

Sept. 6, 1938.

O. H. DICKE

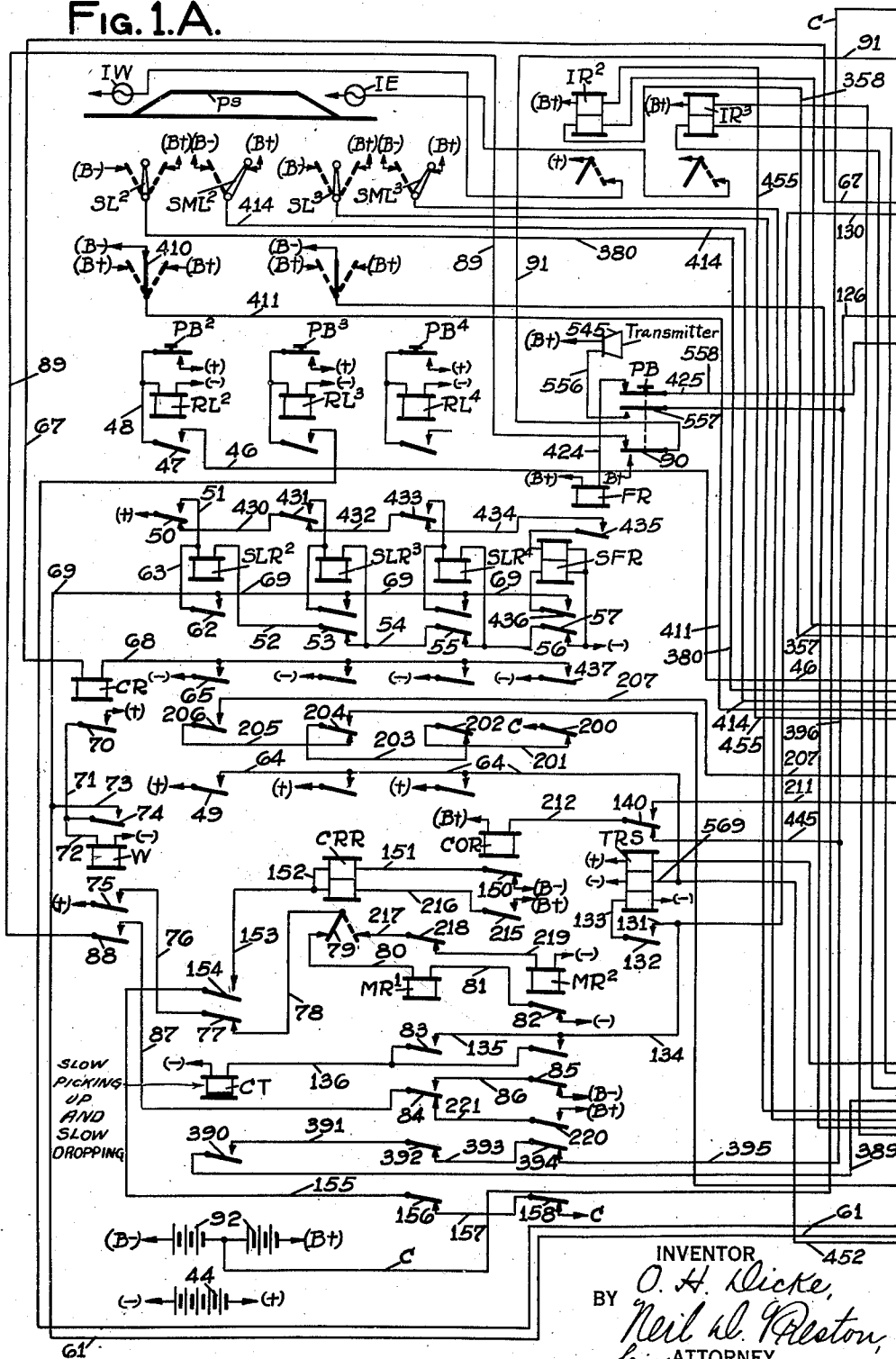
2,129,168

CENTRALIZED TRAFFIC CONTROL SYSTEM

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Fig. 1.A.



