, front neutral contact 14 of relay RW, the left-hand contact of a second polar armature 15 of relay RW, and to the opposite terminal C of the current source. At such time as the track relay RW is energized with current of reverse polarity and its polar armatures 12 and 15 are shifted into engagement with their respective right-hand contacts, the current supplied to the above line cir-

cuit is reversed. In order to clarify the description, I shall refer to the polarity of the current supplied over the left-hand contacts of the polar armatures 12 and 15 as being of normal polarity, and that supplied over the right-hand polar contacts as being of reverse polarity. The line relay HV, when energized with current of normal polarity shifts its polar armature 54 into engagement with its left-hand contact, that is, to the position illustrated in Fig. 1a. When relay HV is supplied with current of reverse polarity, its polar armature 54 is shifted into engagement with its right-hand contact, that is, to the position opposite that illustrated in the drawings. Each of the remaining track sections of my system is provided with a line circuit controlled in the same manner as just explained for the line circuit of section V—W.

To sum up thus far, each track section is provided with a polarized track circuit and a polarized line circuit. The track circuit receives current at all times, and the polarity of the current is determined by the energized or deenergized condition of the line relay for the section next in advance. The line circuit is deprived of current, when either the track relay for the same section or the track relay for the section next in advance is deenergized, and the polarity of the current supplied to the circuit is determined by the position of the polar armatures of the track relay for the section next in advance.

The track relays R and the line relays H are preferably of the retained-neutral polarized type having slow to pick up characteristics. The structure of such relays may take different forms but a preferred form is that disclosed and claimed in a copending application for Letters Patent of the United States, Serial No. 638,718, filed October 20, 1932, by A. E. Dodd, for Electrical relays. It is deemed sufficient for the present application to state that, whereas with ordinary polarized relays the neutral armature must release and then pick up during each period of reversal of the current supplied to the winding; with relays of the retained-neutral polarized type the neutral armatures are held in engagement with their front contacts during the period of ordinary pole-changing, but should the absence of current exist for a period greater than that ordinarily required to pole change the circuit, the neutral armatures are released. Furthermore, the structure of these relays is such that the neutral armatures are not brought into engagement with their front contacts until energy has been supplied to the winding for a predetermined interval. The functions of these characteristics with which the track and line relays are provided will appear as the specification progresses.

Each track section is preferably provided with an approach lighting relay designated by the reference character A with a suffix corresponding to the location. These relays are preferably direct current neutral relays and the winding of each approach lighting relay is interposed in the line circuit for the track section to the rear. In describing the line circuit for the section V—W, it was pointed out that the winding of the approach lighting relay AW is included in the connection between the B terminal of the source of current and the line wire 11 or 10, as the case may be, and hence the relay AW is energized whenever current flows in this line circuit irrespective of the polarity of the current, and is deenergized whenever the circuit is open. Each of the remaining approach lighting relays A is controlled in the same manner. The function of the approach lighting relay will appear when the operation of the system is described. It will be understood, however, that my invention is not limited to approach lighting of the signals, and these relays A may be omitted if found desirable.

To govern the passage of trains through the stretch of railway, a wayside signal designated by the reference character S with an appropriate exponent is located at the entrance of each track section. Each of these signals comprises a top unit T and a lower unit L. These units may take any one of several forms of signal mechanism such as the semaphore, color light, search light, or position light. As here illustrated, each unit is a color light signal capable of displaying a green light G, a yellow light Y and a red light R.

The manner in which the aspects of these signals are controlled will best be understood by tracing the circuits and explaining the operation of the apparatus simultaneously.

A train is indicated diagrammatically at K in the section immediately to the right of location Z. The train shunt of train K will deenergize the track relay RZ in the usual manner. The line relay HZ will be without energy due to the front contact 16 of relay RZ being open, and the line circuit for the section Y—Z will be without current due to the front contact 17 of relay RZ being open. Hence, both the line relays HZ and HY and also the approach lighting relay AZ are deenergized as long as the train K occupies the section illustrated in Fig. 1b.

All three relays RZ, HZ and AZ being deenergized, current will flow from the terminal B of the current source over the back contact 18 of the approach lighting relay AZ, wire 19, back contact 20 of relay RZ, lamp R of the top unit T of signal SZ and thence to the C terminal of the current source; and the R lamp of that unit will be illuminated. Current will also flow from the B terminal of the current source over the back contact 18 of relay AZ, wires 19 and 21, back contact 22 of the line relay HZ, the R lamp of the lower unit L of signal SZ and thence to the C terminal of the current source; and that lamp will be illuminated. It follows that the signal SZ will display the R lamp of each of its two units. That is to say, as long as the train K occupies the section immediately in advance of the signal SZ, the aspect of that signal is a red light above a red light to indicate "stop".

