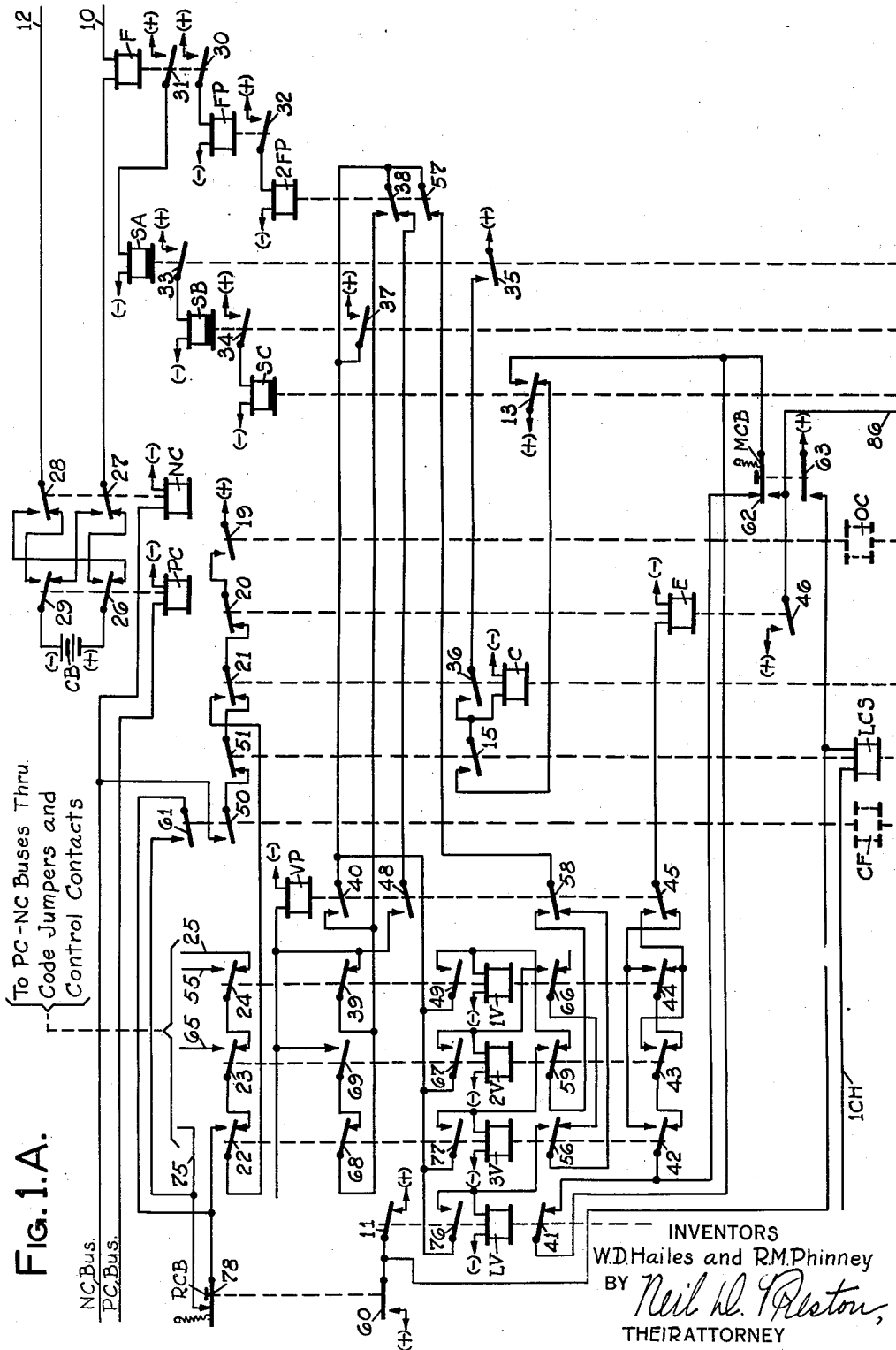


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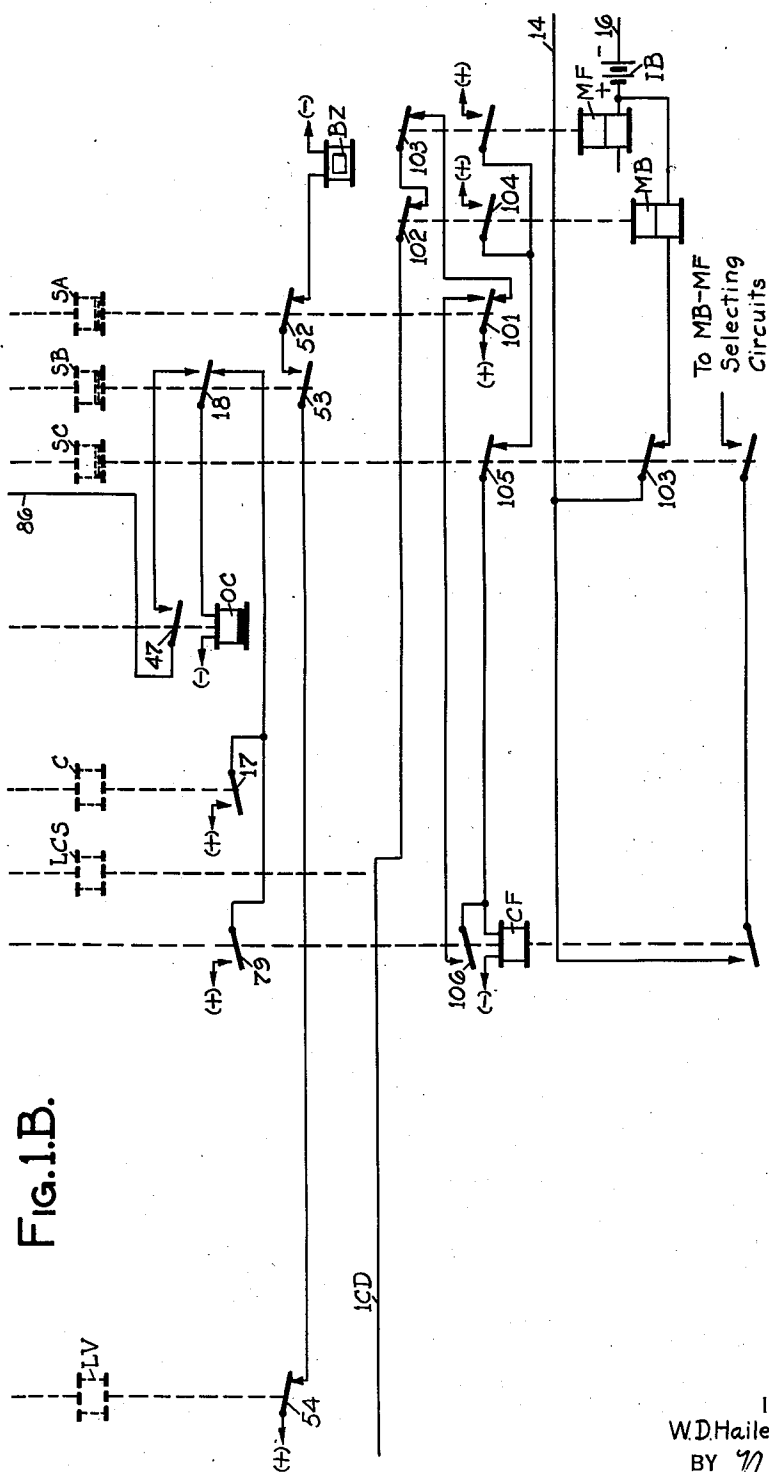
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

Filed March 14, 1935

4 Sheets-Sheet 2



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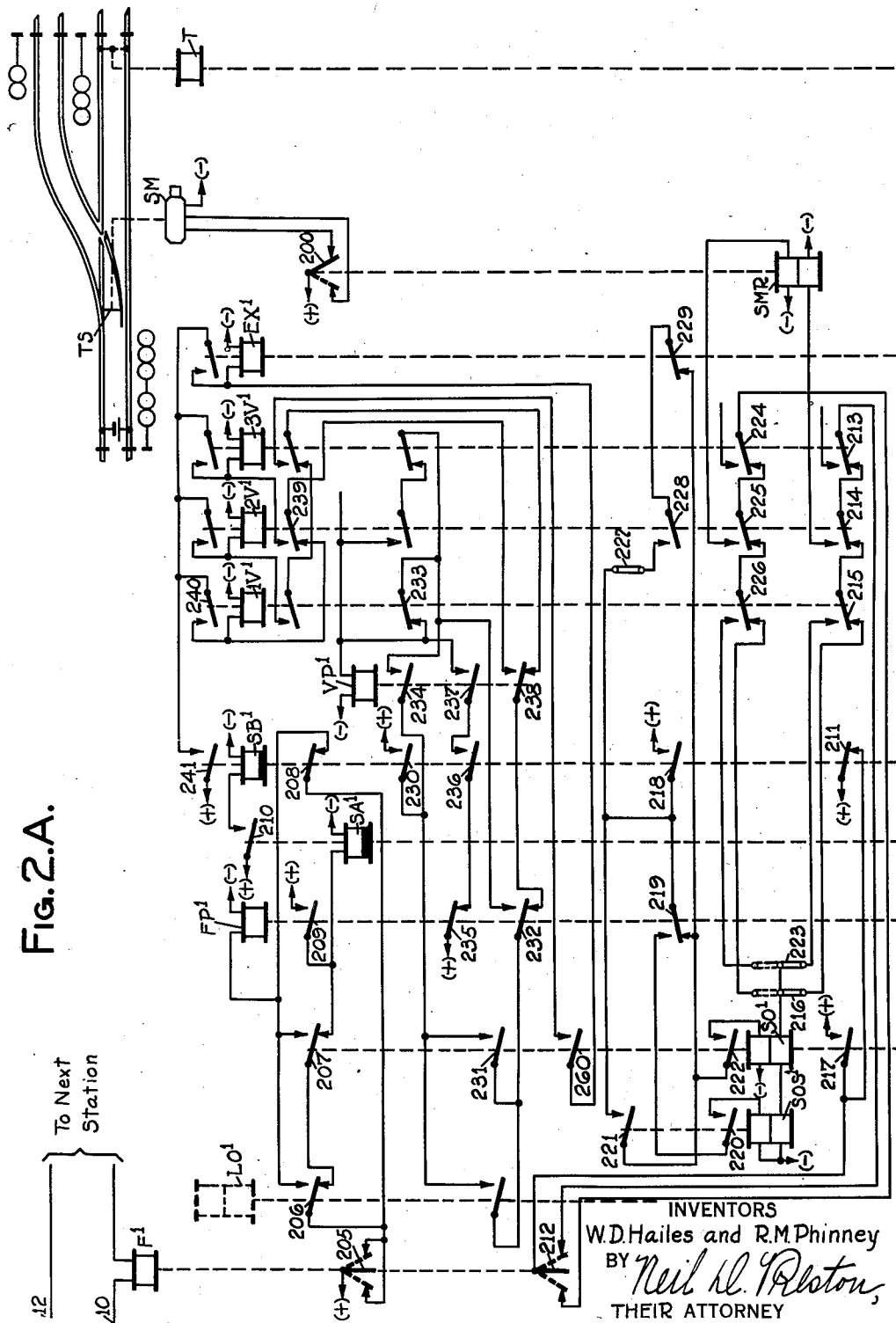
W. D. HAILES ET AL

