

Aug. 9, 1938.

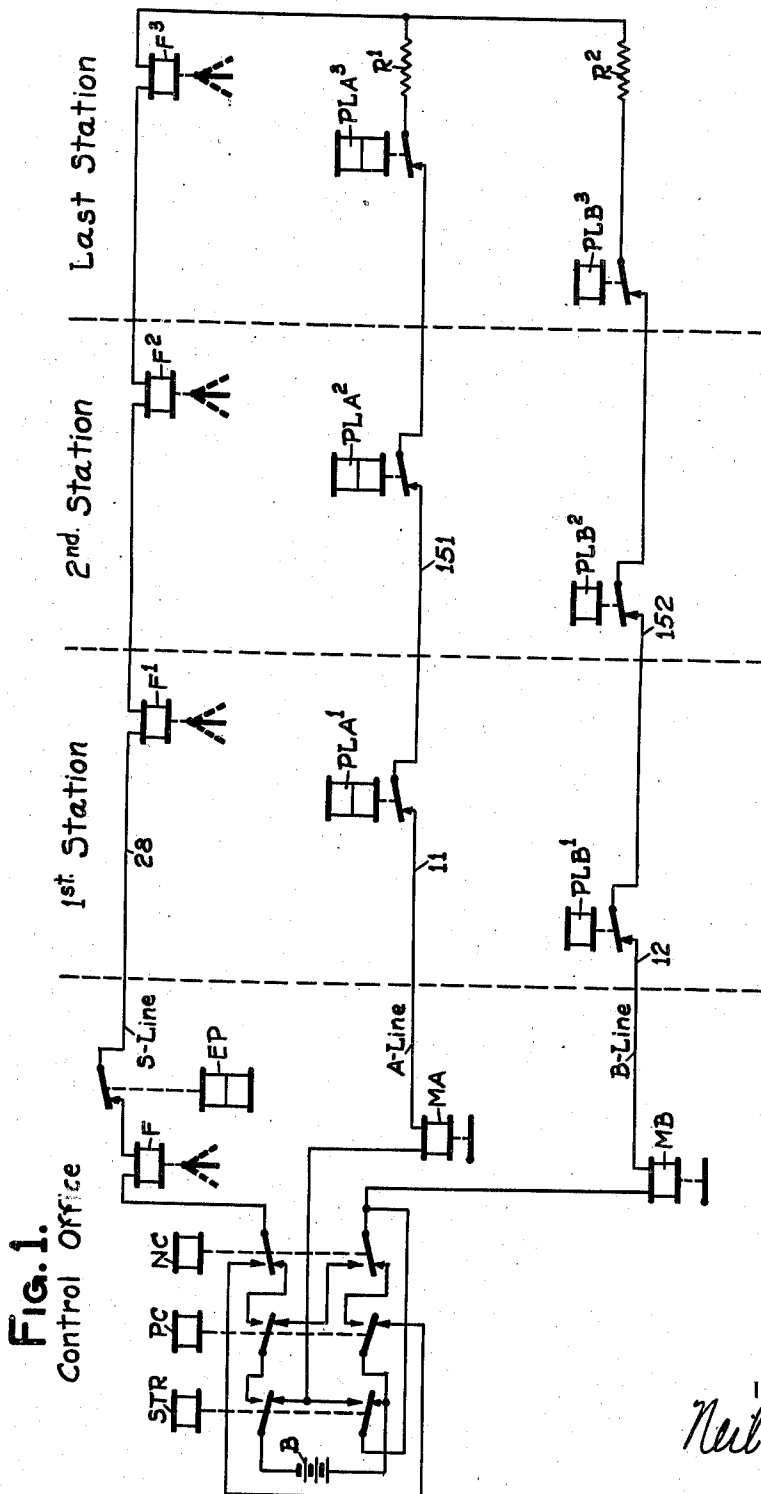
N. D. PRESTON

2,126,209

CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

Original Filed Nov. 26, 1932

5 Sheets-Sheet 1.



INVENTOR
Neil D. Preston

Aug. 9, 1938.

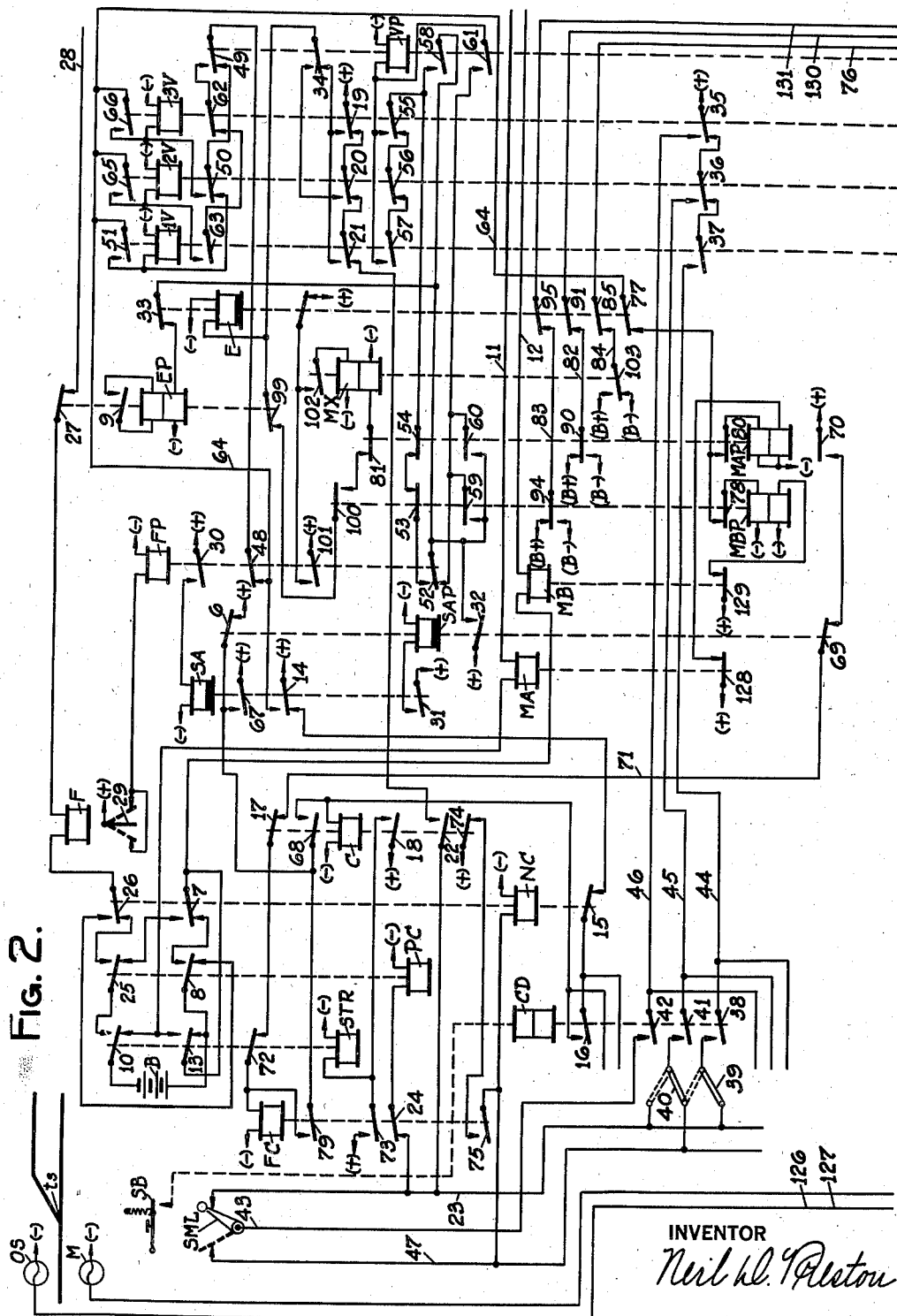
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

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5 Sheets-Sheet 2



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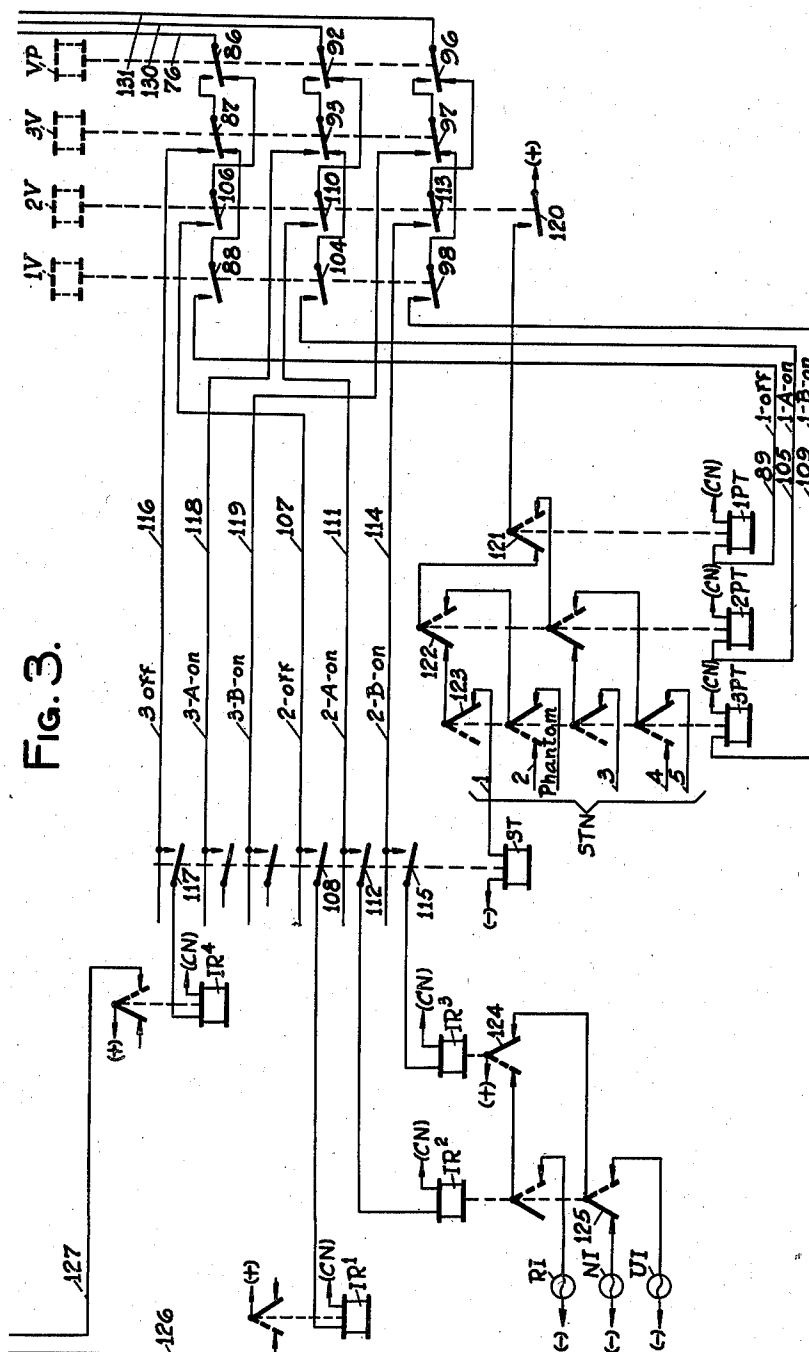
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

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**INVENTOR**

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Neil H. Preston

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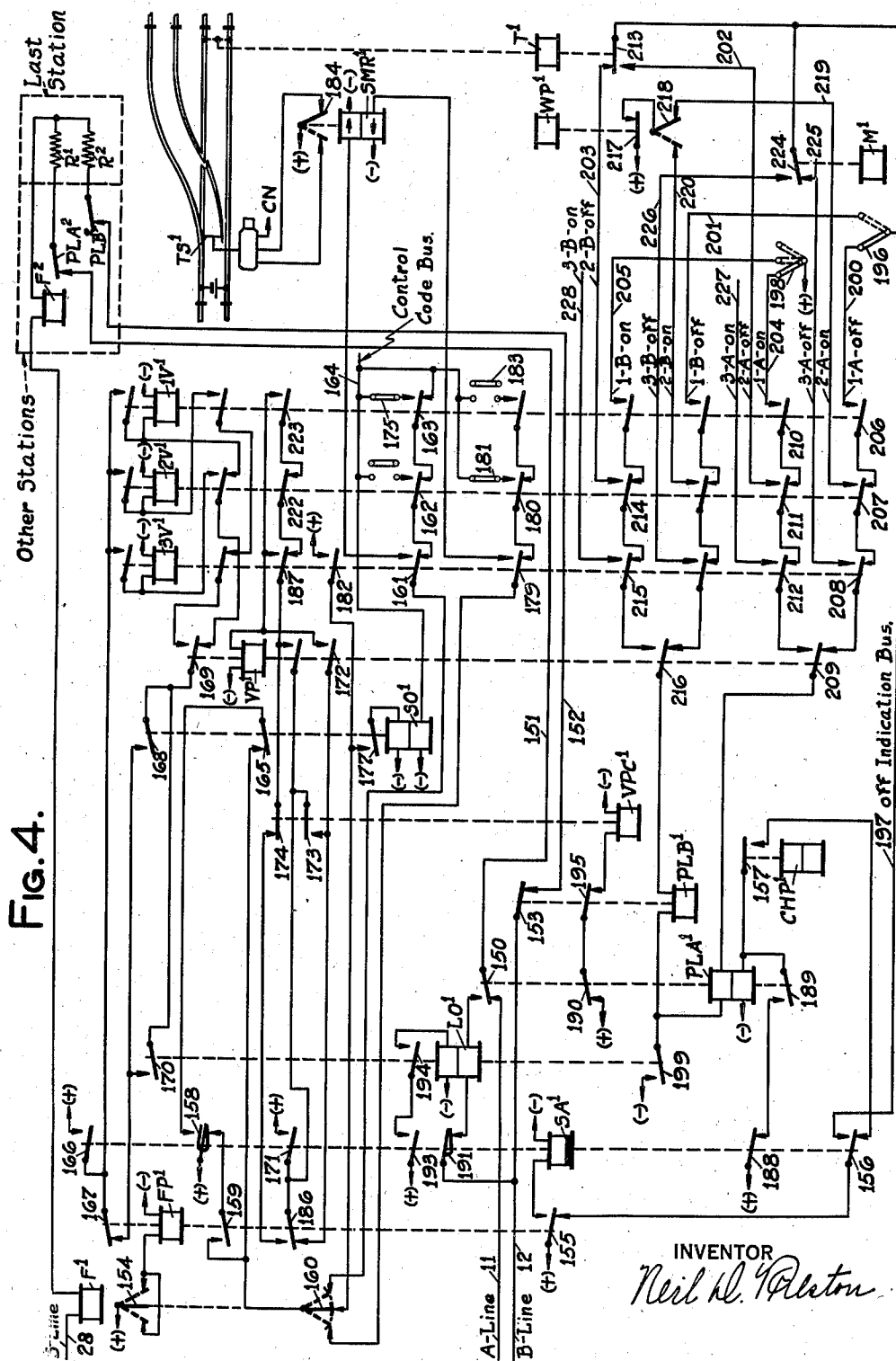
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