The connection for the track circuit of the section Y—Z next in the rear of the section occupied by the train K will be over the back contacts of the neutral armatures 23 and 24 of the line relay HZ, and hence the track relay RY will now be energized with current of reverse polarity to shift its polar armatures into engagement with their right-hand contacts as illustrated in Fig. 1b. Since the line circuit for the section Y—Z is open at the front contact 17 of the track relay RZ, the line relay HY will be deenergized as illustrated in the drawings. The track relay RY being energized, the line circuit for the section X—Y will be supplied with current and the approach lighting relay AY will be picked up. Consequently, at the location Y, the track relay RY will be energized in its reverse position, the line relay HY will be deenergized, and the approach lighting relay AY will be picked up.

Assuming that a second train enters the sec-

tion X—Y and shunts its track relay RX with the result that the line circuit for that section is open at the front contact 59 of relay RX, the approach lighting relay AY will be deenergized. Current will now flow from the terminal B of the current source at location Y over the back contact 26 of approach lighting relay AY, wire 27, front contact 28 of track relay RY, right-hand contact of polar armature 29, lamp Y of the top unit T of signal SY and to the opposite terminal C of the current source; and lamp Y of that unit will be illuminated. Current will also flow from the B terminal of the current source over the back contact 26, wires 27 and 30, back contact 31 of the line relay HY, lamp R of the lower unit L of signal SY and to the opposite battery terminal C; and lamp R of that unit will be illuminated. The aspect of the signal SY will, therefore, be a yellow light above a red light to indicate to this train I have assumed to be approaching the location Y, "prepare to stop at next signal".

Considering next the condition of the track and the line circuits for the section X—Y, the second section to the rear of the section occupied by the train K, the line relay HY being deenergized, the connection for the track circuit for the section X—Y will be over the back contacts of the neutral armatures 65 and 66 of relay HY. Consequently, the track relay RX will be energized with current of reverse polarity to shift its polar armatures to the right-hand position as illustrated in Fig. 1a. The track relay RY being energized with its polar armatures in the reverse position, the current supplied to the line circuit for the section X—Y will be of reverse polarity and the line relay HX will, therefore, be energized with its polar armature 38 in engagement with its right-hand contact as illustrated in Fig. 1a. It is to be seen, therefore, that with train K occupying the section illustrated in Fig. 1b, both relays RX and HX will be energized in the reverse position and relay AX will be picked up.

On the assumption that a following train now enters the section W—X and shunts the track relay RW to open the line circuit for the section W—X and deenergizes the approach lighting relay AX, current will flow from the B terminal of the current source at location X over the back contact 32 of relay AX, wire 33, front contact 34 of track relay RX, right-hand contact of the polar armature 35, lamp Y of the top unit T of signal SX and to the opposite terminal C of the current source; and the lamp Y of that unit will be illuminated. At the same time, current will flow from the B terminal of the current source over the back contact 32, wires 33 and 36, front contact 37 of line relay HX, right-hand contact of the polar armature 38 of relay HX, lamp Y of the lower unit of signal SX and to the opposite terminal C of the current source; and the lamp Y of that unit will be illuminated. The aspect of the signal SX will, therefore, be a yellow light above a yellow light to indicate to the train approaching the location X "proceed at not exceeding medium speed".

I shall next consider the condition of the track and line circuits for the section W—X, the third section to the rear of the section occupied by the train K. The line relay HX is energized so that the connection of the track battery 5 at the location X is over the front contacts of the neutral armatures 67 and 68 of relay HX, and hence the track relay RW is energized with current of normal polarity to shift its polar armatures to the left-hand position as illustrated in Fig. 1a. The track relay RX being energized in the reverse position, the line circuit for the section W—X is supplied with current of reverse polarity, and the line relay HW shifts its polar armature 46 to the right-hand position as illustrated in Fig. 1a. Hence, at location W, the track relay RW is energized in its normal position, and the line relay HW is energized in its reverse position.

Assuming the approach lighting relay AW to be deenergized in response to a train entering the section V—W, current will flow from the B terminal of the current source at location W over the back contact 39 of relay AW, wire 40, front contact 41 of relay RW, left-hand contact of polar armature 42, front contact 43 of line relay HW, lamp G of the top unit T of signal SW and to the opposite terminal C of the current source; and the lamp G of that unit will be illuminated. Current also will flow from the terminal B of the current source over back contact 39, wires 40 and 44, front contact 45 of relay HW, right-hand contact of polar armature 46, lamp Y of the lower unit L of signal SW and to the opposite terminal C of the current source; and the lamp Y of that unit will be illuminated. It follows that the aspect of the signal SW will be a green light above a yellow light to indicate to a train approaching the location W "approach next signal at not exceeding medium speed".