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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

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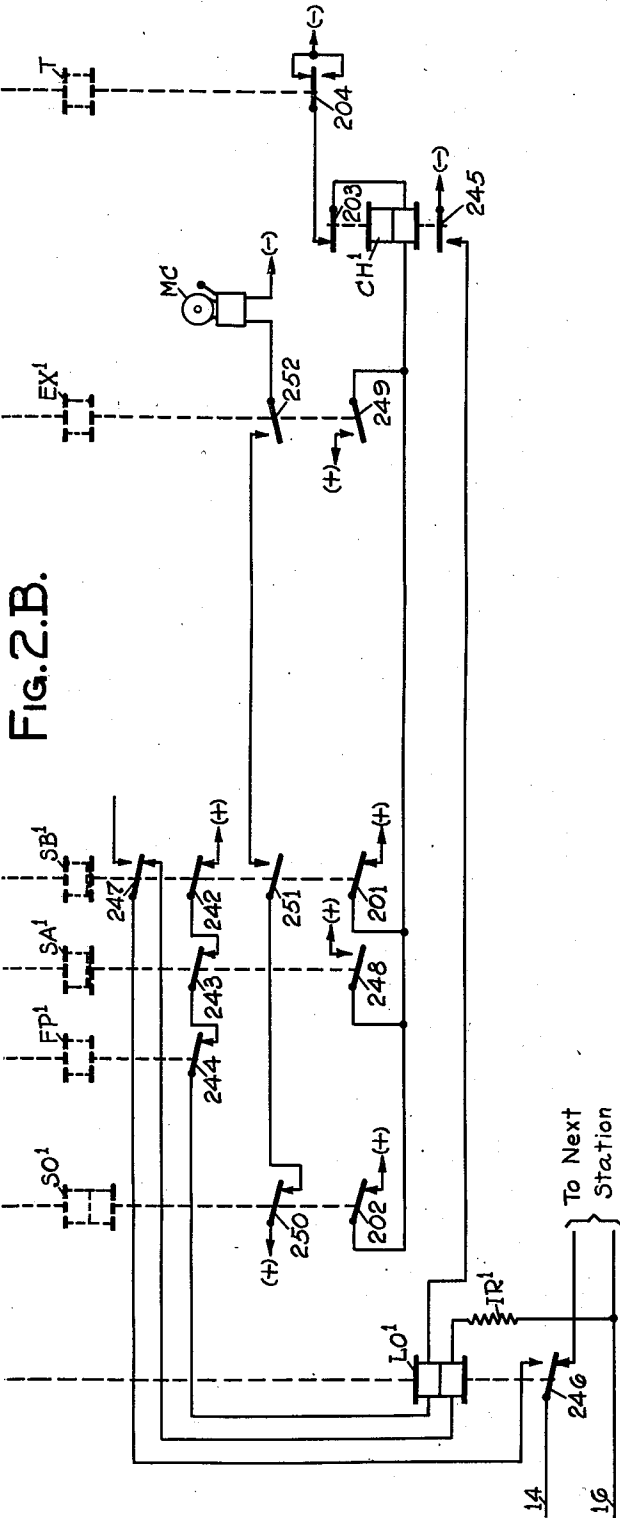
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

Filed March 14, 1935

4 Sheets-Sheet 4



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2,090,912

CENTRALIZED TRAFFIC CONTROLLING
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Application March 14, 1935, Serial No. 11,090

16 Claims. (Cl. 246—3)

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

5 The present invention contemplates a centralized traffic controlling system in which communication is established between a central control office and a number of outlying field stations distributed along the railway system. This communication is effected by means of a system of the station selective coded duplex type. In a system of this type a series of impulses forming a particular code combination are transmitted over a control line circuit interconnecting the control office with the various outlying field stations for the selection and control of a particular station.

10 Similarly a series of impulses forming a particular code combination are transmitted over an indication line circuit interconnecting the control office with the several outlying field stations for the registration of a particular station in the control office and the transmission of indications from the registered station. The control line circuit and the indication line circuit are so interrelated in the selector type apparatus employed that controls and/or indications may be transmitted during any particular cycle of operations.

15 In such a system where there are a plurality of field stations, lockout means are provided at each station so that only one station may transmit its code call and its indications during any one particular cycle of operations. Suitable means are provided to restore apparatus in the control office and at the field stations to normal conditions as soon as a cycle of operations has been completed.

20 For the transmission of controls the impulses placed upon the control line circuit are of selected polarities. The apparatus at the control office and at each field station is operated through a cycle of operations (with exceptions hereinafter described) for each series irrespective of the character of the impulses of the series, while the character of the impulses of each series determines the particular station selected for that cycle and the controls transmitted to the selected station.

25 For the transmission of indications the impulses applied to the indication line circuit set up distinctive conditions by reason of their presence or absence on the steps of each cycle, which steps are marked off by the impulses placed upon the control line circuit. Since the operation of the present embodiment with respect to the transmission of indications is immaterial for an understanding of the present invention this portion of the communication system is omitted in order that the drawings and description may be made as simple as possible. A portion of the indication line circuit is shown in the drawings in order to provide a means for indicating how the system is initiated from the field station when new indications are ready for transmission and when the system is to be initiated for the purpose of rechecking indications. The recheck feature forms an important part of the present invention, which feature will be explained in detail.

30 Another feature of the present invention relates to the provision of a special maintainer's calling signal which may be a visual signal, an audible signal or the like, so controlled that it responds to a deliberate over-step of the step-by-step mechanism at the field station, which over-step is governed from the control office by the operation of a maintainer's call button.

35 The recheck feature above mentioned is provided by means of an under-step of the step-by-step mechanism at the field station initiating an indication cycle in response to the actuation of a recheck button in the control office.

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

40 In describing the invention in detail reference will be made to the accompanying drawings in which those parts having similar features and functions are designated throughout the several views by like letter reference characters which are generally made distinctive either by reason of distinctive exponents representative of their location or by reason of preceding numerals representative of the order of their operation and in which:—

45 Figs. 1A and 1B illustrate the apparatus and circuit arrangement provided for the control office constructed and arranged in accordance with the present invention.

50 Figs. 2A and 2B illustrate the apparatus employed at a typical field station arranged in accordance with the present invention.

In tracing the detailed circuits of the present disclosure Fig. 1A should be placed above Fig. 1B, Fig. 2A should be placed above Fig. 2B and Fig. 2A should be placed to the right of Fig. 1A, with correspondingly numbered lines in alignment.

For the purpose of simplifying the illustrations and facilitating in the explanation the various parts and circuits constituting the embodiment of the invention have been shown diagrammatically and certain conventional illustrations have been employed. The drawings 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 that would be employed in practice. For example, the various relays and their contacts are illustrated in a conventional manner and symbols are used to indicate connections to the terminals of batteries or other sources of electric current instead of showing all of the wiring connections to these terminals.

The symbols (+) and (-) are employed to indicate the positive and negative terminals respectively of suitable batteries or other sources of direct current and the circuits with which these symbols are used always have current flowing from (+) to (-).

While the features of the present invention are applicable to and usable with many types of communication system for centralized traffic control, the specific embodiment of the invention illustrated has been shown in a form adapted for use with a selective communication system of the coded duplex type such as shown and described in the pending application of T. J. Judge, et al., Ser. No. 640,062, filed October 28, 1932. Before considering the structure and mode of operation of the parts constituting this invention a general explanation will be given of some of the features of a centralized traffic controlling system of this particular coded duplex type insofar as is material to an understanding of the present invention, it being understood that various other details of the structure and operation of the complete system not directly related to the features of this invention may be as shown and described in the above mentioned pending application, Ser. No. 640,062.

A centralized traffic controlling system applied to a railway system as contemplated by the present invention comprises a control office and a plurality of field stations located throughout the territory under the control of an operator in the control office. Each field station is provided with transmitting and receiving equipment which is connected by suitable line circuits to receiving and transmitting equipment located in the control office.

A portion of such control office has been illustrated in Figs. 1A and 1B as being typical of that part of the control office associated with the communication system. A control wire 10 extends from the control office to the first field station, at which point line relay F¹ is connected in series therewith. The control line wire then extends to the second field station and so on to the end of the system where it is connected to the control line return conductor 12, which conductor extends from the control office through each of the field stations.

Similarly an indication line wire 14 extends from the control office to the first field station, from the first field station to the second field station and so on to the end of the system where it is left open. Associated with the indication line wire 14 is an indication return line conductor 16 extending from the control office through the several field stations and to which the indication line is connected at that particular field station

selected for the transmission of indications during a cycle of operations.