Original Filed Nov. 26, 1932

5 Sheets-Sheet 5

FIG. 5.
OPERATION CHART
CONTROL CYCLE

Normal Period	Operating Cycle									
	Conditioning Period	1st OFF	1st ON	2nd OFF	2nd ON	3rd OFF	3rd ON	4th OFF	4th ON	Change to Normal Period OFF
Line-S-O	ON	0	+	0	+	0	+	0	+	0
Line-A-O	+	0	+	0	+	0	+	0	+	0
Line-B-O	-	0	-	0	-	0	-	0	-	0
Manual Start	Pick up All 50 Relays	Pick up IV Relays	Pick up VP Relays	Pick up 2V Relays	Drop VP Relays	Pick up 3V Relays	Pick up VP Relays	Pick up 3V Relays	Pick up VP Relays	Drop SAP Relay
Office	No.1 Control Conditioned	No.1 Control Executed	No.1 Control Executed	No.2 Control Conditioned	No.2 Control Executed	No.3 Control Conditioned	No.3 Control Executed	No.3 Control Conditioned	No.3 Control Executed	Drop STR Relay
Station Selection										
Station Code + -										

Normal Period	Operating Cycle									
	Initiating Period	Lockout Period	Conditioning Period	1st OFF	1st ON	2nd OFF	2nd ON	3rd OFF	3rd ON	Change to Normal Period OFF
Line-S-O	OFF	ON	ON	0	+	0	+	0	+	0
Line-A-O	+	-	+	0	+	0	+	0	+	0
Line-B-O	-	0	+	0	+	0	+	0	+	0
Automatic Start	Pick up FP Relays	Pick up SAP Relays	Pick up SAP Relay	Pick up IV Relays	Pick up VP Relays	Pick up 2V Relays	Pick up VP Relays	Pick up 2V Relays	Pick up VP Relays	Drop STR Relay
Office	No.1 Off Indication Conditioned	No.1 On Indication Conditioned	No.1 On Indication Conditioned	No.1 Off Indication Conditioned	No.1 On Indication Conditioned	No.2 Off Indication Conditioned	No.2 On Indication Conditioned	No.2 Off Indication Conditioned	No.2 On Indication Conditioned	Drop V Relays
Station Registration										
Station Code - - +										

INVENTOR

Neil H. Preston

UNITED STATES PATENT OFFICE

2,126,209

CENTRALIZED TRAFFIC CONTROLLING
SYSTEM FOR RAILROADSNeil D. Preston, Rochester, N. Y., assignor to Gen-
eral Railway Signal Company, Rochester,
N. Y.Application November 26, 1932, Serial No. 644,481
Renewed March 6, 1936

18 Claims. (Cl. 177—353)

This invention relates to centralized traffic controlling systems for use in dispatching trains on railway systems and more particularly to the communication part of such systems; and an improvement over the invention disclosed in my earlier filed applications Ser. No. 589,186 filed January 27, 1932, and Ser. No. 596,516 filed March 3, 1932, and no claim is made herein to any invention disclosed in either of said earlier filed applications.

In railroad traffic controlling systems the traffic is controlled from a central control office and also the location of trains and the condition of the traffic controlling devices at remote locations are indicated to the attendant at the control office. 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 very short time. A single dispatcher can handle 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 the accumulation of stored controls and indications is avoided.

Such a traffic controlling system is supplemented by the well known automatic block signal system and other local means ordinarily provided to guard against unsafe train movements, improper operation of track switches or the like.

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

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. The three line conductors are referred to in this disclosure as the S line, which is the stepping and control line and the A and B lines which are the return lines. The S line and the A and B lines are connected together at the last field station of the series in order to provide a return circuit for the S line. In accordance with the present invention, it is proposed to use the three line wires for transmitting to and from the field stations for selecting and registering field stations and for actuating controlling devices at the field stations and indica-

tion devices at the control office. Combinations of impulses of distinctive character are applied to the S line, using the A and B lines in multiple for the return circuit, to select a desired field station, after which a relay or control device for each switch or signal at the selected station may be actuated or conditioned, by means of these characteristic impulses for controlling the respective devices and thereby governing the traffic at the selected station. Such selection and control is referred to as transmission of controls.

The communication system is also used to transmit to the control office indications of the positions of the switches and signals and for indicating the presence or absence of trains in particular track sections, as well as any other indications which may be useful in directing and supervising train movements. These indications are preceded by the registration in the control office of the particular field station that is transmitting. This function is automatically effected when a new indication is ready to be transmitted to the control office and is conveniently referred to as transmission of indications.

The system is of the coded duplex type and is operated through cycles, during each of which transmission of controls and transmission of indications can occur separately or simultaneously to and from the same station or to and from different stations.

When controls are transmitted, 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 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 particular indications are transmitted 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 station sending.

For the transmission of controls, a predetermined number of impulses of selected polarities is placed on the line circuit for operating the apparatus at the control office and at the field stations through a cycle of operations, irrespective of the character of the impulses, while the distinctive character of such impulses determines the particular station to be selected and the controls to be transmitted to the selected station.

For the transmission of indications, means are provided to condition the A and B lines during a portion of the energized periods of the S line

for creating two code characters, either one of which may be selected for conditioning an indication receiving device in the control office. During another portion of the energized periods of the S line, the A and B line wires are again conditioned to provide a choice of three code characters, any one of which may be selected for conditioning an indication receiving device in the office. Therefore, a choice of five code characters for each step is obtained during the energized periods of the S line circuit. The energized periods of the S line circuit will be referred to as the "on" periods, while the deenergized periods of this line circuit will be referred to as the "off" periods.

One feature of the present invention relates to the manner in which indications are preconditioned during the "off" periods for obtaining a choice of two code characters and the manner in which indications are conditioned during the "on" periods for obtaining an additional choice of three code characters, with the chosen indications executed during a portion of the "on" period and a portion of the next succeeding "off" period. For example, in systems of this type, one energization of the stepping line or "on" period and one deenergization or "off" period has usually been designated as comprising a single step, with the field station circuits so arranged that indications are transmitted by distinctively changing or varying the conditioning of the line circuit once for each step. In the present embodiment, with the S line energized at the start of an "on" period, the A or B line may be energized resulting in two distinctive conditions. With the S line energized later during the same "on" period, the return circuit may be by way of the A line alone, the B line alone or the A and B lines in multiple, thus giving three more distinctive conditions resulting in five distinctive conditions or code combinations for each step for the transmission of indications.

Obviously, the provision of five distinctive code characters for each step results in obtaining twenty-five distinctive codes where each complete code comprises two steps. Similarly, one hundred and twenty-five distinctive complete codes may be obtained where each complete code comprises three steps. In other words, the number of code combinations obtained is equal to five raised to the power of the number of steps. Therefore, one purpose of the present invention is to provide a code type selector system which builds up rapidly as the number of steps increases and to accomplish this over a minimum number of line wires.

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 comprising this invention will be in part pointed out and in part apparent as the description progresses.

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 repre-

sentative of their location, or by the use of suitable preceding numerals representative of the order of their operation and in which:—

Fig. 1 is a diagrammatic showing of the three wire line circuit with the contacts, relay windings and resistance coils which are included in the three lines schematically indicated.

Figs. 2 and 3 illustrate the apparatus and circuits employed at the control office;

Fig. 4 illustrates the apparatus and circuits employed at one of the field stations;

Fig. 5 illustrates an operation chart which will be conveniently referred to during the following description for obtaining a concentrated picture of the sequence of operations of the system during control and indication cycles.

In tracing the detailed circuits, Fig. 4 is placed to the right of Fig. 2 and Fig. 3 is placed below Fig. 2.

General description

The three wire line circuit which connects the control office with the field stations, extends from the right hand portion of Fig. 2 to the left hand portion of Fig. 4, the S line being in the upper part of these drawings with the A and B lines located near the center. The dotted rectangle in the upper right hand portion of Fig. 4 indicates that the S line extends through other field stations and includes other line relays such as F^2 , and that the A and B lines extend through other field stations and include back contacts of the respective impulsing relays located at these other field stations, such as PLA^2 and PLB^2 . This is also clearly indicated in Fig. 1.

It will be understood that these additional stations have apparatus and circuit arrangements practically the same as that shown in Fig. 2. As will be more specifically pointed out in the following description, the points of difference in the circuit connections at different field stations are the distinctive connections of the code jumpers for conditioning the circuits, so 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 and facilitating the explanation, various parts and circuits have been diagrammatically shown and certain conventional illustrations have been employed. The drawings have been made more with the purpose of making it easy to understand the principles and mode of operation, than with the idea of illustrating the specific construction and arrangement of parts and circuits that would be employed in practice. Thus, 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 the 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 the typical field station will now be considered.

10 *Control office equipment.*—As typical of the equipment located in the control office illustrated in Fig. 2, a control machine having a group of control levers for each field station is provided. A miniature track switch, indicated by reference
15 character *ts*, corresponds to a particular track switch in the field and is considered to be representative of the actual track layout in the field. Various indicating lamps, or equivalent devices, together with apparatus and circuits to accom-
20 plish the desired operation of the system are likewise provided. The portion of the control office apparatus illustrated in Fig. 2 shows more particularly that part of the control machine which is typical of the apparatus associated with
25 a single field station having a track switch, a crossover or the like, together with the common transmitting apparatus employed for controlling the circuit operation for all such stations.

This equipment for one track switch comprises
30 a switch machine lever SML, a self-restoring starting button SB, the miniature track switch *ts* and the indication lamps RI, NI, UI, OS and M. Similarly, one or more signal control levers (not shown) would be associated with the single field
35 station, but in order to simplify the drawings and description, these devices have been omitted. It is obvious that the selection of the field station illustrated in Fig. 4, by means of starting button SB of Fig. 2 and thereafter the control of a track
40 switch TS¹ by means of a lever SML may be considered as typical of the selection of other field stations and the control of other traffic controlling devices.

The actuation of the lever SML to one extreme
45 position or the other, followed by the actuation of the starting button SB, results in the normal or reverse operation of the track switch corresponding to lever SML at that field station which is associated with starting button SB. The momentary actuation of the starting button SB is
50 preferably stored by a storing relay (not shown), which in turn picks up the corresponding code determining relay CD of the associated station. The starting button SB is shown connected to the code determining relay CD by means of a dotted
55 line in order to simplify the present disclosure.

The storing relays for each starting button and their corresponding code determining relays CD are so interconnected that only one relay CD for
60 one particular station may be picked up during one cycle of operations, irrespective of the number of storing relays which are simultaneously energized or energized in rapid succession. This interlocking circuit connection is so arranged
65 that if several storing relays are up at the same time, their corresponding CD relays will be picked up one at a time during successive operating cycles, in an order predetermined by their relative locations in the bank of relays, all of which
70 has been completely disclosed in the prior application of N. D. Preston et al., Ser. No. 455,304, filed May 24, 1930, corresponding to Australian Patent No. 1501 of 1931.

The control office includes a line relay F, and a
75 line repeating relay FP, both of which are nor-

mally down or deenergized during the normal period of rest of the system and also during the period of blank between successive operating cycles.

Slow acting line repeating relays SA and SAP
5 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
10 during all "off" periods between successive impulses of a cycle, except the last "off" period which is comparatively long for the purpose of returning the system to the normal period of rest or period of blank.

Associated with the line relay F and its repeating relays is a bank of stepping relays, including stepping relays 1V, 2V and 3V together with
15 a half step or steering relay VP, which are provided to mark off the successive steps of each cycle. Steering relay VP serves the purpose of steering the impulses from relay FP to the proper stepping relay and for steering the executing circuits to the proper selecting contacts of the
20 stepping relays, all at the proper time. An impulsing relay E is jointly controlled by the stepping relays and the steering relay. The pick-up and drop-away operations of relay E are repeated by relay EP which governs the opening and closing
25 of the S line conductor.

Relay E, in addition to controlling the line pulsing relay EP, jointly controls, with relay FP, the stick circuit of relay MX. Relay E also controls the stick circuit of relays MAP and MBP, all
30 of which will be specifically pointed out in the detailed description. Relay E also controls the circuits over which the indications are executed.

Relay MA is controlled over the A line conductor, relay MB is controlled over the B line conductor and their repeating relays MAP and MBP
35 provide a choice of five indication code combinations during the "on" period of each step. Relay MX is jointly controlled by relays MAP and MBP to record the choice of two indication code combinations during the first part of the "on" period
40 of each step. Relays MAP and MBP are thereafter used to record the choice of three combinations during a succeeding part of this period.

The polarity of the impulses applied to the line circuit from a battery B is determined by
45 positive code sending relay PC and negative code sending relay NC. These two relays are controlled on steps of a control cycle in accordance with the station code and the controls to be transmitted for that particular cycle.

A starting relay STR is picked up to initiate a cycle of operations both when controls are to be transmitted, due to the manual initiation of the
50 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
55 is initiated by the control office.

For the purpose of illustrating station registration, a typical pilot relay arrangement is shown
60 in Fig. 3. Pilot relays 1PT, 2PT and 3PT are connected to the indication buses so that they may be positioned on the first step of the cycle when indications are transmitted. Relay 1PT is connected to No. 1 "off" bus so that this relay is positioned to the right or left as predetermined
65 during the first "off" period. Relay 2PT is connected to No. 1A "on" bus and it is positioned to
70 75

the right or left as predetermined by the condition of the A line conductor during the first "on" period. Relay 3PT is connected to No. 1B "on" bus and is positioned to the right or left as predetermined by the condition of the B line conductor during the first "on" period. 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 are obtained.

A station relay ST is provided for registering, in the control office, the station transmitting indications. Relay ST is merely typical of a number of such relays which would ordinarily be provided to register individual stations, other relays similar to relay ST being connected to the conductors leading to bracket STN. The conductor indicated "phantom", leading to bracket STN, is not used in this embodiment for connection to a station relay similar to ST. This is because when controls alone are being transmitted, the system inherently transmits back to the control office a code combination which is not sent by a field station.

