Oct. 31, 1950

W. V. GROSJEAN

2,528,052

SUPPLEMENTAL SIGNALING SYSTEM
FOR SPECIAL RAILWAY VEHICLES

Filed Jan. 29, 1948

7 Sheets-Sheet 1

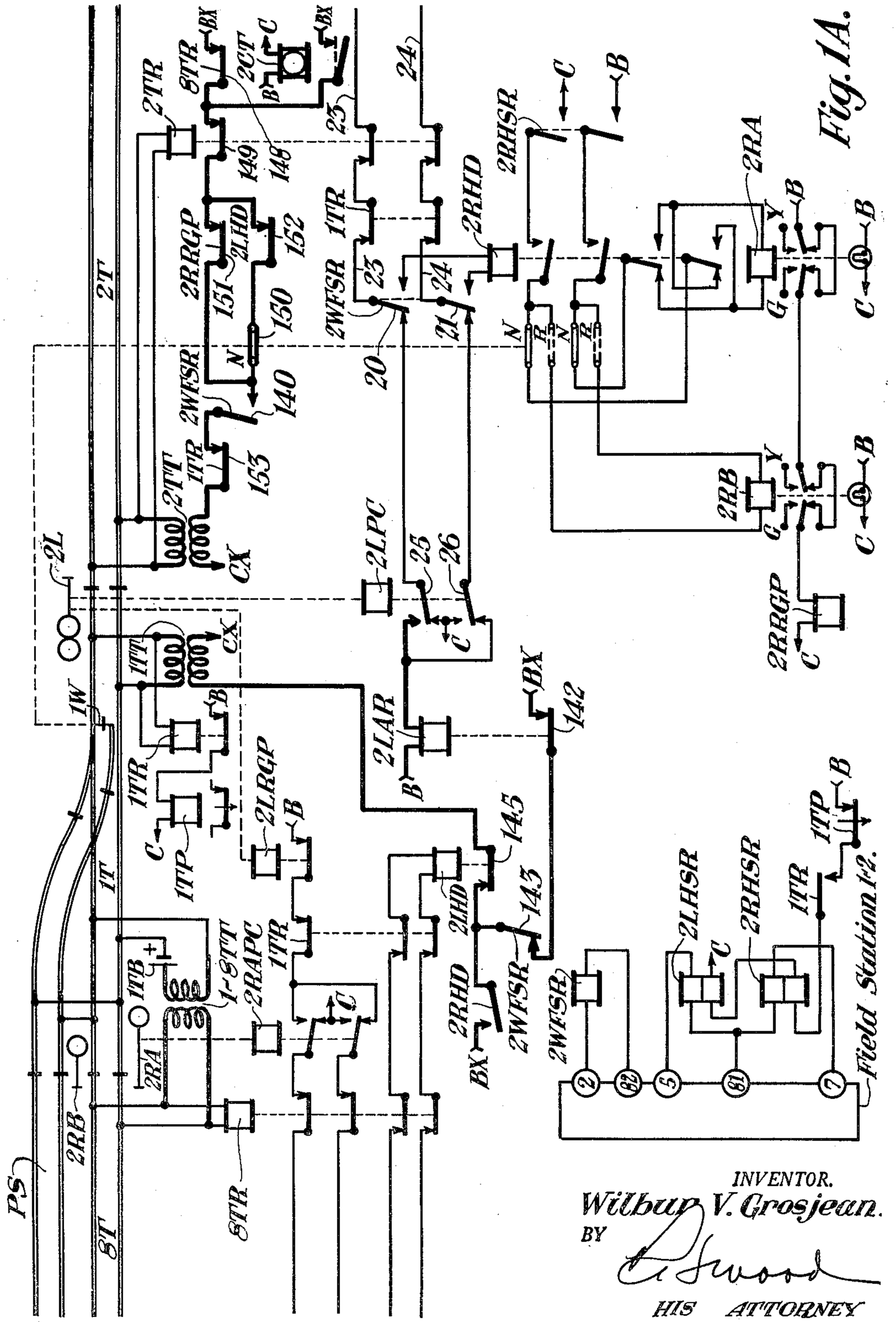

Fig. 1A.

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7 Sheets-Sheet 2

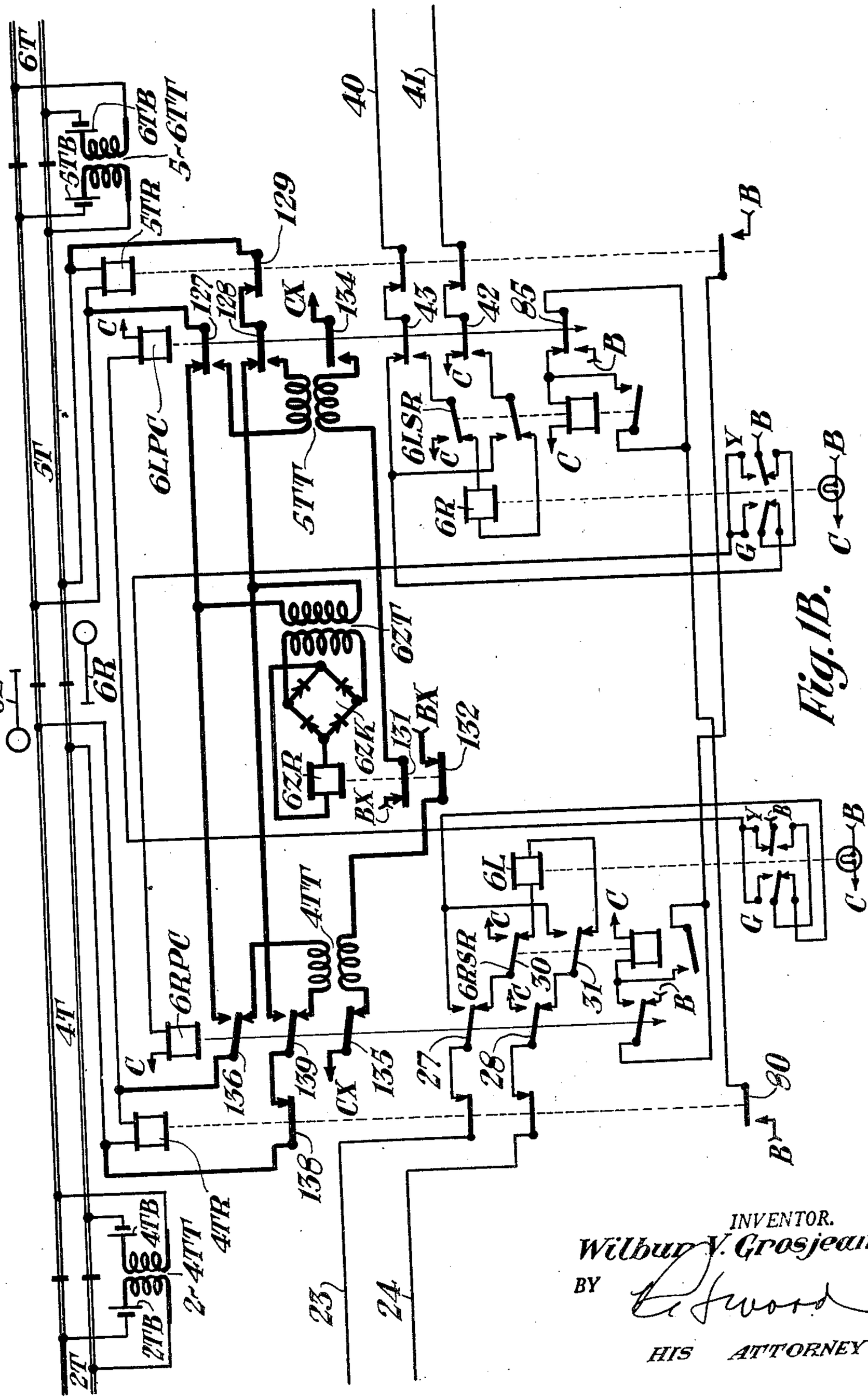

Fig. 1B.

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7 Sheets-Sheet 3

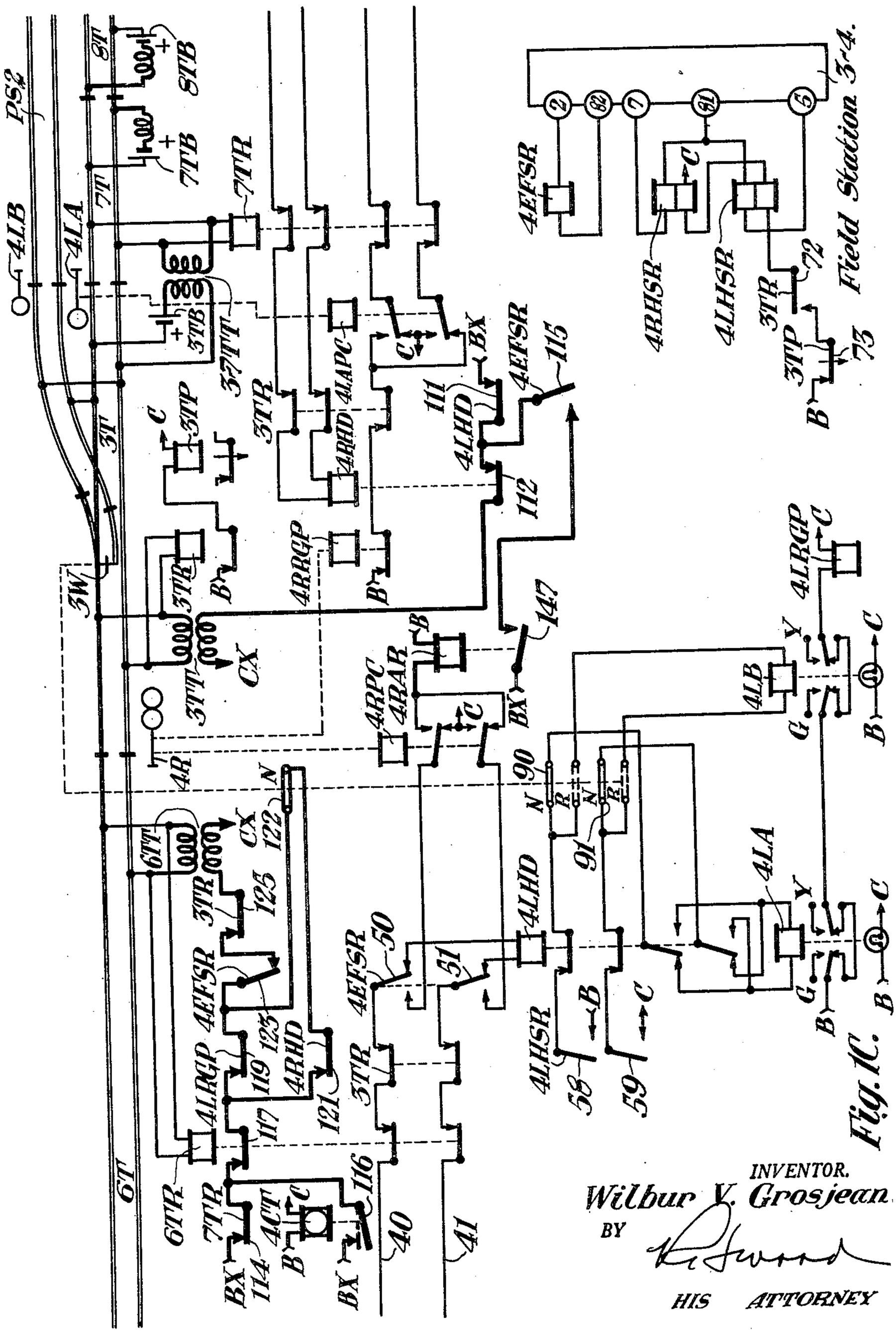

Fig. IC.