The control line circuit includes a three position biased-to-neutral polar line relay (such as relay F¹) at each field station. This line circuit includes a quick acting neutral type relay F in the control office. Energy for the control line circuit is supplied from a control battery CB in the control office, with the particular polarity of energization of the control line selected by pole changing contacts located on positive code sending relay PC and negative code sending relay NC.

When relay PC is energized a positive impulse is applied to the control line circuit and when relay NC is energized a negative impulse is applied to the control line circuit. In the event that both relays PC and NC become energized, or when both remain de-energized the control line circuit is maintained de-energized. When energy is applied to the control line circuit by the code sending relays, such energization is broken up into time spaced impulses by the periodic operation of relay E which energizes and de-energizes the selected code sending relay PC or NC.

Control office equipment.—The control office (see Figs. 1A and 1B) includes, in addition to the above mentioned apparatus, a control machine having a group of control levers for each field station, a miniature track layout corresponding in every way to the actual track layout in the field and various indicating lamps or equivalent devices, together with apparatus and circuits arranged to accomplish the desired functioning of the system. Since an understanding of the present invention may be had without referring to these various devices they have been omitted from the present disclosure, it being understood that the code sending relays PC and NC are selected during various steps of the cycle in accordance with the positions of code jumpers and control levers in a manner which has been disclosed in the above mentioned application, Ser. No. 640,062. It will be understood that the conductors leading to the bracket associated with the upper row of contacts of the stepping relay bank selectively connect to the PC and NC buses through the code jumpers and control lever contacts as indicated by the reference to this connection in the upper portion of Fig. 1A.

Associated with each group of control levers is a change storing relay and a code determining relay (not shown but which are indicated by reference characters CH and CD respectively in the above mentioned application Ser. No. 640,062). The actuation of a starting button causes the energization of its corresponding change storing relay, which in turn energizes the corresponding code determining relay for transmitting a code for the selection of the associated field station. In the event that several starting buttons are simultaneously actuated or actuated in rapid succession the change relays and the code determining relays, together with a stick relay LCS (see Fig. 1A), are so interlocked that only one code determining relay may be picked up for any one particular cycle of operations, with the interlock so arranged that the code determining relays are picked up in a predetermined sequence dependent upon their location in the bank of relays.

Line relay F has associated therewith a neutral quick acting line repeating relay FP which repeats each energization and each de-energization of line relay F irrespective of the polarity with which relay F is energized. For purposes later to be explained relay FP is provided with a neu-

tral quick acting repeating relay 2FP. A slow acting line repeating relay SA is picked up at the beginning of each cycle and is dropped at the end of each cycle of operations. This slow acting relay has such characteristics that its pick up time is relatively slow compared to the pick-up time of neutral relay FP for example, although its pick-up time is relatively fast in comparison with its drop away time. Relay SA is thus sufficiently slow acting to maintain its contacts in their picked up positions between successive impulses applied to the control line circuit during a cycle of operations. Associated with relay SA is a neutral slow acting repeating relay SB which has associated therewith a neutral slow acting repeating relay SC, for purposes hereinafter pointed out.

Associated with the line and line repeating relays is a bank of stepping relays including half step relay VP and stepping relays 1V, 2V, 3V and LV. This bank of stepping relays marks off the steps of each cycle of operations. Impulsing relay E is jointly controlled by the stepping and half-step relays and by controlling the operation of code sending relays PC and NC governs the impulses and the time spacing of the impulses applied to the control line circuit. As above mentioned the polarity of these impulses is determined by code sending relays PC and NC.

For the purpose of illustrating the manner in which a cycle of operations is initiated from a field station the two neutral message receiving relays MB and MF disclosed in the above mentioned application Ser. No. 640,062 are shown in Fig. 1B. It will be understood that these relays are provided to repeat the condition of the indication line circuit for each step, with such conditions stored in suitable pilot relays and indication storing relays for registering the station which is transmitting indications and the indications transmitted therefrom. Since this portion of the system is immaterial for an understanding of the present invention it has been omitted from the disclosure.

For the purpose of initiating the system and determining whether such operation occurs at a field station or at the control office, relays LCS, C, CF and OC are provided. The functions of these relays will be more readily apparent from the description which follows, it being sufficient for the present to understand that relay C is always picked up for a control cycle and relay CF is always picked up for an indication cycle. Furthermore, relay LCS is picked up when a cycle is initiated from the control office by means of (—) energy which is applied to conductor 1CH, which conductor extends to the change storing and code determining bank of relays above mentioned. The removal of (+) potential from conductor 1CD at back contact 101 of relay SA opens the energizing circuits of the CD relays to prevent any one of these relays being picked up after the cycle is initiated, all of which is explained and shown in detail in the above mentioned application Ser. No. 640,062. Relay OC is picked up for both control and indication cycles and its detailed operation will be explained later in the description.

A maintainer's call button MCB is provided in the control office to enable the operator to use the communication system for actuating a maintainer's call signal at a selected station. A re-check button RCB is provided in the control office for the purpose of enabling the operator to cause any desired field station to initiate the system

into a cycle for the transmission of indications. This is accomplished by the operator selecting the desired station with button RCB actuated.

Field station equipment.—The field station illustrated in Figs. 2A and 2B is typical of all stations of the system and may be adapted for use at the first, second or any other location by merely altering the code jumper connections to arrange for its response to the proper code. For convenience in describing the present invention it is assumed that this field station is at the first location along the line extending from the control office and is so designated by reason of the distinctive exponents employed in connection with the reference characters.

A turnout track is illustrated as being connected to a main track by a track switch TS. This track switch is operated from one extreme locked position to the other by a suitable switch machine SM, which in turn is governed by a switch machine control relay SMR of the two position polar magnetic stick type. Relay SMR is governed from the control office through the medium of the communication system herein described. Relay SMR controls the operation of the switch machine to its normal locked position by energizing its normal operating wire by way of contact 200 in its right hand position. This relay controls the operation of the switch machine to its reverse locked position by energizing its reverse operating wire by way of contact 200 in its left hand dotted position. This control preferably includes suitable approach and detector locking (not shown) in order to prevent the unsafe operation of track switch TS.

Suitable signals are associated with the track switch for governing traffic thereover and they are provided with automatic block signalling means, with selections made in accordance with the position of the track switch and the condition of the detector track section and such other sections of track and traffic controlling devices as may be associated therewith, all in accordance with approved practice in connection with such control. The signal controlling circuits are not shown since they form no part of the present invention and their arrangement is immaterial for an understanding of the present invention. It will be understood that these signals are governed from the control office by means of the communication system over which suitable control relays are positioned in a similar manner as relay SMR.

A detector track section having a normally closed track circuit is provided with a track relay T and a suitable track battery for indicating the passage of trains over the section.

The communication part of the system includes the three position biased-to-neutral polar line relay F¹ above mentioned, together with its quick acting line repeating relay FP¹. Slow acting line repeating relays SA¹ and SB¹ correspond to similar relays in the control office and are used to define the bounds of a cycle of operations of a field station by being picked up at the beginning of each cycle and dropped at the end of each cycle.

The field station has a bank of stepping relays including half-step relay VP¹ and stepping relays 1V¹, 2V¹ and 3V¹. Relay EX¹ is an executing relay used for controlling certain executing circuits as will be later described in detail.

For the selection of the station for the reception of controls a station selecting relay SO¹, together with a station selecting stick relay SOS¹,

are provided to determine when the code call placed upon the control line circuit corresponds to the code call assigned to this field station.

The selection of a station for the transmission of indications is effected at the station by the continued energization of lockout relay LO¹. When the lockout relay is picked up for a cycle of operations, pulsing relays (not shown) are effective to transmit the code call of a station, followed by the transmission of the indications. Similarly, when the lockout relay is picked up the indication line circuit extending from this station to the control office is energized to initiate the system into a cycle of operations.

A change relay CH¹ is provided to register a change in any of the traffic controlling devices at the station and it functions to initiate the system for the transmission of indications by picking up the lockout relay at the associated station.

At any one or more of the stations a maintainer's call signal MC, which may be a vibrating bell or any other suitable audible or visual signal device, is provided and arranged to operate in response to an actuation of the maintainer's call button MCB in the control office for the purpose of calling a member of a train crew or a signal maintainer, or for any other purpose desired.

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

Operation

The system of the present invention is normally in a condition of rest from which it may be initiated into a cycle of operations either from the control office or from any field station whenever there are new controls or new indications respectively ready to be transmitted. If new controls for several different field stations are ready for transmission at substantially the same time these controls for the several stations are transmitted on separate cycles of operation. Similarly, if several field stations have transmissions ready at the same time these indications are transmitted from such field stations 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 the same time and in such instances controls are transmitted to a selected field station during the same cycle with the transmission of indications from the same or some other field station. This feature of the present invention is conveniently referred to as duplex transmission but it is convenient to first consider the transmission of controls, after which the initiation of an indication cycle will be explained.

Normal at rest conditions.—The line circuits of the system are arranged to be normally de-energized and similarly the remaining circuits of the systems are arranged to be normally de-energized with a few exceptions. For example, the detector track circuit associated with the track switch TS of Fig. 2A is of the closed circuit type for normally energizing track relay T. Change relay CH¹ is normally energized by means of its stick circuit extending from (+), back contacts 201 and 202 of relays SB¹ and SO¹ in multiple, lower winding and front contact 203 of relay CH¹ and front contact 204 of relay T to (—).

Manual start.—With the system in a condition of rest it may be manually initiated into a cycle of operations for the transmission of controls to any desired station. Whenever such a cycle is desired the operator first positions the control levers associated with the desired station and then actuates the corresponding starting button. This operation effects the energization of a change relay and a code determining relay. By means of code jumpers connected in a particular combination associated with the actuated code determining relay a particular code call is applied to the control line circuit. The actuated code determining relay also selects the control levers associated with that particular station for determining the code combination applied to the communication system for operating the desired control devices at the selected station.

