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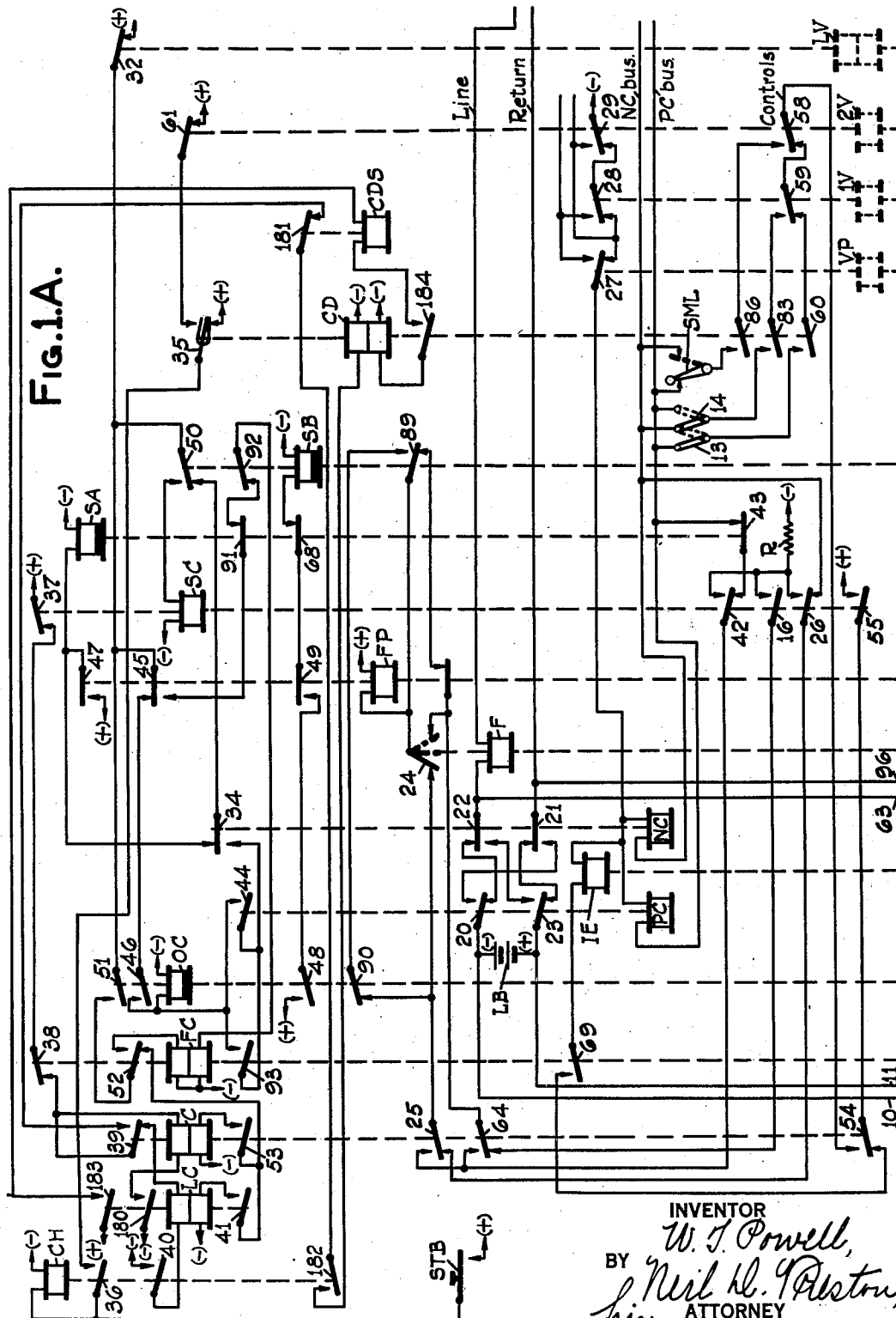
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2,169,479

CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

Filed May 28, 1937

6 Sheets-Sheet 1



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2,169,479

6 Sheets-Sheet 2

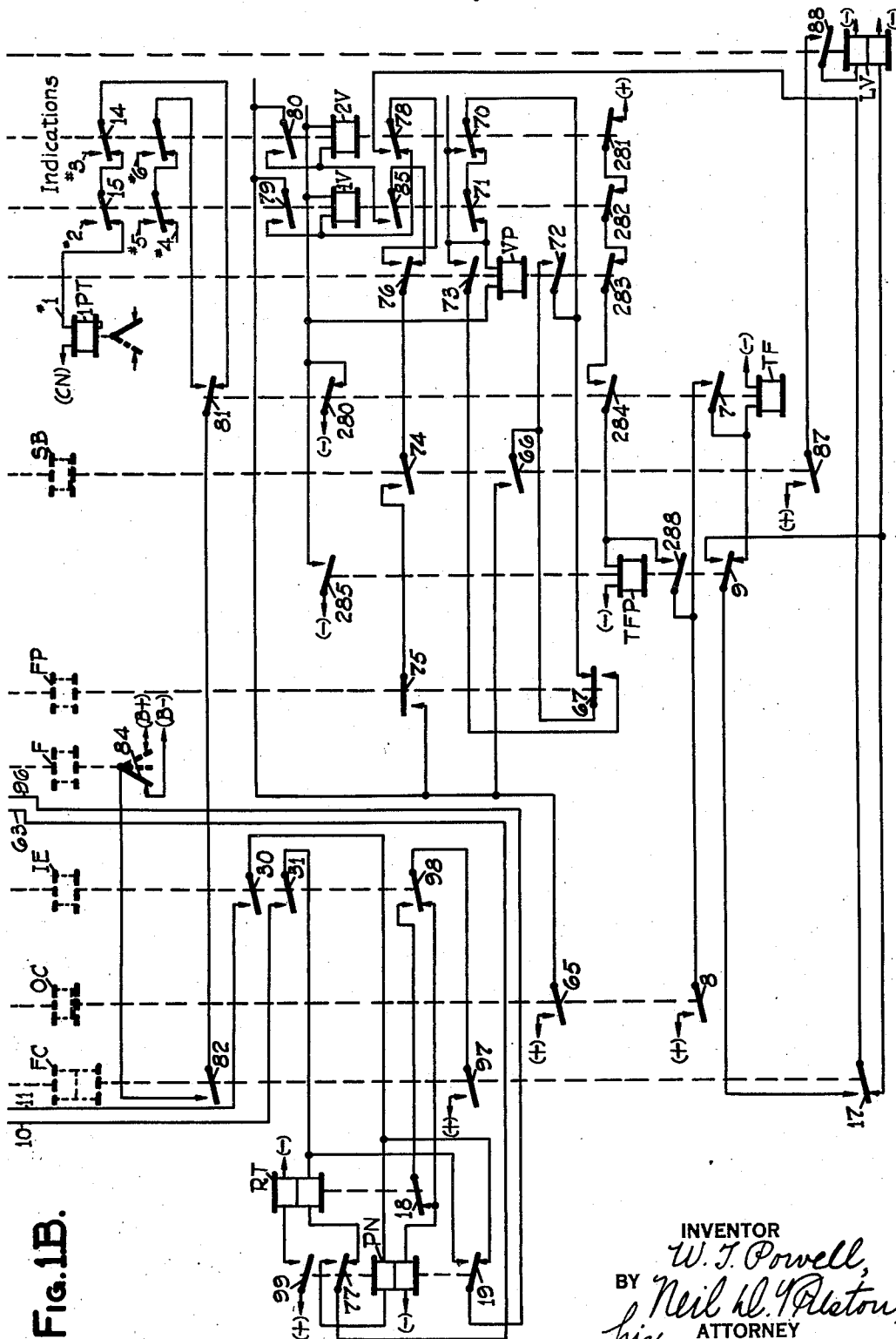


Fig. 1B.

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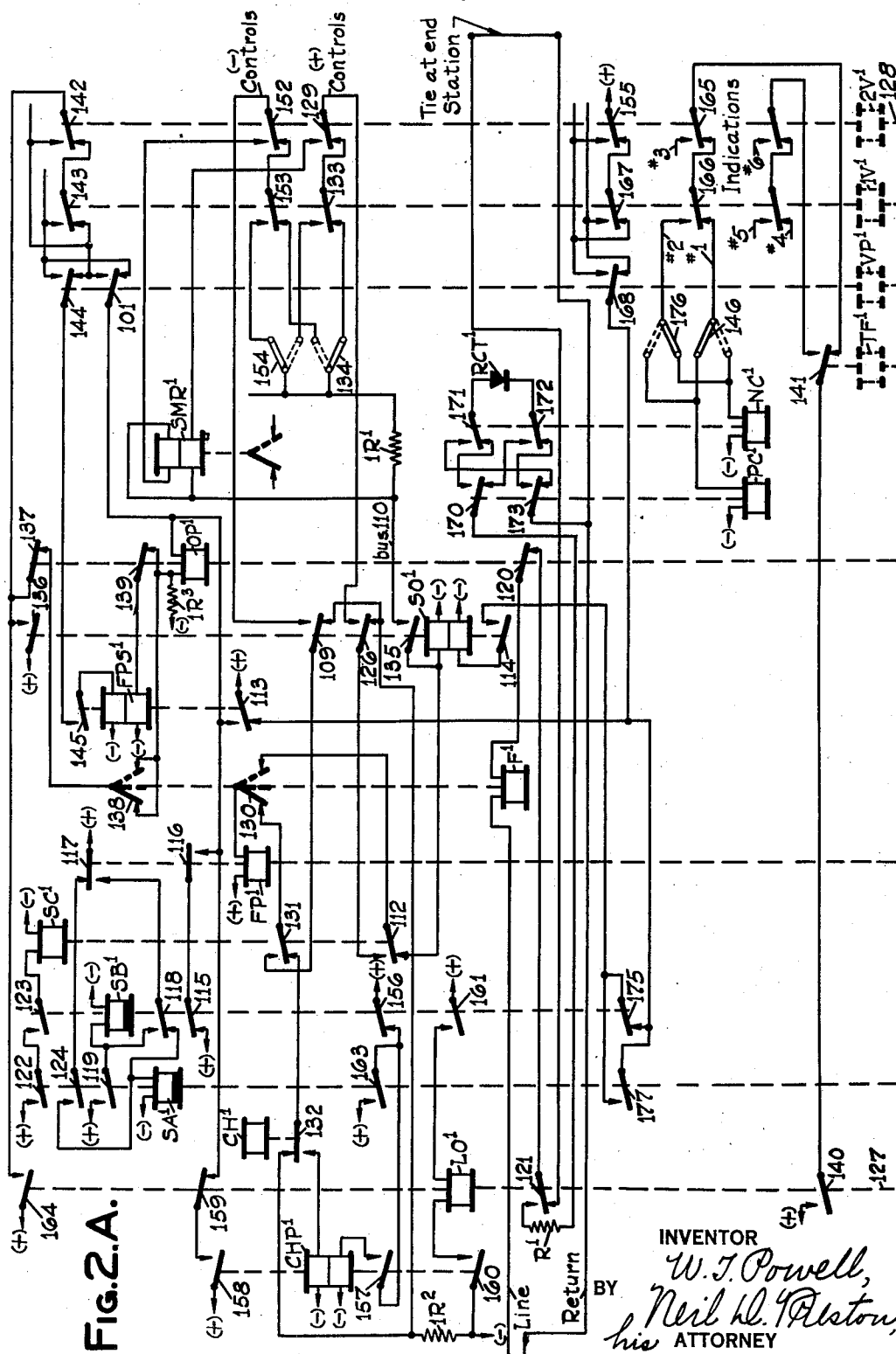
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