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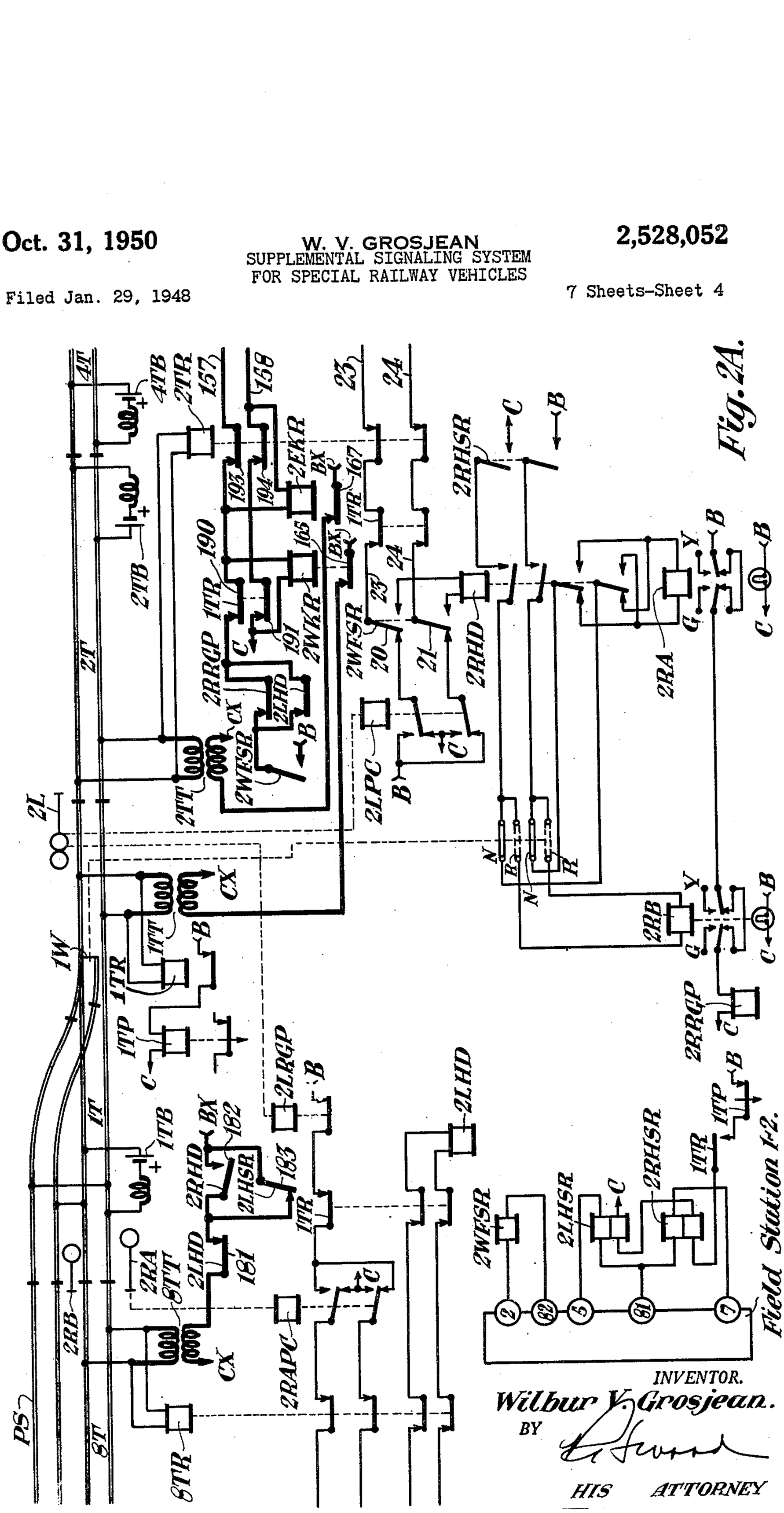

Fig. 2A.

Field Station 1-2.

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SUPPLEMENTAL SIGNALING SYSTEM
FOR SPECIAL RAILWAY VEHICLES

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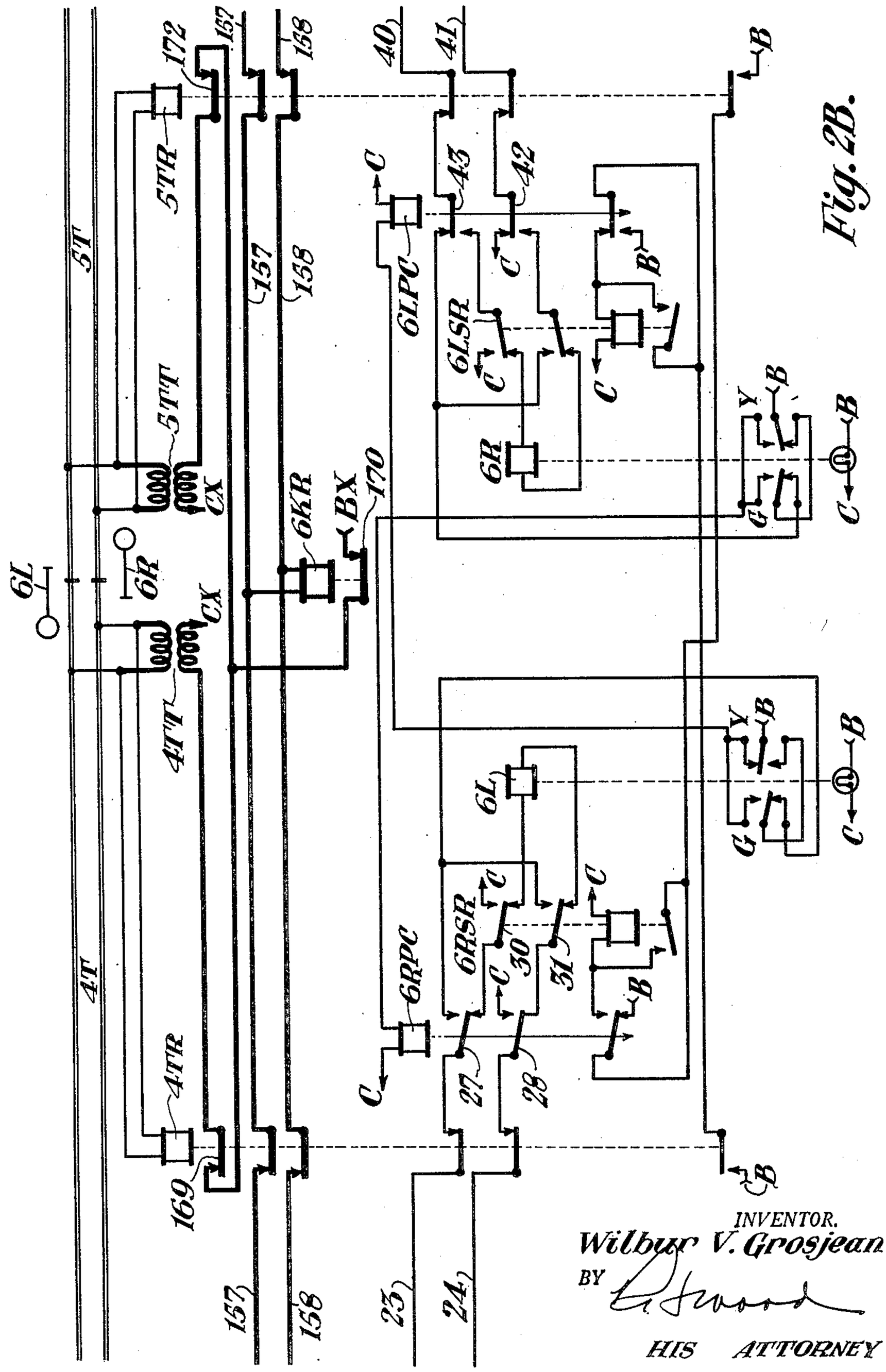

Fig. 2B.

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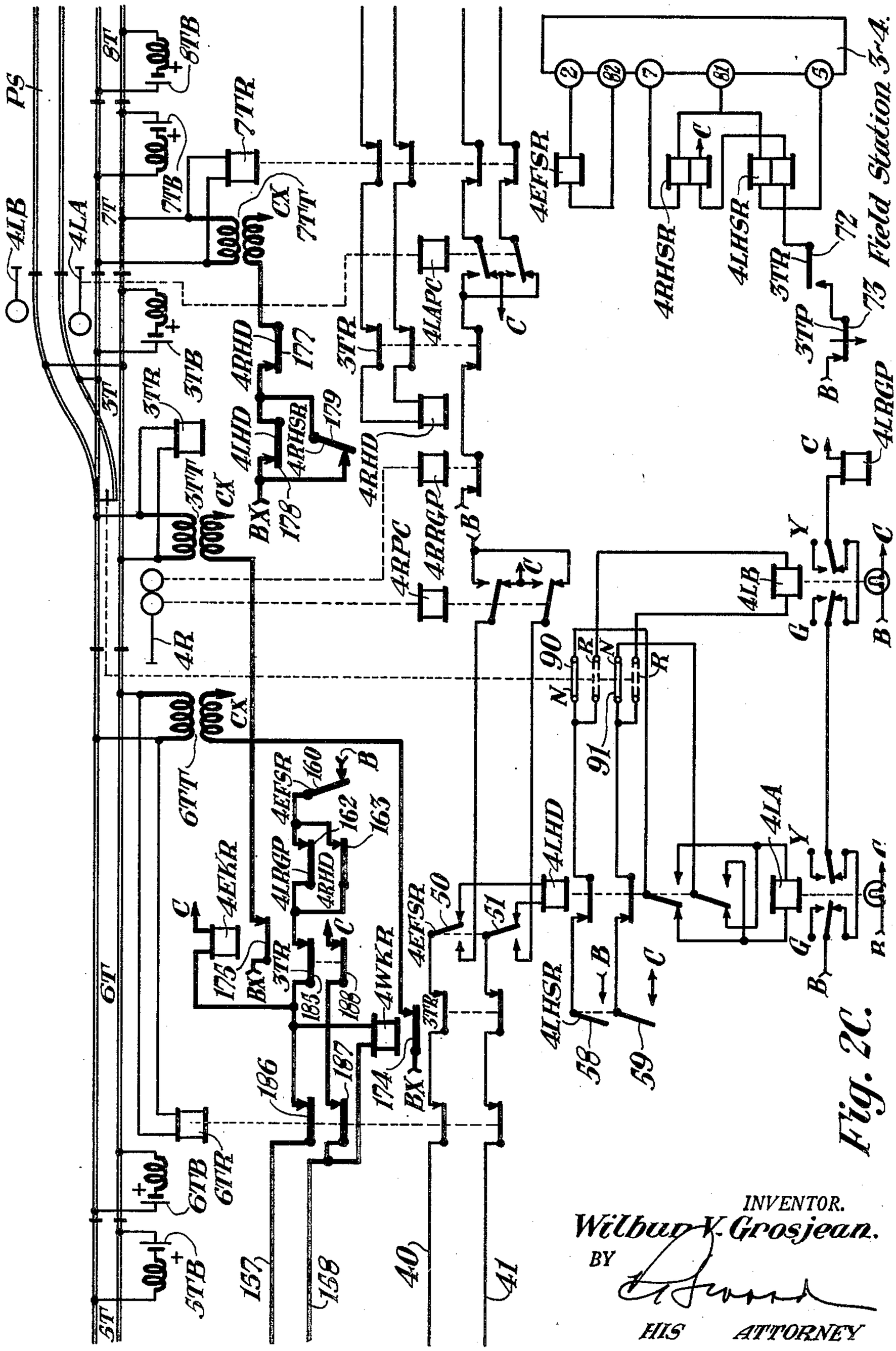

Fig. 2C.