A choice of five code characters for each step results in selectively positioning the three pilot relays as illustrated in Fig. 3 and although six combinations are obtained, as indicated by the six conductors connected to contacts of relay 3PT, only five of these combinations are used since the sixth is associated with the "phantom" code.

The control machine also includes suitable indication storing relays IR¹, IR², IR³ and IR⁴ for storing the various indications transmitted from the field stations, after a field station has been registered in the control office by the selection of a relay similar to ST. The indication storing relay IR¹ is controlled in accordance with the occupied or unoccupied condition of the detector track section, associated with the outlying track switch illustrated in Fig. 4, as repeated by a track relay T¹, so that an indicating lamp OS is controlled by the passage of a train.

Indication storing relays IR² and IR³ store the indications of whether the associated track switch is locked normal, locked reverse, or unlocked in mid-stroke as repeated by the switch repeating relay WP¹ at the station, so that indicator lamps NI, RI, and UI are displayed to indicate the normal locked, reverse locked, and the unlocked positions respectively of the track switch. Indication storing relay IR⁴ stores any other required condition of a device at the field station such as relay M¹, and controls indicating lamp M of Fig. 2 to display the condition of the device which causes relay M¹ to be up or down.

The fundamental coding arrangement for indications disclosed in the present invention is of particular advantage, since the preselection of two indications during each "off" period may be used to indicate the two conditions of a track circuit, that is, occupied or unoccupied. Similarly, there are three conditions of a switch to be indicated, namely, locked normal, locked reverse, or unlocked in mid stroke so that the selection of three additional indications during each "on" period may be advantageously used for registering these switch conditions.

Field station equipment.—The field station illustrated in Fig. 4 includes, besides the apparatus above mentioned, a quick acting line relay F¹ and a quick acting line repeating relay FP¹ which repeat the energizations and deenergizations of

the S line circuit. Relay FP¹ repeats the impulses in the S line circuit irrespective of their polarities, while relay F¹ is conditioned to the right by a positive impulse and to the left by a negative impulse.

A slow acting relay SA¹ of the neutral type repeats the energized condition of the FP¹ relay. Relay SA¹ defines the bounds of each cycle of operations, being energized at the beginning of each cycle and remaining energized or actuated until the "change to normal" period at the end of the cycle.

The field station likewise includes a bank of stepping relays IV¹, 2V¹ and 3V¹ together with the associated steering or half step relay VP¹, operating in a similar manner and in synchronism with the stepping relay bank in the control office. Steering relay VP¹ steers the impulses from relay FP¹ to the proper stepping relay and it also steers the line impulsing relays PLA¹ and PLB¹ to the proper indication buses, all at the proper time.

Line impulsing relays PLA¹ and PLB¹ are provided to open the A and B lines respectively, to provide code combinations during the transmission of indications, these two relays being conditioned in accordance with the condition of the indication buses shown in the lower right hand portion of Fig. 4. Relay VPC¹ controls the steering relay VP¹ in such a way that relay VP¹ can not shift until the line impulsing relays PLA¹ and PLB¹ are in their normal or deenergized positions.

A change repeating relay CHP¹ is provided to register a change in the traffic controlling devices at the station, so that the system will be initiated for the transmission of new indications as required. A lock-out relay LO¹ is provided at each field station to determine when a particular field station is to transmit new indications. Relay LO¹ 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 the cycle. The lock-out relay supplies (—) potential to the A and B line pulsing relays PLA¹ and PLB¹, so that these relays receive current only at the station transmitting indications.

A station selecting relay SO¹ is picked up at all stations during the conditioning period of a cycle, when controls are being transmitted. These relays are dropped out at various stations during the code transmitting periods, so that only the one associated with the desired station remains actuated after the transmission of the station selecting code. Relays SO¹ and LO¹ control the circuits to the stepping relays so that stepping is not effective at those stations not in connection with the communication circuit.

Resistance units R¹ and R², illustrated within the dotted rectangle in the upper right hand portion of Fig. 2, are of such value that a sufficient drop in potential is provided for picking up a lock-out relay similar to LO¹ during the initiating period of an indication cycle.

A track switch TS¹ is operated by a switch machine SM¹ of any suitable type, such for example, as disclosed in the patent to W. K. Howe, 1,466,903, dated September 4, 1923. This switch machine may, if desired, be provided with a dual control selector as disclosed for example, in the pending application of W. K. Howe, Ser. No. 354,039, filed April 10, 1929, the purpose of such a selector being to permit the local manual operation of the track switch. The position, locked and

unlocked conditions of the track switch is repeated by the usual switch repeating relay WP¹ of the polar neutral type. This relay is controlled by a suitable circuit (not shown) so that it is energized with one polarity or the other, depending upon the normal or reverse positions of the track switch. In this disclosure, it will be assumed that the polar contact of relay WP¹ is positioned to the right when the track switch is in its normal locked position, to the left when the track switch is in its reverse locked position and its neutral contact is dropped when the track switch is in mid-stroke.

The track switch has associated with it the usual detector track section having a track battery and a track relay T¹, also suitable approach locking and detector locking means are provided (not shown) to govern the safe operation of the track switch in accordance with traffic conditions. It is understood that a change in the position of the track switch TS¹ is repeated by the relay WP¹ and a change in the condition of the detector track section is repeated by relay T¹. The field station also includes suitable bus wires, circuit connections, code jumpers and other devices which are necessary in operating the system, but which have not been completely illustrated in this disclosure for the sake of simplicity.

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.

General operation

The system of the present invention is shown in Figs. 2, 3 and 4 in the normal or condition of rest, from which it may be initiated into a cycle of operations, either by a manual operation at the control office or an automatic operation at any of the field stations, whenever there are new controls or new indications, respectively, to be transmitted. In the event that there are several different controls ready for transmission to field stations at substantially the same time, they are transmitted on separate cycles, one station for each cycle of operations. Likewise, if several field stations have indications to be transmitted at substantially the same time, they are transmitted to the control office, one station at a time, on separate operating cycles.

It may happen that there are new controls and new indications ready for transmission at a given time, and in this event controls are transmitted simultaneously with the indications. On such occasions, indications may be transmitted from the same field station to which controls are transmitted, or they may be transmitted from some other field station, during the same cycle of operations.

Irrespective of whether the cycle is for the transmission of controls and/or the transmission of indications, a predetermined number of impulses is applied to the line circuit to accomplish the synchronous operation of the stepping relays at the control office and at the field stations. These impulses are of comparatively short duration, the deenergized or "off" periods of the stepping line circuit being comparatively shorter than the energized or "on" periods.

When a cycle of operations is initiated for the transmission of controls, the character of the impulses applied to the stepping line is determined by the particular station to be selected and the particular controls to be transmitted to

the selected station, in accordance with the code jumper connections and the positions of the control levers, respectively, for that station.

When a cycle of operations is initiated for the transmission of indications alone, the character of the impulses applied to the stepping line is the same for all impulses and this particular combination does not effect the selection of any field station, since the initiating impulse applied to the stepping line is of such a character, for example (—), that none of the station relays similar to SO¹ of Fig. 4 are picked up. When such a cycle of operations is initiated from a field station, the line circuit is energized with a series of (—) impulses. Since such a cycle starts out with no station relay (similar to SO¹) up, the (—) impulses which follow are not effective to select a station or a control device at a station.

The A and B line conductors are normally energized, the stepping line conductor S is normally deenergized, and when controls or indications are initiated, start relay STR in the control office is picked up, resulting in switching the battery connection so that temporarily the S line is energized, the return circuit being by way of both the A and B lines for transmission of controls and by way of the B line alone for transmission of indications. This period during which the battery is switched from the A and B line conductors to include the S line is conveniently referred to as the conditioning period at the start of a control cycle and the initiating period at the start of an indication cycle. Immediately following the conditioning or initiating period is the lock-out period, which is effective to so condition the circuits that only one station may transmit indications to the control office at the same time.

After the conditioning and lock-out periods, the system continues through a complete cycle of operations consisting of a number of "off" and "on" periods, this number being determined by the number of steps required and the number of steps in turn being governed by the size of the system. After the last "on" period, a comparatively long "off" or deenergized period is effective to condition the relays for changing to normal or the period of blank. After this "change to normal" period, the A and B line conductors are again energized by current from battery B, which restores the system to the normal period.

For convenience in describing the operation of the present invention, an operation chart is shown in Fig. 5. In the upper portion of this chart the important functions of the system during a control cycle are illustrated, while the lower portion illustrates the important functions of an indication cycle. Referring to the chart illustrating a control cycle, the normal period is shown at the extreme left and during this period line S is deenergized or open, as indicated by reference character O. Line A is energized with (+) potential and line B with (—) potential as illustrated. It is during this period that the system is manually started by an operation in the control office. This normal period is an "off" period since line S is deenergized.

During the next or conditioning "on" period, line S is energized with (+) potential, the return circuit being by way of lines A and B as indicated by the (—) reference characters. It is during this "on" period that all relays similar to SO¹ are picked up.

From the beginning of the conditioning period, up to and including the end of the cycle is con-

veniently referred to as the operating cycle. The beginning of the first "off" period and the end of the third "on" period is bounded by what may be conveniently referred to as the transmitting period.

The transmitting period is divided into "off" and "on" periods and since the present disclosure shows only three steps, the first, second and third "off" and "on" periods are indicated in this chart. It will be understood that additional steps, when provided, are inserted between the third "on" period and the "change to normal" period.

The indication cycle chart shown in the lower portion of Fig. 5 comprises a normal period followed by an operating cycle divided into initiating, lock-out, conditioning, transmitting and "change to normal" periods. The transmitting period is divided into "off" and "on" periods, with these "off" and "on" periods subdivided as indicated. For want of space, the third "off" and "on" periods of the indication cycle have not been included but it will be understood that they are similar to preceding periods.

An analysis of a duplex cycle has not been provided since such a cycle is merely a combination of control and indication cycles. During duplex transmission, impulses of distinctive character are placed on line S for operating the apparatus at the control office and at the field stations, the character of these impulses determining the selection of the station and thereafter the control device at the station. The A and B lines are conditioned for the return circuit in accordance with the indication code combinations to be transmitted from the field station to the control office in the same manner as when indications alone are transmitted.

Detailed operation

Normal period.—With the communication part of the centralized traffic controlling system, with which this invention is concerned at normal, most of the relays in the control office and at the field stations are in their normal or deenergized positions. The exceptions are relays MA, MB, MAP and MBP in the control office and relay VPC¹ at the field station. Relays MA and MB are energized by current flowing from battery B over the A and B lines in series and, as indicated in the operation chart under normal period, (+) potential is applied to the A line and (−) potential to the B line. Referring to Fig. 2, this circuit may be traced from the (+) terminal of battery B, back contact 10 of relay STR, winding of relay MA, A line 11, back contact 150 of relay PLA¹ of Fig. 4, over the A line conductor 151 extending through all of the field stations in series, including back contacts of other A line impulsing relays such as PLA², resistance coils R¹ and R² in series, located at the last station, back contacts of the B line impulsing relays such as PLB², B line conductor 152, back contact 153 of relay PLB¹, B line 12, winding of relay MB and back contact 13 of relay STR to the (−) side of battery B. The circuit for energizing relay MAP extends from (+), front contact 128 of relay MA and lower winding of relay MAP, to (−). The energizing circuit for relay MBP extends from (+), front contact 129 of relay MB and lower winding of relay MBP, to (−).

The circuit for energizing relay VPC¹ extends through back contacts 190 and 195 of relays PLA¹ and PLB¹ respectively.

At the field station, the change repeating relay

CHP¹ is normally picked up over circuits (not shown), track relay T¹ is normally picked up by a circuit (not shown) energized by the track battery and relay WP¹ is normally energized, with its polar contacts to the right, by means of a circuit (not shown) which is controlled by the switch machine. Although these circuits for controlling relays CHP¹, T¹ and WP¹ have not been included in the drawing of Fig. 4, it will be readily understood by those skilled in the art how they are conditioned by the different devices at the field station.

Manual starting.—With the system in its normal condition, it will be assumed that the operator in the control office desires to transmit controls to a particular field station, such as the one illustrated in Fig. 4. When the starting button SB is actuated, a suitable storing relay is positioned and the CD relay associated with the desired station is picked up. The actuation of the CD relay closes a circuit for picking up relay C, extending from (+), back contact 14 of relay SA, back contact 15 of relay NC, front contact 16 of relay CD and winding of relay C, to (−). Relay C closes a stick circuit for itself extending from (+), back contact 6 of relay SAP, front contact 68 and winding of relay C, to (−).

The operation of relay C opens the pick-up circuit of relay FC at back contact 17, which prevents the picking up of relay FC after the cycle is initiated by a manual start in the control office. This gives the control office priority, since relay C can be picked up with relay SA down, while relay FC can not be picked up until relay SAP is down. Thus, a time interval is introduced between the dropping of relay SA and the dropping of relay SAP, when the system advances through the "change to normal" period during which the control office may take control of the system.

If a field station attempts to start the cycle by picking up relay FC at the same time the control office starts the cycle, the actuation of relay C prevents the picking up of relay FC so that the control office gets first choice of the system. If the field station start occurs slightly in advance of the control office start, relay FC is picked up, which energizes relay NC so that relay C can not thereafter be picked up during this same cycle, because the pick-up circuit of relay C is opened at back contact 15.

The actuation of relay C closes a circuit for picking up relay STR, extending from (+), front contact 18 of relay C and winding of relay STR, to (−). Relay C also closes a circuit for picking up relay PC, extending from (+), back contacts 19, 20 and 21 in series of relays 3V, 2V and 1V, front contact 22 of relay C, (+) bus 23, back contact 24 of relay FC and winding of relay PC, to (−).

This is the conditioning period. The energization of relay PC causes the S line to be energized with (+) potential, while the A and B lines are energized (−) as indicated in the conditioning period of the operation chart. The circuit for energizing the line conductors extends from the (+) terminal of battery B, front contact 10 of relay STR, front contact 25 of relay PC, back contact 26 of relay NC, winding of relay F, back contact 27 of relay EP, S line conductor 28, winding of relay F¹ of Fig. 2, windings of other line relays similar to F² at other field stations, resistance coils R¹ and R² at the last field station, back contacts of relays such as PLA² and PLB² at other field stations, A and B line conductors 151 and 152, back contacts 150 and 153 of relays PLA¹ and

PLB¹ respectively, A and B lines 11 and 12, windings of relays MA and MB and thence from the winding of relay MB through back contact 7 of relay NC and front contact 8 of relay PC to the (-) terminal of battery B. The A line conductor circuit extends from the winding of relay MA through front contact 13 of relay STR, back contact 7 of relay NC and front contact 8 of relay PC to the (-) terminal of battery B.

