

Dec. 8, 1959

T. P. MARPLE

2,916,612

RAILWAY SIGNALING SYSTEM WITH AUTOMATIC MEETS BETWEEN TRAINS

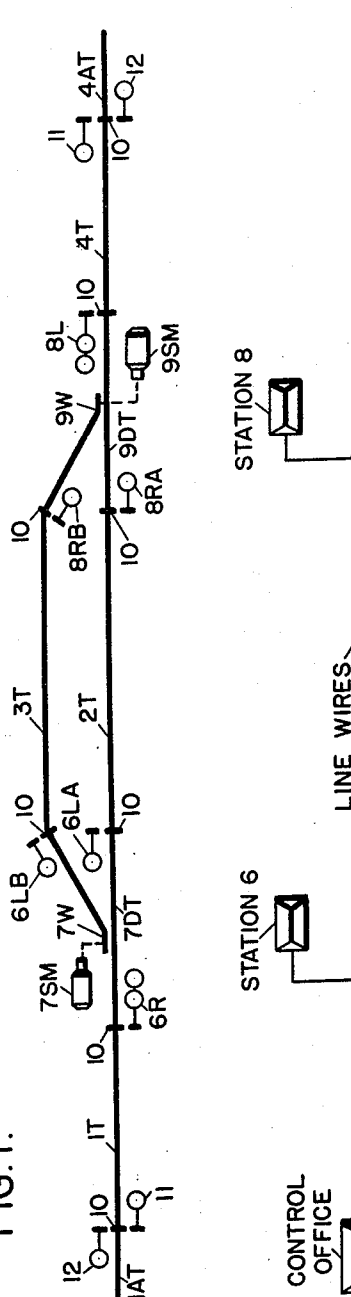
Filed Dec. 24, 1956

9 Sheets-Sheet 1

FIG. 5B.

[illegible]

FIG. 1.



STATION 8

STATION 6

**CONTROL
OFFICE**

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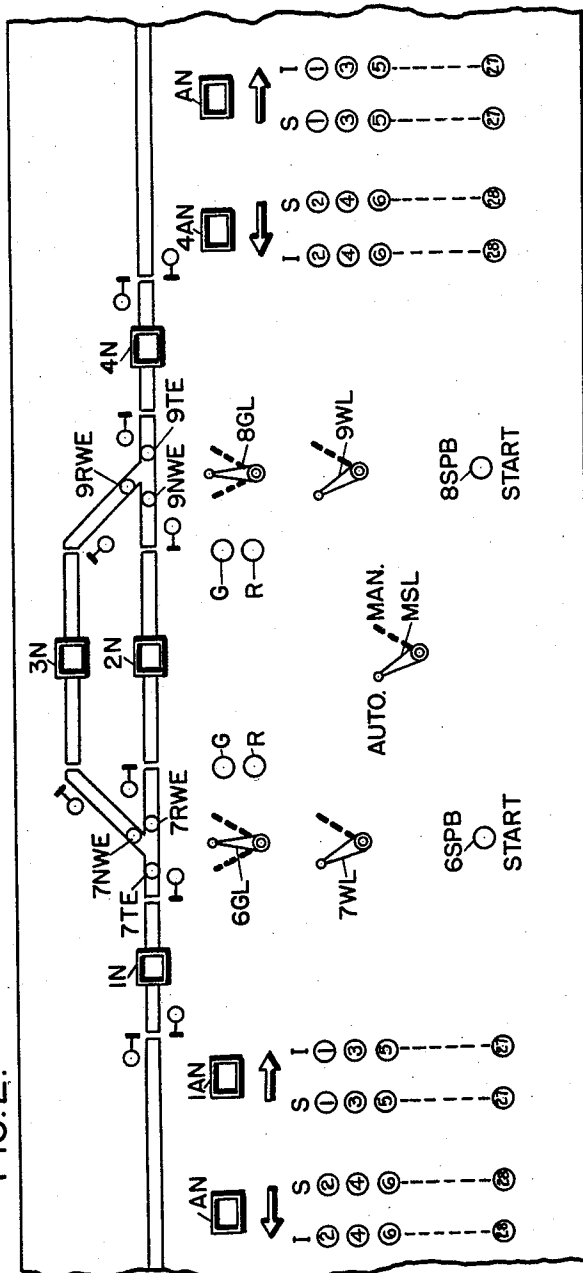
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FIG. 5A.

CODE CHART FOR DESCRIBING TRAINS

TRAIN CLASS		SUPERIOR																															
TRAIN NUMBERS																																	
INDICATOR POSITIONS		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
POSITIONS OF INDICATOR CONTACTS (F = FRONT CONTACT) (B = BACK CONTACT)	1	F	B	F	B	F	B	F	B	F	B	F	B	F	B	F	B	F	B	F	B	F	B	F	B	F	B	F	B	F	B	F	B
	2	F	F	B	B	F	B	B	F	B	B	F	B	B	F	B	B	F	B	B	F	B	B	F	B	B	F	B	B	F	B	B	F
	3	F	F	F	B	B	B	F	F	B	B	B	F	F	B	B	B	F	F	B	B	B	F	F	B	B	B	F	F	B	B	B	F
	4	F	F	F	F	F	F	B	B	B	B	B	B	B	B	B	B	B	F	F	F	F	F	B	B	B	B	B	B	B	B	B	B
	5	B	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
	6	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F

FIG. 2.



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FIG. 3A.

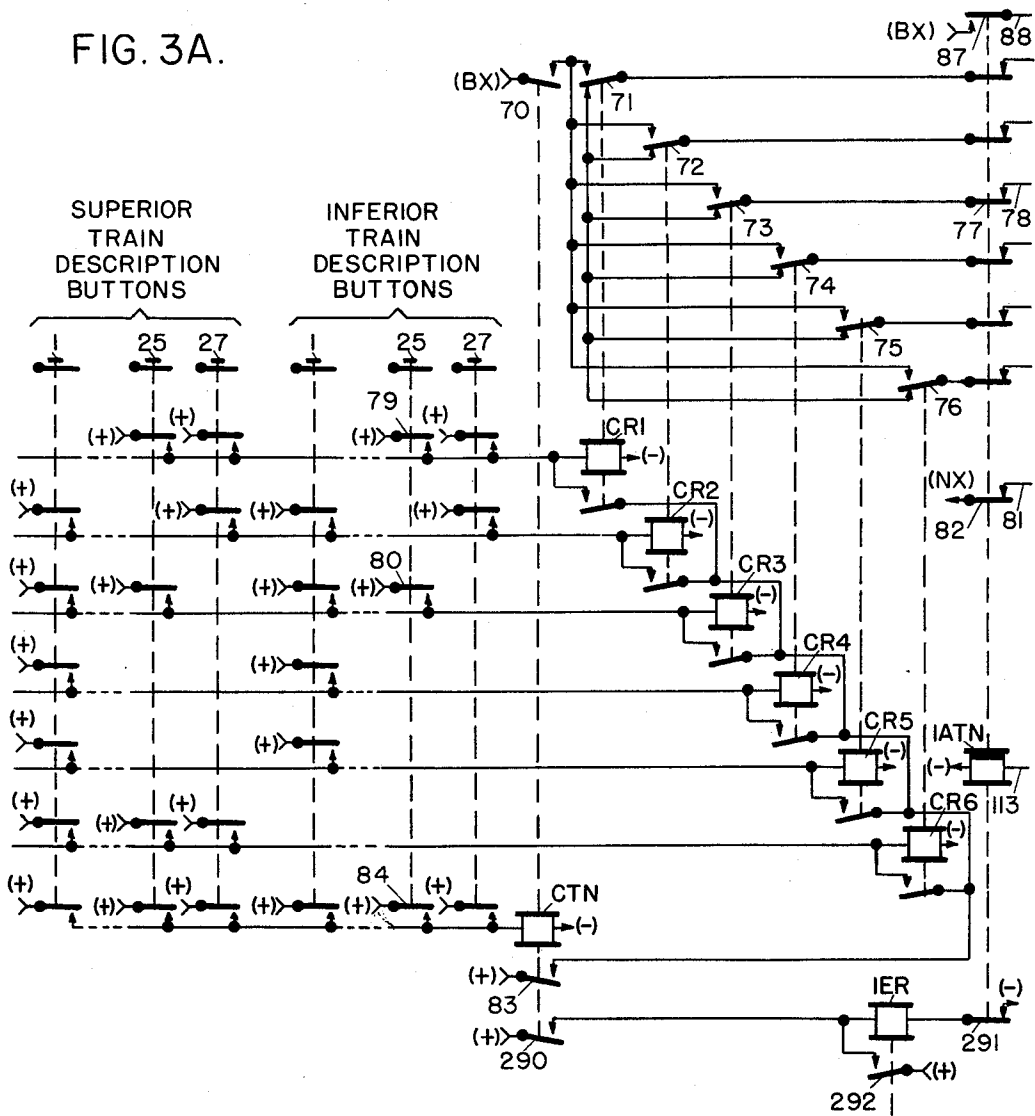


FIG. 4.

FIG. 3F.				
FIG. 3A.	FIG. 3B.	FIG. 3C.	FIG. 3D.	FIG. 3E.

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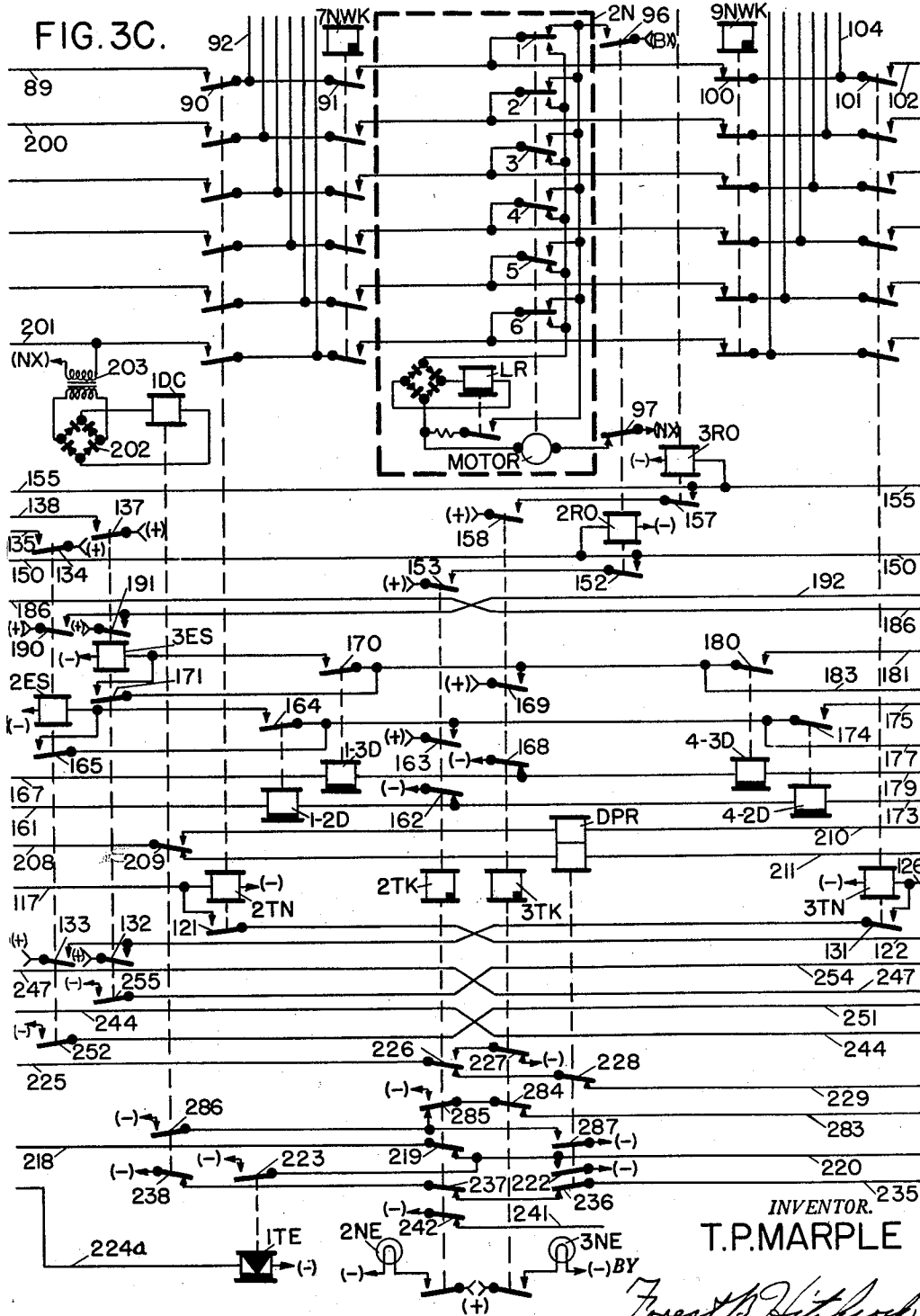
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FIG. 3C.



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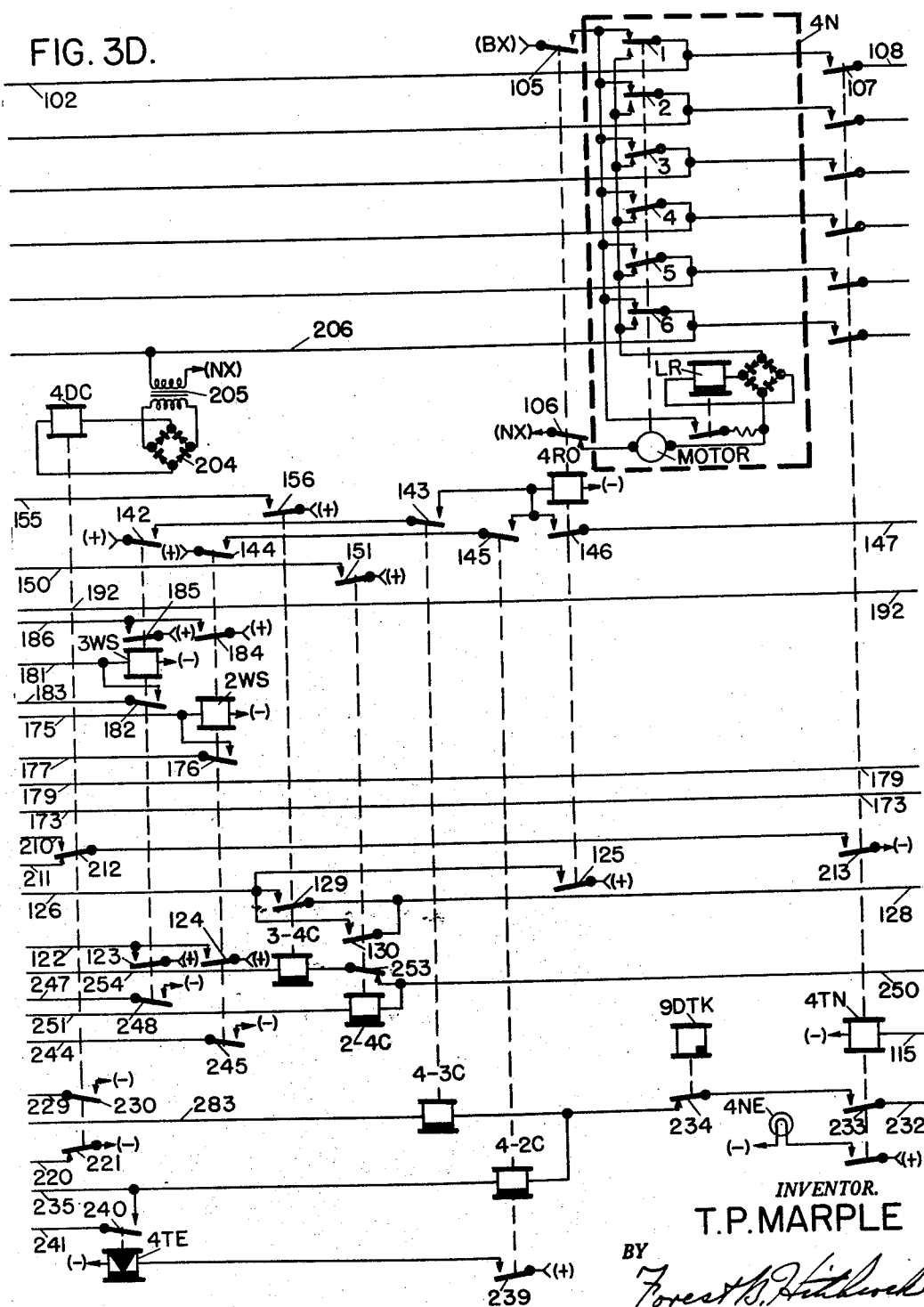
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FIG. 3D.