Filed May 28, 1937

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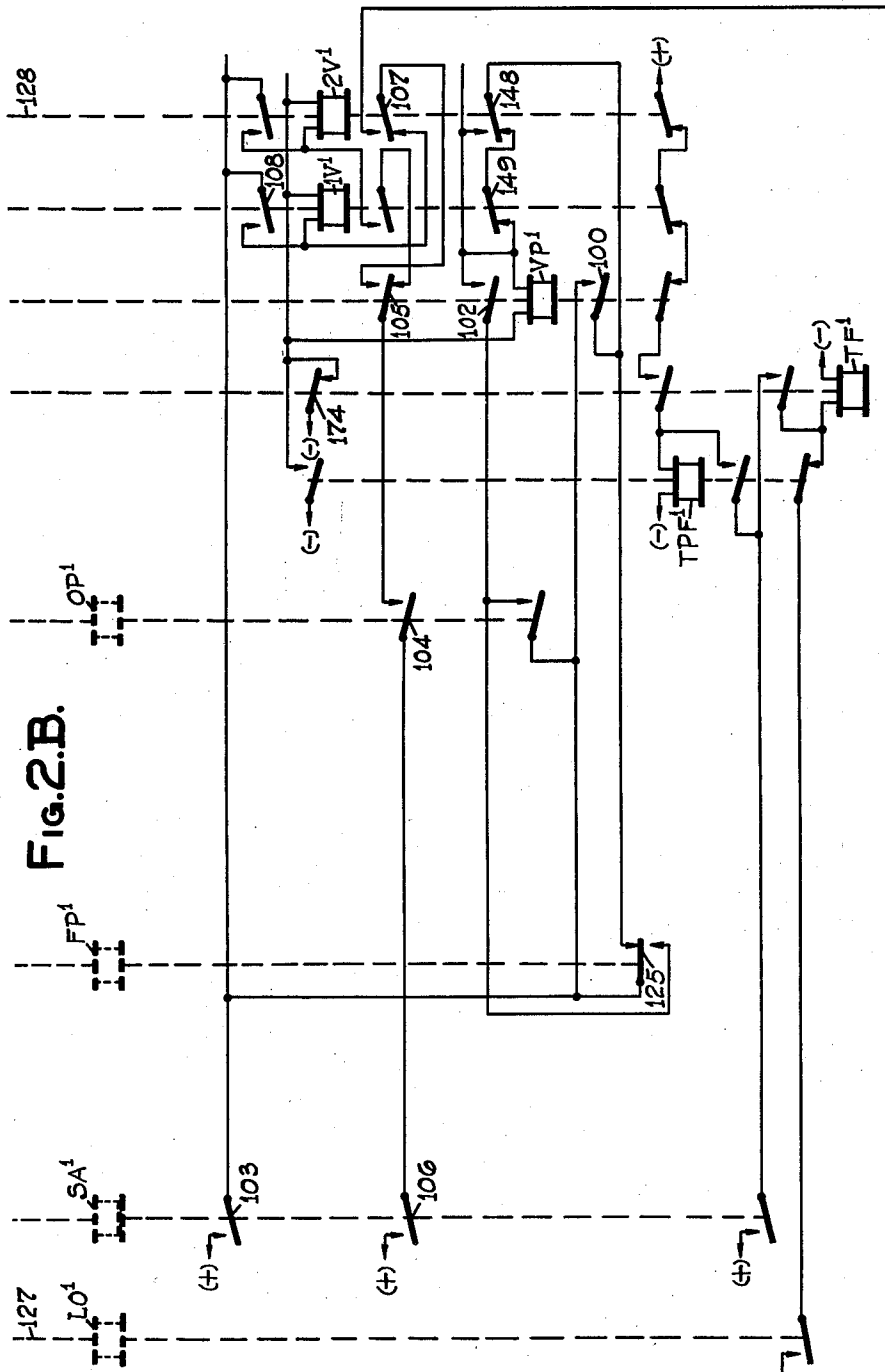
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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

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Fig. 8.

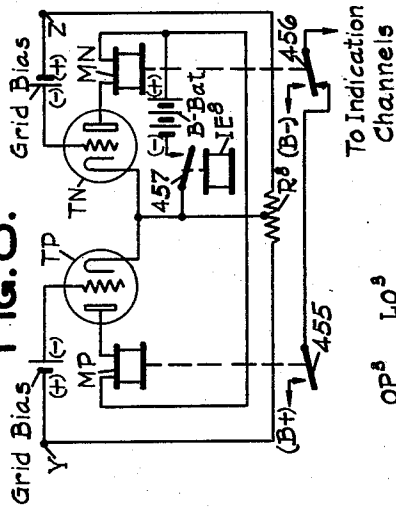
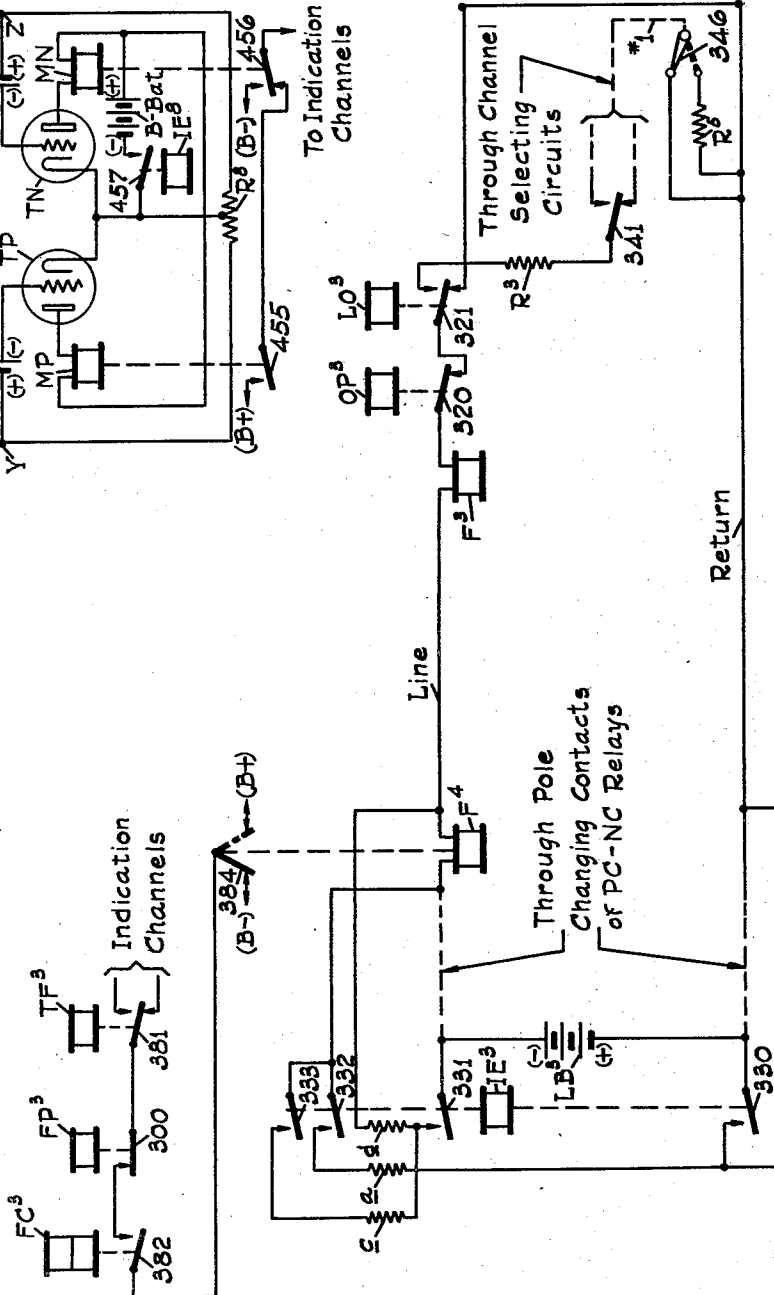


Fig. 3.



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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

Filed May 28, 1937

6 Sheets-Sheet 6

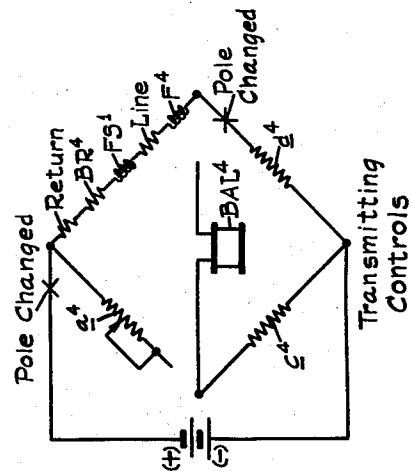
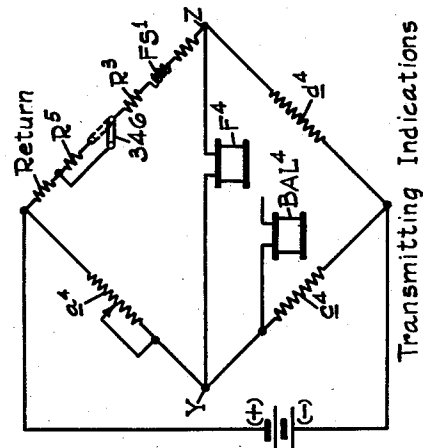
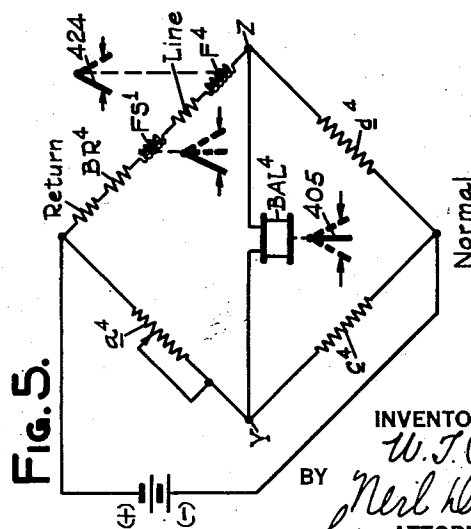
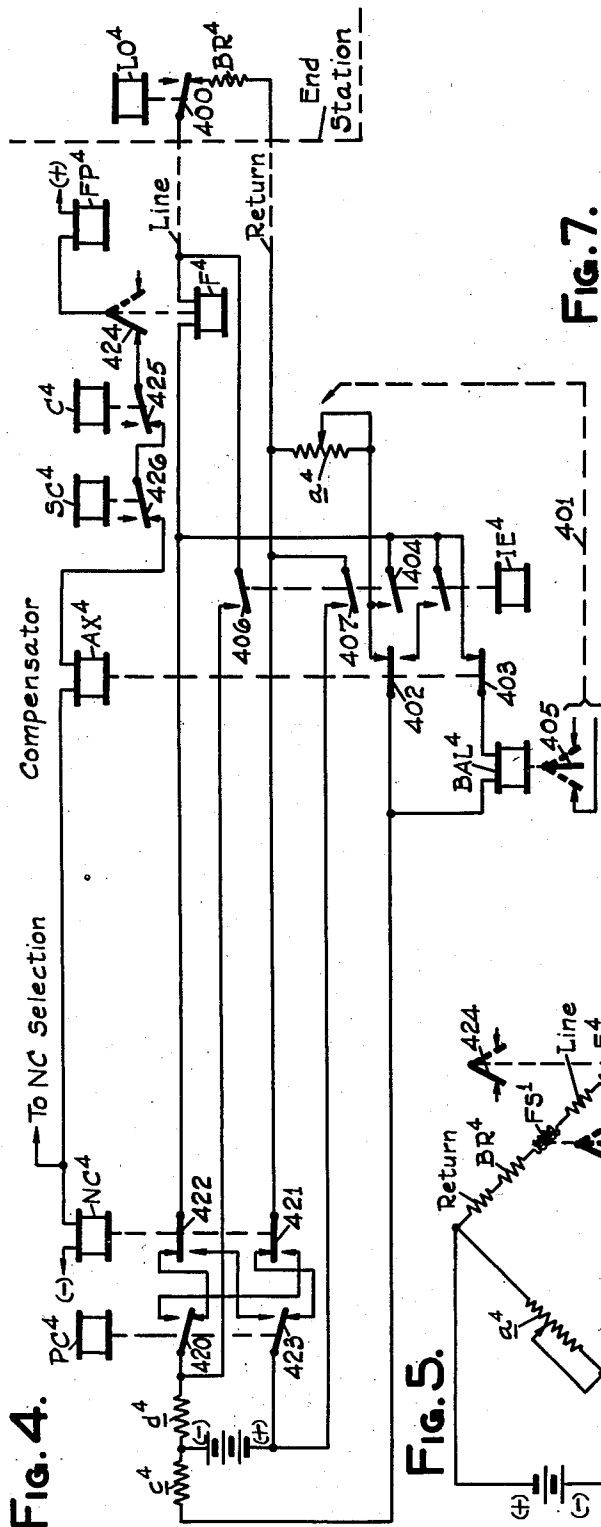


Fig. 6.

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UNITED STATES PATENT OFFICE

2,169,479

CENTRALIZED TRAFFIC CONTROLLING
SYSTEM FOR RAILROADSWinfred T. Powell, Brighton, N. Y., assignor to
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Application May 28, 1937, Serial No. 145,323

4 Claims. (Cl. 177—353)

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

5 In centralized traffic controlling systems of the type contemplated by this invention, the switches and signals are distributed at field stations throughout the territory and are governed from the control office by means of the transmission
10 of controls over a two-wire line circuit interconnecting the control office with the several field stations. Indications relating to the condition of the switches and signals, as well as track occupancy and unoccupancy conditions, are trans-
15 mitted over the same two-wire line circuit to the control office.

The two line wires connecting the control office with all of the field stations comprise a single circuit, which serves the purpose of carrying the
20 impulses used to select the required station and for transmitting controls to the selected station, as well as carrying the impulses used to identify a calling station in the office and transmitting indications therefrom.