INVENTOR
O. H. Dicke,
BY Neil W. Preston,
his ATTORNEY

Sept. 6, 1938.

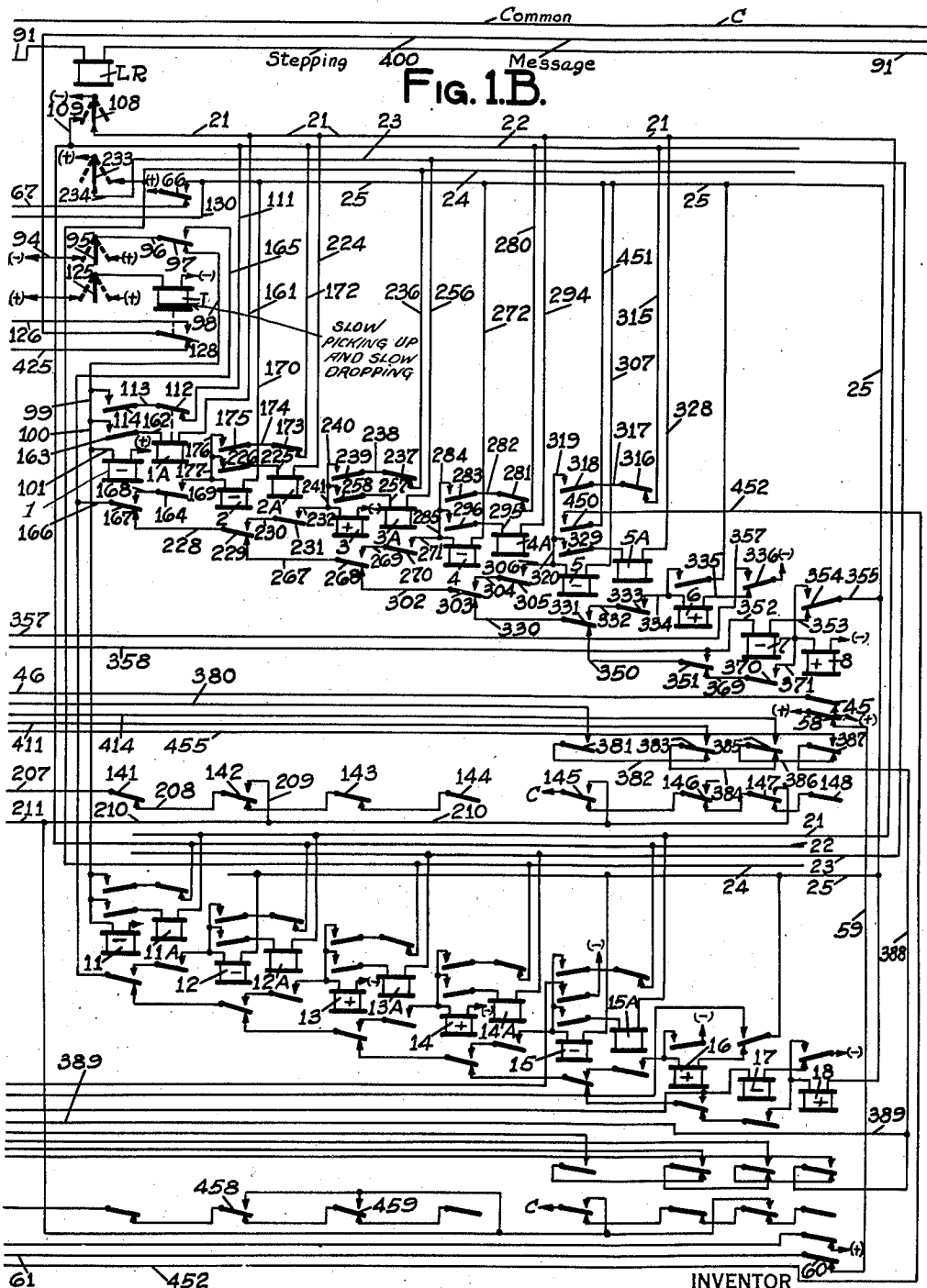
O. H. DICKE

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4 Sheets-Sheet 2