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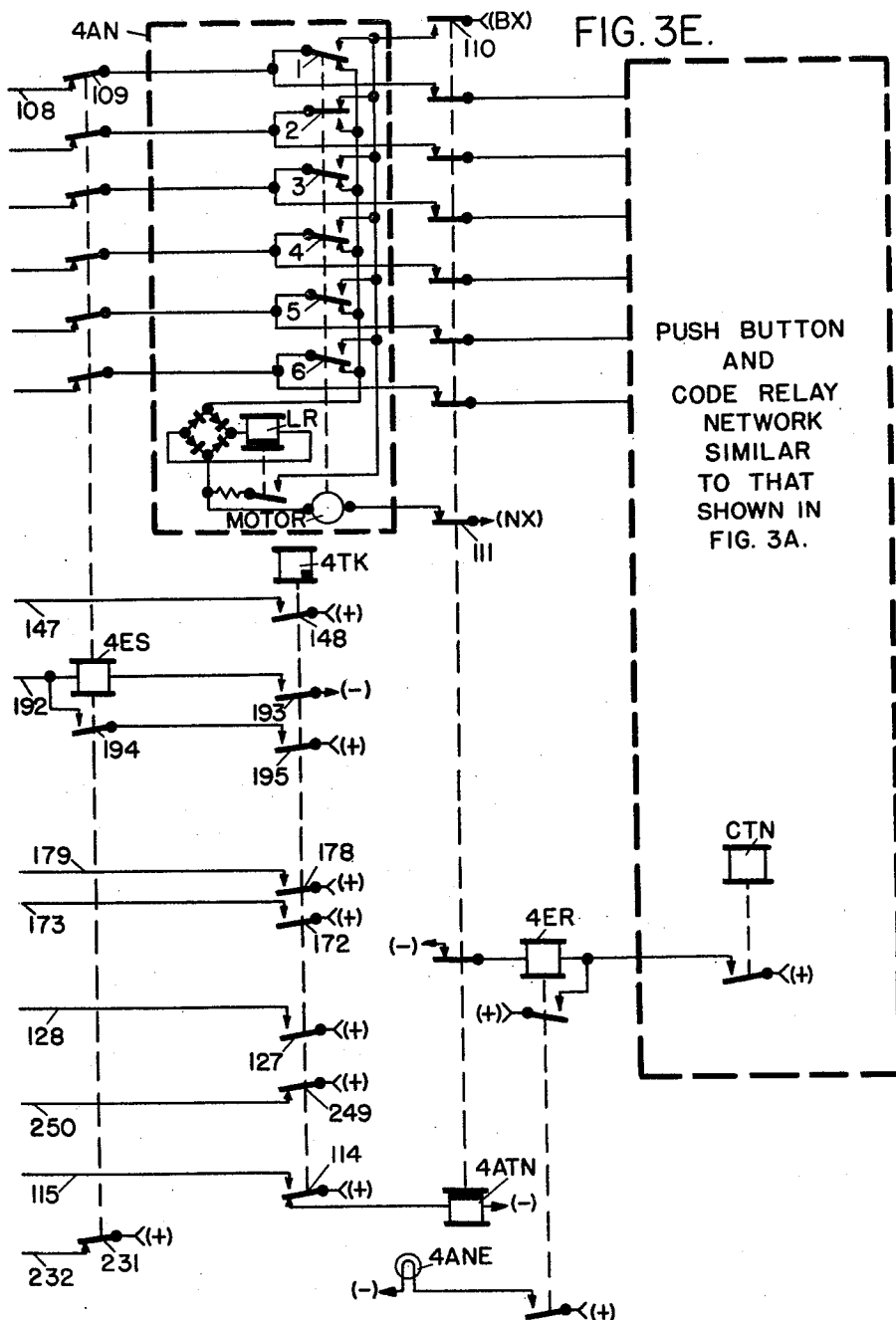
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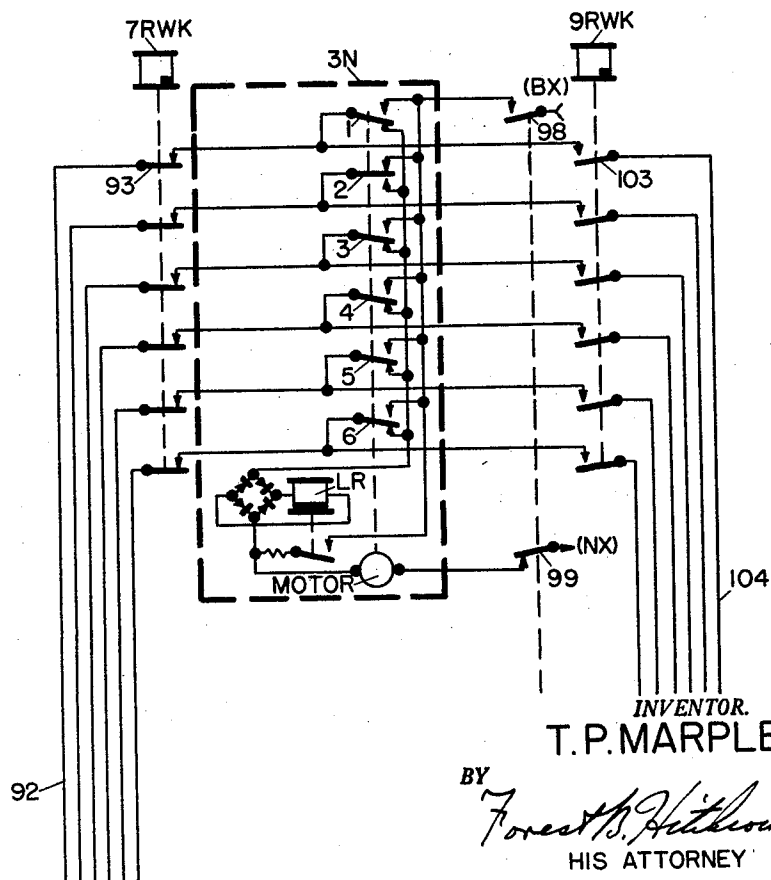
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FIG. 3F.



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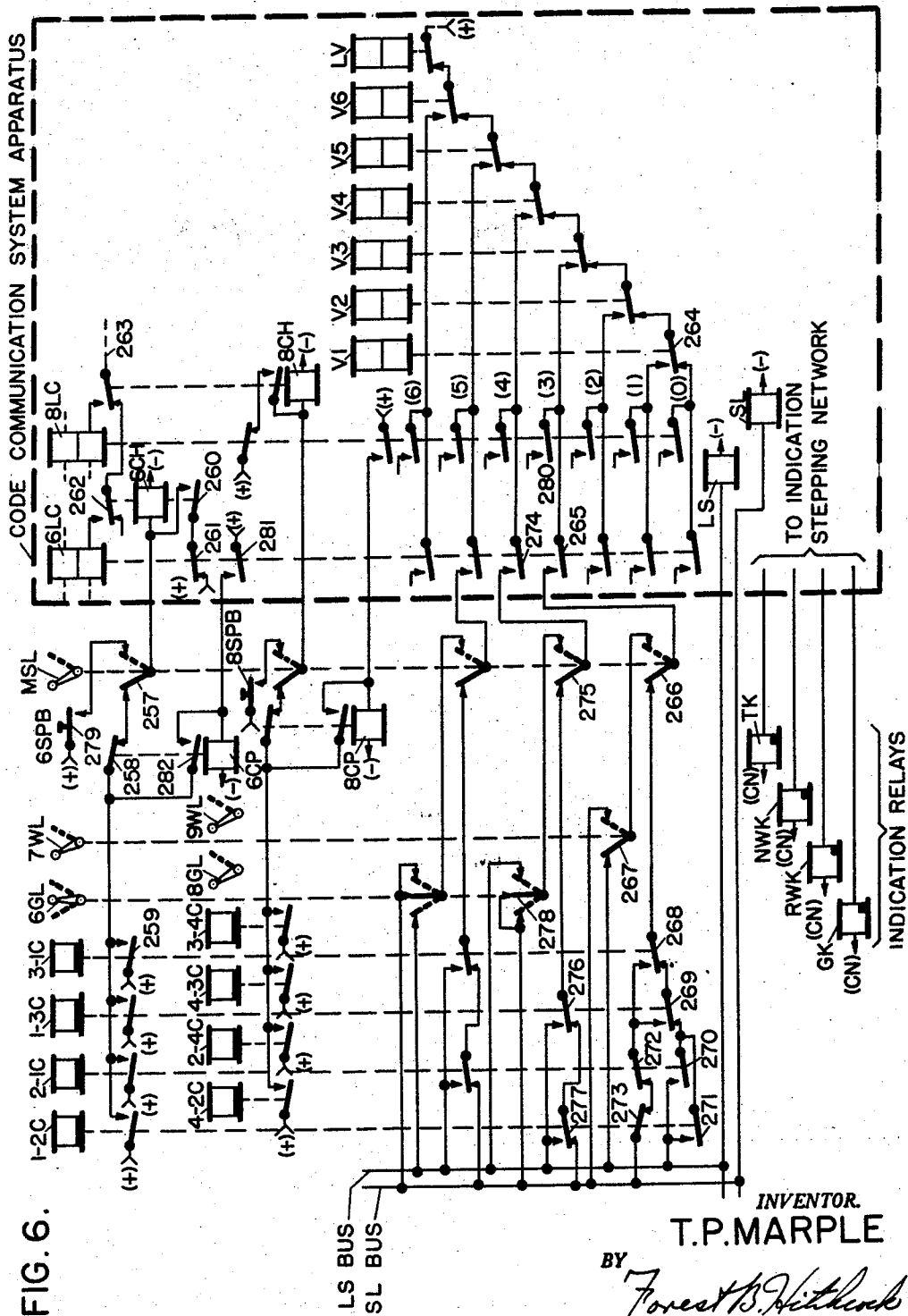
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RAILWAY SIGNALING SYSTEM WITH AUTOMATIC MEETS BETWEEN TRAINS

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RAILWAY SIGNALING SYSTEM WITH AUTOMATIC MEETS BETWEEN TRAINS

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Application December 24, 1956, Serial No. 630,273

10 Claims. (Cl. 246—2)

This invention relates to railway signaling systems; and more particularly pertains to signaling systems for stretches of single track which are provided with spaced passing sidings to permit train movements in both directions.

In systems of the so-called centralized traffic control type extensive stretches of trackway may be placed under the jurisdiction of a central control office. A dispatcher, or operator, is provided with a control panel having a miniature track diagram representing the stretch of track under his supervision. Control levers are provided on such panel for controlling track switches and signals at various field locations; and, indication lights are also provided on the panel to indicate particular conditions such as the conditions of track switches, signals and detector track circuits.

In most systems, the control office is connected to the various switch and signal locations by a code type communication system which, when activated, transmits selected control and indication codes between the control office and field locations. Such systems require the operator to arrange meets between opposing trains at passing siding locations by manipulating track switch and signal control levers in accordance with the desired routing arrangement. The code communication apparatus is then activated to transmit selected control codes to the siding end locations.

The arrangement of meets between trains is usually based on a train classification basis under which some trains are superior to others. Thus, for example, a freight train may be routed into a siding to await the passing of a fast passenger train which may be moving in either the same or opposite direction. When the trains are past the point of possible conflict the operator causes the transmission of selected controls to the siding end locations for operating track switches and signals to allow the trains to depart from the passing siding location.

At all times the dispatcher, or operator, is aware of train positions by observing track occupancy lights in the track diagram. However, the operator must be able to mentally correlate occupancy indications with particular trains.

In view of the above considerations, the present invention proposes the use of storage means, or train descriptors, which can be operated to store descriptions of train classifications for trains approaching siding end locations; and, such descriptions are used to arrange routes for trains and to arrange meets between trains automatically. Through the use of a plurality of storage means and interconnecting transfer circuits a train description can be advanced as the train advances through successive track-circuited sections. Thus, a description introduced into a storage unit as a train enters a block can be advanced by the train to a storage unit at a siding end location, and can be used to initiate controls for routing the train through either the main track or the passing siding.

Since storage means are provided at both ends of a

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siding, a comparison between concurrently stored descriptions for opposing trains is made, and the superior description determines which train will be routed into the siding. In the case of identical classes of opposing trains identified by concurrently stored descriptions, the present invention provides means for arbitrarily giving superiority to one train on a directional basis.

Thus, the use of storage means to automatically control train movements relieves the dispatcher of the necessity of performing a large number of switch and signal control manipulations, thereby simplifying operating procedures.

Once a meet between trains is effected and both trains are clear of the detector track circuits associated with the track switches at the siding end locations, the switches and signals must be controlled to permit the trains to proceed. This can be done either by controls initiated by the dispatcher or automatically. The present invention, therefore, provides both manual and automatic control means for arranging leaving moves by trains.

