

April 5, 1938.

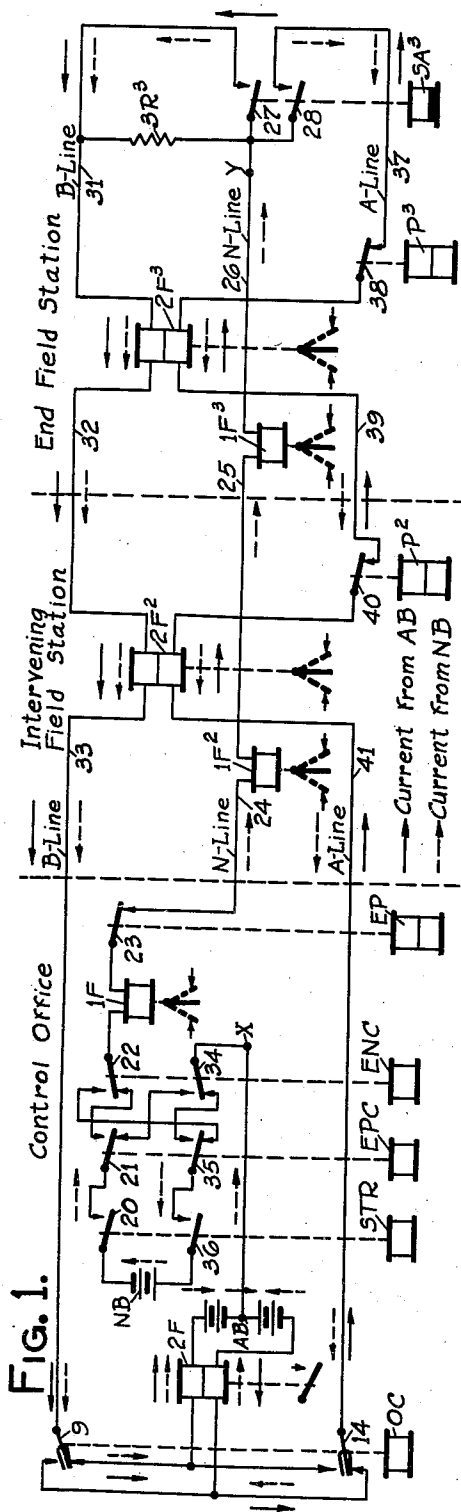
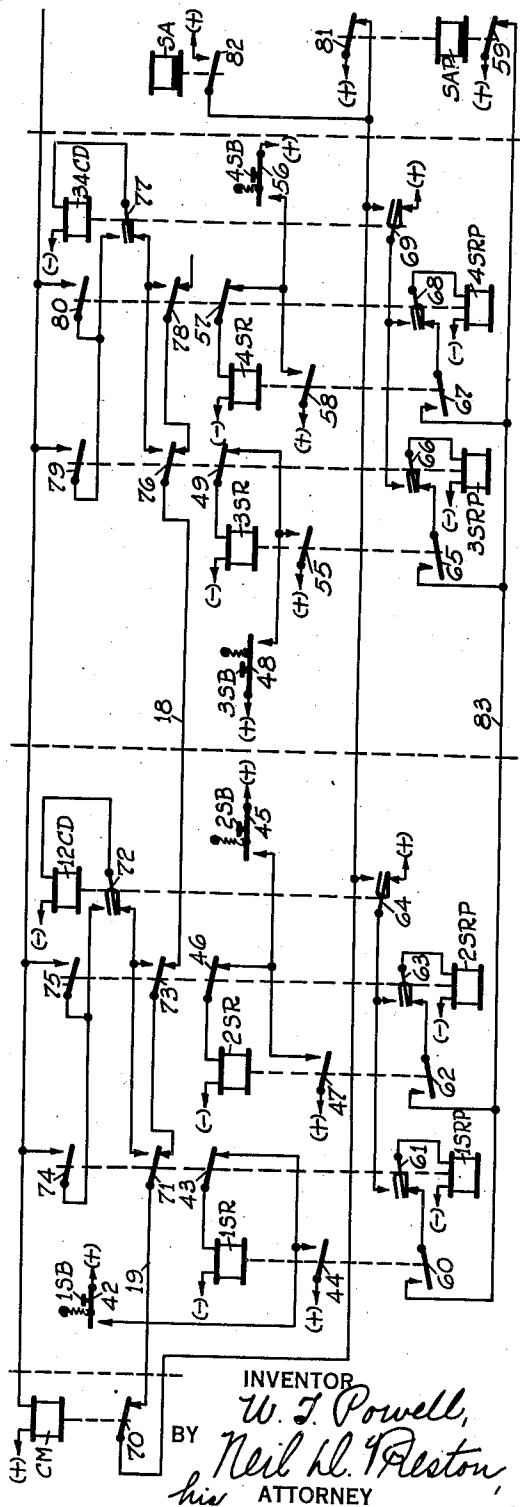
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2,113,383

CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

Filed April 13, 1933

7 Sheets-Sheet 1



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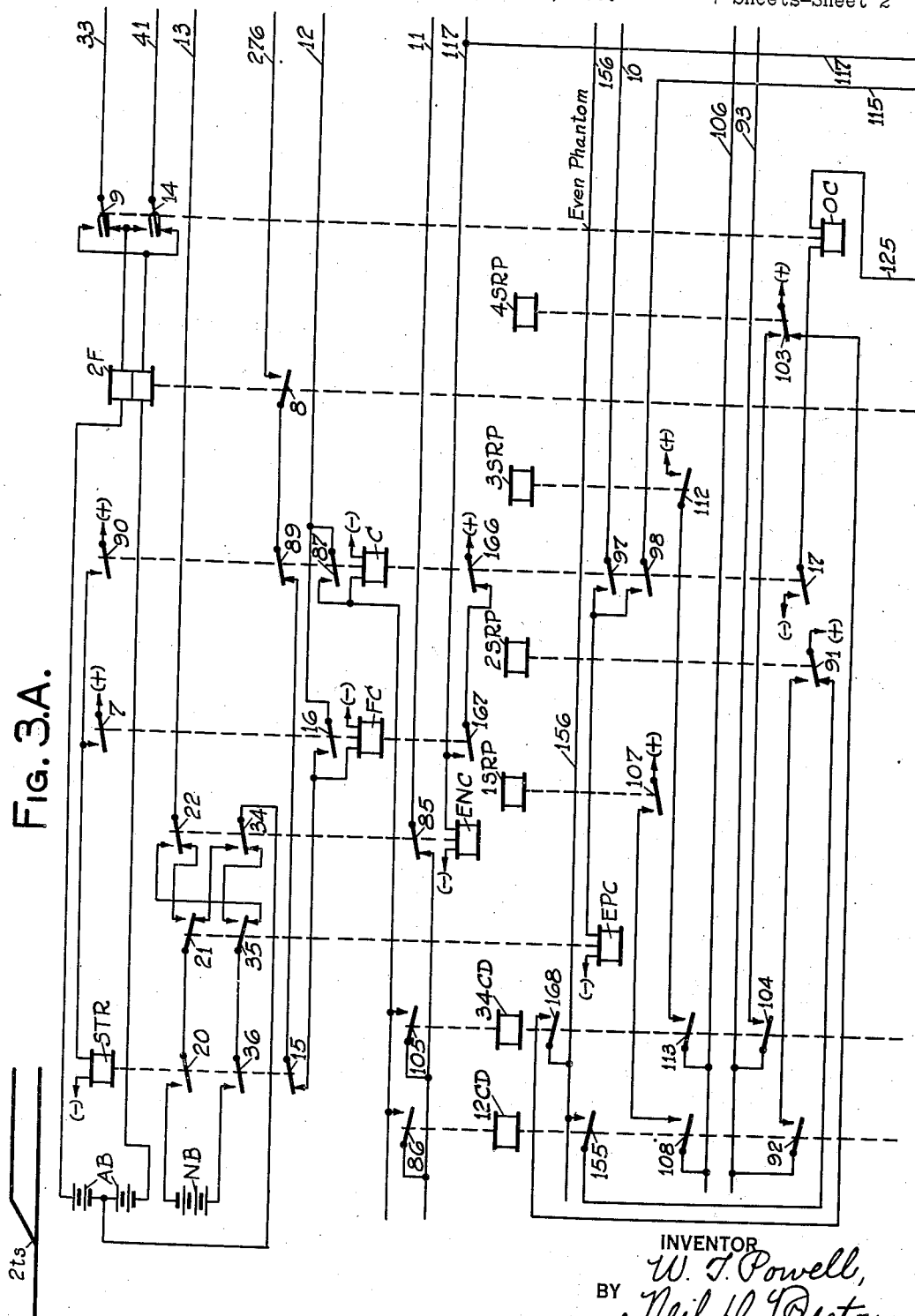
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

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7 Sheets-Sheet 2

Fig. 3.A.



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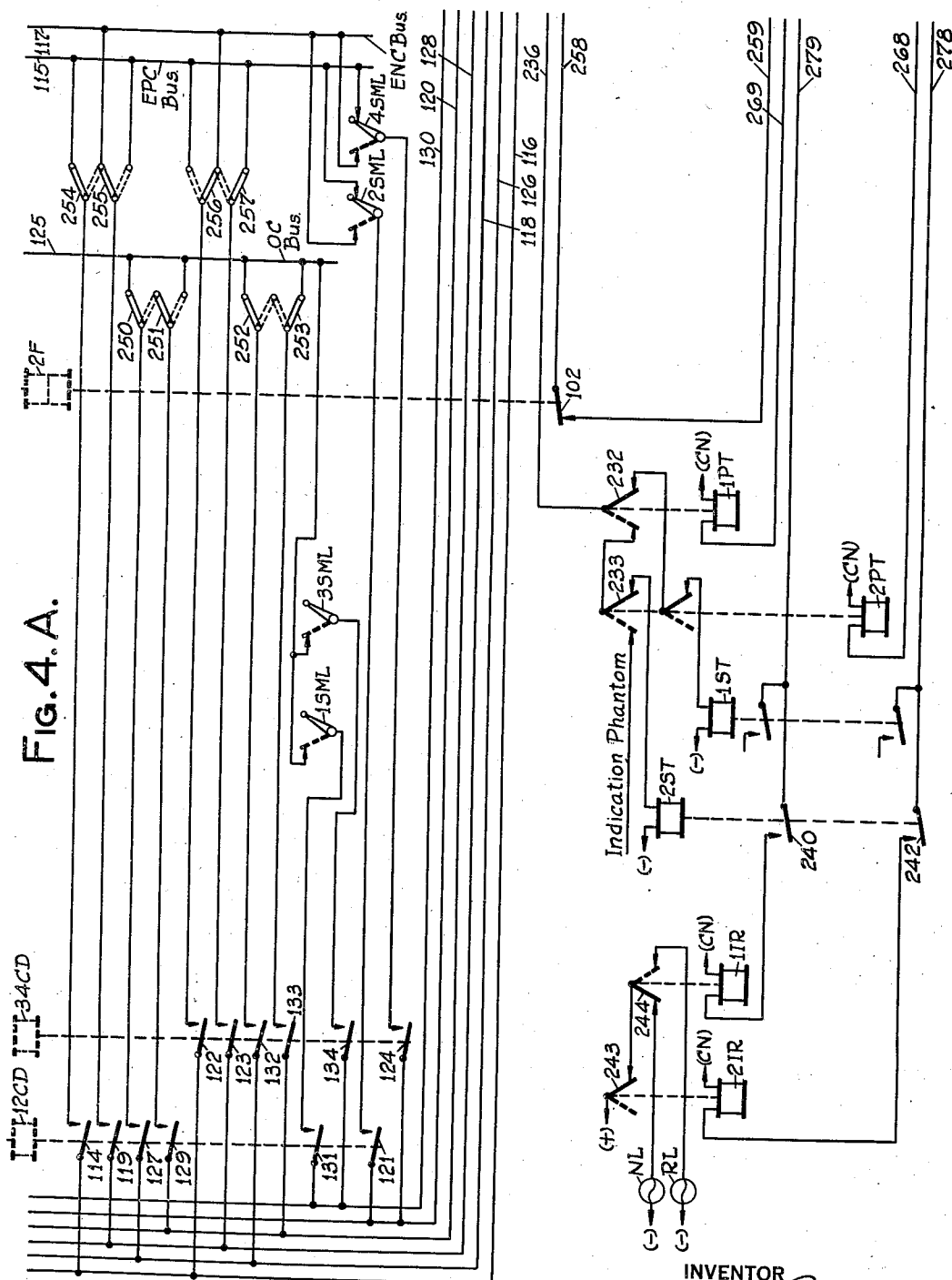
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

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7 Sheets-Sheet 4



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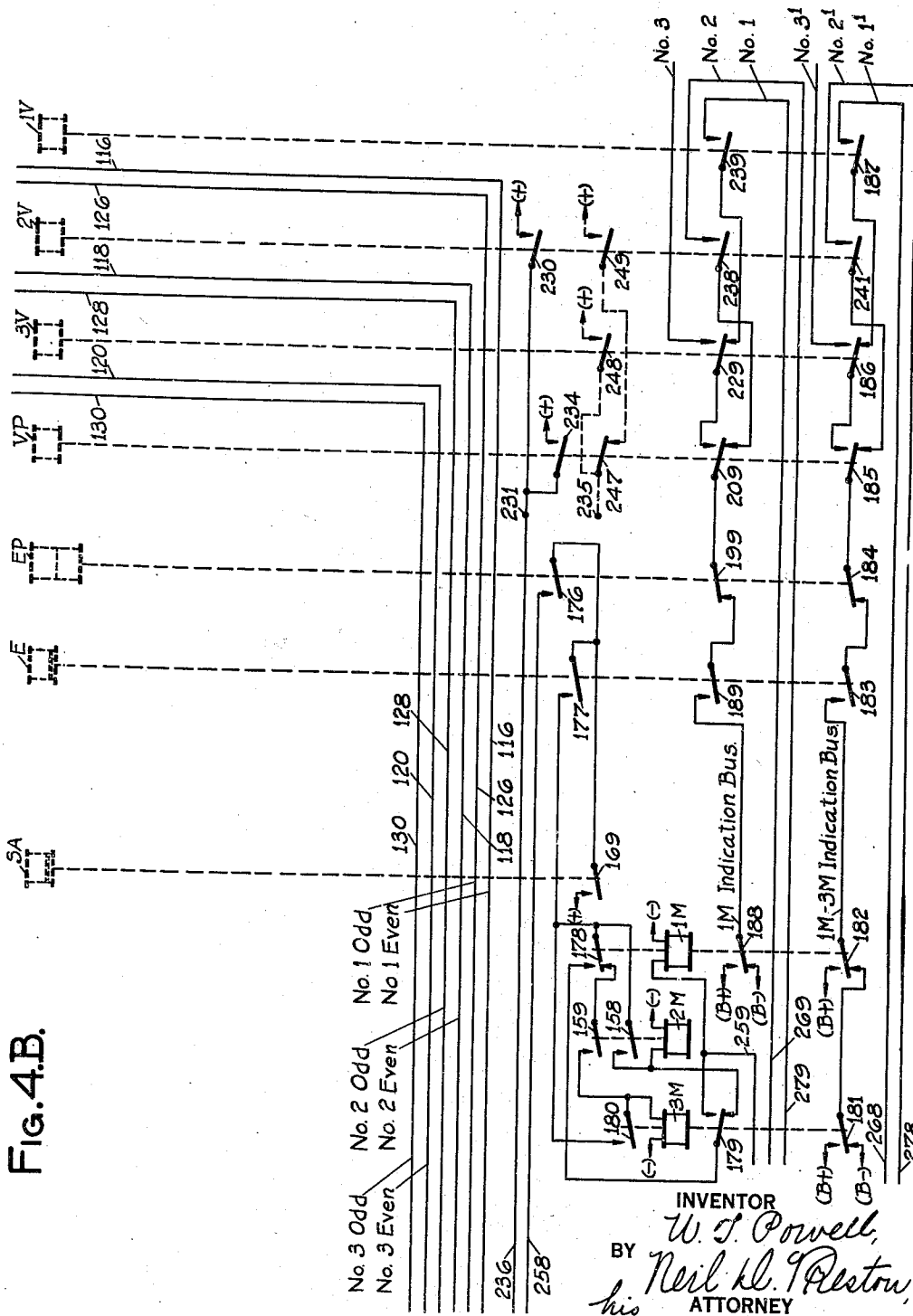
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