Considering next the condition of the track and line circuits for the section V—W, the fourth section to the rear of the section occupied by the train K, the line relay HW is energized so that the connection of the track battery 5 with the traffic rails of the section V—W is over the front contacts of the neutral armatures 6 and 7, and the track relay RV is energized with current of normal polarity. The track relay RW being energized with current of normal polarity, the current supplied to the line circuit for the section V—W is of normal polarity and the line relay HV is energized in its normal position. Hence, at the location V, both the track relay RV and the line relay HV are in their normal positions.

Going on the assumption that the approach lighting relay AV is deenergized in response to a train occupying the section to the left of the location V, current will flow from the battery terminal B over back contact 47 of relay AV, wire 48, front contact 49 of relay RV, left-hand contact of polar armature 50, front contact 51 of line relay HV, lamp G of the top unit T of signal SV and to the battery terminal C; and lamp G of that unit will be illuminated. Current will also flow from battery terminal B over back contact 47, wires 48 and 52, front contact 53 of relay HV, left-hand contact of polar armature 54 of relay HV, left-hand contact of polar armature 55 of track relay RV, lamp G of the lower unit L, and to battery terminal C; and the lamp G of that unit will be illuminated. The aspect of the signal SV will, therefore, be a green light above a green light to indicate "clear".

From the foregoing description, it is evident that a distinctive control condition is provided for each of the four successive track sections to the rear of an occupied section. These control conditions may be summed up as follows: The track circuit for the section occupied is shunted in the usual manner to open both the track and line relays of that section. The first section to the rear of the occupied section has its track

circuit supplied with current of reverse polarity and its line circuit deenergized. The second section has its track circuit and its line circuit both supplied with current of reverse polarity. The third section has its track circuit supplied with current of normal polarity, and its line circuit with current of reverse polarity. The fourth section has both its track and line circuits supplied with current of normal polarity. From these different control conditions, five different signal aspects are obtained, namely, a red light above a red light at the first signal to the rear of a train to indicate "stop", a yellow light above a red light at the second signal to the rear of a train to indicate "prepare to stop at the next signal", a yellow light above a yellow light at the third signal to the rear of a train to indicate "proceed at not exceeding medium speed", a green light above a yellow light at the fourth signal to indicate "approach next signal at not exceeding medium speed", and a green light above a green light at the fifth signal to the rear of a train to indicate "clear".

It should be observed that the track relay controls all lamps of the top unit of the associated signal, the green and yellow lamps over a polar armature, and that it also controls the green lamp of the lower unit over a polar armature. Consequently, the green lamp of the lower unit cannot be displayed unless the polar armature of the track relay is in a position to close the circuit for the green lamp of the top unit.

Although a specific combination of lights is here set forth for the different signal aspects, it will be understood that my invention is not limited to this one arrangement and other combinations of lights may be obtained should some other arrangement of aspects seem desirable.

The function of the retained-neutral and the slow to pick up features of the track and line relays will now be pointed out. The signal SX displays a yellow light above a yellow light to a train in the section W—X as long as the train K occupies the section to the right of location Z. I shall now assume that while a following train is approaching the signal SX, the train K moves on out of the section to the right of location Z. Under these conditions, the picking up of the line relay HY pole changes the track circuit for the section X—Y, and the track relay RX is deenergized and then reenergized in its normal direction causing its polar armature to be shifted from the right-hand position to the left-hand position. The position of the track relay RY is not changed at this time, and, consequently, the position of the line relay HX is not changed. Shifting the polar armature **35** of the track relay RX shifts the signal control circuit from that for the Y lamp of the top unit T of signal SX to the circuit for the G lamp of the top unit T. The circuit for the Y lamp of the lower unit L is not changed inasmuch as no change takes place in the position of the line relay HX. It follows that the aspect of the signal SX is changed from that of a yellow light above a yellow light to that of a green light above a yellow light. The "retained-neutral" feature of the track relay RX prevents the back contact **56** from becoming momentarily closed to give a momentary flashing of the R lamp of the top unit T. That is, false signal flashing of the signal SX is avoided. Furthermore, the retained-neutral feature of relay RX prevents the front contacts **59** and **60** from momentarily opening the circuits for the line relays HX and HW during the pole changing of the track circuit for section X—Y. The energization of these line relays not being disturbed, successive tumble-down of the signal circuits for the sections to the rear of location X is avoided.