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SUPPLEMENTAL SIGNALING SYSTEM
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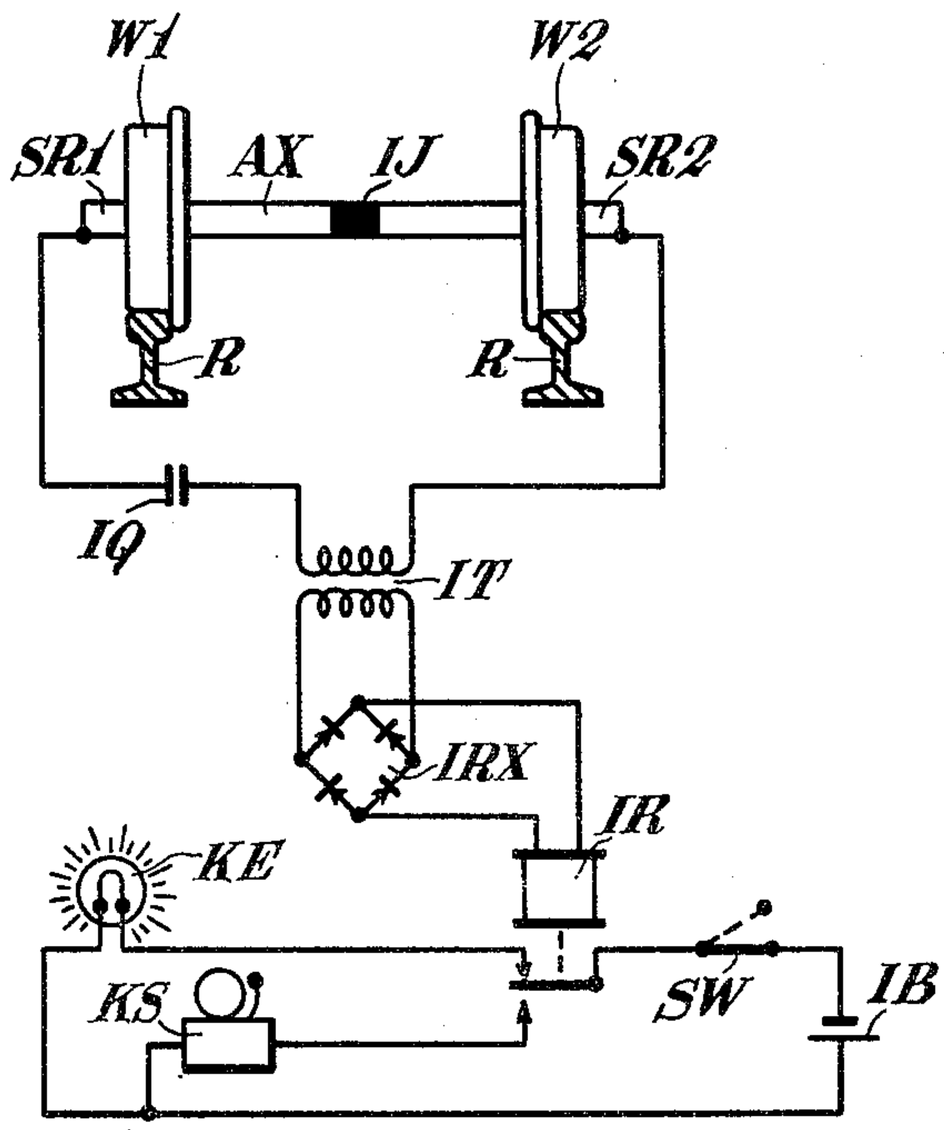

Fig. 3.

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Patented Oct. 31, 1950 2,528,052

UNITED STATES PATENT OFFICE

2,528,052

SUPPLEMENTAL SIGNALING SYSTEM FOR SPECIAL RAILWAY VEHICLES

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Application January 29, 1948, Serial No. 5,138

8 Claims. (Cl. 246—3)

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My invention relates to supplemental signaling systems for special railway vehicles, and particularly to improved systems of the type described adapted to be used in stretches of single track railway equipped with a principal signaling system which is manually controlled from a central office.

Special railway vehicles, such as small motor cars used by maintenance personnel, are usually equipped with insulated wheels or axles so that these cars do not shunt the track circuits by which block signaling systems for controlling train movements are conventionally controlled. As a result, such systems ordinarily do not indicate the presence of a motor car. Accordingly, no protection is afforded to the motor car and its operator by the conventional block signaling systems.

In my copending application for Letters Patent of the United States, Serial No. 996, filed January 7, 1948, there is shown a supplemental signaling system for governing indicators on special railway vehicles, which system may be applied to a track stretch equipped with an automatic block signaling system.

It is an object of my invention to provide improved means of the type described which may be applied to a stretch of single track railway equipped with a principal signaling system of the type in which the wayside signal apparatus is manually controlled from a central office so as to prepare each track stretch for train movements at times in one direction and at other times for train movements in the other direction.

Another object of my invention is to provide improved means of the type described which employs currents of a distinctive character in the track rails for the control of the special vehicles and which is incapable of interfering with the operation of the principal signaling system.

A further object of my invention is to provide means of the type described which may be applied to existing railway block signaling systems with a minimum of additional apparatus.

Still another object of my invention is to provide a supplemental signaling system for governing indicators on special railway vehicles which will operate to warn the operator of the vehicle of the approach of a train in ample time to allow removal of the vehicle from the track.

A further object of my invention is to provide a supplemental signaling system for governing indicators on special railway vehicles which will provide the operator of such a vehicle with continuous information concerning traffic conditions in a stretch of railway over which the vehicle is operating.

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Another object of the invention is to provide means effective when a train is approaching a single track stretch which is occupied by a motor car for indicating the approach of the train to the operator of the motor car only in the event that the train is authorized by signal indication, to enter the stretch, with the advantage that the operation of the motor car is not interfered with by the approach of a train which is not authorized to enter the single track stretch and therefore does not represent a hazard to the motor car.

A further object of the invention is to provide indication means of the type described which is governed by the wayside signaling apparatus in such a manner that the indicator on the motor car is controlled in accordance with the condition of the head block signal at the entrance end, for the established traffic direction, and by traffic approaching that signal, so as to provide a warning indication on the motor car when a train is approaching the entrance end of the single track stretch only if this train is authorized to enter the stretch. This warning indication is provided in ample time to enable the motor car to be removed from the track, if the train is authorized to enter the single track stretch.

Other objects of my invention and features of novelty will be apparent from the following description taken in connection with the accompanying drawings.

I shall describe two forms of supplemental signaling systems embodying my invention and shall then point out the novel features thereof in claims.

In the drawings, Figs. 1A, 1B, and 1C, when placed together in the order named with Fig. 1A at the left, form a diagram of a stretch of single track railway equipped with wayside signaling apparatus embodying my invention, and

Figs. 2A, 2B, and 2C, when placed together in the order named with Fig. 2A at the left, form a diagram of a stretch of single track railway equipped with wayside signaling apparatus and embodying a modification of my invention which I may employ.

Fig. 3 is a diagrammatic view of a preferred form of indication equipment which may be applied to a railway motor car to be used in cooperation with the wayside apparatus of my invention, and is similar to that shown and de-

scribed in my copending application, Serial No. 996.

In practicing my invention the traffic relays which are located at the opposite ends of each single track stretch and are governed from a central office to cause the wayside signal system to establish traffic in one direction or the other are employed to govern means for supplying current of a distinctive character to the rails of the single track stretch, such as alternating current of a selected frequency, for example, to thereby govern indication means on motor cars in the single track stretch. The supplementary signaling system is so controlled that when a single track stretch is set up for traffic in either direction, the supply of current of distinctive character to the rails of the track stretch is governed from the corresponding entrance end of the stretch.

The means for supplying the motor car control current to the entrance end of each single track stretch is also governed by the head block signal at that end so that when the head block signal is at stop, thereby preventing entrance of a train into the stretch, motor car control current will be supplied to the rails of the single track stretch regardless of traffic conditions in the stretch approaching the head block signal. On the other hand, when the head block signal is cleared to authorize entrance of a train into the single track stretch, the supply of motor car control current to the rails of the single track stretch is governed by traffic conditions in the stretch approaching the head block signal so that a motor car present anywhere in the single track stretch will have adequate warning of the approach of a train.

In one form of the invention alternating current is supplied to the rails of the stretch at the entrance end and is cascaded or repeated from section to section to the exit end of the stretch so that alternating current is supplied to all of the sections in the stretch if the stretch is unoccupied, or is supplied to the sections in the stretch behind a train if the stretch is occupied.

In a modification of the invention a special line circuit controlled by traffic conditions in the stretch extends the length of each single track stretch and governs relays which control the supply of alternating current to the rails of the various sections in the stretch. Energy is supplied to this line circuit at the entrance end of the stretch and controls the relays energized therefrom to cause alternating current to be supplied to the rails of all of the sections in the stretch if the stretch is unoccupied, or to be supplied to the sections in the stretch behind a train if the stretch is occupied.

This invention also includes means for controlling the supply of alternating current to the rails of the main track portions adjacent the passing sidings in such manner that alternating current is supplied to the rails of each of these track portions when the signals governing entrance of traffic into the main track portion are held at stop, while the supply of alternating current to the rails of one of these track portions is cut off when a signal is cleared to authorize entrance of a train into the track portion.

Referring to Figs. 1A, 1B and 1C of the drawings, there is shown therein a stretch of single track railway extending between two passing sidings PS. This stretch is provided with wayside signal apparatus governed from a central office through a conventional centralized traffic

control system for authorizing traffic to move in one direction through the stretch at times and to move in the other direction at other times. In the present application only the portions of the wayside apparatus essential to the understanding of my invention have been shown, and the remainder of the equipment may be arranged as shown in Letters Patent of the United States No. 2,424,038, granted to Arthur L. Jerome on July 15, 1947.

As shown, the wayside signals are of the well-know searchlight type and may be constructed as shown in Letters Patent of the United States No. 1,864,224, granted on June 21, 1932, to Wesley B. Wells.

The equipment at the left-hand or west end of the stretch includes a code controlled field station unit of the centralized traffic controy system, designated station 1—2, and the equipment at the right-hand or east end of the stretch includes a similar field station unit designated station 3—4. Inasmuch as my invention relates to wayside apparatus, it is deemed sufficient to point out that the field station units are connected to a control office by a line circuit not shown, over which control codes may be transmitted to the field stations one at a time. The control codes transmitted to these stations serve to operate a group of control relays of the stick polar type, in accordance with the positions of control levers at the office. Three such control relays are shown herein at each station and these comprise a traffic relay, such as relay 2WFSR, Fig. 1A which governs the direction of traffic movement in the single track stretch by cooperation with a similar relay 4EFSR at the opposite end of the single track stretch, shown in Fig. 1C, and also includes two code controlled signal control relays, such as the relay 2RHSR or 2LHSR, in Fig. 1A, by which the clearing of the correspondingly designated signals is made subject to manual control from the office.

