May 23, 1939. N. D. PRESTON 2,159,567

CENTRALIZED TRAFFIC CONTROL SYSTEM

Filed Nov. 5, 1931 4 Sheets-Sheet 1

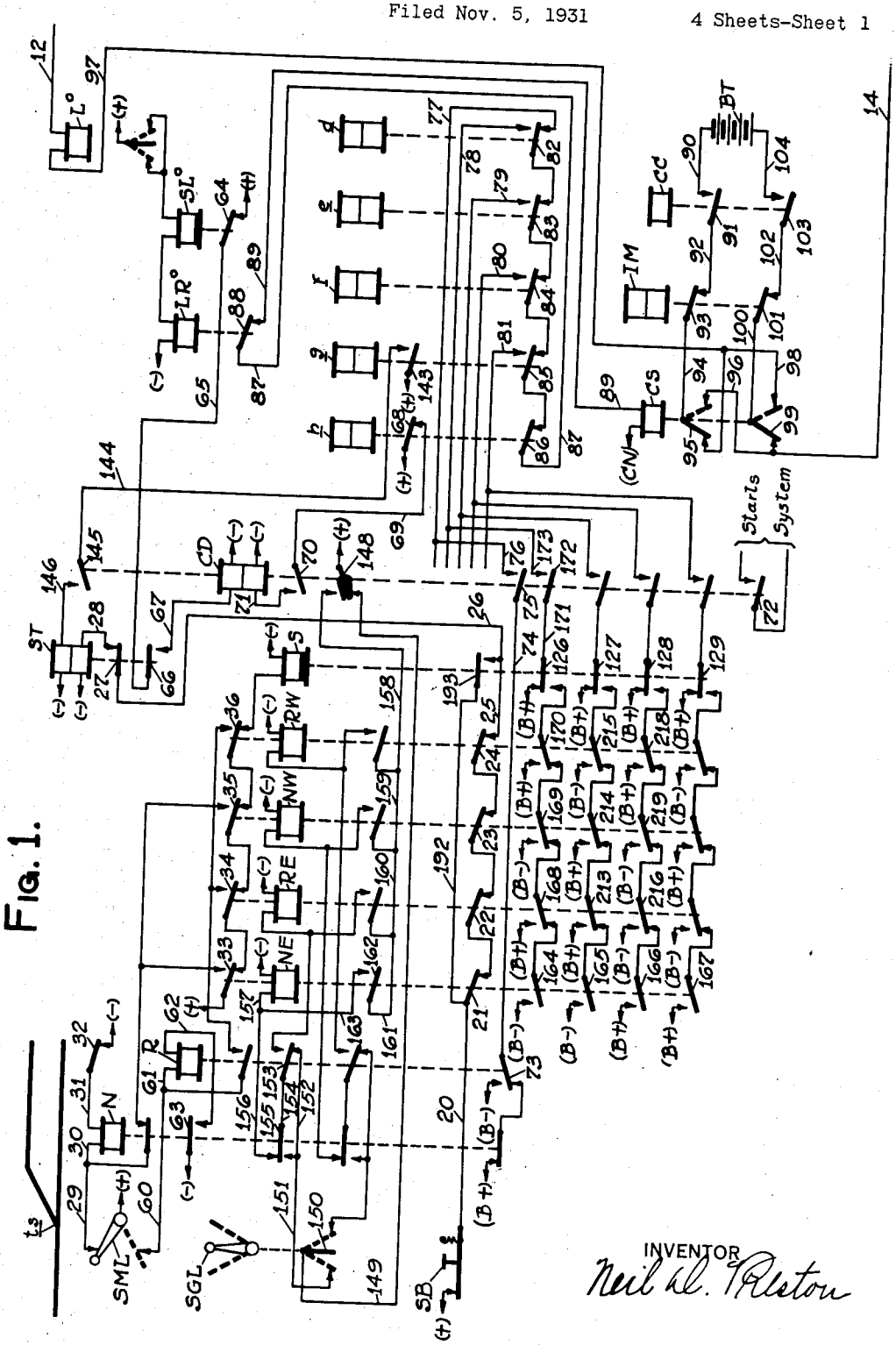


FIG. 1.

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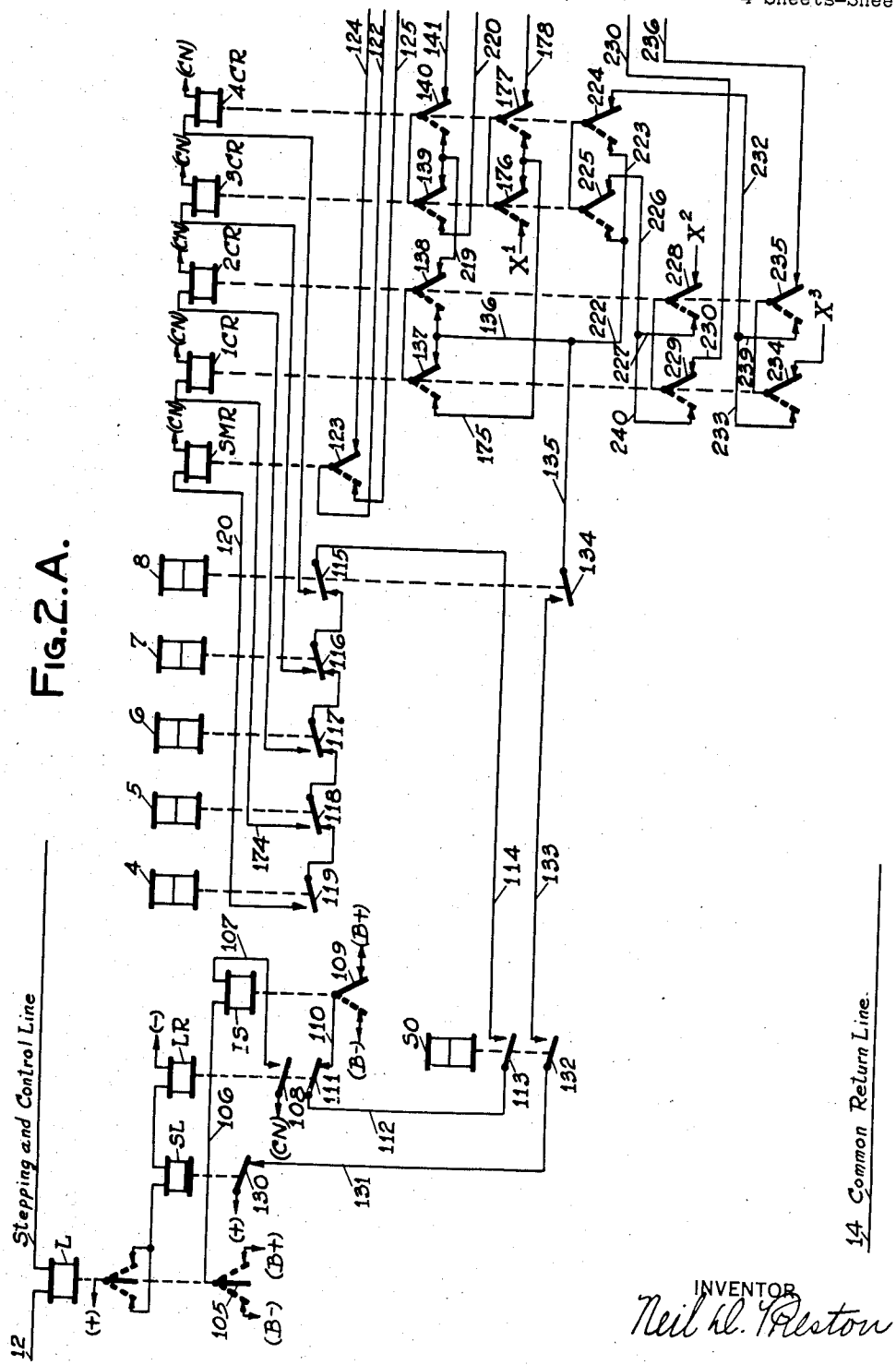


FIG. 2.A.

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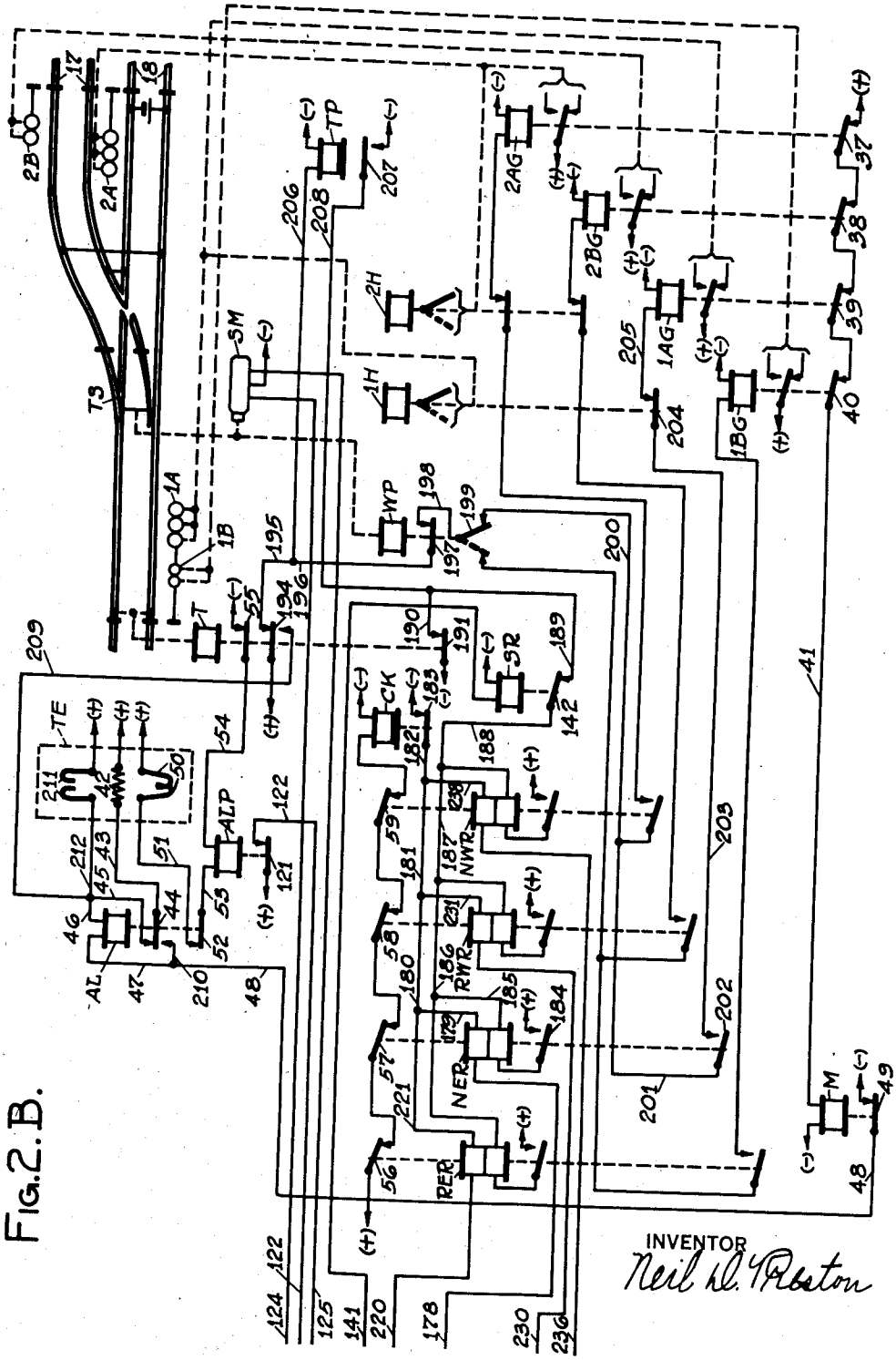


FIG. 2. B.

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FIG. 3.

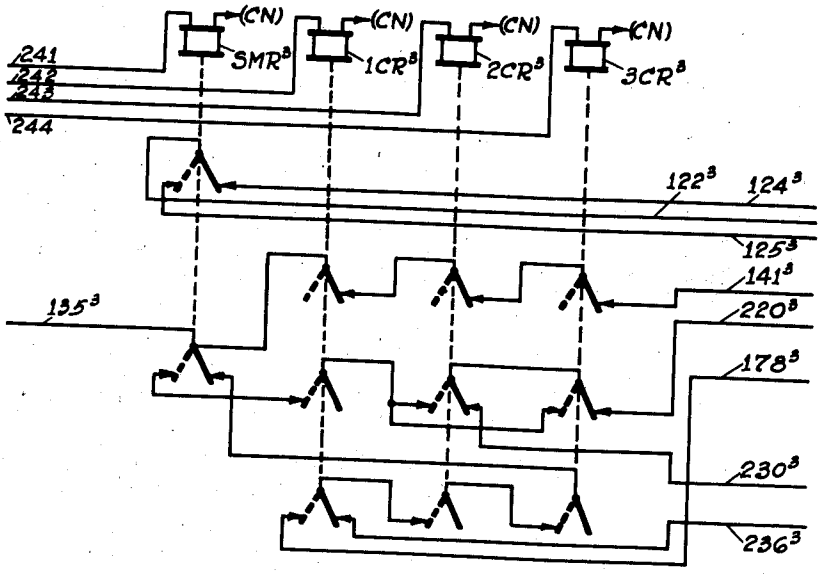


FIG. 4.