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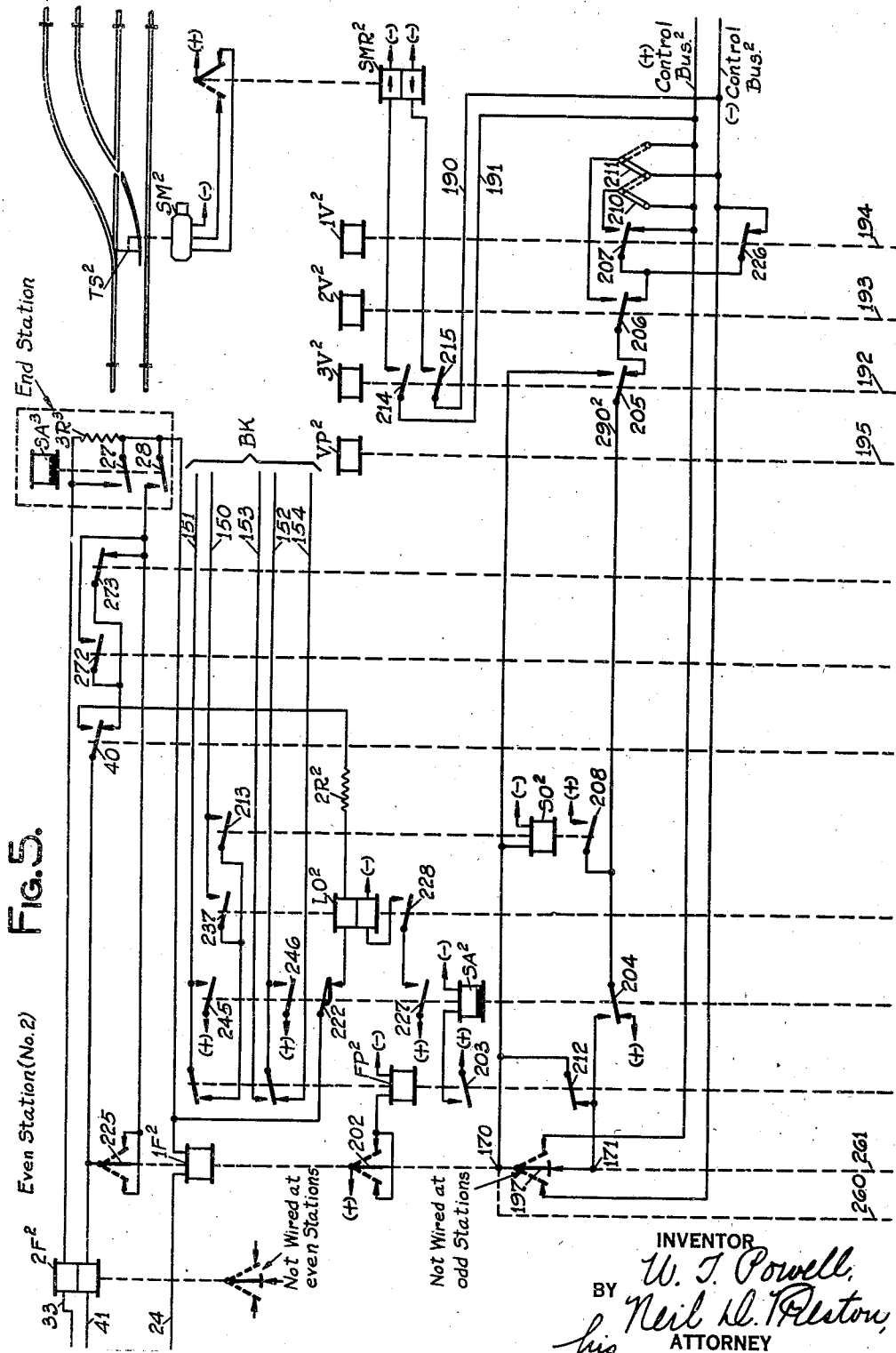
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

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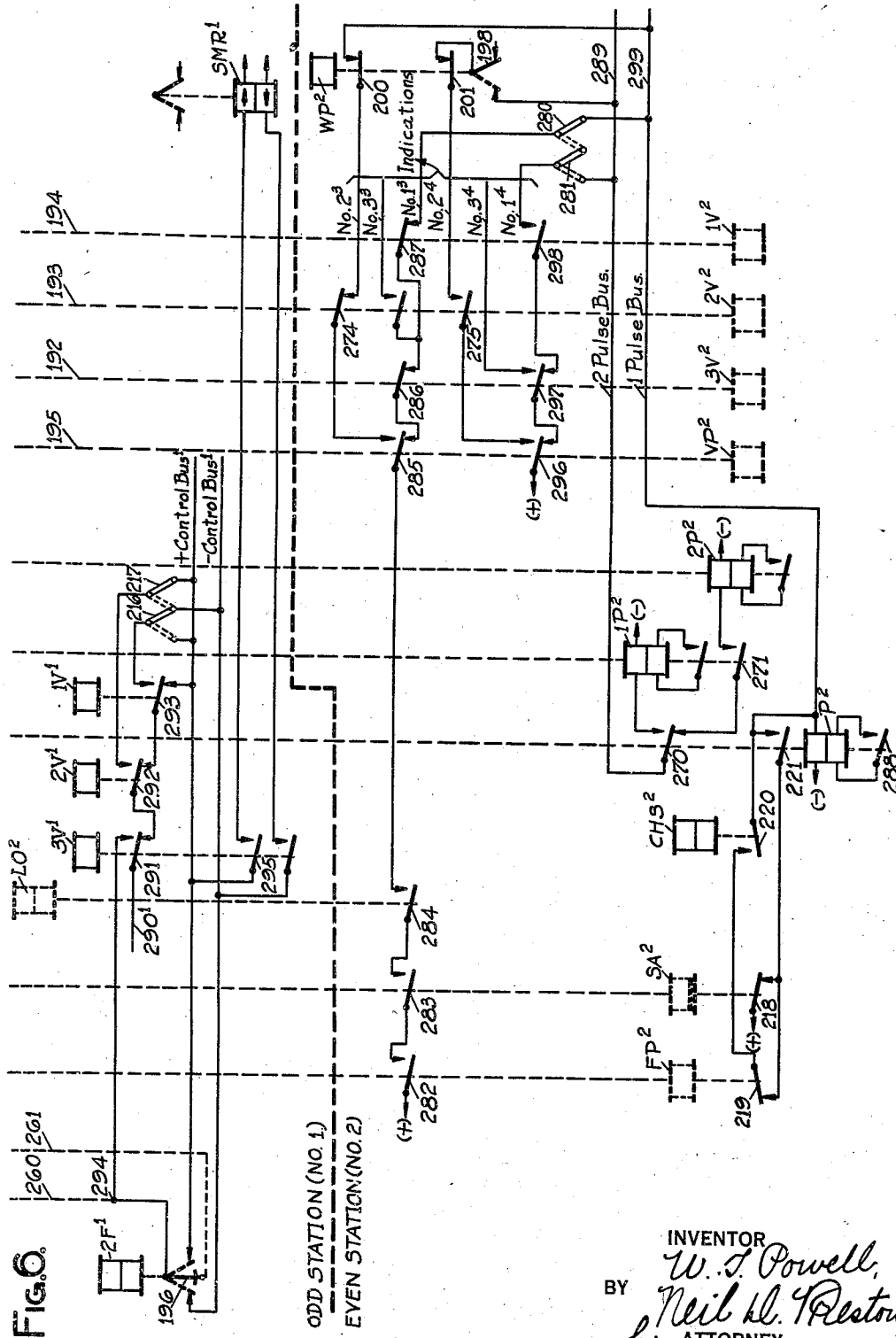
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

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UNITED STATES PATENT OFFICE

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CENTRALIZED TRAFFIC CONTROLLING
SYSTEM FOR RAILROADSWinfred T. Powell, Rochester, N. Y., assignor to
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Application April 13, 1933, Serial No. 665,991

25 Claims. (Cl. 177—353)

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

5 In a centralized traffic controlling system of the type contemplated by the present invention, the switches and signals at various points along a railroad system are placed under the control of an operator in a central control office in such
10 a way that the operator may at will change the position of the switches and signals, subject to the safeguards which are customarily provided to prevent unsafe operations. Also, the system provides means whereby indications are displayed
15 in the control office to inform the operator of the presence or absence of trains on the various track sections throughout the territory under his supervision and to indicate the positions and conditions of the various switches, signals and the
20 like.

This invention is particularly useful in such a system which is called upon to carry out a large number of control and indication functions during a short time. A single dispatcher can handle
25 the traffic over a large section of track, so it is apparent that the controls and indications should be capable of transmission at such a high rate of speed that excessive accumulation of stored controls and indications is avoided.

30 The switches and signals are distributed throughout the territory but those located relatively near or adjacent each other, together with the apparatus provided for their control are conveniently referred to as comprising a field station.
35 The communication system is provided to interconnect the control office with the several field stations and is so organized that the operator obtains complete supervision of the various switch and signal devices at the stations.

40 In accordance with the present invention, the communication system includes three line wires extending from the control office through the several field stations in series. For convenience in describing the operation of the system, these
45 three line wires are referred to as the N, A and B lines. Line N is the neutral line over which stepping impulses and certain control impulses are transmitted. The A and B lines serve as the return conductors for the N line and are also used
50 for transmitting certain other control impulses, as well as indication impulses. In other words, line N in combination with lines A and B comprise the stepping line circuit, while lines A and B in combination with line N comprise the mes-
55 sage line circuit.

Since the system is of the coded duplex type, it is operable through cycles for the transmission of controls and/or the transmission of indications. The system is also of the duplex type which provides for the transmission of two simultaneous
5 coded control combinations during a cycle of operations for selecting two field stations and for transmitting simultaneous controls to these two field stations.

When controls are transmitted to a single
10 station during an operating cycle, a station selecting code is first applied to the line for selecting the particular station desired, after which the controls are transmitted to the selected station by means of code impulses. When controls
15 are transmitted to two stations during a single cycle, two station selecting codes are simultaneously applied to the line for selecting the two particular stations desired, after which the controls are transmitted to these selected stations
20 by means of simultaneous code impulses.

When indications are transmitted, the field station transmitting such indications first sends a station registering code for registering that station in the control office. Thereafter the partic-
25 ular indications are transmitted from the registered station to the control office by means of an additional code and are displayed on indicator devices, such as lamps or the like associated with the transmitting station.
30

For the transmission of controls, a predetermined number of impulses of selected polarities is placed on the stepping line circuit. The apparatus at the control office and at the field stations operate through a cycle of operations, irre-
35 spective of the polarities of the impulses, while the distinctive polarities of such impulses determine the particular station to be selected and the controls to be transmitted thereto. During the transmission of a predetermined number of im-
40 pulses over the stepping line circuit for selecting a station, an additional station may be selected by the distinctive polarities of the impulses which are applied to the message line circuit. In other words, the stepping operation during a cycle is
45 controlled over the stepping line conductor N with station selection and the transmission of controls to selected stations controlled independently over line N and over the message lines A and B.
50

If a single station is to be selected which responds to distinctive polarities applied to the message line circuit, then the impulses applied to the stepping line circuit are used for stepping purposes only and are all of the same polarity.
55

If a single station is to be selected which responds to a distinctive code applied to the stepping line circuit, then the impulses applied to this circuit control the stepping operations and by virtue of their polarities, control the selection of the desired station. Under this condition, the current impulses applied to the message line circuit in the control office serve no useful purpose and are all of the same polarity.

For the transmission of indications, means are provided to condition the message line circuit during the de-energized periods of the cycle between impulses in any one of three different ways. First, leaving the A and B lines closed; second, opening the A and B line circuit once; and third, opening the A and B line circuit twice. This provides a choice of three code characters for each step.

Obviously, the provision of three distinctive code characters for each step results in obtaining nine distinctive codes where each complete code comprises two steps. Similarly, twenty-seven distinctive complete codes are obtained where each complete code comprises three steps. In other words, the number of indication code combinations obtained is equal to three raised to the power of the number of steps.

Other objects and advantages of the present invention will be hereinafter set forth in the specification and claims and shown in the drawings. The characteristic features will be explained more in detail in the following description of one embodiment of the invention, while various other characteristic features and advantages of the system will be in part pointed out and in part apparent as the description progresses.

For convenience in describing the operation of the system, the energized periods of the stepping line circuit will be referred to as the "on" periods while the de-energized periods which separate the "on" periods will be referred to as the "off" periods.

In describing the invention in detail, reference will be made to the accompanying drawings which illustrate in a diagrammatic manner the apparatus and circuits employed. Those parts having similar features and functions are designated in the different figures by like letter reference characters, generally made distinctive either by the use of distinctive exponents representative of their location or by the use of suitable prefix numerals representative of the order of their operation and in which:—

Fig. 1 is a diagrammatic showing of the three-wire line circuit extending from the control office through a typical intervening field station to an end field station;

Fig. 2 illustrates the interlocking circuits of the storing, storing repeating and code determining relays located in the control office and associated with four field stations;

Figs. 3A, 3B, 4A and 4B illustrate the apparatus and circuits employed at the control office;

Fig. 5 illustrates a portion of the apparatus and circuits employed at a typical even field station;

Fig. 6 illustrates an additional portion of the apparatus and circuits associated with the typical even field station illustrated in Fig. 5, together with a small part of the apparatus and circuits employed at a typical odd field station.

In tracing the detailed circuits, Fig. 4A should be placed below Fig. 3A, Fig. 4B should be placed below Fig. 3B, and to the right of Fig. 4A, Fig. 6

should be placed below Fig. 5, and Fig. 5 should be placed to the right of Fig. 3B, with correspondingly numbered lines in alignment.

General description

The general plan of operation of the system may be best understood by referring to Fig. 1, which illustrates the fundamental line circuits extending from the control office through one intervening field station to the end field station. Two line batteries are used in the control office for controlling the stepping operations and for the transmission of controls. Battery NB is conveniently referred to as the neutral battery, since it is applied to the neutral line N for impulsing and for transmitting controls to those stations which have their controls effected through the medium of the N line. Battery AB is used for transmitting to those stations whose controls are effected over the A and B line conductors. Battery AB has a center tap X which is connected to line N through battery NB when the system is going through a cycle of operations.

Assuming that relays STR and EPC are picked up and that relays ENC and OC are de-energized, a circuit may be traced for energizing line N which extends from the (+) terminal of battery NB, front contact 20 of relay STR, front contact 21 of relay EPC, back contact 22 of relay ENC, winding of relay 1F, back contact 23 of relay EP, N line conductor 24, winding of relay 1F², line conductor 25, winding of relay 1F³, line conductor 26, front contacts 27 and 28 of relay SA³ (relay SA³ will be picked up as will be later described), to both the A and B line conductors in the direction indicated by the dotted line arrows. The current will divide and partly return by way of the B line conductor 31, upper winding of relay 2F³, conductor 32, upper winding of relay 2F², conductor 33, back contact 9 of relay OC, upper winding of relay 2F, through the upper portion of battery AB to terminal X, back contact 34 of relay ENC, front contact 35 of relay EPC, and front contact 36 of relay STR to the (—) terminal of battery NB.

Again referring to the end field station, as mentioned above the current divides and another portion of the current flows through A line conductor 37 in the direction of the dotted line arrows, back contact 38 of relay P³, lower winding of relay 2F³, conductor 39, back contact 40 of relay P², lower winding of relay 2F², conductor 41, back contact 14 of relay OC, lower winding of relay 2F, through the lower portion of battery AB to terminal X and thence to the (—) terminal of battery NB over the remainder of the circuit previously described.