It has been pointed out hereinbefore that the signal SW displays a green light above a yellow light during the time the train K occupies the section illustrated in Fig. 1b. I shall now assume that while a following train is approaching the signal SW, the train K moves on and vacates the section to the right of location Z. Under these conditions, the energization of the track relay RX is changed from reverse to normal when the line relay HY is picked up, and the track relay RX, in turn, pole changes the line circuit for the relay HW and the energization of that relay is changed from reverse to normal. The line relay HX does not change its position at this time and hence no change takes place in the track relay RW. The shifting of the polar armature **46** of line relay HW from its right-hand position to its left-hand position transfers the signal control circuit from that for the Y lamp of the lower unit of signal SW to that for the G lamp. The retained-neutral feature of the relay HW prevents the back contact **61** from being momentarily closed to flash the Y lamp of the top unit T, and also prevents the back contact **62** from being momentarily closed to flash the R lamp of the lower unit, that is, false signal flashing is avoided. Furthermore, the front contacts of the neutral armatures **6** and **7** being retained closed, successive tumble-down of the signal circuits to the rear of location W is avoided.

A short train passing from one section into a next may fully vacate the rear section before the track relay for the section just entered is released. Under such traffic conditions, the track relay for the section vacated may pick up before the track relay for the section just entered is shunted, and when this occurs with the usual type of relays, a momentary loss of control is the result. I have found that the slow to pick up feature of the type of relays here proposed is sufficient to assure that the track relay of the section being vacated by a short train will not pick up during the ordinary delay encountered in the shunting of a track relay. It follows, that this slow to pick up feature of the relays here proposed assures that no loss of control and momentary display of an improper signal will occur. It is evident from the above discussion that signal flashing, successive tumble-down of the control circuits and momentary loss of control are avoided by the retained-neutral and slow to pick up features by the track and line relays without the need of the usual additional repeater relays.

It is to be noted that a broken line wire for the section Y—Z while the train K occupies the section illustrated in Fig. 1b will make no change in the indication displayed by the signal SY due to the fact that the line circuit for this section is open at the front contact **17** of the track relay of the section occupied. A broken line wire for the section X—Y, while the train K occupies the section to the right of location Z, will cause the line relay HX to be down and display the lamp R of the unit L for signal SX in place of the lamp Y. Hence, under the above cited traffic conditions, a broken line wire will result in the signal SX displaying the more restricted indication "prepare to stop at next signal" in place of the usual indication "proceed at not exceeding

medium speed". The line relay HX being down, if a broken line wire occurs, the track circuit for the section W—X will be supplied with current of reverse polarity and hence the track relay RW and the line relay HW will both be energized in the reverse position, and the aspect of the signal SW will be a yellow light above a yellow light, which is its proper aspect when the signal SX indicates "prepare to stop at next signal".

Again, a broken line wire for the section W—X while the train K occupies the section illustrated in the drawings will deenergize the line relay HW and cause the R lamp of the lower unit L of signal SW to be illuminated in place of the lamp Y, and will illuminate the Y lamp of the top unit T in place of the green lamp G. It follows that under the above cited traffic conditions and a broken line wire, the signal SW displays a yellow light above a red light in place of a green light above a yellow light, and thereby indicates the more restricted speed condition of "prepare to stop at the next signal". By an analysis of the circuits for the section V—W, it is clear that a broken line wire for that section will result in the signal SV displaying a yellow light above a red light similar to that already described for the remaining signals. It is to be seen, therefore, that a broken line wire under any traffic condition will not result in the display of a false combination of lights. The aspect established as the result of a broken line wire will in each case be that for indicating "prepare to stop at next signal". From the above, it is apparent that in the case of a complete failure of the line circuits, trains will be permitted to run at restricted speeds by signal indication.

Apparatus such as here proposed provides a simple arrangement for a four block, five indication, railway signal system without the need of additional repeater relays of the slow release type and the slow to pick up type to avoid signal flashing, tumble-down of control circuits, and loss of control. It will be understood, however, that the polarized track circuit and polarized line circuit control here proposed may be used to govern relays not provided with the retained-neutral and slow to pick up features should it seem desirable. In this latter case, the usual repeater relays or their equivalents, would be employed.

Although I have herein shown and described only one form of apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. A railway signal system comprising, a stretch of railway track divided into sections, a track circuit for each section including the traffic rails, a line circuit for each section, a polarized track relay for each track circuit, a polarized line relay for each line circuit, means controlled by each track relay for supplying to the line circuit for the section next in the rear of the associated section current of one polarity or of the other polarity for controlling the relay of that line circuit, means controlled by each line relay for supplying to the track circuit for the section next in the rear of the associated section current of one polarity or of the other polarity for controlling the relay of that track circuit, and traffic governing means for governing the passage of trains along said stretch controlled by said track and line relays.