1	+	+	+	+
2	+	+	+	−
3	+	+	−	+
4	+	+	−	−
5	+	−	+	+
6	+	−	+	−
7	+	−	−	+
8	+	−	−	−
9	−	+	+	+
10	−	+	+	−
11	−	+	−	+
12	−	+	−	−
13	−	−	+	+
14	−	−	+	−
15	−	−	−	+
16	−	−	−	−

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UNITED STATES PATENT OFFICE

2,159,567

CENTRALIZED TRAFFIC CONTROL SYSTEM

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Application November 5, 1931, Serial No. 573,079

40 Claims. (Cl. 246—3)

This invention relates to systems for governing traffic on railroads, and more particularly pertains to systems known as centralized traffic control systems.

In a centralized traffic control system of the type contemplated by this invention, the switches and signals at various points along a railroad system throughout an extended territory, are placed under the control of an operator in a central control office, in such a way that the operator may at will change the position of the switches, subject to automatic approach and detector locking circuits which prevent unsafe operation of any switch, and may also hold at stop any of the signals, or allow them to clear dependent upon the position of the associated switches, and also provided the location of trains makes it safe for such a signal to indicate proceed. Also, various indications are displayed in the control office to show the presence or absence of trains on the various track sections and to show the operated positions of the various switches, signals and the like.

In a centralized traffic control system, as above outlined, the various traffic controlling devices, including the switches and signals at passing sidings and the like, distributed throughout the railway system are grouped in what are conveniently termed field stations, which usually include those traffic controlling devices located near or adjacent to each other. A communication system is provided to interconnect the central control office with these field stations for the transmission of the controls and indications, which communication system, as contemplated by this invention, is preferably of the station selective coded duplex type, as disclosed for example in the prior Patent No. 2,129,183 granted to N. D. Preston et al. September 6, 1938. A communication system of this type is usually operable through cycles of operation during which a code call is transmitted for the selection of the particular field station with which communication is desired to be held, after which the controls are transmitted to the individual traffic controlling devices at that field station.

In accordance with the present invention, it is proposed to provide a communication system of the station selective coded duplex type for a centralized traffic control system, which communication system is operable through cycles of operation in the usual manner but is adapted to first transmit a station code call for the selection of a particular station after which another code is transmitted for the operation of a particular group of devices at that field station.

More specifically, in the case of a field station having only one track switch with the necessary signals for governing traffic thereover, there are four possible routes over the track switch, only one of which may be set up at any one time. In accordance with the present invention, it is proposed to transmit after the selection of such a station what is termed a composite route control code, which code is effective to control all of the devices necessary for the setting up of a particular route, as contrasted with the method heretofore employed where each of the traffic controlling devices has been controlled individually.

One composite route control code is assigned to each of the four possible routes over a track switch; while an additional composite control code, called the stop code, is assigned for holding all routes at stop in the event that the operator desires to hold a train which he previously thought should be allowed to pass over a particular route.

Although the present invention provides composite route control codes, means is also provided whereby a track switch may be individually operated without clearing any of the four routes over that switch. This is particularly desirable in localities where snow and ice is apt to prevent operation of the switches unless they are periodically operated, for during such periodic operations it would be undesirable to clear any route, as a train might be falsely allowed to pass.

In cases where a field station includes several track switches arranged in a complicated track layout together with the signals for governing traffic thereover, the present invention proposes that, depending upon the track layout, either the system will be arranged to transmit a single composite route control code for the setting up of any one particular route during any one particular operating cycle, or the system will be so arranged as to transmit several composite route control codes after the selection of a station to set up several non-conflicting routes at the same time, all of which will be explained in detail hereinafter.

In a centralized traffic control system, as above outlined, the safety features of the system reside in the signalling part of the system located along the railway track. In other words, two conflicting routes cannot possibly be set up by reason of the signalling circuits which are adapted to prevent interfering train movements. However, in order that the reliability of such a system may be increased, and in order that undesirable train movements shall not be accidentally effected due to failure of the communication part of the system, although such train movements are not

necessarily dangerous, it is proposed in accordance with the present invention that the codes employed both for the station selection and for the transmission of what is conveniently termed the composite route control code shall be arranged so as to be inherently protected against the transmission of a false or undesired code. More specifically, it is proposed that the codes shall be so arranged that it is necessary for two failures to occur, one on each of two different steps of a selective type system, in order to cause the transmission of an erroneous composite route control code. With such an arrangement as provided in accordance with the present invention, any single error in the transmission of a code call either for the station or for a composite route code will result in failure of the system to transmit any control whatsoever.

These characteristic features of the invention thus briefly stated, will be explained more in detail in the following description of one embodiment of the invention; and the various characteristic features, functions and advantages of a system embodying this invention will be in part pointed out and in part apparent as the description progresses.

In the accompanying drawings, the invention has been shown applied to a single track switch and its associated signals, such as used at one end of a passing siding, but it should be understood that the invention is not limited, as thus shown, to the control of one switch and its signals, but may be extended for any desired number of switches and signals, and may be readily applied to all types of track layouts.

In describing the invention in detail, reference will be made to the accompanying drawings, in which similar parts throughout the several views are designated by similar reference characters provided with distinctive exponents, and in which:—

Fig. 1 illustrates the apparatus and circuit arrangement provided as a portion of a complete control office equipment constructed and arranged according to the present invention;

Figs. 2A and 2B when placed end to end illustrate the apparatus and circuit arrangement employed at a typical field station for providing the control of a single railroad track switch in accordance with the present invention, and adapted to be associated with the apparatus employed in the control office;

Fig. 3 illustrates a modified form of the code deciphering means employed in Fig. 2A of the accompanying drawings; and,

Fig. 4 illustrates, by symbols, a typical code table of the codes which are employed in the embodiment of the present invention.

For the purpose of simplifying the illustration and facilitating in the explanation, the various parts and circuits constituting the embodiment of the invention have been shown diagrammatically and certain conventional illustrations have been employed, the drawings having been made more with the purpose of making it easy to understood the principles and mode of operation than with the idea of illustrating the specific construction and arrangement of parts that would be employed in practice. Thus, 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 suitable sources of electric current instead of showing all of the wiring connections to these terminals.

The symbols (+) and (−) are employed to indicate the positive and negative terminals respectively of suitable batteries, or other sources of direct current; and the circuits with which these symbols are used, always have current flowing in the same direction. The symbols (B+) and (B−) indicate connections to the opposite terminals of a suitable battery, or other source of current which has a central or intermediate tap designated (CN); and the circuits with which these symbols are used, may have current flowing in one direction or the other depending upon the particular terminal used in combination with the intermediate tap (CN). When alternating current is employed in place of direct current, the particular symbols employed represent relative instantaneous polarities.

While certain features of the invention are applicable to and useable with any type of communication system for centralized traffic control, whether obtained by direct line wire control or some form of selective type communication system, the specific embodiment of the invention illustrated has been shown in a form adapted for use with a selective communication system of the duplex coded type, shown and described in detail in the prior patent of N. D. Preston et al., Patent No. 2,129,183 dated September 6, 1938. Thus, before considering the structure and mode of operation of the parts constituting this invention, it becomes necessary to explain some of the features of this particular duplex coded type of communication system insofar as material to an understanding of the present invention, reference being made to said prior application for other details of the structure and operation of such a duplex coded communication system not directly related to the features of this invention.

Communication part of the system.—Although the present invention is contemplated as being employed in connection with a communication system providing both for the transmission of controls from a central control office to any one of a plurality of field stations, and for transmission of indications from each of the field stations to the control office, as in the above mentioned Patent No. 2,129,183, the present invention relates more particularly to the transmission of controls from the control office. Thus, only those parts of the communication system relating more directly to the transmission of controls have been indicated; and similarly the description relative to the features of the communication system will be directed more particularly to the transmission of controls.

For the transmission of controls, a transmitting equipment is located in the control office and a receiving equipment is located at each of the various field stations. These receiving equipments are connected to the transmitting equipment in the control office by a suitable stepping and control circuit comprising a stepping line and a common return line. In the drawings, the stepping line is designated **12**; while the common return line is designated **14**.

The stepping line includes a three position biased to neutral polar line relay L^0 at the control office and a similar relay L at each of the field stations. Suitable means is provided in the control office for governing this stepping circuit by energizing it with series or cycles of time-spaced impulses of particular polarities in accordance with the station code calls and the composite route code calls that are transmitted. The impulses of any one series, as repeated by the

line relays L, operate a stepping bank at the control office and at each of the field stations through a cycle of operation irrespective of the polarity of such impulses; while the polarity of the impulses determines the distinctive characters of the codes transmitted to the field stations.

The apparatus for governing the cycles of time-spaced impulses includes a cycle controlling relay CC, which closes the stepping circuit, when energized, at the beginning of each cycle of operation and opens the stepping circuit at the end of each such cycle. An impulsing relay IM is employed to time space the impulses applied to the stepping circuit, while the polarity of these impulses is determined by a code sending relay CS which is energized with one polarity or the other on the successive steps in accordance with the particular codes to be transmitted for that cycle.

Each series of time-spaced impulses comprising a predetermined number corresponding to the number of steps to be taken, is conventionally termed an operating cycle. In the beginning of such an operating cycle, a slow acting relay SL^0 in the control office (see Fig. 1) and a similar relay SL at each field station (see Fig. 2A) is energized. These relays SL are made sufficiently slow acting to be maintained picked up between successive impulses throughout the operating cycle.

The application of the successive impulses of a cycle to the stepping circuit causes the operation of the stepping relays at the control office and at each field station, one step for each impulse irrespective of the polarity of the impulses, while an impulse storing relay IS of the two position polar magnetic stick type is actuated in accordance with the polarity of each impulse, one of these impulse storing relays being provided at each field station. During the execution period of each step, which is the time period or space between successive impulses, the character of the preceding code impulse is executed as stored by the impulse storing relay IS. This prevents the overlapping of impulses on the successive steps. These execution periods are marked off by a quick acting line repeating relay LR^0 in the control office and a similar relay LR at each field station.

The stem is normally at rest, but may be manually set into a cycle of operation which consists of a station selecting part and a control transmitting part. During the station selecting part of the operating cycle, the station to receive controls from the control office is selected in a manner explained more in detail in the above mentioned patent of N. D. Preston et al., Patent No. 2,129,183 dated September 6, 1938, resulting in the energization of the relay SO at the desired station (see Fig. 2A).

As the station selecting part of the operating cycle is completely disclosed in the above mentioned application, only the second part or control part of the operating cycle has been indicated in the accompanying drawings by showing the stepping relays *d*, *e*, *f*, *g* and *h* in the control office and a corresponding bank of stepping relays **4**, **5**, **6**, **7** and **8** at each of the field stations, which stepping relays are sequentially energized one at a time and in synchronism by the impulses applied to the stepping circuit after a particular station has been selected. It is to be understood that the stepping relay bank at the selected field station is the only field station stepping relay bank which operates during the control or second part of the operating cycle, which bank operates in synchronism with the one in the control office.

Although any one of a plurality of field stations may be selected for the transmission of controls thereto and/or the reception of indications therefrom during any particular operating cycle, as provided in the duplex coded type of communication system above mentioned, it is not necessary for the purpose of an understanding of the present invention to explain how the stations are selected and/or how the controls and indications are transmitted in this type of communication system, but it is sufficient to note that the transmission of control codes results in the positioning of the contact fingers of two position polar relays, one for each step, to one position or the other in correspondence with the position of the respective controlling contacts. Each of these two position polar relays is of the dead beat or magnetic stick type so that its contact fingers are held in the position to which they were last operated, this by means of permanent magnets or other means.

Keeping in mind this general organization of the complete communication system contemplated in connection with the particular embodiment of the invention illustrated, and particularly the fact that station selecting code calls may be transmitted for the selection of any particular field station from among a plurality of such field stations, after which composite route control codes may be transmitted to the particular selected station, consideration may now be given to an explanation of the present invention as if it were applied to only one station, as shown in the accompanying drawings.

Control office equipment.—The control office (see Fig. 1) includes a control machine having a group of control levers for each field station, a miniature track layout corresponding in every way to the actual track layout in the field, and various indicating lamps or equivalent devices together with apparatus and circuits to accomplish proper functioning of the system. Fig. 1 illustrates diagrammatically that portion of such a control machine which is constructed in accordance with the present invention and which is typical of that apparatus associated with a single track switch, a cross-over or the like.