Current in the above assumed direction applied to line N is effective to position line relays 1F, 1F² and 1F³ to their right hand positions. It is obvious that the reversal of current flow from battery NB, by relay ENC being picked up and relay EPC being down, is effective to position line relays 1F, 1F² and 1F³ to their left hand positions. Therefore, the selective operation of relays EPC and ENC effect the selective operation of the polar relays connected in the neutral line N.

Referring to the dotted line arrows (battery NB current) associated with relays 2F, 2F² and 2F³, it will be noted that the current flow through the two windings of each of these relays is in the same direction. The upper and lower windings of each of these relays are either oppositely wound or the wires leading to the terminals of one winding are reversed with respect to the wires

leading to the other winding, either of which expedient results in the 2F relays (with suitable exponent) not being affected by the currents above mentioned and being properly operated by current flowing in line conductors A and B in series as will be later described.

Since the reversal of the current in line N results in a current flow in opposition to that indicated by the dotted line arrows at all points, it will be apparent that the same relation exists with respect to the 2F relay windings just mentioned, because the reverse in direction through one winding of each 2F relay is accompanied by a similar reverse in direction through the other winding of the same relay. Briefly, line N may be impulsed with (+) or (-) impulses from battery NB to effect the positioning of the 1F relays to the right or left respectively, without adversely affecting any of the 2F relays.

Referring now to the full line arrows which indicate the current flow when the A and B line conductors are energized from battery AB. This energizing circuit may be traced from the (+) terminal of battery AB, lower winding of relay 2F¹, back contact 14 of relay OC, conductor 41, lower winding of relay 2F², back contact 40 of relay P², conductor 39, lower winding of relay 2F³, back contact 38 of relay P³, conductor 37, front contacts 28 and 27 of relay SA³, conductor 31, upper winding of relay 2F³, conductor 32, upper winding of relay 2F², conductor 33, back contact 9 of relay OC and upper winding of relay 2F¹, to the (-) terminal of battery AB. The full line arrows indicate that the current flow through the upper windings of the 2F relays is in opposition to the current flow through the lower windings of these relays and it follows from the above discussion relating to the direction of the windings of these relays or their terminal connections, that the magnetic flux in the two windings aid.

It will be assumed that (+) current flowing through the lower windings of the 2F relays from left to right and through their upper windings from right to left, is effective to position these relays to their right hand positions. By picking up relay OC, the direction of current flow over the above described circuit is reversed and since this reversal affects both windings of the 2F relays alike, the full line arrows will be assumed transposed to indicate this condition, with the result that both windings of the 2F relays are energized in aiding relation, so that these relays actuate their contacts to the left hand positions.

A brief statement of the four conditions of energization of the three line conductors is as follows:

First, line N energized with (+) potential from battery NB, line A energized with (+) potential from battery AB and line B energized with (-) potential from battery AB results in a current flow from battery NB through the 1F relays from left to right. The current from the upper portion of battery AB through line N is in series aiding relation with the current from battery NB, while the current flow from the lower portion of battery AB through line N is of opposite sign, with the result that the 1F relays are positioned to the right.

Second, reversing the connection of battery NB to line N places battery NB and the lower portion of battery AB in series aiding relation, while the current from the upper portion of battery AB is opposite in sign from both other battery units,

with the result that the 1F relays are positioned to the left.

The third condition is the same as the first with the connection of battery AB to lines A and B reversed, which results in the 1F relays being positioned to the right because again the upper portion of battery AB aids and the lower portion opposes battery NB.

The fourth condition is the same as the second with the connection of battery AB to lines A and B reversed, which results in the 1F relays being positioned to the left because again the lower portion of battery AB aids, while the upper portion opposes battery NB.

These four conditions effect the proper operation of the 2F relays because, under the first condition currents from battery NB and the upper portion of battery AB combine and flow through the upper windings of the 2F relays (on line B) from right to left, which positions these relays to the right. Under the second condition, currents from battery NB and the lower portion of battery AB combine and flow through the lower windings of the 2F relays (on line A) from left to right to position these relays to the right. Under the third condition, currents from battery NB and the upper portion of battery AB combine and flow through the lower windings of the 2F relays (on line A) from right to left, which positions these relays to the left. Under the fourth condition, currents from battery NB and the lower portion of battery AB combine and flow through the upper windings of the 2F relays (on line B) from left to right to position these relays to the left.

This discussion relating to the 2F relays does not refer to the 2F relay in the control office, since this is not a polar relay. Under the four conditions discussed, the currents which combine in a winding of a 2F relay predominate over the current through the other winding of the same relay, which is either of comparatively low value or entirely neutralized by the current flow from the two battery units in opposition. It is therefore apparent that conditioning the A and B line conductors by applying (+) and (-) polarities from battery AB thereto does not interfere with the conditioning of the N line conductor by battery NB. Further, these two circuits may be simultaneously conditioned without interference, so that controls may be transmitted simultaneously over the 3 wire circuits indicated in Fig. 1 to two different field stations.

It will be understood that additional stations connected in the line, either between the control office and the intervening field station or between the intervening field station and the end field station, have their line circuits arranged the same as the intervening station shown in Fig. 1. As will be more specifically pointed out, the points of difference in the circuit connections at different field stations are the distinctive connections of the code jumpers, which so condition the circuits that a particular field station will be fully responsive only to the particular code assigned to that station.

For the purpose of simplifying the drawings, certain conventional illustrations have been employed which are used more with the idea of making it easy to understand the principles and mode of operation, rather than with the attempt of illustrating the specific construction and arrangement of parts and circuits that would be employed in practice. The various relays and their contacts are illustrated in a

conventional manner, the use of symbols being employed to indicate the connections to the terminals of batteries or other sources of current instead of showing all of the wire connections to these terminals.

The symbols (+) and (−) indicate the positive and negative terminals respectively of suitable batteries or other sources of current and the circuits with which these symbols are used always have current flowing in the same direction. The symbols (B+) and (B−) are employed to indicate the positive and negative terminals respectively of a suitable battery or other source of current having an intermediate tap (CN), and the circuits with which these symbols are used may have current flowing in one direction or the other, depending upon whether the terminal (B+) or (B−) is used in combination with the intermediate tap (CN).

No attempt has been made to show all of the apparatus employed, such as the total number of manual controls at the control office, the total amount of equipment or its exact arrangement at the field stations since this apparatus and equipment may vary to suit local conditions. The character of that apparatus illustrated in the typical control office and at the typical field station will now be considered.

Control office equipment.—The control office includes a control machine having a group of control levers for each of the field stations, a miniature track layout corresponding to the actual track layout in the field and indicating lamps or equivalent devices, together with apparatus and circuits to accomplish the desired operation of the system. That part of the control office illustrated in Figs. 3A, 3B, 4A and 4B shows more particularly that part of a control machine which is typical of the apparatus associated with a single field station having a track switch, a cross-over or the like, together with the general transmitting apparatus employed for all such field stations.

The apparatus for one track switch comprises a miniature track switch 2ts, a switch machine control lever 2SML, a self-restoring starting button 2SB and switch machine indicating lamps NL and RL. Starting buttons 1SB, 3SB and 4SB illustrated in Fig. 2 and corresponding switch machine levers 1SML, 3SML and 4SML illustrated in Fig. 4A are associated with respective field stations, in addition to the No. 2 field station apparatus previously mentioned. Attention is particularly directed to the miniature track switch 2ts, starting button 2SB and switch machine lever 2SML, because in describing the detailed operation of the system it will be assumed that station No. 2, which corresponds to these devices will be selected and controls transmitted thereto.

Similarly, signal control levers are also associated with the respective miniature track switches and starting buttons, but in order to simplify the drawings and description, these levers have been omitted, since the control of the track switch at station No. 2 may be considered as typical of the control of other types of traffic controlling devices.

The actuation of lever 2SML to one extreme position or the other followed by the actuation of the starting button 2SB, results in the normal or reverse operation of the track switch corresponding to lever 2SML at field station No. 2 illustrated in Fig. 5. The momentary actuation of a starting button is stored by its associated

storing relay 1SR, 2SR, 3SR or 4SR, see Fig. 2. Storing repeating relays 1SRP, 2SRP, 3SRP and 4SRP are associated with corresponding storing relays. Code determining relay 12CD is associated with starting buttons 1SB and 2SB, while code determining relay 34CD is associated with starting buttons 3SB and 4SB. Common relay CM cooperates with the bank of storing, storing repeating and code determining relays to deenergize the series pick-up circuit of the CD relays as long as a CD relay is energized.

The control office includes a biased-to-neutral polar line relay 1F and a neutral line repeating relay FP, both of which are normally deenergized. Slow acting line repeating relays SA and SAP are picked up at the beginning of each cycle and dropped during the "change to normal" period at the end of each cycle. The releasing or drop-away time of relay SA is sufficiently long so that its contacts remain in their actuated positions during all "off" periods between successive "on" periods. During the last "off" period, which is comparatively long for the purpose of returning the system to normal, relay SA is released and after a predetermined interval of time, its repeating relay SAP is released.

Associated with line relay F and its repeating relays is a bank of stepping relays 1V, 2V and 3V, together with a half step relay VP, which are provided to mark off the successive steps of each cycle. An impulsing relay E is jointly controlled by the half step relay and the stepping relays, with the operations of relay E repeated by impulse repeating relay EP, which in turn opens and closes the N line conductor. Relays E and EP also control the pick-up and stick circuits of the indication message relays 1M, 2M and 3M, as well as controlling the indication executing circuits, all of which will be specifically pointed out in the detailed description. Line relay 2F, of the neutral type, is for the purpose of controlling the circuits to the message relays 1M, 2M and 3M and also to start the system into a cycle of operations in response to a change in condition at a field station.

The polarities of the impulses applied to the stepping line circuit from battery NB on successive steps of a cycle, are determined by positive code sending relay EPC and negative code sending relay ENC. The reference character E associated with these code sending relays indicates that even numbered stations are selected over the line circuit controlled by these two relays. This is merely a typical arrangement used for convenience in describing the operation of the system, since the stations controlled over line N could as well be referred to as odd stations. The polarities of the impulses applied to the message line circuit from battery AB are determined by odd code sending relay OC and for convenience in the description, it will be assumed that odd numbered stations in the system are controlled over the message line circuit.

A starting relay STR is picked up to initiate a cycle of operations, both when controls are to be transmitted to an odd and/or an even station due to the manual initiation of the cycle in the control office and when indications are to be transmitted due to the automatic initiation of a cycle by a field station. Field start relay FC is picked up when the cycle of operations is initiated by a field station and office start relay C is picked up when a cycle of operations is initiated in the control office.

For the purpose of illustrating station registration, a typical pilot relay arrangement is shown in Fig. 4A. Pilot relays 1PT and 2PT are selectively connected to the indication buses so that they may be positioned on the first step of the cycle when indications are transmitted. Similarly, additional pilot relays (not shown) may be provided for additional steps, up to the point where a sufficient number of codes for station registration is obtained.

Station relays 1ST and 2ST are provided for registering, in the control office, the station transmitting indications. The conductor indicated "indication phantom" is not used in this embodiment for connection to a station relay, because when controls alone are transmitted during a cycle, the system inherently transmits back to the control office an indication code combination which positions relays 1PT and 2PT to the left and which code combination does not correspond to a field station.

A choice of three code characters for each step results in selectively positioning the two pilot relays in three distinctive positions, two of which may be used as indicated. By adding two more pilot relays and conditioning them on the second step, nine different code combinations are obtained, eight of which may be used, with the ninth or "phantom" combination not being employed.

The control machine also includes suitable indication storing relays 1IR and 2IR for storing the indications of whether the associated track switch is in its locked normal position, its locked reverse position, or unlocked, as repeated by a switch repeating relay at the station. Indicator lamp NL is displayed to indicate the locked normal position and indicator lamp RL is lighted to indicate the locked reverse position. Both of these lamps unilluminated is an indication that the switch is in its unlocked position.

It will be obvious that additional indication receiving relays may be provided and connected in the manner typically illustrated by relays 1IR and 2IR, for receiving and displaying additional indications from a registered field station.

Field station equipment.—The even field station illustrated in Figs. 5 and 6 is typical of all field stations of the system and may be adapted to be used at the first, second or any other location by merely altering certain code jumpers to arrange for the desired codes and by altering certain wire connections to arrange for the distinction between odd and even stations. The end field station differs slightly from the others with respect to contacts 27 and 28 on relay SA³ and resistance 3R³, the purpose of which will be pointed out later in the description. For convenience in the description, the field station illustrated in Fig. 5 and in the portion below the dashed line in Fig. 6, is assumed to be even station No. 2. It will be understood that the equipment and apparatus at all other even field stations are the same as illustrated in connection with the No. 2 station with the exception of the above mentioned code jumpers.

All odd numbered stations, of which station No. 1 partly illustrated above the dashed line of Fig. 6 is typical, have apparatus and circuits the same as the illustrated even field station, except that the polar contact 196 of relay 2F¹ is used at the odd stations and is not used at the even stations. Likewise, polar contacts similar to 197 of relay 1F² are not used on corresponding relays at the odd stations. The organization of the different

odd station circuits is otherwise the same except for the distinctive connections of the code jumpers.

With reference to Fig. 5, a turn-out track is illustrated as connected to a main track by means of a track switch TS², which is operated from one extreme locked position to the other by a suitable switch machine SM². The switch machine is operated by the two-position polar magnetic stick relay SMR², which is in turn controlled from the control office through the medium of the communication system.

Suitable signals are associated with the track switch TS² for governing traffic thereover and automatic signaling means are provided, interrelating the traffic over this track switch with such other sections of track and traffic controlling devices as may be associated therewith. These signals are also controlled from the control office through the medium of the communication system by means of control relays operated in a manner similar to the operation of relay SMR², which operation may be considered typical. For the sake of simplicity, the signals and signal relays are omitted from the present disclosure. The detector track section having a normally closed track circuit with the usual track relay and suitable track battery (not shown), are also associated with the track switch TS² for indicating the passage of trains thereover.

Switch repeating relay WP² shown in Fig. 6 repeats the position and condition of track switch TS². This relay is of the polar neutral type and is so controlled that it positions its polar contact 198 to the right when the track switch is in its normal locked position and to the left when the track switch is in the reverse locked position. Neutral contacts 200 and 201 are dropped when the track switch is in its unlocked or mid stroke position. It will later be explained how these three conditions of relay WP² effect the transmission of indications from this station when it is registered in the control office. It is believed that this explanation will be sufficient to indicate the manner in which similar indications relating to other conditions at the field station may be transmitted, as will be apparent from a discussion of the typical operations effected by the positions of relay WP².

A quick acting biased-to-neutral polar relay 1F² repeats the impulses applied to line N. A quick acting biased-to-neutral polar relay 2F² responds to the impulses applied to line conductor A. As above mentioned, the polar contacts on this relay are not used at even numbered stations but to make the system symmetrical, it is preferred to make use of the windings of this relay at all field stations. A quick acting line repeating relay FP² repeats the energizations and deenergizations of the N line circuit, irrespective of the polarities of the energizations. A slow acting relay SA² of the neutral type repeats the energized condition of relay FP² and is used to define the bounds of each cycle of operations at the field station, since it is energized at the beginning of each cycle and is not dropped until the "change to normal" period at the end of the cycle.

A bank of stepping relays 1V², 2V², 3V² and the associated half step relay VP² is likewise included at each field station. Since these relays operate in a similar manner and in synchronism with the stepping relay bank in the control office, their detailed circuits have not been shown. Conductors 150, 151, 152, 153 and 154 leading to bracket

BK correspond to conductors 50, 51, 52, 53 and 54 of Fig. 3B so that it is obvious how the field station stepping relay bank operates in synchronism with the control office bank of stepping relays. Odd station stepping relays $1V^1$, $2V^1$ and $3V^1$ shown in the upper portion of Fig. 6 are illustrated for the purpose of indicating the manner in which the 2F relays effect station selection and control relay operation at odd numbered stations.