The stepping line conductor S being energized (+) causes relay F¹ in the control office and relay F¹ at the field stations to be positioned to the right. Relay F¹ closes a circuit for actuating relay FP extending from (+), contact 29 of relay F¹ in its right hand dotted position and winding of relay FP, to (-). Relay F¹ closes a circuit for picking up relay FP¹ extending from (+), contact 154 of relay F¹ in its right hand dotted position and winding of relay FP¹, to (-).

The actuation of relay FP in the control office closes a circuit for picking up relay SA, extending from (+), front contact 30 of relay FP and winding of relay SA, to (-). The operation of relay SA closes a circuit for picking up relay SAP, extending from (+), front contact 31 of relay SA and winding of relay SAP, to (-).

Referring to the field station, the actuation of relay FP¹ opens its back contact 155 which disables the pick-up circuit of relay PLA¹, extending through back contact 156 of relay SA¹ and back contact 157 of relay CHP¹, to the lower winding of relay PLA¹, which pick-up circuit is effective to start a cycle of operations from a field station. It will thus be seen that as soon as relay FP¹ is picked up and its contact 155 opened, no field station can obtain access to the line for transmission of indications.

The picking up of relay FP¹ also closes a circuit for picking up relay SO¹, extending from (+), back contact 158 of relay SA¹, front contact 159 of relay FP¹, contact 160 of relay F¹ in its right hand dotted position, back contacts 161, 162 and 163 in series of relays 3V¹, 2V¹ and 1V¹, control bus 164 and lower winding of relay SO¹, to (-). At this time, relays similar to SO¹ at all other stations are picked up by means of similar circuits, but as will be specifically pointed out during the detailed description, these relays are dropped out at the other stations, while the one illustrated in Fig. 2 is maintained energized.

The actuation of relay FP¹ also closes a circuit for picking up relay SA¹, extending from (+), front contact 155 of relay FP¹ and winding of relay SA¹, to (-). The operation of relay SA¹ interrupts the above described pick-up circuit of relay SO¹, but it is not released since a substitute circuit is closed for holding relay SO¹, which extends from (+), make-before-break front contact 158 of relay SA¹, front contact 165 of relay SO¹, contact 160 of relay F¹ in its deenergized position and the remainder of the circuit above described, to the lower winding of relay SO¹.

Referring back to the control office, the actuation of relay SAP closes a circuit for picking up relay EP which extends from (+), front contact 32 of relay SAP, back contact 33 of relay E and lower winding of relay EP, to (-). It will be mentioned here that the purpose of front contact 9 of relay EP is to short circuit the upper winding of this relay when it is actuated which has the effect of rendering this relay quick to pick up and slow to release for obtaining the desired timing of the stepping operation. The actuation of relay EP opens the stepping line circuit, at back con-

tact 27, which advances the cycle into the first "off" period.

Polarity selection of impulses.—As above pointed out, the first impulse in line S is (+) when a cycle of operations is started from the control office. This is indicated in the chart under the conditioning period and is due to the fact that (+) control relay PC is picked up at the start of a control cycle.

When line S is deenergized, by relay EP opening its contact 27 to advance the system into the first "off" period, relay F¹ is released and by opening its contact 29, causes the release of relay FP. As will be specifically pointed out later on in the description, stepping relay 1V is picked up during the first "off" period. This is effective to condition the No. 1 control, by selecting the polarity to be applied to line S during the first "on" period. This conditioning circuit holds relay PC in its actuated position and extends from (+), back contacts 35 and 36 of relays 3V and 2V, front contact 37 of relay 1V, No. 1 code bus 44, front contact 38 of relay CD, code jumper connection 39, (+) bus 23, back contact 24 of relay FC and winding of relay PC, to (-). This connection of code jumper 39 to the (+) bus selectively conditions the first control impulse (+). If code jumper 39 were connected to the (-) bus 47, then relay NC would be picked up instead of relay PC, thus providing a (-) impulse for the No. 1 control.

The control of the PC and NC relays is effected during other "off" periods by means of other code jumpers such as jumper 40. Thus, in the second "off" period, relays 2V and VP will be up and the selection of the (+) or (-) bus, by means of jumper 40, is extended by way of front contact 41 of relay CD, No. 2 code bus 45, front contact 36 of relay 2V and back contact 35 of relay 3V to (+), so that relay PC will be again picked up if code jumper 40 connects to the (+) bus. However, in the present embodiment it is assumed that the No. 2 code jumper 40 connects to the (-) bus, so that relay NC is picked up during the second "off" period. Relay PC is dropped during the second "off" period when relay 2V picks up and opens its back contact 36.

The actuation of relay NC connects the (-) terminal of battery B through back contact 8 of relay PC and front contact 26 of relay NC to the S line. The (+) terminal of battery B is connected to the A and B line conductors over circuits extending through front contact 10 of relay STR, back contact 25 of relay PC, front contact 7 of relay NC to the B line and through front contact 13 of relay STR to the A line.

During the third "off" period, it will be assumed that relay 3V is up as indicated in the operation chart. The No. 3 control is conditioned during this period by dropping relay NC and picking up relay PC, since the polarity of the third "on" period is assumed to be (+) in the S line. Relay NC is dropped when the No. 2 code bus 45 is opened at back contact 35 of relay 3V and relay PC is picked up when the No. 3 code bus 46 is closed from (+), front contact 35 of relay 3V, No. 3 code bus 46, front contact 42 of relay CD, contact 43 of switch machine lever SML, assumed to be in its right hand position, (+) bus 23, back contact 24 of relay FC and winding of relay PC, to (-). The actuation of relay PC selects a (+) potential to be applied to line S during the third "on" period.

It will be apparent that a (-) impulse would be conditioned during the third "off" period and

applied to the S line during the third "on" period if lever SML should be in its left hand dotted position, because this would extend the above traced circuit to relay NC instead of relay PC.

From the above it will be observed that different code combinations may be chosen for selecting different stations, by arranging the jumper connections 39 and 40 in different positions, but with these jumpers arranged as shown in Fig. 2, the two impulses applied to the line for selecting the station are (+) for the first impulse and (-) for the second impulse. It will also be obvious that while only two steps are indicated for making station selection, additional steps and associated code jumpers may be provided in systems requiring a larger number of code combinations. It will also be understood that more than one step may be provided for selecting additional control devices, similar to lever SML, but it is believed that the typical arrangement disclosed is sufficient to illustrate the complete functioning of the system.

From the above it will be seen that the impulses applied to the line circuit during a control cycle always begin with a (+) and a combination of (+) and (-) impulses follow. These following impulses are dependent upon the code jumper connections and the control lever positions, made effective by the particular code determining relay CD which is picked up during the control cycle. Also, the character or polarity of the impulses in the stepping line circuit is selected by polarity determining relays, PC for a (+) impulse and NC for a (-) impulse and these polarity determining relays are positioned during the "off" periods, in readiness for the application of the preselected polarity during the following "on" periods.

Line pulsing and operation of stepping relays.—It has been mentioned that the impulses which follow the conditioning period vary in polarity and with the code jumpers and switch machine lever conditioned as shown in Fig. 2, the impulses in the S line energize this line during the three "on" periods with (+), (-) and (+) polarities. Irrespective of the particular polarities with which line S is energized, relay FP in the control office and relay FP¹ at the field station repeat the operations of relays F and F¹.

Relay IV in the control office is picked up during the first "off" period by means of a circuit extending from (+), front contact 14 of relay SA, back contact 48 of relay FP, back contact 49 of relay VP, back contact 50 of relay 2V and winding of relay IV, to (-). The operation of relay IV closes a stick circuit for itself extending from (+), front contact 14 of relay SA, stick conductor 64 and front contact 51 of relay IV to the winding of relay IV. When relay IV is picked up, a circuit is completed for picking up relay E, extending from (+), back contact 19 of relay 3V, back contact 20 of relay 2V, front contact 21 of relay IV, back contact 34 of relay VP and winding of relay E, to (-). Relay E opens its back contact 33 which allows relay EP to drop and again energize line S.

This is the first "on" period. Relays F and FP are now picked up in turn and relay FP closes a circuit for actuating relay VP extending from (+), front contact 32 of relay SAP, front contact 52 of relay FP, front contact 53 of relay MBP, front contact 54 of relay MAP, back contact 55 of relay 3V, back contact 56 of relay 2V, front contact 57 of relay IV and winding of relay VP, to (-). Relay VP establishes a stick circuit for itself extending from (+), front contact 32 of

relay SAP, front contact 58 of relay VP and over the remainder of the above described actuating circuit, to the winding of relay VP. This stick circuit for relay VP is effective until stepping relay 2V is picked up and opens contact 56, which occurs during the second "off" period. For maintaining relay VP in its actuated condition during the second "off" period, an additional stick circuit is established extending from (+), front contact 32 of relay SAP, back contact 59 of relay MBP or back contact 60 of relay MAP or back contact 52 of relay FP and front contact 61 of relay VP, to the winding of relay VP.

Relay VP, in picking up, opens the circuit of relay E at back contact 34, so that relay E drops after a short time interval and closes the circuit for picking up relay EP, which has been described. This advances the system from the first "on" period into the second "off" period, since the actuation of relay EP opens its contact 27 and deenergizes the S line as well as the A and B lines.

This is the second "off" period. Relays F and FP are dropped and a circuit is established for picking up relay 2V extending from (+), front contact 14 of relay SA, back contact 48 of relay FP, front contact 49 of relay VP, back contact 62 of relay 3V, front contact 63 of relay IV and winding of relay 2V, to (-). Relay 2V closes its own stick circuit to stick conductor 64 by way of its front contact 65. A circuit is now closed for picking up relay E, extending from (+), back contact 19 of relay 3V, front contact 20 of relay 2V, front contact 34 of relay VP and winding of relay E, to (-). Relay E opens its back contact 33 which allows relay EP to drop and energize the S line at its back contact 27. This advances the system out of the second "off" period.

This is the second "on" period. Relays F and FP are again energized and relay VP is dropped during this period, since its pick-up circuit is open at back contact 56 of relay 2V and its stick circuit is open at back contacts 52 of relay FP, 59 of relay MBP and 60 of relay MAP. The circuit of relay E is now interrupted at front contact 34 of relay VP, allowing relay E to drop and establish the pick-up circuit for relay EP which has been previously described. Relay EP picks up and deenergizes the S line and the A and B lines, which advances the system out of the second "on" period.

This is the third "off" period. Relays F and FP are again dropped and a circuit established for picking up relay 3V, which extends from (+), front contact 14 of relay SA, back contact 48 of relay FP, back contact 49 of relay VP, front contact 50 of relay 2V and winding of relay 3V, to (-). Relay 3V closes a stick circuit for itself to stick conductor 64 by way of its front contact 66. A circuit is now established for picking up relay E, extending from (+), front contact 19 of relay 3V, back contact 34 of relay VP and winding of relay E, to (-). Relay E opens its back contact 33 which allows relay EP to drop and close the energizing circuit for the line conductors to advance the system out of the third "off" period.

This is the third "on" period. Relays F and FP are again picked up and a circuit is established for picking up relay VP which extends from (+), front contact 32 of relay SAP, front contact 52 of relay FP, front contact 53 of relay MBP, front contact 54 of relay MAP, front contact 55 of relay 3V and winding of relay VP, to (-). Relay VP again closes a stick circuit for itself which is effective until the system advances through the

"change to normal" period and which extends from (+), front contact 32 of relay SAP, front contact 58 of relay VP and front contact 55 of relay 3V, to the winding of relay VP. The circuit of relay E is now open at back contact 34 of relay VP, which allows relay E to drop after a short time interval and establish the pick-up circuit for relay EP. Relay EP is actuated and opens the S line circuit at its contact 27, which deenergizes the line conductors and advances the system out of the third "on" period.

This is the "change to normal" period. Relays F and FP are dropped and since there are no more stepping relays to be picked up during this "off" period, relay E can not be picked up and relay EP can not be dropped, in the manner described for the previous "off" periods. This results in relays F and FP remaining down for a sufficient time to allow relay SA to drop, which opens its front contact 14 and allows all the stepping relays to be restored to normal. Relay SA opens its front contact 31 which deenergizes relay SAP which releases and by opening its front contact 32, causes the release of relay VP. Relay SAP, in opening its front contact 32, also opens the circuit of relay EP allowing this relay to drop.

Relay SA, in releasing, opens its front contact 67 which deenergizes the stick circuit of relay C allowing this relay to be released and by opening its front contact 18, the circuit of relay STR is interrupted and relay STR restores to normal. The S line conductor is deenergized shortly after the dropping of relay SA and before the release of relay SAP causes relay EP to release and close its contact 27. The A and B line conductors are again energized with (+) potential on the A line and (-) potential on the B line, as indicated in the second part of the "change to normal" period. Relays MA, MB and their repeating relays MAP and MBP are now picked up and the system is advanced into its normal period with the A line conductor still energized (+) and the B line conductor energized (-).

It is to be understood that these circuit connections may be extended for as many steps as desired, with the pick-up and stick circuits of the stepping relays and the steering relay extended in an obvious manner. It has already been mentioned that the stepping relays and the steering relays at the field stations operate in a substantially identical manner and for this reason it is not believed necessary to describe the operating and pick-up circuits of these relays in detail. Relays 1V¹, 2V¹ and 3V¹ of Fig. 4 are picked up in synchronism with relays 1V, 2V and 3V of Fig. 2. The pick-up circuits of the stepping relays shown in Fig. 4 extend from (+), front contact 166 of relay SA¹, back contact 167 of relay FP¹ (which operates in synchronism with relay FP in the control office) and front contact 168 of relay SO¹, during the transmission of control impulses. The extension of this circuit to the stepping relay windings is through back and front contacts 169 of relay VP¹, which circuits are similar to those of Fig. 2.

As will be later explained, some of the relays similar to SO¹ at other stations are dropped out, which is effective to open their contacts similar to 168 and at these stations the stepping circuits are interrupted, so that stepping does not continue throughout the cycle at such stations. During the transmission of indications when no relay similar to SO¹ is picked up, front contact 170 of

relay LO¹ is effective to complete the pick-up circuits of the stepping relays.