This apparatus for one track switch comprises a switch machine control lever SML, a signal control lever SGL, a self restoring starting button SB, and a miniature track switch *ts*.

The movement of the switch machine control lever SML to one extreme position or the other results in the normal or reverse operation of the corresponding track switch at the corresponding field station through the medium of the communication system; and the movement of the signal control lever SGL from its intermediate or vertical position shown, corresponding to signals at stop, to the right or left clears a signal for traffic over the associated track switch in east or west bound directions respectively through the medium of the communication system.

The movement of the signal lever SGL from the stop position to a right or left hand proceed position causes the momentary deenergization of the stick circuit and dropping of a storing relay ST, this through the medium of the stick relay NE, NW, RE or RW associated therewith, one of which stick relays is picked up and stuck up by such movement of the lever SGL; while the movement of this signal lever SGL from a proceed position to a stop position does not pick up a stick

relay and does not momentarily deenergize this stick circuit for relay ST. Likewise, the momentary actuation of the starting button SB by the operator, also results in the deenergization of the stick circuit of the storing relay ST. The deenergization of the storing relay ST causes the system to be initiated (by means not shown) for the transmission of the associated station code call and the transmission of the composite route control code as then set up by the composite route control code determining means.

The storing relays ST, one for each station, and a corresponding code determining relay CD, one for each station, are arranged in a bank of relays, so interlocked that irrespective of the number of storing relays ST that are deenergized simultaneously or in rapid succession resulting from the actuation of control levers and/or starting buttons simultaneously or in rapid succession, only one code determining relay CD may be energized during any one operating cycle of the communication system. This bank of relays is so arranged that if several storing relays ST are deenergized at the same time, their corresponding code determining relays CD will be energized successively on successive operating cycles in a predetermined sequence or order determined by their relative location in the code determining bank of relays, all of which has been completely disclosed in the application of W. D. Hailes et al., Ser. No. 526,674, filed March 31, 1931.

Lever repeating relays N and R are employed for respectively repeating the normal and reverse positions of the switch machine lever SML; and when one of these relays is picked up in correspondence with the lever SML, the other cannot possibly be energized as will presently be explained.

Four route relays NE, RE, NW and RW are associated with the signal lever SGL and selected in accordance with the position of the lever SML as repeated by the relays N and R. Only one of these route relays may be energized at any one time thus determining which route is to be cleared by the transmission of a suitable composite route control code. Whenever the signal lever SGL is in an "at stop" position and all of the relays NE, RE, NW and RW are deenergized, a "no route" relay S is energized for transmitting a stop code.

The control office equipment also includes a battery BT for supplying positive and negative potential to the stepping circuit in accordance with the position of the contacts of the code sending relay CS.

Field station equipment.—With reference to the typical field station shown in Figs. 2A and 2B, a turn-out track having rails 17 is connected to the main track having rails 18 by means of a track switch TS. This track switch TS is suitably controlled from one extreme locked position to the other by a suitable switch machine SM, such for example as shown in the patent to W. K. Howe, No. 1,466,903, dated September 4, 1923. This switch machine SM is controlled by the switch machine relay SMR subject to suitable approach locking means, one type of which is shown embodied in the approach locking relay AL and approach locking repeating relay ALP provided with the usual time release mechanism shown as a thermal time element relay TE.

The switch machine SM thus remotely controlled by the operator, is preferably provided with a dual control selector, such as disclosed in the application of W. K. Howe, Ser. No. 354,039, filed April 10, 1929, so that a member of a train crew can locally operate the track switch TS for local track movements, after first obtaining permission from the operator by telephone or the like.

The position of the track switch TS is indicated by the usual switch repeating relay WP which is a polar neutral type relay energized with a particular polarity in accordance with the position and locked condition of the track switch TS through the usual switch box or point detector contact mechanism (not shown), but deenergized whenever the track switch is unlocked or is in operation. The energization of this relay WP is also governed in accordance with the operated condition of the dual control selector when such a mechanism is employed in conjunction with the switch machine SM.

Associated with the track switch TS is a detector track section having the usual track relay T and track battery. A track repeating relay TP is provided for repeating the energized and deenergized conditions of the track relay T, for reasons hereinafter pointed out.

Signals 1A and 1B serve to govern east bound traffic over the track switch TS on the main track or onto the turn-out track respectively, while signals 2A and 2B serve to govern west bound traffic over the track switch TS on the main track or off the turn-out track respectively.

Each of the signals has been illustrated as being of the light signal type, but it is to be understood that they may be of any other suitable type. Each signal has associated therewith a control relay; for example, the signal control relays 1AG and 1BG are associated with the signals 1A and 1B respectively; while the relays 2AG and 2BG are associated with the signals 2A and 2B respectively. Whenever these signal control relays are deenergized, their respective signals are caused to indicate stop; but when a particular control relay is energized, its associated signal is allowed to indicate proceed dependent upon traffic conditions as indicated by the home relays 1H and 2H, all in accordance with the usual block signalling principles, as disclosed for example in the patent of S. N. Wight, Patent No. 2,082,436 dated June 1, 1937. The home relay 1H is controlled by traffic in advance of signal 1A on the main track; while home relay 2H is controlled by traffic in advance of signals 2A and 2B on the main track. These home relays are polar-neutral relays and are deenergized when it is unsafe for train movements, but are energized with current of one polarity or the other depending upon the number of blocks intervening between the signals which they control and the block in advance in which the next train in advance is located.

The signal control relays 1AG—1BG and 2AG—2BG are manually governed from the central tower through the medium of the communication system. Each relay is dependent for its energization upon its respective route storing relay, one of which is provided for each of the four possible routes over the track switch TS, as for example, route storing relays RER, NER, RWR and NWR. A stop route storing relay SR is provided to put any one of the four routes to stop.

These route storing relays RER, NER, RWR and NWR together with the stop route relay SR are controlled by codes transmitted from the control office as deciphered by the code receiving relays 1CR, 2CR, 3CR and 4CR. Only one

of the route storing relays may be picked up at any one time by reason of a slow acting check relay CK.

When all of the routes are at stop, a relay M is energized through a circuit including back contacts on each of the signal control relays.

Suitable approach locking with time release is provided by approach locking relays AL and ALP together with the time element relay TE. This relay TE is preferably of the thermal type having a front and a back contact.

It is of course to be understood, that although the field station has not been shown as having indication transmitting means nor has the control office been shown as having indication receiving means, a complete system, as contemplated to be employed in accordance with the present invention, would have such features. However, for the purpose of describing the present invention such features have been considered as immaterial.

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

Operation

The system is normally at rest, but may be initiated by the operator for the transmission of controls, as hereinafter explained. While the system is at rest, or in the period of blank as such condition is sometimes termed, the stepping line circuit is normally deenergized; and similarly the major part of the relays of the system are deenergized.

In order that the storing relay ST (see Fig. 1) may be responsive to a plurality of changes occurring simultaneously or in rapid succession, it is normally in a sensitized condition by having a stick circuit which includes those contacts that change in condition, all of which has been explained in detail in the above mentioned application of W. D. Hailes, Ser. No. 526,674 filed March 31, 1931.

The stick circuit for the storing relay ST is closed from (+), through front contact of starting button SB, wire **20**, back contacts **21**, **22**, **23** and **24** of route relays NE, RE, NW and RW respectively, wires **25** and **26**, front contact **27** of storing relay ST, wire **28**, lower winding of storing relay ST, to (—).

As the switch machine lever SML is illustrated as being in the normal position, the lever repeating relay N is energized through a circuit from (+), through lever SML in a normal position, wires **29** and **30**, windings of relay N, wire **31**, back contact **32** of lever repeating relay R, to (—).

With the signal lever SGL in its stop position (center position), then all of the route relays are deenergized closing the energizing circuit for the stop relay S from (+), through back contacts **33**, **34**, **35** and **36** of relays NE, RE, NW and RW respectively, windings of relay S, to (—).

At the field station (see Fig. 2B), the signal control relays **1AG**, **1BG**, **2AG** and **2BG** are deenergized thereby causing their respective signals to indicate stop. With these signal control relays deenergized the circuit for the relay M is completed from (+), through back contacts **37**, **38**, **39** and **40** of relays **2AG**, **2BG**, **1AG** and **1BG** respectively, wire **41**, windings of relay M, to (—).

With the contacts of the relay M picked up, the stick circuit for the approach locking relay AL is completed from (+), through the heating element **42** of the thermal time element relay TE, wire **43**, front contact **44** of relay AL, wires **45** and **46**, windings of relay AL, wires **47** and **48**, front contact **49** of relay M, to (—). It is noted, that the current which flows in this stick circuit for the approach locking relay AL is not sufficient to cause the contacts of the thermal relays TE to be actuated thereby.

As the back contacts of the relay TE are closed, the energizing circuit for the approach locking relay ALP is closed from (+), through back contacts **50** of relay TE, wire **51**, front contact **52** of relay AL, wire **53**, windings of relay ALP, wire **54**, front contact **55** of track relay T, to (—).

With all of the route relays RER, NER, RWR and NWR deenergized, the check relay CK is energized by a circuit from (+), through back contacts **56**, **57**, **58** and **59** of route relays RER, NER, RWR and NWR respectively, windings of relay CK, to (—).

The track switch TS is usually in a normal position with this normal position suitably repeated by the switch repeating relay WP, while the detector track circuit associated therewith is normally unoccupied. Under such conditions, the track switch TS may be operated in response to the movement of the switch machine lever SML and any particular route may be set up as jointly selected by the levers SML and SGL in a manner presently to be described.

Switch operation.—The operator may cause the movement of the track switch TS from one extreme locked position to the other in response to movement of the lever SML to a new position whenever all the routes over that switch are at stop.

For example, let us assume the operator moves the switch machine lever SML from the normal position shown to the reverse dotted line position. This causes the deenergization of the lever repeating relay N and closes the pick-up circuit of the lever repeating relay R from (+), through lever SML in a reverse position, wires **60** and **61**, windings of relay R, wire **62**, back contact **63** of relay N, to (—). It is to be noted, that the relay R cannot be picked up until the relay N has dropped its contacts. Thus, if the relay N for one reason or another remains stuck up undesirably, then the relay R cannot be picked up.

The movement of the switch control lever SML to a new position does not initiate the operation of the communication system but an additional operation is required by the operator, namely, the momentary actuation of the starting button SB, which opens the normally closed stick circuit of the storing relay ST causing its contacts to drop away.

As previously mentioned, the storing relay ST and its associated code determining relay CD for that station are located in a bank of relays so interlocked that irrespective of the number of storing relays which may be deenergized at any one time, only one code determining relay may be picked up during the same operating cycle. However, for convenience only the storing and code determining relays associated with the field station illustrated have been shown.

When the storing relay ST is deenergized and the system is in a period of blank or at rest, as illustrated, then the code determining relay CD is picked up by a circuit from (+), through back contact **64** of relay SL^0, wire **65**, back contact **66** of relay ST, wire **67**, upper winding of code determining relay CD, to (—). As soon as the contacts of the relay CD are picked up, a stick cir-

cuit for relay CD is closed for maintaining it energized throughout the cycle of operation thus initiated. This stick circuit is closed from (+), through back contact **68** of stepping relay *h*, wire **69**, front contact **70** of relay CD, wire **71**, lower winding of relay CD, to (—).

The energization of the code determinng relay CD causes the initiation of the system by closure of front contact **72** through means not shown but which results in the energization of the cycle controlling relay CC and the intermittent actuation of the impulsing relay IM as the successive steps of the cycle are taken so that time spaced impulses of a polarity determined by the code sending relay CS are placed upon the stepping and control circuit.

After the initiation of the system into operation, the first part of the operating cycle is allotted to the transmission of the station code call of the particular station with which communication is to be held for that particular operating cycle; while the second part of the cycle is employed to transmit the composite route control code. It is sufficient for an understanding of the present invention to know that the code call for a particular station is determined by the code determining relay CD energized for that cycle of operation. In this particular case, the code determining relay CD is energized and causes a code call for the station illustrated in Figs. 2A and 2B to be transmitted which results in the selection of that station.

As the code determining relay CD is energized prior to the starting or initiation of the stepping operations, the relay CS may be energized with current of the proper polarity in accordance with the station code call before the stepping circuit is closed and the first step is taken. Irrespective of the polarity of this first stepping impulse, the line repeating relays SL^0 and LR^0 are energized through circuits obvious from the drawings (see Fig. 1) as well as the relays SL and LR at each of the field stations (see Fig. 2*A*). The relays SL are slow acting so that the first stepping impulse is made slightly longer in duration than the remaining impulses of the cycle. This slow action of the relays SL causes them to remain picked up throughout the cycle, while the relays LR repeat each impulse applied to their respective line relays L.