25 The present invention is of the station selection coded simplex type, that is, the system is operated through cycles during each of which a station selection control code may be transmitted, followed by the transmission of control
30 codes to the selected station.

For the transmission of controls, a predetermined number of impulses of selected polarities are placed on the line circuit for operating the
35 step-by-step apparatus in the control office and at the field stations in synchronism through cycles of operations, irrespective of the polarity of the impulses. The distinctive polarity of the impulses of each series make up a code combination which determines the particular station to
40 be selected and the controls to be transmitted thereto.

One feature of the present invention resides in the manner in which the line circuit apparatus is checked or locked in its energized or deenergized condition, until the apparatus affected by
45 the energization and deenergization of the line responds.

Another feature of the present invention resides in the circuit arrangement provided for
50 checking the continuity of the circuits including the channel circuits which select the code jumpers and the control relays at selected stations, to maintain the station selecting relay circuit complete and to provide a circuit for energizing the

line repeater relay, as will be pointed out in detail in the following description.

Still another object of the present invention is the lockout arrangement provided at the field stations, whereby the lockout function is effective during the first deenergization of the line circuit at the beginning of a cycle initiated from the field station, that is, only a very short interval of time is required to provide the lockout function and this time is that which is also
10 provided for initiating the system, all as will be explained in detail later in the description.

A further feature of the present invention is the provision of a line repeater stick relay at each station, cooperating with the stepping re-
15 lays for checking the response of the stepping relays before the circuit condition is changed to effect the next required step.

Another feature of the present invention resides in the manner in which indications are
20 transmitted from a transmitting field station to the control office, by means of polar impulses applied to the line circuit, the polarity of which is determined at the field station from energy applied to the line circuit in the control office, as
25 will be specifically pointed out later in the description.

Still another feature of the present invention resides in the manner in which a rectifier or valve at the transmitting field station is con-
30 nected in the line circuit, to allow (+) energy which is first applied to the line in the control office, to find a path through the transmitting station or not; and if the rectifier is so connected in the line that current is not allowed to flow in
35 response to the (+) energy applied thereto, the office changes to a (-) energization.

A further feature of the present invention, shown as a modification, resides in providing an over-balance or an under-balance in a Wheat-
40 stone bridge circuit, one arm of which includes the line circuit, for operating a polar line relay in the office to one position or another for selectively receiving indications.

Another important feature of the present invention resides in a compensating arrangement
45 for maintaining the line circuit in approximate balance when the communication system is in a condition of rest, so that the proper margins may be provided for the over-balance and under-
50 balance, in accordance with the indications to be transmitted.

A further feature of the present invention resides in the provision of a pair of thyatron tubes, or tubes of the gas filled, arc discharge
55

type, for selectively detecting the over-balance and the under-balance condition of the line circuit in accordance with indications to be transmitted.

5 These characteristic features of the present invention thus briefly stated, and other features of the present embodiment will be explained more in detail in the following description of one arrangement for carrying out the invention, while various other characteristic features
10 functions and advantages of a system embodying this invention will be in part pointed out and in part apparent as the description progresses.

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

Figs. 1A and 1B (with Fig. 1A placed above
25 Fig. 1B and with correspondingly numbered lines in alignment), illustrate the apparatus and circuit arrangement of the preferred form of the present invention, employed in the control office for providing means whereby the operator may
30 select the stations and govern the switches and signals at the selected stations; and also for providing means whereby indications may be received from the various field stations throughout the territory.

35 Figs. 2A and 2B (with Fig. 2B placed below Fig. 2A and with correspondingly numbered lines in alignment), illustrate the apparatus and circuit arrangement employed at a typical field station for receiving the polar control impulses
40 applied to the line circuit, for causing the station stepping mechanism to operate in synchronism with the office stepping mechanism and for providing the control code combinations. Figs. 2A and 2B also illustrate the apparatus and circuit arrangement employed at the field station
45 for providing for the transmission of indications to the control office.

Fig. 3 illustrates a small portion of the apparatus and circuits employed in the control office
50 and at the field station for transmitting and receiving indications by means of the over-balance and under-balance Wheatstone bridge method. The circuits and apparatus illustrated in Fig. 3 represent certain modifications of similar apparatus shown in the preferred embodiment and it
55 will be later explained how the preferred arrangement is modified to provide the operation obtained in the Fig. 3 modification.

Fig. 4 illustrates the apparatus and circuits
60 applied to the line circuit of the over-balance and under-balance Wheatstone bridge arrangement, whereby a compensator maintains the resistance value of the line at an approximate fixed value, by adjusting the value of a compensating resistance in the control office, up or down, during the
65 normal condition of the communication system.

70 Figs. 5, 6 and 7 illustrate the different conditions of the line circuit, shown in schematic form for the purpose of obtaining a better picture of the circuit arrangement of Figs. 3 and 4 under various conditions.

Fig. 8 illustrates the apparatus and circuit arrangement employed for receiving indications by
75 the over-balanced and under-balanced Wheat-

stone bridge method, by the use of gas filled, arc discharge tubes.

For the purpose of simplifying the drawings and facilitating in the explanation, various parts and circuits have been diagrammatically shown 5 and certain conventional illustrations have been employed. For example, the various relays and their contacts are illustrated in a conventional manner and symbols are used to indicate the connections to the terminals of batteries or other
10 sources of current, instead of showing all of the wiring connections to these terminals. Furthermore, the circuit for operating relay CD in Fig. 1A is not shown in detail, since it is immaterial just how this relay is controlled for an under-
15 standing of the present invention.

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
20 these symbols are used always have current flowing in the same direction, that is, from (+) to (−).

The symbols (B+) and (B−) are employed to indicate the positive and negative terminals respectively of a suitable battery or other source of current, having a mid-tap (CN) and the circuits with which these symbols are used have current
25 flowing in one direction or another, in accordance with whether the connection is to be (B+) or (B−).

The detailed circuit arrangement and the operation of the present system may be more readily understood by considering the drawings, in connection with typical operations explained
35 in detail in the specification.

Control office equipment.—The control office includes a control machine having a group of control levers for each field station, only one of which (SML) is shown in Fig. 1A, since the
40 control transmitted by other levers, when provided, will be understood from the typical example to be described with respect to the operation controlled in accordance with the position of lever SML. The customary miniature track
45 layout, corresponding to the actual track layout in the field, together with the various indicating lamps, or the like, and the apparatus and circuits required to accomplish the desired functions with which this apparatus is related, all
50 have been omitted from the present drawings for the sake of simplicity.

Each group of control levers representing a field station has associated therewith a starting button STB, a change relay CH and a code
55 determining relay CD which cooperate with relays C, LC and CDS common to all the groups to initiate the system into operation. For example, code determining relay CD selects jumpers 13 and 14, as well as lever SML, and is picked
60 up when the system is at rest if its relay CH is picked up. Similarly, each of the other code determining relays (not shown) are controlled by their respective relays CH to select the code jumpers and control levers of their station, all
65 of which has been shown in detail in the prior application Ser. No. 640,062 filed October 28, 1932, now Patent No. 2,082,544 dated June 1, 1937. This prior disclosure also shows the contemplated interlock between the several code
70 determining relays which allows only one to be picked up for any particular cycle of operation. These features have been omitted for the sake of simplicity in the present disclosure.

Positive and negative code relays PC and NC 75

are for the purpose of applying positive and negative impulses to the line circuit in accordance with the control code required. Line relay F is of the biased-to-neutral polar type and, since it is connected in series with the line circuit, it responds to the impulses applied to the line circuit by positioning its polar contacts to their neutral positions when the line is deenergized, to their right-hand positions when the line is energized with a positive impulse and to their left-hand positions when the line is energized with a negative impulse.

Line repeating relay FP repeats the impulses applied to the line circuit from the control office, this relay following the operations of line relay F during each control cycle. Slow acting relays SA and SB and quick acting relay SC are for the purpose of defining the bounds of an operating cycle, that is, these relays are all picked up during the conditioning period at the beginning of a cycle, are held up during the impulsing periods of the cycle and are released during the clearing out period at the end of the cycle. Relay SA is again picked up after the clearing out period, when the system is restored to normal and remains picked up until the initiating or start interval at the beginning of the cycle, when it is released and then picked up as above described.

Associated with the line and line repeating relays is a bank of stepping relays, comprising half-step relay VP and stepping relays IV, 2V and LV. Relay OC is picked up at the beginning of each cycle and is maintained energized throughout the cycle as long as impulsing continues. In the event of a trouble condition, which causes the system to stop with the line deenergized, relay OC is released for restoring the system to normal.

Relay FC is the station start relay, this relay being picked up when the system is initiated from a field station and stuck up throughout the succeeding cycle, it then being released during the clearing out period at the end of the cycle.

Relay IE is an indication impulse relay, being operated during an indication cycle for applying energy to the line circuit from line battery LB. Resistance R is for the purpose of providing a uniform circuit path for energizing relay FP, under conditions when neither relay PC nor NC is connected in series with relay FP.

Positive negative relay PN and retest relay RT cooperate in providing the indication code, as will be explained in detail. Transfer relay TF and transfer repeater relay TFP are for the purpose of effecting a second operation of the stepping relay bank during an indication cycle only. Pilot relay IPT is for the purpose of illustrating how the two indication codes per step are distinctively registered.

Most of the relays of Figs. 3, 4, 5, 6 and 7 correspond to similarly identified relays in Figs. 1A, 1B, 2A and 2B, but having distinguishing exponents to indicate that they belong to a modification. The purpose of other relays and apparatus will be explained in detail when considering the operation of the circuits with which they are associated.

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 any location by merely connecting certain code jumpers in certain positions to arrange for the desired codes, but for convenience in the

description it is assumed that this is the first station on the line by reason of the distinctive exponents employed.

The track switch, switch machine, switch machine control relay, signals and signal control relays are not shown on the drawings, since the method of controlling the track switch and signals by polar impulses applied to the line circuit is immaterial to an understanding of the present invention and may be the same as disclosed in Patent No. 2,082,544 dated June 1, 1937.

The communication part of the system, to which the present invention is more closely related, includes a line relay F¹ of the three-position, biased-to-neutral, polar type, together with its quick acting repeating neutral relay FP¹, quick acting line repeating stick relay FPS¹ and repeating relays SA¹, SB¹ and SC¹, all for a purpose which will be pointed out in detail.

The field station includes a bank of stepping relays, comprising half-step relay VP¹ and stepping relays IV¹ and 2V¹, also transfer relay TF¹ and transfer repeating relay TFP¹, these relays being operated in synchronism with and for a purpose similar to corresponding relays in the control office.

Compensating resistance R¹ is employed for the purpose of compensating for the line beyond a sending station, when this sending station energizes the line in towards the control office for starting the system and for providing the lockout feature. Relay CH¹ is provided to register a change in any of the traffic controlling devices at the station or a change in the position of the track relay, and the like, so that the system may be initiated for the transmission of indications. The operating circuits of relay CH¹ have been omitted, it being understood that this relay releases in response to a momentary deenergization of its stick circuit, the manner in which this is accomplished being disclosed in Patent No. 1,852,402.

Lockout relay IO¹ is provided to determine when this field station is to transmit its indications. Whenever the lockout relay is picked up, the associated field station is permitted to transmit its indications. Station selecting relay SO¹ is provided for illustrating station selection for controls, this relay being picked up at the illustrated station (and at all other stations connected to the system) at the beginning of a control cycle, after which those SO relays at non-selected stations are dropped out, with only that one at the selected station remaining picked up throughout the complete control cycle.

Relay CHP¹ is a repeater of relay CH¹ and its function will be described in connection with the lockout feature. Resistance IR¹ is a resistance which compensates for the resistance of the application or control relays which may be connected to bus 110, so that the constants of the FP and SO relay circuits will not vary when the check circuits of these relays are effective, irrespective of whether the check is effected through a control relay or not, all of which will be described in detail later in the description.

Line opening relay OP¹ is for the purpose of providing the line lock and step check feature, above mentioned, the detailed manner in which this is accomplished being pointed out later in the description. Resistance IR³ cooperates in the operating circuit of relay OP¹, whereby a contact closed in the neutral position of line relay F¹ is not required, as will be apparent from the description of the operation of the line lock fea-

ture. Resistance $1R^2$ is for the purpose of providing a path for normally energizing relay FP^1 during the normal condition of the system.

- Relays PC^1 and NC^1 are for the purpose of providing the polar indication coded impulses, by connecting valve RCT^1 in the line in normal and reverse order. Switch machine relay SMR^1 is of the polar magnetic stick type and is for the purpose of illustrating how control relays at a selected station are distinctively controlled by the polar control impulses following the station selection code.