2. A railway signal system comprising a stretch of railway track divided into sections, two polarized relays for each section, a track circuit for controlling one of said relays and including the traffic rails of the associated section, a line circuit for controlling the other of said relays and including a pair of line wires, means controlled by the relay associated with the track circuit for reversibly supplying current to the line circuit for the section next in the rear of the associated section, means controlled by the relay associated with the line circuit for reversibly supplying current to the track circuit for the section next in the rear of the associated section, and signaling means for each section controlled jointly by said two relays of the section.

3. A railway signal system comprising, a stretch of railway track divided into sections, a track circuit for each section including the traffic rails, a line circuit for each section including a pair of line wires, a polarized track relay for each track circuit, a polarized line relay for each line circuit, means controlled by each track relay for supplying to the line circuit for the section next in the rear of the associated section current of one polarity or of the other polarity for controlling its line relay, means controlled by said line relay for supplying to the track circuit for the second section in the rear of said associated section current of one polarity or of the other polarity for controlling the track relay of said track circuit, and traffic governing means for governing the passage of trains along said stretch controlled by the track and line relays.

4. A railway signal system comprising, a stretch of railway track divided into sections, a track circuit for each section including the traffic rails, a line circuit for each section, an electroresponsive means for each track circuit and for each line circuit, said electroresponsive means each being selectively responsive to the polarity of the current supplied thereto, means controlled by each track circuit electroresponsive means for supplying to the line circuit for the section next in the rear of the associated track section current of one polarity or of the other polarity in accordance with traffic conditions in advance for controlling the electroresponsive means of said line circuit, means controlled by each line circuit electroresponsive means for supplying to the track circuit for the section next in the rear of the associated section current of one polarity or of the other polarity in accordance with the condition of the governing track circuit electroresponsive means for controlling the electroresponsive means of said track circuit, and traffic governing means for governing the passage of trains along said stretch controlled by the track and line electroresponsive means.

5. A railway signal system comprising, a stretch of railway track divided into sections, two electroresponsive means for each section each being selectively responsive to the polarity of the current supplied thereto, a track circuit for controlling one of said electroresponsive means and including the traffic rails of the associated section, a line circuit for controlling the other of said electroresponsive means and including a pair of line wires, means governed by the electroresponsive means associated with the track circuit for reversibly supplying current to the line circuit for the section next in the rear in accordance with traffic conditions in advance, means gov-

erned by the electroresponsive means associated with the line circuit for reversibly supplying current to the track circuit for the section next in the rear in accordance with other traffic conditions in advance, and signaling means for each section jointly controlled by the two electroresponsive means of the section.

6. A railway signal system comprising a plurality of successive sections of railway track, two electroresponsive means for each section each selectively responsive to the polarity of the current supplied thereto, a track circuit for each section for controlling one of its electroresponsive means and including the traffic rails, a line circuit for each section for controlling the other of its electroresponsive means, traffic governing means for each section controlled jointly by the two associated electroresponsive means, means governed by the track circuit electroresponsive means of each section for supplying to the line circuit for the section next in the rear of the associated section current of one polarity or of the other polarity in accordance with traffic conditions in advance, and means governed by the line circuit electroresponsive means of each section for supplying to the track circuit for the section next in the rear of the associated section current of one polarity or of the other polarity in accordance with the condition of the track circuit electroresponsive means governing said line circuit.

7. A railway signal system comprising; a first, a second and a third consecutive track section over which traffic normally progresses in the order named; a track circuit for each section responsive to traffic conditions of its section, a polarized track relay governed by the track circuit of the first section, a line relay for controlling the polarity of the current supplied to the track circuit of said first section and arranged to supply current of normal polarity when energized and to supply current of reverse polarity when deenergized, means controlled by the track circuit of said second and third track sections for governing said line relay and arranged to energize said relay when and only when both of said sections are unoccupied, and a wayside signal to govern traffic through the first section controlled by said track relay.

8. A railway signal system comprising; a first, a second and a third consecutive track section over which traffic normally progresses in the order named; a track circuit for each section including the traffic rails of the section, a line circuit for each section, a polarized track relay for each track circuit, a polarized line relay for each line circuit, means controlled by a train occupying the third section to deenergize both the track and line relays of that section and to open the line circuit for the second section, means governed by the line relay for the third section when deenergized to supply current of reverse polarity to the track circuit of the second section, means governed by the line relay for the second section when deenergized to supply current of reverse polarity to the track circuit for the first section, means governed by the track relay of the second section when reversed to supply current of reverse polarity to the line circuit for the first section, a signal for the third section caused to indicate stop when its track and line relays are both deenergized, a signal for the second section caused to indicate a restrictive indication when its track relay is reversed and its line relay is deenergized, and a signal for the first section caused to indicate a less restrictive indication when both its track and line relays are reversed.