For the purpose of illustrating the selection of a station, station relay SO^2 is provided. These station relays are picked up at all stations at the beginning of a cycle and as stepping progresses, they are dropped out, one-half of those up being dropped at each step, until only the one associated with the desired station remains picked up after the station selecting steps have been marked off. It is to be understood that any suitable station selecting means may be employed, such as the use of pilot relays and a station relay at each station and still be within the scope of the present invention.

A lock-out relay LO^2 is provided at each station to determine when a particular station is to transmit new indications. Relay LO^2 is picked up during the initiating period of a cycle when indications are transmitted and is stuck up until the "change to normal" period at the end of a cycle. Resistance units such as $2R^2$ are provided to compensate for the resistance of the 2F relays in the A line conductor toward the end of the line, which is removed from this conductor when the lock-out relay is energized. Resistance $3R^3$ at the end field station is for the purpose of providing a return path to line B when line N is energized during the conditioning period of a control cycle.

Line impulsing relays P^2 , $1P^2$ and $2P^2$ are provided to impulse the A and B line circuit to provide code combinations during the transmission of indications. These relays are conditioned in accordance with the condition of the No. 1 pulse bus and the No. 2 pulse bus as selected by the code jumpers and relay contacts at the different steps of a cycle. Relay P^2 also functions to effect the lock-out circuit operation at the beginning of a cycle, in response to a change in condition at the station as repeated and stored by change storing relay CHS^2 .

It is believed that the nature of the invention, its advantages and characteristic features may be best understood with further description being set forth in the manner of operation.

Detailed operation

Normal at-rest condition.—Although the system may be initiated from the field stations, the line circuits are normally deenergized and similarly, the remaining circuits of the system are normally deenergized, with a few exceptions. For example, relay WP^2 shown in Fig. 6 is normally energized over a circuit which is controlled by the switch machine and associated apparatus, in a manner which is well-known in the art. The track circuit is preferably of the closed circuit type, so that a normally energized track relay (not shown) is provided to repeat the unoccupied and occupied conditions of the track section. Likewise, one or more normally energized relays control the stick circuit of a normally energized change relay, in such a way that a change in condition at a field station drops the change relay, which in turn picks up the change storing relay CHS^2 . Since these circuit arrangements

have been disclosed in numerous patents and applications and since they are now familiar to those skilled in the art, it is not believed necessary to indicate their control in the drawings of the present invention.

Manual starting and storing.—Referring to Fig. 2, it will be assumed that the system is in its normal condition and that the operator depresses one or more of the starting buttons. If button 1SB is actuated, a circuit is closed for picking up relay 1SR extending from (+), contact 42 of button 1SB, back contact 43 of relay 1SRP and winding of relay 1SR, to (—). Relay 1SR closes a stick circuit for itself extending from (+), front contact 44 of relay 1SR and back contact 43 of relay 1SRP to the winding of relay 1SR.

If button 2SB is actuated, a circuit is closed for picking up relay 2SR extending from (+), contact 45 of button 2SB, back contact 46 of relay 2SRP and winding of relay 2SR, to (—). Relay 2SR closes a stick circuit for itself extending from (+), front contact 47 of relay 2SR and back contact 46 of relay 2SRP to the winding of relay 2SR. If button 3SB is actuated, a circuit is closed for picking up relay 3SR which extends from (+), contact 48 of button 3SB, back contact 49 of relay 3SRP and winding of relay 3SR, to (—). Relay 3SR closes an obvious stick circuit for itself by way of its front contact 55. If button 4SB is actuated, relay 4SR is picked up over a circuit extending from (+), contact 56 of button 4SB and back contact 57 of relay 4SRP to the winding of relay 4SR. Relay 4SR closes an obvious stick circuit for itself by way of its front contact 58.

The picking up of relay 1SR closes a circuit for picking up relay 1SRP which extends from (+), back contact 59 of relay SAP, front contact 60 of relay 1SR, back contact 61 and winding of relay 1SRP, to (—). The picking up of relay 2SR closes a circuit for picking up relay 2SRP extending from (+), back contact 59 of relay SAP, front contact 62 of relay 2SR, back contact 63 and winding of relay 2SRP, to (—). Stick circuits for relays 1SRP and 2SRP are established through their make-before-break front contacts 61 and 63 respectively to (+) at back contact 64 of relay 12CD.

The picking up of relay 3SR closes a circuit for picking up relay 3SRP which extends from (+), back contact 59 of relay SAP, front contact 65 of relay 3SR, back contact 66 and winding of relay 3SRP, to (—). The picking up of relay 4SR closes a circuit for picking up relay 4SRP which extends from (+), back contact 59 of relay SAP, front contact 67 of relay 4SR, back contact 68 and winding of relay 4SRP, to (—). Stick circuits for relays 3SRP and 4SRP are established through their make-before-break front contacts 66 and 68 respectively to (+) at back contact 69 of relay 34CD. The picking up of the storing repeating relays 1SRP, 2SRP, 3SRP and 4SRP causes the dropping of the associated storing relays by opening back contacts 43, 46, 49 and 57.

The actuation of one or more of the starting buttons during a cycle results in the corresponding storing relay or relays being picked up and stuck up. Then when the system returns to normal, the corresponding storing repeating relay or relays will pick up, stick and cause the release of the associated storing relay or relays.

The stations are arranged in pairs, with each code determining relay controlling the selection of one odd and one even station and the trans-

mission of controls thereto. As a typical example, when relay 12CD is up and both relays 1SRP and 2SRP are up during a cycle, odd station (No. 1) and even station (No. 2) are selected and controls transmitted to both stations during the same cycle. With relay 12CD up and relay 1SRP up during a cycle, odd station No. 1 alone is selected and controls are transmitted to it alone. Similarly, when relays 12CD and 2SRP are up together during a cycle, station No. 2 alone is selected and the transmission of controls to this station alone is effected. This discussion applies to relays 34CD, 3SRP and 4SRP which govern the transmission of controls to another pair of stations, No. 3 and No. 4.

The picking up of relay 1SRP closes a circuit for picking up relay 12CD which extends from (+), back contact 81 of relay SAP, back contact 70 of relay CM, conductor 19, front contact 71 of relay 1SRP, back contact 72 and winding of relay 12CD, to (-). When relay 2SRP is picked up alone, then the circuit for picking up relay 12CD extends from (+), back contact 81 of relay SAP, back contact 70 of relay CM, back contact 71 of relay 1SRP, front contact 73 of relay 2SRP, back contact 72 and winding of relay 12CD, to (-). If both relays 1SRP and 2SRP are up, the circuit previously described through front contact 71 of relay 1SRP is effective to pick up relay 12CD. The picking up of relay 12CD closes a stick circuit for itself which extends from (+), winding of relay CM, front contact 74 of relay 1SRP or front contact 75 of relay 2SRP (or both), front contact 72 and winding of relay 12CD, to (-).

The picking up of relay 3SRP closes a circuit for picking up relay 34CD which extends from (+), back contacts 81, 70, 71 and 73 of relays SAP, CM, 1SRP and 2SRP respectively, conductor 18, front contact 76 of relay 3SRP, back contact 77 and winding of relay 34CD, to (-). The picking up of relay 4SRP closes a similar circuit for picking up relay 34CD, this circuit extending through back contact 76 of relay 3SRP and front contact 78 of relay 4SRP. The picking up of relay 34CD closes a stick circuit for itself extending from (+), winding of relay CM, one, the other or both front contacts 79 and 80 of relays 3SRP and 4SRP respectively and front contact 77 of relay 34CD to the winding of this relay.

The stick circuits of all code determining relays includes the winding of relay CM, which picks up and removes the (+) potential from conductor 19 so no other CD relay can pick up until the one that is up is deenergized. It is obvious that, in the event of two or more odd or two or more even storing repeating relays being up at the same time with the system in its normal period the corresponding CD relay nearest the (+) potential at back contact 70 of relay CM will have preference, because the extended pick-up wire 19 to other CD relays to the right is de-energized.

The picking up of relay 12CD transfers (at its make-before-break contact 64) the stick circuit for relays 1SRP and 2SRP to (+) at back contact 81 of relay SAP and at front contact 82 of relay SA. Relays SA and SAP pick up in sequence during the conditioning period at the start of a cycle and are dropped in sequence at the end of a cycle, so that the stick circuit for relays 1SRP and 2SRP is not deenergized until relay SA drops at the end of the cycle. Then when relay SAP drops to restore the system to normal, this stick circuit is again energized but not until those storing repeating relays which were up,

(with the corresponding CD relay picked up) have been released. Those storing repeating relays (if any) which are stuck up at this time to (+) at a back contact such as 64, 69 or the like of their associated CD relays are not released, so that another CD relay has a chance to be picked up to start another cycle when the previously energized CD relay is deenergized to deenergize and release relay CM by the dropping of the corresponding storing repeating relay or relays.

Briefly stated, as many storing relays may be picked up as there are starting buttons actuated, irrespective of the condition of the system. An exception to this is that a storing relay such as relay 1SR cannot be picked up when relay 1SRP is up, because back contact 43 is open. There is no need of operating relay 1SR under this condition, because its associated station is either already being selected or a stored condition for this station is waiting. As many storing repeating relays may be picked up when the system is in its normal period as there are storing relays up, after which the corresponding storing relays are dropped. Only one code determining relay can be up at the same time and controls will be transmitted to the odd, or even, or both stations associated with this code determining relay, as determined by the picked up condition of the odd, or even, or both storing repeating relays.

It is obvious that after a cycle of operations has been started as a result of the picking up of one storing repeating relay, the other storing repeating relay of the pair must be prevented from picking up. Otherwise, a storing repeating relay picking up after the start of a cycle when its associated CD relay is up, would not be up in time to transmit all of the codes necessary. Therefore, when relay SAP picks up to start a cycle, the removal of (+) potential from conductor 83 at its back contact 59 prevents the picking up of any storing repeating relay. It is understood that under this condition, the storing relay is stuck up until the end of the cycle, at which time the corresponding storing repeating relay can be picked up and stuck up until the end of the next cycle.

It will now be assumed that the operator in the control office desires to transmit controls to station No. 2 illustrated in Figs. 5 and 6. When starting button 2SB is actuated, relays 2SR, 2SRP and 12CD are picked up as above described. A circuit is now closed for picking up relay C which extends from (+), back contact 84 of relay SA, conductor 11, back contact 85 of relay ENC, front contact 86 of relay 12CD and winding of relay C, to (-). Relay C closes a stick circuit for itself by way of its front contact 87 to (+) at back contact 88 of relay SAP, which is effective until relay SA picks up and thereafter the stick circuit extends to (+) at front contact 84 of relay SA.

The operation of relay C opens the pick-up circuit of relay FC at back contact 89, which prevents the picking up of relay FC after the cycle is initiated by a manual start in the control office. The picking up of relay C closes a circuit for picking up start relay STR which extends from (+), front contact 90 of relay C and winding of relay STR, to (-). A circuit is now closed for picking up relay EPC which extends from (+), front contact 91 of relay 2SRP, front contact 92 of relay 12CD, even control conductor 93, back contacts 94, 95 and 96 of relays 3V, 2V and 1V respectively, conductor 10, front contact

97 of relay C and winding of relay EPC, to (—).

This marks the beginning of the conditioning period by applying (+) potential to line N for the purpose of conditioning the relays at the field stations. Relays 1F, 1F² (and similar line relays at all the stations) are now positioned to the right by means of a circuit extending from the (+) terminal of battery NB, front contact 20 of relay STR, front contact 21 of relay EPC, back contact 22 of relay ENC, conductor 13, winding of relay 1F, back contact 23 of relay EP, N line conductor 24, winding of relay 1F², resistance 3R³ at the end station, upper winding of relay 2F², B line conductor 33, back contact 9 of relay OC, upper winding of relay 2F, through the upper portion of battery AB, back contact 34 of relay ENC, front contact 35 of relay EPC and front contact 36 of relay STR to the (—) terminal of battery NB. Current flow in this circuit includes the upper portion of battery AB which aids battery NB and is effective to position the 2F relays at all stations to the right and to energize the 2F relay in the control office.

A circuit is now closed for picking up relay FP in the control office which extends from (+), polar contact 99 of relay 1F in its right hand dotted position and winding of relay FP, to (—). Relay FP closes a circuit for picking up relay SA which extends from (+), front contact 100 of relay FP and winding of relay SA, to (—). A circuit is closed for picking up relay SAP which extends from (+), front contact 101 of relay SA and winding of relay SAP, to (—).

Relay FP² (Fig. 5) is picked up over a circuit extending from (+), contact 202 of relay 1F² in its right hand dotted position and winding of relay FP², to (—). A circuit is closed for picking up relay SA² which extends from (+), front contact 203 of relay FP² and winding of relay SA², to (—). Before the picking up of relay SA², relay SO² is picked up over a circuit extending from (+), back contact 204 of relay SA², conductor 290², back contacts 205, 206 and 207 of relays 3V², 2V² and 1V² in series, (+) control bus², contact 197 of relay 1F² in its right hand dotted position and winding of relay SO², to (—). Relay SO² establishes a stick circuit for itself over the circuit just described, to (+) at its front contact 208 which is effective after relay SA² picks up.

It is to be understood that relays similar to 1F², FP², SA² and SO² at all other even field stations are operated by means of circuits similar to those just described. At all odd field stations, the SO relays are picked up over a circuit similar to that which extends from (+) applied to conductor 290¹ (Fig. 6), from back contacts similar to 204 of relays similar to SA² and thence through back contacts 291, 292 and 293 of relays 3V¹, 2V¹ and 1V¹ respectively, (+) control bus¹, contact 196 of relay 2F¹ in its right hand dotted position and the winding of the SO relay which is connected to conductor 294.

Referring back to the control office, the picking up of relay SAP closes a circuit for picking up relay EP which extends from (+), front contact 29 of relay SAP, back contact 30 of relay E and lower winding of relay EP, to (—). The picking up of relay EP deenergizes line N at back contact 23, to mark the end of the conditioning "on" period and the beginning of the first "off" period.

Relay SA³ at the end field station is picked up by means of a circuit similar to that described for picking up relay SA² and by closing its front

contacts 27 and 28, the continuity of the A—B line circuit is established (see Fig. 1). This is effective to energize the A and B lines with (+) potential from battery AB applied to the A line conductor, which maintains the 2F relays (with suitable exponents) positioned to the right.

During this cycle, since it is assumed that a single even station is to be selected, the condition of the A and B line conductors is not changed but these conductors are maintained energized in the same direction so that the 2F relays (with suitable exponents) remain actuated to their right hand positions. Since back contact 102 of relay 2F in the control office is maintained open, the pick-up circuits of relays 1M, 2M and 3M are not energized during this cycle. Therefore, (B—) potential is applied to pilot relays 1PT and 2PT, over circuits which will be later described, so that these relays are both positioned to the left to select the indication phantom wire.

In the event that starting button 4SB is actuated, relays 4SR, 4SRP and 34CD are picked up as above described. Since this requires the selection of an even station, the operations are the same for conditioning the line circuits as explained in connection with relay 12CD, except that the circuit for energizing the even control bus 93 which picks up relay EPC now extends through front contact 103 of relay 4SRP and front contact 104 of relay 34CD. Also the pick-up circuit for relay C extends through front contact 105 of relay 34CD instead of front contact 86 of relay 12CD. It will thus be seen that the picking up of any CD relay initiates a control cycle by applying (+) potential to line N during the conditioning period. As will be later explained, the different conditions set up by the different CD relays which are picked up result in distinctive impulses being applied to the line circuits, following the conditioning impulse, as controlled by the jumper and lever connections associated with the one particular CD relay which is picked up during the cycle.

In the event that starting button 1SB is actuated, relays 1SR, 1SRP and 12CD are picked up and the line is conditioned as above described in connection with the operation of button 2SB, except that relay EPC is energized by means of a circuit extending from (+), front contact 107 of relay 1SRP, front contact 108 of relay 12CD, odd control bus 106, back contacts 109, 110 and 111 of relays 3V, 2V and 1V respectively, conductor 10, front contact 97 of relay C and winding of relay EPC, to (—).