Each traffic relay 2WFSR or 4EFSR, when in its normal position, with its left-hand contacts closed, designates its location as the exit end of the stretch. In this position, the traffic relay supplies energy to the reversible signal control circuits for the single track stretch to enable the signals which govern traffic movements toward this location to be cleared. Each traffic relay when reversed, with its right-hand contacts closed, designates its location as the entrance end of the single track stretch, in which position the traffic relay enables the associated entering head block signal to be cleared, under proper conditions, in response to the reversal of the associated code controlled signal control relay 2RHSR or 4LHSR. The traffic and signal control relays are controlled in a manner fully described in the above-identified Jerome patent, and it suffices to point out that these relays are controlled so that when relay 2WFSR is operated to its normal position, relay 4EFSR is operated to its reverse position, and vice versa, so that the direction of traffic is in one direction at times, and in the other direction at other times.

On each of the motor cars or special vehicles which may be operated through the stretch there is provided apparatus which is responsive only to the presence of alternating current energy in the rails over which the vehicle moves.

Referring now to Fig. 3, there is shown a diagrammatic view of one arrangement of indication apparatus which may be employed on motor or other special cars which are operated over the

stretch of track described above. As shown, the wheels W1 and W2 are insulated from each other by the insulated joint IJ in the axle AX, and the other pair of wheels, not shown, on the motor car are similarly insulated, so that the car will not shunt the track circuit. A slip ring SR1 makes electrical contact with the wheel W1 and a second slip ring SR2 makes electrical contact with the wheel W2. Connected in series between the slip rings SR1 and SR2 are the condenser IQ and the primary winding of a transformer IT. The secondary winding of the transformer IT is connected to the input terminals of a bridge-type rectifier IRX, and the winding of an indicator relay IR is connected across the output terminals of this rectifier. It will be apparent that when the car moves over the rails of a track section the condenser IQ will prevent the flow of direct current track circuit energy, but will permit the flow of alternating current through the primary winding of the transformer IT. The alternating current induced in the secondary winding of transformer IT is rectified by rectifier IRX, and is supplied to the winding of relay IR, and as a result, relay IR picks up to establish a circuit, obvious from the drawing, for supplying energy over its front contact from the battery IB to light the indicator lamp KE. If the supply of alternating current to the rails R is interrupted, energy will no longer be supplied to the winding of relay IR and its contacts will release, extinguishing the lamp KE, and establishing a circuit for supplying energy to a warning bell KS. A switch SW is shown in series with the circuit for supplying energy to the indication lamp KE and the warning bell KS, so that the equipment may be deenergized when the car is removed from the rails.

It is to be understood that my invention is not limited to the specific arrangement of vehicle-carried indicator equipment shown in Fig. 3, and any suitable means for detecting a characteristic of the current supplied to the track rails which differs from that depended upon for the energization of the track relays may be employed. When alternating current is employed, as shown herein, the relay IR may be inductively coupled to the track rails by the provision of receiving coils on the motor car in inductive relation to the rails, together with an amplifier for amplifying the energy induced in such coils, such an arrangement being well-known from its use for the control of train carried cab signals.

The trackway system includes continuous direct current track circuits for all main tracks. Each of the track sections 1T, 2T, 3T, 4T, 5T, 6T, 7T and 8T has a conventional direct current track circuit including a track battery TB and a track relay TR.

Additionally, at the relay end of each track circuit section, the secondary winding of a track transformer TT is connected across the rails of the section. When alternating current is supplied to the primary winding of the track transformer, alternating current induced in the secondary winding is supplied to the rails of the section. The winding of the track relay presents a high impedance to the alternating current so that the flow of alternating current through the winding of the track relay is negligible. Accordingly, it is apparent that alternating current may be supplied to a track circuit section without affecting the operation of the direct current track circuit.

Energy for the operation of the relays other than the track relays is furnished by suitable sources of direct current, not shown, whose positive and negative terminals are designated B and C, respectively. Additionally, there is provided a source of alternating current energy whose terminals are designated BX and CX.

In most instances in the drawings the relay contacts are located directly in line with the winding of the relay, but in some cases in order to simplify the drawings, relay contacts are separated from the relay winding and in these instances the relay with which the contacts are associated is identified by appropriate reference characters placed above the contacts.

As previously explained, the principal signaling system shown in the drawing is similar to that shown and described in the above-identified Jerome patent, but to clarify the drawings the additional circuits and apparatus employed in connection with my invention have been shown by heavier lines.

Referring to Fig. 1, the equipment is shown in the condition which it assumes when the single track stretch is vacant, the signals 2R and 4L are at stop, and the reversible line circuit system for controlling the signals is set up in the direction for right to left, or westbound traffic movements. At this time, the contacts 20 and 21 of the traffic relay 2WFSR at the left-hand or west end of the stretch are in their left-hand or normal position and connect line wires 23 and 24 over contacts 25 and 26 of a pole-changer or repeating relay 2LPC for signal 2L and through the winding of an approach relay 2LAR to terminals B and C of the local source of energy. The relay 2LPC is governed in the well-known manner in accordance with the aspect displayed by signal 2L and controls the polarity of the energy supplied to the line wires 23 and 24. As shown the signal 2L is assumed to be at stop so the relay 2LPC is released and causes the energy supplied to the line wires 23 and 24 to be of reverse polarity. The energy supplied to the line wires 23 and 24 feeds over front contacts of track relays 1TR, 2TR, and 4TR, over back contacts 27 and 28 of a repeating relay 6RPC, for signal 6R, Fig. 1B, and back contacts 30 and 31 of a directional stick relay 6RSR to the winding of the mechanism for signal 6L, and causes this signal to display its yellow or caution indication, while the flow of this energy through the winding of relay 2LAR causes this relay to assume its energized position as shown.

Since signal 6L is now conditioned to display its caution indication, energy is supplied over the front contact Y of its mechanism to its repeating relay 6LPC, the contacts of which are picked up to cause energy of normal polarity to be supplied to line wires 40 and 41 leading to relay 4LHD. At this time wire 41 is connected to terminal C over front contact 42 of relay 6LPC, and wire 40 is connected over front contact 43 of relay 6LPC to terminal B at the back contacts G and Y of the mechanism for signal 6R.

The energy supplied to line wires 40 and 41 is supplied over front contacts of track relays 5TR, 6TR, and 3TR, and reverse polar contacts 50 and 51 of the traffic relay 4EFSR to the winding of a line relay 4LHD for signals 4LA and 4LB, and causes relay 4LHD to close its neutral front contacts and to move its polar contacts to their left-hand or normal position. As shown, the contacts 58 and 59 of the signal control relay 4LHSR are in their normal position and interrupt the circuits for supplying energy to the

windings of signals 4LA and 4LB so that these signals are both at stop and their mechanism contacts establish a circuit for energizing a signal indication relay 4LRGP so that its contacts are picked up.

Relay 4RHD is a polarized line relay which controls signal 4R by means of circuits governed by signal control relay 4RHSR. The circuits are not shown, but are to be understood to be similar to the circuits for controlling signals 4LA and 4LB. By placing Fig. 1C to the left of Fig. 1A, the arrangement of circuits for controlling relay 4RHD may be traced. As shown, relay 4RHD is governed by a two-wire line circuit extending between the ends of the passing siding and the circuit includes front contacts of relays 3TR, 7TR, 8TR, and 1TR, so that when a train occupies any portion of the main track between signal 4R and signal 2L, relay 4RHD will be released. Additionally, a front contact of a signal indication relay 2LRGP is included in the circuit for relay 4RHD, the relay 2LRGP being governed over a circuit similar to that for relay 4LRGP but controlled by signal 2L so that its contacts are picked up when and only when signal 2L indicates stop. Accordingly, when signal 2L is cleared for a train moving from right to left to permit the train to enter the main track stretch between signal 4R and signal 2L, relay 2LRGP will release and interrupt the circuit of relay 4RHD so that signal 4R cannot be cleared, thus providing protection against opposing train movements. The polarity of the energy supplied to relay 4RHD is governed by pole changing contacts of the pole changer relay 2RAPC for signal 2RA so as to cause the aspects displayed by signal 4R to be dependent upon the aspects displayed by signal 2RA.

Relay 2LHD is a polarized line relay controlled in a similar manner by a two-wire line circuit which is arranged in the same manner as the circuit for relay 4RHD, but oppositely directed, and cooperates with relay 2LHSR to govern circuits, not shown, for controlling signals 2L.

Under the condition being described, alternating current is supplied to the primary winding of transformer 3TT by the circuit which is traced from terminal BX at front contact 111 of relay 4LHD, over front contact 112 of relay 4RHD, and through the primary winding of transformer 3TT to terminal CX. As a result, alternating current is induced in the secondary winding of transformer 3TT and is supplied to the rails of the detector track section 3T, and over the rails of section 3T to a first winding of transformer 3—7TT which is connected across the rails of section 3T in series with track battery 3TB. Transformer 3—7TT is a transformer having a turns ratio of 1 to 1, so that current is induced in its second winding which is of substantially the same value as that supplied to the first winding. Accordingly, the alternating current supplied to section 3T causes alternating current to be supplied through the transformer 3—7TT to the rails of section 7T. A reactor in series with the track battery 7TB prevents excessive flow of the alternating current through the battery 7TB, and although the track relay 7TR is effectively connected across the second winding of transformer 3—7TT, the direct current track relay winding presents a relatively high impedance to the alternating current so that very little of the alternating curent flows through the relay winding.

Alternating current is also supplied to the

primary winding of transformer 6TT at this time by a circuit which is traced from terminal BX, over front contact 114 of track relay 7TR in multiple with a front contact 116 of a flasher relay 4CT, over front contact 117 of relay 6TR, over front contact 119 of relay 4LRGP in multiple with a front contact 121 of relay 4RHD, and a normally closed switch correspondence contact 122, over reverse polar contact 123 of relay 4EFSR, over front contact 125 of relay 3TR, and through the primary winding of transformer 6TT to terminal CX. The flasher relay 4CT has its operating winding continuously connected to the direct current source and is of the type having contacts which are recurrently picked up and released at an appropriate rate, for example, 75 times per minute. When contact 114 of relay 7TR is picked up, alternating current is continuously supplied to the primary winding of transformer 6TT over the circuit traced above, but when contact 114 of relay 7TR is released, the supply of alternating current to the primary winding of transformer 6TT is periodically interrupted by contact 116 of relay 4CT.

Accordingly, at this time alternating current is supplied from the secondary winding of the transformer 6TT to the rails of section 6T, and feeds over the rails of section 6T to the first winding of the transformer 5—6TT, Fig. 1B, which is similar to the transformer 3—7TT. The alternating current supplied to the first winding of the transformer 5—6TT induces similar alternating current in the second winding of the transformer 5—6TT from which current is supplied to the rails of section 5T.