As clearly pointed out in the above mentioned prior application Ser. No. 640,602, no code determining relay can be picked up as long as the system is in any other but its normal condition. This is accomplished by opening a control conductor such as conductor ICD, shown in the left hand portion of Fig. 1B, which conductor in this embodiment is de-energized as long as the system is in active operation at back contact 101 of relay SA. This conductor is likewise de-energized the instant the system is initiated from a field station due to relay MB opening its back contact 102. The conductor is similarly de-energized at back contact 103 of relay MF so that the energization of either one of these message receiving relays prevents the picking up of any code determining relay.

With the system in its normal condition a circuit is completed from (+), back contact 11 of relay LV, winding of relay LCS to conductor ICH. This supplies energy to the bank of code determining relays so that the relay of this bank which is selected by the actuated starting button may be energized. Since relay LCS is included in this energizing circuit it is picked up in response to the actuation of the starting button.

The energization of relay LCS closes a circuit for picking up relay C which extends from (+), back contact 13 of relay SC, front contact 15 of relay LCS and winding of relay C, to (—). A circuit is now closed for picking up relay OC which extends from (+), front contact 17 of relay C, back contact 18 of relay SB and winding of relay OC to (—).

The picking up of relay OC closes a circuit for picking up the first selected code sending relay PC or NC extending from (+), front contact 19 of relay OC, back contact 20 of relay E, front contact 21 of relay C, back contacts 22, 23 and 24 of relays 3V, 2V and 1V respectively, channel conductor 25, and through the code jumper connection (not shown) to the PC or NC relay as selected by this jumper. It will be assumed that the first code jumper associated with the station desired connects to the PC bus in which case the above described circuit is completed through the winding of relay PC to (—). This picks up relay PC for energizing the control line circuit with a (+) impulse. It will be obvious that the NC bus will be energized for picking up relay NC in the event that the code jumper is connected to this bus instead of the PC bus previously assumed.

Polarity selection of impulses.—When the system is initiated from the control office, resulting in the energization of relays C and OC and the energization of a code determining relay (such as

one of the CD relays of the above mentioned prior application Ser. No. 640,062), the impulses placed upon the line circuit during the succeeding cycle are of polarities determined in accordance with the positions of the code jumpers and the control levers rendered effective by the picking up of this particular code determining relay.

As soon as the code determining relay is picked up one or the other of the code sending relays PC and NC is energized depending upon the position of the first code jumper. For example, if the first code jumper is in a first position relay PC is energized but if it is in a second position relay NC is energized as above described.

The energization of relay PC results in the application of a (+) impulse to the control line over a circuit extending from the (+) terminal of battery CB, front contact 26 of relay PC, back contact 27 of relay NC, winding of relay F, control line conductor 10 to the first field station, through the winding of relay F¹ and thence over the control line conductor through such other field stations as are provided to the return line conductor 12 at the end field station, back contact 28 of relay NC and front contact 29 of relay PC to the (-) terminal of battery CB.

When the first impulse is placed upon the control line circuit relay F in the control office is energized and a circuit is closed for energizing relay FP at front contact 30. Relay F also closes a circuit at its front contact 31 for energizing relay SA and relay FP closes a circuit at its front contact 32 for energizing relay 2FP. Relay SA closes a circuit at its front contact 33 for energizing relay SB and relay SB closes a circuit at its front contact 34 for energizing relay SC. The picking up of relay SA completes a stick circuit for relay C extending from (+), front contact 35 of relay SA, front contact 36 and winding of relay C to (-). The picking up of relay SB opens the energizing circuit of relay OC at back contact 18, but due to its slow acting characteristics relay OC does not drop before relay E picks up to complete a stick circuit for relay OC as will be presently described.

This application of the first impulse to the control line circuit causes relay VP to be energized over a circuit extending from (+), front contact 37 of relay SB, front contact 38 of relay 2FP, back contact 39 of relay IV and winding of relay VP to (-). Relay VP closes a first stick circuit for itself extending from (+), front contact 37 of relay SB, front contact 40 of relay VP, back contact 39 of relay IV and winding of relay VP to (-). A circuit is now closed for picking up relay E which extends from (+), front contact 13 of relay SC, back contacts 41, 42, 43 and 44 of relays LV, 3V, 2V and IV respectively, front contact 45 of relay VP and winding of relay E to (-). The picking up of relay E opens back contact 20 which de-energizes the control line circuit by dropping relay PC.

As will be presently described the stepping relays are successively picked up during the following de-energized periods of the control line circuit and the VP relay is shifted during each energized period of the control line circuit. That is, relay VP, which is picked up during the first energized period, is dropped during the second energized period, picked up during the third energized period and dropped during the fourth energized period.

The stepping relays shift the energizing circuits of the PC and NC relays from one code bus or control lever contact to another by the

selection of channel circuits 55, 65 and 75 when relays IV, 2V and 3V respectively pick up. This selection is accomplished during the time that the control line circuit is de-energized because the stepping relays are picked up during the de-energized periods, so that the change in position of the PC and NC relays is immaterial in so far as the condition of the line circuit is concerned, because the line circuit is de-energized during these periods and by the time the circuits are ready to energize the line circuit during the following periods the PC and NC relays have taken their proper setting.

Impulsing the control line circuit.—The initial application of the first impulse to the control line circuit results in the successive energization of relays F, FP, 2FP, SA, SB, SC and VP as above pointed out. The energization of relay VP picks up relay E over the above described circuit, which de-energizes the particular PC or NC relay which is picked up by opening back contact 20. With both relays PC and NC de-energized the control line circuit is de-energized to mark the end of the first impulse period. This drops relays F, FP and 2FP but since relay SA is sufficiently slow acting it maintains its contacts in picked up positions until the succeeding application of energy to the control line circuit.

The picking up of relay E closes the stick circuit for relay OC which extends from (+), front contact 46 of relay E, conductor 86, front contact 47 of relay OC, front contact 18 of relay SB and winding of relay OC, to (-). This stick circuit is closed each time relay E picks up during the cycle and is opened each time relay E drops during the cycle, but relay OC remains in its picked up condition throughout the cycle due to its slow acting characteristics and the intermittent energization of this stick circuit.

The dropping of relay 2FP effects the picking up of relay IV over a circuit extending from (+), front contact 37 of relay SB, back contact 57 of relay 2FP, front contact 58 of relay VP, back contact 59 of relay 2V and winding of relay IV, to (-). The dropping of relay 2FP also closes a second stick circuit for relay VP which extends from (+), front contact 37 of relay SB, back contact 38 of relay 2FP, front contact 48 and winding of relay VP, to (-). The picking up of relay IV closes a stick circuit for itself which extends from (+), front contact 37 of relay SB, front contact 49 and winding of relay IV, to (-).

The picking up of relay IV opens the above traced energizing circuit of relay E at back contact 44 which allows relay E to drop and at its back contact 20 a circuit is completed for picking up the selected PC or NC relay (assumed to be relay PC), which circuit has been previously described and extends through front contact 24 to channel conductor 55. The picking up of relay PC energizes the control line circuit with a (+) polarity to mark the beginning of the second impulse period.

Relays F, FP and 2FP are picked up in sequence and relay VP is dropped because its second stick circuit is open at back contact 38 of relay 2FP and because its first stick circuit is open at back contact 39 of relay IV. Relay E now picks up over the previously described circuit extending from (+) at front contact 13 of relay SC, but which now includes front contact 44 of relay IV and back contact 45 of relay VP. The picking up of relay E opens the circuit of relay PC at back contact 20, allowing this relay to release and

de-energize the control line to mark the end of the second impulse period.

Relays F, FP and 2FP are dropped and relay 2V is picked up over a circuit which extends from (+), front contact 37 of relay SB, back contact 57 of relay 2FP, back contact 58 of relay VP, back contact 58 of relay 3V, front contact 66 of relay 1V and winding of relay 2V, to (-). Relay 2V completes an obvious stick circuit for itself at its front contact 67. The picking up of relay 2V effects the dropping of relay E by de-energizing its circuit at back contact 43. Relay E closes the circuit for energizing the selected code sending relay (PC or NC) at back contact 20 and the picking up of this selected code sending relay energizes the control line circuit with (+) or (-) potential as determined by the particular code sending relay which is picked up.

This marks the beginning of the third impulse period and relays F, FP and 2FP are again picked up in sequence and the above described circuit is closed for again picking up relay VP, but which now extends through back contact 68 of relay 3V, and front contact 69 of relay 2V. Relay VP again completes its first stick circuit which obviously extends to front contact 37 of relay SB by way of front contact 43 of relay VP.

Relay E is now energized over the above described circuit which now includes front contact 45 of relay VP and front contact 43 of relay 2V. The picking up of relay E de-energizes the code sending relay at back contact 20 which de-energizes the control line circuit to mark the end of the third impulse period.

Relays F, FP and 2FP are again dropped in sequence and relay 3V is picked up over the above described stepping relay pick up circuit including back contact 57 of relay 2FP, front contact 58 of relay VP, front contact 59 of relay 2V and winding of relay 3V, to (-). Relay 2FP again closes the second stick circuit for relay VP as above described and relay 3V closes an obvious stick circuit for itself at its front contact 77. Relay E is now de-energized by the opening of its circuit at back contact 42 of relay 3V. This again completes the selective pick up circuit for the PC and NC relays by way of back contact 20 of relay E and front contact 22 of relay 3V to channel conductor 75. This channel conductor is completed in this instance because contact 78 of button RCB is closed. The energization of the selected code sending relay energizes the control line circuit with the fourth impulse, which is (+) or (-) as determined by the particular code sending relay which is picked up.

Relays F, FP and 2FP are now energized and relay VP is de-energized because both of its stick circuits are de-energized as previously mentioned. Relay E is now picked up over the previously described circuit which now includes back contact 45 of relay VP and front contact 42 of relay 3V. The picking up of relay E opens the code sending relay circuit at back contact 20, allowing this relay to drop and de-energize the control line circuit to mark the end of the fourth impulse period.

Relays F, FP and 2FP are now dropped and relay LV is picked up over the previously described stepping relay circuit which now extends through back contact 58 of relay VP, front contact 56 of relay 3V and winding of relay LV, to (-). Relay LV completes an obvious stick circuit for itself at its front contact 76.