Operation

- The system of the present invention is normally at rest, from which it may be started into a cycle of operations from the control office, when new controls are to be transmitted, or from a field station when new indications are to be transmitted. In the event that new controls and new indications are ready to be transmitted at the same time, then the system functions to give the control office preference, in a manner which will be later described.

- For convenience in describing the operation of the present system, an operating cycle will be divided into a number of impulse periods separated by time spaces and these impulse periods will be referred to as "on" periods of the cycle, with the time spaces being referred to as "off" periods of the cycle.

- Normal conditions.*—The line circuit is normally energized with what may be conveniently referred to as (—) energization, over a circuit which may be traced from the (+) terminal of line battery LB in the control office, back contact 23 of relay PC , front contact 21 of relay NC , return line conductor, through the tie at the end station, back contact 121 of relay LO^1 , back contact 120 of relay OP^1 , winding of line relay F^1 , line conductor, winding of line relay F , front contact 22 of relay NC and back contact 20 of relay PC , to the (—) terminal of battery LB . It will be understood that the line circuit includes relays and contacts at other field stations in the system (when provided), similar to those traced for the field station illustrated in Fig. 2A.

- Relays FP and NC are normally energized in series over a circuit extending from (+), winding of relay FP , contact 24 of relay F in its left-hand position, back contact 25 of relay C , back contact 26 of relay SC , winding of relay NC , back contacts 27, 28 and 29 of relays VP , IV and $2V$ respectively, to (—). The above described energizing circuit for the line effects the energization of relays F , F^1 and the line relays the other stations connected to the line circuit. Since a (—) energization is normally applied to the line circuit, it will be assumed that current flow in this direction over the line is effective to operate the polar contacts of the line relays to the left.

- Relay SA in the control office is normally energized over a circuit extending from (+), back contact 32 of relay LV , back contact 50 of relay SB , front contact 34 of relay NC and winding of relay SA , to (—). All other relays in the control office are normally deenergized.

- All relays at the illustrated field station are deenergized except relays CH^1 and F^1 , energized as previously described and relay FP^1 which is normally energized over a circuit extending from (+), winding of relay FP^1 , contact 130 of relay F^1 in its left-hand position, back contact 131 of relay SC^1 , front contact 132 of relay CH^1 and resistance $1R^2$, to (—).

Manual start.—For the purpose of considering the operation of the present system, it will be assumed that the station illustrated in Figs. 2A and 2B is selected in response to the operation of starting button STB of Fig. 1A. It will furthermore be assumed that switch machine lever SML is positioned to the left for controlling the operation of the track switch (not shown) at the illustrated station to its normal position.

The actuation of button STB closes an obvious circuit for picking up relay CH . Relay CH sticks up over a circuit extending from (+), back contact 35 of relay CD , front contact 36 and winding of relay CH , to (—). Relay LC is now picked up over a circuit extending from (+), back contact 37 of relay SC , back contact 38 of relay FC , back contact 39 of relay C , upper winding of relay LC , front contact 40 of relay CH , to (—).

Relay LC closes a pick-up circuit for relay C from (+), through a circuit including back contact 37 of relay SC , back contact 38 of relay FC , upper winding of relay C , front contact 180 of relay LC , to (—).

The picking up of relay C closes a pick-up circuit for the relay CD from (+), through a circuit including back contact 37 of relay SC , back contact 38 of relay FC , front contact 39 of relay C , back contact 181 of relay CDS , front contact 182 of relay CH , upper winding of relay CD , to (—).

As soon as relay CD picks up, a stick circuit is closed from (+), through a circuit including front contact 183 of relay LC , winding of relay CDS , front contact 184 of relay CD , lower winding of relay CD , to (—). It is apparent that relay CDS is in series in this stick circuit and immediately picks up opening back contact 181 to prevent the picking up of more superior CD relays (not shown) should their relays CH (not shown) be picked up.

The picking up of relay CD shifts the stick circuit of relay CH from back contact 35, through front contact 35 of the make-before-break type, back contact 61 of relay $2V$ (or the stepping relay next to relay LV), to (—).

The picking up of relay C , effects the release of relay NC because its previously described energizing circuit is opened at back contact 25 of relay C . Relay PC is now picked up over a circuit extending from (+), winding of relay FP , contact 24 of relay F in its left-hand position, front contact 25 of relay C , back contact 42 of relay SC , front contact 43 of relay SA , winding of relay PC and over the above described circuit including the contacts of the stepping relay bank, to (—) at back contact 29 of relay $2V$.

The release of relay NC and the picking up of relay PC changes the (—) energization of the line to a (+) energization by reason of pole changer contacts 20, 21, 22 and 23. This change in energization of the line circuit switches the polar contacts of the line relays from their left to their right-hand positions.

Relay OC is now picked up over a circuit extending from (+), back contact 32 of relay LV , back contact 50 of relay SB , back contact 34 of relay NC , front contact 44 of relay PC and winding of relay OC , to (—). Relay OC closes a stick circuit for itself extending from (+), back contact 32 of relay LV , front contact 45 of relay FP , front contact 46 and winding of relay OC , to (—). This stick circuit is intermittently interrupted by the release of relay FP during the following impulses, but due to the slow acting characteristics of relay OC , it is maintained in

its picked up position as long as these impulses continue at the required rate.

Relay SA is released because of open front contact 34 of relay NC. The release of relay SA effects the release of relay PC, because its above described circuit is now open at front contact 43 of relay SA. The release of relay PC deenergizes the line circuit to mark the end of the start or initiating period and the beginning of the conditioning "off" period.

The line relays release in response to the deenergization of the line circuit and relay FP is released because contact 24 of relay F assumes its neutral position. Relay SA is now picked up over a circuit extending from (+), back contact 47 of relay FP and winding of relay SA, to (-). Relay SB is picked up over a circuit extending from (+), front contact 48 of relay OC, back contact 49 of relay FP, front contact 68 of relay SA, and winding of relay SB, to (-). Relay SC is picked up over a circuit extending from (+), back contact 32 of relay LV, front contact 50 of relay SB and winding of relay SC, to (-).

Relays C and LC remain stuck up in multiple over a circuit that was completed by the picking up or relay OC and which extends from (+), back contact 32 of relay LV, front contact 51 of relay OC, back contact 52 of relay FC, front contact 53 and lower winding of relay C, to (-); and through back contact 52 of relay FC, front contact 41 of relay LC, lower winding of relay LC, to (-).

The picking up of relay SC closes a circuit for picking up relay PC which extends from (+), front contact 55 of relay SC, front contact 54 of relay C, back contacts 58 and 59 of relays 2V and 1V respectively, front contact 60 of relay CD, code jumper 13, winding of relay PC and over the above described circuit including the contacts of the stepping relay bank to (-) at back contact 29 of relay 2V. This picking up of relay PC marks the end of the conditioning "off" period and the beginning of the first "on" period.

Impulsing and stepping operations.—When relay PC picks up to mark the beginning of the first "on" period, as previously described, a (+) energization is applied to the line circuit for actuating the polar line relays to the right. Relay FP is now picked up over a circuit extending from (+), winding of relay FP, contact 24 of relay F in its right-hand dotted position, front contact 64 of relay C, front contact 42 of relay SC and resistance R, to (-).

Relay VP is now picked up over a circuit extending from (+), front contact 65 of relay OC, front contact 66 of relay SB, front contact 67 of relay FP, back contacts 70 and 71 of relays 2V and 1V respectively, winding of relay VP and back contact 280 of relay TF, to (-). Relay VP closes a first stick circuit for itself extending from (+), front contact 65 of relay OC, front contact 66 of relay SB, front contact 72 of relay VP and back contacts 70 and 71 to the winding of relay VP.

Relay PC is now released, because of open back contact 27 of relay VP, which marks the end of the first "on" period and the beginning of the first "off" period, by deenergizing the line circuit. The line relays release in response to the line circuit deenergization and relay FP is released because of open contact 24 of relay F.

A second stick circuit is now closed for relay VP which extends from (+), front contact 55 of relay OC, front contact 66 of relay SB, back contact 67 of relay FP, front contact 73 and wind-

ing of relay VP and back contact 280 of relay TF, to (-). Relay 1V is now picked up over a circuit extending from (+), front contact 65 of relay OC, back contact 75 of relay FP, front contact 74 of relay SB, front contact 76 of relay VP, back contact 78 of relay 2V, winding of relay 1V and back contact 280 of relay TF, to (-). Relay 1V is stuck up over a circuit extending from (+), front contact 65 of relay OC, front contact 79 and winding of relay 1V and back contact 280 of relay TF, to (-). At this time it will be pointed out that the other stepping relays 2V and the like, are stuck up, when picked up, over a similar circuit including their front contacts 80, and the like.

Relay NC is not picked up over a circuit extending from (+), front contact 55 of relay SC, front contact 54 of relay C, back contact 58 of relay 2V, front contact 59 of relay 1V, front contact 83 of relay CD, code jumper 14, winding of relay NC, front contact 27 of relay VP, front contact 28 of relay 1V and back contact 29 of relay 2V, to (-).

The picking up of relay NC applies a (-) energization to the line circuit for actuating the line relays to the left. Relay FP is now picked up over a circuit extending from (+), winding of relay FP, contact 24 of relay F in its left-hand position, front contact 25 of relay C, front contact 42 of relay SC and resistance R, to (-).

Relay VP is now released because its first stick circuit is open at back contact 71 of relay 1V and its second stick circuit is open at back contact 67 of relay FP. Relay NC is now released because of open front contact 27 of relay VP.

The release of relay NC deenergizes the line to mark the end of the second "on" period and the beginning of the second "off" period, at which time the line relays are released. Relay FP is released because of open contact 24 of relay F.

Relay 2V is now picked up over a circuit extending from (+), front contact 65 of relay OC, back contact 75 of relay FP, front contact 74 of relay SB, back contact 76 of relay VP, front contact 85 of relay 1V, winding of relay 2V and back contact 280 of relay TF, to (-).

Relay PC is now picked up to apply a (+) energization to the line to mark the end of the second "off" period and the beginning of the third "on" period, resulting in the picking up of the line relays. The circuit for picking up relay PC extends from (+), front contacts 54 and 55 of relays C and SC, front contact 58 of relay 2V, front contact 86 of relay CD, lever SML in its left-hand position, winding of relay PC, back contact 27 of relay VP and front contact 29 of relay 2V, to (-).

In response to the energization of the line and the picking up of the line relay in the office, relay FP is picked up over the previously described circuit including contact 24 of relay F in its right-hand dotted position. Relay VP is now picked up over its previously described circuit, but which now extends through front contact 70 of relay 2V and front contact 67 of relay FP. The first stick circuit of relay VP is completed and relay PC is released, because of open back contact 27 of relay VP.

This deenergizes the line to mark the end of the third "on" period. The end of the third "on" period is the beginning of the "clearing out" period, at which time the line is deenergized and the line relays are released. Relay FP is released because of open contact 24 of relay F. Relay 1V is now picked up over the previously

described pick-up circuit for the other stepping relays, but which now extends through front contact 18 of relay 2V, back contact 17 of relay FC and lower winding of relay LV, to (—). A stick circuit is closed for relay LV which extends from (+), front contact 87 of relay SB, front contact 88 and upper winding of relay LV, to (—).

It is to be noted that the picking up of stepping relay 2V (or the stepping relay next to relay LV, in case there are a greater number of stepping relays) opened the stick circuit for relay CH. So that the opening of back contact 32 of relay LV deenergizes the stick circuits for relays C and LC so that these relays are released and open the stick circuit for relay CD at front contact 183. Relay SC is also released at this time because of open back contact 32. Since relay LV does not select a channel circuit for controlling the PC and NC relays, neither of these relays is picked up during the "clearing out" period to again energize the line, consequently relay FP remains down and the stick circuit for relay OC remains deenergized, at open front contact 45 of relay FP, for a sufficiently long interval of time to allow relay OC to release.

The release of relay OC and the consequent opening of its front contact 65 effects the release of all of the stepping relays, except relay LV, but including relay VP. The opening of front contact 48 of relay OC deenergizes relay SB and this relay releases after an interval of time measured by its slow acting characteristics. It will first be assumed that no office start condition is stored at this time, therefore the system goes into its normal condition with relay SA remaining picked up. This is because relay SA remains energized at back contact 47 as long as relay FP is down, then relay NC is picked up to complete the above described normal energizing circuit for relay SA at front contact 34 before SA has time to release.

Relay NC is picked up during the "clearing out" period, after the stepping relays have released and after relays SC, C and OC have released, but before relay SB releases, over a circuit extending from (+), winding of relay FP, front contact 89 of relay SB, back contact 90 of relay OC, back contact 25 of relay C, back contact 26 of relay SC, winding of relay NC, back contacts 27, 28 and 29 of relays VP, IV and 2V, to (—). This circuit also effects the picking up of relay FP.