As previously noted, most systems require the dispatcher to be able to mentally correlate track occupancy indications with particular trains. The use of suitable multiple position indicators which can display actual train identification numbers as well as store such numbers in contact positions can greatly aid the dispatcher in keeping abreast of changing traffic conditions. One type of indicator which can be employed for embodying the present invention is of the type disclosed in the co-pending U.S. application Serial No. 580,123 of G. E. Marsh filed April 23, 1956. Such indicator is operable to any one of a plurality of positions in which particular electrical circuits are opened and closed by its contacts, and the proper character for that position is located on a tape behind a display opening. Thus, such an indicator can be used as a code storage means and also be operable to visually describe a train. The present disclosure provides means for operating such indicators and for transferring descriptions between indicators so that train movements can be traced visually. In addition, the present invention provides means for decoding train descriptions stored by such indicators, thereby being able to utilize train descriptions to control switches and signals.

In view of the above, one object of the present invention is to provide a signaling system for single track railways having spaced passing sidings in which train descriptions are stored and are advanced in response to detected train movements.

Another object of this invention is to provide control circuits responsive to stored train descriptions for automatically routing trains and arranging meets between trains at passing siding locations.

Another object of this invention is to provide means for automatically arranging meets between trains of the same classification or degree of superiority.

A further object of this invention is to provide a control system employing multi-position indicators for displaying train identification characters and for storing train classification descriptions.

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

Fig. 1 shows diagrammatically a stretch of railway track and a passing siding, along with a control office, wayside locations and signaling apparatus;

Fig. 2 shows diagrammatically a portion of a control panel having a miniature track diagram representing the stretch of track in Fig. 1, and having various control and indication devices;

Figs. 3A-3F when placed together show diagrammati-

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cally control office circuits for controlling and indicating train movements through the stretch of track in Fig. 1;

Fig. 4 is an arrangement plan showing how Figs. 3A-3F must be arranged to present a complete circuit diagram.

Figs. 5A and 5B when placed together form a code chart showing the correlation between the operating positions of a multi-position indicator and arbitrary train classification descriptions; and

Fig. 6 shows diagrammatically circuit means for controlling code communication apparatus by the circuits shown in Figs. 3A-3F.

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 understand the principles and mode of operation, than with the idea of illustrating the specific construction and arrangement of parts that would be employed in practice. Thus, the various relays and their contacts are illustrated in a conventional manner, and symbols are used to indicate connections to the terminals of batteries, or other sources of electric current, instead of showing all of the wiring connections to these terminals.

The symbols (+) and (-) are employed to indicate the positive and negative terminals, respectively, of suitable batteries, or other sources of direct current; and the circuits with which these symbols are used always have current flowing in the same direction. The symbols (BX) and (NX) represent connections to the opposite terminals of an alternator, transformer, or other source of alternating current energy.

The organization and utility of the present invention will be disclosed through a description of one form of circuit organization which can be applied to control and indicate traffic and signaling conditions in a typical portion of a railway (see Fig. 1).

Fig. 1 represents a stretch of track and an associated passing siding. It is assumed that the trackway shown is a portion of an extensive stretch of single track along which passing sidings are provided at spaced intervals. The stretch of track and passing siding are divided into track sections, such as 1AT, 1T, 2T, 3T, 4T and 4AT, which have associated track circuits for detecting trains. Using common terminology, track sections 1AT and 4AT are approach track sections, while track sections 2T and 3T are referred to, respectively, as the main and siding track sections. The passing siding is connected at its ends to the stretch of track by power operable track switches 7W and 9W which are selectively positioned by switch machines 7SM and 9SM. Each track switch is protected by a detector track circuit associated with a short detector track section, such as sections 7DT and 9DT. The various track sections are electrically insulated from each other by insulated rail joints 10.

Train movements through the stretch of track and passing siding are governed by signals. Signal 6R governs trains moving to the right from track section 1T into either track section 2T or 3T, while signal 8L governs trains moving to the left from track section 4T into either track section 2T or 3T. Trains leaving either track section 2T or 3T are governed by signals 6LA or 6LB if moving to the left, and by signals 8RA or 8RB if moving to the right. Approach signals, such as signals 11, are located in advance of each siding end to govern approaching trains. Intermediate signals 12 are shown in accordance with usual practice.

The switch machines and signals can be of any of a number of well-known electroresponsive types.

It is assumed that the siding end locations are under the jurisdiction of a central control office which may be located at a considerable distance from the siding area. Thus, in accordance with standard practices, the various

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switches and signals are controlled via a code communication system. Various control apparatus and code communication apparatus are assumed to be located both in the control office and in the field stations 6 and 8. The control office and field stations are shown connected by line wires over which code communication is effected.

The organization of track switch and signal control circuits located in the field and including so-called safety circuits are assumed to be of any of a number of standard types which are well-known in the art. Therefore, the present disclosure will be directed exclusively to control office circuits and will show the manner in which the present control office circuits are used to selectively operate a code communication system which, in turn, selectively operates field apparatus. It must be pointed out, however, that the present control circuits can be used for controlling track switches and signals directly as well as through the medium of code communication apparatus.

Control office apparatus

The trackway under the jurisdiction of the control office is assumed to be controlled from a control panel having a miniature track diagram and having control and indication apparatus located to correspond with the actual field layout. A portion of the control panel is shown in Fig. 2, and this panel section includes apparatus associated with control and indication functions relative to the stretch of track and passing siding shown in Fig. 1.

In Fig. 2 a plurality of track switch control levers, such as levers 7WL and 9WL, are provided for manual selections of the operating positions to be assumed by track switches 7W and 9W. The switch levers are of a two-position type, each position corresponding to a track switch position. A plurality of signal control levers, such as levers 6GL and 8GL, are provided for manual designations of stop and proceed operations to be performed by signals 6R, 6LA, 6LB, 8L, 8RA and 8RB. The signal levers are of a three-position type, i.e. a center position for stop controls, a left position for clearing signals governing traffic to the left, and a right position for clearing signals governing traffic to the right.

Each set of track switch and signal control levers is located at the respective associated siding end location shown in the track diagram, and each set of levers has an associated start pushbutton, such as pushbuttons 6SPB and 8SPB, for activating code communication apparatus to transmit control codes of selected characters. The code characters are selected, as will be described, through contacts of the various control levers.

Indication lights of a standard type are provided to indicate traffic and routing conditions. The lights 7NWE and 7RWE are selectively energized in response to indication code characters originating at field station 6 (see Fig. 1), and these lights indicate the operated position (normal or reverse) of switch 7W. Similar lights 9NWE and 9RWE are provided to indicate the condition of track switch 9W. Track lights 7TE and 9TE indicate, when lighted, occupancy by trains of the respective detector track sections 7DT and 9DT at the siding ends. Signal indication lights such as G (green) and R (red) are provided to indicate aspects displayed by the signals.

Since the present invention provides for both manual and automatic designations of route controls, a selector lever MSL is provided to permit the operator to manually select which mode of operation is to be in effect.

A plurality of indicator units 1AN, 1N, 2N, 3N, 4N and 4AN are provided to indicate both track occupancy and train description. These indicators, which will be described more specifically, are assumed to be of the type disclosed in the copending U.S. patent application of G. E. Marsh, Ser. No. 580,123 filed April 23, 1956. Each indicator is operable to a plurality of positions, and includes a movable tape which passes behind an opening. The tape has characters printed on it, and in the present disclosure these characters are assumed to

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be train identification numbers. Included in each indicator unit is a lamp which will be energized to illuminate the symbol then displayed only during occupancy of the corresponding track section. More specifically, indicators 1N, 2N, 3N and 4N are located in the track diagram at positions comparable to track sections 1T, 2T, 3T and 4T (see Fig. 1). The indicators 1AN and 4AN are approach indicators which are operated by selector buttons to display descriptions which identify trains approaching the siding location. The indicators 1N, 2N, 3N and 4N are associated, respectively, with track sections 1T, 2T, 3T and 4T, and each indicator can be operated to indicate the occupancy of the associated track section and to indicate further a description of the occupying train. Since, as will be described, descriptions stored by the indicators 1N and 4N are utilized to condition route control circuits, these indicators can be conveniently termed control indicators.

As will be described later, transfer circuits are provided for transferring train descriptions from one indicator to another as train progress. For example, a train moving to the right would automatically advance its description from indicator 1AN to indicator 1N, then from indicator 1N to either indicator 2N or 3N (depending on routing conditions), and from indicator 2N or 3N to indicator 4N.

The initial storages of train descriptions in the approach indicators 1AN and 4AN are effected by the operation of classification buttons located on the control panel below each approach indicator. It will be assumed that all trains moving to the right are identified on train lists by odd numbers, while those moving to the left are identified by even numbers. In this manner, the displaying of a train number by an indicator is also indicative of train direction. For the preceding reasons, the buttons associated with indicator 1AN are odd-numbered, while those associated with indicator 4AN are even-numbered.

Other approach indicators AN and associated buttons are shown in Fig. 2 in the vicinity of indicators 1AN and 4AN. These indicators AN are assumed to be provided for storing descriptions for trains moving from the illustrated passing siding locations to the next passing siding locations (not shown) in either direction.

The train description buttons associated with the approach indicator 1AN are arranged in two identical vertical rows. The buttons in each row are odd-numbered, ranging from 1 through 27. Similar rows of buttons associated with indicator 4AN are even-numbered, ranging from 2 through 28. Thus, the arrangement shown permits the posting and storing of train identifications for trains listed as any number from 1 through 28. The reason for having two rows of identically numbered buttons is to permit the identification of a train as either superior or inferior. Thus, for example, a train listed as No. 27 may be either a superior train or an inferior train. If it is a superior train, button 27 in the row headed "S" is used for operating the storage indicator 1AN, while button 27 in the row headed "I" is used if the train is inferior in classification. The arrangement and utility of the train description buttons can be described in greater detail following a description of the indicator devices assumed for use in the present system.

As previously stated, the train description storage means is assumed to be a display indicator of the type disclosed in the U.S. patent application of G. E. Marsh, Ser. No. 580,123 filed April 23, 1956; but, it should be understood that any other suitable indicator may be employed such, for example, as disclosed in the prior patent of Field et al., Patent No. 2,731,632 dated January 17, 1956. The present disclosure will be confined, for simplicity, to general analogous description of the indicator disclosed in the above mentioned Marsh application.

Each indicator includes a movable tape having inscribed thereon suitable characters or symbols. The tape

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is operated to its different positions through a gearing by a motor which assumes different positions dependent upon the selective energization of six control wires. When the tape is located in any particular position in front of an opening or window, the symbol thereon can be plainly seen when an associated lamp is energized to illuminate the symbol. In this way, the particular indicator having active information can be readily distinguished from those which are inactive.

It is, of course, readily understood that six control wires can be energized and deenergized in sixty-four different combinations corresponding to the well-known binary Baudot code; but for basic reasons the first and last codes of a symmetrical table of such binary code cannot be used. Also, the applicant Marsh in the above mentioned application desired to have his indicator readily adaptable for control either over six control wires or over five code wires, the latter of which would, of course, provide only thirty-two code combinations. When the indicator is thus used with only five control wires and corresponding structural characteristics, the first and last of said thirty-two codes are unused. The net result is that for the indicator disclosed in the Marsh application and assumed to be here employed, only sixty-one codes are actually usable.

However, in order to provide proper gear ratios and the like, it is necessary that each indicator have sixty-four actual physical positions. In view of this, two of the positions have characters which are duplicates on the tape, and one position has a blank space on the tape. But in the present case, there are sufficient positions of the indicator so that the duplicate positions 1 and 17 of Figs. 5A and 5B are not shown as used. Likewise, the positions 33 and 49 of the indicator are duplicate positions and they are not shown as used. Positions 31 and 63 are extra positions; and position 64 cannot be employed but the application of any combination of energizations of the code wires causes the indicator to continue moving through such position without stopping. In other words, the physical structure is present but the tape does not have any symbol for such position and the indicator under normal usage does not stop in such position.

The six control wires which are energized in different combinations to represent codes lead to the commutator combinations in the indicator which are constructed in such a way that the motor operates the indicator until the particular commutator positions are reached where the circuit to the motor is opened for the particular combination of control wires then energized. Although the indicator comprises six commutators and six cooperating movable disc-carried brushes, the commutator elements and brushes are represented in this disclosure (see Figs. 3B through 3F) as motor driven contacts 1 through 6. The front and back contact points correspond to the commutator elements, while the movable contact element corresponds to the disc-carried brush. The structure of the indicator is such that the contacts 1 through 6 of each indicator are operable in the different contact making positions designated in the chart of Figs. 5A and 5B. The letters F and B designate contact making conditions under which front and back points are closed respectively.

When the indicator is in its position 1, for example, the positions assumed by contacts 1-6 (Fig. 3B) shows position 29, in indicator 1AN are such that contacts 1-4 and 6 form closed front contacts and contact 5 forms a closed back contact; in position 2, contacts 2-6 form closed front contacts while contact 1 forms a closed back contact. Thus, the sequence of operation of the indicator contacts 1-6 to form closed front and back contacts can be traced with reference to the code chart.

Referring to the indicator 1AN in Fig. 3B, the equivalent contacts 1-6 are interconnected so that all front contacts are bussed together and all back contacts are bussed together. The movable contacts 1-6 are con-

ected to external wires which, as will be described, can be selectively energized individually or in combination. It must be noted here that the particular indicator assumed for use herein is an alternating current device, and externally applied energy is assumed to be of such character.

The back contact bus is connected to the motor and the latching relay LR through a rectifier 67. The arrangement of the rectifier and the interconnecting wiring is such that the motor is operated by alternating current energy while the relay LR is operated by rectified, or unidirectional current energy. The front contact bus can be connected to the motor through front contact 63 of relay LR and a limiting resistor 69. Whenever (BX) energy is applied to particular movable elements of contacts 1-6, the motor will be operated if any of the positions of the particular contacts are such that energy can reach the back contact bus leading to the rectifier 67 and motor. Under such conditions, relay LR is energized closing its front contact 63 to also provide for the energization of the motor from the front contact bus. As soon as the motor operates the various contacts 1 through 6 to positions wherein the particular energized contacts break connections with the back contact bus relay LR is deenergized. This conditions the latching structure (not shown) for positively engaging the tape driving gear when the proper position is reached. But since the front contact 63 cannot open until the latch has locked the gear, the motor is actually effective to drive the gear into its locking position. The opening of front contact 63 then removes all energy from the motor which immediately comes to rest. Relay LR is slow-acting to allow time for the motor to nearly reach the desired operating position before attempting to lock the tape and motor. Thus, once energized, the motor operates contacts 1-6 through various positional alignments until open-circuit conditions (back contact bus deenergized) are reached, at which time relay LR releases to disconnect the motor from the front contact bus and to lock the tape and motor in position.

Since the application of energy to one or more control wires causes the indicator to operate until open circuit conditions exist in the commutators, the present analogous representation requires that the indicator be operated until any of the movable elements of contacts 1-6 connected to energized control wires must be operated to form open back contacts (i.e. closed front contact positions). Thus, the characters F in the present code chart of Figs. 5A and 5B indicate closed front contact conditions (open back contact conditions), and thereby also define which of the six control wires must be energized to operate the indicator to its various positions.