Relay LV, unlike the other stepping relays, does not effect the dropping of relay E, therefore the

control line circuit is maintained in its de-energized condition for a substantially long period of time which results in the dropping of relays SA, SB and SC. The dropping of relay SA de-energizes relay C by opening front contact 35 and the opening of front contact 37 of relay SB de-energizes the stepping relays. The opening of front contact 18 of relay SB de-energizes relay OC which is dropped after a predetermined period of time is measured off. Relay E is de-energized both by the opening of front contact 13 of relay SC and by the restoration of the contacts of the stepping relays which select this relay.

The picking up of relay LV removes (+) potential from the circuit extending to the change and code determining relay bank (conductor 1CH), which circuit includes the winding of relay LCS. Relay LCS will therefore be de-energized and the operation of the change and code determining relay bank previously mentioned will be properly effected.

Station selection for controls.—The impulsing operation of the control line circuit and the step-by-step operation of the stepping relay bank in the control office has been described and it will be understood that additional steps may be provided, the number of which is determined by the capacity of the system.

Similar step-by-step operation of the stepping banks at the field stations takes place in response to the impulsing of the control line circuit. The stepping relay banks at the field stations in the present embodiment respond only when they have the possibility of being selected for the reception of controls or when they are transmitting indications. In other words, the operation of the stepping relay bank at a particular field station is made dependent upon station selection either for the reception of controls or for the transmission of indications.

It will be apparent that the impulses are received at all stations and are then repeated by the line relay, such as relay F¹ of Fig. 2A, at each station. However, for convenience in describing the operation at the field stations reference will be more particularly made to Figs. 2A and 2B, which illustrate a typical station and which for convenience is considered the first station of the system and which is responsive only to (+) impulses applied to the control line circuit on the first two steps of the cycle.

The application of the first impulse to the control line circuit causes the line and line repeating relays to be picked up, with the line relays actuating their polar contacts to the right in response to a positive impulse and to the left in response to a negative impulse. Since it is assumed that the first impulse of the code call placed upon the control line circuit is positive, then a portion of the field stations will have their selecting relays SO¹ and SOS¹ picked up during the application of this impulse. If the first impulse of the code call placed upon the control line circuit is negative, then the remaining field stations will have their selecting relays picked up during the application of this impulse. In other words, depending upon the polarity of the first impulse transmitted only one or the other part of the field stations will have their station selecting relays energized at the beginning of a cycle.

More specifically, the first (+) impulse actuates the contacts of relay F¹ to the right which closes a circuit for picking up relay FP¹ extending from (+), contact 205 of relay F¹ in its right hand dotted position, back contact 208 of relay

SB¹, and winding of relay FP¹, to (-). Relay FP¹ closes a circuit for picking up relay SA¹ extending from (+), front contact 209 of relay FP¹, and winding of relay SA¹, to (-). During the intermittent operation of relay FP¹ in response to the succeeding impulses, relay SA¹ is maintained picked up over the circuit including front contact 209 of relay FP¹. Relay SA¹ closes an obvious circuit for energizing relay SB¹ at contact 210.

Prior to the picking up of relay SB¹ a circuit is completed for picking up relays SO¹ and SOS¹ which extends from (+), back contact 211 of relay SB¹, contact 212 of relay F¹ in its right hand dotted position, back contacts 213, 214 and 215 of relays 3V¹, 2V¹ and 1V¹ respectively, code jumper 216 and lower windings of relays SO¹ and SOS¹ in series, to (-). The picking up of relay SO¹ applies (+) potential by way of its front contact 217 to the above described circuit, so that this circuit will remain energized after the opening of back contact 211 of relay SB¹. A stick circuit is completed for relay SOS¹ which extends from (+), front contact 218 of relay SB¹, front contact 219 of relay FP¹, front contact 220 and upper winding of relay SOS¹, to (-).

It will be apparent that the F, FP, SA and SB relays at all of the field stations respond to the first impulse. The FP relays at the several field stations are all insured of being picked up by reason of a circuit including a back contact of their corresponding SB relays (similar to contact 208 of relay SB¹). However, the FP relays are maintained energized throughout the remainder of the first impulse following the picking up of the SB relays and are maintained operated throughout the remainder of the cycle only at those stations still having possibilities of selection by reason of the picked up condition of the SO relays at such stations. This is because after the SB relays open the back contact similar to contact 208 the associated FP relays cannot thereafter be energized unless an associated lockout relay has its front contact 206 closed or an associated SO relay has its front contact 207 closed. At those stations where the SO relays are picked up the FP relays follow the impulsing of the control line circuit until their associated SO relays drop out. Therefore at only one station of the system will the FP relay operate throughout the control cycle, since the SO relays which are picked up at the beginning of a cycle are selectively dropped out until only one remains.

For example, with relay SO¹ of Fig. 2A picked up because jumper 216 is in the position shown, the next impulse of the series is assured of being received at this station. Upon the following de-energized condition of the control line circuit relays F¹ and FP¹ are de-energized and the upper winding of relay SOS¹ is de-energized because of open front contact 219 of relay FP¹. Thus relay SOS¹ is maintained energized by way of its stick circuit until after the de-energization of relay FP¹. While relay SOS¹ is still picked up, relay SO¹ is maintained energized by a stick circuit which extends from (+), front contact 218 of relay SB¹, front contact 221 of relay SOS¹, front contact 222 and upper winding of relay SO¹, to (-). Then upon the dropping away of relay SOS¹ this stick circuit is opened at front contact 221, but prior to its dropping away the contacts of relay FP¹ assume de-energized positions thereby closing another stick circuit for relay SO¹ by way of back contact 219 of relay FP¹ and front contact 222 of relay SO¹.

Upon the next energization of the control line circuit a part of those SO relays which are still picked up are energized through their lower windings, depending upon the correspondence between the polarity of the impulse and the position of their respective code jumpers.

For example, assuming that relay SO¹ is still picked up by reason of a positive impulse having been applied during the first energized period, the relays SO¹ and SOS¹ will be energized in series if the second impulse is positive by means of a circuit extending from (+), front contact 217 of relay SO¹, contact 212 of relay F¹ in its right hand dotted position, back contacts 213 and 214 of relays 3V¹ and 2V¹ respectively, front contact 215 of relay 1V¹, code jumper 223 and lower windings of relays SO¹ and SOS¹, to (-).

At those stations where code jumper 223 is connected in an upper position for a negative impulse the SO relays will not be energized through their lower windings. Therefore the picking up of their corresponding FP relays, which opens the stick circuits through the upper windings of these SO relays, they will be de-energized and thereby eliminate the associated stations from the possibility of selection during the cycle in progress.

This dropping out of an SO relay in response to an impulse which does not correspond to the character assigned its code jumper for that step may be best understood by considering the dropping out of relay SO¹ of Fig. 2A when the second impulse is negative. This negative impulse applies (+) potential by way of contact 212 of relay F¹ in its left hand dotted position, back contacts 224 and 225 of relays 3V¹ and 2V¹ respectively, front contact 226 of relay 1V¹ to the terminal directly above jumper 223. Since jumper 223 is in its lower position this circuit remains incomplete at the upper position of this jumper so that relays SO¹ and SOS¹ are not energized through their lower windings. Then upon the picking up of back contact 219 of relay FP¹ the stick circuit for relay SO¹ is opened. Upon the second de-energized period of the line circuit the stick circuits for relay SO¹ cannot be closed. In other words, those SO relays which are de-energized when the impulse on the control line circuit does not correspond to the position of their code jumpers drop away when such impulse is repeated by their associated FP relays.

In the present embodiment only two impulses are used for selecting the station for controls. Therefore the single SO relay which is maintained in its picked up position during the second impulse period is continued in this position throughout the remainder of a cycle by means of a stick circuit which extends from (+), front contact 218 of relay SB¹, jumper 227, front contact 228 of relay 2V¹, back contact 229 of relay EX¹, front contact 222 and upper winding of relay SO¹, to (-). It will be understood that this jumper connection 227 may be associated with any stepping relay of a bank as determined by the number of steps required for station selection.

It will be evident that the selection of the station selecting relays, such as relay SO¹, may continue for as many steps as necessary until the stations have been selectively dropped out until only one SO relay will remain energized at the end of the station code call. It is believed that the above example is sufficient to indicate how stations are selected for controls by the various combinations of jumpers 216 and 223. This station selection operation is explained more in de-

tail in the above mentioned prior application Ser. No. 640,062.

Stepping operation at the field station.—The manner in which the FP relays pick up at the various field stations independent of the SO relays, by reason of the back contacts of their respective SB relays, has been pointed out. With reference to Fig. 2A it will be apparent that as soon as relay SB¹ has been picked up and its back contact 208 opened, relay FP¹ is dependent for its energizing circuit upon front contact 207 of relay SO¹ in order to repeat relay F¹. This of course is assuming that relay LO¹ is not picked up during the cycle in question. It will be understood that it is necessary for relay FP¹ to operate in order to cause the step-by-step operation at the associated field station.

At the beginning of a cycle of operations the response of relays FP¹ and SO¹ closes a pick up circuit for relay VP¹ which extends from (+), front contact 230 of relay SB¹, front contact 231 of relay SO¹, front contact 232 of relay FP¹, back contact 233 of relay IV¹ and winding of relay VP¹, to (—).

The response of relay VP¹ closes its first stick circuit which extends from (+), front contact 230 of relay SB¹, front contact 234 of relay VP¹, back contact 233 of relay IV¹ and winding of relay VP¹, to (—). During the following de-energized period of the line circuit the second stick circuit for relay VP¹ is completed from (+), back contact 235 of relay FP¹, front contact 236 of relay SB¹, front contact 237 and winding of relay VP¹, to (—). It will be understood that these pick up and stick circuits for relay VP¹ are effective during the steps of the cycle in a similar manner as described in detail for relay VP in the control office. Therefore the detailed description of the VP¹ relay operation at the field station will not be given.