With relay NC thus energized, a (—) energization is applied to the line circuit for actuating the polar line relays to the left, which completes the above-described normal energizing circuit for relay NC at contact 24 of relay F in its left-hand position. This (—) energization of the line restores the system to its normal condition, relay LV being released when relay SB releases, as previously mentioned, to open the stick circuit for relay LV at front contact 87.

Polarity selection of impulses.—In the above example, it has been pointed out how relays PC and NC are picked up to mark the end of an "off" period and the beginning of an "on" period and how they are released to mark the end of an "on" period and the beginning of an "off" period. Relay NC is always picked up during the "clearing out" period to provide the next (—) normal energization of the line circuit and relays PC and NC are selectively picked up to provide (—) or (+) energizations of the line in accordance with the code jumper connections and lever positions, as pointed out in the above example.

In the event that jumper 13 is in its alternate

dotted line position, then relay NC is picked up to make the first "on" a (—) energization instead of a (+) energization. The same applied to jumper 14, which is selected when relay IV picks up during the first "off" period, for selecting the PC or the NC relay, for determining the polarity of the second "on" period. This operation occurs on each step of the cycle for determining the code to be applied to the line circuit, by selecting the PC or the NC relay during "off" periods, for determining whether the line will be energized with a (+) or a (—) impulse during succeeding "on" periods.

It will be understood that this arrangement may be extended for as many steps as desired, with stepping relays being picked up during the "off" periods and the VP relay being shifted from one position to another during the "on" periods. It is therefore believed unnecessary to point out in detail how the line is energized with the (+) and (—) impulses under the various additional conditions, since the above typical example will indicate how such a selection is provided.

Line lock, step check and station selection.—As above explained, line relay F¹ at the illustrated field station responds to the "on" and "off" periods the same as line relay F in the control office. During the initiation part of the cycle, when relay F¹ is shifted from its left to its right-hand position, relay SO¹ is picked up over a circuit extending from (+), winding of relay FP¹, contact 130 of relay F¹ in its right-hand dotted position, back contact 112 of relay SC¹ and upper winding of relay SO¹, to (—). A stick circuit is now closed for relay SO¹ extending from (+), back contact 113 of relay FPS¹, back contact 175 of relay SB¹, front contact 114 and lower winding of relay SO¹, to (—).

When relay F¹ releases, at the beginning of the conditioning "off" period, relay FP¹ (normally energized as previously described), releases because of open contact 130 of relay F¹. Relay OP¹ is now picked up over a circuit extending from (+), back contact 115 of relay SB¹, back contact 116 of relay FP¹, winding of relay OP¹ and resistance 1R³, to (—). Relay SA¹ is picked up over a circuit extending from (+), back contact 117 of relay FP¹, back contact 118 of relay SB¹ and winding of relay SA¹, to (—). At front contact 177 of relay SA¹, the above described stick circuit for relay SO¹ is maintained complete by bridging back contact 175 of relay SB¹.

Relay SB¹ is now picked up over an obvious circuit closed at front contact 119 of relay SA¹ and relay SC¹ is picked up over an obvious circuit completed through front contacts 122 and 123 of relays SA¹ and SB¹. Due to the slow acting characteristics of relay SA¹, it will not be released when its circuit is opened at back contact 118, because of a stick circuit completed immediately thereafter by the picking up of relay FP¹ and the consequent closure of its front contact 117, which stick circuit includes front contact 124 of relay SA¹.

The picking up of relay OP¹, in response to the opening of the line circuit in the control office, opens up the line circuit at the field station at back contact 120. Relay OP¹ is released when relay SB¹ picks up and opens its back contact 115. The release of relay OP¹ and the consequent closure of its back contact 120 closes up the line circuit at the field station. It will thus be seen that relay OP¹ picks up and opens the line at the station in response to the opening of the line in the office and does not release to close

up the line at the station until conditioning at the station has been completed by the picking up of relay SB¹. Relay OP¹ performs this same function during each "off" period as will be described.

At the beginning of the first "on" period, the picking up of relay F¹ effects the picking up of relay FP¹ over a circuit extending from (+), winding of relay FP¹, contact 130 of relay F¹ in its right-hand dotted position, front contact 112 of relay SC¹, front contact 126 of relay SO¹, back contacts 129 and 133 of relays 2V¹ and IV¹ respectively, code jumper 134 in its full line position, resistance 1R¹, front contact 135 and upper winding of relay SO¹, to (-). This pick-up circuit for relay FP¹ includes the selecting circuit for relay SO¹, so that relay SO¹ remains energized by means of this selecting circuit, completed before relay FPS¹ picks up and opens its back contact 113 to open the stick circuit for relay SO¹, as will now be described.

Relay FPS¹ is picked up over a circuit extending from (+), front contact 136 of relay SO¹, back contact 137 of relay OP¹, contact 138 of relay F¹ in its actuated position, back contact 139 of relay OP¹ and lower winding of relay FPS¹, to (-). It will thus be seen that the picking up of relay FPS¹ in an "on" period is dependent on relay SO¹ being picked up and relay OP¹ being down. Relay FPS¹ is stuck up over a circuit extending from (+), front contact 136 of relay SO¹, back contacts 142, 143 and 144 of relays 2V¹, IV¹ and VP¹ respectively, front contact 145 and upper winding of relay FPS¹, to (-).

As previously mentioned, the picking up of relay FPS¹ and the consequent opening of its back contact 113 breaks the temporary stick circuit for relay SO¹, so that relay SO¹ is dependent for its energization on the selecting stick circuit, including code jumper 134 and contact 130 of relay F¹ in its right-hand dotted position, since relay VP¹ has not yet picked up to close its front contact 168.

Relay VP¹ is now picked up over a circuit extending from (+), front contact 103 of relay SA¹, front contact 125 of relay FP¹, back contacts 148 and 149 of relays 2V¹ and IV¹, respectively, winding of relay VP¹ and back contact 174 of relay TF¹, to (-). The first stick circuit for relay VP¹ is completed at its front contact 100, which is independent of the position of contact 125 of relay FP¹. The above described stick circuit for relay FPS¹ is now opened at back contact 144 of relay VP¹, so that the continued energization of relay FPS¹ is now dependent on the circuit through its lower winding, which includes contact 138 of relay F¹. It will thus be seen that relay FPS¹, when picked up, cannot release in response to an "off" period and the consequent release of relay F¹ unless the previous "on" step was taken, that is, relay VP¹ must have picked up and opened the stick circuit of relay FPS¹, including its upper winding.

During the first "off" period, the release of relay F¹ effects the release of relay FP¹ because of open contact 130. Relay FPS¹ is now released because of open contact 138. Relay OP¹ has (+) energy applied to its right-hand terminal as soon as relay VP¹ picks up, over a circuit extending from (+), front contact 136 of relay SO¹, back contacts 142 and 143 of relays 2V¹ and IV¹ respectively, and front contact 101 of relay VP¹. At this time, (+) energy is applied to the left-hand terminal of relay OP¹ over a circuit extending from (+), front contact 136 of relay SO¹,

back contact 137 of relay OP¹ and contact 138 of relay F¹ in its actuated position. When relay F¹ releases, at the beginning of the "off" period, the opening of contact 138 removes (+) from the left-hand terminal of relay OP¹, so that this relay is picked up over the previously described circuit extending from (+) to its right-hand terminal, through the winding of relay OP¹ and resistance 1R¹, to (-). It will thus be seen that relay OP¹ is picked up immediately after the release of relay F¹, without the use of a contact closed by the release of this relay.

When relay FPS¹ releases in the first "off" period, the above described circuit for relay SO¹ is again closed at back contact 113. The release of relay FP¹ during the first "off" period closes a second stick circuit for relay VP¹ extending from (+), front contact 103 of relay SA¹, back contact 125 of relay FP¹, front contact 102 of relay VP¹ and winding of relay VP¹ and back contact 174 of relay TF¹, to (-).

Relay IV¹ is picked up during the first "off" period over a circuit extending from (+), front contact 106 of relay SA¹, front contact 104 of relay OP¹, front contact 105 of relay VP¹, back contact 107 of relay 2V¹, winding of relay IV¹ and back contact 174 of relay TF¹, to (-). Relay IV¹ is stuck up over a circuit extending from (+), front contact 103 of relay SA¹, front contact 108 and winding of relay IV¹ and back contact 174 of relay TF¹, to (-). It will be mentioned at this time that similar stick circuits are completed at front contacts of relays 2V¹, and the like, when these relays are picked up.

Since relay FPS¹ is down and (+) is removed from the right-hand terminal of relay OP¹ at open front contact 113 and since relay IV¹ is up and (+) is removed from the right-hand terminal of relay OP¹ at back contact 143, relay OP¹ is released. It will thus be seen that relay OP¹ picks up in response to the line deenergization at the beginning of the first "off" period, to further open the line at back contact 120 and that this relay is not released to close up the line at this station until the step is taken, that is, until relay IV¹ picks up.

Since this same operation is effective during the following "off" and "on" periods, it is believed unnecessary to point out the circuits in detail, it being obvious how these circuits are controlled from the above described typical examples during the conditioning "off" period and during the first "off" period. From the above examples it will be apparent that relay VP¹ is controlled by relay FP¹ and that the F¹ relays are controlled by relay OP¹.

When relay FPS¹ picks up during the second "on" period, due to the previously described circuit being closed at contact 138 of relay F¹, the temporary stick circuit for relay SO¹ is opened at back contact 113. Relay SO¹ is now dependent for its energization on a circuit including a contact closed by relay F¹ (which was necessarily picked up before relay FPS¹ was picked up), which circuit extends from (+), winding of relay FP¹, contact 130 of relay F¹ in its left-hand position (since the second impulse was (-)), front contact 131 of relay SC¹, front contact 109 of relay SO¹, back contact 152 of relay 2V¹, front contact 153 of relay IV¹, code jumper 154 in its full line position, resistance 1R¹, front contact 135 and upper winding of relay SO¹, to (-).

It will thus be seen that the combination of (+) and (-) impulses applied to the line circuit during the station selection part of the cycle,

which in the present embodiment is assumed to be during the first and second "on" periods, as determined by the positions of jumpers 13 and 14 in the control office, effect the continued energization of relay SO¹ at the illustrated field station. The circuits for the other field stations are similar, the difference being in the positions of the station code jumpers (not shown), which serve to condition selecting circuits for the associated SO relays so that only one of these relays will remain energized after the receipt of the last station selecting code impulse.

For example, at a station having a code jumper similar to 134 connected in its dotted line position, the first (+) energization of the line would fail to complete a selecting stick circuit for the associated SO relay because the polar contact of the line relay, similar to contact 130, would be actuated to the right and the above described selecting stick circuit would be open at the code jumper connection. Similarly, if the first impulse applied to the line is (-), then relay SO¹ at the illustrated field station would be deenergized because contact 130 of relay F¹ is actuated to the left, so that the selecting stick circuit for relay SO¹ is open at jumper 134.

With relay SO¹ down, the next energization of the line is ineffective to complete a circuit for picking up relay SO¹, but FP¹ is picked up over a circuit extending from (+), winding of relay FP¹, contact 130 of relay F¹ in either actuated position, either front contact 112 or front contact 131 of relay SC¹, either back contact 126 or back contact 109 of relay SO¹ and resistance 1R², to (-).

The release of an SO relay, when a station drops out, removes (+) energy at an open front contact similar to 136 from the circuits leading to contact 138 of relay F¹ and contact 142 of relay 2V¹, so that the associated OP relay and the associated FPS relay are not controlled during the remainder of the cycle. Therefore, stepping is discontinued and the line circuit is not opened at a station, after it fails to be selected. The associated line relay continues to operate in response to the impulses applied to the line and at contacts similar to 130, the associated FP relays are controlled over circuits extending through a resistance similar to 1R². The operation of the FP relays at non-selected stations maintains the SA, SB and SC relays energized during the remainder of the cycle.

It will be seen that the windings of switch control relay SMR¹ are connected to bus 110. This is for the purpose of checking the continuity of the channel circuits selected after the station selection portion of the cycle, as well as those selected during station selection. Recalling that the third "on" period was (+), because of the position of lever SML in the office, the actuation of the contacts of relay F¹ to the right closes a circuit for energizing relays FP¹ and SMR¹ in series which extends from (+), winding of relay FP¹, contact 130 of relay F¹ in its right-hand dotted position, front contact 112 of relay SC¹, front contact 126 of relay SO¹, front contact 129 of relay 2V¹, lower winding of relay SMR¹, front contact 135 and upper winding of relay SO¹, to (-). Since current flows through the lower winding of relay SMR¹ from right to left, the polar contacts of this relay will be positioned to the left for controlling the associated switch machine (not shown) to its normal position, in accordance with the position of lever SML.