From the above description and by referring to the operation chart, it will be observed that the stepping relays are picked up in rotation during successive "off" periods and the steering relays are shifted during the "on" periods. The steering or half step relays VP and VP¹ pick up during the odd "on" periods and release during the even "on" periods.

Contacts 59 and 60 of relays MBP and MAP of Fig. 2, connected in multiple with back contact 52 of relay FP, are for the purpose of preventing the release of relay VP during the even "on" periods, until relays MBP and MAP are picked up. The purpose of contacts 53 and 54 of relays MBP and MAP, in series with front contact 52 of relay FP, is to insure that relays MBP and MAP are picked up at the beginning of the odd "on" periods before relay VP can be picked up. These four contacts on relays MBP and MAP therefore serve the purpose of holding back the shifting of relay VP until the relays, which are to be conditioned over the line conductors, are properly positioned.

During the "change to normal" period, the stepping relays and the steering relay of Fig. 4 are released in a manner similar to those in the control office, when relay SA¹ drops and opens its front contacts 166 and 171.

The purpose of relay VPC¹ is to prevent the shifting of relay VP¹ until the relays in the line conductors have been properly conditioned. The stick circuit of relay VP¹, extending through its front contact 172, is not interrupted during an even "on" period until relay VPC¹ picks up and opens its back contact 173. Relay VPC¹ can not pick up until both the A and B line impulsing relays PLA¹ and PLB¹ are down. Therefore, relay VP¹ can not drop until both the A and B line conductors are conditioned by relays PLA¹ and PLB¹ during the even "on" periods. Similarly, relay VP¹ can not be picked up during the odd "on" periods until relay VPC¹ picks up and closes its front contact 174 and relay VPC¹, as above mentioned, can not pick up until both relays PLA¹ and PLB¹ are down. This insures that the relays at the field station in the A and B line conductors will be in their proper positions, as well as the relay in the S line conductor, before relay VP¹ can be shifted.

Transmission of controls.—It will now be assumed that the stepping relays in the control office and at the field station illustrated in Fig. 4, together with the respective steering relays, operate as above described and an explanation will be given of the circuits which are effective during this operation to transmit controls.

As above explained, line S is conditioned with a (+) impulse for picking up relays similar to SO¹ at all field stations and during this conditioning period, relays SA and SAP in the control office and relays similar to SA¹ at the field stations are actuated.

It is assumed that the impulse applied to line S during the first "on" period is (+), determined in the control office as above explained. During the first "on" period, this first (+) impulse is executed, so to speak, at the field stations by maintaining those relays similar to SO¹ operated, which have the code jumpers associated with the first step connected to the control code bus similar to 164. It has been assumed that the station shown in Fig. 4 is the one to be selected and that all others are to be dropped out. At those sta-

tions having a jumper similar to 175, relays similar to SO¹ will be maintained energized during the first "on" period by means of a circuit similar to that extending from (+), front contact 158 of relay SA¹, front contact 165 of relay SO¹, contact 160 of relay F¹ in its right hand dotted position, back contact 161 of relay 3V¹, back contact 162 of relay 2V¹, front contact 163 of relay IV¹, code jumper 175, bus 164 and lower winding of relay SO¹, to (-). At those stations not having a code jumper similar to 175 connected to bus 164, the relays similar to SO¹ are dropped.

When the system advances into the second "off" period, those relays similar to SO¹ which are up will be stuck up over a circuit similar to that extending from (+), front contact 158 of relay SA¹, front contact 165 of relay SO¹, contact 160 of relay F¹ in its deenergized position, front contact 177 of relay SO¹ and upper winding of relay SO¹, to (-). It is of course obvious that the stick circuits of those relays similar to SO¹ which are dropped during the first "on" period, are not completed during the second "off" period, since their contacts similar to 177 are open.

The system now advances into the second "on" period by means of a (-) impulse applied to line S, which was conditioned during the second "off" period in a manner which has already been explained. Relay 2V¹ is up and relay VP¹ is down during this period and a circuit is completed for holding relay SO¹ in its operated position, which extends from (+), front contact 158 of relay SA¹, front contact 165 of relay SO¹, contact 160 of relay F¹ in its left hand dotted position, back contact 179 of relay 3V¹, front contact 180 of relay 2V¹, code jumper 181, bus 164 and lower winding of relay SO¹, to (-).

It will be understood that, in the embodiment disclosed herewith, only the relay SO¹ illustrated in Fig. 4 will be maintained energized during this period, since it is assumed that only two stepping relays are used for station selection. With two steps for station selection, four stations may be selectively chosen by dropping out one half of the stations on the first step, which leaves two relays similar to SO¹ picked up. On the second step, one half of the remaining relays similar to SO¹ will be dropped, leaving only one (which is assumed to be that one illustrated in Fig. 4) in its actuated position.

During the third "off" period, relay 3V is picked up and relay SO¹ is stuck up over the above described circuit, including its front contact 177 and make-before-break contact 160 of relay F¹ in its deenergized position. As soon as relay 3V¹ is picked up, (+) potential is connected through its front contact 182 to the stick circuit of relay SO¹, so that this relay is maintained energized during the remainder of the stepping impulses. With relay SO¹ stuck up after station selection, additional impulses are effective to operate only those stepping relays at the station illustrated in Fig. 4, since the circuit for these relays is by way of front contact 168 of relay SO¹ at the one station illustrated.

During the third "on" period, which occurs after station selection, the No. 3 control (+) is executed by actuating relay F¹ of Fig. 4 to the right. A circuit is now closed for actuating switch machine relay SMR¹ to the right, which extends from (+), front contact 158 of relay SA¹, front contact 165 of relay SO¹, contact 160 of relay F¹ in its right hand dotted position, front contact 161 of relay 3V¹ and upper winding of relay SMR¹, to (-). With relay SMR¹ positioned to the right,

a circuit is closed from (+), contact 184 of relay SMR¹ in its right hand position and normal operating winding of switch machine SM¹, to (CN). This results in operating the switch machine in such a direction that switch TS¹ is advanced to its normal locked position.

It will be noted that in the event of a (-) impulse during the third "on" period, relay F¹ would be positioned to the left and the above described circuit for operating relay SMR¹ would be extended by way of contact 160 of relay F¹ in its left hand dotted position, front contact 179 of relay 3V¹ and lower winding of relay SMR¹, to (-). This would result in positioning relay SMR¹ to the left and by closing its contact 184 in its left hand dotted position, would energize the switch machine in the opposite manner for moving the track switch TS¹ to the reverse locked position.

In brief, the positioning of control lever SML determines the polarity applied to the switch machine control relay SMR¹, which in turn governs the operation of the switch machine. Obviously, if the control lever is moved to a position out of correspondence with the track switch TS¹, this track switch will be operated, but if the control lever is in a position which corresponds with the position of the track switch, the track switch will remain in its former position.

Although no signal relays or other control devices, other than relay SMR¹, have been shown, it will be understood that the step-by-step operation of the stepping relays may occur in sequence and in synchronism for as many steps as required to transmit controls to such other signal relays or other devices as desired.

This transmission of controls continues until the predetermined number of steps have been taken, which by way of example, has been specifically illustrated as including three steps, two of which have been employed for station selection, followed by one which is employed for transmission of controls after station selection.

End of control cycle.—It has been explained that relays F, FP, SA, SAP and all stepping relays in the control office are released during the "change to normal" period which follows the third "on" period. It will be recalled that the "change to normal" period is long compared with other "off" periods, resulting in relays F and FP in the control office and relays F¹ and FP¹ at the field station being down for a time interval sufficient to allow relays SA and SAP in the control office and relay SA¹ at the field station to be released. The stepping relays and the associated steering or half step relay at the field station release when relay SA¹ drops and opens its contacts 166 and 171. The stick circuit of relay SO¹, including its front contact 177, is interrupted when relay 3V¹ drops and opens its front contact 182 and since relays FP¹ and SA¹ are down at this time, there is no circuit for holding relay SO¹ and it is dropped.

Simultaneously with the dropping away of the stepping relays in the control office, the particular code determining relay CD which was picked up during the cycle, is deenergized so that the next code determining relay in order may be effective at the beginning of the next cycle, if its corresponding starting button has been actuated and this condition stored by a storing relay (not shown).

The release of relay SA in the control office breaks the energized stick circuit of relay C which extends through its front contact 68 so that relay 75

C drops and by opening its front contact 13, causes the release of relay STR.

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 manually governed from the control office, when such a device assumes a new position.

For example, track switch TS¹ may be shifted from a normal position to a reverse position in response to a control transmitted by lever SML, in a manner previously explained. When the track switch responds to such a control signal, it causes relay WP¹ to deenergize during the transition period, when the switch is shifting from normal to reverse, after which relay WP¹ is energized with opposite polarity. The deenergization of relay WP¹, as well as its reenergization, momentarily interrupts the stick circuit of a change relay in a manner which is not shown in Fig. 4 but which is well known in the art, and is shown, for instance, in the patent to De Long and Plank No. 1,852,402, dated April 5, 1932. Relay CHP¹ is dropped as a result of such a change at the field station.

Relay CHP¹ may also be released upon a change in traffic conditions, such for example, as the deenergization of track relay T¹ when a train passes over the associated detector track circuit, in accordance with the usual practices. In brief, the stick circuit for the change relay is carried through front and back contacts of the WP¹ relay, the T¹ relay and may be similarly carried through like contacts of other traffic controlling devices associated with the field station.

Irrespective of the particular change which occurs, it results in dropping the change repeating relay CHP¹ which closes a circuit for picking up relay PLA¹, extending from (+), back contact 155 of relay FP¹, back contact 156 of relay SA¹, back contact 157 of relay CHP¹ and lower winding of relay PLA¹, to (—). Relay PLA¹ closes a stick circuit for itself extending from (+), back contact 188 of relay SA¹, front contact 183 of relay PLA¹ and lower winding of relay PLA¹, to (—).

The actuation of relay PLA¹ opens its back contact 190 which allows relay VPC¹ to release. Relay PLA¹ also opens the A line conductor at its back contact 150 and since the system is in the normal period when this automatic start of the cycle is effected, the opening of the A line conductor results in dropping relays MA, MB, MAP and MBP in the control office.

Referring to the indication cycle portion of Fig. 5, the system is now in the first part of the initiating period with all three line conductors deenergized as indicated by reference character O (open) associated with all three lines. The release of relay MAP closes a circuit for picking up relay FC extending from (+), back contact 70 of relay MAP, back contact 69 of relay SAP, field start conductor 71, back contact 17 of relay C, back contact 72 of relay STR and winding of relay FC, to (—). Relay FC, which is operated only during a cycle which is initiated at a field station, prevents the picking up of relay PC during such a cycle, by opening the circuit of relay PC at back contact 24. Relay FC closes a stick circuit for itself extending from (+), back contact 6 of relay SAP, front contact 79 and winding of relay FC, to (—). A circuit is now completed for picking up start relay STR, extending from (+), front contact 73 of relay FC and winding

of relay STR, to (—). A circuit is also closed for picking up relay NC, which extends from (+), back contact 74 of relay C, front contact 75 of relay FC and winding of relay NC, to (—).

Since this is a cycle for the transmission of indications alone, all of the impulses applied to the S line are (—) because relay NC is held in its picked up position throughout the cycle. Relay NC opens its back contact 15, which is effective to prevent the control office breaking in on the connection after the communication system has been initiated from a field station. The operation of relay STR closes a circuit for energizing the S line conductor with (—) potential, which extends from the (—) terminal of battery B, back contact 8 of relay PC, front contact 26 of relay NC, winding of relay F and back contact 27 of relay EP to line 28.

This is the second portion of the initiating period with line S energized (—), the A line open (O) and the B line energized (+) as indicated in the operation chart. The (—) potential, applied to the S line conductor 28, extends from the control office through relay F¹ at the field station shown in Fig. 4, through relays F² at other field stations, resistance coils R¹ and R² at the last field station, back contacts of relays such as PLB² at other field stations, conductor 152, back contact 153 of relay PLB¹, B line conductor 12, winding of relay MB, front contact 7 of relay NC, back contact 25 of relay PC and front contact 10 of relay STR to the (+) terminal of battery B. The circuit branches from resistance coil R¹ and leads through back contacts such as PLA² at other stations, conductor 151, front contact 150 of relay PLA¹, lower winding of lockout relay LO¹, back contact 191 of relay SA¹, to the B line conductor 12 and thence by way of the remainder of the circuit just traced to the (+) terminal of battery B.

It will be noted from the above traced circuit that the A line conductor 11 is open toward the control office, at back contact 150 of relay PLA¹ at the station initiating the call. The A line conductor 151 extending toward stations farther away from the control office, is connected to the B line conductor at the station initiating the call through the lower winding of relay LO¹. The resistance coils R¹ and R² provide a sufficient drop in the A and B line conductors, extending from the station shown in Fig. 4 to the end of the line, so that the lower winding of relay LO¹ is not short circuited, but receives sufficient potential across the terminals of its winding to cause it to be energized.

With the system in the second part of the initiating period and with line S energized (—), line A extending to the control office deenergized and line B energized (+), relays F, MB and MBP in the control office are picked up and relay F¹ at the field station is positioned to the left. Relay FP in the control office and relay FP¹ at the field station are picked up over circuits closed by contacts 29 and 154 of relays F and F¹ respectively. Relay LO¹ is picked up by means of current flowing in line conductor 151, as above described.

The system is now in the lock-out period. Relay SA in the control office is picked up over its previously described pick-up circuit and a circuit is closed for sticking relay MBP, extending from (+), front contact 14 of relay SA, stick conductor 64, back contact 77 of relay E, front contact 78 of relay MBP and upper winding of relay MBP, to (—). An additional stick circuit is

closed for relay FC extending from (+), front contact 67 of relay SA, front contact 79 of relay FC and winding of relay FC, to (-).

Relay SA¹ at the field station is picked up by a circuit completed at front contact 155 of relay FP¹. With relays FP¹ or SA¹ up, no other relay similar to PLA¹ can be picked up because the pick-up circuit is open at back contacts similar to 155 or 156. Relay SA¹ closes a stick circuit for relay LO¹ extending from (+), front contact 193 of relay SA¹, front contact 194 of relay LO¹ and upper winding of relay LO¹, to (-). The picking up of relay SA¹ opens the pick-up circuit of relay PLA¹ at back contact 156 and the stick circuit of relay PLA¹ at back contact 188 so that relay PLA¹ is dropped.