Each time the quick acting line repeating relays LR are picked up, the several banks of stepping relays at the control office and at the field stations are caused to take one step. As each stepping relay is provided with a stick circuit dependent upon the energized condition of its associated relay SL, each stepping relay when once picked up preferably remains picked up until the end of the operating cycle and the relay SL is deenergized.

Also, during the execution period of each step, that is, the deenergized period of the stepping circuit marked off by the deenergization of the relays LR, the relay CS is positioned in accordance with the code to be transmitted, so that each impulse is of the proper polarity. This station selecting part of the operating cycle has, for convenience, been omitted, but if the SO relay at a particular station is picked up at the end of the third step (in this case), that station is selected and is in readiness to receive a control code, all of which has been explained in great detail in the above mentioned application of N. D. Preston, et al., Ser. No. 455,304, filed May 24, 1930.

On the third step (or through the back contact of the stepping relay *d*) the polarity of the fourth step is determined by suitably positioning the code sending relay CS in accordance with the first impulse of the composite route control code to be transmitted to the selected station.

As the switch machine lever SML has been assumed, by way of example, to be in a reverse position, the code sending relay CS is energized with negative potential from (BB—), through front contact **73** of lever repeating relay R, wire **74**, front contact **75** of code determining relay CD, wire **76**, code bus **77**, back contacts **82**, **83**, **84**, **85** and **86** of stepping relays *d*, *e*, *f*, *g* and *h*, wire **87**, back contact **88** of quick acting line repeating relay LR^0, wire **89**, windings of relays CS, to (CN). Current flowing in this direction through the windings of the relay CS causes its contacts to be actuated to right hand dotted line positions. This causes a negative impulse to be placed upon the stepping circuit upon the deenergization of the relay IM at the end of the third step. This energizes the stepping relays *d* and **4** in synchronism.

The stepping circuit for this fourth step is closed from the positive terminal of the battery BT through wire **90**, front contact **91** of the cycle controlling relay CC, wire **92**, back contact **93** of the impulsing relay IM, wire **94**, polar contact **95** of the code sending relay CS in a right hand position, wire **96**, to the common return line **14** and thence to the last field station, through the stepping and control line including a line relay L at each of the field stations, to the control office over the line wire **12**, windings of the line relay L^0 in the control office, wires **97** and **98**, polar contact **99** of relay CS in a right hand position, wire **100**, back contact **101** of relay IM, wire **102**, front contact **103** of relay CC, wire **104**, to the negative terminal of battery BT.

Current flowing in this direction through the stepping circuit causes the contacts of line relays L to be actuated to left hand positions. The energization of the quick acting line repeating relay LR in response to the energized line relay allows the impulse storing relay IS to be energized in accordance with the polarity applied to the line relay L. Thus, the relay IS receives energy from (B—), through polar contact **105** of line relay L in a left hand position, wire **106**, windings of relay IS, wire **107**, front contact **108** of relay LR, to (CN). If the line relay L had been actuated with positive potential, the contact **105** would have been in a right hand position energizing the relay IS with positive potential from (B+). Thus, the contact **109** of impulse storing relay IS is actuated to right or left hand extreme positions depending upon whether positive or negative polarity is applied to the line relay L.

In this case, the contact **109** is in a left hand position, so that upon the deenergization of the stepping circuit after the stepping relays *d* and **4** have picked up, the switch machine relay SMR is energized by a circuit from (B—), through polar contact **109** of relay IS in a left hand position, wire **110**, back contact **111** of line repeating relay LR, wire **112**, front contact **113** of relay SO, wire **114**, back contacts **115**, **116**, **117** and **118** of stepping relays **8**, **7**, **6** and **5**, front contact **119** of stepping relay **4**, wire **120**, windings of relay SMR, to (CN).

On the other hand, if the lever SML is in a normal position, then the relay N is energized causing (B+) to be applied to the code sending

relay CS which in turn causes (B+) to be applied to the impulse storing relay IS which in turn causes (B+) to be applied to the switch machine relay SMR. Thus, the contacts of the relay SMR may be positioned to right or left positions in accordance with whether the switch machine lever SML is in a normal position or in a reverse position.

With the contact 123 of relay SMR in a right hand position, the normal operating circuit for the switch machine SM is completed from (+), through front contact 121 of approach lock repeating relay ALP, wire 122, polar contact 123 of relay SMR in a right hand position, wire 124, through the switch machine operating mechanism, to (−); while, if the contact 123 is in a left hand position, the reverse operating circuit is completed from (+), through front contact 121 of approach lock repeating relay ALP, wire 122, polar contact 123 of relay SMR in a left hand position, wire 125, through the switch machine operating mechanism, to (−).

During the execution period (deenergization of the stepping circuit) of the fourth step, the code sending relay CS is positioned in accordance with the polarity applied to the code bus 78; and similarly during the execution periods of each of the remaining steps, the relay CS is positioned in accordance with the polarity of the code impulse to be transmitted upon the succeeding step.

As the stop relay S is energized with the signal lever SGL in a central position, (B+) is applied to the code buses 78, 79, 80 and 81 through front contacts 126, 127, 128 and 129 respectively which causes the contacts of the code sending relay CS to be actuated to left hand positions on each of the remaining steps. The resulting transmission of positive impulses on the succeeding steps of the cycle causes the actuation of the polar contacts of the code relays 1CR, 2CR, 3CR and 4CR respectively to right hand positions, in a manner similar to that explained for relay SMR. The impulsing of the line circuit with four positive impulses is allotted as the stop code, and thus the positions assumed by the contacts of the relays 1CR, 2CR, 3CR and 4CR form a circuit which permits the execution of the code transmitted at the end of the cycle.

More specifically, at the end of the operating cycle when the last of the predetermined number of steps is taken and the stepping relay 8 (in this case) is picked up, the cycle controlling relay CC is deenergized causing the stepping circuit to be deenergized. After the stepping circuit has been deenergized for a predetermined period of time, the slow acting relay SL^0 at the control office and the corresponding slow acting relay SL at each field station become deenergized.

During the time after the dropping of the relay SL at the field station and before the relays 8 and SO are dropped away (as relays 8 and SO are stuck up through a front contact of the relay SL and require a certain time to drop away), an execution circuit is completed for momentarily energizing the stop relay SR from (+), through back contact 130 of relay SL, wire 131, front contact 132 of relay SO, wire 133, front contact 134 of stepping relay 8, wires 135 and 136, polar contact 137 of relay 1CR in a right hand position, polar contact 138 of relay 2CR in a right hand position, polar contact 139 of relay 3CR in a right hand position, polar contact 140 of relay 4CR in a right hand position, wire 141, windings of relay SR, to (−). The relay SR is thus momentarily energized during the time that the relay 8 is dropping away, which is possible as the drop away time of a relay is inherently longer than its pick-up time. The opening of back contact 142 of relay SR insures that the route relays RER, NER, RWR and NWR are deenergized.

On the seventh step of the operating cycle when the stepping relay *g* is energized (see Fig. 1), that particular deenergized storing relay ST which has its corresponding code determining relay CD energized for that particular operating cycle, is reenergized through front contact 143 of stepping relay *g*. In this particular case, the relay ST illustrated in Fig. 1 is deenergized and the relay CD is energized, thus on the seventh step, the relay ST is picked up through a circuit from (+), through front contact 143 of stepping relay *g*, wire 144, front contact 145 of code determining relay CD, wire 146, upper winding of storing relay ST, to (−). The energization of the relay ST through this pick-up circuit causes its contacts to be picked up closing its stick circuit at front contact 27 and allowing it to be in a resensitized position in readiness for further initiating the system, as soon as the stepping relay *g* has dropped away at the end of the cycle.

On the next step of the cycle with the stepping relay *h* picked up, the particular code determining relay energized for that cycle, is dropped out. In this case, the relay CD is deenergized by the opening of back contact 63.

The picking up of the relay *h* also causes the cycle controlling relay CC to be deenergized which in turn causes the line circuit to be deenergized allowing the slow acting relays SL to drop away. Thus, the system is returned to its normal "at rest" condition.

From the above description it can be seen that the switch machine SM may be governed by the control lever SML to operate the track switch TS whenever the detector track section is unoccupied and the signals are at stop. Also, each time the switch machine is operated with the signal lever SGL in its stop position, a stop code is transmitted which causes the energization of the stop relay SR at the field station insuring that the route relays are deenergized so as to prevent the clearing of any route.

The establishment of a route.—Although the track switch TS may be controlled separately, it may also be controlled whenever a new route is to be established, which route is set up by movement of the signal lever SGL to the right or to the left to establish east bound or west bound traffic respectively. The movement of the signal lever SGL from its stop position to either proceed position causes the initiation of the system automatically without the actuation of the starting button SB. Thus, if a new route is to be established which requires the operation of the track switch TS to a new position, the switch machine lever SML should be first moved to the new position after which the signal lever SGL may then be moved to its proper proceed position.

For convenience in describing this operation of the system, it may be assumed that the switch machine lever SML remains in the normal position, as the operation involved when the switch lever is moved to a new position is similar to that already described.

The movement of the lever SGL to a right hand position, for example, causes its contact 150 to be moved to a left hand position closing the pick-up circuit for one or the other of the route relays NE or RE dependent upon whether the switch machine lever SML is in a normal or a reverse position. Similarly the movement of the lever SGL to a left hand position moves its contact 150 to a right hand position closing the pick-up circuit for either the relay NW or RW dependent upon the position of the switch machine lever SML.

For convenience, let us assume that the lever SGL is moved to the right to establish east bound traffic over the track switch TS in a normal position. This closes a pick-up circuit for the route relay NE from (+), through make-before-break back contact 148 of code determining relay CD, wire 149, contact 150 of lever SGL in a left hand position, wires 151 and 152, back contacts 153 of reverse relay R, wire 154, front contact 155 of normal relay N, wires 156 and 157, windings of route relay NE, to (—). The energization of the relay NE opens the energizing circuit for the relay S, as previously pointed out, at open back contact 33. Also, the energization of the relay NE opens the stick circuit of the storing relay ST at back contact 21 while the slow acting relay S is dropping away. In other words, the stick circuit for the relay ST is opened for sufficient time period, measured by the drop away time of the relay S, to allow its own contacts to drop and thereby be maintained deenergized by reason of open front contact 27.

The deenergization of the storing relay ST causes the system to be initiated into a cycle of operation, as previously pointed out, by causing the energization of the corresponding station code determining relay CD through back contact 66. The picking up of the contacts of the code determining relay CD opens the pick-up circuit of the relay NE and closes its stick circuit from (+), through front point of make-before-break contact 148 of relay CD, wires 158, 159, 160 and 161, front contact 162 of relay NE, wires 163 and 157, windings of relay NE, to (—). The stick circuit for the relay NE is completed before its pick-up circuits break, as the contact 148 of relay CD is a make-before-break contact.

The picking up of the code determining relay CD which opens the pick-up circuit of the route relays and closes the stick circuit of the particular route relay then energized, prevents the interruption of the particular composite route code that is being transmitted for that cycle of operation. In other words, the operator may change the particular code transmitted in response to the initiation of the system any time up to the time that the code determining relay for the associated station is picked up, but he cannot thereafter effect or change the composite route control code transmitted to that station until the code determining relay CD is again deenergized. In the particular case above described, it may be seen that the closure of front contact 148 will maintain the relay NE energized through its stick circuit, but open back contact 148 prevents the application of energy to the pick-up circuit of any of the other route relays. The contact 148 is preferably made a make-before-break contact so that there will be no interval of time between the opening of a pick-up circuit of a route relay and the closure of its stick circuit.

The system operates to select the proper station in accordance with the code call transmitted by the code determining relay CD which causes the energization of the relay SO at that station. The system then transmits the switch machine control, as above described, being followed by the composite route control code as determined by the route relay NE.

For example, on the fourth step with the stepping relays *d* and *4* picked up, the code sending relay CS is conditioned during the execution period of that step by a circuit which is closed from (B—), through front contact 164 of relay NE, back contacts 168, 169, 170 and 126 of relays RE, NW, RW and S respectively, wire 171, front contact 172 of code determining relay CD, wire 173, code bus 78, front contact 82 of stepping relay *d*, back contacts 83, 84, 85 and 86 of stepping relays *e*, *f*, *g* and *h* respectively, wire 87, back contact 88 of relay LR°, wire 89, windings of relay CS, to (CN).

This causes the impulse for the fifth step to be a negative impulse positioning the impulse storing relay IS in a manner previously described, so that during the execution period of the fifth step, the code relay 1CR is energized with negative potential from (B—), through polar contact 109 of relay IS in a left hand position, wire 110, back contact 111 of relay LR, wire 112, front contact 113 of relay SO, wire 114, back contacts 115, 116 and 117 of relays 8, 7 and 6 respectively, front contact 118 of stepping relay 5, wire 174, winding of relay 1CR, to (CN). This application of negative potential to the windings of the relay 1CR causes its contacts to be actuated to left hand positions.