Upon the next de-energized period of the control line circuit, relay IV¹ is energized over a circuit extending from (+), front contact 230 of relay SB¹, front contact 231 of relay SO¹, back contact 232 of relay FP¹, front contact 238 of relay VP¹, back contact 239 of relay 2V¹ and winding of relay IV¹, to (—). Relay IV¹ closes an obvious stick circuit for itself at its front contact 240 which extends to (+) at front contact 241 of relay SB¹.

It is believed unnecessary to explain the further operation of the field station stepping relay bank, since it is apparent that the operation of relay FP¹ is dependent for its repeating the operation of relay F¹ upon the closed condition of front contact 207 of relay SO¹, so that upon the dropping away of relay SO¹ during any impulse period, the circuit to relay FP¹ is immediately opened. The dropping away of relay FP¹ at the beginning of an impulse by reason of the dropping of relay SO¹ (because of the lack of correspondence between the polarity of that impulse and the position of its code jumper) does not result in the picking up of the next stepping relay since this pick up circuit is opened at front contact 231.

Since relay SO¹ can only be picked up at the beginning of a cycle it is obvious that when it is once dropped out the stepping operation is discontinued and relay FP¹ is prevented from repeating relay F¹. However those stepping relays that have been picked up prior to the dropping out of relay SO¹ are maintained energized until the end of the cycle.

Further operation of the stepping relay bank

at the field station is similar to that explained in connection with the control office stepping relay bank. It will be understood that the stepping relays at other field stations of the system are operated in a similar manner.

Transmission of controls.—Assuming that the field station illustrated in Figs. 2A and 2B is selected by having its relay SO¹ maintained energized, then upon the application of the third impulse to the control line circuit (the second stepping relay 2V¹ having been picked up on the preceding de-energized period) the two position polarized relay SMR is energized in one direction or the other depending upon the character of this third impulse.

For example, if the third impulse is positive the lower winding of relay SMR will be energized over a circuit extending from (+), front contact 217 of relay SO¹, contact 212 of relay F¹ in its right hand dotted position, back contact 213 of relay 3V¹, front contact 214 of relay 2V¹ and lower winding of relay SMR, to (—).

If the third impulse applied to the control line circuit is negative then the upper winding of relay SMR is energized over a circuit extending from (+), front contact 217 of relay SO¹, contact 212 of relay F¹ in its left hand dotted position, back contact 224 of relay 3V¹, front contact 225 of relay 2V¹, and the upper winding of relay SMR, to (—).

With the lower winding of relay SMR energized by a (+) impulse, polar contact 200 is actuated to a right hand position for closing the normal operating circuit of the switch machine. With the upper winding of relay SMR energized in response to a negative impulse, polar contact 200 is actuated to its left hand dotted position for closing the reverse operating circuit of the switch machine.

In a similar manner any number of additional control relays similar to relay SMR may be suitably positioned for governing additional traffic controlling devices by the use of additional channel circuits selected at additional steps of the stepping relay bank.

Transmission of indications.—The selection of field stations and the transmission of controls to a selected station is accomplished over the control line circuit as above described. The transmission of indications is accomplished over the indication line circuit, following the registration of a particular field station in the control office.

It is not believed necessary to describe the detailed arrangement for transmitting indications in the present embodiment, since this arrangement forms no part of the present invention and is immaterial to an understanding thereof. It will be pointed out how a change in conditions at a field station initiates the system into a cycle of operations in order that an explanation may be given of the operation of the system for accomplishing the recheck feature which forms an important part of the present invention.

A change in conditions at a field station may include a change in the condition of the detector track section, a change in the condition of the track switch, a change in the condition of the signals or any one of several other changes may occur, but as illustrative of such conditions only the change in the condition of the detector track section has been shown as being effective to initiate the system into an indication cycle.

For example, the movement of track relay contact 204 from a front point to a back point, or vice versa, momentarily opens the stick circuit of

relay CH¹ so that its contacts assume dropped away positions prior to the reclosure of its stick circuit insofar as contact 204 is concerned. This will be readily understood, since it is well known in the art that a quick acting relay such as relay CH¹ will accomplish this result when employed with relatively slow switching contacts such as contact 204 of relay T.

With the system in a normal at rest condition the de-energization of relay CH¹ closes a pick up circuit for lockout relay LO¹ which extends from (+), back contact 242 of relay SB¹, back contact 243 of relay SA¹, back contact 244 of relay FP¹, upper winding of relay LO¹ and back contact 245 of relay CH¹, to (-). As soon as the contacts of relay LO¹ have responded, a holding circuit is closed for this relay which is not shown in the present disclosure but which is clearly disclosed in the above mentioned prior application Ser. No. 640,062.

The closure of front contact 246 of relay LO¹ energizes the indication line over a circuit which extends from this particular station to the control office. This circuit which may be traced from the (+) terminal of indication battery IB, lower winding of relay MB, back contact 103 of relay SC, indication line conductor 14, front contact 246 of relay LO¹, back contact 247 of relay SB¹, lower winding of relay LO¹, resistance IR¹ and indication line return conductor 16, to the (-) terminal battery IB.

The lockout feature, which is for the purpose of allowing only one field station to actively associate itself with the communication system at any one time, is not shown in detail in the present embodiment, since this feature is immaterial to an understanding of the present invention. It may be accomplished in the manner disclosed in the above mentioned prior application Ser. No. 640,062.

The energization of the indication line circuit, including the lower winding of message receiving relay MB, results in the initiation of the system. The picking up of relay MB opens the circuit of conductor 1CD at back contact 102, which prevents the operation of any code determining relay in response to an attempt to initiate the system for the transmission of controls from the control office. Since relay SA will be picked up and its back contact 101 opened before back contact 102 is again closed, this circuit is maintained open throughout the cycle. However, it will be explained in connection with a duplex cycle how a CD relay (controlled over conductor 1CD) may be in its picked up position at the start of a cycle during which the lock-out relay at a transmitting field station may also be in its picked up position.

The picking up of relay MB closes a pick up circuit for relay CF which extends from (+), front contact 104 of relay MB, back contact 105 of relay SC and winding of relay CF, to (-). A circuit is now closed for picking up relay OC which extends from (+), front contact 79 of relay CF, back contact 18 of relay SB and winding of relay OC, to (-).

Since this is a cycle for the transmission of indications alone and since no code determining relay will be picked up to select the PC and NC buses, it is necessary that a circuit be provided for energizing one of the code sending relays throughout this cycle at the various steps. This circuit extends from (+), front contact 19 of relay OC, back contact 20 of relay E, back contact 21 of relay C, back contact 51 of relay LCS,

front contact 50 of relay CF and winding of relay NC, to (-). This circuit causes the intermittent energization of relay NC for applying a series of (-) impulses to the control line during an indication cycle.

The application of the first negative impulse to the control line circuit is repeated by the F and FP relays at the control office and at each of the field stations. The repeating of this impulse by the FP relays at each field station opens the pick up circuits of all of the lockout relays so that no other lockout relay may thereafter be picked up, but the lockout relay which is already picked up will remain energized by reason of the circuit including its lower winding, which is connected to the indication line circuit.

The application of the first negative impulse to the control line circuit continues until the system is initiated as described in connection with a control cycle. In other words, this impulse remains on the control line circuit until the F, FP, SA, SB, SC, VP and E relays are all picked up, after which the line is de-energized to mark the beginning of the first de-energized period in the manner previously described. Each impulse applied to the control line circuit is negative in character since relay CF remains energized throughout the cycle by reason of a stick circuit which is closed by the picking up of relay SA and which extends from (+), front contact 101 of relay SA, front contact 106 and winding of relay CF, to (-).

The series of negative impulses thus impressed upon the control line circuit do not result in the selection of any field station for the reception of controls because the station code call (-) (-) is assigned to the phantom station as shown and described in the above mentioned prior application Ser. No. 640,062.

The closure of front contact 247 of relay SB¹, together with the closure of front contact 246 of relay LO¹ places the control of the indication line circuit in the pulsing relays, which are connected to the front contact 247 of relay SB¹ and from this point the circuit leads through contacts of relay FP¹ for the purpose of preconditioning the front and back branches of the indication line circuit for the transmission of the station code call and the indications from this station, all of which is not shown in the present embodiment but which may be arranged as in the above mentioned prior application Ser. No. 640,062.

After the last impulse has been applied to the control line circuit the slow acting relays drop away as previously explained in connection with a control cycle. The stick circuit of relay LO¹ is then interrupted and the field station is restored to its normal condition. During the cycle of operations (after relay LO¹ is selected), change relay CH¹ is restored to its normal energized condition through suitable means not shown in the present embodiment but which are disclosed in the above mentioned application. In the control office the relays are restored to normal conditions as previously mentioned, with relay CF being de-energized by the de-energization of its stick circuit when relay SA opens its front contact 101.

Duplex operation.—It is apparent from the above description that the step-by-step operation at each field station is dependent upon the station selection for outgoing controls and upon the selection of a field station during the lockout period for incoming indications. Considering that a control cycle is in progress, the stepping

relay banks will operate at all of those stations necessary to accomplish the selection of a station. Then if some other station (at which the stepping operation is not effected by reason of its non-selection for controls by the SO relay), is transmitting indications, the stepping operation at such a station is effected by reason of the energization of the associated lockout relay. Therefore regardless of whether a cycle of operations is initiated for the transmission of controls alone, indications alone or both controls and indications, the stepping relays will operate at all of the necessary field stations.

From the above description and an examination of the circuits it will be apparent that relay LO¹ at the field station may be picked up (and stuck up throughout the following cycle) at the same time that a code determining relay in the office is picked up. In this event the closure of front contact 246 of relay LO¹ permits the conditioning of the indication line (by means of circuits selected through front contact 247 of relay SB¹) for transmitting indications. Since relay C is energized by the picking up of relay LCS, the control line is impulsed in accordance with a code selected through front contact 21 of relay C.