In the event that button 3SB is actuated, relays 3SR, 3SRP and 34CD pick up as above explained and the N line circuit is conditioned (+) in the same manner as described in connection with the actuation of button 2SB, except in this case relay EPC is energized over the circuit just described, including odd control bus 106, but this time through front contacts 112 and 113 of relays 3SRP and 34CD respectively.

Polarity selection of impulses.—It will first be assumed (and later described) that the stepping relays in the control office and at the field stations step through the cycle in synchronism (except certain field stations which are dropped out during the cycle). When line N is deenergized to mark the end of the conditioning period as previously discussed, relay 1F in the control office, relay 1F² at the field station illustrated in Fig. 5 and similar line relays at all other field stations are deenergized. The first stepping relay

in the control office is now picked up, following which relay E picks up and relay EP drops to mark the end of the first "off" period.

The picking up of relay IV establishes the No. 1 control conditioning circuit, extending from (+), front contact 91 of relay 2SRP, front contact 92 of relay 12CD, conductor 93, back contacts 94 and 95 of relays 3V and 2V respectively, front contact 96 of relay IV, No. 1 even conductor 116, front contact 114 of relay 12CD, jumper 254, EPC bus 115, front contact 98 of relay C and winding of relay EPC, to (-). This circuit is effective to pick up relay EPC during the first "off" period for energizing line N with (+) potential during the following or first "on" period.

In the event that jumper 254 is connected to ENC bus 117 instead of EPC bus 115, then the above described circuit extends by way of bus 117 and the winding of relay ENC, to (-), which is effective to pick up relay ENC for energizing line N with (-) potential during the first "on" period.

Relay 2V is picked up during the second "off" period and the No. 2 even conductor 118 is selected at front contact 95 of relay 2V. The circuit extends through front contact 119 of relay 12CD and jumper 255 to the ENC bus 117, which is effective to energize relay ENC for selecting a (-) potential to be applied to line N during the second "on" period. In the event that jumper 255 is connected in its alternate position to EPC bus 115, then relay EPC is picked up to select (+) potential for the No. 2 "on" impulse.

Relay 3V is picked up during the third "off" period to select the No. 3 even conductor 120 by way of its front contact 94. This circuit is extended through front contact 121 of relay 12CD to lever 2SML. Should lever 2SML be in its right hand position, the conditioning circuit would be connected to the EPC bus 115 for picking up relay EPC to apply (+) potential to line N during the third "on" period. Or if lever 2SML is in its left hand dotted position, the ENC bus 117 is selected and relay ENC is picked up to apply (-) potential to line N during the third "on" period.

From the above discussion, it will be apparent that line N is impulsed with a combination (following the conditioning (+) impulse) of (+) (-) (+) impulses with jumpers 254 and 255 and lever 2SML in the positions indicated in the drawings. Also, the polarity to be applied to line N during an "on" period is determined by the particular polarity control relay EPC or ENC which is picked up during the preceding "off" period. In the event that relay 34CD is picked up as a result of button 4SB being actuated, then the impulses applied to line N are (-) (+) (+). The first impulse (following the (+) conditioning impulse) is (-) as determined by jumper 256 connecting the No. 1 even conductor 116 by way of front contact 122 of relay 34CD to the ENC bus. The second impulse is (+) as selected by jumper 257 connecting the No. 2 even conductor 118 by way of front contact 123 of relay 34CD to the EPC bus. The third impulse is (+) as determined by lever 4SML connecting the EPC bus to the No. 3 even conductor 120 by way of front contact 124 of relay 34CD.

In the event that relay 12CD is picked up as a result of button 1SB being actuated, the AB line circuit is impulsed (following the (+) conditioning impulse) with a combination of (-) (+) (+) impulses. The first impulse is (-) because jumper 250 is connected to OC bus 125

for completing an energizing circuit for relay OC when relay IV is picked up, which extends from (+), front contact 107 of relay 1SRP, front contact 108 of relay 12CD, odd control conductor 106, back contacts 109 and 110 of relays 3V and 2V respectively, front contact 111 of relay IV, No. 1 odd conductor 126, front contact 127 of relay 12CD, jumper 250, conductor 125, winding of relay OC and front contact 17 of relay C, to (-). Relay OC connects (+) potential from battery AB through the lower winding of relay 2F and front contact 9 of relay OC to B line conductor 33, while (-) potential from battery AB through the upper winding of relay 2F is connected to the A line conductor 41 at front contact 14 of relay OC.

The second impulse is (+) because jumper 251 is effective to deenergize relay OC when the No. 2 odd conductor 128 is selected at front contact 110 of relay 2V, which conductor extends through front contact 129 of relay 12CD to jumper 251. Relay OC remaining deenergized reverses the connection of battery AB to lines A and B from that explained in connection with the first impulse. The third impulse is (+) because with lever 1SML in the position shown, relay OC is deenergized when the circuit including the No. 3 odd conductor 130 and front contact 131 of relay 12CD is established.

Jumpers 252, 253 and lever 3SML are selected by relays 3SRP and 34CD and when connected as shown, result in relay OC being picked up during the No. 1 and the No. 2 odd steps respectively, to make the first two impulses in the A line (-). This is because these two jumpers are connected by way of front contacts 132 and 133 of relay 34CD and the No. 1 odd and No. 2 odd conductors to the odd control conductor 106 by way of front contacts 111 of relay IV and 110 of relay 2V respectively, at the first two steps of the cycle. Odd control conductor 106 extends through front contact 113 of relay 34CD and front contact 112 of relay 3SRP, to (+). Lever 3SML de-energizes the OC bus 125, as selected on the third step by way of front contact 134 of relay 34CD.

From the above description it will be seen that line circuits N and AB are distinctively conditioned with (+) and (-) impulses, as selected by a combination of SRP and CD relays. In other words, a CD relay being picked up in combination with an even numbered SRP relay, causes line N to be impulsed with a combination of (+) and (-) impulses as determined by the associated jumper and lever connections. A CD relay being up in combination with an odd numbered SRP relay causes the A and B line circuit to be impulsed with a combination of (+) and (-) impulses as determined by the associated jumper and lever connections. Since these two line circuits are independently energized without interference between the two circuits, it is apparent that the system will function to transmit a single combination of impulses for selecting a single odd or even station, or a double combination of impulses for selecting an odd and an even station during the same cycle.

Line impulsing and operation of stepping relay bank.—Relay IV in the control office is picked up during the first "off" period as a result of relay 1F being de-energized to drop relay FP. The circuit for picking up relay IV extends from (+), front contact 135 of relay SA, back contact 136 of relay FP, back contact 137 of relay VP, back contact 138 of relay 2V and winding of relay IV, to

(—). Relay 1V closes a stick circuit for itself extending from (+), front contact 135 of relay SA, front contact 139 and winding of relay 1V, to (—). Relay E is now picked up over a circuit extending from (+), back contact 140 of relay 3V, back contact 141 of relay 2V, front contact 142 of relay 1V, back contact 143 of relay VP and winding of relay E, to (—).

Relay EP is now dropped due to the energizing circuit through its lower winding being open at back contact 30 of relay E. Relay EP is slightly slow to release due to its upper winding being short circuited at its front contact 144. This slow releasing feature of relay EP is for the purpose of timing the "off" periods between impulses. The slight delay in the release of relay EP delays the energization of the line. The release of relay EP and the resulting energization of line N at back contact 23 marks the end of the first "off" period and the beginning of the first "on" period.

Relays 1F and FP now pick up in turn and relay FP closes a circuit for picking up relay VP extending from (+), front contact 145 of relay SA, front contact 146 of relay FP, back contacts 147 and 148 of relays 3V and 2V respectively, front contact 149 of relay 1V and winding of relay VP, to (—). Relay VP establishes a stick circuit for itself extending from (+), front contact 145 of relay SA, front contact 160 of relay VP and over the remainder of the previously described circuit to the winding of relay VP. The stick circuit is effective until stepping relay 2V picks up and opens its back contact 148, which occurs during the second "off" period. For maintaining relay VP in its energized condition during the second "off" period, an additional stick circuit is established which extends from (+), front contact 145 of relay SA, back contact 146 of relay FP, front contact 161 and winding of relay VP, to (—).

Relay VP, in picking, up opens the circuit of relay E at back contact 143, so that relay E drops after a predetermined time interval and closes the pick-up circuit for relay EP at its back contact 30. Relay EP picks up and deenergizes line N by opening its back contact 23 to mark the end of the first "on" period and the beginning of the second "off" period.

Relays 1F and FP are now dropped and relay 2V is picked up over a circuit extending from (+), front contact 135 of relay SA, back contact 136 of relay FP, front contact 137 of relay VP, back contact 162 of relay 3V, front contact 163 of relay 1V and winding of relay 2V, to (—). Relay 2V establishes an obvious stick circuit for itself by way of its front contact 154.

Relay E is now picked up over the previously described circuit through back contact 140 of relay 3V, which now extends through front contacts 141 and 143 of relays 2V and VP respectively. Relay EP is dropped and line N is energized as before, which marks the end of the second "off" period and the beginning of the second "on" period.

Relays 1F and FP are now picked up in turn and relay VP is dropped, because one stick circuit is open at back contact 148 of relay 2V and the other stick circuit is open at back contact 146 of relay FP. Relay E is now dropped because its energizing circuit is open at front contact 143 of relay VP. Relay EP is again energized and line N is deenergized to mark the end of the second "on" period and the beginning of the third "off" period.

Relays 1F and FP are now dropped and relay 3V is picked up over the previously described

circuit, which now extends through back contact 137 of relay VP and front contact 138 of relay 2V to the winding of relay 3V. Relay 3V closes an obvious stick circuit for itself by way of its front contact 165. Relay E is now picked up over a circuit extending from (+), front contact 140 of relay 3V, back contact 143 of relay VP and winding of relay E, to (—). Relay EP is now dropped to mark the end of the third "off" period and the beginning of the third "on" period, by energizing line N.

Relays 1F and FP now pick up in turn and relay VP is picked up over the previously described circuit which now extends through front contact 147 of relay 3V. Relay VP closes the previously described stick circuits for itself through its front contacts 160 and 161. Relay E is now released because the (+) potential applied to its winding through front contact 140 of relay 3V is interrupted at back contact 143 of relay VP. Relay EP is picked up as before and line N is deenergized to mark the end of the third "on" period and the beginning of the "change to normal" period.

Relays 1F and FP now drop in turn and since there is no other stepping relay to be picked up, relay VP remains stuck up and relay E cannot again pick up to deenergize relay EP. After a predetermined interval of time, relay SA is dropped because its energizing circuit remains open at front contact 100 of relay FP. Relay SAP is dropped after an additional interval of time because its energizing circuit remains open at front contact 101 of relay SA. The dropping of relay SA deenergizes the pick-up and stick circuits of the stepping relays and the half step relay, by opening its front contacts 135 and 145, with the result that these relays are dropped.

Relay 2SRP is dropped when relay SA drops its front contact 82. The energizing circuit of relay 12CD is opened at front contact 75 of relay 2SRP, with the result that relays 12CD and CM are dropped. Relay C is deenergized when relay SA drops its front contact 84 and since relay 12CD is dropped at substantially the same time, the pick-up circuit of relay C through front contact 86 of relay 12CD is interrupted. Relay STR is deenergized when relay C drops its front contact 90. Relay EP is deenergized when relay SAP drops its front contact 29.

Since relays 1F² and FP² operate substantially in synchronism with the corresponding relays in the control office and since the stepping relays illustrated in Figs. 5 and 6 operate substantially in synchronism with the stepping relays in the control office, it is not believed necessary to explain the field station stepping operations in detail. It should be mentioned, however, that the SA relays at the field stations are dropped substantially in synchronism with the corresponding relay in the control office and when relay SA³ at the end station is released, the A—B line circuit is deenergized which results in deenergizing relay 2F in the control office and the 2F relays at the field stations. The system is now in its normal condition.

Station selection and transmission of controls.—It will now be assumed that the stepping relays in the control office and at the field station operate as above described and an explanation will be given of the circuits which are effective during this operation for selecting the illustrated even station and the transmission of controls thereto.

As above explained, line N is conditioned with 75

a (+) impulse for picking up the station relays similar to relay SO² at all field stations. During each "off" period of the cycle, all SO relays which remain up throughout the preceding "on" period are stuck up by means of a circuit similar to that extending from (+), front contact 208 of relay SO², front contact 204 of relay SA², back contact 212 of relay FP² (and contact 197 of relay IF² in its neutral position in multiple) and winding of relay SO², to (-).

With jumpers 210 and 211 connected as shown in Fig. 5, the No. 2 even station is selected when starting button 2SB in the office is actuated. It will be recalled that the actuation of this button causes relays 2SRP and 12CD to be up during the cycle and that these two relays up together energize even control bus 93. This energized bus is extended to relays EPC and ENC in sequence on the first two steps, by way of jumpers 254 and 255 so that line N is impulsed (+) (-) for station selection.

Relay IF² at the illustrated station (and similar relays at all other stations) is positioned to the right by the (+) impulse. A circuit is closed for energizing relay SO² which extends from (+), front contact 208 of relay SO², back contacts 205 and 206 of relays 3V² and 2V² respectively, front contact 207 of relay 1V², jumper 210, (+) control bus², contact 197 of relay IF² in its right hand dotted position, terminal 170 and winding of relay SO², to (-).

At those stations having a jumper similar to 210 connected to the (+) control bus, relays similar to SO² will be maintained energized during the first "on" period by means of a circuit similar to that just described. At those stations not having a code jumper similar to 210 connected to the (+) control bus, the SO relays will be dropped because there is no circuit for maintaining them energized.

When the system advances into the second "off" period, relay SO² and similar relays at other stations, which are up will be stuck up as previously described. It is obvious that the stick circuits of those station relays similar to relay SO² which were dropped during the first "on" period, are not completed during the second "off" period since their contacts similar to 208 are open.

The system advances into the second "on" period after relay 2V² has been picked up and the (-) impulse applied to line N is effective to position relay IF² (and similar relays at all other stations) to the left. A circuit is completed for energizing relay SO² extending from (+), front contact 208 of relay SO², back contact 205 of relay 3V², front contact 206 of relay 2V², jumper 211, (-) control bus², contact 197 of relay IF² in its left hand dotted position, terminal 170 and winding of relay SO², to (-). Any other station with a jumper connection similar to 211 and with its SO relay up, will maintain this relay energized throughout the second "on" period in a similar manner. Any other station with its SO relay up and without such a jumper connection will drop this relay in the second "on" period.

During the third "off" period, relay 3V is picked up and relay SO² is stuck up over a circuit extending from (+), front contact 208 of relay SO², front contact 205 of relay 3V² and winding of relay SO², to (-). This maintains relay SO² picked up during the remainder of the cycle, irrespective of the number of stepping relays which may be used for the selection of controls after the station is selected. With relay SO² picked

up after station selection, additional impulses are effective to operate only those stepping relays at this particular station, since the circuit for the stepping relays is by way of front contact 213 of relay SO². It will be understood that the contacts similar to 213 of other station relays which are dropped during the cycle, are effective to discontinue the stepping relay operation at those stations.

During the third "on" period, the No. 3 control impulse is (+) as determined by lever 2SML of Fig. 4A being actuated to its right hand position. This (+) impulse in line N actuates relay IF² to the right and closes a circuit for energizing relay SMR² which extends from (+), front contact 208 of relay SO², front contact 205 of relay 3V², contact 197 of relay IF² in its right hand dotted position, (+) control bus², conductor 191, front contact 214 of relay 3V² and upper winding of relay SMR², to (-). This actuates relay SMR² to the right, which closes a circuit for energizing the motor to operate the track switch TS² to its normal locked position.

It will be obvious that lever 2SML in its alternate position is effective to energize relay ENC, which applies a (-) impulse to line N at the third step for actuating relay IF² to the left. This transfers the above described circuit from (+) at contact 197 of relay IF² to the (-) control bus² and thence through conductor 190 and front contact 215 of relay 3V² to the lower winding of relay SMR². This circuit is effective to energize relay SMR² in the opposite sense for actuating the switch machine motor in the proper direction to operate the track switch TS² to a reverse locked position. In a similar manner, any number of additional steps may be provided for transmitting additional controls to the selected field station for governing the signals and such other devices as may be necessary.