INVENTOR

BY

O. H. Hicke,
Neil H. Preston,
his ATTORNEY

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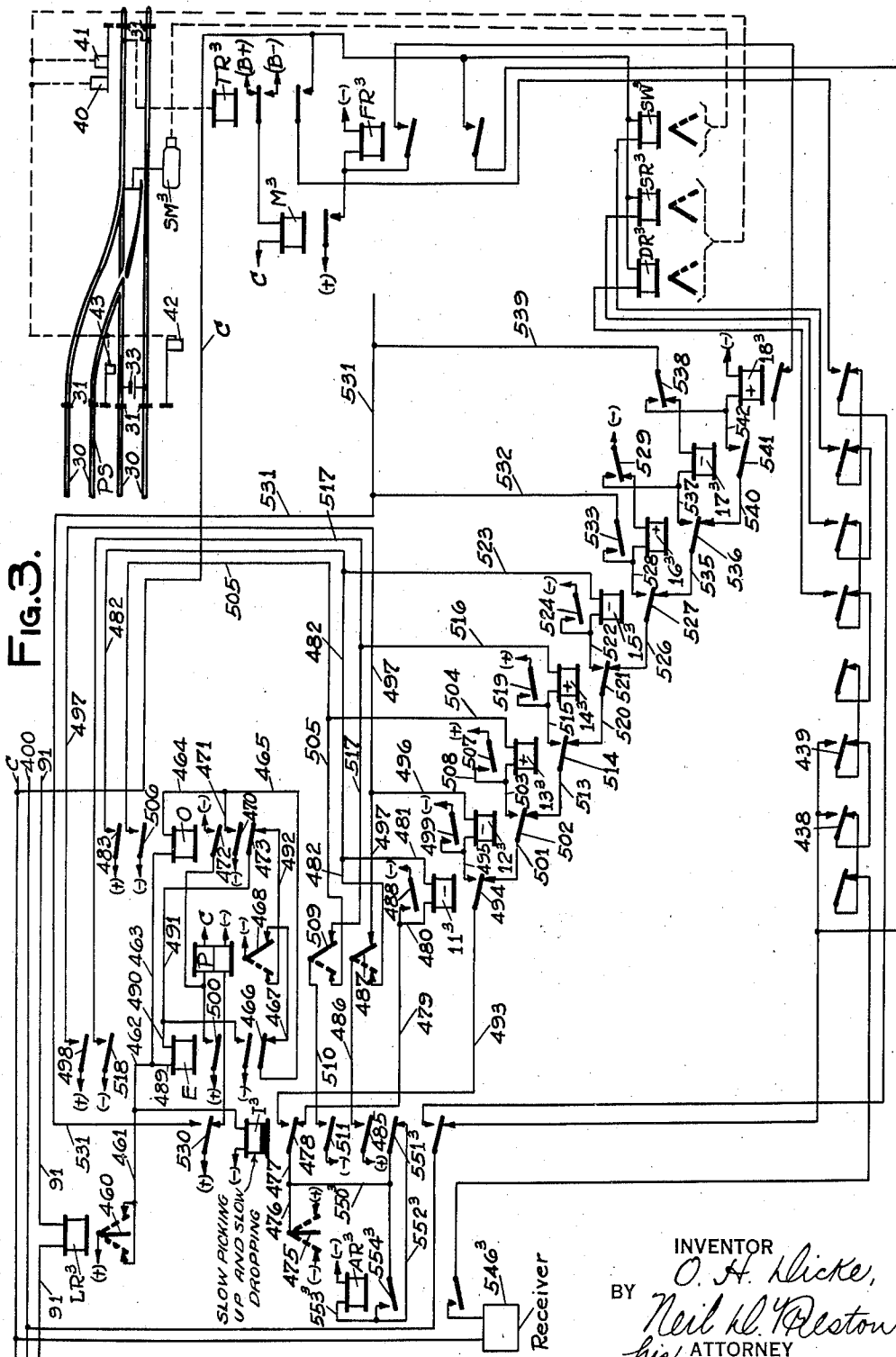
O. H. DICKE