At this time track relay 5TR is picked up, and relay 6LPC is picked up, and a circuit is established to connect the primary winding of transformer 6ZT across the rails of section 5T. This circuit is traced from the upper rail of section 5T, over front contact 127 of relay 6LPC, through the primary winding of transformer 6ZT, over front contact 128 of relay 6LPC, and over front contact 129 of relay 5TR to the lower rail of section 5T. The alternating current supplied to the primary winding of transformer 6ZT induces alternating current in the transformer secondary winding and this current is rectified by the full-wave rectifier 6ZK and is supplied to the winding of an indicator control relay 6ZR. As a result, the contacts of relay 6ZR are picked up. The relay 6ZR is of the type which is slow in releasing its contacts, and is arranged so that its contacts will remain picked up if recurrent pulses of energy are supplied to its winding at a certain rate, for example, 75 times per minute. When relay 6ZR is picked up, its contact 131 in the circuit for supplying current to the primary winding of transformer 5TT is closed, but this circuit is interrupted by back contact 134 of relay 6LPC, so that no alternating current is supplied to the primary winding of transformer 5TT at this time. When contact 132 of relay 6ZR is picked up, it establishes the circuit for supplying alternating current to the primary winding of transformer 4TT, which circuit is traced from terminal BX over front contact 132 of relay 6ZR, through the primary winding of transformer 4TT, and over back contact 135 of relay 6RPC, to terminal CX.

The alternating current induced in the secondary winding of transformer 4TT at this time is supplied to the rails of section 4T and feeds over the rails of section 4T to a winding of transformer 2—4TT by a circuit which is traced from

the right-hand terminal of the secondary winding of transformer 4TT, over back contact 139 of relay 6RPC, over the upper rail of section 4T, through the first winding of transformer 2—4TT, through battery 4TB, over the lower rail of section 4T, over front contact 138 of relay 4TR, and over back contact 139 of relay 6RPC to the left-hand terminal of the secondary winding of transformer 4TT. Accordingly, it will be seen that the current induced in the secondary winding of transformer 4TT is supplied over the rails of section 4T to the first winding of transformer 2—4TT, and as a result alternating current is induced in the second winding of transformer 2—4TT and is supplied therefrom to the rails of section 2T.

At this time, since traffic relay 2WFSR, Fig. 1A, is in its normal position, its contact 140 interrupts the circuit for supplying alternating current to the primary winding of transformer 2TT, but as explained above, alternating current is supplied to the rails of section 2T from the second winding of transformer 2—4TT.

Alternating current is supplied to the primary winding of transformer 1TT at this time by the circuit which is traced from terminal BX, over front contact 142 of relay 2LAR, over normal polar contact 143 of traffic relay 2WFSR, over front contact 145 of relay 2LHD, and through the primary winding of transformer 1TT to terminal CX. The alternating current induced in the secondary winding of transformer 1TT is supplied over the rails of the detector track section 1T to the first winding of transformer 1—8TT, and the alternating current energy induced in the second winding of transformer 1—8TT is supplied to the rails of section 8T.

From the foregoing it will be seen that under the condition described, that is, when there is no train in the vicinity of the single track stretch and the reversible line circuit system is set up in the direction required for a train movement from right to left, alternating current is supplied to the rails of the stretch at the entrance end, and is cascaded through section by section to the exit end of the stretch, so that alternating current is supplied to each of the track sections.

If a motor car having insulated wheels and equipped with suitable means for indicating the presence of alternating current in the track rails, such for example, as is shown in Fig. 3, traverses the block, the indication means on the motor car will indicate the presence of alternating current in each of the track sections to thereby indicate to the operator of the car that he may proceed safely.

It will now be assumed that a train moving from right to left, that is, westbound, approaches the right-hand or entrance end of the stretch. Accordingly, due to the release of one or more of the track relays which control its circuit, the line relay 4RHD will be deenergized and its neutral contacts will release. Due to the release of relay 4RHD, its contact 121 in the circuits for supplying alternating current to the transformer 6TT is open, but as it is assumed that signal 4LA or 4LB has not been cleared the relay 4LRGP remains picked up and its contact 119 maintains the supply of energy to transformer 6TT and thus maintains the supply of alternating current to the rails of all of the track sections in the single track stretch. Accordingly, the indication means on a motor car present anywhere in the single track stretch will provide an

indication that it is safe for the car to remain on the track rails.

Even though a westbound train has approached the entrance end of the single track stretch, it is evidently safe for the motor car to remain on the rails of the single track stretch when the head block signals 4LA and 4LB governing entrance of a westbound train into the track stretch are held at stop so as to prevent the approaching westbound train from entering the single track stretch.

If the approaching westbound train should over-run the head block signal 4LA or 4LB and enter the single track stretch without authority, it would, as hereinafter explained, cut off the supply of alternating current to the entrance end of the stretch and thus cut off the supply of alternating current to the track rails throughout the stretch so that the indication means on a motor car present anywhere in the stretch would then warn the operator of the motor car of the approaching train.

At this time, as it is assumed that the wayside signal system has been set up for westbound traffic, the head block signals 2RA and 2RB, which govern entrance of eastbound traffic into the stretch, are held at stop and cannot be cleared. Hence eastbound trains are prevented from entering the single track stretch, and it is only necessary to protect the operators of motor cars from approaching westbound trains.

When front contact 112 of relay 4RHD releases, it interrupts the circuit previously traced for the primary winding of transformer 3TT, and as a result, the supply of alternating current to the rails of the detector track section 3T is cut off. Since energy is no longer supplied to the primary winding of transformer 3—7TT, there is no alternating current induced in the secondary winding of the transformer, and as a result no alternating current is supplied to the rails of section 7T at this time.

Accordingly, a motor car moving through the stretch from left to right, receives alternating current from the track sections of the single track stretch including section 6T, but when the motor car advances into sections 3T and 7T, no alternating current will be received from the section rails, and the apparatus on the motor car will indicate that a train is approaching, so that the operator can remove the car from the rails.

When the approaching westbound train enters section 7T, track relay 7TR releases and its front contact 114 interrupts the supply of steady alternating current to transformer 6TT, and alternating current is now recurrently supplied to transformer 6TT over the circuit including contact 116 of flasher relay 4CT. As a result, impulses of alternating current are recurrently supplied to the rails of section 6T, and through the transformer 5—6TT to the rails of section 5T, and are rectified and supplied to the winding of relay 6ZR. As previously explained, the relay 6ZR is of the slow release type, and will not release its contacts at this time. As a result, the supply of alternating current energy to transformer 4TT is maintained at this time.

From the foregoing it will be seen that, at this time, the apparatus on a motor car moving from left to right will receive steady alternating current until the motor car enters section 5T and 6T, at which time the recurrent impulses of alternating current will cause the apparatus on the motor car to operate periodically, to thereby warn

the operator that a train is approaching, but is not yet in dangerous proximity to the motor car.

It will now be assumed that the central office operator causes a control code to be transmitted to field station 3—4 to clear signal 4LA and thereby authorize the approaching westbound train to enter the single track stretch. This control code causes the contacts of relay 4LHSR to be operated to their reverse or right hand position. On reversal of the contacts 58 and 59 of relay 4LHSR, energy is supplied from terminals B and C of the local source to the winding of signal 4LA over the circuit controlled by neutral and polar contacts of relay 4LHD, and by contacts 90 and 91 which are governed in accordance with the position of the track switch 3W and of the control relay therefore so as to establish the circuit of signal 4LA when and only when the track switch and its control relay are in their normal position. As shown, the switch 3W is in its normal position and the polar contacts of the line relay 4LHD are in their normal position so that energy is supplied to the winding of signal 4LA to cause it to display its green of proceed indication. When signal 4LA clears, the circuit of relay 4LRGP is interrupted and its contacts release. When front contact 119 of relay 4LRGP releases, the supply of alternating current is cut off from the primary winding of transformer 6TT, since contact 121 of relay 4RHD is already released. Accordingly, the supply of alternating current to the rails of section 6T is interrupted, and the supply of alternating current through transformer 5—6TT to the rails of section 5T and over the circuit previously traced to the primary winding of transformer 6ZT is interrupted. As a result, energy ceases to be supplied to the winding of relay 6ZR, and its contacts release. When contact 132 of relay 6ZR releases, it interrupts the circuit previously traced for supplying alternating current to the primary winding of transformer 4TT, with the result that alternating current is no longer supplied to the rails of section 4T, and therefore ceases to be supplied over the rails of section 4T to the first winding of transformer 2—4TT, so that alternating current is no longer supplied from the secondary winding of transformer 2—4TT to the rails of section 2T.

From the foregoing, it will be seen that when the signal 4LA is cleared for an approaching train, and the train has caused relay 4RHD to be released, the supply of alternating current is cut off from the rails of all of the sections in the single track stretch, so that a motor car traveling through the stretch does not receive alternating current and the indication apparatus carried by the car thereby informs the operator that a train is approaching.

In the event the central office operator clears signal 4LA before relay 4RHD is released by the approaching train, relay 4LRGP will release, but the supply of energy to transformer 6TT will be maintained by front contact 121 of relay 4RHD and switch correspondence contact 122. When the signal 2L at the right hand end of the passing siding PS is cleared, or when the approaching train enters section 1T at the right hand end of the siding, relay 4RHD releases and the supply of alternating current to transformer 6TT is cut off, with the results described above.

If a westbound train occupying the side track approaches signal 4LB, the supply of energy to transformer 6TT will continue as long as signal 4LB remains at stop, but when the switch 3W is reversed prior to clearing signal 4LB, contact 122 is opened, so that when signal 4LB is cleared and relay 4LRGP releases, its front contact 119 interrupts the supply of energy to transformer 6TT and, although front contact 121 of relay 4RHD is closed, contact 122 interrupts the circuit so that no energy is supplied to transformer 6TT at this time.

Accordingly, it will be seen that the motor car operator will be provided with a clear indication until such time as traffic conditions require the clear indication to be cancelled.

When signal 4LB is cleared, and also when signal 4LA is cleared and relay 4RHD is released because of the approach of a westbound train on the main track at the right hand end of the single track stretch, the supply of alternating current to the primary winding of transformer 1TT, Fig. 1A, at the left hand end of the single track stretch is maintained by the circuit previously traced, and accordingly, alternating current is supplied to sections 1T and 8T, at the left, as previously described. It will be apparent, therefore, that an eastbound motor car traveling through sections 8T and 1T will have its indication apparatus energized until the motor car enters the first section 2T of the single track stretch, when the absence of alternating current will cause the apparatus on the motor car to indicate that a train is approaching the opposing entering signal at the right hand end of the single track stretch.

When a westbound train accepts signal 4LA or 4LB and enters the detector track section 3T, the track relay 3TR releases to interrupt the circuit of relay 4LHD, while a contact of relay 3TR interrupts a circuit of the slow release relay 3TP. After release of relay 3TR and prior to release of relay 3TP, energy is supplied over back contact 72 of relay 3TR and front contact 73 of relay 3TP to the lower winding of relay 4LHSR and moves the relay contacts 58 and 59 to their normal positions in which they interrupt the circuit of signal 4LA to prevent reclearing of signal 4LA unless the contacts of relay 4LHSR are reversed by a control code transmitted from the office.

When signal 4LA displays its stop indication, relay 4LRGP is energized and its front contact 119 in the circuit for the primary winding of transformer 6TT is closed, but this circuit is interrupted at this time by front contact 125 of relay 3TR. It follows that when the train enters the stretch and returns signal 4LA to stop, alternating current is not supplied to the rails of the track stretch in advance of the train and consequently the indication means on a motor car present in the single track stretch will display its danger indication.

As the westbound train advances into sections 6T and 5T, the track relays 6TR and 5TR release to interrupt the line wires 40 and 41 and thus maintain relay 4LHD deenergized. Front contact 117 of relay 6TR additionally interrupts the circuit for the primary winding of transformer 6TT, and front contact 129 of relay 5TR interrupts the circuit for connecting the primary winding of transformer 6ZT to the rails of section 5T.