It will be understood that contacts 214 and 215 on relay 3V² are typical of the arrangement used when additional steps are provided. For example, wires 190 and 191 will be connected through back contacts of additional stepping relays starting at the last stepping relay of the series and extending up to contacts such as 214 and 215.

During the selection of an even station alone, odd control relay OC of Fig. 3A remains deenergized, due to the No. 1 and No. 2 odd control conductors which extend through jumpers 250, 251, 252 and 253 to relay OC not being energized. This is because odd control bus 106 is deenergized at front contact 107 of relay 1SRP which is down. This results in line A being energized continuously from the (+) terminal of battery AB so that relays similar to relay 2F² at all odd stations remain actuated to their right hand positions. A series of all (+) impulses applied to line A during the station selecting steps of a cycle corresponds to a phantom code and does not result in the selection of an odd numbered station.

Assuming that starting button 1SB alone is actuated to initiate a cycle of operations, then relays 1SRP and 12CD will be up during the cycle and odd control bus 106 will be energized. This results in the selection of the No. 1 odd conductor 126, the No. 2 odd conductor 128 and the No. 3 odd conductor 130 on the three steps of the cycle respectively. Since conductor 126 extends through front contact 127 of relay 12CD and jumper 250 to odd control bus 125, the first impulse applied to line A (with line B serving as

the return conductor) is (—) because relay OC is picked up.

With conductor 128 extending through front contact 129 of relay 12CD to jumper 251, which is disconnected from the OC bus, relay OC is de-energized on the second step so that line A is energized with a (+) impulse from battery AB. Since conductor 130 extends through front contact 131 of relay 12CD to lever 1SML and since this lever is shown disconnected from bus 125, relay OC remains deenergized so that the third impulse applied to line A is (+).

Referring to the field station circuits, relay 2F¹ is actuated to the left by the first impulse (—) and a circuit is closed for energizing the station relay (SO with suitable exponent) at odd station No. 1. This circuit is similar to that previously traced in connection with even station No. 2, except that it extends from a terminal such as 170 at the odd station through conductor 294, contact 196 of relay 2F¹ in its left hand dotted position, (—) control bus¹, jumper 216, front contact 293 of relay 1V¹, back contact 292 of relay 2V¹, back contact 291 of relay 3V¹, conductor 290¹ (which corresponds to conductor 290² associated with even station No. 2) and through a front contact similar to 208 of the station relay to (+).

The second impulse which is (+), actuates relay 2F¹ to the right and completes the above described circuit by way of contact 196 in its right hand dotted position, (+) control bus¹, jumper 217, front contact 292 of relay 2V¹, back contact 291 of relay 3V¹, conductor 290¹ and over the remainder of the previously described circuit.

The third impulse which is (+), actuates relay 2F¹ to the right and extends (+) which is applied to conductor 290¹ from the front contact similar to 208 of the station relay, through front contact 291 of relay 3V¹, contact 196 of relay 2F¹ in its right hand dotted position, (+) control bus¹, front contact 295 of relay 3V¹ and upper winding of relay SMR¹, to (—). This actuates relay SMR¹ to the right for actuating the switch machine at the odd station to its normal locked position, in a manner which is obvious from the previous description.

It has been mentioned that the 2F relays are not dropped during a cycle for the selection of an even station. During a cycle for the selection of an odd station, the 2F relays at the stations are of course shifted during "off" periods, in accordance with the polarities required for the succeeding "on" periods. Relay 2F in the control office is not dropped during stepping because the make-before-break contacts 9 and 14 of relay OC prevent the deenergization of relay 2F. This results in back contact 102 of relay 2F remaining open during a control cycle to prevent the energization of any message relay 1M, 2M or 3M of Fig. 4B.

During the selection of the No. 1 odd station and the transmission of controls thereto, line N is impulsed with a series of (—) impulses which corresponds to an even phantom code and is ineffective to select any even station. This series of (—) impulses is provided by relay ENC being picked up during all station selecting impulses over a circuit extending from (+), back contact 91 of relay 2SRP, front contact 155 of relay 12CD, even phantom bus 156, front contact 157 of relay 1V, conductor 117 and winding of relay ENC, to (—). The even phantom bus is also energized for the same purpose when relays 3SRP and 34CD

are up, through back contact 103 of relay 4SRP and front contact 168 of relay 34CD.

It will be obvious that odd station selection may be accomplished with additional steps provided in the manner previously mentioned in connection with even station selection and that additional steps may be provided for the transmission of additional controls for governing signals and such other devices as may be necessary.

The jumpers connected as shown in Fig. 4A indicate the method of odd and even station selection on two steps each. This invention contemplates the use of a different number of steps during a cycle for selecting odd and even stations. For example, the No. 1 odd conductor 126 might be selectively connected by jumper 250 or 252 to bus OC for selecting station 1 or 3 respectively on the first step. The No. 2 odd conductor 123 could then be connected through switch machine lever or signal lever contacts to selectively energize bus OC on the second step. Then with both the No. 1 even and the No. 2 even conductors 116 and 118 connected by means of jumpers 254, 255, 256 and 257 as shown, even station selection is accomplished on two steps, after which the No. 3 even wire 120 connected through switch machine or signal lever contacts, selectively energizes buses EPC and ENC on the third step. In other words, while jumpers 250 to 257 inclusive are shown for selecting both odd and even stations on two steps, these jumpers may be replaced by jumper and lever contacts in any desired combination.

Diplex transmission.—It has been explained how the present invention functions during the transmission of controls to even stations and to odd stations on separate cycles of operation. Diplex transmission is effected when both storing repeating relays and the associated CD relay are up at the same time when a cycle is initiated. For example, relays 2SRP, 1SRP and 12CD may be up at the start of a cycle. In this event, station No. 2 is selected over the N line circuit and station No. 1 is selected over the AB line circuit in the manner already explained.

Since the N line circuit is used for controlling the stepping at all stations and for the selective conditioning of a polar relay during stepping at each even station and since the AB line circuit is independently used for the selective conditioning of a polar relay during stepping at each odd station, both stations of a pair are simultaneously selectable and controls may be transmitted to both during the same cycle. An explanation of the effect of simultaneously conditioning the two line circuits has been given in connection with the fundamental line circuit arrangement shown in Fig. 1.

Automatic start by a field station.—Whenever the system is in the normal period or period of blank, it may be initiated from a field station, either in response to some automatic change in traffic conditions or in response to the operation of a traffic controlling device to a new position, such as moving the track switch TS² from its reverse locked to its normal locked position during a control cycle. Such a change results in change storing relay CHS² being picked up. It is not believed necessary to show or describe the detailed circuits for picking up relay CHS², since this may be accomplished in the manner disclosed in connection with relay CHS shown and described in the patent to DeLong et al., Patent No. 1,852,402 issued April 5, 1932.

The picking up of relay CHS² closes a circuit for picking up relay P² extending from (+),

back contact 218 of relay SA², back contact 219 of relay FP², front contact 220 of relay CHS² and upper winding of relay P², to (—). Relay P² closes a stick circuit for itself extending from (+), back contact 218 of relay SA², front contact 221 and upper winding of relay P², to (—).

The actuation of the P² relay contacts opens the A line conductor, extending from the calling station toward the end of the line, at back contact 40. The A line conductor is connected to the N line conductor at front contact 40 of relay P² in series with resistance 2R², the upper winding of relay LO² and back contact 222 of relay SA².

Since line N is open at front contact 21 of relay EPC in the control office, there is no potential applied to this line up to the calling station. A circuit is effective for energizing the AB line circuit, which extends from the (+) terminal of battery AB, lower winding of relay 2F, back contact 14 of relay OC, A line conductor 41, lower winding of relay 2F², front contact 40 of relay P², resistance 2R², upper winding of relay LO², back contact 222 of relay SA², line N through to the end station, resistance 3R³, B line conductor, upper winding of relay 2F², B line conductor 33, back contact 9 of relay OC and upper winding of relay 2F to the (—) terminal of battery AB.

Current flow in this circuit results in picking up relay 2F in the control office and actuating relay 2F² at the field station to the right. It will be understood that all 2F relays at both odd and even stations, are actuated to the right. Relay LO² at the calling station is picked up. Since the N line conductor is connected to the B line conductor at the end station, those 1F relays farther out the line pick up and effect the picking up of the SA relays at the respective stations.

The picking up of relay 2F in the control office closes a circuit for picking up relay FC which extends from (+), back contact 29 of relay SAP, conductor 276, front contact 8 of relay 2F, back contact 89 of relay C, back contact 15 of relay STR and winding of relay FC, to (—). Relay FC closes a stick circuit for itself through its front contact 16 to (+) at back contact 88 of relay SAP until relay SA is picked up and thereafter to (+) at front contact 84 of relay SA.

A circuit is now closed for picking up relay STR which extends from (+), front contact 7 of relay FC and winding of relay STR, to (—). A circuit is also closed for picking up relay ENC which extends from (+), back contact 166 of relay C, front contact 167 of relay FC and winding of relay ENC, to (—). The picking up of relays ENC and STR applies (—) potential to line N for energizing all other 1F relays connected in this line, including relay 1F². Relay SA² is picked up to open the circuit including resistance 2R². Other SA relays likewise pick up.

Relay 1F³ (not shown) at the end field station is effective when actuated to pick up relay FP³ (not shown), which in turn picks up relay SA³ by means of circuits which will be obvious from those shown in connection with the No. 2 station. This establishes the line circuit arrangement as illustrated in Fig. 1 (assuming front contacts 27 and 28 of relay SA³ picked up). The continuity of the A line conductor at the calling station is established at polar contact 225 of relay 1F², so that this line conduc-

tor is pieced out irrespective of its open condition at back contact 40 of relay P².

The station relays (SO with suitable exponent) are picked up at all odd stations by means of a circuit, similar to that extending through contact 196 of relay 2F¹ in its right hand dotted position. The station relays at even stations are picked up over circuits similar to that previously described, through contact 197 of relay 1F² in its right hand dotted position, but since contact 197 is now in its left hand dotted position, the circuit extends by way of (—) control bus² and back contact 226 of relay 1V².

Since this is a cycle for the transmission of indications alone, all of the impulses applied to line N are (—) because relay ENC remains up throughout the cycle. Line A is energized during each "on" period from the (+) terminal of battery AB because relay OC remains deenergized throughout the cycle. Therefore, the 2F relays at the stations are actuated to the left in response to a series of (—) impulses and the 2F relays are actuated to the right in response to a series of (+) impulses applied to line A. It will be recalled that a series of all (+) impulses, positioning the 2F relays to the right, corresponds to a phantom code and does not select any odd station and that a series of all (—) impulses, which position the 1F relays to the left, also corresponds to a phantom code combination and does not effect the selection of an even station.

After relay SA² is picked up at the calling station, a circuit is closed for sticking the lock-out relay which extends from (+), front contact 227 of relay SA², front contact 228 and lower winding of relay LO², to (—). The picking up of relay 1F in the control office, due to the energization of line N, is followed by the picking up of relays FP, SA, SAP and EP in the manner previously described in connection with a control cycle. The system is now stepped through the cycle as previously described and during the "off" periods between the energized periods of the line circuit, the A and B line conductors are conditioned for transmitting indication code combinations.

Registration of a field station.—It will now be assumed that the system is advanced through a cycle and an explanation will be given of the manner the field station (illustrated in Figs. 5 and 6) is registered in the control office.

The AB line circuit is impulsed during the first "off" period (following the conditioning period above explained) once or twice or not at all, as determined by the connections of jumpers 280 and 281. With jumper 280 connected to the No. 1 pulse bus 299 as shown and with jumper 281 disconnected as shown, the AB line circuit is impulsed once. It will be recalled that relay P² was picked up to start the cycle. It is stuck up until relay SA² picks up, when its energizing circuit is opened at back contact 218 of relay SA². Another energizing circuit for relay P² is established when relay SA² picks up which extends from (+), front contact 282 of relay FP², front contact 283 of relay SA², front contact 284 of relay LO², back contacts 285, 286 and 287 of relays VP², 3V² and 1V² respectively, the No. 1³ conductor, jumper 280, No. 1 pulse bus 299 and upper winding of relay P², to (—).

With relay P² picked up and its back contact 40 open, the AB line circuit is deenergized when relay 1F² is dropped at the start of the first "off" period, by the opening of its contact 225.

The deenergization of the AB line circuit causes the 2F relays to drop. The dropping of the 2F relay in the control office closes a circuit for picking up relay 1M extending from (+), front contact 169 of relay SA, front contact 176 of relay EP, conductor 258, back contact 102 of relay 2F, conductor 259 and winding of relay 1M, to (-). A circuit is now closed for picking up relay 2M which extends from (+), front contact 169 of relay SA, front contact 177 of relay E, front contact 178 of relay 1M, back contact 179 of relay 3M and winding of relay 2M, to (-). Relay 2M closes an obvious stick circuit for itself through its front contact 159, which is effective until relay E is dropped during the next "on" period.

Referring back to the field station, relay P² which is made slightly slow releasing due to its front contact 288 short circuiting its lower winding, is dropped during the first "off" period to energize the AB line circuit by closing its back contact 40. This picks up all the 2F relays (including relay 2F in the control office). Relay 1M is deenergized when relay 2F opens its back contact 102.

A circuit is closed for picking up relay 3M which extends from (+), front contact 169 of relay SA, front contact 177 of relay E, back contact 178 of relay 1M, front contact 159 of relay 2M and winding of relay 3M, to (-). Relay 3M closes a stick circuit for itself through its front contact 180, so that this relay is stuck up until the release of relay E. This results in relay 3M being up and relay 1M being down during the first "on" period after the picking up of relay VP, so that a circuit is closed for executing the No. 1 indication which extends from (B+), front contact 181 of relay 3M, back contact 182 of relay 1M, front contact 183 of relay E, back contact 184 of relay EP, front contact 185 of relay VP, back contact 186 of relay 3V, front contact 187 of relay 1V, No. 1¹ indication conductor 268 and winding of relay 2PT, to (CN). This effects the positioning of relay 2PT to the right. During this same period a circuit is closed for positioning relay 1PT to the left which extends from (B-), back contact 188 of relay 1M, front contact 189 of relay E, back contact 199 of relay EP, front contact 209 of relay VP, back contact 229 of relay 3V, front contact 239 of relay 1V, No. 1 indication conductor 269 and winding of relay 1PT, to (CN).

With relay 2PT positioned to the right and relay 1PT positioned to the left, a circuit is closed for energizing relay 2ST after the second step has been taken, which circuit extends from (+), front contact 239 of relay 2V, conductor 236, contact 232 of relay 1PT in its left hand position, contact 233 of relay 2PT in its right hand position and winding of relay 2ST, to (-). This circuit is effective before the picking up of relay 2V, because relay VP connects (+) to the circuit at its front contact 234. This is for the purpose of energizing the station relay during the "on" period following the execution of the first indication, so that the station relay will be picked up and the circuits prepared to the indication receiving relays before the 2V relay is picked up, which occurs during the second "off" period when the AB line circuit is again impulsed to condition the indication receiving relays.

The dotted wiring of contacts 247, 248 and 249 of relays VP, 3V and 2V indicates the circuit arrangement which would be used for energizing the station relay when station registration is

effected on two steps of the cycle. In this case, contacts 234 and 230 would be omitted and wire 236 would be connected to terminal 235 instead of terminal 231. With this arrangement, a station relay would be first energized when relay VP drops after relay 2V picks up and since front contact 248 of relay 3V is closed before relay VP again picks up, terminal 235 is maintained energized until the end of the cycle. The AB line circuit remains closed throughout the succeeding "on" period until the second "off" period, when it is again impulsed as determined by the condition of relay WP², as a typical example.