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CENTRALIZED TRAFFIC CONTROL SYSTEM

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UNITED STATES PATENT OFFICE

2,129,168

CENTRALIZED TRAFFIC CONTROL SYSTEM

Oscar H. Dicke, Rochester, N. Y., assignor to General Railway Signal Company, Rochester, N. Y.

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This invention relates to centralized traffic controlling systems, and particularly to a system in which a large number of distant traffic control devices located at various points may be controlled from, and a large number of indications transmitted to, a local central office over a comparatively few line wires.

In accordance with the present invention, it is proposed to employ two circuits extending along a railway track, comprising three line wires, one wire of which is common to the two circuits mentioned. It is further proposed to select any one of a large number of way stations independently by a distinctive code, and to provide means for controlling several distinctive devices at each of said way stations when such way station has been selected and to receive indications from such way station.

The system under consideration is a system that is normally at rest, and in order to indicate in a local office the occurrence of a certain event at a distant way station immediately after such occurrence, it requires the ability for a particular way station to communicate with the local or central office. Since the way stations are selected by a code, it would at first hand appear that suitable lock-out means would be required to prevent two way stations transmitting codes to the local office in over-lap relation, thereby resulting in a jumbled up code. This, however, is not the case in accordance with the present invention, this because the central office is the code radiating point for selecting a distant way station by a distinctive code transmitted over, what is conveniently called a "stepping circuit" or "coding circuit", and the other circuit, conveniently called the "message circuit", is employed to enable a way station to dictate the code, so to speak, which is to be transmitted from the central office to communicate with a particular way station.

It would then, on first thought appear that if two way stations were dictating what code shall be transmitted from the central office at the same time, there might be conflict between these dictations of code, but this is not the case, in that the dictation of a code is obtained by short circuiting the message circuit and in not short circuiting the message circuit at a particular instant, and if the message circuit is shorted at one point, it is immaterial whether or not it is shorted at another point. The short circuiting of the message circuit is a dominating effect, so that if two or more way stations are endeavoring to dictate a code which is to radiate from the central office over the stepping circuit, the particular

way station, of the way stations endeavoring to communicate with the central office, whose code has the largest number of dominating steps in prior order will be selected because it has the dominating code.

Putting this in different language, for in-coming messages the polarity code impressed on the stepping line is determined by whether or not the message circuit was short circuited on the next preceding step, and if the message circuit was short circuited on the next preceding step a positive impulse is transmitted over the stepping circuit, and if the message circuit was not short circuited on the preceding step a negative impulse is transmitted over the stepping circuit, and for out-going messages the codes originate in the central office. From this it is apparent that positive impulses follow superior or dominating steps, and negative impulses follow inferior steps, in that positive impulses are obtained by short circuiting the message circuit, and that the short circuiting of the message circuit by one way station cannot be disturbed by a conflicting code at another way station which does not require such short circuiting.

From these considerations, it is apparent that any one of a large number of way stations may get into communication with a central office independently through the medium of the dictation of a particular code, and without the provision of a lock-out, it however, being understood that a slow acting relay is used at each way station for manifesting that the system is in operation or is not in operation, this slow acting relay, however, not being a lock-out relay in that it produces the same effect at the central office and at each way station. These slow acting relays (I , I^2 , I^3) may conveniently be called "cycle demarking" relays, in that they define by their operation the limits of the various cycles.