When the rear of the train vacates section 3T, the track relay 3TR picks up, and its front contacts again establish a circuit for relay 4RHD, and its contacts pick up.

When the rear of the train vacates section 6T, track relay 6TR picks up, and its front contact 117 completes the circuit for the primary winding of transformer 6TT so that alternating cur-

rent is supplied to the rails of section 6T. As a result, a motor car following the train under discussion will receive alternating current from the rails of section 6T as the train progresses so the motor car operator may safely follow a train through the stretch. However, the shunting effect of the wheels and axles of the train prevents the alternating current from reaching the rails ahead of the train.

When the train enters section 4T, the track relay 4TR releases and energy is supplied to relay 6LSR over the circuit which includes back contact 80 of relay 4TR and front contact 85 of relay 6LPC. Accordingly, relay 6LSR picks up and establishes for itself a stick circuit which is effective as long as either relay 4TR or relay 6LPC is released.

On release of relay 4TR the supply of energy over line wires 23 and 24 to the mechanism for signal 6L is cut off and the signal displays its stop indication and interrupts the circuit of relay 6LPC and it releases so that energy of reverse polarity is supplied to the line wires 40 and 41 over back contacts 43 and 42 of relay 6LPC, front contacts of relay 6LSR, and back contacts G and Y of the mechanism for signal 6R.

When relay 4TR releases and interrupts the circuit for signal 6L, the series approach relay 2LAR, Fig. 1A, in that circuit releases and opens its contact 142 which cuts off the supply of alternating current from the primary winding of transformer 1TT so that alternating current is no longer supplied to the rails of section 1TT and is no longer supplied over the rails of section 1T to the winding of transformer 1—8TT. As a result, alternating current is no longer supplied to the rails of section 8T.

It will be seen, therefore, that when a westbound train advances into section 4T the supply of alternating current to the rails of sections 1T and 8T in the main track portion beside the passing siding PS in advance of the train is cut off so that the indication means on a motor car present in either of these sections will warn of the approach of the train.

When the westbound train vacates sections 6T and 5T, the track relays 6TR and 5TR pick up and complete the circuit for the line wires 40 and 41 and energy is supplied to relay 4LHD to pick up its neutral contacts and move its polar contacts to their right-hand or reverse position, so that, if the contacts of relay 4LHSR are reversed to clear signal 4LA, this signal will display its yellow or caution indication.

When relay 4LHD picks up, its front contact 111 in the circuit for supplying energy to the primary winding of transformer 3TT is again closed.

Additionally, when relay 5TR picks up, its front contact 129 establishes the circuit which includes back contacts 127 and 128 of relay 6LPC for connecting the secondary winding of transformer 5TT to the rails of section 5T. However, at this time, no energy is supplied to relay 6ZR and its contacts are released. Contact 131 interrupts the supply of energy to the primary winding of transformer 5TT, and contact 132 of relay 6ZR interrupts the supply of energy to the primary winding of transformer 4TT.

When the westbound train occupies section 2T, track relay 2TR releases and its contacts additionally interrupt the line circuit for signal 6L and also interrupt the circuit for the primary winding of transformer 2TT.

When the train vacates section 4T, track relay 4TR picks up, and its front contact 138 again connects the secondary winding of transformer 4TT across the rails of section 4T. However, at this time relay 6LPC is released, so that energy is not supplied from the rails of section 5T to relay 6ZR, with the result that contact 132 of relay 6ZR continues to interrupt the circuit for the primary winding of transformer 4TT. Accordingly, at this time alternating current is not supplied to the rails of section 4T.

If signal 2L is now cleared to permit the westbound train to pass out of the single track stretch, the train may advance into section 1T, so that relay 1TR releases and in turn, releases relay 2LHD, contact 145 of which further interrupts the circuits for supplying alternating current to the rails of sections 1T and 8T.

When signal 2L is cleared, relay 2LRGP releases, and, as will be clear by placing Fig. 1C at the left of Fig. 1A, the release of relay 2LRGP opens the circuit for the signal control relay 4RHD for the opposing signal at the left hand end of the passing siding. Relay 4RHD releases and by opening its contact 112 cuts off the supply of alternating current from the rails of sections 3T and 7T of the stretch of main track adjacent the passing siding.

When the train vacates the single track block so that relays 1TR and 2TR pick up, current is supplied over line wires 23 and 24 to the mechanism for signal 6L to cause it to display a permissive indication and to establish the circuit of relay 6LPC so that it picks up to release relay 6LSR and to cause current of normal polarity to be supplied to the line wires 40 and 41. This current keeps the neutral contacts of relay 4LHD picked up and moves the polar contacts of the relay to their left hand or normal position so that if the signal 4LA is again cleared for a following train, the signal will display its green or proceed indication.

When relay 6LPC picks up, its front contacts 127 and 128 again establish the circuit previously traced for connecting the primary winding of transformer 6ZT across the rails of section 5T. Accordingly the alternating current supplied over the rails of section 5T energizes the relay 6ZR through the transformer 6ZT and the rectifier 6ZK. When contact 132 of relay 6ZR picks up, it establishes the circuit for the primary winding of transformer 4TT, with the result that alternating current is again supplied to the rails of section 4T, and through the transformer 2—4TT to the rails of section 2T.

When the train vacates section 1T and the track relay 1TR picks up, its front contacts in the circuit for relay 2LHD again close, but relay 2LHD remains deenergized because relay 8TR is released due to the occupancy of section 8T by the train. As a result, no alternating current is supplied to the rails of section 1T at this time, since the circuit for the primary winding of transformer 1TT remains interrupted by contact 145 of relay 2LHD. When relay 1TR picks up and energy is again supplied over the line wires 23 and 24 to the mechanism for signal 6L, relay 2LAR again becomes energized and its contact 142 in the circuit for transformer 1TT is closed.

When the westbound train under discussion progresses further, and vacates section 3T of the single track block at the left, relay 2LHD will again be energized, and when its contact 145 picks up, energy is supplied to the primary winding of transformer 1TT, and as a result, alternat-

ing current is supplied to the rails of section 1T and through the transformer 1—3TT to the rails of section 3T. The system is now in the condition originally described.

It will now be assumed that the operator at the control office desires to set up the system for a train movement from left to right. Accordingly, control codes are set to field stations 1—2 and 3—4 and relay 2WFSR is operated to its reverse position and relay 4EFSR is operated to its normal position.

As explained above, when the traffic relays 2WFSR and 4EFSR at the opposite ends of the single track stretch are positioned for westbound traffic, energy is supplied to the reversible line circuits which control the wayside signals at the west or exit end of the stretch and is cascaded or repeated to the east or entrance end of the stretch. In addition, the supply of alternating motor car indicator control current to the track rails is governed by the traffic relays 2WFSR and 4EFSR in such manner that when the stretch is set up for westbound traffic, alternating current is supplied to the track rails at the east or entrance end of the stretch and is cascaded or repeated to the west or exit end of the stretch.

As hereinafter explained, when the traffic relays 2WFSR and 4EFSR are positioned to establish eastbound traffic in the single track stretch, energy is supplied to the reversible line circuits for governing the wayside signals at the east end, which therefore becomes the exit end, and the west end then becomes the entrance end. Similarly, when the traffic relays 2WFSR and 4EFSR are positioned for eastbound traffic in the track stretch, the supply of alternating current to the rails of the stretch is transferred from the east to the west end of the stretch so as to be supplied at the new entrance end of the stretch.

In order to cause the traffic relays 2WFSR and 4EFSR to change the signaling system from westbound to eastbound traffic, the contacts of relay 3WFSR are moved from their normal to their reverse position and the contacts of relay 4EFSR are moved from their reverse to their normal position.

On movement of the contacts of relay 2WFSR to their reverse position, the supply of current to line wires 23 and 24 is cut off and these wires are connected to relay 2RHD. When the supply of current to wires 23 and 24 is cut off, the signal 6L goes to stop and interrupts the supply of current to relay 6LPC and it releases to cut off the supply of current to line wires 40 and 41, and to interrupt the pick-up circuit of relay 6LSR to insure that it remains released. When the supply of current to line wires 40 and 41 is cut off, the relay 4LHD releases, if it is not already released because of interruption of its circuit due already because of interruption of its circuit due to movement of contacts 50 and 51 of relay 4EFSR to their normal position.

When the contacts 50 and 51 of relay 4EFSR move to their normal position, current of one polarity or the other is supplied to line wires 40 and 41 through the winding of relay 4RAR. The polarity of the current supplied to wires 40 and 41 is governed by contacts of relay 4RPC, which is controlled in the usual manner in accordance with the indication displayed by signal 4R.

The current supplied to line wires 40 and 41 feeds over back contacts of relays LPC and 6LSR to the mechanism for signal 6R and conditions this signal to display an appropriate indication, while the contacts of the signal mechanism establish a circuit for relay 6RPC and it picks up to establish a circuit for supplying current of normal polarity to line wires 23 and 24.

The current supplied to line wires 23 and 24 is supplied over reverse polar contacts 20 and 21 of relay 2WFSR to relay 2RHD and picks up its neutral contacts and moves its polar contacts to their left-hand or normal position, so as to enable current to be supplied over its contacts to the mechanism for signal 2RA when the contacts of relay 2RHSR are reversed in order to clear signal 2RA for an eastbound train movement.

When contacts of relay 4EFSR are operated to their normal position, contact 123 interrupts the circuit for the primary winding of transformer 6TT, and as a result the supply of alternating current from transformer 6TT to the rails of section 6T is cut off. Accordingly, alternating current is no longer supplied from the rails of section 6T through the transformer 5—6TT to the rails of section 5T, and as a result energy ceases to be supplied to transformer 6ZT, and through transformer 6ZT and the rectifier 6ZK to the indicator control relay 6ZR, if it has not already been cut off because of release of relay 6LPC. When relay 6ZR releases, its contact 132 interrupts the supply of energy to the primary winding of transformer 4TT, so that the supply of alternating current from transformer 4TT to the rails of section 4T is interrupted, if it is not alread interrupted because of picking up of relay 6RPC, and the alternating current supplied from the rails of section 4T through the transformer 2—4TT to the rails of section 2T is also cut off.

Additionally, when the contacts of relay 4EFSR operate to their normal position, polar contact 115 establishes a circuit including front contact 147 of relay 4RAR for supplying energy to transformer 3TT.

When relay 6LPC releases, its contacts 127 and 128 interrupt the circuit for connecting the primary winding of transformer 6ZT to the rails of section 5T, and establishes the circuit for connecting the secondary winding of transformer 5TT to the rails of section 5T.

When signal 6R clears, the relay 6RPC is energized and its contacts pick up, and its contacts 136 and 139 disconnect the secondary winding of transformer 4TT from the rails of section 4T, and connect the rails of section 4T to the primary winding of transformer 6ZT.

When relay 2WFSR reverses, its contact 140 establishes the circuit for the primary winding of transformer 2TT, which circuit is traced from terminal BX, over front contact 148 of relay 3TR, front contact 149 of relay 2TR, front contact 151 of relay 2RRGP in multiple with front contact 152 of relay 2LHD and correspondence contact 150, reverse polar contact 140 of relay 2WFSR, over front contact 153 of track relay 1TR, and through the primary winding of transformer 2TT to terminal CX. As a result, alternating current is supplied to the rails of section 2T and through the windings of transformer 2—4TT to the rails of section 4T and over the rails of section 4T to the primary winding of transformer 6ZT. The energy supplied to the primary winding of transformer 6ZT induces alternating current in the secondary winding of the transformer which is rectified by the full-wave rectifier 6ZK, and is supplied to the winding of the indicator control relay 6ZR. When relay 6ZR picks up, it

establishes a circuit including back contact 134 of relay 6LPC for the primary winding of transformer 5TT. As a result, alternating current is supplied to the rails of section 5T and through the windings of transformer 5—6TT to the rails of section 6T. As previously explained, the supply of energy to the primary winding of transformer 6TT is cut off by polar contact 123 of relay 4EFSR which now occupies its normal position.