The above condition may be brought about for example by controls and indications awaiting transmission when a previous cycle is terminated. In this event, relay LO¹ will be picked up when relay SB¹ at the station closes its back contact 242, and stuck up over the indication line during the lock-out period when relay SC in the office closes its back contact 103. During the interval between the picking up of relay LO¹ in response to the closure of back contact 242 and the opening of back contact 102 by relay MB picking up in series with the stick circuit of relay LO¹, a code determining relay can pick up and effect the picking up of relay LCS. Then when relay SC drops to pick up relay MB by way of back contact 103, relay C is picked up by way of back contact 13. Relay FC will also pick up but the closure of front contact 21 of relay C marks the cycle as one for the transmission of controls. Relay LO¹ being up also marks the cycle as one for the transmission of indications.

The only difference between a duplex cycle and a cycle for the transmission of indications alone is that the stepping relay operation at the field station which is transmitting during a duplex cycle is accomplished by a code call which is characteristic of a particular station being called instead of by the code call of a phantom station which is employed when there is no station being called for the reception of controls during an indication cycle. This is because relay C in the control office is made superior to relay CF by reason of front contact 21 of relay C (closed at the beginning of a cycle of operations) allowing the character of the succeeding impulses on the control line circuit to be determined in accordance with the code jumper and code lever contacts rendered effective, regardless of the fact that relay CF may be picked up to close its front contact 50, since the circuit leading from front contact 50 is open at back contact 21 of relay C.

Indication recheck.—It will now be assumed that the operator in the control office desires to be informed of the conditions of the control devices at a particular field station. This result is accomplished by momentarily opening the

stick circuit of the change relay such as relay CH¹ at the station in question.

The starting button for the station to be rechecked is pressed and recheck button RCB is actuated and held actuated until buzzer BZ sounds. The operation of the starting button selects the station with which it is associated. Since button RCB is actuated a cycle of operations is effected with one less than the normal number of impulses.

Assuming for example that the station illustrated in Figs. 2A and 2B is to be selected, the starting button associated with this station will effect its selection during the first part of the control cycle previously described. With button RCB actuated contact 78 is open. The open condition of contact 78 prevents the energization of either the PC or the NC relay after the third step has been taken (picking up of relay 3V). This is because the circuit for energizing the selected code sending relay extending through front contact 22 of relay 3V is open at contact 78 of button RCB. Therefore the fourth impulse described in connection with the previous control cycle is not sent over the control line circuit. This means that relays F, F¹, FP, FP¹, 2FP and the slow acting relays at the station and control office will all be de-energized during this de-energized condition of the control line circuit without the transmission of the fourth impulse.

Since the fourth impulse is not transmitted, relay LV at the office is not picked up and relay EX¹ at the station is not picked up. Relay SO¹ at the selected station will be in its picked up condition with its back contact 202 open. Relay SA¹ will be dropped and its front contact 243 will be opened before back contact 201 of relay SB¹ is closed and since relay EX¹ is not picked up, its front contact 249 will not be closed. Therefore the stick circuit including the lower winding of relay CH¹ is momentarily interrupted when front contact 248 of relay SA¹ drops.

This de-energizes relay CH¹ which initiates a cycle for the transmission of indications from this station so that the operator is advised of the conditions of the various control devices such as track relay T and the like.

The reason that the stick circuit of relay CH¹ is not opened when button RCB is not actuated (as in the operation of the control cycle previously described), is because relay EX¹ is picked up in synchronism with relay LV in the control office following the fourth impulse. (+) is therefore applied to the stick circuit of relay CH¹ at front contact 249 and since the stick circuit for relay EX¹ is controlled by relay SB¹, contact 249 remains closed until after back contact 201 of relay SB¹ is closed. This prevents the interruption of the stick circuit of relay CH¹.

Referring to the control office, the buzzer is energized when relay SA is de-energized to close its back contact 52 before front contact 53 of relay SB is opened. The energizing circuit for buzzer BZ extends through these two contacts to (+) at back contact 54 of relay LV. Since relay LV is picked up during a control cycle when button RCB is not actuated, the energizing circuit for buzzer BZ will not be completed during such a cycle because relay LV is not de-energized to close its back contact 54 until after relay SB opens its contact 53. With button RCB actuated relay LV is not picked up, therefore the closure of back contact 52 of relay SA before front contact 53 of relay SB is opened momen-

tarly completes the energizing circuit for buzzer BZ.

Contact 60 applies (+) potential to the circuit including the winding of relay LCS for the following purpose:—The operator is instructed to actuate the recheck button and hold it actuated until the buzzer sounds. If some other field station happens to actively associate itself with the communication system for the transmission of indications at the start of this cycle (which is possible because of the duplex feature of the system), relay CF would be picked up and the closure of its front contact 61 would allow the full number of steps to be taken, since this front contact bridges contact 78 of button RCB. Therefore the buzzer would not be energized and without contact 60 on button RCB the operator would need to restore the recheck button and start all over again. With contact 60 provided, (+) potential is continuously maintained on conductor ICH (through the winding of relay LCS) which leads to the change and code determining relay bank so that a control cycle will be initiated again and again as long as the button is held until a cycle is effective with one less step than normal to accomplish the energization of buzzer BZ as described.

Front contact 61 on relay CF is for the purpose of nullifying the recheck feature if the recheck is attempted at the time indications are coming in. This is accomplished by shunting contact 78 of button RCB so that the full number of steps will be taken both in the office and at the selected station. This is to prevent the loss of an indication which might otherwise occur.

Maintainer's call.—The maintainer's call signal, such as bell MC at the station, is energized by causing the system to take one more step than normally provided. This is accomplished by the operator actuating the starting button for the station desired, actuating the maintainer's call button MCB and holding it actuated during the cycle and as long thereafter as it is desired to ring the bell. This action causes the control office stepper to apply one extra impulse to the control line circuit and maintain this impulse on the control line circuit until the maintainer's call button is released.

Assuming button MCB in the office to be actuated and the starting button associated with the station illustrated in Figs. 2A and 2B to be actuated, this station will be selected as previously described with relay SO¹ remaining picked up until the end of the cycle.

Assume that button MCB in the control office is actuated and the system in the period when the control line circuit is de-energized following the fourth impulse period: Relay LV will be picked up and stuck up as before but relay E will be de-energized under this condition upon the picking up of relay LV because of open back contact 41 of relay LV. The reason relay E was not de-energized during the previously described control cycle at this point was because back contact 41 of relay LV was shunted by normally closed contact 62 of button MCB. Under the present assumed condition however, front contact 62 is open to permit the dropping of relay E and back contact 62 is closed to maintain relay OC energized after relay E drops its front contact 46.

The dropping of relay E closes its back contact 20 to pick up the last selected code sending relay for again energizing the line circuit (for the fifth time during the cycle) and this energization of

the line circuit is maintained as long as button MCB is held actuated. Contact 63 of button MCB applies energy to the change and code determining relay bank for maintaining the selected relay energized which corresponds to the selected station.

At the selected station, relay SO¹ is de-energized because of open back contact 229 of relay EX¹, which relay was picked up by the de-energized condition of the control line circuit following the fourth impulse. It will be recalled that the circuit for maintaining relay SO¹ energized after station selection (during the energized condition of the control line circuit) extends from (+) at front contact 218 of relay SB¹, jumper 227, front contact 228 of relay 2V¹, back contact 229 of relay EX¹, front contact 222 and upper winding of relay SO¹, to (—). Since back contact 229 is open this energizing circuit for relay SO¹ is interrupted and the relay drops. Since the line is energized, relay F¹ is picked up to close a circuit through back contacts 206 and 207 of relays LO¹ and SO¹ for maintaining relay SA¹ energized. Relay FP¹ is de-energized because of open front contacts 206 and 207 and open back contact 208 of relays LO¹, SO¹ and SB¹ respectively. It will be noted that the closure of back contact 219 takes place after relay SO¹ is de-energized so that its stick circuit is not energized at this time because of open front contact 222 of relay SO¹.

Since relay SA¹ is energized, relay SB¹ remains energized by reason of closed front contact 210. The stepping relays remain energized because of the energized stick circuit extending to (+) through front contact 241 of relay SB¹. The maintainer's call signal is operated over a circuit extending from (+), back contact 250 of relay SO¹, front contact 251 of relay SB¹, front contact 252 of relay EX¹ and maintainers call signal device MC, to (—).

When button MCB is restored to normal, relay E is energized over a circuit extending from (+), front contact 13 of relay SC, front contact 62 of button MCB, front contact 42 of relay 3V, back contact 45 of relay VP and winding of relay E, to (—). The picking up of relay E opens the circuit of the code sending relay at back contact 20, which de-energizes the control line circuit for restoring the system to its normal condition as previously described.

Front contact 260 of relay SO¹ of Fig. 2A is for the purpose of preventing the maintainer's call signal at a station not selected for controls being operated when the associated station is transmitting indications. If it were not for contact 260 preventing relay EX¹ picking up and closing its front contact 252 (as will be obvious from the drawings) the maintainer's call signal circuit would be energized when not desired. By thus preventing the closure of front contact 252 by preventing the energization of relay EX¹ on an indication cycle (because relay SO¹ is not picked up on such a cycle) bell MC is not energized even though back contact 250 of relay SO¹ and front contact 251 of relay SB¹ are closed at the same time.

The operation of the maintainer's call signal at the selected station may be used for calling a maintainer, an engineer or conductor of a train to a telephone located at the station or it may be used for such other purposes in connection with a centralized traffic controlling system as may be desired.

Having thus shown and described a centralized traffic controlling system as one specific embodiment—

ment of the present invention, it is desired to be understood that this form is selected to facilitate in the disclosure of the invention rather than to limit the number of forms which it may assume and it is further to be understood that various modifications, adaptations and alterations may be applied to the specific form shown to meet the requirements of practice without in any manner departing from the spirit or scope of the present invention except as limited by the appended claims.

What we claim is:—

1. In a remote control system, a control office and a field station connected by a control line circuit, step-by-step mechanisms at said office and at said station, means in said office for impressing series of impulses on said control line circuit, means controlled by a first series of impulses for operating said mechanisms in synchronism through a cycle comprising a first number of steps, means controlled by a second series of impulses for operating said mechanisms in synchronism through a cycle comprising a second number of steps, and means controlled by the response of the mechanism at said station to said second number of steps for causing said office to impress another series of impulses on said control line circuit.