9. A railway signal system comprising; a first, a second, a third and a fourth consecutive track section over which traffic normally progresses in the order named; a track circuit for the fourth section responsive to traffic conditions of that section, a track relay for said track circuit and deenergized in response to a train occupying said fourth section, a line circuit including a line relay for the third section governed by said track relay and deenergized when said relay is deenergized, a track circuit for the second section having a polarized track relay, means governed by said line relay of the third section when deenergized to supply current of reverse polarity to the track circuit of the second section to energize its relay in a reverse position, a line circuit for the first section including a polarized line relay, means governed by the track relay of said second section when reversed to supply current of reverse polarity to the line circuit of the first section to energize its relay in a reverse position, and a signaling means rendered active by the reverse position of the last mentioned line relay.

10. A railway signal system comprising; a first, a second, a third and a fourth consecutive track section over which traffic normally progresses in the order named, a track circuit for each of said track sections responsive to traffic conditions of its section, a first polarized line relay governed by the track circuits of the third and fourth sections and energized when and only when those sections are both unoccupied, neutral armatures controlled by said line relay for pole-changing the track circuit of the second track section, a polarized track relay governed by the track circuit of the second section, a second polarized line relay, polar armatures controlled by said polarized track relay for pole-changing the line circuit for said second polarized line relay, means governed by the track circuit of the first track section for closing said line circuit only when said first section is unoccupied, and a signal controlled by said second polarized line relay.

11. A railway signal system comprising, a stretch of railway track divided into sections, two polarized relays for each section, a track circuit including the traffic rails for governing one of said relays, a line circuit for governing the other of said relays, means controlled by the relay governed by the track circuit for selectively supplying current of normal or reverse polarity or supplying no current to the line circuit for the section next to the rear, means controlled by the relay governed by the line circuit for selectively supplying current of normal or reverse polarity to the track circuit for the section next to the rear; and a signal controlled by the two relays of a section and arranged to have a first aspect when both relays are deenergized, a second aspect when the track relay is energized reverse and the line relay is deenergized, a third aspect when both relays are energized reverse, a fourth aspect when the track relay is energized normal and the line relay is energized reverse and a fifth aspect when both relays are energized normal.

12. A railway signal system comprising; a first, a second, a third and a fourth track section over which traffic normally progresses in the order named, two polarized relays for each section, a track circuit for governing one of said relays, a line circuit for governing the other of said relays, means controlled by the track relay of the fourth section for discontinuing the supply of current

to the line circuit for the third section when the fourth section is occupied, means including a back neutral contact of the line relay for the third section for supplying current of reverse polarity to the track circuit for the second section, means including a reverse polar contact of the track relay for the second section for supplying current of reverse polarity to the line circuit for the first section, a signal for said first section, means including a reverse polar contact of the line relay for the first section to render said signal active whereby said signal indicates that the fourth section is occupied.

13. A railway signal system comprising, a track section, a signal to govern traffic through said section and capable of assuming several distinctive aspects, a polarized track relay, a polarized line relay, operating circuits including neutral and polar contacts of said relays for selectively establishing the different aspects of said signal, a track circuit including the traffic rails of the section for governing said track relay, a line circuit for governing said line relay, a pole-changer for reversibly supplying current to the line circuit, a first traffic controlled means responsive to traffic conditions immediately in advance of the section to govern said first pole-changer, a second pole-changer for reversibly supplying current to the track circuit, and a second traffic controlled means responsive to traffic conditions in advance of the section more remote than said first traffic controlled means for governing said second pole-changer.

14. A railway signal system, comprising, a stretch of railway track divided into track sections, a track circuit for each section responsive to traffic conditions of its sections, a polarized track relay governed by each track circuit, a line circuit for each section, a polarized line relay governed by each line circuit, contacts operated by each track relay to pole change the line circuit for the section next in the rear of the section associated with the track relay, contacts operated by each line relay to pole-change the track circuit for the section next in the rear of the section associated with said line relay, a signal for each section having several different aspects controlled by the track and line relays of the same section, and said track and line relays each characterized by retaining its neutral armatures in engagement with front contacts during periods of pole-changing the controlling circuit whereby signal flashing is avoided.

15. A railway signal system comprising, a stretch of railway track, a signal to govern traffic through the stretch comprising two units each having three different conditions, said units capable of different combinations of conditions to form five distinctive aspects to indicate five different traffic conditions of the stretch, two direct current polarized relays, means for selectively controlling the conditions of the top unit including a neutral and a polar armature of one of said relays, means for selectively controlling the conditions of the lower unit including a neutral and a polar armature of the other relay, a first circuit means responsive to certain traffic conditions of the stretch and including a pole-changer for governing one of said relays, a second circuit means responsive to other traffic conditions of the stretch and including a pole-changer for governing the other relay, and said relays each characterized by retaining its neutral armature in engagement with the front contact during pole-changing periods of its controlling circuit means whereby signal flashing is avoided.