In a similar manner, the relays 2CR, 3CR, and 4CR are governed in accordance with the polarity applied to the code buses 79, 80 and 81 by the front contacts 165, 166 and 167 of the route relay NE. The composite route control code assigned to the normal east route over the track switch TS is —, —, +, +, thus causing the polar contacts of the code receiving relays 1CR, 2CR, 3CR and 4CR to assume left hand, left hand, right hand and right hand positions respectively.

At the end of the operating cycle, the last stepping relay is maintained and energized a short time after the slow acting relay SL has become deenergized, as previously pointed out, thus executing the composite route code as set up in the code receiving relays. With the normal east code transmitted as just explained, the normal east route relay NER is picked up, during this momentary energization of the code executing circuit, by a circuit from (+), through back contact 130 of relay SL, wire 131, front contact 132 of relay SO, wire 133, front contact 134 of stepping relay 8, wires 135 and 136, polar contact 138 of relay 2CR in a left hand position, polar contact 137 of relay 1CR in a left hand position, wire 175, polar contact 176 of relay 3CR in a right hand position, polar contact 177 of relay 4CR in a right hand position, wire 178, upper winding of relay NER, wires 179, 180, 181 and 182, front contact 183 of check relay CK, to (—). As soon as the contacts of the relay NER are picked up, a stick circuit is closed from (+), through front contact 184 of relay NER, lower winding of relay NER, wires 185, 186, 187 and 188, back contact 142 of stop route relay SR, wires 189 and 190, front contact 191 of track relay T, to (—). The relay NER is thus maintained energized through its stick circuit irrespective of the deenergization of its pick-up circuit.

As soon as the contact 57 of relay NER is picked up, the check relay CK is deenergized thus preventing the energization of any other route stor-

ing relay on subsequent cycles of operation by reason of open contact 183, until the relay NER is caused to drop thus again putting the normal east route to stop.

During the operating cycle above described in connection with the transmission of the normal east route control code, the storing relay ST is reenergized on the seventh step as previously explained through the front contact 143 of the stepping relay g. However, it is to be noted that in this case, the route relay NE has its contacts picked up so that the relay S is deenergized. Thus, the reenergization of the storing relay ST causes its stick circuit to be completed from (+), through front contact of the starting button SB, wires 20 and 192, back contact 193 of stop relay S, wire 26, front contact 27 of storing relay ST, wire 28, lower winding of storing relay ST, to (—).

Also, the code determining relay CD and the cycle controlling relay CC are dropped out on the eighth step, as previously described. The dropping of the contacts of the code determining relay CD, causes the stick circuit of the relay NE to be opened and its pick-up circuit to be again closed. In other words, the route relays NE, RE, NW and RW are always dependent for their energization upon the position of the lever SGL except during the transmission of a composite route control code to the associated field station. The system then returns to the normal at rest condition, as originally explained.

The description above more specifically points out the transmission of a composite route control code for the energization of the relay NER, but any one of the route controlling relays may similarly be energized during an operating cycle in response to the transmission of the associated composite route control code as applied to the stepping and control circuit in the control office by the corresponding route relay.

For example, assuming the reverse east route control relay RE to have caused the transmission of the reverse east composite route control code, the relays 1CR, 2CR, 3CR and 4CR would be positioned as to complete an energizing circuit for the relay RER during the closure of the code executing circuit at the end of the operating cycle. This code executing circuit is traced from (+), through back contact 130 of relay SL, wire 131, front contact 132 of relay SO, wire 133, front contact 134 of stepping relay 8, wires 135 and 136, polar contact 137 of relay 1CR in a right hand position, polar contact 138 of relay 2CR in a right hand position, wire 219, polar contact 140 of relay 4CR in a left hand position, contact 139 of relay 3CR in a left hand position, wire 220, upper winding of relay RER, wires 221, 180, 181 and 182, front contact 183 of check relay CK, to (—).

For example, assuming the reverse west composite route control code to be placed upon the stepping and control circuit by the reverse west route relay RW, then the relays 1CR, 2CR, 3CR and 4CR would be properly positioned to close an energizing circuit for the reverse west route relay RWR during the closure of the code executing circuit at the end of the operating cycle. This code executing circuit is traced from (+), through back contact 130 of relay SL, wire 131, front contact 132 of relay SO, wire 133, front contact 134 of stepping relay 8, wires 135, 222 and 223, polar contact 224 of relay 4CR in a left hand position, polar contact 225 of relay 3CR in a right hand position, wires 226 and 227, polar contact 228 of relay 2CR in a left hand position, polar contact 229 of relay 1CR in a right hand position, wire 230, winding of relay RWR, wires 231, 181 and 182, front contact 183 of check relay CK, to (—).

For example, assuming the normal west code to be placed upon the stepping and control circuit by the normal west route relay NW, then the relays 1CR, 2CR, 3CR and 4CR will be properly positioned to close an energizing circuit for the normal west route relay NWR during the closure of the code executing circuit at the end of the operating cycle. This code executing circuit is traced from (+), through back contact 130 of relay SL, wire 131, front contact 132 of relay SO, wire 133, front contact 134 of stepping relay 8, wires 135 and 222, polar contact 225 of relay 3CR in a left hand position, polar contact 224 of the relay 4CR in a right hand position, wires 232 and 233, polar contact 234 of relay 1CR in a left hand position, polar contact 235 of relay 2CR in a right hand position, wire 236, upper winding of relay NWR, wires 238 and 182, front contact 183 of check relay CK, to (—).

Although there has been no means illustrated in the control office for suitably applying the composite control codes to set up those extra code circuits illustrated in Fig. 2A as terminating in the reference characters X^1, X^2 and X^3, these code executing circuits will be traced assuming the relays 1CR, 2CR, 3CR and 4CR to be in proper positions after the reception of the proper code, so that the application of the code table in Fig. 4 will be more completely understood, as later explained.

Assuming code No. 7 to have been transmitted, then a code executing circuit is completed at the end of the operating cycle from (+), through back contact 130 of relay SL, wire 131, front contact 132 of relay SO, wire 133, front contact 134 of stepping relay 8, wires 135 and 222, polar contact 225 of relay 3CR in a left hand position, polar contact 224 of relay 4CR in a right hand position, wires 232 and 239, polar contact 235 of relay 2CR in a left hand position, polar contact 234 of relay 1CR in a right hand position, to the reference character X^3.

Assuming code No. 10 to have been transmitted, then a code executing circuit is completed at the end of the operating cycle from (+), through back contact 130 of relay SL, wire 131, front contact 132 of relay SO, wire 133, front contact 134 of stepping relay 8, wires 135, 222 and 223, polar contact 224 of relay 4CR in a left hand position, polar contact 225 of relay 3CR in a right hand position, wires 226 and 240, polar contact 229 of relay 1CR in a left hand position, polar contact 228 of relay 2CR in a right hand position, to the reference character X^2.

Assuming code No. 16 to have been transmitted, then a code executing circuit is completed at the end of the operating cycle from (+), through back contact 130 of relay SL, wire 131, front contact 132 of relay SO, wire 133, front contact 134 of stepping relay 8, wires 135 and 136, polar contact 138 of relay 2CR in a left hand position, polar contact 137 of relay 1CR in a left hand position, wire 175, polar contact 177 of relay 4CR in a left hand position, polar contact 176 of relay 3CR in a left hand position, to the reference character X^1.

The manner in which the transmission of a code call is suitably deciphered at a field station and that particular code is executed so as to be stored in a route storing relay such, as for example relays RER, NER, RWR and NWR, will

now be readily understood. Each of these route storing relays is capable of clearing the signal for its corresponding route whenever the track switch has actually set up the proper route over the track rails, this being indicated by the proper position of the contacts of the switch repeating relay WP, and also providing that traffic conditions are proper to allow clearing of the associated route.

For example, the energization of the relay NER causes the energization of the signal control relay 1AG, by a circuit closed from (+), through front contact 194 of track relay T, wires 195 and 196, front contact 197 of relay WP, wire 198, polar contact 199 of relay WP in a right hand position, wires 200 and 201, front contact 202 of relay NER, wire 203, front contact 204 of relay 1H, wire 205, windings of relay 1AG, to (−). The energized condition of the relay 1AG causes the clearing of the signal 1A dependent upon traffic conditions as indicated by the signal 1H. It is assumed for convenience that there are no trains in advance of the signal 1A and that it is allowed to give a proceed signal.

The energization of the relay 1AG also opens the energizing circuit of the relay M at open back contact 39 which in turn opens the stick circuit for the approach locking relay AL at open front contact 49. The dropping of the contacts of the relay AL opens the energizing circuit for the approach locking repeating relay ALP at open front contact 52. With the relay ALP deenergized, the switch machine SM cannot be operated due to open front contact 121, thereby locking the switch machine against erroneous control while a route is cleared over the track switch TS.

Now that the signal 1A is cleared for the passage of traffic in an east bound direction over the track switch TS in a normal position, we may assume that a train proceeds to accept the signal and passes onto the detector track section. The dropping of the track relay T further opens the energizing circuit for the relay ALP at open front contact 55, thus providing suitable detector locking. The dropping of contact 194 of track relay T opens the energizing circuit for the signal control relay 1AG, causing the signal 1A to indicate stop in the rear of the train, which condition is further maintained by the deenergization of the relay 1H while the train is one block in advance of signal 1A, all in accordance with the usual signal practices.

The opening of front contact 194 of track relay T also opens the energizing circuit of the track repeating relay TP which is normally energized by a circuit from (+), through front contact 194 of relay T, wires 195 and 206, windings of track repeating relay TP, to (−). During the time that the track relay T is deenergized and the contacts of the track repeating relay TP are dropping away, the stick circuit for the relay NER is momentarily opened, thus causing the relay 1AG to remain deenergized independent of the train which has just passed beyond the signal 1A. In other words, the opening of front contact 191 deenergizes the route relay NER, for example, so that its contacts drop away, but a short time thereafter the contacts of the relay TP reach deenergized positions placing (−) potential on wire 189 through back contact 207 and wire 208. Therefore, if a composite route control code is transmitted during the occupied condition of the detector track section, the corresponding route relay is picked up in the usual way and is maintained energized through a stick circuit including the back contact 207 of relay TP. Obviously, upon the energization of the track relay T, the stick circuit is closed through front contact 191 before back contact 207 opens.

The passage of a train onto the detector track section effecting the deenergization of the relay 1AG and a display of a stop indication by signal 1A, closes the circuit for the relay M at back contact 39 which in turn closes a pick-up circuit for the approach locking relay AL without the necessity for the intervention of a time period provided by the time element relay TE. This pick-up circuit is closed from (+), through back contact 194 of track relay T, wires 209 and 46, windings of relay AL, wires 47 and 48, front contact 40 of relay M, to (−). Thus, with the relay AL energized the relay ALP will be picked up as soon as the train passes beyond the detector track section allowing the energization of the track relay T.

As the passage of the train has put the signal 1A to stop and has caused the route storing relay NER to be deenergized, it is not necessary for the transmission of a stop route code upon the return of the lever SGL to its stop position by the operator. Thus, assuming the operator is made aware of the passage of the train, he then moves the signal lever SGL to its stop position. This causes the relay NE to be deenergized and its contact 21 assumes a deenergized position before the contact 193 of stop relay S is picked up, thus causing the stick circuit for the storing relay ST to be maintained intact until the system is returned to normal conditions. It is of course to be understood that the storing relay ST has been resensitized at the end of the cycle of operation for the transmission of the outgoing composite route control code.

Putting a route to stop.—If the operator clears a route over the track switch TS, as above described, and desires to change that route before the passage of a train, he must put the route to stop by returning the signal lever SGL to its stop position and then actuate the starting button SB. Thus, this stop condition may not accidentally be set up by the operator and cause a route to be put to stop in the face of an oncoming train, but an extra operation is required of the operator in order that this function of the system shall be carried out. More specifically, if the operator has cleared a route and returns the signal lever SGL to its stop position, he is required to actuate the starting button SB, as the returning of the signal lever SGL to a stop position does not initiate the system. This is because the relay S is deenergized with one of the relays NE, RE, NW or RW energized, thereby closing back contact 193 which shunts contacts 21, 22, 23 and 24 to maintain the relay ST energized through its stick circuit. Then the return of the lever SGL to a stop position deenergizes the particular relay NE, RE, NW or RW which was energized, thereby closing the stick circuit for relay ST at one of the contacts 21, 22, 23 or 24 before it is opened by the energization of relay S at back contact 193. In other words, the energization of a relay such as relay NE, and the resulting deenergization of the relay S provides a sequence for deenergizing the stick circuit of the relay ST; while the deenergization of a relay, such as relay NE, and the resulting energization of the relay S provides a sequence for maintaining the stick circuit of the relay ST intact.