The code chart also shows the characters inscribed on a movable tape which are to be displayed in each indicator position. In this case, the characters are numbers representing train identification numbers. It is proposed, for example, that train identification numbers ranging from 1 through 28 be inscribed for identifying twenty-eight different trains. It is further proposed that two duplicate sets of train numbers be inscribed on each tape for reasons to be explained.

It can be seen from the code chart (Figs. 5A and 5B) that indicator positions 1-32 call for front contact 6 to be closed, while back contact 6 is closed for indicator positions 33-64. Thus, the condition of contact 6 (and the associated control wires to be described) can be used to differentiate between superior and inferior train classifications. A train identified as No. 1, for example, may be superior or inferior in classification. If the train is superior a description stored in an indicator for the train must be effected so that the indicator is operated to position 2 in which a tape character 1 is displayed and front contact 2-6 are closed. If the train is inferior the stored description must be effected so that the indicator is op-

erated to position 34, wherein a character 1 is displayed by the tape and front contacts 2-5 are closed.

For visual identification, the train numbers 1-28 for superior trains can, for example, be of a different color than the numbers 1-28 for inferior trains.

It can now be seen why two rows of train description buttons headed S and I are provided (Fig. 2) for each approach indicator. The actuation of button 1 in row S will, as will be described, operate indicator 1AN to its position 2 (Fig. 5A); similarly, the actuation of button 1 in row I will operate indicator 1AN to its position 34 (Fig. 5B). Regardless of which button 1 is operated, indicator 1AN will display a character 1, but the contact make-ups in the indicator differ in the two cases. The same mode of operation applies to the indicator 4AN and its associated train classification buttons.

The assignments of specific train numbers to indicator positions (Figs. 5A and 5B) is based on several requisites to be described. First, each superior train number must be assigned to an indicator position in which front contact 6 is closed, while each inferior train number must be assigned to a position in which back contact 6 is closed. Position 64 of the indicator is, as described unsuitable for use. Positions 1 and 17 are identical insofar as contact make-ups are concerned, and positions 33 and 49 are similarly identical. To simplify the present disclosure positions 1, 17, 33 and 49 are not used, thereby eliminating the need for further duplicating train numbers. The elimination of positions 1, 17, 33, 49 and 64 from use leaves fifty-nine positions for use in identifying trains. For symmetry, however, positions 31, 32, 33 and 63 are arbitrarily eliminated from use, so that fifty-six positions are finally used for train identification. Thus, twenty-eight superior trains and twenty-eight inferior trains are provided for. In this manner, fourteen even-numbered trains (those moving to the left in Fig. 1) and fourteen odd-numbered trains (those moving to the right) can be accommodated. For this reason each vertical row of train classification buttons (Fig. 2) comprises fourteen buttons.

Referring to Figs. 2, 3A and 3B, the operation of the approach indicator 1AN to store and display a train description can be described. The superior train description buttons 1-27 (row S in Fig. 2) and the inferior train description buttons 1-27 (row I in Fig. 2) are shown, in part, in Fig. 3A. It will not be necessary to show the circuit arrangements including contacts of all of the buttons because such arrangements will be obvious from the portions shown.

Contacts of the various train description buttons are connected to busses in a predetermined manner for selectively energizing a plurality of code relays CR1, CR2, CR3, CR4, CR5 and CR6. These code relays are used to control the indicator 1AN to display train numbers corresponding with the numbers of the buttons operated. The manner in which the code relays CR are operated can be seen following a description of the control circuits for indicator 1AN.

Control energy (BX) for indicator 1AN is supplied through a front contact 70 of a button-operated transfer relay CTN. Contact 70 is connected to a bus which interconnects front contacts 71-76 of relays CR1-CR6, respectively. The back contact points of contacts 71-76 are also bussed together, and the respective movable contact terminals of contacts 71-76 are connected to contacts 1-6 respectively, of the indicator 1AN through respective front contacts such as 77 of a transfer relay 1ATN and respective wires such as 78. Thus, whenever front contact 70 of relay CTN is closed (BX) energy can be applied to the indicator 1AN only when one (or more) of the code relays CR is picked up and relay 1ATN is also in a picked-up condition.

The condition of the indicator 1AN as shown is the expected condition when the indicator had been operated to its position 29 (see Fig. 5A) in which front contacts

2 and 6 are closed. In this condition the train description stored by the indicator is for a train No. 27 having a superior classification.

Assume that the dispatcher wishes to store a description for a train No. 25 of inferior classification. The dispatcher presses the inferior train description button 25, closing contacts 79, 80 and 84 of the button, causing the energization of relays CR1, CR3 and CTN, respectively. Front contacts 70, 71 and 73 of the respective relays CTN, CR1 and CR3 close to apply (BX) energy to contacts 1 and 3 of indicator 1AN. Since back contact 3 of indicator 1AN is closed, energy is supplied to the motor and to the latching relay LR in indicator 1AN through the back contact bus, the complete circuit to (NX) energy extending from the motor through wire 81 and front contact 82 of relay 1ATN. Relay LR picks up to release the locking of the indicator gearing, and the motor operates to drive contacts 1-6 and the movable tape (not shown) to the indicator position 59 (see Fig. 5B). When indicator position 59 is approached back contact 1 opens (back contact 3 being previously opened) to deenergize relay LR and the direct motor circuit. However, relay LR cannot release to open its contact 68 until the relay's latching structure can drop into slot which is associated with position 59. The motor coasts, driving the contacts until front contact 1 is made, and at this time (BX) energy applied to contact 1 from the code relays passes through the front contact bus, front contact 68 of relay LR and the limiting resistor 69 to the motor. The motor is thereby driven at a reduced energy level until the latching structure of relay LR is able to drop into the slot associated with position 59, at which time contact 68 of relay LR opens to completely deenergize the motor. The slow-release characteristics of relay LR are useful in holding the latching structure (not shown) picked up for a time so that it does not ride on the indicator gearing and produce a drag.

From the foregoing description it can be seen that the connection between the code relay CR and indicator 1AN contacts is such that the indicator is operated to a position wherein its contact alignment (fronts or backs closed) must be identical to the alignment of the code relay contacts (fronts or backs closed). Thus, if the indicator 1AN is to store a description for a superior train No. 1, the indicator must be operated to indicator position 2 (Fig. 5A) in which front contacts 2-6 of the indicator are closed. To attain this condition front contacts 72-76 of relays CR2-CR6 must be closed to call for proper indicator operations. Thus, relays CR2-CR6 must be energized by the superior train button 1, and contacts of button 1 are included in each pick-up bus for those relays. The other train description buttons also have contacts included in the pick-up busses for relays CR1-CR6 in accordance with the principles described above and in view of the code chart (Figs. 5A-5B).

Every time a train description button is operated relay CTN is energized, since a contact of each button (such as 84 of button 25) is connected to the pick-up bus for relay CTN. Relay CTN closes its front contacts 70 and 83 to provide, respectively, energy (BX) for operating the indicator 1AN and stick energy (+) for any picked-up code relays CR. When a selected button is released, relay CTN and selected CR relays are released, but energy (BX) is removed from the control wires for indicator 1AN before the code relays CR are released. In this manner, an indicator position cannot be changed because of possible differences in the release times of relays CR.

Similar circuits for operating the approach indicator 4AN are indicated in block form in Fig. 3E. Such circuits are assumed to include code relays CR, a transfer relay CTN and train description buttons for even-numbered trains (see Fig. 2).

Train descriptions stored in the approach indicators 1AN and 4AN can be transferred by circuit means to be described into the indicators 1N and 4N, from which descriptions can be transferred to the remaining indicators 2N and 3N. The transfer of descriptions can take place in both directions between indicator 1N and indicators 2N and 3N, and similar transfers between indicator 4N and indicators 2N and 3N are possible. Without describing specifically the various transfer circuit means at this time attention can be given to the interconnecting wiring between the various indicators while making general reference to the mode of operation of the transfer circuits.

In Figs. 3A and 3B, the contacts 1-6 of indicator 1AN are connected to respective corresponding contacts in the indicator 1N through contacts such as 85 and 86 of relays 1WS and 1TN, respectively. Relay 1WS is a directional stick relay which is operated to prevent transfers from indicator 1N to indicator 1AN, while relay 1TN is a transfer relay operable to permit storage transfers from indicator 1AN to indicator 1N. Assuming that relay 1WS is deenergized and relay 1TN is energized, indicator 1N can be operated whenever relay 1ATN is dropped away. Specifically, when relay 1ATN is dropped away, its back contact 87 closes to apply (BX) energy to the front contact bus in indicator 1AN through wire 88. This energy is applied through any of the contacts 1-6 in indicator 1AN which are closed in their front contact positions. Indicator 1AN is then operated by the selective energization of the interconnecting wires through corresponding closed back contacts in the indicator. In other words, the operation of indicator 1AN to a particular position is identical to the previously described operation of indicator 1AN to a position called for by the alignment of contacts of the code relays CR. In this manner, when so-called read-out energy (BX) is applied to an indicator, a second indicator can be operated to a position corresponding to the position of the first indicator. In order to preclude possible operations of any indicator to which read-out energy is applied for operating a second indicator, the motor circuit of the first indicator must be interrupted. For this reason, when read-out energy (BX) is applied to the indicator 1AN, the motor circuit for the indicator is opened by front contact 82 of relay 1ATN.

Referring to Figs. 3A-3F, the indicator 1N is connected to indicator 2N on a contact-to-contact basis so that operations of either indicator by the other can be effected. Contact 1 in indicator 1N, for example, is connected to contact 1 in the indicator 2N by wire 89, front contact 90 of a transfer relay 2TN, and front contact 91 of a track switch indication relay 7NWK. The remaining contacts in the two indicators are interconnected in a similar manner. By the same token, the contacts 1-6 in indicator 1N are connected to corresponding contacts in indicator 3N by circuits such as one including wire 89, front contact 90 of the transfer relay 2TN, wire 92, and front contact 93 of a track switch indication relay 7RWK. Read-out energy for operating either indicator 2N or 3N is applied to the front contacts of indicator 1N by front contact 94 of a read-out relay 1RO. Relay 1RO also acts to open the motor circuit for indicator 1N at back contact 95 during read-out operations. When read-out operations are taking place from indicator 2N to indicator 1N, read-out energy is applied to indicator 2N by front contact 96 of another read-out relay 2RO, and back contact 97 of relay 2RO opens the motor circuit for indicator 2N during read-out operations. Similarly, transfers of storages from indicator 3N to indicator 1N are effected by the operation of a read-out relay 3RO which applies read-out energy to indicator 3N through its front contact 98, and opens the motor circuit for indicator 3N at its back contact 99. Transfer operations between indicators 1N-2N and 1N-3N are dependent upon the position of track switch 7W (Fig. 1)

and other considerations which will be described later. Descriptions stored by indicator 2N can be transferred to the indicator 4N through similar circuit operations. The contacts 1-6 in indicator 2N are connected to corresponding contacts in indicator 4N by circuits such as that including front contact 100 of a track switch indication relay 9NWK, front contact 101 of a transfer relay 3TN and wire 102. Read-out energy for such a transfer is provided by front contact 96 of relay 2RO. The transferring of descriptions from indicator 3N to indicator 4N are effected through circuits which interconnect respective indicator contacts, such as the circuit including front contact 103 of the track switch indication relay 9RWK, wire 104, front contact 101 of relay 3TN, and wire 102. Read-out energy for such transfers is applied to the indicator 3N by front contact 98 of the read-out relay 3RO.

Transfer operations in which descriptions stored by indicator 4N are to be transferred to either indicator 2N or 3N are accomplished by way of similar interconnecting circuits. Read-out energy in such cases is applied to the contacts of indicator 4N by front contact 105 of read-out relay 4RO. Back contact 106 of relay 4RO opens the motor circuit for indicator 4N during read-out operations.

The contacts 1-6 in indicator 4N are connected to corresponding contacts and indicator 4AN (see Figs. 3D and 3E) by circuits such as that including front contact 107 of a transfer relay 4TN, wire 108 and back contact 109 of a directional stick relay 4ES. Since it is assumed that read-out operations can be effective on a single direction basis, from indicator 4AN to indicator 4N, the read-out energy is supplied in such cases by back contact 110 of a transfer relay 4ATN. Undesirable operations of indicator 4AN during read-out operations are precluded by the opening of front contact 111 of relay 4ATN.

A description can now be given of the various relays and circuit means necessary to provide for the transferring of train descriptions between successive indicators.

It is assumed in the present disclosure that code communication apparatus is employed to connect the control office with the various field stations located at the passing siding. The code communication system can be of any of a number of well-known types and will not be described at this time except with reference to indication relays which are usually employed in conjunction with such code communication systems. Track occupancy indication relays 1TK, 2TK, 3TK, 4TK, 7DTK and 9DTK are shown in Figs. 3A-3F. These relays are assumed to be of the magnetic stick type and are selectively operated in response to indication code characters transmitted by the code communication apparatus from the various field stations. Each track indication relay TK is assumed to be picked up when an indication code indicates that the associated track section is occupied, and these relays are dropped away when the associated track sections are indicated as being unoccupied. Also shown in the drawings are track switch indication relays 7NWK, 7RWK, 9NWK and 9RWK. These relays are also of the magnetic stick type and are responsive to selected indication codes for indicating the positions assumed by respective associated track switches. Relay 7NWK, when picked up, indicates that the operated position of track switch 7W is normal, or arranged for moves straight through the stretch of track. Relay 7RWK, when picked up indicates that switch 7W is in its reverse position for routing traffic into or out of the passing siding. Relays 9NWK and 9RWK function in similar manners to indicate the respective normal and reverse positions of track switch 9W.

A transfer relay 1ATN is provided for permitting transfers of train descriptions from the code relays CR1-CR6 to indicator 1AN. Relay 1ATN is normally energized by a circuit including back contact 112 of relay 1TK and wire 113. In this manner, relay 1ATN is energized

whenever track section 1T is indicated as being unoccupied. A similar transfer relay 4ATN is provided for permitting transfers of train descriptions into indicator 4AN from similar code relays CR. This relay 4ATN is also operated in accordance with track occupancy conditions, and its pick-up circuit includes back contact 114 of the track indication relay 4TK. A transfer relay 1TN is provided for permitting transfers of train descriptions from indicator 1AN to indicator 1N. This relay is responsive to track occupancy conditions and can be energized by front contact 112 of relay 1TK. A similar transfer relay for permitting transfers of train descriptions from indicator 4AN to indicator 4N is provided. This relay is responsive to the condition of track section 4T and has a pick-up circuit including front contact 114 of relay 4TK and wire 115.