In accordance with the present invention, if the central office has been connected to a particular way station through the medium of a distinctive code, either determined by the central office equipment or dictated over the message circuit by such particular way station's equipment, the succeeding steps over the stepping circuit set up distinctive message circuits connecting particular apparatus at that particular way station to the central office equipment.

As heretofore explained, the steps of a particular code for an in-coming message, and the polarity of each of its steps determined in accordance with whether or not the message circuit was short circuited during the next preced-

ing step, will of course not enable the polarity of the first step to be determined by the condition of the message circuit, for which reason the first step of each code is of the same polarity, which in the system shown is negative. This enables an initial step of positive polarity to be employed for other purposes, and in accordance with the present invention, it is proposed to connect either a printing telegraph or a loud speaker at certain or all of the way stations in circuit with a printing telegraph transmitter or a telephone transmitter in the central office when a single impulse of positive polarity is placed and maintained on the stepping circuit, this in order to enable the central office operator or dispatcher to simultaneously communicate with some or all of the way stations informing them of the movement of trains, whether on time or late, and other information of interest to the ticket agents, crossing watchman, and the like, along the railway system.

Other objects, purposes and characteristic features of the present invention will in part be apparent from the accompanying drawings and will in part be more specifically pointed out hereinafter.

In describing the invention in detail, reference will be made to the accompanying drawings in which Figs. 1A and 1B, when laid side by side, conventionally illustrate the apparatus in the central office of the particular portion of the system illustrated;

Fig. 2 illustrates the way station apparatus for the west end of a passing siding PS; and

Fig. 3 illustrates a modified form of way station apparatus, eliminating certain half-step relays, and used for controlling the apparatus at the east end of the passing siding PS.

Structure

Referring to Figs. 1A and 1B of the drawings, the top portion of Fig. 1B illustrates a series of code responsive stepping relays, 1, 1A, 2, 2A, 3, 3A, 4, 4A, 5, 5A, 6, 7 and 8, which are adapted to be controlled through the medium of the line relay LR and the slow acting or cycle demarking relay I, when a code of minus, minus, plus, minus, minus, plus, minus and plus, is transmitted to the line relay LR, whereas the series of stepping relays 11, 11A, 12, 12A, 13, 13A, 14, 14A, 15, 15A, 16, 17 and 18 respond only to a code of minus, minus, plus, plus, minus, plus, minus and plus.

Referring now more particularly to Fig. 1A which shows a miniature track layout corresponding in every respect to the entire railway system to which the present invention is applied, and illustrating for convenience only the miniature passing siding ps, at the east end of this miniature passing siding is provided an indicating lamp IE, which if lighted manifests the occupancy of the detector track circuit at the east end of the passing siding PS, and similarly the indicating lamp IW associated with the miniature passing siding ps, when lighted manifests that the detector track circuit at the west end of the passing siding PS (see Fig. 2) is occupied, these lamps IW and IE being controlled by the indicating relays IR² and IR³, respectively. With the west end of the miniature passing siding ps are associated the signal lever SL² and the switch machine lever SML², whereas the east end of the miniature passing siding ps has associated therewith a signal lever SL³ and a switch machine lever SML³, these levers controlling the apparatus at the passing siding PS through the me-

dium of the selector system embodying the present invention.

As heretofore mentioned, the code current impressed on the stepping circuit including the line relays LR, LR² and LR³, has its code at times determined by the central office equipment and is at times dictated by one or more way stations in accordance with whether or not the message circuit has been short circuited. In accordance with the present invention, this code originates at the code relay COR and is dictated by the way station equipment when the transfer relay TRS is deenergized, but originates from the central office equipment when the transfer relay TRS is energized, and the code is then repeated to the code repeater relay CRR, which through the medium of main relays MR¹ and MR² applies impulses to the stepping line in polarity code fashion and in accordance with the condition of energization of the relay COR. In order to provide a definite demarkation between successive impulses of like polarity, such as one plus following another plus, or one minus following another minus, the stepping line is deenergized for a definite period of time between steps, and this is determined by the channel time relay CT.