In the event that both jumpers 281 and 280 are disconnected from bus wires 289 and 299, then relay P² is dropped during the conditioning "on" period, shortly after relay SA² opens its back contact 218. This results in the AB line circuit remaining closed throughout the first "off" period, so that relay 2F in the control office is not dropped and none of the message relays 1M, 2M and 3M are picked up. With relay 1M down, the previously described circuit is effective to position relay 1PT to the left and with relay 3M down, the above described circuit for energizing relay 2PT extends from (B-) through back contact 181 of relay 3M, so that relay 2PT is positioned to the left.

In the event that jumper 280 is connected to conductor 299 and jumper 281 is connected to conductor 289, then the AB line circuit is impulsed twice. This is brought about by relay P² being energized as before, so that the AB line circuit is opened first when relay 1F² drops. When relay P² drops, the AB line circuit is reenergized. When relay 1V² is picked up during the first "off" period, a circuit is closed for picking up relay 1P² which extends from (+), back contact 296 of relay VP², back contact 297 of relay 3V², front contact 298 of relay 1V², the No. 1⁴ indication conductor, jumper 281, conductor 289, front contact 270 of relay P² and upper winding of relay 1P², to (-). When relay P² drops, the circuit through contact 270 is now transferred through its back point and front contact 271 of relay 1P² to the winding of relay 2P², which energizes this relay.

Relay 1P² drops shortly after relay P² opens its front contact 270, which is effective to again deenergize the AB line circuit by opening its front contact 272, because relay 2P² is up at this time with its back contact 273 picked up. Relay 2P² drops shortly after relay 1P² drops its front contact 271, which again energizes the AB line circuit by closing back contact 273.

It will thus be seen that the AB line circuit is impulsed twice under this condition and this is registered in the control office by relays 1M and 3M being up when the indication circuit is executed. Relays 1M and 2M are picked up as previously described. When relay 1M is dropped for picking up relay 3M, it is again energized after relay 3M picks up because relay 2F is down completing a circuit from (+), front contact 169 of relay SA, front contact 176 of relay EP, conductor 258, back contact 102 of relay 2F, conductor 259 and winding of relay 1M, to (-). In this case the system advances into the first "on" period with relays 1M, 2M and 3M picked up. When relay VP picks up to execute this indication, (B+) potential through front contacts 188 and 182 of relay 1M positions relays 2PT and 1PT to the right.

The above explanation indicates how a selection of three conditions for the transmission of

indications is obtained on the first step of the cycle. First, no impulse in the AB line circuit during an "off" period results in the message relays 1M and 3M being down, when the execution is effected in the succeeding "on" period. Second, one impulse in the AB line circuit during an "off" period results in relay 3M being up and relay 1M being down, when the execution is effected in the succeeding "on" period. Third, two impulses in the AB line circuit during an "off" period result in the message relays 3M and 1M both being up, when the execution is effected in the succeeding "on" period.

It will be understood that line AB may be impulsed during succeeding steps as determined by additional jumper connections, for example, between conductors 299 and 289 and the No. 2³ and the No. 2⁴ indication wires in a system of increased capacity. It is believed, however, that the above typical example indicates the method of registering stations in the control office by means of code combinations made up of a variable number of impulses in the AB line circuit.

Transmission of indications.—After thus having registered in the control office the particular station which has indications ready to transmit, the remaining steps of the cycle are employed for the transmission of these indications.

Assuming that relay WP² is in the position shown in Fig. 6, as an indication that the associated track switch TS² is in its normal locked position, it is necessary that the AB line circuit be so conditioned that relay 1IR be positioned to the left and relay 2IR be positioned to the right, in order that an energizing circuit may be established for the lamp NL (Fig. 4A) which indicates this condition. To thus position relays 1IR and 2IR, it is necessary that the AB line circuit be impulsed once during the second "off" period.

Relay P² is picked up, to open its back contact 40, during the first "on" period over a circuit which extends from (+), front contact 282 of relay FP², front contact 283 of relay SA², front contact 284 of relay LO², front contact 285 of relay VP², back contact 274 of relay 2V², No. 2³ indication conductor, front contact 200 of relay WP², No. 1 pulse bus 299 and upper winding of relay P², to (—). This circuit is deenergized when relay FP² drops at the beginning of the second "off" period and since relay P² is slightly slow to release, the AB line circuit is opened by contact 225 of relay 1P² restoring to its neutral position.

The open condition of the AB line circuit is effective to drop relay 2F in the control office and a circuit is closed for picking up relay 1M which has been previously described. Relay 2M is picked up as previously described and when relay P² at the field station drops, the AB line circuit is energized through back contact 40. This picks up relay 2F in the control office and by opening its back contact 102 causes relay 1M to drop. Since the AB line circuit is impulsed once during the second "off" period, relay 1M is not again picked up during this "off" period. Relay 3M is picked up when relay 1M is dropped, by means of the previously described circuit extending through back contact 178 of relay 1M and front contact 159 of relay 2M.

When the system advances into the second "on" period, relay VP drops to execute the above described condition (relay 1M down and relay 3M up) by closing a circuit for positioning relay 1IR to the left extending from (B—), back contact 188 of relay 1M, front contact 189 of relay E,

back contact 199 of relay EP, back contact 209 of relay VP, front contact 238 of relay 2V, the No. 2 indication conductor 279, front contact 240 of relay 2ST and winding of relay 1IR, to (CN).

The circuit for positioning relay 2IR to the right extends from (B+), front contact 181 of relay 3M, back contact 182 of relay 1M, front contact 183 of relay E, back contact 184 of relay EP, back contact 185 of relay VP, front contact 241 of relay 2V, the No. 2¹ indication conductor 278, front contact 242 of relay 2ST and winding of relay 2IR, to (CN). With relay 2IR positioned to the right and with relay 1IR positioned to the left, a circuit is closed for energizing lamp NL which extends from (+), contact 243 of relay 2IR in its right hand position, contact 244 of relay 1IR in its left hand position and lamp NL, to (—).

In the event that relay WP² has its contact 198 in its left hand dotted position and its contacts 200 and 201 in their energized positions for indicating a reverse locked condition of the track switch, then relay P² is picked up as before and relay 1P² is picked up over a circuit extending from (+), front contact 296 of relay VP², front contact 275 of relay 2V², the No. 2⁴ indication conductor, front contact 291 of relay WP², polar contact 198 of relay WP² in its left hand dotted position, No. 2 pulse bus 289, front contact 270 of relay P² and upper winding of relay 1P², to (—). Upon release of relay P², the switching of contact 270 from its front to its back point extends the above described circuit through front contact 271 of relay 1P² and upper winding of relay 2P², to (—) for picking up relay 2P².

It will be understood that because relay P² is picked up when relay 1P² is dropped, the AB line circuit is opened. Then when relay P² drops, the AB line circuit is energized and at the time relay 1P² drops (shortly after relay P² opens its front contact 270) the line circuit is again deenergized by the dropping of front contact 272 of relay 1P². Shortly after relay 1P² drops, relay 2P² drops and the AB line is closed up again at back contact 273. All this results in the application of two impulses to the AB line circuit during the second "off" period.

As previously explained, two impulses in the AB line circuit result in relays 1M and 3M being up at the time the indication is executed and in this case (B+) through front contact 188 of relay 1M and (B+) through front contact 181 of relay 3M is applied to the windings of relays 1IR and 2IR for positioning these two indication receiving relays to the right. This closes a circuit from (+), through the right hand contacts of these two relays for energizing lamp RL.

In the event that relay WP² has its contacts 200 and 201 in their deenergized positions as an indication that the associated switch is in its unlocked position, then both buses 289 and 299 remain deenergized so that none of the relays P², 1P² and 2P² are picked up, with the result that the AB line circuit is not deenergized during the second "off" period and with the further result that none of the message relays 1M, 2M and 3M are picked up. This indication is executed by applying (B—), through back contacts 180 and 181 of relays 1M and 3M respectively, to the 1IR and 2IR relays for positioning them to the left. This results in neither lamp NL nor lamp RL being energized, which is an indication that the associated switch at the field station is in its unlocked position.

Although the transmission of indications has been explained in detail for a single step only, it

is to be understood that any number of steps may be similarly employed with each additional step providing for the transmission of a choice of two or three indication conditions as required.

5 *End of indication cycle.*—The step-by-step operation of the system and the impulsing of the N line during an indication cycle is similar to those operations during a control cycle and the N line is opened at the end of the last impulse, in
10 a manner previously explained in connection with a control cycle, for allowing the relays of the system to assume normal positions. The dropping of relay SA in the control office opens the stick circuit of relay FC at front contact 84, so that
15 relay FC is dropped after which starting relay STR is dropped. The N line circuit is thus de-energized until the system is again initiated.

The dropping of relay SA² at the field station opens at its front contact 227 the stick circuit for relay LO² and this relay is released. The pick-up and stick circuits for the stepping relays and the half step relay are deenergized when relay SA² drops its front contacts 245 and 246. Other line
20 relays 1F (with suitable exponent) and other line repeating relays FP and SA (with suitable exponents) at the other stations are dropped, so that all stations are placed in their normal at-rest conditions. When relay SA³ at the end station
25 drops and opens its front contacts 27 and 28, resistor 3R³ is included in the N and B line conductors, which provides a conductive path for the conditioning impulse when the next cycle is initiated in the control office.

30 *Lock-out between field stations.*—It may happen that changes occur at several field stations at the same time or in rapid succession, so that more than one station will have new indications to transmit at the beginning of a cycle. In order to prevent more than one station obtaining access
35 to the communication circuit during any particular cycle, lock-out means are provided at each field station effective to select that station nearest the control office under the above condition.

The system may be considered as having an
40 initiating period and a lock-out period at the beginning of each cycle. The initiating period may be said to be marked off by the time interval extending from the occurrence of a change in condition either in the control office or at a field station, up to the instant that the line repeating relays FP (with suitable exponent) at the control office and at each field station pick up in response to the first or conditioning impulse applied to the N line circuit. The lock-out period may be
45 considered as that time marked off between the actual picking up of the FP relay contacts and the picking up of the respective contacts of the slow acting relays SA (with suitable exponent). The various operations of the system during the
50 initiating period and the lock-out period may be best understood by considering the line circuits illustrated in Figs. 3A, 3B, 5 and 6.

Assuming that the even station illustrated in
55 Figs. 5 and 6 is the first station nearest the control office. A change occurring at this station results in relay CHS² being picked up. This closes a circuit for picking up relay P² and the cycle is initiated by the picking up of relay 2F in the control office as previously explained. As soon as
60 the first impulse is repeated by relay FP², the pick-up circuit for relay P² is opened at back contact 219. Throughout the remainder of the cycle this pick-up circuit is open at back contact 218 of relay SA².
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In other words, the last chance that a field station has for transmitting a message to the control office that a change at the field station has taken place, ends when the FP relay at that field station is picked up. This means that relay P²
5 must be energized for a sufficient period, prior to the picking up of contact 218 of relay SA², to allow the upper winding of relay LO² to be energized over the line circuit, so that its front contact 228 is closed when relay SA² closes its front contact
10 227 for completing the stick circuit of the lock-out relay. In order that the pick-up circuit through the upper winding of relay LO² is not interrupted before the stick circuit is closed, back contact 222 of relay SA² is of the follow-up type, that is, front contact 227 makes before back
15 contact 222 breaks.

It will now be assumed that relay CHS² at the first field station and a similar relay at the second field station are picked up at the same time, or that both are up when the system returns to its normal or period of blank condition after a preceding cycle. Under this assumption, relay CHS² causes relay P² to be picked up and the CHS relay (assumed to be relay CHS³) at the second station farther out the line causes its associated relay (assumed to be relay P³) to be picked up.
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Immediately upon the closure of front contact 40 of relay P² at the first field station, the AB line circuit is energized, resulting in the initiation of the cycle as previously explained. At the second field station, the lock-out relay (for example, relay LO³) is not energized because the A line circuit leading to the second field station is open at back contact 40 of relay P² at the first station.
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The FP relays at both stations are picked up because the return path for the current applied to line A from the (+) terminal of battery AB, is by way of line N from the first field station to the end field station and thence through resistor 3R³ to the (−) terminal of battery AB over line B. This of course effects the picking up of the 1F relays at all stations farther out the line and this is repeated by the respective FP relays.
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The picking up of the FP² and FP³ relay contacts at the first and second stations opens the pick-up circuits of the P² and P³ relays and the picking up of the SA² and SA³ relays at these stations opens the stick circuits of the P² and P³ relays. Therefore, the P³ relay at the second station is dropped and the continuity of the A line conductor is completed at its back contact similar to 40. At the second field station, the lock-out relay failed to be energized so that its stick circuit is incomplete at its own front contact similar to 228, after the SA³ relay picks up and closes its front contact similar to 227.
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In brief, the first field station has preference in obtaining access to the communication circuit by reason of its geographic location. Irrespective of whether such changes occur in sequence or simultaneously, the station nearest the control office obtains energy through a front contact such as 40 for energizing its lock-out relay such as relay LO², so at the end of the initiating period the lock-out relay at the preferred station will be maintained energized, while at the second field station the lock-out relay can not be energized during this cycle. This dropping out or locking out occurs subsequent to the picking up of the FP relay contacts at the several stations. Although this lock-out condition has been explained with reference to the first and second field stations it is to be understood that
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similar conditions may exist between various combinations of field stations in the system, but it is believed that the typical example given is sufficient for an understanding of all such combinations.

Duplex transmission.—It has been pointed out above that control and indication cycles may each occur separately or simultaneously. The operation for control and indication cycles alone has been described and it will now be explained how the system operates when controls and indications are transmitted during the same cycle.

The actuation of a starting button in the control office effects the energization of the control office cycle controlling relay C, during the time that the system is at rest and any time up to the end of the period marked off by the picking up of relay ENC in the control office. In other words, if a field station initiates a cycle by causing the field station cycle controlling relay FC to be picked up which in turn causes relay ENC to be picked up, then the control office cannot change or alter the conditions set up but must wait until the next period of blank in order to start the system by picking up relay C.

On the other hand, relay C may be picked up any time up to the point where relay ENC is picked up, even if a field station has caused relay FC to be picked up. This condition results in relays C and FC both being up at the start of a cycle. Also, if the control office first initiates the cycle by picking up relay C, relay FC can be picked up at any time up to the picking up of contact 89 of relay C. Since the first impulse applied to line N results in picking up all station relays such as relay SO² of Fig. 5 and since the initiation of a cycle by a field station results in picking up its lock-out relay such as relay LO², a cycle of operations may be started with all station relays up and one lock-out relay up at the same time.

Thus, when the system is initiated with relays C and FC picked up, relays ENC and EPC will be selectively conditioned as determined by the code combination or combinations of the station or stations to be selected and for the transmission of controls thereto. This is due to the fact that although relay FC closes its front contact 167, which was used during an indication cycle for maintaining relay ENC picked up to provide a series of (—) impulses to line N, relay C being up opens the energizing circuit of relay ENC at its back contact 166. Since some CD relay and one or more SRP relays will be picked up, the EPC and ENC buses will be selectively energized in a manner previously described.

The resulting cycle of operations, insofar as the transmission of polar impulses over the N line circuit and the AB line circuit is concerned, will be the same as described for individual control and indication cycles. It is, therefore, evident that only one CD relay in the control office and one lock-out relay at a field station can be up at the same time during a cycle of operations and since transmission of controls and transmission of indications take place during separate and distinctive conditions of the line circuit, these transmissions are independent of each other and can be incorporated into the same cycle for obtaining the duplex feature. The cycle of operations, insofar as the conditioning of the A and B line conductors during the "off" periods is concerned, is the same as described for a cycle during which indications alone are transmitted.

Various other novel features of the present in-

vention reside in the detailed circuit arrangements disclosed, such as energizing the line relays in the neutral branch of an Edison 3-wire circuit with current which is ineffective to energize the line relays connected in the return paths of the neutral line and energizing the line relays connected in the return paths from a separate source of current which is ineffective to energize the first mentioned line relays.

Although one specific embodiment of the present invention has been shown, it is to be understood that various rearrangements of the circuits may be made without departing from the spirit of the invention.