Since the energization of relays FP¹ and SO¹

during the third "on" period is dependent on a complete circuit including the third channel circuit, it will be seen that this checks the circuit conditions at the station after the station selection steps, because an open relay winding or an open channel circuit would prevent the picking up of relay FP¹ and the energization of relay SO¹ by means of its selecting stick circuit. This would result in the release of relay SO¹ as soon as relay FPS¹ picked up, during this "on" period, and opened its back contact 113.

In the event that lever SML is in its right-hand dotted position, then a (-) impulse is applied to the line during the third "on" period for positioning relay F¹ to the left. This closes a circuit through the upper winding of relay SMR¹ extending from (+), winding of relay FP¹, contact 130 of relay F¹ in its left-hand position, front contact 131 of relay SC¹, front contact 109 of relay SO¹, front contact 152 of relay 2V¹, upper winding of relay SMR¹, front contact 135 and upper winding of relay SO¹, to (-). This likewise checks the continuity of the (-) channel circuit at this step and, since the upper winding of relay SMR¹ is energized in opposite direction to that described in connection with its lower winding, it positions its polar contacts to the right for controlling the switch machine to its reverse position.

In a similar manner, any number of additional steps may be used for transmitting additional controls to the selected field station for governing signals and such other devices as may be employed. It will be noted that the (+) and (-) control channel circuits can only be energized at a station where relay SO¹ has its front contact 135 closed. This results in controls being effective only at a selected station, as determined by the associated SO relay being energized.

It is believed unnecessary to describe additional stepping operations, since the V relays pick up and stick during the "off" periods, in a manner similar to that described in connection with relay IV¹, and also similar to the V relays in the control office. Likewise, relay VP¹ is released and picked up in a manner similar to that described in connection with relay VP in the control office.

The field station is restored to normal during the "clearing out" period, by the release of relay F¹ in response to the deenergization of the line circuit, which effects the release of relays FP¹ and FPS¹ because of open contacts 130 and 138, as previously described. Relay OP¹ picks up during this "clearing out" period, the same as in other "off" periods. Relay FP¹ remains down long enough during the "clearing out" period to release relay SA¹ because of open front contact 117. Relay SB¹ is stuck up during the "clearing out" period over a circuit including back contact 117 of relay FP¹ and front contact 112 of relay SB¹, but relay SC¹ is released when relay SA¹ opens its front contact 122.

The release of relay SA¹ and the consequent opening of front contacts 103 and 106 effects the release of the stepping relays, after which relay OP¹ is released because of open front contact 113 of relay FPS¹ and because of open front contact 136 of relay SO¹.

The sticking and the release of relay SO¹ will now be explained more in detail. During an "on" period, the energization of relays SO¹ and FP¹ are both dependent on a completed channel circuit. If an open channel circuit is encountered, neither SO¹ nor FP¹ can pick up, resulting in the

dropping out of this station, as previously described.

During each "on" relay FPS¹ opens its back contact 113 to break the stick circuit for relay SO¹, but its selecting stick circuit is completed ahead of this. This completed selecting stick circuit picks up relay FP¹ and shifts relay VP¹. Therefore, the picking up of relay VP¹ in the first "on" completes a stick circuit for relay SO¹ at front contact 168, which is opened in the first "off" at back contact 167, but not until after relay FPS¹ has released to complete the stick circuit at back contact 113. This same operation applies to other steps.

During the "clearing out" period, relay SA¹ is down with its front contact 177 open, while relay SB¹ is up with its back contact 175 open, so that the stick circuit for relay SO¹ is incomplete and, since this is an "off" period, its upper winding is open at contact 130 of relay F¹ and also at front contacts 112 and 131 of relay SC¹. Relay SO¹ is thus released.

When the line is reenergized at the end of the clearing out period in the office, as previously described, effective when relay OP¹ has released and closed its back contact 120, relay F¹ positions its contacts to the left and relay FP¹ is picked up over its previously described normal energizing circuit. Relay SB¹ is released by the picking up of relay FP¹ and the consequent opening of its back contact 117.

Transmission of indications.—A change in the condition of the track section or a change in the condition of the traffic controlling devices at the field station, effect the deenergization of relay CH¹, which closes a circuit for picking up relay CHP¹ extending from (+), winding of relay FP¹, contact 130 of relay F¹ in its left-hand position, back contact 131 of relay SC¹, back contact 132 of relay CH¹, and upper winding of relay CHP¹, to (—). CHP¹ closes a stick circuit for itself extending from (+), back contact 152 of relay SB¹, front contact 157 and lower winding of relay CHP¹, to (—).

Relay OP¹ is now picked up, over a circuit extending from (+), front contact 153 of relay CHP¹, back contact 159 of relay LO¹, winding of relay OP¹ and resistance 1R³, to (—). Relay OP¹ opens the normally energized line circuit at back contact 120, to mark the end of the normal "on" period and the beginning of the starting "off" period, at which time line relay F¹ in the office and the line relays at the field stations are released.

Referring to the control office, relays NC and FP are released because of open contact 24 of relay F. The release of relay NC also opens the line in the control office at contacts 21 and 22, thus effecting the opening of the line circuit in the office in response to an open line circuit condition applied at the field station. The line circuit cannot be energized until the apparatus in the office and at the station has responded, at which time it will be closed at both locations.

Relay FC in the control office is picked up over a circuit extending from (+), back contact 32 of relay LV, back contact 45 of relay FP, front contact 94 of relay SA, back contact 92 of relay SB and lower winding of relay FC, to (—). Relay OC is picked up over a circuit extending from (+), back contacts 32, 50 and 34 of relays LV, SB and NC, front contact 33 of relay FC and winding of relay OC, to (—). Relay SB is picked up over a circuit extending from (+), front contact 48 of relay OC, back contact 49 of relay

FP, front contact 68 of relay SA and winding of relay SB, to (—). Relay SC is picked up over a circuit extending from (+), back contact 32 of relay LV, front contact 51 of relay SB and winding of relay SC, to (—).

Relay FC is stuck up, when relay OC picks up, over a circuit extending from (+), back contact 32 of relay LV, front contact 51 of relay OC, front contact 52 and upper winding of relay FC, to (—). It will be seen that the picking up of relay FC opens the pick-up circuit of relay C at back contact 38 and the stick circuit of relay C at back contact 52.

Relay PN of Fig. 1B is picked up during the start "off" period, over a circuit extending from (+), front contact 37 of relay FC, back contact 98 of relay IE and lower winding of relay PN, to (—). Relay RT is now picked up over an obvious circuit closed at front contact 99 of relay PN.

Relay IE is picked up over a circuit extending from (+), front contact 55 of relay SC, back contact 54 of relay C, front contact 69 of relay FC, winding of relay IE and back contacts 27, 28 and 29 of relays VP, IV and 2V respectively, to (—). With relays PN and IE picked up, (+) energy is applied to the line over a circuit extending from the (+) terminal of battery LB, conductor 11, front contact 30 of relay IE, upper winding of relay PN, front contact 77 of relay PN, conductor 63 and winding of relay F to the line conductor, with the circuit from the (—) terminal of battery LB extending by way of conductor 10, front contact 31 of relay IE, front contact 19 of relay PN and conductor 95 to the return line conductor.

Referring to the field station, the release of relay F¹ effects the release of relay FP¹ because of open contact 130 of relay F¹. Relay SA¹ is picked up over a circuit extending from (+), back contacts 117 and 118 of relays FP¹ and SB¹ and winding of relay SA¹, to (—). Relay SB¹ is picked up over an obvious circuit closed at front contact 119 of relay SA¹ and relay SC¹ is picked up over an obvious circuit closed at front contacts 122 and 123 of relays SA¹ and SB¹.

Relay LO¹ is picked up over a circuit extending from (+), front contact 161 of relay SB¹, winding of relay LO¹ and front contact 160 of relay CHP¹, to (—). Relay PC¹ is now picked up over a circuit extending from (+), front contact 149 of relay LO¹, back contact 141 of relay TF¹, back contact 165 of relay 2V¹, back contact 166 of relay IV¹, jumper 146 and winding of relay PC¹, to (—). Relay OP¹ is released because of open back contact 159 of relay LO¹.

With relay IE in the control office up, with relay OP¹ at the field station down and with relay PC¹ at the field station picked up, the line circuit is now given a (+) energization over the previously described circuit extending to the line and return conductors, it being recalled that (+) was applied to the line conductor and (—) to the return conductor. (+) now extends over the line conductor, through relay F¹, back contact 120 of relay OP¹, front contact 121 of relay LO¹, resistance R¹, front contact 170 of relay PC¹, back contact 171 of relay NC¹, through valve RCT¹, back contact 172 of relay NC¹ and front contact 173 of relay PC¹ to the return conductor. It will thus be seen that, because of indication jumper 146 connected in its full line position, relay PC¹ is picked up to permit the (+) energization of the line by way of valve RCT¹. This provides one choice of the two indications which may be transmitted at each step, the other choice being ex-

plained in connection with the second "on" period.

The (+) energization of the line circuit marks the end of the start "off" period and the beginning of the first "on" period, at which time the line relays in the office and at the field stations (up to and including that station which initiated the system) position their contacts to the right. Relay FP in the control office is picked up over a circuit extending from (+), winding of relay FP, contact 24 of relay F in its right-hand dotted position, back contact 64 of relay C, front contact 16 of relay SC and resistance R, to (-). Relay VP is now picked up over its previously described circuit and its previously described first stick circuit is completed. Relay IE is released because of open back contact 27 of relay VP.

Relays PC and NC in the control office are not operated during an indication cycle, because no CD relay is picked up to complete the control channel circuits and because of open front contact 54 of relay C. The release of relay IE opens the line circuit in the office at contacts 30 and 31, to mark the end of the first "on" period and the beginning of the first "off" period.

During the first "on" period, relay FP¹ is picked up over a circuit extending from (+), winding of relay FP¹, contact 130 of relay F¹ in its right-hand dotted position, front contact 112 of relay SC¹, back contact 126 of relay SO¹ and resistance IR², to (-). Relay FPS¹ is picked up over a circuit extending from (+), front contact 164 of relay LO¹, back contact 137 of relay OP¹, contact 138 of relay F¹ in its right-hand dotted position, back contact 139 of relay OP¹ and lower winding of relay FPS¹, to (-). Relay FPS¹ closes a stick circuit for itself extending from (+), front contact 164 of relay LO¹, back contacts 142, 143 and 144 of relays 2V¹, IV¹ and VP¹, front contact 145 and upper winding of relay FPS¹, to (-). Relay VP¹ is now picked up over its previously described pick-up circuit and its first stick circuit is completed, as above described.

The opening of the line by the release of relay IE in the control office, to mark the beginning of the first "off" period, effects the release of the line relays. Relay FP in the control office is released because of open contact 24 of relay F and the previously described second stick circuit for relay VP is closed. The previously described pick-up circuit for relay IV is closed, this relay is stuck up and relay IE is picked up over a circuit extending from (+), front contact 55 of relay SC, back contact 54 of relay C, front contact 69 of relay FC, winding of relay IE, front contacts 27 and 28 of relays VP and IV and back contact 29 of relay 2V, to (-).

Relay FPS¹ at the field station is released because its pick-up circuit is open at contact 138 of relay F¹ and because its stick circuit is open at back contact 144 of relay VP¹. Relay FP¹ is released, because of open contact 130 of relay F¹ and relay OP¹ is picked up, when contact 138 is opened to remove the short circuit from the terminals of the winding of relay OP¹, the circuit for picking up relay OP¹ extending from (+), front contact 164 of relay LO¹, back contacts 142 and 143 of relays 2V¹ and IV¹, front contact 101 of relay VP¹, winding of relay OP¹ and resistance IR³, to (-).

The opening of back contact 120 of relay OP¹ opens the line at the field station. It will thus be seen that the office deenergizes the line to mark the beginning of an "off" period and the station

gization, which relay further opens up the line circuit and holds it open until the step has been taken. Relay IV¹ is picked up and stuck up as previously described and relay VP¹ is stuck up over its previously described second stick circuit. Relay OP¹ is now released to close up the line at the station, because relay IV¹ picked up and opened the above described circuit at back contact 143.

The above description indicates how the transmitting field station permits the line to be energized with a (+) impulse in accordance with one indication to be transmitted. It will now be explained how the field station prevents the line being energized with a (+) impulse and causes the office to change to a (-) impulse and for permitting the (-) energization of the line for the transmission of another indication. Although this operation will only be described for one impulse period, it will be understood that the choice of two indications discussed in the typical examples can be used at additional steps of the cycle, for transmitting indications on a choice of two per step.