16. A railway signal system comprising, a stretch of railway, a signal to govern traffic through the stretch and which includes several different lamps each adapted to display a distinctive color to form distinctive aspects to indicate different traffic conditions of the stretch, a direct current polarized relay, circuit means for selectively controlling the different lamps of the signal including a front contact and a back contact of a neutral armature and a normal and a reverse contact of a polar armature of said relay, a track circuit including the traffic rails of the stretch to supply current for the energization of said relay, other traffic controlled means for governing the polarity of the energization of said relay including a pole-changer, and said relay being characterized by retaining its neutral armature in engagement with its front contact during pole-changing periods of said other traffic controlled means and by slow pickup of its neutral armature out of engagement with its back contact when said stretch is vacated by a train and the relay is energized, whereby signal flashing and improper control of said signal lamps are avoided.

17. A railway signal system comprising, a stretch of railway track divided into track sections, a track circuit for each section including the traffic rails of the section, a line circuit for each section including a pair of line wires, a polarized track relay governed by each track circuit, a polarized line relay governed by each line circuit, polar armatures and a neutral armature of each track relay adapted to pole-change and open respectively the line circuit for the section next in the rear of the associated section, neutral armatures of each line relay adapted to pole-change the track circuit for the section next in the rear of the section associated with said line relay whereby a distinctive control is effected for each of four consecutive track sections to the rear of an occupied section.

18. A railway signal system comprising, a stretch of railway track divided into track sections, a track circuit for each section including the traffic rails of the section, a line circuit for each section including a pair of line wires, a polarized track relay governed by each track circuit, a polarized line relay governed by each line circuit, polar armatures and a neutral armature of each track relay adapted to pole-change and open respectively the line circuit for the section next in the rear of the associated section, neutral armatures of each line relay adapted to pole-change the track circuit for the section next in the rear of the section associated with said line relay whereby a distinctive control is effected for each of four consecutive track sections to the rear of an occupied section, and said track and line relays being characterized by retaining their neutral armatures in engagement with their front contacts during pole-changing periods of the controlling circuit for the relay whereby successive tumble-down of the circuits to the rear is avoided.

19. A railway signal system comprising, a stretch of railway track, a signal located at the entrance of the stretch to govern traffic entering the stretch, said signal capable of displaying a stop indication and four different proceed indications having varying degrees of speed restriction, a track relay and a line relay, a track circuit responsive to traffic conditions of the traffic rails of the stretch for controlling the

track relay, traffic controlled means for governing the line relay including a pair of line wires, circuit means controlled jointly by said relays for selectively governing the indications of said signal and arranged in such a manner that the track relay is effective to control the stop and the most restrictive proceed indication in the event of a broken line wire.

20. A railway signal system comprising, a stretch of railway track divided into track sections, a signal for each section capable of displaying a stop indication and four different proceed indications having varying degrees of speed restriction, a track relay and a line relay for each section, a track circuit responsive to traffic conditions of the traffic rails of the section for governing the track relay, a line circuit including a pair of line wires for governing the line relay, a first traffic controlled means responsive to traffic conditions in advance of a section to pole-change the track circuit of the section, a second traffic controlled means responsive to other traffic conditions in advance of a section to open or close and to pole-change the line circuit of the section, operating means including neutral and polar armatures of each of the relays of a section for selectively establishing the different indications of said signal, said operating means arranged in such a manner that the track relay is effective to control the stop and the most restrictive proceed indication in the event of a broken line wire.

21. In combination, a section of railway track, a track circuit for said section including the traffic rails of the section and a pole-changer responsive to traffic conditions in advance of said section, a polarized relay energized by current supplied by said track circuit and having the characteristics of holding its front neutral contacts closed when the polarity of the energizing current is reversed and of retaining its back neutral contacts closed a predetermined interval after energizing current is supplied thereto, and a signal for said section having a stop circuit including a back neutral contact of said relay and a proceed circuit including a front neutral contact whereby signal flashing when the pole-changer is operated and momentary loss of control when a train vacates the section are avoided.

22. In combination, a forward and a rear section of railway track each provided with a track circuit, a first relay included in the track circuit for the forward section governed by traffic conditions in advance of said forward section, a second relay controlled by said first relay and by other traffic conditions in advance of said forward section, means governed by said second relay for reversibly governing the energy supplied to the track circuit for the rear section, a pair of line conductors for the rear section, means governed by said first relay for reversibly governing the energy supplied to said line conductors, and traffic governing means for the rear section connected across said line conductors and controlled by the energy supplied to the line conductors.