The deenergization of the storing relay ST and the resulting transmission of the stop code causes the stop route relay SR to be energized momentarily at the field station deenergizing the particular route storing relay which has been previously picked up, as for example the relay NER which in turn drops the relay 1AG. The deenergization of the relay 1AG, for example, under such conditions, causes the relay M to be picked up. However, the approach locking relays AL and ALP are not immediately picked up but are energized only after a predetermined time measured by the time element relay TE.

For example, after the relay M is energized, the heating element of the thermal relay TE is energized through a circuit from (+), through heating element 42, wire 43, back contact 44 of relay AL, wires 210 and 48, front contact 49 of relay M, to (—). After a predetermined time the heating element 42 is effective to close the contacts 211 and open the contacts 50 of the time element relay TE. A pick-up circuit for the relay AL is then closed from (+), through closed contact 211, wires 212 and 46, windings of relay AL, wires 47 and 48, front contact 49 of relay M, to (—). The picking up of the contacts of the relay AL opens the energizing circuit for the heating element 42 and closes a stick circuit for the relay AL, as previously described. This stick circuit includes the winding of the relay AL which is of sufficiently high resistance to allow the heating element to cool opening the front contacts 211 and closing the back contact 50. Closure of contacts 50 with the relay AL energized, energizes the relay ALP, as previously pointed out. Thus, after a predetermined time measured by the heating and cooling time of the time element relay TE, the front contact 121 of relay ALP is closed allowing the operation of the switch machine SM in response to control by the operator.

In other words, the system of the present invention provides a switch machine lever SML and a signal lever SGL for determining the route direction and whether a route shall be clear or stop, with coding means and a code transmitting means operated in accordance with the route conditions selected together with a code receiving means and code deciphering means at the field station, which system functions in such a way that any particular route may be established over the track switches, and the signals for the desired direction may be cleared or held at stop. With this arrangement, a signal can not be cleared unless the route which that signal governs is actually set up over the track switch. In other words, if the track switch fails to respond to a switch machine control, the route will not be erroneously established; or, if the track switch is properly operated and the improper route storing relay is picked up, the signal for the route established by the switch will not be cleared.

For example, if a reverse west route is desired to be set up but the switch machine SM fails to respond to the control of the relay SMR, no route will result. This is because the relay RWR is picked up to clear the proper signal but the switch still being in a normal position prevents the energization of relay 2BG at polar contact 199 of relay WP, which contact has remained in a right hand position.

Thus, it is evident that the use of composite route control codes in accordance with the present invention supplies a very desirable coordination between a track switch and the clearing of the routes including that switch.

Code characteristics.—The composite route control codes for actuating the route storing relays RER, NER, RWR and NWR together with the stop route relay SR, are chosen in such a manner as to add to the reliability of the system. In accordance with the present invention, the failure of the transmission of a proper code impulse on any particular step results in the failure of the control of any route storing relay. This may be best explained by more particular reference to the typical code table in Fig. 4 of the accompanying drawings and with reference to the code relays 1CR, 2CR, 3CR and 4CR in Fig. 2A.

Each of the code receiving relays CR may have its polar contacts positioned to either a right hand or a left hand extreme position on its respective step. Thus, on four steps with four code receiving relays CR, the contacts of these relays may be positioned in sixteen different combinations. This has been illustrated in the typical code table illustrated in Fig. 4 of the accompanying drawings by the use of symbols. For example, a + symbol represents the polar contacts of a code receiving relay CR as being in right hand positions; while a — symbol indicates the polar contacts of a code receiving relay CR as being in left hand positions. The first vertical column of symbols (see Fig. 4) represents the positions of the contacts of the relay 1CR; the second vertical column of symbols represents the positions of the contacts of relay 2CR; and so on for each of the columns illustrated.

These symbols also represent the two opposite kinds of impulses that are applied to these relays on the respective steps, namely, positive and negative impulses. In other words, one of two choices may be made for each step, that is, either a positive or a negative impulse may be transmitted which positions the contacts of the particular code receiving relay for that step in either right or left hand positions. When a code receiving relay on each of four steps is employed, and one of two choices is made on each step then any one of sixteen different combinations of choices may be made.

These different combinations are then assigned as the composite route control codes. Then during any operating cycle a particular code may be transmitted, as for example code No. 1 which has been assigned as the stop code and the transmission of which has already been described. In a similar manner, certain of the remaining codes are assigned as composite route control codes, in a manner presently to be explained.

In accordance with the present invention, only those codes in the typical code table illustrated in Fig. 4 are employed which differ by two steps, that is, only alternate codes are actually used. For example, if the system failed to transmit the proper code impulse for the code receiving relay 1CR in the effort to transmit code No. 1, then code No. 9 would be formed. If this code were employed as a composite route control code, then an erroneous route would be established. The present invention provides, however, that code No. 9 shall not be employed but that a code such as No. 13 shall be employed thus require that, if code No. 1 is being transmitted, two errors must occur, namely, the change of the code impulse for code receiving relay 1CR from a + to a — and the change of a code impulse for the code receiving relay 2CR from a + to a —, in order for an erroneous route to be established. Thus, it is

seen that two codes may be selected which differ by two steps.

In order that the number of codes necessary for controlling the several routes over the track switch TS (see Fig. 2B) may be sufficiently large, all of the codes that differ by two steps have been selected from the typical code table in Fig. 4 and illustrated in Fig. 2A. By employing the rule of trial and error to select these codes differing by two steps in the above code table, we have eight codes, namely, code No. 1, 4, 6, 7, 10, 11, 13 and 16. These codes are either employed in Figs. 2A and 2B for selecting or putting to stop the various routes, as indicated in the following table, or as spare codes indicated by the reference characters X with suitable exponents.

Code No.	Use	Relay controlled
1	Stop route code	SR
4	Reverse east route	RER
6	Reverse west route	RWR
7	X^3	
10	X^2	
11	Normal west route	NWR
13	Normal east route	NER
16	X^1	

Thus, it can be seen that a total code table may be formed for any number of steps in a similar manner as illustrated above. The number of code combinations which may be obtained for any number of steps may be found as follows:—

Let S=the number of steps
N=the number of choices
C=the total number of codes or combinations

Then: $C=N^S$

From those codes selected as differing by two steps, it will be noted that the symbols of the first three steps form a perfect total code type for three steps. Also, certain of these codes, as for example code Nos. 4 and 6 already differ by two steps without the fourth step. With the addition of the fourth step, every code differs by two steps. In other words, every code of any total code table may be made to differ by two steps by properly adding a step. Thus, the maximum number of codes differing by two steps which may be selected from any total code table may be expressed by:—

Let X=the number of codes differing by two steps

Then: $X=N^{S-1}$ or $\frac{C}{N}$

As the addition of the fourth step is an unsymmetrical arrangement, it is perhaps the best method to form a complete total code table with the proper number of steps and then select those codes from the total code table by following the empirical rules:—

1. The first code is selected only from code tables having an even number of steps.
2. The last code is always selected.
3. All codes having two + symbols or any even number of + symbols are selected.
4. Rules 1, 2 and 3 divide the codes of a total code table into halves, either half of which may be employed.

It is to be understood that the above rules apply only to code tables based upon a choice of two on each step. In other words, all code tables formed upon the basis that either a positive or a negative impulse is transmitted on each step, or some other equivalent arrangement, may have the above given Rules 1, 2, 3 and 4 apply to such tables. Where a choice of three or some other number of choices is employed, it is necessary to form suitable rules to determine the selection of the proper codes, it being believed sufficient for disclosure of the invention to merely point out the relationship with respect to the typical total code table illustrated above.

Although this arrangement or selection of codes from a total code table has been shown as applied only to the control of routes over a track switch from a particular field station, it is to be understood that the same arrangement and selection of codes may be applied in selecting the field stations. In other words, any system employing code type station selection, may so select those station code calls as to have each code call employed differ by two steps from every other code call. One such system where such code selection may be employed, is shown and described in the pending application of N. D. Preston et. al., Ser. No. 455,304, filed May 24, 1930.

Modified code receiving relays.—With reference to Fig. 3, the relay SMR^3 is employed to control the switch machine in the same manner as pointed out in conection with Fig. 2A, but is also employed as one of the code receiving relays for designating or choosing the particular route to be set up.

The relays SMR^3, $1CR^3$, $2CR^3$ and $3CR^3$ are substituted for the relays SMR, 1CR, 2CR and 3CR in Fig. 2A, it being noted that there is no relay corresponding to relay 4CR. These relays of Fig. 3 are connected to the front contacts 119, 118, 117 and 116 of the respective stepping relays 4, 5, 6 and 7 through wires 241, 242, 243 and 244. The wire 135^3 is connected to the heel of contact 134 in place of wire 135. Similarly, the wires 141^3, 220^3, 178^3, 230^3 and 236^3 are connected to the wires 141, 220, 178, 230 and 236 of Fig. 2B respectively, so that the route relays RER, NER, RWR, NWR and SR are controlled thereby in a similar manner as they are controlled by the relays 1CR, 2CR, 3CR and 4CR. The wires 124^3, 122^3 and 125^3 are also connected to the wires 124, 122 and 125 respectively of Fig. 2B. The relay SMR^3 is operated in a similar manner as relay SMR so that the switch machine may be operated to normal or reverse positions in accordance with the control of the lever SML by the operator. However, the switch machine relay SMR^3, is now included as a code receiving relay, or in other words it is controlled in accordance with the switch machine lever but is made a part of the route control and those code executing circuits for normal routes include a contact of this relay in the right hand position, while those code executing circuits for reverse routes include a contact of this relay in a left hand position.

The codes have been assigned to the control of the various routes as follows:—

Code No.	Use	Relay controlled
1	Stop route code	SR
9	Stop route code	SR
14	Reverse west route	RWR
4	Normal west route	NWR
15	Reverse east route	RER
8	Normal east route	NER

Although certain of the above codes differ by two steps, except as later to be explained, these codes have not been selected in accordance with

the rules previously given. In other words, inasmuch as the maximum number of codes obtainable from four steps are not employed in this specific case, certain other codes than those that come under the rules, may be arbitrarily selected and employed to accomplish the control of the various routes assigned thereto. In the case of the stop codes, it is immaterial whether one code or the other is transmitted, as either results in putting the routes to stop.

It is believed that the code executing circuits through the code receiving relays will be understood by analogy to the explanation given in connection with Figs. 2A and 2B.

The code relays employed with this modified form require the code jumpers associated with the relays NE, NW, RE, RW and S in the control office to be rearranged to transmit the proper codes. As this is merely a rearrangement of the code jumpers already provided, and does not necessitate the change of any structure, merely the application of the different polarities to the front contacts of relays NE, NW, RE, RW, and S will be pointed out, by listing the reference characters of the contacts and the particular polarity which must be applied to the front points of these contacts located directly beneath the contact reference number.

164	168	169	170	126
B—	B—	B+	B—	B+
165	213	214	215	127
B—	B—	B—	B+	B+
166	216	219	218	128
B—	B+	B—	B—	B+

It will be noted that inasmuch as code receiving relay 4CR is omitted in this modification, the jumpers for the front contacts on the relays NE, RE, NW and RW for applying code impulses to the code bus 81 are omitted.

Field station track layouts.—Although the present invention has been shown as applied to a field station including a single track switch, it may be applied to a field station having any type of track layout.

In case a track layout includes several track switches all of which are included in conflicting routes, that is, routes that include each one or all of the track switches, a route storing relay may be assigned to each route and a suitable number of code receiving relays employed to receive the codes which are assigned to these routes. In other words, when the field station has that type of track layout in which only one route may be established at any one time, then the field station is merely an enlargement of the arrangement already described in connection with Figs. 1, 2A and 2B.

On the other hand, if a track layout is such that certain of the switches are in non-conflicting or parallel routes, it is sometimes desirable to provide separate field stations for governing those track switches which are in these non-conflicting routes. However, if desired, the same field station equipment may be arranged to have two or more groups of code receiving relays, each group being capable of receiving a composite route control code during the same operating cycle that any one of the other groups is receiving a composite route control code. In other words, by the addition of steps and the addition of code receiving relays in groups with their corresponding route storing relays, several routes may be set up on the same operating cycle at the same field station for non-conflicting route track layouts.

Thus, the present invention has been shown and described as embodying a centralized traffic control system for railroads wherein composite route control codes are transmitted so as to increase the reliability of the system, and wherein these codes are so selected in accordance with the present invention as to require that two failures must occur in the transmission of these codes in order to obtain an erroneous route.

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

What I claim is:

1. In a centralized traffic control system for railroads, a track switch, a plurality of signals governing traffic over said track switch, a route storing relay for each of said signals, a stop route relay, a control office, a code transmitting means manually governable in said control office for transmitting anyone of a plurality of series of code impulses, a code receiving means at said track switch said means including a plurality of code receiving relays each being individually controlled in accordance with a particular impulse in a series of code impulses received from the control office, means selectively energizing a particular one of said route storing relays or said stop route relay in accordance with the composite response of said code receiving relays to a particular series of code impulses, and means preventing the selective energization of any other route storing relay in response to said code receiving relays after the energization of said particular route storing relay until either said stop route relay is selectively energized or a train passes over said track switch.