When traffic relay 2WFSR reverses its contacts, the supply of current to the winding of relay 2LAR is interrupted and relay 2LAR releases so that its front contact 142 interrupts the circuit for the primary winding of transformer 1TT.

It will be apparent that alternating current is now supplied at the entrance end of the single track stretch, and is cascaded from the west or entrance end of the stretch to the east, or the exit end of the stretch, in a manner similar to that originally described for westbound traffic, so that alternating current is supplied to each section in the stretch.

Although the supply of alternating current is interrupted for a short time while the direction of traffic is being changed, this interval is usually short enough so that the motor car operator is not likely to remove the car from the track before the alternating current is again supplied to the rails.

The operation of the equipment when the east-bound signals 2RA or 2RB are cleared, and when an east-bound train moves into and through the stretch is similar to that described above for the westbound direction, and a detailed description of the operation under such circumstances is considered unnecessary.

From the foregoing it will be seen that my invention provides means for at times supplying alternating current to the rails of each section on a stretch of single track railway through which traffic may move in either direction. The alternating current is supplied to the section at the entrance end of the stretch and is cascaded through the track sections to the exit end of the stretch. When a train approaches and the signal authorizes entrance of the train into the stretch, and when the train moves through the stretch, the supply of alternating current is cut off at the entrance end of the stretch, and, consequently, is cut off throughout the stretch and remains cut off in advance of the train as the train moves through the stretch. Alternating current is again supplied to the sections in the rear of the train after the train has advanced a predetermined distance from the section.

Additionally, alternating current is supplied to the rails of the sections of main track adjacent the passing siding during the time that the signals governing the entrance of trains into these sections are at stop and no train is occupying any of the sections. When a train is authorized to proceed through these sections, the alternating current is cut off from the rails ahead of the train and after the train has vacated the sections, alternating current is again supplied to the rails of the sections in the rear of the train.

Accordingly, it will be apparent that motor cars equipped with apparatus responsive to the presence or absence of alternating current in the rails over which the motor cars operate will be provided with information as to traffic conditions in the stretch, so that on the approach of a train authorized to enter the stretch the

operators of the cars are warned in ample time to remove the car from the track.

Referring to Figs. 2A, 2B and 2C of the drawings, there is shown a modification of my invention which I may employ. The wayside signaling circuits are substantially the same as shown in Figs. 1A, 1B and 1C and a detailed explanation of their arrangement and operation is not considered necessary.

Each of the track sections in Figs. 2A, 2B and 2C is provided with a track transformer TT having its secondary winding connected across the rails at the track relay end of the section, and the track battery TB located at the other end of the section has a reactor in series therewith to limit the flow of alternating current through the battery.

In addition, a supplementary two-wire line circuit is provided, which extends the length of the single track stretch. This supplementary line circuit is governed by the traffic relays 2WFSR and 4EFSR at the opposite ends of the stretch in such a manner that it is supplied with energy at the entrance end, in accordance with the direction of traffic established, by these relays.

Furthermore, as hereinafter explained, the supply of energy to the supplementary line circuit is also governed by traffic conditions in the track stretch approaching the ends of the single track stretch with which the line circuit is associated.

Indicator control relays are connected across the supplementary line circuit at locations where it is desired to supply alternating current to the track sections in the single track stretch. The supplementary line circuit for the indicator control relays is carried over front contacts of each of the track relays for the track sections in the single track stretch for purposes hereinafter explained.

The supply of alternating current to the rails of the track sections in the main track portions beside the passing sidings is governed by the relays which govern the signals controlling entrance of traffic into these track sections.

The system of Figs. 2A, 2B and 2C is shown in the condition which it assumes when the track stretch is vacant, the head block signals are all at stop, and the reversible signal circuits are set up as required for westbound traffic.

At this time current is supplied to the line wires 157 and 158 of the supplementary line circuit at the east end of the stretch, where contact 160 of traffic relay 4EFSR, Fig. 2C is reversed to connect the supplementary line wire 157 to terminal B of the local source of current over front contact 162 of relay 4LRGP and front contact 163 of relay 4RHD in multiple, and line wire 158 is connected to terminal C of this source at contact 188 of relay 3TR. Since all of the track relays are picked up, it will be apparent from the drawings that each of the indicator control relays 2WKR, 2EKR, 6KR, 4WKR, and 4EKR are energized at this time. The primary winding of transformer 1TT, Fig. 2A, is supplied with energy over a circuit extending to terminal BX of an alternating current source at front contact 165 of relay 2WKR, and the primary winding of transformer 2TT is supplied with energy over a circuit extending to terminal BX at front contact 167 of relay 2EKR. The primary windings of transformers 4TT and 5TT are supplied with energy over circuits including front contacts 169 and 172 of relays 4TR and 5TR, respectively, which extend

to terminal BX at front contact 170 of relay 6KR. The primary winding of transformer 6TT is supplied with energy at this time over a connection to terminal BX at front contact 174 of relay 4WKR, and the primary winding of transformer 3TT is connected to terminal BX at front contact 175 of relay 4EKR. In addition, the primary winding of transformer 7TT is supplied with energy over a circuit including front contact 177 of relay 4RHD and extending to terminal BX over front contact 178 of relay 4LHD in multiple with a normal polar contact 179 of relay 4RHSR, and the primary winding of transformer 8TT is supplied with energy over a circuit including front contact 181 of relay 2LHD extending to terminal BX over front contact 182 of relay 2RHD in multiple with a normal polar contact 183 of relay 2LHSR.

Accordingly, it will be apparent that at the time, alternating current is supplied to the rails of each of the track sections in the single track stretch and in the main track stretch adjoining the passing sidings so that a motor car moving through the stretch at this time will receive alternating current from the rails of each section, thereby indicating that it is safe for the car to be operated in the stretch.

It is now assumed that the operator desires to clear the westbound head block signal 4LA to authorize an approaching westbound train to move through the stretch from right to left. Accordingly, a control code is sent from the office to field station 3—4 to reverse relay 4LHSR. When signal 4LA clears, the circuit for relay 4LRGP is interrupted, and its contact 162 opens, but current continues to be supplied to the supplementary line wires 157 and 158 over front contact 163 of relay 4RHD. When the train approaches within the control limits of relay 4RHD, and enters section 1T, as shown by placing Fig. 2A at the right of Fig. 2C, or when the supply of energy to relay 4RHD is cut off as a result of clearing the westbound entering signal 2L, relay 4RHD releases and its front contact 177 interrupts the supply of energy to the primary winding of transformer 7TT, and as a result, the supply of alternating current to section 7T is cut off.

In addition, when relay 4RHD releases its front contact 163 interrupts the supply of energy to supplemental line wires 157 and 158, and the indicator control relays 2WKR, 2EKR, 6KR, 4WKR, and 4EKR are deenergized and their contacts release, thereby interrupting the supply of alternating current to the rails of sections 1T, 2T, 3T, 4T, 5T and 6T.

It will be apparent that a motor car moving over any of these sections will receive no alternating current at this time, thus indicating the approach of a train.

When the westbound train passes signal 4LA and enters section 3T, track relay 3TR releases, and as a result, signal 4LA is restored to stop and the contacts of the signal control relay 4LHSR are restored to normal. When signal 4LA is restored to stop, the circuit for relay 4LRGP is established and relay 4LRGP picks up. Contact 162 of relay 4LRGP is again closed, but since the contacts of track relay 3TR are released, no energy is supplied over the supplemental line circuit to the indicator control relays and they remain released.

When the train advances into sections 6T and 5T, relays 6TR and 5TR release and further interrupt the supply of energy to the supplemental line wires 157 and 158.

When the train vacates section 3T, relay 3TR picks up, and relay 4RHD is again energized. When relay 4RHD picks up, energy is supplied to the primary winding of transformer 7TT by the circuit which includes front contact 177 of relay 4RHD and normal polar contact 179 of relay 4RHSR, so that alternating current is again supplied to the rails of section 7T in the rear of the westbound train.

At this time, that is to say, when relay 3TR picks up, a circuit is established for energizing relay 4EKR extending from terminal B at reverse polar contact 160 of relay 4EFSR, over front contact 162 of relay 4LRGP, and front contact 163 of relay 4RHD in multiple, over front contact 185 of relay 3TR through the winding of relay 4EKR to terminal C. When relay 4EKR picks up, its contact 175 completes the circuit for the primary winding of transformer 3TT so that alternating current is now supplied to the rails of section 3T.

Although when relay 3TR picks up connections are established for supplying energy to the right hand or east end of the supplementary line wires 157 and 158, the circuits which include these wires are interrupted by contacts of the track relays of the occupied track sections so as to prevent the supply of energy to the indicator control relays governing the supply of alternating current to the rails of the sections occupied by the train or in advance of the train. Accordingly, the supply of alternating current to the occupied sections and to the sections in advance of the train continues to be interrupted so that the indication means on a motor car present in one of these sections will display a danger indication.

When the train advances into sections 4T and 2T, relays 4TR and 2TR release to further interrupt the circuits which include the line wires 157 and 158.

When the train vacates section 6T, relay 6TR picks up and energy is supplied to relay 4WKR over a branch of the circuit for relay 4EKR which includes front contact 185 of relay 3TR, the winding of relay 4WKR, front contact 187 of relay 6TR, and extends to terminal C at front contact 188 of relay 3TR. When relay 4WKR picks up, its front contact 174 completes the circuit for the primary winding of transformer 6TT, so that alternating current is supplied to the rails of section 6T.

As pointed out above, the contacts of the track relays of the occupied sections prevent the supply of energy over the supplementary line circuit to the other indicator control relays and they remain released to prevent the supply of alternating current to the associated sections.

When the train vacates section 5T, relay 5TR picks up, and energy is again supplied over the supplementary line wires 157 and 158 to relay 6KR. Additionally, front contact 172 of relay 5TR is closed so that alternating current is again supplied over front contact 170 of relay 6KR to the primary winding of transformer 5TT, and as a result, alternating current is supplied to the rails of section 5T.

Although front contact 170 of relay 6KR is picked up, energy is not supplied to the primary winding of transformer 4TT since contact 169 of relay 4TR remains released as long as the train occupies section 4T.

If signal 2L is now cleared to permit the train

to leave the single track stretch, relay 2LHSR, Fig. 2A, will be reversed, and its normal polar contact 183 will interrupt the circuit for the primary winding of transformer 8TT, so that alternating current will not be supplied to the rails of section 8T.

In addition, when signal 2L is cleared, relay 2LRGP is released and causes release of the opposing signal control relay at the other end of the passing siding, corresponding to relay 4RHD as shown by placing Fig. 2C at the left of Fig. 2A, thus cutting off the supply of alternating current from the rails of section 7T in the stretch of main track adjacent the passing siding.

When the train passes signal 2L, track relay 1TR releases and relay 2LHSR is restored to its normal position. However, the contacts of relay 1TR now interrupt the circuit for relay 2LHD and its contact 181 releases to further interrupt the circuit for the primary winding of transformer 8TT, so that the supply of alternating current to the rails of section 8T continues to be interrupted.