A transfer relay 2TN is provided for permitting transfers of train descriptions from indicator 1N to either indicator 2N or 3N, and conversely. Relay 2TN has a plurality of pick-up circuits, one including front contact 116 of a read-out relay 1RO and wire 117, the other pick-up circuit including front contact 118 of relay 1TK, either front contact 119 of a control relay 2-1C or front contact 120 of a control relay 3-1C and wire 117. The function of the various pick-up circuits can be best described following a later description of the various control relays. Relay 2TN is provided with a stick circuit including its front contact 121, wire 122, and either front contact 123 of a directional stick relay 3WS or front contact 124 of a directional stick relay 2WS. A similar transfer relay 3TN is provided for permitting transfers from indicator 4N to either indicator 2N or 3N, and conversely. Relay 3TN has a plurality of pick-up circuits, one including front contact 125 of a read-out relay 4RO and wire 126, the other pick-up circuit including front contact 127 of relay 4TK, wire 128, either front contact 129 of a control relay 3-4C or front contact 130 of a control relay 2-4C and wire 126. A stick circuit for relay 3TN includes its front contact 131 and either front contact 132 of a directional stick relay 3ES or front contact 133 of a directional stick relay 2ES.

As previously stated, each of the indicators 1N, 2N, 3N and 4N have associated read-out relays 1RO, 2RO, 3RO and 4RO for effecting transfers of train descriptions from respective associated indicators to other indicators. Relay 1RO can be energized by either of two pick-up circuits. One pick-up circuit includes front contact 134 of relay 2ES, wire 135 and front contact 136 of a control relay 1-2C. The other pick-up circuit includes front contact 137 of relay 3ES, wire 138, and front contact 139 of a control relay 1-3C. Relay 1RO also has a stick circuit including its front contact 140 and front contact 141 of relay 1TK. Relay 4RO, which is comparable to relay 1RO, is provided with two pick-up circuits. One circuit includes front contact 142 of a directional stick relay 3WS and front contact 143 of a control relay 4-3C. The other pick-up circuit includes front contact 144 of a directional stick relay 2WS and front contact 145 of a control relay 4-2C. Relay 4RO has a stick circuit including its front contact 146, wire 147 and front contact 148 of relay 4TK. The read-out relay 2RO has two pick-up circuits and a stick circuit. One pick-up circuit includes front contact 149 of control relay 2-1C, and wire 150, and the other pick-up circuit includes front contact 151 of control relay 2-4C and wire 150. The stick circuit for relay 2RO includes its front contact 152 and front contact 153 of relay 2TK. Similar pick-up and stick circuits are provided for relay 3RO. One pick-up circuit includes front contact 154 of control relay 3-1C and wire 155, and the other pick-up circuit includes wire 155 and front contact 156 of a control relay 3-4C. The stick circuit for relay 3RO includes its front contact 157 and front contact 158 of relay 3TK.

A plurality of directional and directional stick relays

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are provided for detecting directions of train movements, and these relays function to permit transfers of train descriptions between indicators on a directional basis in accordance with train direction. A directional relay 1-2D and a directional stick relay 2ES are provided to detect trains moving from track section 1T into track section 2T. Relay 1-2D has a pick-up circuit including front contact 160 of relay 1TK, wire 161 and back contact 162 of relay 2TK. Thus, relay 1-2D can be energized only when track section 1T is occupied, but track section 2T is unoccupied. The companion directional stick relay 2ES has a pick-up circuit including front contact 163 of relay 2TK and front contact 164 of relay 1-2D. Relay 2ES also has a stick circuit including its front contact 165 and front contact 163 of relay 2TK. Thus, when a train occupies track section 1T, relay 1TK is picked-up closing its front contact 160 to energize relay 1-2D. As the train advances to occupy both track sections 1T and 2T, relay 2TK picks up, opening its back contact 162 to deenergize relay 1-2D and closing its front contact 163 to pick-up and stick relays 2ES. The picking up of relay 2ES is possible because relay 1-2D (and all of the other directional relays D) is assumed to be slow-acting in releasing its armature; thus, front contact 164 of relay 1-2D remains closed in the pick-up circuit for relay 2ES long enough to permit relay 2ES to be picked up.

Directional relay 1-3D and directional stick relay 3ES detect train movements from track section 1T to track section 3T in a similar manner. Relay 1-3D has a pick-up circuit including front contact 166 of relay 1TK, wire 167 and back contact 168 of relay 3TK. Relay 3ES has a pick-up circuit including front contact 169 of relay 3TK and front contact 170 of relay 1-3D; and a stick circuit for relay 3ES includes its front contact 171 and front contact 169 of relay 3TK.

Directional relay 4-2D and direction stick relay 2WS detect train movements from track section 4T into track section 2T, while similar relays 4-3D and 3WS detect train movements from track section 4T into track section 3T. The pick-up circuit for relay 4-2D includes front contact 172 of relay 4TK, wire 173, and back contact 162 of relay 2TK. Relay 2WS has a pick-up circuit including front contact 163 of relay 2TK, front contact 174 of relay 4-2D and wire 175; a stick circuit for relay 2WS includes its front contact 176, wire 177 and front contact 163 of relay 2TK. Relay 4-3D has a pick-up circuit including front contact 178 of relay 4TK, wire 179, and back contact 168 of relay 3TK. Relay 3WS has a pick-up circuit including front contact 169 of relay 3TK, front contact 180 of relay 4-3D, and wire 181; a stick circuit for relay 3WS includes its front contact 182, wire 183, and front contact 169 of relay 3TK.

Two other directional stick relays 1WS and 4ES are provided for detecting trains moving from either track section 2T or 3T into track sections 1T and 4T (i.e. trains leaving the siding location). Relay 1WS detects leaving trains moving to the left into track section 1T, while relay 4ES detects leaving trains moving to the right into track section 4T. Relay 1WS has a pick-up circuit including either front contact 184 of relay 2WS or front contact 185 of relay 3WS, wire 186, and front contact 187 of relay 1TK; a stick circuit for relay 1WS includes its front contact 188 and front contact 189 of relay 1TK. Relay 4ES has a pick-up circuit including either front contact 190 of relay 2ES or front contact 191 of relay 3ES, wire 192, and front contact 193 of relay 4TK; a stick circuit for relay 4ES includes its front contact 194 and front contact 195 of relay 4TK.

As described earlier, superior and inferior train descriptions differ in that an indicator storing such descriptions must be operated to a position wherein its front contact 6 is closed if the description is superior, and its back contact 6 is closed if the description is inferior. Transfers, or read-out operations, between in-

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dicators will therefore result in the energization of the code wire connecting the contacts 6 in respective indicators. For example, the illustrated condition of indicator 1AN is that which the indicator assumes when storing a description for a superior train No. 29 (see Fig. 5A). When read-out energy (BX) is applied to indicator 1AN by contact 87 of relay 1ATN through wire 88, front contacts 2 and 6 in indicator 1AN are closed. If relays 1WS and 1TN are in the proper positions, (BX) energy is applied by obvious means to contacts 2 and 6 in indicator 1N, and will operate the indicator 1N accordingly. It must be noted, however, that contacts 2 and 6 of indicator 1N are also connected to contacts 2 and 6 in indicator 2N (or 3N) by obvious circuits including wires 200 and 201. Since read-out operations between indicators 1N and 2N (or 3N) in either direction are accomplished via wires such as 89, 100 and 201, it follows that wire 201 will always be connected to (BX) energy during a transfer operation involving indicator 1N, provided that a description being transferred is for a superior train. In order to detect superior train classifications a decoding, or superiority detection, relay 1DC is provided. Relay 1DC is connected to a rectifier 202 which is, in turn, connected to the secondary winding of a transformer 203. The primary winding of transformer 203 is connected at one terminal to (NX) energy and at the other terminal to wire 201. Thus, when wire 201 is connected to (BX) energy during transfers of superior train descriptions, relay 1DC is picked up. A similar decoding relay 4DC is provided, and is connected through a rectifier 204 and transformer 205 to a wire 206 which is connected to contact 6 in indicator 4N. As will be seen, the primary function of relay 1DC is to detect superior classification descriptions for trains entering the siding location (Fig. 1) from track section 1T, while relay 4DC performs similar detections of superior trains entering via track section 4T.

Since situations can arise wherein two opposing trains entering the stretch of track have identical superiority classifications, it may be desirable to give priority to one train on a directional basis. The present system is arbitrarily arranged to give a directional superiority to trains moving from left to right in Fig. 1. The detection of conditions wherein two trains of the same classification are present concurrently is performed by a directional priority relay DPR. A pick-up circuit for relay DPR extends from (+), through front contact 207 of relay 1TN, wire 208, contact 209 of relay 1DC, the upper or lower windings of relay DPR, wires 210 or 211, contact 212 of relay 4DC, and front contact 213 of relay 4TN, to (-). Whenever two train descriptions for opposing trains are being transferred into indicators 1N and 4N, contacts 207 and 213 of relays 1TN and 4TN, respectively, close in the pick-up circuit for relay DPR. If the train classifications are identical, relays 1DC and 4DC will both be either energized (superior) or deenergized (inferior). Under such conditions, contacts 209 and 212 of relays 1DC and 4DC, respectively, will assume comparable positions, energizing either the upper or lower winding of relay DPR. If the classification for the trains are not identical, however, contacts 209 and 212 of relays 1DC and 4DC will not assume comparable positions, and relay DPR cannot be energized.

A plurality of route control relays are provided to call for routings for trains entering the stretch of track in Fig. 1. Relays 1-2C and 1-3C, when energized, call for routes from track section 1T to track sections 2T and 3T, respectively. Similar relays 2-1C and 3-1C call for routes from respective track sections 2T and 3T to track section 1T. Relays 4-2C and 4-3C call for routes from track section 4T to respective track sections 2T and 3T, while relays 2-4C and 3-4C call for routes from respective track sections 2T and 3T to track section 4T. Since route controls are assumed to be effected via code communication apparatus, it will be shown later that

operations of the control relays C activate control office code communication apparatus and select the characters of control codes to be transmitted to the field stations 6 and 8 (see Fig. 1). For example, the energization of relay 1-2C will result in the transmitting of control codes calling for track switch 7W to be operated to its normal position and calling for the clearing of signal 6R; in other words, calls are made to establish a route for a train moving from track section 1T to track section 2T.

Before describing the circuits for operating the control relays C it must be stated that the present system is arranged to operate in accordance with an arbitrary premise that any train will be normally routed straight through the stretch of track rather than via the siding. Under automatic operating conditions, therefore, a train will be routed through via the passing siding when a concurrently present opposing train of a superior classification is detected.

The control relay 1-2C is energized whenever a train is to be routed from track section 1T into track section 2T. This relay has a pick-up circuit including back contact 215 of relay 1WS, front contact 216 of relay 1TN, back contact 217 of relay 7DTK, wire 218, back contact 219 of relay 2TK, wire 220, and back contact 221 of relay 4DC. Thus, relay 1-2C can be energized whenever relay 1TN is energized in response to the detection of a train entering track section 1T, provided that track section 2T is not occupied and/or an opposing train of a superior classification is not detected. In cases where two opposing trains of the same classification are present, relay DPR is operated as previously described closing its front contact 222 to by-pass back contact 221 of relay 4DC in the previously described pick-up circuit for relay 1-2C. Connected in parallel with contacts 221 and 222 of relays 4DC and DPR, respectively, is a front contact 223 of a timing relay 1TE. The function of the timing relay 1TE is to measure a time interval during which relay 1-2C can be deenergized by the detection of an opposing superior train. In other words, the energization of relay 1-2C to establish a route for a train results in the starting of the timer 1TE by the closing of front contact 224 of relay 1-2C in a circuit including wire 224a. Until the timer 1TE completes its timing operation to close its front 223, relay 1-2C can be deenergized by the opening of back contact 221 of relay 4DC in response to the detection of a superior opposing train.

Routes from track section 1T to track section 3T are called for by the energization of control relay 1-3C. This relay is normally operated only when a route to track section 2T is not available because of track occupancy, or because of conditions wherein a train which would be normally routed to track section 2T is opposed by another train having a superior classification. Under conditions wherein relay 1-3C is to be operated because of track occupancy conditions, the relay has a pick-up circuit including back contact 215 of relay 1WS, front contact 216 of relay 1TN, back contact 217 of relay 7DTK, wire 225, front contact 226 of relay 2TK, and back contact 227 of relay 3TK. If track section 2T is not occupied, back contact 226 of relay 2TK in the previously described pick-up circuit is closed, and the pick-up circuit is altered to include back contact 228 of relay DPR, wire 229, and front contact 230 of relay 4DC.

The setting up of routes for trains entering the stretch of track from the opposite direction is controlled by relays 4-2C and 4-3C. The pick-up circuits for these relays have a common portion including back contact 231 of relay 4ES, wire 232, front contact 233 of relay 4TN and back contact 234 of relay 9DTK. Under normal conditions, relay 4-2C is operated by a pick-up circuit including the described portion and extending through wire 235, back contact 236 of relay DPR, back contact 237 of relay 2TK, and back contact 238 of relay 1DC.

This pick-up circuit is dependent upon the occupied condition of track section 2T, upon the detection of an opposing superior train, and upon conditions of directional superiority which occur when an opposing train of an equal classification is present. Associated with relay 4-2C is a timing relay 4TE which is operated by the closing of front contact 239 of relay 4-2C. As in the case of the previously described relay 1TE, relay 4TE measures a time interval during which relay 4-2C can be deenergized in response to the detection of an opposing superior train. If relay 4TE completes a timing operation holding circuit for relay 4-2C is established through front contact 240 of relay 4TE, wire 241, and back contact 242 of relay 2TK. Relay 4-3C, on the other hand, can be picked up in response to the entrance of a train into track section 4T from the right by circuits including the common portion shared with relay 4-2C, wire 283, back contact 284 of relay 3TK, contact 285 of relay 2TK, front contact 286 of relay 1DC and front contact 287 of relay DPR. A pick-up circuit for relay 4-3C can be completed when track section 2T is occupied by another train and/or when track section 2T is unoccupied but an opposing train of either a superior or equal classification is detected.

Relays 1-2C, 1-3C, 4-2C and 4-3C are capable when operated of routing an incoming train from respective track sections 1T or 4T into either track section 2T or 3T. When a train has been routed into either track section 2T or 3T, it is necessary to operate a second route control relay C to call for track switch and signal operations which will permit the train to leave the siding location via either track section 1T or 4T. Relays 2-1C and 3-1C are operable to call for routes for trains leaving either track section 2T or 3T by way of track section 1T. For this reason, the two relays have pick-up circuits including a common portion which includes back contact 243 of relay 1TK. From this point, the pick-up circuit diverge. The pick-up circuit for relay 2-1C includes wire 244 and front contact 245 of relay 2WS. For this pick-up circuit to be effective, track section 1T must be unoccupied and the direction of the train as indicated by relay 2WS must be from right to left in the track diagram. The remainder of the pick-up circuit for relay 3-1C includes back contact 246 of relay 2-1C, wire 247, and front contact 248 of relay 3WS. This pick-up circuit can be effective only when track section 1T is unoccupied and the direction of train movement is again from right to left in the track diagram.