Having thus described one preferred embodiment of a centralized traffic controlling system, it is desired to be understood that this form is selected to facilitate in the disclosure of the invention rather than to limit the number of forms which it may assume and it is further desired to be understood that various modifications, adaptations and alterations may be applied to the specific form disclosed to meet the problems encountered in practice without in any manner departing from the spirit or scope of the present invention, except as limited by the appended claims.

What I claim is:—

1. In a remote control system, the combination with a plurality of field stations, of control office equipment comprising a control lever for each station, means controlled by said lever for effecting a control operation at the associated station, a button for each station, code determining relays each controlled by a plurality of buttons, means for interlocking said relays to permit energization of only one at a time in a predetermined order, and means governed by each code determining relay for rendering effective the control levers of a plurality of stations.

2. In a remote control system, the combination with a plurality of field stations, of control office equipment comprising a control lever for each station, means controlled by said lever for effecting a control operation at the associated station, a button for each station, a storing relay controlled by each button, code determining relays each controlled by a plurality of storing relays, means for interlocking said code determining relays to permit energization of only one at a time in a predetermined order, and means governed by each code determining relay in combination with a plurality of storing relays for rendering effective the control levers of a plurality of stations.

3. In a remote control system, the combination with a plurality of field stations, of control office equipment comprising a control lever for each station, means controlled by said lever for effecting a control operation at the associated station, a button for each station, a storing relay controlled by each button, code determining relays each controlled by a plurality of storing relays, means for interlocking said code determining relays to permit energization of only one at a time in a predetermined order, means governed by one of said storing relays in conjunction with one of said code determining relays for rendering effective the control lever of one of said stations, and means governed by a plurality of said storing relays in conjunction with one of said code determining relays for rendering effective the control levers of a plurality of stations.

4. In a remote control system, a control office, a plurality of field stations, a plurality of relays

in said control office, means governed by each of said relays for controlling the simultaneous selection of two stations, a plurality of manually selectable circuits for storing the condition that a plurality of said stations are to be selected, means for allotting the order in which said relays are operated when more than two stored conditions exist at the same time, and means responsive to the operation of one of said relays for simultaneously selecting its associated two stations.

5. In a remote control system, a stepping line, means for impressing a first series of time spaced impulses of selected characters on said stepping line, a plurality of return lines for said stepping line, means for impressing a second series of impulses of selected characters on said return lines in synchronism with said first series of impulses, step-by-step mechanisms operated one step for each of said impulses for preparing a plurality of channel circuits for each step, and means for energizing said channel circuits for each step in accordance with the character of the impulses for that step.

6. In a remote control system, a stepping line, means for impressing a first series of time spaced impulses of selected characters on said stepping line, a plurality of return lines for said stepping line, means for impressing a second series of impulses of selected characters on said return lines in synchronism with said first series of impulses, step-by-step mechanisms operated one step for each of said impulses for preparing a plurality of channel circuits for each step, means for energizing a portion of said channel circuits for each step in accordance with the character of the impulse impressed on said stepping line for that step, and means for energizing another portion of said channel circuits for each step in accordance with the character of the impulse impressed on said return lines for that step.

7. In a remote control system, a stepping line, means for impressing a first series of time space impulses of selected characters on said stepping line, a first line relay connected to said stepping line, a plurality of return lines for said stepping line, a second line relay connected to said return lines, means for impressing a second series of impulses of selected characters on said return lines in synchronism with said first series of impulses, means responsive to said series of impulses for characteristically operating said line relays, step-by-step mechanisms operated one step by said line relays for each of said impulses for preparing a plurality of channel circuits for each step, and means including said line relays for energizing said channel circuits for each step in accordance with the character of the impulses for that step.

8. In a remote control system, a stepping line, means for impressing a first series of time spaced impulses of selected characters on said stepping line, a first line relay connected to said stepping line, a plurality of return lines for said stepping line, a second line relay connected to said return lines, means for impressing a second series of impulses of selected characters on said return lines in synchronism with said first series of impulses, means responsive to said series of impulses for characteristically operating said line relays, step-by-step mechanisms operated one step by said line relays for each of said impulses for preparing a plurality of channel circuits for each step, means including said line relays for energizing said channel circuits for each step in

accordance with the character of the impulses for that step, and means for neutralizing the effect of said first series of impulses on the operation of said second line relay.

9. In a remote control system, a control office, a plurality of field stations, a stepping line and a plurality of return lines connecting said office with said stations, step-by-step mechanisms at said office and at said stations, means for energizing said stepping line with a first series of time spaced impulses of distinctive character, means for energizing said return lines with a second series of time spaced impulses of distinctive character in synchronism with said first series of impulses, means responsive to said impulses for operating said mechanisms in synchronism, means responsive to the character of said first series of impulses for selecting one of said stations, and means responsive to the character of said second series of impulses for simultaneously selecting another of said stations.

10. In a remote control system, a control office, a plurality of field stations, a stepping line and a plurality of return lines connecting said office with said stations, step-by-step mechanisms at said office and at said stations, means for energizing said stepping line with a first series of time spaced impulses of distinctive character, means for energizing said return lines with a second series of time spaced impulses of distinctive character in synchronism with said first series of impulses, means responsive to said impulses for operating said mechanisms in synchronism, means responsive to the character of said first series of impulses for selecting one of said stations, means responsive to the character of said second series of impulses for simultaneously selecting another of said stations, means for conditioning by energizing or deenergizing said return lines during the time spaces between said second series of said impulses, and means responsive to said conditioning for registering one of said stations in said office.

11. In a remote control system, a control office, a plurality of field stations, a stepping line and a plurality of return lines connecting said office with said stations, step-by-step mechanisms at said office and at said stations, means for energizing said stepping line with a first series of time spaced impulses of distinctive character, means for energizing said return lines with a second series of time spaced impulses of distinctive character in synchronism with said first series of impulses, means responsive to said impulses for operating said mechanisms in synchronism, means responsive to the character of said first series of impulses for selecting one of said stations, means responsive to the character of said second series of impulses for simultaneously selecting another of said stations, means for conditioning by energizing or deenergizing said return lines during the time spaces between said second series of said impulses, and means responsive to said conditioning for transmitting messages from said stations to said office.

12. In a remote control system, a control office, a plurality of field stations, a first line circuit and a second line circuit connecting said office with said stations, a code determining relay in said office, means including a plurality of manually operable devices for operating said code determining relay, means responsive to the operation of said code determining relay for simultaneously energizing said first line circuit with a first series of coded impulses and said second line circuit with

a second series of coded impulses, and means responsive to said first and said second series of impulses for simultaneously selecting a plurality of said stations.

13. In a remote control system, a control office, a plurality of field stations, a first line circuit and a second line circuit connecting said office with said stations, a code determining relay in said office, means including a plurality of manually operable devices for operating said code determining relay, a plurality of control levers, means responsive to the operation of said code determining relay for simultaneously energizing said first line circuit with a first series of coded impulses and said second line circuit with a second series of coded impulses, means responsive to said first and said second series of impulses for simultaneously selecting a plurality of said stations, and means controlled by said levers for effecting a simultaneous remote control operation at a plurality of said stations.

14. In a remote control system, a first line and a plurality of other lines connecting a central office with a plurality of stations, means for energizing said first line and said other lines with a first series of impulses, means for energizing said other lines with a second series of impulses, a first line relay at each of said stations in series with said first line, a second line relay at each of said stations in series with said other lines, means controlled by said first series of impulses for energizing said first line relays and for preventing the energization of said second line relays, means controlled by said second series of impulses for energizing said second line relays, and means responsive to the energization of said line relays for selectively registering said first and second series of impulses at said stations.

15. In a remote control system, a first line and a plurality of other lines connecting a central office with a plurality of stations, means for energizing said first line and said other lines with a first series of impulses, means for energizing said other lines with a second series of impulses concurrently with said first series of impulses, a first line relay at each of said stations in series with said first line, a second line relay at each of said stations in series with said other lines, means controlled by said first series of impulses for energizing said first line relays and for preventing the energization of said second line relays, means controlled by said second series of impulses for energizing said second line relays, and means responsive to the energization of said line relays for selectively registering said first and second series of impulses at said stations.

16. In a remote control system, a control office and a plurality of remote stations interconnected by a plurality of line circuits, a single transmitter, means including said transmitter for applying a first series of impulses to a first one of said line circuits and simultaneously applying a second series of impulses to a second one of said line circuits, means for simultaneously and characteristically marking each impulse of each series, means for selectively registering and translating the character of said first series of impulses at certain stations only, means for selectively registering and translating the character of said second series of impulses at certain other stations only, and means responsive to the selective registration and translation of said first and second series of impulses for simultaneously selecting

one of said certain stations and one of said certain other stations only.

17. In a remote control system, a control office and a plurality of remote stations interconnected by a plurality of line circuits, a single transmitter, means including said transmitter for applying a first series of impulses to a first one of said line circuits and simultaneously applying a second series of impulses to a second one of said line circuits, means for simultaneously and characteristically marking each impulse of each series, means for selectively registering and translating the character of said first series of impulses at certain stations only, means for selectively registering and translating the character of said second series of impulses at certain other stations only, and means responsive to the selective registration and translation of said series of impulses for simultaneously transmitting messages to a plurality of said stations.

18. In a remote control system, a control office and a plurality of remote stations interconnected by a plurality of line circuits, a single transmitter, means including said transmitter for applying a first series of impulses to a first one of said line circuits and simultaneously applying a second series of impulses to a second one of said line circuits, means for simultaneously and characteristically marking each impulse of each series, means for selectively registering and translating the character of said first series of impulses at certain stations only, means for selectively registering and translating the character of said second series of impulses at certain other stations only, and means responsive to the selective registration and translation of said series of impulses for selecting one of said stations and simultaneously transmitting a message to another of said stations.

19. In a remote control system; a control office; a first field station, a second field station and a third field station; a first line wire, a second line wire and a third line wire extending from said office through said first and second stations to said third station; a transmitter at each station rendered active to transmit code signals to said office over certain of said line wires; a lock-out relay at each station having active and inactive positions for rendering the associated transmitter active and inactive respectively; initiating means at each of said stations rendered active when the associated station has code signals to transmit; means controlled by the active condition of the initiating means at said second station for effecting the energization of a first lock-out circuit comprising said first and second line wires extending from said office to said second station and including said first and third line wires extending from said second station to said third station; means responsive to the energization of said first lock-out circuit for placing the lock-out relay at said second station in its active position; means controlled by the active condition of the initiating means at said first station for effecting the de-energization of said first lock-out circuit and for effecting the energization of a second lock-out circuit comprising said first and second line wires extending from said office to said first station and including said first and third line wires extending from said first station to said third station; and means responsive to said de-energization of said first lock-out circuit and said energization of said second lock-out circuit for returning the lock-out relay at said second station to its inactive position and

for placing the lock-out relay at said first station in its active position, whereby the consequent transmission of code signals is switched from said second station to said first station.

5 20. In a remote control system of the selector type; the combination with a control office and a plurality of field stations; of a first line circuit and a second line circuit connecting said office with said stations; impulsing means at said
10 office for energizing said first line circuit with a first plurality of impulses; coding means at each of said stations controlled by said first plurality of impulses for energizing said second line circuit with a second plurality of impulses to transmit
15 a code; means at each of said field stations which if actuated establishes a new circuit comprising said line circuits in distinctive combination for the flow of one impulse of said second plurality of impulses; means responsive to said one impulse in said new circuit to allow the coding
20 means at a first station, nearer said office than a second station, to transmit; and means at said second station responsive to said one impulse in said new circuit to prevent the coding
25 means at said second station transmitting; whereby said new circuit allows only the station near said office of several stations attempting to transmit, during the energization of said first line circuit with said first plurality of impulses,
30 to transmit a code.

21. A remote control system of the character described for transmitting controls from a control office to any one of a plurality of field stations and for transmitting indications from any
35 one of said stations to said office comprising, a first line circuit and a second line circuit interconnecting said office and said stations, means for intermittently energizing said first line circuit, step-by-step mechanisms in the office and
40 at each station operated synchronously to take one step in response to each energization and each de-energization of said first line circuit, pole-changing means in said second line circuit at said office, impulsing means in said second
45 line circuit at each station, circuits controlled by the step-by-step mechanism in said office for controlling said pole-changing means successively during each energization of said first line circuit in accordance with the controls to be
50 transmitted, and circuits controlled by the step-by-step mechanism at each station for controlling said impulsing means at that station a number of times during each de-energization of said first line circuit in accordance with the indications to be transmitted.
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22. A remote control system of the character described for transmitting controls from a control office to any one of a plurality of field stations and for transmitting indications from any
60 one of said stations to said office comprising, a first line circuit and a second line circuit interconnecting said office and said stations, means for intermittently energizing said first line circuit, step-by-step mechanisms in the office and
65 at each station operated synchronously to take one step in response to each energization and each de-energization of said first line circuit, pole-changing means in said second line circuit at said office, impulsing means in said second
70 line circuit at each station, circuits controlled by the step-by-step mechanism in said office for controlling said pole-changing means successively during each energization of said first line circuit in accordance with the controls to be
75 transmitted, circuits controlled by the step-by-

step mechanism at each station for controlling said impulsing means at that station a number of times during each de-energization of said first line circuit in accordance with the indications to be transmitted, and lock-out means at each
5 station for preventing the control of said impulsing means at more than one of said stations during the synchronous operation of said step-by-step mechanisms.

23. In a remote control system, a control office, 10 a first and a second field station, a first line circuit connecting said office and said stations, step-by-step mechanism at said office and at each of said stations operated in synchronism by impulses applied to said first line circuit by said office, code
15 responsive means at said first station controlled by the step-by-step mechanism at said first station and responsive to the character of the impulses applied to said first line circuit, a second line circuit connecting said office and said
20 stations having impulses applied thereto by said office and for transmitting indications from either of said stations to said office through the medium of said step-by-step mechanisms, code responsive mechanism at said second station responsive
25 to the step-by-step mechanism at said second station and the character of the impulses applied to said second line circuit by said office, and means at each of said stations for transmitting indications over said second line circuit
30 to said office.

24. In a remote control system, a local office, a plurality of field stations, a stepping circuit including a stepping line connecting said office and said stations and a pair of return lines in multiple
35 extending from the most distant station to said office, step-by-step means and a source of direct current at said office for impressing a series of impulses of selected polarities on said stepping circuit to characterize a code, a polar relay at
40 each of said field stations in series in said line circuit responsive to said impulses, a relay at each field station each having two windings one included in series in one return line and the other included in series in the other return line in such
45 relation that current flowing in said stepping circuit is neutralized and current flowing in said return lines in series is cumulative, means including said step-by-step means and a source of direct current at said office for impressing im-
50 pulses in a circuit including said return lines in series to characterize a code, step-by-step means at each field station controlled by the impulses impressed on said stepping circuit irrespective of their polarity, and decoding means at each field
55 station controlled by its associated step-by-step means to decode the series of impulses flowing in said stepping circuit and the impulses flowing in said return lines in series.

25. In a remote control system, a local office, 60 a plurality of field stations, a stepping circuit including a stepping line connecting said office and said stations and a pair of return lines in multiple extending from the most distant station to said office, step-by-step means and a source of current
65 at said office for impressing a series of impulses of selected characters on said stepping circuit to characterize a code, a relay at each of said field stations in series in said line circuit responsive to said impulses, a relay at each field station
70 each having two windings one included in series in one return line and the other included in series in the other return line in such relation that current flowing in said stepping circuit is neutralized and current flowing in said return
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lines in series is cumulative, means including
said step-by-step means and a source of current
at said office for impressing impulses in a circuit
including said return lines in series to character-
ize a code and in a manner not to impress im-
pulses on said stepping circuit, step-by-step
means at each field station controlled by the im-

pulses impressed on said stepping circuit irre-
spective of their character, and decoding means
at each field station controlled by its associated
step-by-step means to decode the series of im-
pulses flowing in said stepping circuit and the
impulses flowing in said return lines in series.

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