2. In a centralized traffic control system for railroads, a field station including a track switch, a switch machine for operating said track switch, a plurality of signals governing traffic over said track switch, a route storing relay for each route over said track switch for governing the signals of the corresponding route, a stop route relay, a switch machine relay, a control office having a code transmitting means capable of transmitting a plurality of series of code impulses to said field station, code receiving means at said field station said means including a plurality of code receiving relays and said switch machine relay each being individually controlled in accordance with a particular impulse in each series of code impulses received from said control office, means selectively energizing a particular one of said route storing relays or said stop route relay in accordance with the composite response of said code receiving relays to a particular series of code impulses, means maintaining energized that particular selected route relay until said stop route relay is selectively energized, means effective while that particular selected route storing relay is energized for preventing any other route storing relay from being selectively energized, means causing the signals for a route to indicate proceed when the corresponding route storing relay is energized,

and means preventing operation of said switch machine by said switch machine relay when said signals for any route over said track switch indicate proceed.

3. The method of assigning codes in a centralized traffic control system for railroads wherein the communication system is of the coded type requiring an impulse of either of two distinctive characters on each of a predetermined number of steps, comprising the forming of a code table having code combinations equal in number to two raised to the power of the number of predetermined steps by the use of two distinctive symbols with said table arranged in a symmetrical manner so that the first code combination has all symbols of one character and the last combination has all symbols of the opposite character, the assigning of the first code combination from all code tables formed on the basis of an even number of steps, the assigning of the last code from all code tables irrespective of the number of steps, and the assigning from all code tables of all other code combinations having an even number of those symbols similar to the symbols found in the first code combination.

4. In a centralized traffic control system for railroads, a railroad track switch, a switch machine for operating said track switch, signals for governing traffic in either direction with said track switch in either of two extreme positions, a switch machine control lever for governing said switch machine, a signal control lever for governing said signals said lever having a stop position and a proceed position, a normally at rest communication system connecting said switch machine control lever and said signal control lever with said switch machine and said signals respectively, a starting button for initiating said communication system into operation, and other initiating means including said signal lever operable to initiate said communication system into operation only when said signal lever is moved from a stop position to a proceed position.

5. In combination, a central control office, a distant way station, a railway signal at said way station, a selector system of the normally "at rest" code type for transmitting distinctive controls to said way station to clear said signal subject to local traffic control and to put such signal to stop, a lever for determining whether said signal shall be put to stop or shall be permitted to clear through the medium of said selector system, and means effective to initiate said system if said lever is moved to its clear position but not to initiate said system if said lever is moved to the stop position.

6. In combination, a central control office, a distant way station, a railway signal at said way station, a selector system of the normally "at rest" code type for transmitting distinctive controls to said way station to clear said signal subject to local traffic control and to put such signal to stop, a lever for determining whether said signal shall be put to stop or shall be permitted to clear through the medium of said selector system, means effective upon the passage of a train by a signal at proceed to place such signal in its stop condition and maintain it there until conditioned for clearing by said selector system, and means effective to initiate said selector system if said lever is moved to its clear position but not to initiate said system if said lever is moved to the stop position.

7. In combination, a central control office, a distant way station, a railway signal at said way station, a selector system of the normally "at rest" code type for transmitting distinctive controls to said way station to clear said signal subject to local traffic control and to put such signal to stop, a lever for determining whether said signal shall be put to stop or shall be permitted to clear through the medium of said selector system, means effective upon the passage of a train by a signal at proceed to place such signal in its stop condition and maintain it there until conditioned for clearing by said selector system, means effective to initiate said selector system if said lever is moved to its clear position but not to initiate said system if said lever is moved to the stop position, and other means manually operable for initiating said selector system.

8. In combination, a local control office, a distant way station, a plurality of railway signals at said way station, a stick relay for each signal each of which if energized permits clearing of such signal subject to traffic conditions, a line circuit connecting said office and way station, a selector system operating through the medium of said line circuit to pick up any one of said stick relays, and a slightly retarded relay controllable by any one of said stick relays to prevent a second stick relay being picked up following the picking up of one of said stick relays, stick circuits for said stick relays, and contacts included in said stick circuits opened upon passage of a train by said signals.

9. In combination, a local control office, a distant way station, a plurality of railway signals at said way station, a stick relay for each signal each of which if energized permits clearing of such signal subject to traffic conditions, a line circuit connecting said office and way station, a selector system operating through the medium of said line circuit to pick up any one of said stick relays, and a slightly retarded relay controllable by any one of said stick relays to prevent a second stick relay being picked up following the picking up of one of said stick relays, stick circuits for said stick relays, a track circuit adjacent said signals including a track relay, and contacts included in said stick circuits opened upon entrance of a train upon said track circuit but not opened if said track circuit was occupied prior to picking up of a particular stick relay.

10. In combination, a local control office, a distant way station, a plurality of railway signals at said way station, a stick relay for each signal each of which if energized permits clearing of such signal subject to traffic conditions, a line circuit connecting said office and way station, a selector system operating through the medium of said line circuit to pick up any one of said stick relays, and a slightly retarded relay controllable by any one of said stick relays to prevent a second stick relay being picked up following the picking up of one of said stick relays, stick circuits for said stick relays, a track circuit adjacent said signals including a track relay, and contacts included in said stick circuits opened upon entrance of a train upon said track circuit but not opened if said track circuit was occupied prior to picking up of a particular stick relay nor opened upon departing of a train from said track circuit.

11. In combination, a local control office, a distant way station, a plurality of railway signals at said way station, a stick relay for each signal each of which if energized permits clearing of such signal subject to traffic conditions,

a line circuit connecting said office and way station, a selector system operating through the medium of said line circuit to pick up any one of said stick relays, and a slightly retarded relay controllable by any one of said stick relays to prevent a second stick relay being picked up following the picking up of one of said stick relays, stick circuits for said stick relays, a track circuit adjacent said signals including a track relay, contacts included in said stick circuits opened upon entrance of a train upon said track circuit but not opened if said track circuit was occupied prior to picking up of a particular stick relay nor opened upon departing of a train from said track circuit, and other contacts in said stick circuits controllable manually through the medium of said selector system.

12. In a railway traffic controlling system of the type in which any one of a large number of traffic controlling devices at a way station of a railway system may be controlled from a central office through the medium of a code type selector system, of a switch machine lever for controlling a track switch at said way station through the medium of said selector system, a signal lever for controlling a signal associated with said switch through the medium of said selector system, two stick relays interlocked so that either can be picked up only if the other is down and which may be picked up by said switch lever, and stick circuits for holding said stick relays energized independently of said switch lever while said selector system is conditioned to clear such signal.

13. In a railway traffic controlling system of the type in which any one of a large number of traffic controlling devices at a way station of a railway system may be controlled from a central office through the medium of a code type selector system, of a switch machine lever for controlling a track switch at said way station through the medium of said selector system, a signal lever for controlling a signal associated with said switch through the medium of said selector system, other means for transmitting to said way station through the medium of said selector system information as to what position said track switch should assume, and means for preventing clearing of said signal if the switch machine does not assume a position corresponding the said information.

14. In a centralized traffic controlling system for railroads; the combination with a control office and a field station; of a line circuit connecting said control office and said field station; code transmitting means at said control office for transmitting any one of a plurality of different codes, each code of which comprises a plurality of time spaced impulses, each impulse being one of a plurality of differing characters, certain of which characters are recurring but so arranged that every code differs from every other in the character of at least two impulses for the corresponding elements of each of the different codes; manually governable means for selecting which code is to be transmitted at any one time; code responsive means at the field station responsive to register every code; traffic controlling devices at the field station; and means for controlling said traffic controlling devices in accordance with said code responsive means when one of said codes is registered but said means being ineffective when a code having its impulses differing in the character of only one impulse is registered.

15. In a railway traffic controlling system of the type in which any one of a large number of traffic controlling devices at a way station of a railway system may be controlled from a central office through the medium of a code type selector system, of a switch control lever, two stick relays having pick-up circuits so interlocked that one may be picked up with said lever in one position only if the other is down and the other can be picked up with said lever in its other position only if said one relay is down, means for transmitting controls to a track switch through the selector type system in accordance with the positions of said stick relays, and stick circuits for at times holding said stick relays energized independently of said switch control lever.

16. In a centralized traffic controlling system for railroads; a control office and a field station connected by a line circuit; traffic controlling devices at said station; manual means in said office; means responsive to the operation of said manual means for applying any one of a plurality of series of direct current polar impulses to said line circuit, each series comprising the same number of impulses and differing from each other series in the polarity of at least two corresponding impulses; and code responsive means at the field station including a plurality of relays each individually responsive to the polarity of a particular impulse of a particular order in a series, said code responsive means being effective to govern said traffic controlling devices in accordance with the polarities of the impulses of each of said series.

17. A centralized traffic control system for controlling the clearing of signals at a distant field station from a control office comprising, a line circuit extending from the control office to the field station, stepping relays operated sequentially in response to impulses applied to said line circuit irrespective of their character, a neutral signal control relay for governing the clearing of a signal for a particular direction, means governed by said stepping relays and responsive to the character of energization of said line circuit for energizing said signal control relay, a track relay of a track circuit adjacent the signal and in advance thereof, a slow-release repeater relay directly controlled by said track relay, and a stick circuit for signal control relay closed only if said detector track relay is energized or said repeater relay is deenergized.

18. A centralized traffic control system for governing the clearing of a signal at a distant field station from a control office, a single stepping and control line circuit extending from the control office to the field station, a neutral signal control relay for controlling the clearing of a signal governing traffic in a particular direction, means responsive to the polarity of energization of said line circuit for momentarily energizing said control relay, a track relay of a track circuit adjacent said signal in advance thereof, a stick circuit for said control relay including a front contact of said track relay, and means controlled by said track relay for establishing said stick circuit after an interval of delay following deenergization of said track relay and until said track relay is again energized to close said stick circuit through its front contact.

19. In a centralized traffic control system of the multiple impulse type, a line circuit, a signal control relay for controlling the clearing of a signal governing traffic in a particular direction, means responsive to the polarity of energization of said line circuit for momentarily energizing

said control relay, a track relay of a track circuit adjacent to and in advance of said signal, a slow releasing repeater relay directly controlled by said track relay and assuming its energized and deenergized condition respectively after an interval of relay as said track relay is energized and deenergized, and a stick circuit for said control relay including in multiple a front contact of said track relay and a back contact of said repeater relay.

20. A centralized traffic control system of the multiple polarized impulse type for governing the clearing of signals associated with a track switch comprising, a single stepping and control line circuit, a polar relay in said line circuit, a series of stepping relays operated sequentially in response to the energization of said line circuit, two neutral signal control relays controlling the clearing of signals governing traffic in opposite directions over the track switch, means governed by said stepping relays and said polar line relay for energizing one or the other of said control relays, a track relay of a detector track circuit adjacent said switch and in advance of said signals, a slow release repeater relay directly controlled by said track relay, and a stick circuit for said control relays jointly governed by said track relay and its repeater relay, said stick circuit being broken by the movement of a train into said track circuit but not by a movement of a train out of said track circuit, and being closed after an interval of delay following deenergization of said track relay.

21. A centralized traffic control system for governing the clearing of signals associated with a track switch by the character of impulses applied to a single stepping and control line circuit comprising, in combination with said line circuit, a polar relay in said line circuit, a bank of stepping relays operated sequentially by a series of impulses applied to said line circuit, a neutral signal control relay controlled jointly by said polar line relay and said stepping relays, and a stick circuit for said control relay interrupted momentarily only during the movement of a train into the track section in advance of the signal controlled by that relay, whereby said control relay when energized to clear the signal is automatically deenergized by the passage of a train but may be again energized by a subsequent series of impulses applied to said line circuit even though a train is present.

22. A centralized traffic control system for governing the operation of signals at a distant field station from a control office comprising, a stepping and control line circuit, a bank of stepping relays sequentially operated in response to impulses applied to said line circuit irrespective of their character, a neutral signal control relay, means governed by said stepping relays and responsive to the character of energization of said line circuit for momentarily energizing said control relay, a stick circuit for said signal control relay, a track relay of a track circuit adjacent to and in advance of the signal controlled by said control relay for interrupting said stick circuit, and means governed by said stepping relays and responsive to the character of the energization of said line circuit for also deenergizing said signal control relay without operation of said track relay.