The controlling of routes for trains occupying either track section 2T or 3T, when such trains have destinations involving track section 4T, are controlled by the respective relays 2-4C and 3-4C. Relays 2-4C and 3-4C have pick-up circuits including a common portion which includes back contact 249 of relay 4TK and wire 250. Thus, both relays are dependent upon the unoccupied condition of track section 4T. The remainder of the pick-up circuit for relay 2-4C includes wire 251 and front contact 252 of relay 2ES. The remainder of the pick-up circuit for relay 3-4C includes back contact 253 of relay 2-4C, wire 254, and front contact 255 of relay 3ES. In order for either pick-up circuit for the respective relays to be effective, therefore, the direction of movement of a train must be from left to right in the track diagram, as indicated by the condition of either relay 2ES or 3ES.

Code communication apparatus

The code communication system used in conjunction with the present invention can be of any of a number of well-known types. The type selected for illustration, however, is assumed to be of the type disclosed in the U.S. Patent No. 2,399,734 to W. D. Hailes et al., dated May 7, 1946. This patent discloses a code communication system which is operable to transmit selected control codes from a control office to field stations and to trans-

mit selected indication codes from the field stations to the control office. Coding and decoding circuits translate control codes for selectively operating track switches and signals, and translate indication codes for operating indication relays in the control office.

Relying on the above patent to Hailes et al. for a complete description of code communication operations, the present disclosure will be limited to more general descriptions and will show the manner in which the present invention can be used in conjunction with the system.

In Fig. 6, the control office portion of the code communication system disclosed in the above Hailes et al. patent is shown in partial detail. Only those elements necessary to show cooperation with the present invention are shown, and the various elements can be readily associated with their counterparts in the Hailes et al. disclosure.

The apparatus includes location relays LC and start relays CH which are associated with respective field stations (see Figs. 1 and 2). Relays 6LC and 6CH are associated with field station 6 and the signaling devices at the left end of the siding. Relays 8LC and 8CH are associated with field station 8 and the apparatus at the right end of the siding. In addition, the various LC and CH relays are also associated with the control levers (Fig. 2) and other apparatus (Figs. 3A-3F) which are used to selectively control each field location.

Whenever a start relay CH and its associated location relay LC are energized, the code communication system is activated in the manner described in Hailes et al. A bank of stepping relays 1V-6V and LV are actuated, and these relays operate in a sequence (or cycle) during which a plurality of step channels are formed by a network of stepping relay contacts. Energy is supplied through the stepping contact network to step terminals in sequence, and these terminals are connected by contacts of the various LC relays to control levers or relays which, in turn, are capable of selectively energizing coding relays LS and SL. Relays LS and SL, in turn, operate to apply distinctive code characters to the line circuit connecting the control office and the field stations.

As previously described, the control panel (Fig. 2) includes a manual selection lever MSL which can be operated to selectively determine whether manual or automatic controls are to be exercised to route trains through the stretch of track and passing siding (Fig. 1). If automatic controls are to be effected the lever MSL is positioned to the left as shown, and contacts of the lever MSL (Fig. 6) connect the code communication apparatus to networks of contacts associated with the route control relays C. When positioned to the right, contacts of lever MSL connect the code communication apparatus to a network of track switch and signal control levers, and to start pushbuttons SPB.

The switch control lever 7WL, the signal lever 6GL and the start button 6SPB (Fig. 2) are provided to control the track switch 7W and signals 6R, 6LA and 6LB at field station 6 (Fig. 1). The route control relays 1-2C, 1-3C, 2-1C and 3-1C (Figs. 3A-3F) are provided to exercise automatic controls over the signaling devices at field station 6. Thus, the start relay 6CH (Fig. 6) and the associated location relay 6LC can be operated in a plurality of ways to cause the transmission of control codes to field station 6.

Under automatic conditions relay 6CH is connected by contact 257 of lever MSL and back contact 258 of a cut-off relay CP to a parallel combination of control relay C contacts such as front contact 259 of relay 3-1C. Thus, whenever relay 1-2C, 2-1C, 1-3C or 3-1C is energized relay 6CH is picked-up. Once energized, relay 6CH is held by a stick circuit including its front contact 260 and back contact 261 of relay 6LC. The subsequent closing of front contact 262 of relay 6CH connects the winding of relay 6LC into a chain circuit which receives energy via a wire 263. As disclosed in the above

patent to Hailes et al., relay 6LC picks up and is held by a stick circuit (not shown) which is effective for the duration of a control code transmission cycle. The energization of relay 6LC activates the code communication apparatus, causing the stepping relays 1V-6V and LV to operate in sequence. When relay V1 picks up, its front contact 264 closes to apply (+) energy to a step terminal identified by the character (1). As relays V2-V6 are operated in sequence other step terminals (2)-(6) are energized in sequence. The step terminals (1)-(6) are connected through contacts such as 265 of relay 6LC to contact networks which selectively apply (+) energy to busses for picking up the code determining relays LS and SL.

As described in the above Hailes et al. patent the first step or steps in each control cycle are used to transmit station call codes which selectively render the apparatus at a selected field station responsive to codes transmitted on succeeding steps. For this reason step terminals (1) and (2) are not shown connected, but are assumed to be connected in a predetermined manner to the LS and SL busses. Step (3) is assigned here for track switch control, and steps (4) and (5) are assigned to signal controls. Thus, when front contact 265 of relay 6LC is closed, step (3) terminal is connected selectively to either the LS or SL bus through contact 266 of lever MSL, and either contact 267 of the switch control lever 7WL or contacts 268, 269, 270, 271, 272 and 273 of the respective control relays 3-1C, 1-3C, 2-1C and 1-2C. The assumption is made that if switch 7W is to be operated to its normal position, relay LS is to be energized to cause the transmission of a particular code character, while reverse operations of switch 7W require relay SL to be energized to select a different code character for transmission. Thus, on step (3), under automatic operating conditions, the alignment of the contacts 268-273 of relays 3-1C, 1-3C, 2-1C and 1-2C determines which relay LS or SL will be energized by the stepping network through contact 266 of lever MSL and front contact 265 of relay 6LC. Since the routes associated with relays 1-2C and 2-1C, for example, both call for the normal positions of track switch 7W, the energization of either relay will connect relay LS to step terminal (3). If relay 1-2C is energized the circuit from step terminal (3) to relay LS can be traced through front contact 265 of relay 6LC, contact 266 of lever MSL, back contact 268 of relay 3-1C, back contact 269 of relay 1-3C, and front contact 271 of relay 1-2C. With the exception of front contact 271 of relay 1-2C, the same connection would be made if relay 2-1C were energized instead, resulting in the closing of front contact 270 of relay 2-1C in the network.

If either route control relay 1-3C or 3-1C is operated, the routes defined by these relays require track switch 7W to be operated to its reverse position. Therefore, on the third step relay SL must be connected to step terminal (3). It should be evident that such connections are made when either front contact 268 of relay 3-1C or front contact 269 of relay 1-3C are closed.

The connecting network described between step (3) terminal and the LS and SL relay busses is arranged to prevent conflicting route calls to be made. If either relay 1-2C or 2-1C is energized at the same time as either relay 1-3C or 3-1C, a complete circuit to either relay LS or SL from step terminal (3) cannot be made.

The fourth step (4) is assigned, insofar as field station 6 is concerned, to the operating of signal 6R, and the fifth step (+) is assigned to the controlling of signals 6LA and 6LB. Assuming that a stop signal control requires relay SL to be connected to a step terminal, and assuming that a proceed signal control requires relay LS to be connected to a step terminal, it will be sufficient to describe operations for only one signal 6R. Signal 6R governs traffic to the right over switch 7W

(Fig. 1). The signal 6R has two heads for governing both of the divergent routes over switch 7W. The manner in which the signal mechanisms are selectively controlled is a function of switch position and, although not shown in the present disclosure, is well-known in the art. The routes defined by control relays 1-2C and 1-3C both require that signal 6R be cleared. Thus, on the fourth step, step terminal (4) is connected to the SL or LS relay busses by circuits including front contact 274 of relay 6LC, left contact 275 of selection lever MSL, and contacts 276 and 277 of the respective relays 1-3C and 1-2C. If either relay 1-2C or 1-3C is energized relay LS is connected to step terminal (4), resulting in the transmission of a signal-clearing code character. If neither relay 1-2C nor 1-3C is energized, no route to the right over switch 7W is presumably called for and relay SL is connected to step (4) terminal. In the latter case, a stop control code is transmitted on the fourth step.

If manual operations are in effect, lever MSL is positioned to the right (Figs. 2 and 6), and step terminals (3), (4) and (5) are connected by contacts such as right contacts 266 and 267 of lever MSL through contacts of the switch and signal control levers to the LS and SL relay busses. Contact 267 of switch lever 7WL, for example, selectively connects the LS and SL busses to step terminal (3), while contact 278 of the signal lever 6GL selectively connects the LS and SL busses to step terminal (4). At the same time, the starting of the code communication systems under manual conditions is such that relay 6CH must be energized by the closing of contact 279 of the start button 6SPB, since contact 257 of lever MSL is closed to the right.

Since manual operations are well-known, and are described in the above Hailes et al. patent, no further description will be given here. It should also be evident that manual and automatic controls for the signaling devices at field station 8 (Fig. 1) are effected in a similar manner. The present disclosure (Fig. 6) shows the circuits necessary to operate the start relay 8CH and location relay 8LC, but does not show circuit connections from the step terminals (1)-(6) to various lever and control relay contacts through contacts of relay 8LC such as 280.

Under manual operating conditions, each actuation of a start button such as 6SPB energizes a start relay such as 6CH. The start relay is held by a stick circuit until the associated location relay LC picks up to start code transmissions. In Fig. 6, when relay 6LC picks up, its back contact 261 opens the stick circuit for relay 6CH, denenergizing the latter relay. If relay 6CH is held energized by its pick-up circuit, however, another code cycle is started after the completion of the first. Push-button operations to obtain starts are usually brief and do not close the pick-up circuit for a start relay CH for a length of time sufficient to cause the transmission of a plurality of control code cycles. Under automatic conditions, however, a control relay C may be energized for a period long enough to cause repeated cycles to be effected. To prevent such conditions cut-off relays such as 6CP are provided.

When relay 6CH is picked-up by the closing of a contact such as 259 of relay 3-1C, relay 6LC is caused to be energized as described. Front contact 281 of relay 6LC energizes relay 6CP which closes its stick contact 282. The stick circuit for relay 6CP also includes front contact 259 of relay 3-1C, so relay 6CP remains picked up until relay 3-1C drops away. Back contact 258 of relay 6CP opens the automatic pick-up circuit for relay 6CH, and the stick circuit for relay 6CH is open at back contact 261 of relay 6LC. Thus, relay 6CH is effectively deenergized. The cut-off relay 6CP (and 8CP) picks up when code transmission begins and remains picked-up until the control relay C which called for the code transmission is dropped away.

As described in the above Hailes et al. patent, the code communication system selectively transmits indication codes from the field stations and operates track indication relays TK, switch indication relays NWK and RWK, and signal indication relays GK. Such operations and relays are indicated in Fig. 6, and specific indication relays have been shown and described in Figs. 3A-3F.

In view of the above Hailes et al. patent and other well-known signaling systems, the present disclosure does not show actual switch and signal control circuits located in the field stations. The primary consideration here is to show means for selectively operating such well-known control circuits in response to the storage and transfer of train descriptions.

Operation

Assume that a train is detected approaching the passing siding area (Fig. 1) from the left, via the approach track section 1AT. The operator, or dispatcher, at the control office is informed of the approach of the train by indication means such as a track occupancy indication light (not shown) in the track diagram on the control panel (Fig. 2). The operator is aware of the number and type of the train either from reference to a train sheet or from information received from the last control office passed by the train, or from the description of the train displayed by an indicator at the preceding siding location.

The operator then effects the storage of a description for the train in the storage indicator 1AN by operating a train description button on the control panel. The button operated will be one inscribed with the proper train identification number, and will be located either in the row headed S or the row headed I, depending upon the classification (superior or inferior) of the train.

When a button is depressed, contacts of the button close (Fig. 3A) to selectively energize the code relays CR1-CR6 and to energize the transfer relay CTN. Relay CTN will remain energized as long as a button is held depressed, and the selectively energized code relays CR will also remain energized.

The closing of front contact 70 of relay CTN applies (BX) energy to the front contacts 71-76 of the respective code relays CR1-CR6. Any of these contacts 71-76 which are closed in their front positions will connect (BX) energy to contacts 1-6 in indicator 1AN (Figs. 3A and 3B) through front contacts such as 77 of relay 1ATN and wires such as 78. Indicator 1AN then operates, as described, until its front contacts 1-6 are closed in the same combination as that assumed by front contacts 71-76 of the code relays CR1-CR6, at which time the motor in indicator 1AN is cut off and the latching relay LR releases to lock the indicator mechanism in place. At this time the indicator tape displays the same number as the number of the operated train description button.

As soon as the indicator 1AN completes its operation the operator releases the train description button, resulting in the deenergization of relay CTN and the opening of the pick-up busses for relays CR1-CR6. The selected code relays CR1-CR6 do not drop away, however, until their stick circuits are opened by the opening of front contact 83 of relay CTN. Front contact 70 of relay CTN opens to remove (BX) energy from the contacts 71-76 of relays CR1-CR6, thereby removing energy (BX) from the indicator 1AN. As previously described, relay CTN functions to hold any code relays CR1-CR6 energized through its front contact 83 so that these relays are deenergized concurrently with the removal of (BX) energy from the control circuits for indicator 1AN by the opening of front contact 70 of relay CTN. In this manner, possible differences in release times of the code relays CR1-CR6 cannot cause further operations of indicator 1AN which would result if the combination of closed front and back contacts 71-76 were changed.

As previously described, train descriptions stored in an indicator can identify a train as being superior or inferior. Superior descriptions all call for indicator positions in which front contact 6 in the indicator is closed. In the present description of operations associated with a single train approaching from the left, superior and inferior classifications are immaterial, but will be carried through the description of operation.

When the train occupies track section 1T, the associated track circuit is shunted causing the code communication system to perform an indication cycle during which indication codes are sent to the control office from field station 6. The characters of the indication codes are such that the track indication relay 1TK is picked up. Since relay 1TK is of the magnetic stick type, it will remain picked up until knocked down in response to later indication codes which will be transmitted when track section 1T is vacated. Such operations are fully described in the above cited patent to Hailes et al.

When back contact 112 of relay 1TK opens (Figs. 3A-3B) relay 1ATN is deenergized. Front contacts such as 77 of relay 1ATN open the circuits connecting the code relays CR1-CR6 to the indicator 1AN, and front contact 82 of relay 1ATN disconnects the motor of indicator 1AN from (NX) energy. Front contact 112 of relay 1TK closes, causing the picking up of the transfer relay 1TN. Front contacts such as 86 of relay 1TN close circuits connecting contacts 1-6 in indicator 1AN to respective contacts 1-6 in indicator 1N. The previously deenergized relay 1ATN closes its back contact 87 to apply (BX) energy to the front contact bus in indicator 1AN through wire 88.