2. In a remote control system, a control office and a field station connected by a control line circuit, step-by-step mechanisms at said office and at said station, means in said office for applying series of impulses to said control line circuit, a special calling button in said office and a special calling signal at said station, means controlled by a series of impulses for operating said mechanisms in synchronism through a cycle comprising a first number of steps, means responsive to the actuation of said button for causing said series of impulses to operate said mechanisms in synchronism through a cycle comprising a second number of steps, and means responsive to the operation of said mechanism at said station through a cycle comprising said second number of steps for operating said special calling signal.

3. In a remote control system, a control office and a field station connected by a control line circuit, step-by-step mechanisms at said office and at said station, means in said office for applying series of impulses to said control line circuit, a special calling button in said office and a special calling signal at said station, means controlled by a series of impulses for operating said mechanisms in synchronism through a cycle comprising a first number of steps, means responsive to the actuation of said button for causing said series of impulses to operate said mechanisms in synchronism through a cycle comprising a second number of steps, and means responsive to the operation of said mechanism at said station through a cycle comprising said second number of steps for operating said special calling signal as long as said button is maintained actuated.

4. In a remote control system, a control office and a field station connected by a control line circuit, step-by-step mechanisms at said office and at said station having normal positions, means in said office for applying series of impulses to said control line circuit, a special calling button in said office and a special calling signal at said station, means controlled by a series of impulses for operating said mechanisms in synchronism through a cycle comprising a first number of steps, means responsive to the

actuation of said button for causing said series of impulses to operate said mechanisms in synchronism through a cycle comprising a second number of steps, means responsive to the operation of said mechanism at said station through a cycle comprising said second number of steps for operating said special calling signal as long as said button is maintained actuated, and means for preventing the return of said mechanisms to their normal positions as long as said button is maintained actuated.

5. In a remote control system; a control office and a field station connected by a stepping line circuit; means for impressing a plurality of series of control codes on said stepping line circuit, each code comprising the same number of impulses of current; step-by-step mechanisms in said office and at said station operable in synchronism through a separate cycle of operations in response to each of said series of impulses; means controlled by each control code for transmitting control messages to said station; means for impressing a checking code on said stepping line circuit comprising a number of impulses different from said control codes; a first initiating means for initiating said mechanisms into cycles of operations for the transmission of said control codes; a manually operable checking device cooperating with said first initiating means for initiating said mechanisms into a cycle of operations for the transmission of said checking code; and means responsive to said checking code for initiating said mechanisms into cycles of operations.

6. In a remote control system; a control office and a field station connected by a stepping line circuit and an indication line circuit; means for impressing a plurality of series of control codes on said stepping line circuit, each code comprising the same number of impulses of current; step-by-step mechanisms in said office and at said station operable in synchronism through a separate cycle of operations in response to each of said series of impulses; means for impressing a plurality of series of indication codes on said indication line circuit; means controlled by each control code for transmitting control messages to said station; means for impressing a checking code on said stepping line circuit comprising a number of impulses different from said control codes; a first initiating means for initiating said mechanisms into cycles of operations for the transmission of said control codes; a manually operable checking device cooperating with said first initiating means for initiating said mechanisms into a cycle of operations for the transmission of said checking code; and means responsive to said checking code for initiating said mechanisms into cycles of operations for the transmission of indication codes.

7. In a remote control system; a control office and a field station connected by a stepping line circuit and an indication line circuit; means for impressing a plurality of series of control codes on said stepping line circuit, each code comprising the same number of impulses of current; step-by-step mechanisms in said office and at said station operable in synchronism through a separate cycle of operations in response to each of said series of impulses; means for impressing a plurality of series of indication codes on said indication line circuit in synchronism with said control codes; means controlled by each control code for transmitting control messages to said station; means for impressing a checking code on

said stepping line circuit comprising a number of impulses different from said control codes; a first initiating means for initiating said mechanisms into cycles of operations for the transmission of said control codes; a manually operable checking device cooperating with said first initiating means for initiating said mechanisms into a cycle of operations for the transmission of said checking code; and means responsive to said checking code for initiating said mechanisms into cycles of operations for the transmission of indication codes.

8. In a remote control system; a plurality of locations comprising a control office and a field station connected by a control line circuit and an indication line circuit; means for impressing a plurality of series of control codes on said stepping line circuit, each code comprising the same number of impulses of current; means controlled by said control codes for transmitting messages between said locations; means for impressing a checking code on said control line circuit comprising a number of impulses different from said control codes; an initiating means for initiating said system into operation for the transmission of a control code; a manually actuated checking device having active and inactive positions; means responsive to the operation of said initiating means and the actuation of said checking device to its active position for initiating said system into operation for the transmission of said checking code; means for impressing a series of indication codes on said indication line circuit; means controlled by said indication codes for transmitting indication messages between said locations; and means responsive to said checking code for initiating said system into operation for the transmission of an indication code.

9. In a remote control system; a plurality of locations comprising a control office and a field station connected by a control line circuit and an indication line circuit; means for impressing a plurality of series of control codes on said stepping line circuit, each code comprising the same number of impulses of current; means controlled by said control codes for transmitting messages between said locations; means for impressing a checking code on said control line circuit comprising a number of impulses different from said control codes; an initiating means for initiating said system into operation for the transmission of a control code; a manually actuated checking device having active and inactive positions; means responsive to the operation of said initiating means and the actuation of said checking device to its active position for initiating said system into operation for the transmission of said checking code; means for impressing a series of indication codes on said indication line circuit; means controlled by said indication codes for transmitting indication messages between said locations; means responsive to said checking code for initiating said system into operation for the transmission of an indication code; and a signal operable to indicate when said device is to be restored to its inactive position.

10. In a remote control system; a control office and a plurality of stations connected by a control line circuit and an indication line circuit; means for impressing a plurality of series of control codes on said stepping line circuit, each code comprising the same number of impulses of current of distinctive character; means controlled

by the character of the impulses of said control codes for selecting said stations and transmitting controls thereto; means for impressing a checking code on said control line circuit comprising a number of impulses different from said control codes; an initiating means for initiating said system into operation for the transmission of a control code; a checking device having active and inactive positions; means responsive to the operation of said initiating means and the actuation of said checking device to its active position for effecting the impression of said checking code on said control line circuit; means for registering said checking code; and means responsive to the registration of said checking code for conditioning said indication line circuit for the transmission of an indication code.

11. In a remote control system; a control office and a plurality of stations connected by a control line circuit and an indication line circuit; means for impressing a plurality of series of control codes on said stepping line circuit, each code comprising the same number of impulses of current of distinctive character; means controlled by the character of the impulses of said control codes for selecting said stations and transmitting controls thereto; means for impressing a checking code on said control line circuit comprising a number of impulses different from said control codes; an initiating means for initiating said system into operation for the transmission of a control code; a checking device having active and inactive positions; means responsive to the operation of said initiating means and the actuation of said checking device to its active position for effecting the impression of said checking code on said control line circuit; means for registering said checking code; means responsive to the registration of said checking code for conditioning said indication line circuit for the transmission of an indication code; and a signal device operable to indicate when the operation of said initiating means and the actuation of said checking device have effected the registration of said checking code.

12. In combination, a plurality of locations, a railway track section at one of said locations, a control device for controlling traffic over said section, an indicating device which selectively responds to the occupied and unoccupied conditions of said track section, a line circuit connecting said locations, means for applying a plurality of series of impulses of variable number and variable polarity to said line circuit, means selectively responsive to the polarities of a first series of impulses of one number for controlling said control device, and means responsive to the number of impulses of a series of impulses of another number for effecting at the distant location an indication of the condition of said device, said last mentioned means being independent of the polarities of the impulses.

13. In a centralized traffic controlling system for railroads, an indication line circuit, a control line circuit, an impulse transmitter, control initiating means for causing said transmitter to apply a fixed number of coded control impulses to said control line circuit, a railway track section including a traffic controlling device, means controlled by said fixed number of control impulses for operating said device, a manually operable key, means governed by the conjoint control of said control initiating means and said key for causing said transmitter to apply a

number of checking impulses to said control line circuit differing in number from said fixed number, and indication transmitting means responsive to said checking impulses for applying
5 a combination of indication impulses to said indication line circuit.

14. In a centralized traffic controlling system for railroads, an indication line circuit, a control line circuit, an impulse transmitter, control initiating means for causing said transmitter to apply
10 a fixed number of coded control impulses to said control line circuit, a railway track section including a traffic controlling device, means controlled by said fixed number of control impulses
15 for operating said device to a plurality of different positions, a manually operable key, means governed by the conjoint control of said control initiating means and said key for causing said transmitter to apply a number of checking im-
20 pulses to said control line circuit differing in number from said fixed number, and indication transmitting means responsive to said checking impulses for applying a combination of indication impulses to said indication line circuit.

25 15. In a centralized traffic controlling system for railroads, an indication line circuit, a control line circuit, an impulse transmitter, control initiating means for causing said transmitter to apply a fixed number of coded control impulses
30 to said control line circuit, a railway track section including a traffic controlling device, means

controlled by said fixed number of control impulses for operating said device to a plurality of different positions, a manually operable key, means governed by the conjoint control of said control initiating means and said key for caus- 5
ing said transmitter to apply a number of checking impulses to said control line circuit differing in number from said fixed number, indication transmitting means responsive to said
10 checking impulses for applying a combination of indication impulses to said indication line circuit, and a signal operable in response to the transmission of said checking impulses over said control line circuit.

16. In a centralized traffic controlling sys- 15
tem for railroads; a control line circuit adapted to have a plurality of combinations of coded impulses applied thereto, each combination comprising the same fixed number of impulses; a railway track switch; means controlled by the 20
various code combinations of said control impulses for operating said track switch to different positions; means including a manually operable key for applying a special call combination of
25 impulses to said line circuit comprising a number of impulses differing from said fixed number; and means responsive to said special call combination of impulses for operating a special call signal as long as said key is operated.

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