As heretofore mentioned, the system is normally at rest, and this system is initiated in response to the energization of the starting relay CR, and will remain in operation so long as the control relay W is energized. Although, as heretofore explained, no interlock between the various way station apparatuses is required, it is considered expedient to have an interlock in the local office for permitting way stations to be selected in a particular order, irrespective of their code, in the event that two levers are operated at substantially the same time, for which purpose the lever selecting relays SLR², SLR³, SLR⁴, etc., are provided, and furthermore a field selecting relay SFR, which is also interlocked with the lever selecting relays SLR², SLR³ and SLR⁴, is employed to prevent the incoming signals from way stations interfering with the out-going signals or controls transmitted in accordance with lever positions. These lever interlocking relays SLR², SLR³ and SLR⁴, may, however, be omitted if desired, in that each code has a different order of superiority to every other code, whereby if two levers are operated at the same time only the one having the dominating code associated therewith will have its way station selected. These interlocked selecting relays SLR², SLR³, SLR⁴ and SFR are controlled by the lever relays RL², RL³, RL⁴ and the field relay FR, respectively. In the event that the selecting lever relays SLR², SLR³, SLR⁴, etc., are omitted, a push button will be provided to pick up the starting relay CR, this push button being effective to pick up the relay CR only if the relay SFR is in its retracted condition.

Referring now to Fig. 2 of the drawings, this drawing shows a series of code responsive stepping relays 1², 1A², 2², 2A², 3², 3A², 4², 4A², 5², 5A², 6², 7² and 8², which relays are controlled in response to the operation of the line relay LR² and the operation of the slow acting or cycle demarking relay I², providing that the line relay LR² operates to transmit the proper code, which for the way station No. 2 is the same as the apparatus shown in the top part of Fig. 1B of the drawings, which code is minus, minus, plus, minus, minus, plus, minus, plus, as indicated by corresponding signs within these stepping relays. Similarly, referring to Fig. 3, the code responsive stepping relays 11³, 12³, 13³, 75

14³, 15³, 16³, 17³ and 18³, are controlled by the line relay LR³, the slow acting relay I³, and the half step relay group comprising the even relay E, the odd relay O, and the polar relay P, providing, of course, that the line relay LR³ is stepped in code of like fashion to constitute the code to which this particular series of code stepping relays will respond, which is a code of minus, minus, plus, plus, minus, plus, minus, plus.

The announcer relays AR² and AR³ shown in Figs. 2 and 3, respectively, are energized only if the first impulse of a cycle, which impulse is preferably of long duration and continues until the announcement has been completed, transmitted over the stepping circuit is of positive polarity.

In Figs. 2 and 3 have been shown respectively the relays DR², SR², SW² and DR³, SR³, SW³, which relays are conveniently called control relays, and are used to control respectively the signals and switch machines at the west and east end of the passing siding PS, all in a manner as described in the patent of S. N. Wight, Patent No. 1,889,457, dated November 29, 1932, as conventionally illustrated by the dotted lines.

Referring now to the passing siding PS shown in part in Fig. 2 and in part in Fig. 3 of the drawings, this passing siding PS is used as a meeting point for trains moving in opposite directions, and to enable one train to pass another from the rear, if desired. In practice many such passing sidings are used in a single system. The main track and passing siding have been illustrated by rails 30, which rails are divided by insulating joints 31 to constitute the usual detector track circuit, the one at the west end of which is provided with a track battery 32 and a track relay TR², and the detector track circuit at the east end of which includes a track battery 33 and a track relay TR³. The track switch at the west end of the passing siding PS is controlled by the switch machine SM² and the track switch at the east end of the passing siding PS is controlled by the switch machine SM³. In accordance with the usual practice in single track signalling, the west end of the passing siding PS is provided with a main entering signal 35, a take-siding signal 36, a main starting signal 37, and a dwarf starting signal 38, and similarly the east end of the passing siding PS is provided with a main entering signal 40, a take-siding signal 41, a main starting signal 42 and a dwarf starting signal 43.