The system is now advanced into the conditioning period. The A line conductor is now energized, due to the current in conductor 151, through back contact 150 of relay PLA¹, A line conductor 11, winding of relay MA, front contact 13 of relay STR, front contact 7 of relay NC, back contact 25 of relay PC and front contact 10 of relay STR to the (+) terminal of battery B. As shown in the operation chart, during the conditioning period line S is energized (-) and lines A and B (+).

Relays MA and MAP in Fig. 2 pick up when the A line is energized during this period and relay MAP establishes a stick circuit for itself, extending from (+) on stick conductor 64, back contact 77 of relay E, front contact 80 of relay MAP and upper winding of relay MAP, to (-). Relay SAP is picked up when relay SA closes its front contact 31. Relay VPC¹ of Fig. 4 is again picked up when relay PLA¹ releases by means of a circuit extending from (+), back contact 199 of relay PLA¹, back contact 195 of relay PLB¹ and winding of relay VPC¹, to (-). Relay EP of Fig. 2 is picked up during the conditioning period, over a circuit extending from (+), front contact 32 of relay SAP, back contact 33 of relay E and winding of relay EP, to (-). Relay EP opens the S line conductor at its back contact 27, which deenergizes the three line conductors 23, 11 and 12.

The system is now advanced into the first "off" period. The stepping relays and their associated steering relays in the control office and at the field stations are operated during an indication cycle, in the same manner as previously described in connection with a control cycle, so that the detailed description of this operation will not be repeated. The line conductor S is impulsed by relay EP in the same manner as previously described so that this operation will not be again explained. The relays similar to SO¹ at the field stations are not picked up during an indication cycle, because the conditioning impulse is (-) which actuates relay F¹ to the left so that their pick-up circuits are not effective. Relay LO¹, however, is picked up as above described and completes a circuit for the stepping relays by way of its front contact 170.

Registration of a field station.—It will now be assumed that the system is advanced through the transmitting period and the "change to normal" period, the transmitting period including first, second and third "off" periods and first, second and third "on" periods.

One of the features of the present invention resides in means for obtaining an increase in the number of indications which may be transmitted during an operating cycle. It is believed that this feature may be best understood by assuming

that the field station shown in Fig. 4 is assigned indication code combination (-)(-)(+), as indicated in the station registration period at the lower part of the indication cycle of Fig. 5. The above assumption means that the No. 1 "off" indication is executed (-) because relay MX is down, connecting (B-) to the No. 1 "off" indication bus. The No. 1 "on" indications are executed (-) and (+) because relay MAP is down, connecting (B-) to the No. 1A "on" indication bus and relay MBP is up connecting (B+) to the No. 1B "on" indication bus.

It will be noted that this station registering code is obtained with only one step of the stepping relay bank. The choice during the "off" period is (+) or (-) and the choice during the "on" period is (-)(+) or (+)(-) or (+)(+), a total of five choices. This does not mean that the line circuits are energized (+) and (-), but is simply a convenient manner of indicating the different combinations obtained. The choice of (+) or (-) "off" refers to relay MX up and down respectively. The "on" choices refer to relays MAP down and MBP up, relays MAP up and MBP down and relays MAP and MBP up, respectively, all as determined by the combinations of the A and B lines for the return circuit for line S.

It has been explained how the system is advanced into the first "off" period during an indication cycle. The stepping line S and the return lines A and B are all deenergized during the first "off" period, resulting in the picking up of relays IV and IV¹ in the manner previously described. Relays F and FP are dropped during the first "off" period and relays MAP and MBP are stuck up by means of a circuit extending from (+), front contact 14 of relay SA, stick conductor 64, back contact 77 of relay E and front contacts 80 and 78 of relays MAP and MBP respectively, to the windings of these relays.

Relay E is picked up during the second part of the first "off" period, which opens the above described stick circuit of relays MAP and MBP and these two relays are released. Relay MX is not picked up during this period because the pick-up circuit through its lower winding is open at back contact 100 of relay MBP, when these relays are up and at front contact 81 of relay MAP when they are down.

When relay IV¹ of Fig. 4 picks up during the first "off" period, a circuit is completed for picking up relay PLA¹ which extends from (+), back contact 155 of relay FP¹, front contact 156 of relay SA¹, "off" indication bus 197, code jumper 196, No. 1A "off" indication bus 200, front contact 206 of relay IV¹, back contact 207 of relay 2V¹, back contact 208 of relay 3V¹, back contact 209 of relay VP¹, upper winding of relay PLA¹ and front contact 199 of relay LO¹, to (-). Relay PLB¹ is down during this "off" period because the No. 1B "off" indication bus 201 is not energized.

The system is next advanced into the first "on" period by the dropping of relay EP in the control office and the energization of line S. The return circuit is by way of line B alone because relay PLA¹ is up, which opens line A at its back contact 150. With the return circuit extending over line B, relays F, FP, MB and MBP are picked up in the control office. With relay MAP down and relay MBP up, there is no circuit for picking up relay MX so that the No. 1 "off" indication is conditioned (-) by relay MX remaining down and connecting (B-) to the No. 1 "off" indica-

tion bus 89, to be executed as will be later described.

With relay PLA¹ up, the circuit of relay VPC¹ is open at back contact 190 so that relay VPC¹ is dropped. During the first part of the first "on" period, relays F¹ and FP¹ at the field station are picked up, which results in disconnecting (+) potential from the "off" indication bus 197 at back contact 155 of relay FP¹. Relay PLA¹ is therefore released during the second part of the first "on" period, which results in energizing the A line and picking up relays MA and MAP in the control office. Relay MX can not be operated under this condition because it requires relay MAP up and relay MBP down to energize the pick-up winding of relay MX. Both relays MAP and MBP are now up.

When relay PLA¹ drops at the field station, the circuit of relay VPC¹ is again completed and this relay is picked up. With relays FP, MAP AND MBP up in the control office, the circuit is completed for picking up relay VP which has previously been described. With relay VPC¹ up at the field station, the circuit is completed for picking up relay VP¹, which extends from (+), front contact 171 of relay SA¹, front contact 186 of relay FP¹, front contact 174 of relay VPC¹, back contact 187 of relay 3V¹, back contact 222 of relay 2V¹, front contact 223 of relay 1V¹ and winding of relay VP¹, to (-).

It will thus be evident that the combination indicated in the operation chart for the second part of the first "on" period, that is, line S (-) and lines A and B (+), is used to control the picking up of relay VP in the control office and relay VP¹ at the field station in synchronism. This feature is provided as a means for synchronizing the steering or half step relay operation at the control office and at the field station.

With the VP and VP¹ relays up, the system is advanced into the third part of the first "on" period by picking up relay PLA¹ over a circuit extending from (+), code jumper 198, No. 1A "on" indication bus 204, front contact 210 of relay 1V¹, back contact 211 of relay 2V¹, back contact 212 of relay 3V¹, front contact 209 of relay VP¹, upper winding of relay PLA¹ and front contact 199 of relay LO¹, to (-). Relay PLA¹ is picked up because code jumper 198 is connected for energizing the No. 1A "on" indication bus. Relay PLB¹ remains down at this time because the No. 1B "on" indication bus 205 is deenergized.

With relay PLA¹ up and relay PLB¹ down, the A line is deenergized and the return circuit for line S is by way of line B alone, which results in dropping relays MA and MAP and holding relays MB and MBP in their operated positions. As indicated in the third part of the first "on" period, this is the point in the cycle when the No. 1 "on" indication is conditioned and in the present example the B line conductor is energized (+), and the A line conductor is deenergized. With relay MAP down, (B-) is connected to conductor 82 and with relay MBP up, (B+) is connected to conductor 83 for later executing the first "on" indication.

The picking up of relay VP during the second part of the first "on" period opens the circuit of relay E, as has already been described and after a time interval measured off by the slow acting characteristics of relay E, it releases its armature and closes the executing circuits for the No. 1 indications which have been conditioned as described.

It will be recalled that relay MX is down, re-

sulting in (B-) being connected to conductor 84, so that this circuit from (B-) is extended through back contact 85 of relay E, conductor 76 (Fig. 3), front contact 86 of relay VP, back contact 87 of relay 3V, front contact 88 of relay 1V, No. 1 "off" indication bus 89 and winding of relay 1PT, to (CN). This results in actuating relay 1PT to its left hand position as shown.

Recalling that relay MAP is down, a circuit for executing the No. 1A "on" indication is now completed, extending from (B-), back contact 90 of relay MAP, conductor 82, back contact 91 of relay E, conductor 130, front contact 92 of relay VP, back contact 93 of relay 3V, front contact 104 of relay 1V, No. 1A "on" indication bus 105 and winding of relay 2PT, to (CN). This results in actuating the contacts of relay 2PT to the left hand position as shown in Fig. 3.

Recalling that relay MBP is up, a circuit for executing the No. 1B "on" indication is now completed, extending from (B+), front contact 94 of relay MBP, conductor 83, back contact 95 of relay E, conductor 131, front contact 96 of relay VP, back contact 97 of relay 3V, front contact 98 of relay 1V, No. 1B "on" indication bus 109 and winding of relay 3PT, to (CN). The current flow in this circuit is in such a direction that relay 3PT will be positioned to the right as shown.

The system is next advanced into the second "off" period and as indicated in the operation chart and as will be evident from an examination of the circuits above traced, the No. 1 execution circuits remain effective during the first part of the second "off" period. These execution circuits are broken at contacts 85, 91 and 95 of relay E when it is picked up to mark the beginning of the second part of the second "off" period.

Relay 2V is picked up in the first part of the second "off" period, closing a circuit for operating relay ST of Fig. 3, extending from (+), front contact 120 of relay 2V, contact 121 of relay 1PT in its left hand position, contact 122 of relay 2PT in its left hand position, contact 123 of relay 3PT in its right hand position and winding of relay ST, to (-).

The above explanation sets forth in detail the manner in which the station shown in Fig. 4, having code combination (-) (-) (+), registers itself in the control office by selecting and operating relay ST of Fig. 3. The code combination of this station is determined by code jumpers 196 and 198 being connected as shown in Fig. 4. The selection of one of two combinations during the "off" period is obtained by selectively connecting code jumper 196 to indication buses 200 and 201 as explained. With jumper 196 connected as shown, relay PLA¹ is picked up, opening line conductor A so that the return circuit is by way of line conductor B, for picking up relays MB and MBP in the office. With relay MBP up and relay MAP down, relay MX remains down to execute a (-) code as explained. The alternate connection of jumper 196 to indication bus 201 would result in picking up relay PLB¹, thus establishing the return circuit by way of the A line conductor so that relay MAP would be up and relay MBP down, which would complete a circuit for picking up relay MX. With relay MX up, the code combination executed is (+). This is the choice of two code combinations for the "off" period.

With jumper 198 connected as shown in Fig. 4, relay PLA¹ is picked up, which opens the A line conductor and establishes the return circuit by way of the B line conductor, so that relay MBP in the control office picks up and relay MAP stays

down. As has been explained, relay MAP down results in positioning relay 2PT to the left and relay MBP up establishes a circuit for positioning relay 3PT to the right.

5 If jumper 198 were connected to indication bus 205, then relay PLB¹ would be picked up and relay PLA¹ would remain down, which would open the B line conductor and establish the return circuit by way of the A line conductor. This
10 would pick up relays MA and MAP and leave relays MB and MBP down. With relay MAP up the No. 1A "on" indication bus of Fig. 3 would be energized (+) for positioning relay 2PT to the right. With relay MBP down, the No. 1B "on"
15 indication bus would be energized (-) for positioning relay 3PT to the left.

If jumper 198 is not connected to either bus 204 or 205, then both relays PLA¹ and PLB¹ would be down and the return circuit would be by way of both the A and B line conductors and relays MAP and MBP would both be picked up. This would result in a (+) potential being applied to both the No. 1A "on" and the No. 1B
20 "on" indication buses for positioning relays 2PT and 3PT to the right. This is the method of obtaining a choice of three combinations during the "on" period.

It will be understood that there is no combination for positioning relays 2PT and 3PT both to the left during an "on" period, because this
30 would require both the MA and MB relays being down which is not possible during an "on" period, because one or the other or both the A and B line conductors must be energized for the return circuit for line S.

The conductor indicated "phantom" is not used for connection to a relay similar to ST, because when controls alone are being transmitted, the "off" and "on" combinations provided
40 by the A and B line conductors inherently result in positioning relay 1PT to the left, relay 2PT to the right and relay 3PT to the right. This is due to the fact that both the A and B line conductors are energized in multiple during all of the conditioning periods, which results in relay
45 MX being down to energize the No. 1 "off" indication bus (-), relay MAP being up to energize the No. 1A "on" indication bus (+) and relay MBP being up to energize the No. 1B "on" indication bus (+).

50 *Transmission of indications.*—Relays 2V and 2V¹ are picked up during the first part of the second "off" period. The No. 2 "off" indication is conditioned, after the picking up of these two stepping relays, during the second part of the second "off" period and the first part of the second "on" period. With relay 2V¹ up and relay VP¹ up at the field station, a circuit is closed for picking up relay PLB¹ which extends from
60 (+), back contact 155 of relay FP¹, front contact 156 of relay SA¹, "off" indication bus 197, front contact 213 of relay T¹, No. 2B "off" indication bus 203, front contact 214 of relay 2V¹, back contact 215 of relay 3V¹, front contact 216
65 of relay VP¹, winding of relay PLB¹ and front contact 199 of relay LO¹, to (-). Relay PLA¹ is not picked up during the second "off" period because the No. 2A "off" indication bus 202 is de-energized.

70 When relay E of Fig. 2 is picked up, after the picking up of relay 2V, in a manner which has been previously described, relay MBP is dropped because relay E opens its stick circuit at back contact 77. Relay MAP is already down and
75 the system therefore goes through the second

part of the second "off" period with relays MAP, MBP and MX down. When relay EP drops and closes the line to advance the system into the first part of the second "on" period, the line S
5 is energized and the return circuit is by way of the A line, because relay PLA¹ is down closing the A line at its back contact 150 and relay PLB¹ is up opening the B line at its back contact 153.

Relays F, FP, MA and MAP of Fig. 2 now
10 pick up and with relay MAP up and relay MBP down, a circuit is closed for picking up relay MX, which extends from (+), back contact 19 of relay 3V, front contact 20 of relay 2V, front contact 34 of relay VP, back contact 99 of relay
15 EP, back contact 100 of relay MBP, front contact 81 of relay MAP and lower winding of relay MX, to (-). Relay MX closes a stick circuit for itself extending from (+), front contact 101 of relay FP, front contact 102 of relay MX and
20 upper winding of relay MX, to (-). Relay MAP is up, relay MBP is down and relay MX is up at this time.