The applied (BX) energy reaches the latching relay LR and the motor in indicator 1N through the various closed front contacts 1-6 in indicator 1AN, back contacts such as 85 of relay 1WS, front contacts such as 86 of relay 1TN and various closed back contacts 1-6 in indicator 1N. Since the latching relay LR and motor in indicator 1N are also connected to (NX) energy through back contact 95 of relay 1RO, the latch relay LR and motor are operated until the indicator 1N assumes an operated position identical to that of the indicator 1AN. At this time the train numbers displayed by the two indicators 1AN and 1N are identical, and the alignments of the contacts 1-6 in the respective indicators are the same.

During the described transfer operation, the latching relay and motor in indicator 1AN could be connected periodically to (BX) energy through various feed-around paths including contacts 1-6 in indicator 1N and any closed back contacts 1-6 in indicator 1AN. Therefore, indicator 1AN could be erroneously operated during the read-out operation unless its motor circuit is interrupted. For this reason front contact 82 of relay 1ATN is provided in the motor circuit to disconnect the motor and latching relay LR in indicator 1AN from (NX) energy while (BX) energy is being applied for read-out transfers by back contact 87 of the same relay 1ATN.

When relay 1TN is picked up to operate indicator 1N to store the train description already stored in indicator 1AN, front contact 216 of relay 1TN closes in the pick-up circuits for the control relays 1-2C and 1-3C. The picking up of one or the other of these relays will, as described, operate the code communication system (Fig. 6) to send selected control codes to field station 6 (Fig. 1), resulting in the positioning of track switch 7W and the clearing of signal 6R. As previously stated, it will be assumed that any single train will be routed straight through the stretch of track via track section 2T unless the presence of other trains make it necessary to route the train into the passing siding (track section 3T). Thus, control relay 1-2C which controls routes from track section 1T to track section 2T should be picked up under the present conditions. It can be seen in Figs. 3B and 3C that the closing of front contact 216 of relay 1TN completes a pick-up circuit for relay 1-2C, while no

closed pick-up circuit for relay 1-3C is available. Specifically, the pick-up circuit for relay 1-2C includes back contact 215 of relay 1WS, front contact 216 of relay 1TN, back contact 217 of relay 7DTK, wire 218, back contact 219 of relay 2TK, wire 220 and back contact 221 of relay 4DC.

The picking up of relay 1-2C activates the code communication apparatus (Fig. 6), as previously described, and contacts 271, 273 and 277 of relay 1-2C select code characters to be transmitted calling for the normal (straight through) position of track switch 7W and for the clearing of signal 6R. When such controls have been effected, indication codes are transmitted to the control office causing the operation of the normal switch indication relay NWK for switch 7W and the signal indication relay GK for signal 6R. Thus, in Figs. 3B-3D, front contacts such as 91 of relay 7NWK are closed, indicating that switch 7W is in its normal position.

When the train accepts signal 6R and advances across track section 7DT and into track section 2T (Fig. 1) indication codes are transmitted to the control office for operating relays 7DTK and 2TK to indicate track occupancies.

At the time when the train was indicated entering track section 1T, causing the picking up of relay 1TK, front contact 160 of relay 1TK closed (Figs. 3B-3C) the pick-up circuit for the directional relay 1-2D; this pick-up circuit also includes wire 161 and back contact 162 of relay 2TK. When relay 2TK is picked up in response to the indicated occupancy of track section 2T, the directional stick relay 2ES is energized. The pick-up circuit for relay 2ES includes front contact 163 of relay 2TK and front contact 164 of relay 1-2D; and a stick circuit for relay 2ES including its stick contact 165 and front contact 163 of relay 2TK closed. Relay 2ES remains energized until track section 2TK is indicated as being unoccupied.

At the time when relays 7DTK and 2TK pick up, back contact 162 of relay 2TK opens to deenergize relay 1-2D and back contact 217 of relay 7DTK opens the energizing circuit for relay 1-2C. Relay 1-2D is slow-acting, however, so that its front contact 164 in the previously described pick-up circuit for relay 2ES is closed long enough to permit the picking up of relay 2ES. Relay 1-2C is also slow-acting in releasing its armature to permit other circuit operations which will now be described.

When relay 2ES picks up it closes its front contact 134 to energize the read-out relay 1RO through front contact 136 of relay 1-2C. Relay 1RO is then held by a stick circuit including stick contact 140 of relay 1RO and front contact 141 of relay 1TK. The slow-acting requirements for relay 1-2C are now evident in that this relay must not open its front contact 136 until relay 1RO can be picked up.

The picking up of relay 1RO results in the picking up of transfer relay 2TN and in the application of read-out energy (BX) to the indicator 1N. Front contact 116 of relay 1RO closes a pick-up circuit for relay 2TN. Relay 2TN then closes its front contacts such as 90. Read-out energy (BX) is applied to the contacts 1-6 in indicator 1N by front contact 94 of relay 1RO, while back contact 95 of relay 1RO opens the motor circuit for indicator 1N. Since at this time the circuits interconnecting the respective contacts 1-6 in indicators 1N and 2N are closed through front contacts such as 90 and 91 of relays 2TN and 7NWK, respectively, (BX) energy is applied to the motor and latching relay LR in indicator 2N; and the motor and latching relay are also connected to (NX) energy through back contact 97 of relay 2RO. The indicator 2N is thereby operated to the same position as that assumed by indicator 1N. Thus, the indicator 2N is operated to display and store the description for the train when the train is detected entering track section 2T.

At the time when relay 2ES is energized the direction of movement of the train is established as being into track section 2T (Fig. 1) from track section 1T. Thus, controls must be effected to permit the train to leave track section 2T via switch 9W and track section 4T.

When relay 2ES closes its front contacts, relay 2-4C is energized (Figs. 3C-3E) by a pick-up circuit including back contact 249 of relay 4TK, wires 250 and 251, and front contact 252 of relay 2ES. This pick-up circuit requires that track section 4T be unoccupied before controls can be sent to route the train into that track section. When relay 2-4C is picked up its contacts activate the code communication system (Fig. 6) to transmit control codes to field station 8 (Fig. 1) where field control circuits for track switch 9W and signal 8RA are located. The network for selecting the code characters to be transmitted to field station 8 is now shown in Fig. 6, but is comparable to that shown for selecting codes to be transmitted to field station 6.

The picking up of relay 2-4C also causes the picking up of the read-out relay 2RO through front contact 151 of relay 2-4C and wire 150 (Figs. 3B-3E). An obvious stick circuit for relay 2RO including front contacts 152 and 153 of relays 2RO and 2TK, respectively, is then closed. Back contact 97 of relay 2RO disconnects the motor circuit for indicator 2N from (NX) energy, and front contact 96 of relay 2RO applies read-out energy (BX) to indicator 2N.

As soon as controls are effected at field station 8, indication codes are sent to the control office calling for the operation of the indication relays associated with switch 9W and signal 9RA to picked-up conditions.

When the train progresses to a point whereby track sections 1T and 8DT are vacated (Fig. 1) and track section 2T alone is occupied, indication codes are sent to the control office resulting in the dropping away of relays 1TK and 7DTK. The opening of front contact 141 of relay 1TK deenergizes relay 1RO (Fig. 3B). Contact 112 of relay 1TK crosses over from front to back, deenergizing relay 1TN and picking up relay 1ATN. The dropping away of relay 1TN opens the connecting circuits between indicators 1AN and 1N at front contacts such as 86 of relay 1ATN. The dropping away of relay 1RO removes read-out energy (BX) from indicator 1N at front contact 94 of relay 1RO, and front contact 116 of relay 1RO opens to deenergize relay 2TN which, in turn, opens its front contacts such as 90 to disconnect indicator 1N from indicator 2N.

When the train accepts signal 8RA (Fig. 1) and moves into track sections 9DT and 4T, indication codes are sent to the control office resulting in the picking up of relays 9DTK and 4TK. The opening of back contact 249 of relay 4TK (Fig. 3E) deenergizes the slow-acting control relay 2-4C which will retain its armature until subsequently described operations are completed. The picking up of relay 4TK results in the energization of relays 3TN, 4ES and 4TN, and also results in the deenergization of relay 4ATN. Contact 114 of relay 4TK crosses over from back to front to cause the deenergization of relay 4ATN and the energization of relay 4TN; front contact 193 of relay 4TK completes a pick-up circuit for relay 4ES including wire 192 and front contact 190 of relay 2ES; front contact 127 of relay 4TK completes a pick-up circuit for relay 3TN including wire 128 and front contact 130 of relay 2-4C. Thus, as noted, relay 2-4C must not release its armature until relay 3TN is picked up. Relays 4ES and 3TN are then held by stick circuits. The stick circuit for relay 4ES includes its stick contact 194 and front contacts 193 and 195 of relay 4TK, while the stick circuit for relay 3TN includes front contact 133 of relay 2ES and front contact 131 of relay 3TN. Since relays 4TN and 4ES pick up at the same time, as described, back contacts such as 109 of relay 4ES open before front contacts such as 107 of relay 4TN close. Thus, the connections

between indicators 4N and 4AN are kept open and read-out energy (BX) cannot be fed to operate indicator 4N to the condition of indicator 4AN in response to the closing of back contact 110 of relay 4ATN. In this manner, the only read-out (BX) energy which will be applied to operate indicator 4N will result from the closing of front contacts such as 101 of relay 3TN. At this time, indicator 4N is operated to the same position as that assumed by indicator 2N, read-out energy (BX) being applied to the motor and latching relay LR in indicator 4N through front contact 96 of the previously picked up relay 2RO, contacts 1-6 of indicator 2N, front contacts such as 100 of relay 9NWK, front contacts such as 101 of relay 3TN and contacts 1-6 of indicator 4N. The motor-relay circuit is connected to (NX) energy through back contact 106 of relay 4RO. When indicator 4N completes its operation it will store and display the train description.

When the train vacates track sections 2T and 9DTK (Fig. 1) indication codes are caused to be transmitted to the control office, resulting in the dropping away of relays 2TK and 9DT. The dropping of relay 2TK results in the deenergization of relays 2ES and 2RO by the opening of the respective stick circuits for those relays at front contacts 163 and 153 of relay 2TK. The dropping away of relay 2RO removes read-out energy (BX) from indicator 2N at front contact 96 of relay 2RO. The dropping away of relay 2ES opens its front contact 133 in the stick circuit for relay 3TN, and relay 3TN drops away. Front contacts such as 101 of relay 3TN open to disconnect indicators 2N and 4N.

When the train leaves track section 4T (Fig. 1), the code communication system is activated to send indication codes to the control office, resulting in the knocking down of relay 4TK. Front contacts 193 and 195 of relay 4TK open to drop relay 4ES, and contact 114 of relay 4TK crosses from front to back, thereby deenergizing relay 4TN and energizing relay 4ATN. At this point the circuits have been returned to a normal condition.

A review of the previous operation shows that the train description stored in indicator 1AN was effected by the use of train description buttons. When the train entered track section 1T indicator 1N was operated to the same condition as indicator 1AN, and at the same time controls were effected to route the train to track section 2T. When the train entered track section 2T, indicator 2N was operated to the same condition as indicators 1AN and 1N, and at the same time route controls were effected to send the train from track section 2T to section 4T. When the train entered track section 4T, indicator 4N was operated to the same condition as indicators 1AN, 1N and 2N. When the train left track section 4T, the control circuits were returned to normal. Thus, the described operation resulted in the operation of indicators 1N, 2N and 4N to the same condition as indicator 1AN, thereby showing the progress of the train. Also, the train automatically routes itself straight through the stretch of track.

Inspection of the circuit drawings (Figs. 3A-3F) will show circuit symmetry which would produce comparable effects for a single train moving from right to left in Fig. 1. Descriptions would be read into successive indicators 4N, 2N and 1N as the train progressed. Similarly, the train would operate control relays 4-2C and 2-1C to call for a straight-through routing. The directional and directional stick relays 4-2D, 2WS and 1WS would be operated in response to the train's progress, along with transfer relays 4ATN, 4TN, 3TN and 2TN and read-out relays 4RO and 2RO.

A primary consideration in the present invention is the ability of the system to permit a train to advance-control its own route, and to permit automatic arrangements of meets between trains. As described earlier, when a train entering from the left occupies track section 1T (Fig. 1) the resulting picking up of relay 1TK (see

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Figs. 3A-3F) results in the picking up of relay 1TN. When relay 1TN picks up, its front contact 216 closes in the common portion of pick-up circuits for the route control relays 1-2C and 1-3C. Under conditions wherein only one train was present in the stretch of track, relay 1-2C would, as described, be picked up to call for a route to track section 2T. By the same token, a single train entering track section 4T from the right would cause the picking up of relay 4TK which will close its front contact 114 to pick up relay 4TN. Front contact 233 of relay 4TN, in closing, closes the common portion of pick-up circuits for relays 4-2C and 4-3C. If this latter train is not in conflict with other trains, relay 4-2C will be picked up, calling for a route from track 4T to track 2T. At the time when either relay 1TN or 4TN picks up, circuits are closed between indicators 1AN and 1N or 4AN and 4N. Thus, a superior train description stored by indicator 1AN would result in the application of (BX) energy to contact 6 of indicator 1N and wire 201; and a superior description stored by indicator 4AN would result in the application of (BX) energy to contact 6 of indicator 4N and wire 206. Whenever wire 201 receives (BX) energy the transformer 202 is energized resulting in the picking up of the decoding relay 1DC through the rectifier 203. Similarly, relay 4DC is picked up through rectifier 204 when the transformer 205 is energized by the application of (BX) energy to wire 206.

Assume now that two opposing trains are approaching at the same time and that a superior description is stored in indicator 4AN for the train approaching from the right, the train approaching from the left having been assigned an inferior classification. Assume further that the trains enter track sections 1T and 4T at approximately the same time. Relays 1TN and 4TN pick up, as described, when relays 1TK and 4TK are picked up. Contacts 216 and 233, respectively, of relays 1TN and 4TN close in the pick-up circuits for relays 1-2C and 1-3C, 4-2C and 4-3C, respectively; and at the same time relay 4DC picks up. Relay 4-2C picks up in response to the closing of its pick-up circuit including back contact 231 of relay 4ES, front contact 233 of relay 4TN, back contact 234 of relay 9DTK, wire 235, back contact 236 of relay DPR, back contact 237 of relay 2TK, and back contact 238 of relay 1DC. Relay 1-2C cannot be picked up as described earlier because back contact 221 of relay 4DC is open. Relay 1-3C does pick up, however, in response to the closing of a pick-up circuit including back contact 215 of relay 1WS, front contact 216 of relay 1TN, back contact 217 of relay 7DTK, wire 225, back contact 226 of relay 2TK, back contact 228 of relay DPR, wire 229, and front contact 230 of relay 4DC. Thus, the operation of relay 4DC and its contacts 221 and 230 renders relay 1-2C inoperative and renders relay 1-3C operative.