During the first "off" period, the picking up of relay IV¹ at the field station selects the second code jumper connection by way of front contact 166 and indication channel circuit No. 2. In accordance with the example chosen, a circuit is closed for picking up relay NC¹ extending from (+), front contact 140 of relay LO¹, back contact 141 of relay TF¹, back contact 165 of relay 2V¹, front contact 166 of relay IV¹, code jumper 176 in its full line position and winding of relay NC¹, to (-). Since relay PC¹ releases when back contact 166 of relay IV¹ is opened, pole changing contacts 170 to 173, inclusive, are in the opposite positions from those previously described, so that the circuit for energizing the line with a (+) impulse is incomplete because of valve RCT¹. This is because relay IE picks up in the first "off" period for applying (+) to the line conductor and (-) to the return conductor, as previously described. In this case, however, the circuit through relay F¹, back contact 120 of relay OP¹, front contact 121 of relay LO¹, resistance R¹, back contact 170 of relay PC¹ and front contact 172 of relay NC¹, connects to the terminal of valve RCT¹, which will not permit current to flow through this valve. The station therefore prevents the (+) energization of the line.

Since the energization of the line, as previously described, extended through the upper winding of relay PN and its front contact 77, it will be seen that the non-energization of the line effects the release of relay PN because its upper winding fails to be energized and because its lower winding is deenergized at back contacts 92 of relay IE and at back contact 18 of relay RT. Relay PN therefore releases and changes the potential applied to the line from (+) to (-). The line is now energized over a circuit which may be traced from (+) terminal of battery LB, conductor 11, front contact 30 of relay IE, back contact 19 of relay PN, conductor 96, return conductor, back contact 173 of relay PC¹, front contact 171 of relay NC¹, valve RCT¹, front contact 172 of relay NC¹, back contact 170 of relay PC¹, resistance R¹, front contact 121 of relay LO¹, back contact 120 of relay OP¹, winding of relay F¹, line conductor, winding of relay F¹, conductor 63, back contact 77 of relay PN, lower winding of relay RT, front contact 31 of relay IE and conductor 10, to the (-) terminal of battery LB. Relay RT is therefore maintained energized by means of current

through its lower winding after relay PN releases and opens its front contact 99.

In response to this (—) energization of the line circuit, the line relays actuate their polar contacts to the left for controlling the FP relays and the stepping relays as previously described. During the second "off" period the deenergization of the line effects the release of relay RT, after which it is again picked up when relay PN picks up during the "off" period for preparing for the next "on" period.

It will thus be seen that the line is energized with polar impulses during an indication cycle for positioning the polar contacts of relay F in the control office to the right or to the left in accordance with whether these impulses are (+) or (—). A (+) impulse effects the energization of an indication receiving relay, such as relay IPT over a circuit extending from (B+), contact 84 of relay F in its right hand dotted position, front contact 82 of relays FC, back contact 81 of relay TF, back contacts 14 and 15 of relays 2V and IV respectively and winding of relay IPT, to (CN). A (—) impulse positions polar contact 84 to the left for applying (B—) to the channel circuit, similar to that above described, for energizing relay IPT in the opposite direction.

It is not believed necessary to illustrate or describe the transmission and the reception of additional polar indication impulses, since these may be provided as in the above described typical examples and since as many may be provided as required. It is furthermore believed unnecessary to illustrate the method of registering the identity of a transmitting station in the control office in accordance with a code combination made up of the polar indication impulses, since such station identification, as well as the transmission of indications to the indication receiving relays associated with the identified station, has been disclosed in numerous applications and is well known to those skilled in the art.

At the end of an indication cycle, the system is cleared out in the manner above described in connection with a control cycle, with relay FC being released when relay OC releases and opens its stick circuit at front contact 51.

Indication cycle stepping operations.—As previously described, the bank of stepping relays is operated through a single cycle in connection with the transmission of controls, with relays TF and TFP remaining deenergized. It will now be explained how the stepping relay bank in the control office repeats its cycle of operations when indications are transmitted, the purpose of this feature being to provide more indication channels, since it has been found in practice that typical installations require approximately twice as many indications as controls during each cycle of the system. Since the station stepping relay bank repeats its cycle by means of circuits similar to those shown in the control office, it is believed unnecessary to describe the stepping operations at the station.

Relay TF (see Fig. 1B) is picked up during the third "off" period over a circuit extending from (+), front contact 55 of relay OC, back contact 75 of relay FP, front contact 74 of relay SB, front contact 76 of relay VP, front contact 78 of relay 2V, front contact 17 of relay FC, back contact 8 of relay TFP and winding of relay TF, to (—). Relay TF is stuck up over a circuit extending from (+), front contact 8 of relay OC, front contact 7 and winding of relay TF, to (—). The VP and the V relays are now released because of

open back contact 280 of relay TF. Relay TFP is picked up over a circuit extending from (+), back contact 281 of relay 2V, back contact 282 of relay IV, back contact 283 of relay VP, front contact 284 of relay TF and winding of relay TFP, to (—). Relay TFP is stuck up over a circuit extending from (+), front contact 8 of relay OC, front contact 288 and winding of relay TFP, to (—).

Relays TF and TFP remain stuck up until relay OC releases and opens its front contact 8 during the "clearing out" period. Since the V and VP relays must be down to effect the picking up of relay TFP, (—) may be applied to their windings at front contact 285 of relay TFP so that they can be sequentially operated through another cycle by means of their previously described circuits, except now the (—) is applied to their windings by way of front contact 285 instead of back contact 280. The switching of contact 81 of relay TF from its back to its front point switches the indication registering circuit from the lower numbered group of channel circuits to the higher numbered group of channel circuits. It will thus be seen that a channel circuit is selected in one group at each step of the stepping relay bank and after this bank has stepped through once, an additional channel circuit is selected in another group by the operation of the stepping relay bank through a similar cycle.

Lockout.—In the event that two or more stations have indications ready for transmission at the same time, the station nearest the control office is given preference and that station (or stations) more remote from the control office is locked out. It will be assumed that the station illustrated in Figs. 2A and 2B has indications to transmit at approximately the same time as the next station, assumed to be station No. 2.

Relay CH¹ is released to initiate the system from the station, in a manner previously discussed. It will be assumed that relay CH² (not shown) is released at the same time.

A circuit is closed for picking up relay CHP¹ extending from (+), winding of relay FP¹, contact 130 of relay F¹ in its left-hand position, back contact 131 of relay SC¹, back contact 132 of relay CH¹ and upper winding of relay CHP¹, to (—). Relay CHP¹ is stuck up over a circuit extending from (+), back contact 156 of relay SB¹, front contact 157 and lower winding of relay CHP¹, to (—). Relay OP¹ is now picked up over a circuit extending from (+), front contact 158 of relay CHP¹, back contact 159 of relay LO¹, winding of relay OP¹ and resistance 1R³, to (—). Similar circuits are effective at station No. 2 (not shown) for controlling the CH, CHP and OP relays at this station.

The picking up of relay OP¹ opens the line circuit at back contact 120, which effects the release of the line relays at all stations and in the control office. Relays FP and NC are released because of open contact 24 of relay F. The release of relay NC further opens the line circuit in the control office. The release of relay F¹ effects the release of relay FP¹ because of open contact 130 and relay SA¹ is picked up because of closed back contact 117 of relay FP¹. Relay SB¹ is picked up because of closed front contact 119 of relay SA¹ and relay SC¹ is picked up because of closed front contacts 122 and 123.

Relay LO¹ is picked up over a circuit extending from (+), front contact 161 of relay SB¹, winding of relay LO¹ and front contact 160 of

relay CHP¹, to (—). Relay OP¹ is released to again close up the line at the station by the opening of back contact 159 of relay LO¹. The line cannot be energized at this time however, since it must wait for the control office to go through the conditioning period, as was previously described.

Similar operations of the OP, F, FP, SA, SB, SC and LO relays are effected at the second station, during the starting "off" period, but the line beyond the first station can not be energized because of open back contact 121 of relay LO¹. The line circuit extends through back contact 120 of relay OP¹, front contact 121 of relay LO¹ and resistance R¹, so that the above described operation of relay OP¹ is effective to provide the line lock feature as previously described.

It will be noticed that the dead line for picking up a CHP relay is at the point where relay F¹ opens its contact 130. This prevents the picking up of another CHP relay when relay CHP¹ picks up, relay OP¹ picks up and relay F¹ releases. In the event however, that the second CHP relay is picked up before this dead line is reached, it becomes necessary to release the associated lockout relay (at the inferior station) and this is accomplished by maintaining the associated SB relay stuck up during the open circuit condition of the line, by way of a circuit similar to that extending through back contact 117 of relay FP¹ and front contact 118 of relay SB¹. Since a contact similar to back contact 118 of relay SB¹ is open and since a contact similar to front contact 117 of relay FP¹ is open, the associated SA relay is released which opens the stick circuit of the associated CHP relay at a contact similar to front contact 163, the contact similar to back contact 158 of relay SB¹ being open. Therefore, at the inferior station, the release of the associated CHP relay and the consequent opening of its front contact similar to 160 effects the release of the associated lockout relay.

The SB relay at the inferior station remains stuck up until the system is restored to normal and the line circuit is reenergized, after which the associated CHP relay is again picked up over a circuit similar to that extending through contact 130 of relay F¹ in its left-hand position, back contact 131 of relay SC¹, back contact 132 of relay CH¹ and upper winding of relay CHP¹, to (—). It will thus be seen that the inferior station gets a chance to obtain active access to the communication system again and the circuits function as above described to give the next superior station control of the line and to lockout any other inferior station that may be attempting to transmit its indications.

Stepping is not effected at an inferior station, under the above conditions, because of open front contacts 136 of relay SO¹ and open front contact 164 of relay LO¹. At a station nearer the office than the one which obtains access to the communication system, the line relay will be intermittently operated in response to the impulses and the associated FP relay will be intermittently operated because of a circuit completed for the FP relay, by way of a contact similar to 139 in either position, front contacts similar to 112 or 131 of relay SC¹, back contacts similar to 126 or 199 of relay SO¹ and a resistance similar to 1R², to (—). The FP relay thus operates to control the associated SA, SB and SC relays, but stepping is not effected at this station because of open front contacts 136 and 164 of relays similar to SO¹ and LO¹.

Stored control conditions.—As previously mentioned, the control office has preference to initiate the system, when it has a stored control condition at the time the system goes through its "clearing out" period.

When relay C is released during the "clearing out" period, as previously described, a stored office start is effective to pick up relay LC over the previously described circuit including back contact 39 of relay C. The CD relay that was up during the previous cycle, is released when relay C releases and opens its front contact 62. Relay C is again picked up over the previously described circuit including front contact 41 of relay LC.

It will be understood that the LC relay now being discussed may be associated with another starting button and another station, so that the closure of a front contact similar to 61 is effective to pick up the associated CD relay.

After the stepping relays have been released during the "clearing out" period, as previously described, relays PC and FP are picked up over a circuit extending from (+), winding of relay FP, front contact 89 of relay SB, back contact 90 of relay OC, front contact 25 of relay C, back contact 42 of relay SC, front contact 43 of relay SA, winding of relay PC and back contacts 27 to 29 inclusive of the stepping relay bank, to (—). This picking up of relay PC applies a (+) energization to the line before the SA or SB relays have released, but after the SC relay has released. This (+) energization of the line positions the contacts of the line relays to the right, which prevents the picking up of a station CHP relay, because the line relay contacts similar to contact 130, must be in their left-hand positions for picking up an associated CHP relay.

After the release of relays SB and SA, due to the release of relay OC and the consequent opening of its front contact 48, relay PC is released because of open front contact 43 of relay SA, to mark the end of the starting period and the beginning of the conditioning "off" period, at which time the line is deenergized and the system steps through the cycle as before. Relay OC is picked up when relay LV releases and closes its back contact 32, the circuit being by way of back contacts 50 and 34 and front contact 44, as previously described. Relay LV is not released at the time the other stepping relays release, its stick circuit not being energized until relay SB releases and opens its front contact 87.

In the event of simultaneous office and field start conditions, when the system is in its normal condition, then the field station is given preference, since an open circuit start condition, effected by a field station is superior to a change in polarity of energization of the line circuit, effected by the control office.

For example, the release of relay CH¹ effects the picking up and the sticking of relay CHP¹, after which relay OP¹ is picked up to open the line at the station, all as previously described. In response to the open line condition, relays F, FP and NC in the office are released and relay FC is picked up. The opening of back contact 38 of relay FC prevents the picking up of relay C (which controls the transmission of controls) so that the succeeding cycle is marked for the transmission of indications. Even though relay C is up at the time relay FC is picked up in response to a field start, the opening of back contact 52 of relay FC opens the stick circuit for

relay C and since its pick up circuit is also open at back contact 38, relay C will be released.

Since it requires a (+) line energization at the start of a cycle to pick up an SO relay and since a field start condition opens the line for preventing this (+) energization, no SO relay will be picked up at the start of an indication cycle.

The "clearing out" operation for an indication cycle is the same as previously described in connection with a control cycle and it is believed unnecessary to again point out the sequence of operations during this portion of the cycle.