The system is now advanced into the second
25 part of the second "on" period by the picking up of relay FP¹ at the field station. The circuit above traced, which picked up relay PLB¹ is now interrupted at back contact 155 of relay FP¹ so that relay PLB¹ is dropped. This results in en-
30 ergizing both the A and B line conductors with (+) potential and as a result, relays MB and MBP are picked up. With relay MAP up and relay MBP up, the pick-up circuit of relay MX is broken but relay MX remains stuck up to
35 (+) potential at front contact 101 of relay FP.

With the MAP, MBP and FP relays all picked up, the stick circuit of relay VP is interrupted at back contacts 60, 59 and 52 of these respective
40 relays. Relay PLB¹ is dropped, when relay FP¹ disconnects (+) potential from "off" indication bus 197 at its back contact 155. With relays PLA¹ and PLB¹ down, the pick-up circuit of relay VPC¹ is again established and this relay is actuated, opens its back contact 173 and inter-
45 rupts the stick circuit of relay VP¹. Relay VP¹ drops and establishes the conditioning circuit for the second "on" indication. This results in picking up relay PLA¹ over a circuit extending from (+), front contact 217 of relay WP¹, contact 218 of relay WP¹ in its right hand position,
50 No. 2A "on" indication bus 219, front contact 207 of relay 2V¹, back contact 208 of relay 3V¹, back contact 209 of relay VP¹, upper winding of relay PLA¹ and front contact 199 of relay LO¹,
55 to (-). Relay PLB¹ remains down because the No. 2B "on" indication bus 220 is open at contact 218 of relay WP¹.

Relay VPC¹ is now dropped because its circuit is open at contact 190 of relay PLA¹. The picking up of relay PLA¹ opens the A line con-
60 ductor return circuit so that relays MA and MAP in the control office are dropped. Relay MAP is now down, relay MBP is up and relay MX is stuck up. The release of relay VP during the second part of the second "on" period opens
65 the circuit of relay E and this latter relay is dropped, after a short time interval. The executing circuits are now closed for the No. 2 indications.

Since relay MX is up, a circuit is extended
70 from (B+), front contact 103 of relay MX, conductor 84, back contact 85 of relay E, conductor 76, (Fig. 3) back contact 86 of relay VP, front contact 106 of relay 2V, No. 2 "off" indication bus 107, front contact 108 of relay ST and wind-
75

ing of relay IR¹, to (CN). This results in actuating relay IR¹ to the right as shown in Fig. 3.

Since relay MAP is down, the circuit for executing the No. 2A "on" indication is now complete, extending from (B-), back contact 90 of relay MAP, conductor 82, back contact 91 of relay E, conductor 130, back contact 92 of relay VP, front contact 110 of relay 2V, No. 2A "on" indication bus 111, front contact 112 of relay ST and winding of relay IR², to (CN). This results in actuating the contacts of relay IR² to the left hand position as shown in Fig. 3.

With relay MBP up, the circuit for executing the No. 2B "on" indication is now complete, which extends from (B+), front contact 94 of relay MBP, conductor 83, back contact 95 of relay E, conductor 131, back contact 96 of relay VP, front contact 113 of relay 2V, No. 2B "on" bus 114, front contact 115 of relay ST and winding of relay IR³, to (CN). The current flow in this circuit is in such a direction that relay IR³ is positioned to the right as shown.

It will be noted that the stick circuit for relay MBP is effective when relay E releases and closes its back contact 77, so that relay MBP will not be released during the first part of the next "off" period, with the circuit through its lower winding incomplete.

The system is next advanced into the third "off" period and as will be evident from an examination of the circuits above traced, the No. 2 execution circuits remain effective during the first part of the third "off" period. These execution circuits are broken at contacts 95, 91 and 95 of relay E when it is picked up to mark the beginning of the second part of the third "off" period.

Relays 3V and 3V¹ are picked up during the first part of the third "off" period and the No. 3 "off" indication is conditioned, after the picking up of these stepping relays, during the second part of the third "off" period and the first part of the third "on" period. With relay 3V¹ up and relay VP¹ down at the field station, a circuit is closed for picking up relay PLA¹, which extends from (+), back contact 155 of relay FP¹, front contact 156 of relay SA¹, "off" indication bus 197, back contact 224 of relay M¹, No. 3A "off" indication bus 225, front contact 208 of relay 3V¹, back contact 209 of relay VP¹, upper winding of relay PLA¹ and front contact 199 of relay LO¹, to (-). Relay PLB¹ is not picked up during this "off" period because the No. 3B "off" indication bus 226 is open at front contact 224 of relay M¹.

When relay E of Fig. 2 is picked up after the picking up of relay 3V, in a manner which has been previously described, relay MBP is dropped because relay E opens its stick circuit at back contact 77. Relay MAP is already down and the system therefore goes through the second part of the third "off" period with relays MAP, MBP and MX down. When relay EP drops and closes the line to advance the system into the first part of the third "on" period, the line S is energized and the return circuit is by way of the B line because relay PLB¹ is down closing the B line at its back contact 153. Relays F, FP, MB and MBP now pick up and since relay MAP is down and relay MBP is up, relay MX remains down.

The system is now advanced into the second part of the third "on" period with relays MAP down, MBP up and MX down. When relay FP¹ at the field station picks up to advance the system into the second part of the third "on" period, it interrupts the circuit of relay PLA¹ at contact 155 so that relay PLA¹ drops and energizes the A line.

This results in picking up relays MA and MAP so that relays MAP and MBP are both up and relay MX is down at this time.

With relays FP, MAP and MBP all up, the pick-up circuit of relay VP is completed, extending from (+), front contact 32 of relay SAP, front contact 52 of relay FP, front contact 53 of relay MBP, front contact 54 of relay MAP, front contact 55 of relay 3V and winding of relay VP, to (-). At the field station, a circuit is completed for picking up relay VPC¹ when relay PLA¹ drops and with relay VPC¹ up, the previously described circuit is completed for picking up relay VP¹, except that it now extends through front contact 187 of relay 3V¹ instead of contact 223 of relay 1V¹.

With relay VP¹ up, the No. 3 "on" conditioning circuits are established, resulting in dropping both relays PLA¹ and PLB¹ because the No. 3A "on" bus 227 and the No. 3B "on" bus 228 are both shown incomplete in Fig. 4. This results in the MA, MAP, MB and MBP relays picking up in the control office and when relay E is released during the fourth part of the third "on" period, the No. 3 indication circuits are executed.

With relay MX down, the No. 3 "off" indication is executed (-) by means of a circuit extending from (B-), back contact 103 of relay MX, conductor 84, back contact 85 of relay E, conductor 76, front contact 86 of relay VP, front contact 87 of relay 3V, No. 3 "off" indication bus 116, front contact 117 of relay ST and winding of relay IR⁴, to (CN). This results in actuating relay IR⁴ to its left hand position as shown in Fig. 3. If relay IR⁴ is actuated to the right, lamp M is lighted by way of conductor 127 as an indication that relay M¹ of Fig. 4 is up.

The circuits of the No. 3 "on" indication buses of Fig. 4 are not completed, since it is believed that the examples specifically described above are sufficient to indicate how the selection of five indication choices is obtained during each step. Likewise, the No. 3 "on" buses 118 and 119 of Fig. 3 are not completed, since they may be connected, in an obvious manner, to other relays similar to the IR relays indicated.

With the indication storing relays IR¹, IR² and IR³ positioned as shown, the circuits to the indication lamps are selectively conditioned. Since relay IR¹ has its contacts actuated to the right, the circuit to lamp OS is not completed, as an indication that the detector track section is unoccupied as repeated by relay T¹ of Fig. 4 being up. Relays IR² and IR³ complete a circuit for lighting lamp NI which extends from (+), contact 124 of relay IR³ in its right hand position and contact 125 of relay IR² in its left hand position to lamp NI. Lighting lamp NI is an indication that the switch TS¹ of Fig. 4 is in its normal locked position as repeated by relay WP¹.

The alternate connection of the contacts of relay WP¹ to indication bus 220 would result in opening the B line conductor by picking up relay PLB¹, so that the return circuit would be by way of the A line conductor alone. This would result in relay MAP being up and relay MBP being down, so that the No. 2A "on" indication bus 111 of Fig. 3 would be energized (+), to position relay IR² to the right and the No. 2B "on" indication bus 114 would be energized (-) to position relay IR³ to the left. Likewise, the No. 2 "off" selection is made by positioning relay MX, in the manner above described, for selectively actuating relay IR¹ of Fig. 3. Relay IR¹

in its dotted position closes a circuit by way of conductor 126 to light lamp OS to indicate the occupied condition of the detector track section.

It will be understood that additional pilot relays similar to 1PT, 2PT and 3PT may be provided and positioned during additional steps and it will be obvious that the provision of one additional group of these pilot relays will result in the selection of 36 code combinations and with the phantom combination eliminated, 35 usable combinations are obtained during two steps for pyramiding the contacts of the pilot relays in the manner illustrated in Fig. 3. In the event that two steps are used for station selection, it is apparent that two additional code jumpers similar to 198 and 198 of Fig. 4 will be provided for selectively connecting to the No. 2A "off" indication bus 202, No. 2B "off" indication bus 203, No. 2A "on" indication bus 219 and No. 2B "on" indication bus 220. In this event, relays T¹ and WP¹ would be connected to the next group of indication buses in the series.

End of indication cycle.—The step-by-step operations and the impulsing of the line circuit during an indication cycle are similar to those during a control cycle and the line S is deenergized when relay EP of Fig. 2 is picked up to mark the end of the third "on" period and the beginning of the "change to normal" period. It will be recalled that the "change to normal" period is long compared with other "off" periods, so that relays F and FP in the control office and relays F¹ and FP¹ at the field station remain down for a time interval which is sufficiently long to allow relays SA and SAP in the control office and relay SA¹ at the field station to release. The stepping relays and the steering or half step relays are released in the same way as described in connection with a control cycle and relay FC of Fig. 2 is restored to normal when relay SA opens its stick circuit at front contact 67. Relay NC is released when relay FC drops and opens its front contact 75 and relay STR is dropped when relay FC opens its front contact 73.

Relay LO¹ of Fig. 4 is restored to normal when relay SA¹ opens its front contact 193 to deenergize the stick circuit of relay LO¹. The A and B line conductors are now energized and the system is advanced into the normal period, in the same manner previously described in connection with a control cycle. With the stepping relays of Fig. 2 in their normal positions, the executing circuits leading from the bottom portion of Fig. 2 to the top part of Fig. 3 are all opened, so that the pilot relays and the indication storing relays are deenergized and left in the positions to which they were actuated. Relay ST is restored to normal when relay 2V drops and opens its front contact 120.

Lock-out between field stations.—As previously mentioned, it may happen that changes take place at the several field stations simultaneously or in rapid succession, so that more than one field station may have indications to transmit at the beginning of a cycle. In order to prevent more than one field station obtaining access to the line during a cycle of operations, lock-out means are provided at each field station which are effective to give control of the line to the field station nearest the end of the line, under the above conditions.

It has already been explained that the picking up of a relay similar to relay SA¹ of Fig. 4, during the lock-out period, prevents the picking

up of any relay similar to relay PLA¹ that is not up at this time. If a single station has started the cycle of operations, by picking up its relay similar to relay PLA¹, other stations are prevented from breaking in during this same cycle when relay SA¹ is picked up. It may occur, however, that two or more relays similar to relay CHP¹ may be down at the same time, while the system is in its normal period or its initiating period. In this case, two or more relays similar to relay PLA¹ can be picked up over circuits similar to that previously described in connection with relay PLA¹ of Fig. 4.

It is believed that the lock-out feature will be best understood by assuming that two relays similar to relay PLA¹ are picked up at the same time and giving an explanation how only the station nearest the end of the line (farthest from the control office) is effective to obtain control of the line under this condition. It will be understood that the operation is the same when more than two relays similar to relay PLA¹ are up at the same time, since only the station nearest the end of the line in this instance will be effective to transmit indications. It will be assumed that relay PLA¹ of Fig. 4 is at the station nearest the end of the line. The two relays similar to relay PLA¹, which are assumed picked up, will be stuck up over circuits similar to that extending from (+), back contact 188 of relay SA¹, front contact 189 of relay PLA¹, and lower winding of relay PLA¹, to (—).

When relays STR and NC of Fig. 2 pick up during the initiating period, current flowing over line S, through resistance coil R¹ at the last station and back contact PLA², extends by way of the A line conductor 151, front contact 150 of relay PLA¹, lower winding of relay LO¹, back contact 191 of relay SA¹ and thence by way of the B line conductor to the other side of battery B in the control office. This circuit through the lower winding of relay LO¹ exists only at the station nearest the end of the line, since at the other stations nearer the control office, having a relay similar to relay SA¹ picked up, the A line conductor 11 is open at back contact 150 of relay PLA¹ at the station nearest the end of the line.

Therefore, only relay LO¹ of Fig. 4 is picked up during the initiating period and it is stuck up through front contact 193 when relay SA¹ picks up. As soon as the relay similar to relay SA¹ at the other station nearer the control office picks up, the stick circuit of the relay similar to relay PLA¹ is opened at back contact 188 of the relay similar to relay SA¹. The pick-up circuit of the relay similar to PLA¹ is opened at back contact 156 of the relay similar to relay SA¹, so that the relay similar to PLA¹ at the station nearest the control office which was picked up, is dropped. Other relays similar to relay PLA¹ get their chance to again pick up and obtain access to the line during the initiating period of the next cycle.

It will now be evident that the station nearest the end of the line is the only one which can pick up its lock-out relay, therefore, this is the only station which can impulse the A and B line conductors in accordance with the connections of the indication buses, since this is the only station with (—) potential connected to the windings of relays PLA¹ and PLB¹. With relays similar to PLA¹ and PLB¹ at all other stations down, the station which obtains access to the line may now impulse the A and B lines, since

these line circuits are completed at back contacts similar to 150 and 153 at all other stations.

Two-way transmission.—It has been pointed out that control and indication cycles may each occur separately or simultaneously. The operation for each of these cycles alone has been described in detail and it will now be explained how the system operates when controls and indications are transmitted during the same cycle, which is conveniently referred to as a duplex cycle.

The actuation of a starting button in the control office and the picking up of relay CD which follows, results in picking up the start relay STR. Relay STR is stuck up until the "change to normal" period when it is dropped as has been previously described.