The picking up of relays 4-2C and 1-3C cause the transmission of control code cycles to field stations 6 and 8 (Fig. 1) calling for switches 7W and 9W to be positioned to route the train approaching from the left into track section 3T and the other train into track section 2T. The selected codes are called for by the circuits in Fig. 6.

It can be seen that if the relative superiorities of the two trains were reversed (i.e. the description for the train from the left stored in indicator 1AN were superior) relay 1DC rather than 4DC would be energized. Inspection of the pick-up circuits for relays 1-2C, 1-3C, 4-2C and 4-3C shows that under these conditions relays 1-2C and 4-3C would be energized by the picking up of relays 1TN and 4TN.

Another condition exists whereby both trains are given the same classification, superior or inferior. In such a case relays 1DC and 4DC will both be either energized or deenergized. Thus, when the entering trains cause relays 1TN and 4TN to be picked up, relay DPR is picked up by one of its previously described pick-up circuits.

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When relay DPR picks up, its back contacts 228 and 236 open the described pick-up circuits for relays 1-3C and 4-2C, and its front contacts 222 and 287 close pick-up circuits for relays 1-2C and 4-3C. Thus, the train from the left (track 1T to 2T) is given directional superiority over the train from the right (track 4T to 3T).

The control circuits for the control relays C are arranged to provide for another condition wherein one of two opposing trains arrives much later than the other. The latter train to arrive may have a classification superior to that of the earlier train. Although it is assumed that the signal control circuits in the field (not shown) include approach locking and other standard features which would prevent unsafe conditions from existing, it is also undesirable to transmit controls for causing an established route to be cancelled in the face of a train (i.e. change a signal to red in the face of an approaching train) except in emergencies. The described normal pick-up circuit for relay 1-2C, for example, can be opened any time a superior opposing train arrives and causes relay 4DC to open its back contact 221, but this contact 221 of relay 4DC can be by-passed by contact 223 of the timing relay 1TE. As described, relay 1TE is energized by the closing of front contact 224 of relay 1-2C. The timing relay will close its front contact 223 after a predetermined time interval based on speed and traffic conditions. Once relay 1TE completes a timing operation, relay 1-2C cannot be dropped away by the arrival of a superior opposing train. Similarly, relay 4TE provides a similar auxiliary pick-up circuit for relay 4-2C through front contact 240 of relay 4TE.

The pick-up circuits for relays 1-2C, 1-3C, 4-2C and 4-3C are also arranged to provide for other conditions. Suppose that track section 2T is already occupied by a train at a time when, for example, a train enters track section 1T. At this time, back contact 219 of relay 2TK is open in the pick-up circuit for relay 1-2C, and relay 1-2C cannot be picked up. However, front contact 226 of relay 2TK is closed to provide a pick-up circuit for relay 1-3C, and a route is called for to route the train to the siding (track 3T). Thus, the previous condition wherein two opposing trains arrive at spaced intervals is taken care of—the earlier train enters track section 2T, and the later train is routed into the siding (3T).

It should be evident from the drawings that a control relay C cannot be picked up under any circumstances if an associated destination track is occupied.

Attention can now be given to relay operations required to route a train from track section 3T (the passing siding) into track sections 1T or 4T. Assume that the meeting of two opposing trains results in the train from the left being routed into track section 2T, and the train from the right into track section 3T. Under such conditions relays 1-2C and 4-3C would have been energized to call for the proper routings. The train occupying track section 2T, as described earlier, will cause relay 2ES to pick up closing its front contact 252 in the pick-up circuit for relay 2-4C. If the other train has moved out of track section 4T and into the siding relay 4TK will be down, and back contact 249 of relay 4TK will be closed to permit relay 2-4C to pick up. Thus, a route is called for to permit the train occupying track section 2T to leave via track section 4T. The opposing train entering track section 3T from track section 4T causes relay 3WS to be picked up by the closing of front contact 169 of relay 3TK. The closing of front contact 142 of relay 3WS in combination with the closed condition of front contact 143 of relay 4-3C picks up relay 4RO. Front contact 125 of relay 4RO closes to pick up relay 3TN. At this time, the train description is read into indicator 3N, operating energy (BX) being supplied by front contact 105 of relay 4RO through contacts 1-6 of indicator 4N. At the time when the train occupied track section 9DT relay 4-3C was deenergized by the opening of back contact 234 of relay 9DTK; but since

relay 4-3C is slow-acting it did not release its front contacts until relay 4RO picked up. When the train has vacated track section 4T, relay 4TK drops away opening the stick circuit for relay 4RO at front contact 148, and relay 4RO releases its armature since its pick-up circuit is also open by now at front contact 143 of relay 4-3C. Assuming that the train entering track section 2T occupies only that track section at a time when the other train occupies track section 3T, relay 3-1C is energized by a pick-up circuit including back contact 243 of relay 1TK, back contact 246 of relay 2-1C, wire 247 and front contact 248 of relay 3WS. The picking up of relay 3-1C causes the transmission of control codes (Fig. 6) for routing the train into track section 1T and also causes the picking up of relays 3RO and 2TN, respectively, through front contacts 154 and 120 of relay 3-1C. It should be noted here that read-out operations from indicator 3N to 1N and from indicator 2N to 4N cannot conflict because of the condition of relays 7NWK, 7RWK, 9NWK and 9RWK. In other words, neither transfer can be effected until the called-for routes are indicated as being aligned; thus, 9NWK is energized and 7RWK is energized, and since 9RWK and 7NWK are deenergized no conflict can exist between the two read-out operations.

Once again it can be pointed out with regard to the symmetry of the circuits that train movements and conditions which are the converse of those described can be effected in a similar manner.

One further condition can exist wherein a train enters track section 2T, for example, and stops. This could occur as the result of a break-down or other operating difficulty. The arrival of a second train moving in the same direction as the first will result in the automatic routing of the second train into track section 3T. Under such conditions the operator must resort to manual operations unless the train occupying track section 2T moves out. It can be seen that the pick-up circuit for relay 3-4C includes back contact 253 of relay 2-4C, and the pick-up circuit for relay 3-1C includes back contact 246 of relay 2-1C. Thus, the train which enters track section 2T causes either relay 2-1C or 2-4C (depending on train direction) to pick up. A following train entering the siding cannot, therefore, cause relay 3-1C or 3-4C to pick up. If such operations were not prevented a slow train (or one which stopped briefly) could possibly have a red signal flashed in its face as the result of the arrival on the siding of a faster following train.

Attention must be given to the pick-up circuits for relays 1-2C and 1-3C, and the included back contact 215 of relay 1WS. Relay 1WS is picked up whenever a detected train enters track section 1T from either of the track section 2T or 3T. The energization of relay 1WS thereby prevents the picking up of a control relay 1-2C or 1-3C when a leaving train occupies track section 1T. Back contact 231 of relay 4ES performs a similar function in the pick-up circuits for relays 4-2C and 4-3C. In other words, a leaving train cannot appear to be an entering train and cause control relay operations calling for the clearing of signals behind the train for traffic in the opposite direction.

A review of the operations of the storage indicator means will reveal that an indicator remains in its last operated position. Thus, the indication displayed by an indicator shows the description of the last train to move through the route or track section associated with the indicator. As disclosed in the above cited Marsh patent application, each indicator includes a lamp which, when lighted, illuminates the character displayed by the indicator tape. The present system provides means for lighting such lamps only when the respective indicators store descriptions for trains which are present.

In Figs. 3A-3F, lamps 1ANE, 1NE, 2NE, 3NE, 4NE and 4ANE are the lamps located in the respective indicators 1AN, 1N, 2N, 3N, 4N and 4AN. Since indicators

1N, 2N, 3N, and 4N are associated with and located in particular track sections in the miniature track diagram (Fig. 2) it is expedient to light these lamps when the respective track sections are occupied. Thus, lamps 2NE and 3NE are energized by obvious circuits whenever track indication relays 2TK and 3TK, respectively, are picked up. Lamps 1NE and 4NE are similarly operated by contacts of the transfer relays 1TN and 4TN, respectively; and three transfer relays are, in effect, repeaters of the respective track indication relays 1TK and 4TK. Lamps 1ANE and 4ANE, however, are lighted by lighting relays 1ER and 4ER which will be described.

Relay 1ER has a pick-up circuit including front contacts 290 and 291 of relays CTN and 1ATN, respectively. When the train description buttons associated with indicator 1AN are operated, relay CTN picks up to energize relay 1ER. Relay 1ER is then held by a stick circuit including front contacts 291 and 292 of relays 1ATN and 1ER, respectively. Thus, front contact 288 of relay 1ER will light the lamp 1ANE until the train associated with the stored description occupies track section 1T. At that time relay 1TK picks up dropping relay 1ATN and picking up relay 1TN. Relay 1ER is deenergized, extinguishing lamp 1ANE, while lamp 1NE is lighted by the picking up of relay 1TN. Relay 4ER is operated in a similar manner in response to operations of the buttons associated with indicator 4AN and operations of the track indication relay 4TK.

Summary

As described, the present invention provides means for automatically routing trains and for arranging meets between trains at passing siding locations. The controls are effected by the use of storage means for describing trains as either superior or inferior in classification.

In order to serve a dual purpose, the disclosed embodiment of the present invention utilizes indicator devices to store classification descriptions as well as visual train number descriptions. The same control circuit effects can be achieved by using relays as storage means instead of using indicator means. Since indicators were shown herein, means for decoding the indicator controls were provided in the form of decoding relays.

The present system is by no means limited by the number of trains involved or the number of classifications possible. Actually, the principles of the present invention can be expanded to the point wherein every train which will traverse a stretch of track can be given a classification which is different from the classification of every other train. In other words, the use of relays instead of, or in conjunction with, indicator devices would permit the identification of trains by more than two simple designations of superior and inferior. By the same token, the use of multiple indicators (one for tens, one for units, etc.) in place of single indicators can be used to describe any train list numbers.

The present invention also discloses means for operating indicator devices on a directional transfer basis so that descriptions are advanced in response to and in accordance with the movements of associated trains.

Having described a railway signaling system with automatic meets between trains 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.

What I claim is:

1. A traffic control system for routing opposing trains through an actual track layout including a stretch of single track having at least one passing siding connected thereto at each end by power track switches and comprising, a control panel having a miniature diagram of the actual

track layout, a plurality of electrically operable train identity indicators each being operable to different conditions corresponding to respectively different train identities and disposed at intervals along said miniature diagram, there being an indicator on said miniature diagram for each end of the actual track layout and for each of said power track switches, means for operating said indicator for one end of said actual track layout to one of its distinctive conditions according to the identity of a particular train upon the entry of said particular train into said actual track layout at said one end thereof, transfer means controlled by the progress of a train through said actual track layout for operating to said one distinctive condition the successive indicators on said panel, and switch control means controlled by the distinctively operated conditions of the indicators respectively associated with said switches for operating said track switches at the respective ends of each siding.

2. The traffic control system according to claim 1 wherein said switch control means includes further circuit means being distinctively controlled by the simultaneous approach of trains to the opposite ends of said passing siding, said further circuit means operating said switch control means for said switches associated with said siding to their normal positions upon the approach of a train to thereby route a train over said single track rather than over said passing siding when said further circuit means has detected that there are no trains simultaneously in approach of the opposite ends of said siding.

3. A traffic control system for routing opposing trains through a track layout including a stretch of single track having at least one passing siding connected thereto by power track switches and comprising, a plurality of storage means each operable to distinctive conditions representing respectively superior and inferior train classes for operating said switches, at least one of said storage means being provided for each track switch of said passing siding, means controlled by the passage of a train through said track layout for distinctively operating to one of its distinctive conditions a first one of said storage means and for subsequently transferring from said first one of said storage units to the next the distinctive condition of said first operated storage means in an order determined by the direction of train operation through said track layout, and means controlled by the distinctively operated conditions of the storage means respectively provided for said track switches for operating said track switches at the opposite ends of said passing siding to respective normal and reverse positions selectively.

4. A traffic control system according to claim 3 wherein the identity storage units are electrically operable posting indicators operable to display train identification indicia on a control panel.

5. A traffic control system according to claim 3 wherein said switch control means also provides for selecting a predetermined route to be established in case both opposing trains are of the same class.

6. A traffic control system according to claim 3 wherein said switch control means further includes code communication means for the remote control of the track switches from a control office.

7. A traffic control system for the establishment of routes for opposing trains through a track layout including a stretch of single track having at least one siding connected thereto by power track switches and having signals for governing traffic over the track switches comprising in combination, a storage means for each track switch being operable to distinctive conditions each representing a different train class for controlling said track switches, means controlled by the approach of a train of a particular class to a first of said track switches for operating the corresponding storage means to a respective one of said distinctive conditions, means controlled

by the passage of the train in either direction for advancing the identity storage for that train from one storage means to the next in an order determined by the direction of train movement, and route establishing means controlled by the distinctively different conditions of the storage means for the switches at the respective ends of said siding caused by opposing trains of different classes approaching said siding for operating said track switches and selectively energizing said signals to establish a route for an inferior train through said siding and a route for the superior train through said single track.

8. In a traffic control system for routing trains traveling in opposite directions through a track layout including a stretch of single track having at least one passing siding connected to said single track at its respective ends by power track switches the combination comprising, a storage means for each switch for controlling each of said power track switches, each of said storage means being operable to at least two distinctive conditions each representing a different train class, circuit means controlled by the approach of a train of a particular class to one of said power switches for operating the respective storage means to the corresponding particular one of its said distinctive conditions, and means governed by said storage means for said power track switches at said ends of said siding for selectively operating said switches, said last-named means being controlled by the approach of trains in opposite directions to the respective ends of said siding to operate said track switches to respective reverse and normal positions to thereby direct said trains over routes according to their relative classes.

9. The control system defined in claim 8 and including input storage means being operable to distinctive conditions each representing a different train class and being operated to a particular one of such distinctive conditions by each train of corresponding particular class entering said track layout and also including further means for transferring said train class data from said input storage means to a selected one of said storage means and thence from one said storage means to the next according to the progress of a train as it moves through said track layout.

10. In a system for routing trains moving in opposite directions through a track layout including a stretch of single track having at least one passing siding connected thereto at its respective ends by power track switches the combination comprising a storage means for each power track switch being operable to at least two distinctive conditions each representing a different train class, data input and transfer means controlled by the approach of a train of a particular class to one of said track switches for operating the corresponding storage means to the respective one of said conditions representing said class, and means for operating said track switches at the ends of said siding being controlled by the distinctively operated conditions of the respective storage means, said last-named means being controlled by the approach of trains in opposite directions to the respective ends of said siding to operate said track switches to respective reverse and normal positions to thereby direct said trains over routes according to their relative classes.

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