23. In combination, a forward and a rear section of railway track each provided with a track circuit, a first relay included in the track circuit for the forward section governed by traffic conditions in advance of said forward section, a second relay controlled by said first relay and by other traffic conditions in advance of said forward section, means including a pole changer governed by said second relay for governing the energy supplied to the track circuit for the rear section, a pair of line conductors for the rear section, means including a pole changer governed by said first relay for governing the energy supplied to said line conductors, and traffic governing means for the rear section connected across said line conductors and controlled by the energy supplied to the line conductors.

24. In combination, a forward and a rear section of railway track each provided with a track circuit, a first relay included in the track circuit for the forward section governed by traffic conditions in advance of said forward section, a second relay controlled by said first relay and by other traffic conditions in advance of said forward section, means including contacts of said second relay for reversibly governing the energy supplied to the track circuit for the rear section, a pair of line conductors for the rear section, means including contacts of said first relay for reversibly governing the energy supplied to said line conductors, and traffic governing means for the rear section connected across said line conductors and controlled by the energy supplied to the line conductors.

25. In combination, a forward and a rear section of railway track, a polarized track relay connected to the rails of the forward section reversibly governed by traffic conditions in advance of said forward section, a polarized line relay reversibly governed by other traffic conditions in advance of said forward section, said relays each characterized by having a retained neutral armature, a track circuit for the rear section including neutral contacts of said line relay, a line circuit for the rear section including neutral contact of said track relay, and traffic governing means for the rear section controlled by said line circuit.

26. In combination, a forward and a rear section of railway track each provided with a track circuit, a first relay included in the track circuit for the forward section governed by traffic conditions in advance of said forward section, a second relay controlled by said first relay and by other traffic conditions in advance of said forward section, means governed by said second relay for reversibly governing the energy supplied to the track circuit for the rear section, a pair of line conductors for the rear section, means governed by said first relay for reversibly governing the energy supplied to said line conductors, and traffic governing means for the rear section governed by the track circuit for the rear section as well as by said conductors and capable of displaying at least three different proceed indications having varying degrees of speed restriction.

27. A railway signal system comprising, a stretch of railway track, a signal located at the entrance of the stretch to govern traffic entering the stretch, said signal capable of displaying a stop indication and at least three different proceed indications having varying degrees of speed restrictions, a polarized track relay and a polarized line relay, a reversible track circuit for governing said track relay, a reversible line circuit for governing said line relay, and circuit means including polar and neutral contacts of said two relays for selectively governing the indications of said signal.

28. A railway signal system comprising, a stretch of railway track, a signal located at the entrance of the stretch to govern traffic entering the stretch, said signal capable of displaying a stop indication and at least three different proceed indications having varying degrees of speed

restrictions, a track relay and a line relay each characterized by having a retained neutral armature, a reversible track circuit for governing said track relay, a reversible line circuit for governing said line relay, and circuit means including contacts governed by the retained armatures of said two relays for selectively governing the indications of said signals.

29. In combination, a forward and a rear section of railway track each provided with a track circuit including a track relay, means for reversibly governing the track relay for the rear section, a line circuit governed by each of said track relays and by traffic conditions in advance of said forward section, a line relay connected to said line circuit, and a signal for the rear section governed jointly by said line relay and by the track relay for the rear section, said signal being capable of displaying at least three different proceed indications having varying degrees of speed restrictions.

30. In combination, a forward and a rear section of railway track each provided with a track circuit including a track relay, a line circuit governed by the track relay for the rear section, means including pole changing contacts of the track relay for the forward section for reversibly governing said line circuit, a line relay connected to said line circuit, and a signal for the rear section capable of displaying at least three different proceed indications, one indication being controlled by the track relay for the rear section and the other indications being controlled by said line relay.

31. A railway signal system comprising a stretch of railway track divided into sections, a track circuit including a track relay for each section, means for each section for reversibly governing the associated track relay, a line circuit for each section governed by the track relay of the associated section as well as by the track relay for the section next in advance of the associated section, a line relay for each section connected to the associated line circuit, and a signal for each section controlled jointly by the associated track and line relays.

32. In combination, a forward and a rear section of railway track, a track circuit including a track relay for each section, a reversible circuit including another relay controlled by said two track relays, a signal for the rear section capable of displaying a stop indication and at least three different proceed indications, signal operating circuits including contacts of the track relay for the rear section for governing the stop indication and one of said proceed indications, and signal operating circuits including contacts of said other relay for governing the other proceed indications.

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