For the transmission of controls, relay C is picked up which results in circuits being effective to select the polarity control relays PC and NC, in accordance with the polarities with which line S is to be energized. In the case where both the control office and the field station are on the line at the start of the cycle, the picking up of relay C prevents the picking up of relay FC, so that the polarity control relays PC and NC may be selectively positioned by way of circuits including front contacts of relay CD. Relay C is picked up and stuck up by way of front contact 67 of relay SA and the circuit of relay FC is opened at back contact 17 of relay C, so that the system will go through a duplex cycle of operations with relay C up and relay FC down. It will be understood that the lock-out feature is effected during a duplex cycle in the same manner as has been described in connection with the transmission of indications alone.

During a duplex cycle of operations, a (+) impulse is applied to line S, during the conditioning period, because relay PC is picked up over the previously described circuit, extending through back contact 24 of relay FC and front contact 22 of relay C, to (+), through back contacts 21, 20 and 19 of relays 1V, 2V and 3V respectively. The following impulses applied to line S are (+) or (—), as determined by the particular CD relay which is up. The return circuit for the S line is preconditioned by way of the A and B lines during the "off" periods, by selectively conditioning the PLA¹ and PLB¹ relays in the same manner as has been described in connection with the transmission of indications alone. Likewise, the A and B lines are conditioned during the "on" periods of a duplex cycle in the same manner as has been described in connection with the transmission of indications alone.

It is therefore evident that, since only one CD relay in the control office and one lock-out relay LO¹ at a field station can be up at one time during a cycle of operations and since transmission of controls and transmission of indications take place during separate and distinct conditions of the line, these transmissions are independent of each other and can be incorporated into the same operating cycle for obtaining the duplex feature. The cycle of operations, insofar as the conditioning of the A and B line conductors for the return circuit is concerned, is the same as described for a cycle during which indications alone are transmitted.

The present embodiment has been described more particularly with reference to the character of the devices employed in a centralized traffic controlling system and their respective functions,

together with typical operating conditions. It will be understood that all possible combinations of circumstances can not be considered in detail and that the drawings and description have been limited as much as possible, in order to avoid undue complications.

Various other novel features of the present invention reside in the circuit arrangements disclosed, such as conditioning the A and B return conductors during a portion of the energized period, to control the shifting of the steering or half step relays in the control office and at the field station which is transmitting. In other words, during an indication cycle when the system advances into the second part of an "on" period, both the A and B line conductors are energized and the resulting picking up of the MA and MB relays in these return conductors, controls the shifting of the VP relay in the control office. Likewise, the picking up of relay VPC¹ at the field station is effected during this same period, because both the PLA¹ and PLB¹ relays are down and this results in controlling the shifting of the VP¹ relay at the field station.

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 the particular arrangements illustrated are only typical illustrations of applicant's invention and are not intended to illustrate the exact circuit design necessary to carry out the features of the invention, but have been selected to facilitate in the disclosure rather than to limit its scope and it is further desired to be understood that various modifications, adaptations and alterations may be applied to the specific form disclosed in order to meet the problems encountered in practice and that the system may be varied in the number of field stations to which the invention is applied and the amount of apparatus installed at a particular field station, all 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 centralized traffic controlling system, a control office, a plurality of field stations, a control line and a plurality of return lines connecting said control office with said stations, one or both of which return lines complete a circuit through said control line, means controlled by a series of characteristic impulses applied to said control line for selecting one of said field stations, and means controlled by simultaneously conditioning said return lines to constitute return paths in different combinations for registering one of said field stations in said control office.

2. In a centralized traffic controlling system, a control office, a plurality of field stations, a control line and a plurality of return lines connecting said control office with said field stations, one or more of said return lines constituting a return conductor for the current flowing from said office over said control line, step-by-step mechanism at said control office and at said field stations, means at said control office for applying a series of distinctive impulses to said control line, means for operating said step-by-step mechanisms in synchronism in response to said series of impulses to comprise a cycle of opera-

tion, means at each station for selectively conditioning said return lines to individually or in combination constitute return conductors for each step of said cycle, means responsive to said series of distinctive impulses for selecting one of said field stations, means responsive to said conditioning of said return lines on each step for registering one of said field stations in said control office, and means for preventing more than one of said stations conditioning said return lines during said cycle.

3. In combination, a control office, a field station, a single stepping line and a plurality of return lines connecting said control office with said field station to thereby form two line circuits, impulsing means at said control office for energizing said stepping line with a plurality of impulses, step-by-step means at said control office and at said field station caused to take one step for each deenergized period between successive impulses only when prepared, means for preparing said step-by-step means only when said stepping line and said return lines are energized by an impulse, code transmitting means at said field station effective on each step following the operation of said step-by-step means for that step to open one or the other of said return lines prior to the energization of said stepping line for the next impulse in accordance with a code, means for closing the particular return line opened for that step following the energization of said stepping line for the next impulse, whereby said step-by-step means are prepared, means at said field station for opening one or the other or neither of said return lines in accordance with a code following the preparation of said step-by-step means until the end of the impulse for that step, and means at said control office responsive to said different conditions on said return lines to register the codes transmitted.

4. In a centralized traffic controlling system of the selector type, the combination with a control office and a field station, of a first line and a plurality of return lines connecting said control office with said station, said return lines each singly or in combination constituting return conductors for current flowing out over said first line, impulsing means at said control office for energizing said first line with a plurality of impulses of distinctive characters to form a code, and means at said field station for establishing the return circuit for said impulses by way of one or more of said plurality of return lines employed in distinctive combinations to form a code.

5. In a selective type communication system, a central office, a field station, a control line and a plurality of return lines in multiple connecting the central office and field station, means at said central office for applying a series of impulses to said control line, step-by-step means at said central office and at said field station caused to take one step for each of said impulses, means at said field station effective on each step to always provide a return path for the impulse for that step by way of said plurality of return wires selectively in accordance with a code, and means at said central office responsive on each step to the selective use of said return wires for the return path of the impulse for that step.

6. In a selective type communication system, a central office, a field station, a control line included in series with a plurality of return lines connected in multiple and connecting the central office and field station, means at said central office for applying a series of impulses to said con-

trol line, step-by-step means at said central office and at said field station caused to take one step for each of said impulses, means at said field station effective on each step to open certain of said return wires in accordance with a code but to always leave at least one return wire closed, and means at said central office distinctively responsive on each step to the open and closed condition of said return wires for that step.

7. In a selective type communication system, a central office, a field station, a control line circuit comprising a control line wire and a plurality of return line wires in multiple and connecting said central office and said field station, means at said central office for applying a series of impulses to said control line circuit, step-by-step means at said central office and at said field station caused to take one step for each of said impulses, means at said field station effective on each step to selectively open any one or more of said return wires but not all in accordance with a code, and means at said central office responsive on each step to the selective use of said return wires for the return path of the impulse for that step.

8. In a selective type communication system, a central office, a field station, a control line and two return lines connecting said central office and said field station, means at said central office for applying to said control line a series of time spaced impulses, step-by-step means at said central office and at said field station caused to take one step during each time space in said series, means at said field station effective on each step to open either one or neither of said return lines in accordance with a code message for that step, and means at said central office distinctively controlled on each step in accordance with the particular open and closed combination of said return lines for that step.

9. In a selective type communication system, a central office, a field station, a control line and a plurality of return lines connecting said central office and said field station, means at said central office for applying to said control line a series of time spaced impulses, step-by-step means at said central office and at said field station caused to take on step during each time space in said series, means at said field station effective on each step to provide a return path for the impulse for that step by way of said plurality of return wires in a distinctive sequence selected for that step in accordance with a code, and means at said central office distinctively controlled on each step in accordance with the particular distinctive sequential use of said return wires for the return path of the impulse for that step.

10. In a selective type communication system, a central office, a field station, a control line having in series therewith two return lines in multiple connecting said central office and said field station, means at said central office for applying to said control line a series of time spaced impulses, step-by-step means at said central office and said field station caused to take one step during each time space in said series, means at said field station effective on each step to cause said return lines to be successively energized in one order or the other in accordance with a code, and means at said central office distinctively controlled on each step in accordance with the order in which said return wires are energized as employed for the return paths for said impulse for that step.

11. In a selective type communication system, a central office, a field station, a control line wire

having in series therewith either or both of two return line wires connecting said control office and said field station, means at said central office for applying a series of time spaced impulses to said control line wire, step-by-step means at said central office and at said field station caused to take one step for each time space in said series, means at said field station effective on each step to cause said two return lines to be sequentially energized in one order or the other upon the application of the impulse for that step and then cause one or the other or neither of said return lines to be opened for the remainder of that step in accordance with a code, and means in said central office distinctively responsive to the particular sequential order of energization of said return wires and the particular return wire combination provided on each step.

12. In a selective type communication system, a central office, a field station, a control line circuit comprising a control wire having in series therewith two return wires in multiple connecting said central office and said field station, a line relay at said central office and at said field station included in said control wire, means at said central office alternately energizing and deenergizing said control line circuit, step-by-step means at said central office and at said field station controlled by said line relay at each respective location to take one step for each deenergization of said control line circuit and to be conditioned to take the next step for each energization of said control line circuit only provided both said return wires are closed, code transmitting means at said field station for selectively opening one or the other but not both of said return lines on each step prior to the energization of said control line circuit for that step in accordance with a code and then closing the opened return line after the energization of said control line circuit for that step, a second code transmitting means at said field station for selectively opening one or the other or neither of said return lines on each step in accordance with a code only after said step-by-step means are conditioned to take the next step, and code receiving means at said central office distinctively responsive to the line circuit combination provided by said return wires as distinctively included in said control circuit both during the first part of each step and on that part of the step after said step-by-step means are conditioned to take the next step.

13. In a selective type communication system; a central office; a plurality of field stations; a control line circuit comprising a control wire having in series therewith two return wires in multiple connecting said central office and said plurality of field stations; a line relay at said central office and at each of said field stations included in said control wire; means at said central office for alternately energizing and deenergizing said control line circuit with each deenergization and following energization comprising a step period; a lock-out relay at each of said field stations; step-by-step means at said central office and at each of said field stations controlled by said line relay at said central office and at each field station to take one step for each of said step periods, but said step-by-step means at each of said field stations responding dependent upon the picked up condition of said lock-out relay at that station; starting means at each field station effective, when new indications are ready for transmission, to open one of said return wires and con-

nect, during the first energization of said control line circuit, said lock-out relay in series with said one return wire extending beyond said field station and in series with said other return line extending to said control office, whereby that station having its said starting means actuated simultaneously with several starting means at other stations, is the only station having its said lock-out relay energized upon the first energization of said control line circuit; code transmitting at each station rendered effective when said lock-out relay at that station is picked up for opening one or the other of said return wires selectively in accordance with the new indications at that station on each step of said step-by-step means; and means at said central office responsive on each step to the opened and closed combination of said return wires on each step to register said new indications.

14. In a remote control system, a control office, a plurality of field stations, a plurality of line circuits interconnecting said office and said stations, a transmitter at each of said stations for transmitting signals over certain of said line circuits to said office when rendered active, a lock-out relay at each of said stations having active and inactive positions for rendering the associated transmitter active and inactive respectively, means at a first one of said stations for effecting the energization of a first one of said line circuits extending from said first station to said office through all of the other stations when said first station has signals to transmit, means responsive to the energization of said first line circuit for placing the lock-out relay at said first station in its active position, switching means at a second one of said stations for effecting the deenergization of said first line circuit and for effecting the energization of a second one of said line circuits extending from said office through all of said stations, means for operating said switching means when said second station has signals to transmit, and means responsive to said de-energization of said first line circuit and said energization of said second line circuit for placing the lock-out relay at said first station in its inactive position and for placing the lock-out relay at said second station in its active position.

15. 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 connected in series with a plurality of return lines connected in multiple and connecting said office with said stations, impulsing means at said office for energizing the circuit including said first line with a plurality of impulses, coding means at each of said field stations for establishing the return circuit for certain of said impulses by way of one or more of said plurality of return lines in distinctive combinations to transmit a code, and means at said field stations for establishing the return circuit for one of said impulses by way of portions of said plurality of return lines in distinctive combinations and responsive to such establishment to determine at which one of said stations the coding means shall be effective to transmit.

16. 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 connected in series with a plurality of return lines connected in multiple and connecting said office with said stations, impulsing means at said office for energizing the circuit including said first line with a

plurality of impulses, coding means at each of said field stations for establishing the return circuit for certain of said impulses by way of one or more of said plurality of return lines in distinctive combinations to transmit a code, and means at said field stations for establishing the return circuit for one of said impulses by way of portions of said plurality of return lines in distinctive combinations and responsive to such establishment to determine that the coding means at a first station shall be rendered ineffective to transmit and that the coding means at a second station farther from the office than said first station shall be rendered effective to transmit when both said first and said second stations attempt to transmit during the energization of said first line with said plurality of impulses.

17. In a selective type communication system; a central office; a plurality of field stations; a control line connectable in series with either or both of two return lines connecting said office with said stations; means at said office for applying a series of time spaced impulses to said control line; step-by-step means at said office and at each of said stations caused to take one step for each of said impulses; means at each of said stations effective on each step to cause the energization of one or another of said return lines in accordance with a code message to be transmitted for that step; means at said office distinctively controlled on said steps in accordance with the particular energized and de-energized combination of said return lines for those steps; and lock-out means at said stations distinctively controlled on a certain other step in accordance

with the particular energized and de-energized combination of said return lines for that step, and means responsive to said lock-out means to allow only one of said stations to transmit a code message at any one time.

18. In a remote control system; a control office; a plurality of field stations; line circuits interconnecting said office and said stations and normally connected to assume an original condition consisting of a stepping line connected in series with two return lines connected in multiple; a transmitter at each of said stations for transmitting signals over said stepping line and return lines when rendered active; a lock-out relay at each of said stations each having an active and an inactive position and rendering the associated transmitter active and inactive respectively; contact means effective when a plurality of stations have signals ready to transmit at the same time for disturbing the original condition of said line circuits by placing each of their associated lock-out relays into a lock-out circuit including in series one of said return lines from the office to the station having such lock-out relay and the other return wire from that station to the most remote station, said lock-out circuits being interlocked by said contact means in a manner so that only the lock-out relay for the station most distant from the office of this particular group of lock-out relays is included in an energizable circuit; and means for restoring said line circuits to their original condition when one of said lock-out relays has fully assumed its energized condition.

NEIL D. PRESTON.