23. A centralized traffic control system for governing the operation of traffic controlling devices at a distant field station from a control office comprising, a single stepping and control line circuit extending from the control office to the field station, a bank of stepping relays at the field station operating sequentially one at a time in response to the energization of said line circuit irrespective of the character of such energization, a group of decoding relays having energizing circuits controlled by said stepping relays and respectively conditioned during successive energizations of said line circuit in accordance with the character of such energization, neutral control relays for governing the traffic controlling devices, means for momentarily energizing said control relays in accordance with the condition of certain of said code responsive relays and during the deenergization of said line circuit at the end of the cycle of operation of said stepping relays, and means for maintaining said control relays energized until changed during a subsequent cycle of operation.

24. A centralized traffic control system for governing the operation of traffic controlling devices at a distant field station from a control office comprising, a single normally deenergized stepping and control line circuit extending from the control office to the field station, control levers in the control office, means governed by said control levers for applying to said line circuit a series of time spaced impulses each of a selected character, a group of decoding relays at the field station, step-by-step means responsive to the successive energizations of said line circuit for rendering said decoding relays responsive to the character of such energizations, neutral stick control relays for governing the operation of the traffic controlling devices, means for momentarily energizing said control relays after the series of impulses operating said code responsive relays have been applied to said line circuit in accordance with the then existing condition of said decoding relays, and stick circuits for maintaining said control relays energized after such momentary energization thereof until changed subsequently by another series of impulses.

25. A centralized traffic control system for governing the operation of traffic controlling devices at a distant field station from a control office comprising a single normally deenergized stepping and control line circuit connecting the control office and the field station, a series of stepping relays at the field station operated sequentially one at a time in response to the energization of said line circuit irrespective of the polarity of such energization, a group of decoding relays having energizing circuits sequentially established by the operation of said stepping relays and respectively responsive to the polarity of successive energizations of said line circuit, a plurality of control relays for governing the operation of the traffic controlling devices, and means for momentarily energizing said control relays simultaneously during the deenergization of said line circuit at the end of the cycle of operation of said stepping relays in accordance with the then existing condition of said decoding relays.

26. In a centralized traffic control system for governing the operation of traffic controlling devices at a field station from a control office over a single stepping and control line circuit, field station equipment comprising, a series of stepping relays operated sequentially as successive impulses are applied to said line circuit irrespective of the character of such impulses, decoding relays, energizing circuits controlled by said stepping relays for conditioning said decoding relays successively in accordance with the character of

the successive impulses applied to said line circuit, neutral stick control relays for governing the operation of traffic controlling devices, means for momentarily energizing said control relays in accordance with the then existing condition of said decoding relays during the deenergization of said line circuit at the end of the cycle of operation of said stepping relays, stick circuits for maintaining said control relays energized, and means responsive to a particular combination of impulses applied to said line circuit for governing said stick circuits.

27. A centralized traffic control system for transmitting controls from a control office to a field station by the character of successive impulses applied to the line wires extending from the control office to the field station, a group of decoding relays at the field station successively energized in accordance with the character of a plurality of impulses applied to said line wires, a plurality of control relays, an energizing circuit for each of said control relays including contacts of a plurality of certain of said decoding relays, means for momentarily supplying current to said energizing circuits for said control relays simultaneously at the end of the series of impulses applied to said line wire, and means for maintaining said control relays energized until changed by a subsequent series of impulses.

28. In a centralized traffic control system, the combination with a power operated track switch at a field station and signals for governing traffic in opposite directions over said switch in its different positions, line wires extending from a control office to said field station, control receiving apparatus at a field station comprising route control relays of the neutral type one for each signal corresponding to a given direction of traffic and a particular position of said track switch, a series of stepping relays operated sequentially as a series of impulses are applied to said line wires during an operating cycle irrespective of the character of said impulses, means for energizing said control relays selectively only one at a time in accordance with the character of several impulses in a given series taken in combination, a stick circuit for each control relay, means responsive to a distinctive series of impulses for temporarily breaking said stick circuits, and other means controlled by a track circuit adjacent the switch for only momentarily breaking said stick circuit upon the passage of a train.

29. In a centralized traffic control system of the character described, the combination with a line circuit extending from a control office to a field station, code receiving apparatus at the field station comprising a plurality of route relays, means for momentarily and selectively energizing said route relays in accordance with the polarity of each of a plurality of successive energizations of said line circuit taken in combination, a stick circuit for maintaining each route relay energized, and means responsive to a distinctive combination of the polarity of another plurality of impulses applied to said line circuit for temporarily breaking said stick circuits.

30. A centralized traffic control system for governing the operation of a power-operated track switch and its associated signals at a distant field station from a control office comprising, line wires extending from the control office to the field station, a series of stepping relays at the field station operated sequentially by impulses applied to said line wires, a plurality of route control relays at the field station one for each route over said track switch in a particular position and in a particular direction, means governed by said stepping relays for selectively energizing said route control relays in accordance with the character of each of a series of impulses applied to said line wires, stick circuits for said route control relays, and a track relay of a track section adjacent the switch for interrupting said stick circuits.

31. A centralized traffic control system for governing the operation of a power-operated track switch and its associated signals at a distant field station from a control office by impulses applied to line wires comprising, a switch control relay, a plurality of signal control relays at the field station one for each position of the track switch and for each direction of traffic over said switch and each control relay being associated with the signal for the corresponding direction of traffic and position of the track switch, means for selectively energizing said control relays in accordance with the character of a series successive impulses applied to said line wires at the control office, a switch position repeater relay conditioned in accordance with the position and locked condition of the track switch, and signal clearing circuits for said signals, the circuit for any given signal being governed by its control relay and said switch position repeater relay so as to clear its signal only when the control relay for that signal is energized and the track switch is in a corresponding position.

32. In a centralized traffic control system of the character described, a control office, a field station, a line circuit connecting the control office with a field station, a bank of stepping relays at the field station operated in response to successive energizations of said line circuit, a power-operated track switch and associated signals for governing traffic over said switch, a plurality of neutral signal control relays, one for each position of said track switch and each direction of traffic over said switch, means governed by said stepping relays for momentarily energizing said signal control relays relectively dependent upon the character of each of a plurality of impulses applied to said line circuit taken in combination, means effective whenever any one of said signal control relays is energized for preventing energization of the others, stick circuits for maintaining said signal control relays energized, a track relay of a track section adjacent the switch for momentarily interrupting said stick circuits, and means responsive to a distinctive series of impulses applied to said line circuit for also momentarily interrupting said stick circuits.

33. A centralized traffic control system for governing the operation of a power-operated track switch and its associated signals at a distant field station from a control office comprising, a stepping and control line circuit extending from the control office to the field station, a bank of stepping relays operated sequentially by impulses applied to said line circuit, a switch control relay for governing the operation of said track switch, an energizing circuit for said switch control relay governed by a particular stepping relay and supplied with current of a polarity dependent upon the character of a particular impulse applied to said line circuit, route control relays one for each route over said track switch in its different positions and in opposite directions, means governed by said stepping relays for selectively energizing said route control relays dependent upon the

character of each of a plurality of impulses in combination applied to said line circuit subsequently to the impulse controlling said switch control relay, a switch position repeater relay governed in accordance with the position and locked condition of said track switch, and signal control circuits controlled by said route control relays and said switch position repeater relay for governing the clearing of the respective signals governing traffic over said switch in opposite directions.

34. Field station equipment for receiving controls transmitted from a control office over a single stepping and control line circuit comprising, a series of stepping relays operated as said line circuit is successively energized irrespective of the character of such energization, a group of decoding relays, energizing circuits for said decoding relays governed by said stepping relays to selectively energize said decoding relays to register the character of each successive energization of said line circuit, a slow-release relay energized at the beginning of the cycle of operation of the stepping relays and deenergized after the last stepping relay has been energized, a group of control relays, energizing circuits for said control relays including contacts of a certain number of said code responsive relays, means for momentarily supplying current to said energizing circuits for said control relays simultaneously after the last stepping relay has been energized and said slow-release relay is deenergized, and means for maintaining said control relays energized until changed by the subsequent series of energization of said line circuit.

35. Field station equipment for a centralized traffic control system on a railroad for registering controls transmitted from a control office over a single stepping and control line circuit comprising, a stepping relay bank caused to operate one step for each impulse on said line circuit irrespective of its polarity, a plurality of decoding relays successively rendered available to be conditioned in accordance with the polarity of successive energizations of said line circuit, a plurality of neutral control relays having energizing circuits including in series contacts of certain of said decoding relays, means for momentarily supplying current to said energizing circuits upon deenergization of said line circuit after said successive energizations thereof, stick circuits for said control relays, and means controlled by traffic on the railroad for at times momentarily breaking said stick circuits.

36. Field station equipment for a centralized traffic control system for receiving controls transmitted from a control office by the polarity of successive energizations of a normally deenergized stepping and control line circuit comprising, a polar line relay in said line circuit, a series of stepping relays operated sequentially as said line circuit is successively energized, a slow-acting relay maintained energized while said line circuit is being successively energized, a station selecting relay responsive to a particular combination of impulses of a predetermined character, decoding relays, means governed by said stepping relays for successively energizing said decoding relays dependent upon the polarity of successive energizations of said line circuit, a group of control relays having energizing circuits including in series the contacts of certain of said decoding relays, and a circuit for momentarily supplying current to said energizing circuits simultaneously including a back contact of said slow-acting relay, a front contact of said station selecting relay, and a front contact of the last stepping relay of said series.

37. Field station equipment for receiving controls transmitted from a control office over a single line circuit comprising a step-by-step means operated step by step through a cycle of operation one step for each energization of said line circuit irrespective of the character of such energization; a plurality of decoding devices, one for each step of said step-by-step means, and each device being of the type that remains in the position to which it was last actuated; energizing circuits for said decoding devices governed by said step-by-step means to selectively position each device in accordance with the distinctive character of the energization of said line circuit for its step; a group of control relays; energizing circuits for said control relays including contacts of said decoding devices, each of said circuits differing from every other of such circuits in its contact selections as to require the operation of at least two of said decoding devices to different positions to close a particular one of such circuits following the closure of any other of such circuits; and means for energizing, only at the end of a cycle of operation of said step-by-step means, the particular one of said energizing circuits closed by said decoding devices during such cycle of operation.

38. In a centralized traffic controlling system for railroads; a line circuit connecting a control office and a field station; manually governable means at the control office for impressing on said line circuit any one of a plurality of series of direct current impulses, each of said series having the same number of impulses of distinctive characters, and each of said series differing from every other series in the character of at least two impulses; step-by-step means at the field station operable to take one step for each impulse of any series; a plurality of decoding devices at the field station, one for each step of said step-by-step means, said devices being of the type that remain in their last actuated positions; circuit means associated with each device for controlling that device to a position in accordance with the distinctive character of the impulse for its step; a plurality of traffic controlling devices at the field station; a plurality of control circuits for controlling said traffic controlling devices, one corresponding to each of said codes, each of said circuits incuding contacts of said decoding devices so selected as to be closed only when its corresponding code is transmitted over said line circuit; and means effective at the end of a series of impulses to only momentarily energize the control circuit closed by said decoding devices during such series; whereby the closure of any particular one of said control circuits following the closure of another of said control circuits requires the operation to new positions of at least two of said decoding devices.

39. In a centralized traffic controlling system for railroads, the combination with a power-operated track switch at a field station and signals for governing traffic in opposite directions over said switch in its different positions; line wires extending from a control office to the field station; route control relays, one for each signal corresponding to a given direction of traffic and a particular position of said track switch; a series of stepping relays operated sequentially as a series of distinctive impulses are applied to said line wires during an operating cycle irre-

spective of the character of said impulses; a plurality of decoding relays of the stay-where-put type, one relay for each step; energizing circuits for said decoding relays, one for each of said relays and each governed on its step in accordance with the distinctive character of the impulse for that step; an energizing circuit for each of said route control relays including contacts of said decoding relays, each of said circuits differing from every other of such circuits in its contact selections as to require the operation of at least two of said decoding relays to new positions to close a particular one of such energizing circuits following the closure of any other of such circuits; means acting only at the end of a cycle of operation for momentarily energizing the particular one of said energizing circuits closed by said decoding relays during that cycle of operation; and stick circuits for said route control relays.

40. A centralized traffic control system for governing a pair of opposing signals controlling traffic in opposite directions over a stretch of track from a distant control office over line wires comprising, a code receiving means at the signals including stepping relays operated sequentially in response to a series of impulses applied to the line wires and adapted to respond distinctively to code signals made up by varying the character of each of several impulses, two neutral stick relays one for each signal controlled by said code receiving means and selectively energized momentarily by different code signals, means preventing energization of either stick relay if the other is energized, a control circuit for clearing each signal and closed only if the corresponding stick relay is energized, another relay controlled by said code receiving means and momentarily energized by a distinctive stop code signal to open the stick circuits for said stick relays and cause deenergization thereof, and track circuit controlled means for also breaking the stick circuits for said stick relays upon movement of a train past either signal.

NEIL D. PRESTON.