Additionally, when relay 1TR releases, its front contact 191 further interrupts the supply of energy over the supplementary line circuit to relay 2WKR, with the result that relay 2WKR remains released and prevents the supply of alternating current to the rails of section 1T.

When the rear of the train vacates section 4T, contact 169 of relay 4TR picks up, and since contact 170 of relay 6KR is picked up, energy is now supplied to the primary winding of transformer 4TT with the result that alternating current is again supplied to the rails of section 4T. When the rear of the train vacates section 2T, track relay 2TR picks up, and its contacts 193 and 194 again establish the connection between relay 2EKR and the supplementary line wires 157 and 158, so that energy is supplied to the winding of relay 2EKR. Accordingly, its contact 167 picks up with the result that energy is again supplied to the primary winding of transformer 2TT so that alternating current is supplied to the rails of section 2T.

When the train vacates section 1T, track relay 1TR picks up and its front contact 191 again establishes the connection between the supplementary line wires 157 and 158 and the winding of relay 2WKR, so that relay 2WKR is energized. When contact 165 of relay 2WKR picks up, energy is again supplied to the primary winding of transformer 1TT and as a result, alternating current is again supplied to the rails of section 1T.

When the train advances beyond the control limits of relay 2LHD, relay 2LHD will be energized and its neutral contact 181 will again establish the circuit for the primary winding of transformer 8TT and as a result alternating current will be supplied to the rails of section 8T.

The system is now restored to the condition originally described. Since the circuits are symmetrical, the operation of the equipment for a movement of an eastbound train through the stretch is similar to that described above for a westbound train movement and a detailed explanation is considered unnecessary.

From the foregoing it will be apparent that the arrangement of apparatus embodying my invention as shown in Figs. 2A, 2B and 2C operates so that alternating current is normally supplied to the rails of each section in the single track stretch and in the main track portions beside the passing sidings, and that the alternating

current is cut off from the rails of each section in the stretch upon the approach of a train authorized to enter the track stretch, and continues to be interrupted during passage of a train through the stretch. In addition, this modification is arranged so that alternating current is supplied to the rails of each section in the stretch when the rear of the train vacates the section. Accordingly, on the approach of a train authorized to enter a stretch, the operators of motor cars moving through the stretch will be warned in ample time to remove the car from the rails and the supplementary signaling system also provides protection for following moves made by motor cars after the train has passed.

On the other hand, the approach of a train not authorized to enter a stretch does not interfere with the supply of alternating current to the rails of the stretch and hence does not cause the indication means on a motor car in the stretch to display its warning indication. This insures that trains will not interfere with operation of the motor cars unless the trains are a hazard to the motor cars.

Although I have herein shown and described only two forms of apparatus embodying my invention, it is to be 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. In a supplemental signaling system for governing indicators on special railway vehicles having insulated wheels and provided with indication means responsive to control current supplied to the rails over which the vehicle operates, the combination comprising a stretch of railway track through which traffic at times moves in a selected direction, the rails of said track stretch being divided into a plurality of track sections, each of said track sections being provided with a track circuit including a source of current and a track relay responsive thereto but not to said control current, a control circuit comprising a line circuit extending the length of the stretch and having in series therewith front contacts of said track relays, means governed by traffic conditions adjacent the entrance end of said stretch for supplying energy to said control circuit at the entrance end of said stretch, and means responsive to energy supplied over said line circuit for supplying said control current to the rails of each of said sections.

2. In a supplemental signaling system for a stretch of railway track through which special vehicles having insulated wheels are operated at times, said special vehicles being equipped with indication means responsive to the flow of current of a distinctive character in the track rails, said track stretch being divided into a plurality of successive track sections each of which is provided with a track circuit for detecting the presence of a train therein comprising a source of current connected across the rails of the section at one end and a track relay responsive thereto connected across the rails at the other end, said track stretch being provided with a principal signaling system comprising a system of reversible circuits governed by said track relays and by manually controllable traffic governing means located at each end of said stretch and controlling signals for governing the movement of trains into and through said stretch in one direction or the

other as designated by said traffic governing means, said supplemental signaling system comprising a line circuit extending the length of the stretch and having in series therewith front contacts of said track relays, means governed by traffic conditions adjacent the entering end of said stretch and by said traffic governing means for supplying energy to said control circuit at the designated entrance end of said stretch, and means for each of said track sections responsive to energy supplied over said line circuit for supplying current of said distinctive character to the rails of such section for the control of the indication means on a special vehicle in such section.

3. In a supplemental signaling system for a stretch of railway track through which special vehicles having insulated wheels are operated at times, said special vehicles being equipped with indication means responsive to current of a distinctive character in the track rails, said track stretch being divided into a plurality of track sections and provided with a principal signaling system for the control of train movements including a signal at each end of the stretch and a system of reversible circuits extending the length of said track stretch for controlling said signals in accordance with traffic conditions in said stretch, said principal signaling system also including traffic control means at the ends of said stretch manually governed from a central office to condition said system of reversible circuits to prepare said stretch for traffic in one direction or the other and thereby permit clearing of the signal at the corresponding entrance end of the stretch, and having signal control means at each end of said stretch manually controlled from said office effective normally to hold the associated signal at stop and to clear the associated signal only when said system of reversible circuits has prepared the stretch for traffic in the direction in which said signal is at the entrance end of the stretch, said supplemental signaling system comprising supplemental control means at each end of said stretch for supplying said current of distinctive character to the rails of each section in the stretch, means governed by the traffic control means at each end of the stretch for controlling the associated supplemental control means so that said current of distinctive character is supplied to the rails at the entrance end of the stretch, and means governed by the signal control means at each end of the stretch for controlling the associated supplemental control means so that it is rendered ineffective to supply said current of distinctive character when said signal control means is operated to clear the associated signal.

4. In a supplemental signaling system for a stretch of railway track through which special vehicles having insulated wheels are operated at times, said special vehicles being equipped with indication means responsive to the presence of current of a distinctive character in the track rails, said track stretch being divided into a plurality of track sections and provided with a principal signaling system including a signal for the control of train movements at each end of the stretch and a system of reversible circuits extending the length of said track stretch for controlling said signals in accordance with traffic conditions in said stretch, said principal signaling system also including traffic control means at the ends of said stretch manually governed from a central office to condition said system of reversible circuits to prepare said stretch for

traffic in one direction or the other and thereby permit clearing of the signal at the corresponding entrance end of the stretch, and having signal control means at each end of said stretch manually controlled from said office effective normally to hold the associated signal at stop and to clear the associated signal only when said system of reversible circuits has prepared the stretch for traffic in the direction in which said signal is at the entrance end of the stretch, said supplemental signaling system comprising supplemental control means at each end of said stretch for supplying said current of distinctive character to the rails of each section in the stretch, means for governing each supplemental control means so that it is effective to supply said current of distinctive character to the rails only when the associated traffic control means designates the end of the stretch at which such supplemental control means is located as the entrance end of the stretch and so that each supplemental control means is rendered ineffective when the associated signal control means is operated to clear the signal governed thereby.

5. In a supplemental signaling system for a stretch of railway track through which special vehicles having insulated wheels are operated at times, said special vehicles being equipped with indication means responsive to the presence of alternating current in the track rails, said track stretch being divided into a plurality of track sections and provided with a principal signaling system including a signal for the control of train movements at each end of the stretch and a system of reversible circuits extending the length of said track stretch for controlling said signals in accordance with traffic conditions in said stretch, said principal signaling system also including traffic control means at the ends of said stretch manually governed from a central office to condition said system of reversible circuits to prepare said stretch for traffic in one direction or the other and thereby permit clearing of the signal at the corresponding entrance end of the stretch, and having signal control means at each end of said stretch manually controlled from said office which normally holds the associated signal at stop and is effective to clear the associated signal only when said system of reversible circuits has prepared the stretch for traffic in the direction in which said signal is at the entrance end of the stretch, said supplemental signaling system comprising supplemental control means at each end of said stretch for supplying alternating current to the rails of each section in the stretch, means for rendering each supplemental control means effective to supply said alternating current to the track rails when the associated traffic control means designates that direction for train movements for which said supplemental control means is at the entrance end of the stretch, provided either that the associated entering signal is held at stop by its signal control means or an approach section of track adjoining said entrance end of the stretch is not occupied by a train.

6. In a supplemental signaling system for a stretch of railway track through which special vehicles having insulated wheels are operated at times, said special vehicles being equipped with indication means responsive to alternating current in the track rails, said track stretch being divided into a plurailty of track sections and provided with a principal signaling system in-

cluding a signal at each end of the stretch for the control of train movements and a system of reversible circuits extending the length of said track stretch for controlling said signals in accordance with traffic conditions in said stretch, said principal signaling system also including traffic control means at the ends of said stretch manually governed from a central office to condition said system of reversible circuits to prepare said stretch for traffic in one direction or the other and thereby permit clearing of the signal at the corresponding entrance end of the stretch, and having signal control means at each end of said stretch manually controlled from said office which normally holds the associated signal at stop and is effective to clear the associated signal only when said system of reversible circuits has prepared the stretch for traffic in the direction in which said signal is at the entrance end of the stretch, said supplemental signaling system comprising supplemental control means at each end of said stretch for supplying alternating current to the rails of each section in the stretch, means for rendering each supplemental control means effective to supply said alternating current to the track rails when the associated traffic control means designates traffic in the direction in which said supplemental control means is at the entrance end of the stretch, and means responsive to the presence of an approaching train within a predetermined distance at the end of the stretch at which said supplemental control means is effective for discontinuing the supply of alternating current to the rails of the stretch provided the entering signal has been cleared to authorize said train to enter the stretch.

7. In a supplemental signaling system for a stretch of railway track through which special vehicles having insulated wheels are operated at times, said special vehicles being equipped with indication means responsive to the presence of current of a distinctive character in the track rails, said track stretch being divided into a plurality of track sections each of which is provided with a track circuit including a track relay for detecting the presence of a train therein, said track stretch having a railway signal at one end for governing the movement of trains into said stretch, and having signal control means governed by said track relays for controlling said signal in accordance with traffic conditions in said stretch, said supplemental signaling system

comprising a line circuit extending the length of said stretch which includes front contacts of the track relay for each track section in said stretch, means for each of said sections responsive to energy supplied over said line circuit for supplying said current of distinctive character to the rails of such section, and means governed by said signal control means for supplying energy to said line circuit at the end adjacent said signal.

8. In a supplemental signaling system for a stretch of railway track through which special vehicles having insulated wheels are operated at times, said special vehicles being equipped with indication means responsive to the presence of current of a distinctive character in the track rails, said track stretch being divided into a plurality of track sections each of which is provided with a track circuit including a track relay for detecting the presence of a train therein, said track stretch having a railway signal at one end for governing the movement of trains into said stretch and having means governed by the track relays for controlling said signal in accordance with traffic conditions in said stretch, said supplemental signaling system comprising a line circuit extending the length of said stretch which includes front contacts of the track relay for each track section in said stretch, means for each of said sections responsive to energy supplied over said line circuit for supplying said current of distinctive character to the rails of such section, means governed by said signal for supplying energy to said line circuit at the end adjacent said signal when said signal stands at stop, and means governed by occupany of a portion of the track adjoining said track stretch and constituting an approach zone for said signal for also supplying energy to said line circuit when said signal is cleared provided said approach zone is not occupied by a train.

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