Wheatstone bridge indications.—In my prior Patent No. 2,068,931, a method of transmitting indications in a centralized traffic controlling system was disclosed, comprising circuit means for unbalancing or leaving balanced a Wheatstone bridge circuit, having the line in one arm thereof. The modification illustrated in Fig. 3, is an improvement over the system in the above patent, in that indications are transmitted by over-balancing and under-balancing a normally balanced Wheatstone bridge circuit, having the line in one arm thereof. The present arrangement is an improvement over the prior disclosure, since the indication executing circuits in the control office are much simpler, because the usual line relay is actuated to the right or to the left in accordance with the over-balance or under-balance of the bridge for applying (B+) or (B-) to the indication channel circuits selected.

Fig. 3 illustrates only a sufficient portion of the circuits to indicate the method of transmitting by the over-balance and under-balance Wheatstone bridge arrangement. It is assumed that the system is in its normal condition, with the line energized (—) by way of the pole changing contacts of the PC and NC relays, the energy being supplied from battery LB³ which corresponds to the line battery LB of Fig. 1A. The path over which the line is energized includes line relay F³, corresponding to relay F¹ of Fig. 2A, and back contacts 320 and 321 of relays OP³ and LO³, which correspond to back contacts 120 and 121 of Fig. 2A.

Relay FC³, corresponding to relay FC of Fig. 1A, is picked up when the system is started from the field station, in response to the open circuit condition of the line, in the manner previously described.

Each time that relay IE³, (corresponding to relay IE of Fig. 1A) is picked up to apply energy to the line circuit, front contacts 330, 331, and 333 are closed to include the line and resistance a, c, and d in a Wheatstone bridge circuit, as more clearly indicated in Fig. 7, corresponding resistances and relays in Figure 7 having exponent 4 applied, it being understood that these resistances and relays correspond to similar resistances and relays of Fig. 3.

It will first be assumed that, when relay IE³ sets up the above described condition, the code jumper 345 at the field station is in the position illustrated in Figs. 3 and 7. This removes resistance R⁵ from the line and it is assumed that the constants of the line circuit, the line relays and the resistances are such that, under this condition the line is under-balanced, that is, more current flows through the arm of the bridge in which resistance R⁵ is connected, than in the arm in which resistance a⁴ is connected. In other words, with resistance R⁵ removed from the line, the product of the resistances in the upper right and the lower left arms of the bridge is substantially greater than the product of the resistances

in the upper left and the lower right arms of the bridge. This causes current to flow through line relay F⁴ from the right to the left to apply (B—) at its polar contact 384 to the selected channel circuit, which circuit may be selected as in Fig. 1A.

The alternate connection of jumper 346 inserts resistance R⁵ in the line and when the Wheatstone bridge circuit is established by relay IE³ applying energy to the line, the bridge is over-balanced, that is, the product of the resistances in the upper right and the lower left arms of the bridge is substantially less than the product of the resistances in the upper left and in the lower right arms of the bridge. This causes current to flow through relay F⁴ from left to right and (B+) is applied to the selected channel circuit by way of polar contact 384.

When such an arrangement is used, it is desirable to periodically make a test of the resistance of the line and compensate for variations in this resistance effected by variations in temperature and the like. The circuit illustrated in Fig. 4 shows such a compensating arrangement and in this circuit the system is assumed to be in its normal condition with relays FP⁴, AX⁴ and NC⁴ normally picked up over a circuit extending from (+), winding of relay FP⁴, contact 424 of relay F⁴ in its left hand position, back contacts 425 and 426 of relays C⁴ and SC⁴, winding of relay AX⁴ and winding of NC⁴, to (—). Under this condition the circuits are as illustrated in Fig. 5, that is, the line is energized over a circuit extending from the (+) terminal of the battery, back contact 423 of relay PC⁴, front contact 421 of relay NC⁴, return line conductor, balancing resistor BR⁴, back contact 400 of relay LO⁴, line conductor, winding of relay F⁴, front contact 422 of relay NC⁴, back contact 420 of relay PC⁴ and resistance d⁴, to the (—) terminal of the battery. Another circuit may be traced from the (+) terminal of the battery, back contact 423 of relay PC⁴, front contact 421 of relay NC⁴, balancing resistor a⁴, front contact 402 of relay AX⁴ and resistor c⁴, to the (—) terminal of the battery.

As indicated in Figs. 4 and 5 balancing relay BAL⁴ has one terminal connected to point Y between resistors a⁴ and c⁴, by way of a connection direct to resistor c⁴ and by way of a connection through front contact 402 of relay AX⁴, to resistor a⁴. The other terminal of relay BAL⁴ is connected to point Z between resistor d⁴ and line relay F⁴. This connection may be traced by way of front contact 403 of relay AX⁴ to the winding of relay F⁴ and by way of front contact 422 of relay NC⁴ and back contact 420 of relay PC⁴, to resistor d⁴.

It is assumed that under the above conditions, the inclusion of resistance BR⁴ at the end of the line provides the proper resistance in the upper right arm of the Wheatstone bridge (see Fig. 5), so that the product of the resistances in this arm and in the lower left arm are approximately equal to the product of the resistances in the upper left arm and the lower right arm. Under this condition the bridge is balanced and no current flows between the terminals Y and Z. Relay BAL⁴ therefore maintains its polar contact 405 in its neutral position as long as the line contains the proper resistance to approximately balance the bridge.

If the line circuit resistance increases or decreases, polar contact 405 of relay BAL⁴ will be operated to one position or the other for controlling (by means of a circuit not shown but

indicated by dotted line 401), resistor a^4 to include in or exclude from the upper left arm of the bridge sufficient resistance to bring the bridge back into balance.

It is not believed necessary to show the circuits in detail for controlling resistor a^4 , since these may be such as shown in Field application, Ser. No. 25,472, filed June 7, 1935. In this prior application, a resistor corresponding to a^4 is stepped up or down by means of a step-by-step device in accordance with the position of a contact on a relay, such as relay BAL⁴, which controls this device.

Front contacts 406 and 407 of relay IE⁴ are for the purpose of setting up the circuit condition illustrated in Fig. 7 during the transmission of indications, when the line is energized by the picking up of relay IE⁴. It will be observed that balancing relay BAL⁴ is removed from the line during the transmission of indications, because relay AX⁴ releases and opens the circuits to relay BAL⁴ at front contact 403. Relay AX⁴ is released when relay F⁴ opens contact 424 at the start of an indication cycle (or a control cycle) and the circuit to relay AX⁴ is maintained open at back contact 426 of relay SC⁴. The circuit for operating relay NC⁴ is then completed as in Fig. 1A, as indicated by the arrow and the note in Fig. 4 (to NC selection).

During the transmission of controls the Wheatstone bridge circuit is not made up, as indicated in Fig. 6. This is because relay IE⁴ does not pick up during a control cycle, so that the only completed circuit from the line battery is that indicated in Fig. 6 and it extends over the line circuit, but includes resistor d^4 .

Fig. 8 illustrates the reception of indications by means of vacuum tubes of the gas filled, arc discharge type. Instead of relay F⁴ being connected between points Y and Z as in Fig. 7, resistor R⁸ is connected between points Y and Z in Fig. 8. Recalling that an over-balance of the bridge causes current to flow from Y to Z and that an under-balance of the bridge causes current to flow from Z to Y, it will be apparent that current is thus caused to flow through resistor R⁸ in one direction under one indication condition and in another direction under another indication condition.

The input circuit of tube TP is connected across the left hand portion of resistor R⁸, therefore, with the proper grid bias, current flowing from left to right through this resistor "triggers" tube TP, causes current to flow in its plate circuit and picks up relay MP for applying (B+) potential to the selected indication channel circuit, through front contact 455 of relay MP and back contact 456 of relay MN.

When current flows through resistor R⁸ from right to left, then the grid bias applied to tube TN is overcome, current flows in the plate circuit of this tube and relay MN is picked up for applying (B-) by way of front contact 456 to the selected channel circuit. Since tubes of this type require some means of "quenching" after they are "fired", relay IE⁸ (corresponding to relay IE⁴ of Fig. 4) connects energy to the tube plate circuit at front contact 457, during the time that this relay is picked up for energizing the line and removes energy from the tube plate circuits by opening front contact 457 to "quench" the "fired" tube after the indication transmission period.

Although one specific embodiment of the invention has been shown, it is to be understood that various re-arrangements may be made and still come within the scope of the invention.

Having thus described a centralized traffic controlling system as one embodiment of the present invention, it is desired to be understood that this form is selected to facilitate in the disclosure rather than to limit the number of forms which the invention 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 invention, except as limited by the appended claims.

What I claim is:

1. In a centralized traffic control and indication system of the selector type for transmitting controls to or indications from any one of a plurality of field stations at one time; the combination with an office and a plurality of field stations; a lock-out relay at each field station; a polar line relay at each field station; a line opening relay at each field station; a line circuit extending through the line relay, a contact of said line opening relay and a back contact of the lock-out relay of each field station in succession in accordance with the distance such field station is from said office and back over a return wire; a bridge partial circuit at each field station connecting the front contact of said lock-out relay contact for that station to the return wire; means in said office for normally energizing said line circuit with current of a particular polarity; means at each field station responsive to a changed condition at such station for actuating said line opening relay and opening said line circuit, said last mentioned means being effective only if said line circuit was energized with current of said particular polarity and said polar line relay assumed a particular position when said changed condition became existent; means for energizing the lock out relay at such station in response to opening of the line circuit by its associated line opening relay; means responsive to the energization of said lock-out relay for again actuating said line opening relay to reclose said line circuit; and means at said office for changing the polarity of energization of said line circuit when said line circuit is to be used for transmitting controls from said office.

2. In a centralized traffic indication system of the selector type for transmitting indications from any one of a plurality of field stations at one time; the combination with an office and a plurality of field stations; a lockout relay at each field station; a polar line relay at each field station; a line opening relay at each field station; a line circuit extending through the line relay, a contact of said line opening relay and a back contact of the lock-out relay of each field station in succession in accordance with the distance such field station is from said office and back over a return wire; a bridge partial circuit including indication impulse creating means at each field station connecting the front contact of said lock-out relay contact for that station to the return wire; means in said office for normally energizing said line circuit with current of a particular polarity; means at each field station responsive to a change condition at such station for actuating said line opening relay and opening said line circuit, said last mentioned means being effective only if said line circuit was energized with current of said particular polarity and said polar line relay assumed a particular position when said changed condition became existent; means for energizing the lock-out relay at

such station in response to opening of the line circuit by its associated line opening relay; and means responsive to the energization of said lock-out relay for again actuating said line opening relay to reclose said line circuit to allow said indicating impulse creating means to transmit an indication to said office.

3. In a centralized traffic indication system of the selector type for transmitting indications from any one of a plurality of field stations at one time; the combination with an office and a plurality of field stations; a lock-out relay at each field station; a polar line relay at each field station; a line opening relay at each field station; a line circuit extending through the line relay, a contact of said line opening relay and a back contact of the lock-out relay of each field station in succession in accordance with the distance such field station is from said office and back over a return wire; a bridge partial circuit including indication impulse creating means at each field station connecting the front contact of said lock-out relay contact for that station to the return wire for creating impulses of current greater than or less than normal value; means in said office for normally energizing said line circuit with current of a particular polarity; regulating means at said office operative only when said system is in its normal condition for maintaining said current of a particular polarity at a normal value; means at each field station responsive to a changed condition at such station for actuating said line opening relay and opening said line circuit, said last mentioned means being effective only if said line circuit was energized with current of said particular polarity and said polar line relay assumed a particular position when said changed condition became ex-

istent; means for energizing the lock-out relay at such station in response to opening of the line circuit by its associated line opening relay; and means responsive to the energization of said lock-out relay for again actuating said line opening relay to reclose said line circuit to render said regulating means inactive and to allow said indicating impulse creating means to transmit an indication to said office.

4. In a code communication system for a control office and a plurality of field stations, a single line circuit connecting the control office and the several field stations, means in the control office for energizing said line circuit with one polarity while the system is at rest, and equipment at each field station comprising a changeable device having different conditions to be indicated in the control office, a starting circuit responding to a change in said device and effective only if said line circuit is energized with said particular polarity for opening said line circuit, sectionalizing means governed by said field starting circuit and operating upon deenergization of said line circuit as a result of a field start at any station for terminating said line circuit in the corresponding station, lock-out means responsive to the flow of current in said line circuit after operation of said sectionalizing means for maintaining energization thereof for an ensuing operating cycle, means for deenergizing said lock-out means after a prolonged deenergization of said line circuit, and a code transmitter effective only if said lock-out means is maintained energized by the flow of current in said line circuit to the corresponding station after the sectionalizing of said line circuit.

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