In order to initiate the system to transmit an indication from the way station to the central office upon a change in the position of the track relays TR² and TR³ or other traffic controlling devices, the change relays M² and M³ are provided, which in turn control the repeater change stick relays FR² and FR³.

Having now specifically referred to each of the elements of the conventional illustration of the systems embodying the present invention, it is deemed expedient to consider the operation of the system in detail, this in order to more clearly understand how the various elements of the system are interconnected, as well as the functions which may be carried out by the system, the extent to which the system may be expanded without the embodiment of a prohibitive number of impulses per unit code, and the speed at which controls may be transmitted to and indications received from a large number of separated way stations.

Operation

Table of codes.—Before the specific operation of

the system is taken up, it is considered helpful to give a table of all the codes that may be used, in the order of their superiority. In this connection, it should be understood that the first five relays in each series constitute in reality the code responsive portion of the series, the last three relays responding to alternate plus and minus impulses carrying out particular functions at a particular way station. With this understanding of the system, the codes are given in the order of their superiority, which means that of any selected group of codes which want to come in at the same time, the code which stands highest in the table dominates the other codes which are endeavoring to dictate the code by which the central office shall call them. These codes in the order of their superiority are as follows:—

Code No.	First step	Second step	Third step	Fourth step	Fifth step	
1. ————	—	+	+	+	+	20
2. ————	—	+	+	—	—	
3. ————	—	+	—	—	—	
4. ————	—	—	—	—	—	25
5. ————	—	—	—	—	—	
6. ————	—	—	—	—	—	
7. ————	—	—	—	—	—	
8. ————	—	—	—	—	—	
9. ————	—	—	—	—	—	
10. ————	—	—	—	—	—	
11. ————	—	—	—	—	—	30
12. ————	—	—	—	—	—	
13. ————	—	—	—	—	—	
14. ————	—	—	—	—	—	
15. ————	—	—	—	—	—	
16. ————	—	—	—	—	—	

As already stated, the first step in each code is negative, this to enable a way station to dictate to the central office what polarity the second step shall be, as is clearly apparent from the table.

Code determination for out-going station selection

As already mentioned in a general way, station selection in the present system is determined by codes of impulses transmitted over the stepping circuit, these codes comprising various patterns or combinations of positive and negative impulses. These impulses originate in the central office but are determined in several different ways. Upon initiation of the system in response to the movement of a lever in the central office, these impulses are determined by contacts on a series of relays directly associated with that lever, but if the system is initiated because one or more way station change relays, such as relay FR², are energized, the impulses are dictated by the relays at such one or more way stations.

Referring particularly to the office equipment shown in Figs. 1A and 1B and the way station equipment shown in Fig. 2, let us assume that the operator in the central office wishes to allow an east bound train to pass into the sidetrack of the passing siding PS, and in order to do so moves the signal lever SL² toward the right, signifying east bound traffic and moves the switch machine lever SML² to the left signifying that the train is to take the sidetrack. When the operator has so operated the levers SL² and SML², he will depress the push button PB², for the purpose of initiating the system, and will thereby pick up the lever relay RL². If desired a substitute contact for this push button may be automatically operated in response to each movement of the corresponding lever, as shown in the patent to Preston and Dicke, Patent No. 1,794,591, dated March 3, 1931.

With the lever relay RL² once picked up it will

stick up through the following circuit:—beginning at the terminal (+) of a suitable central office battery 44 (see bottom of Fig. 1A), back contact 45 of the relay 8, wire 46, front stick contact 47 of the relay RL², wire 48, winding of the relay RL² to the terminal (—) of the same battery.

With the relay RL² picked up the closure of its front contact 50 will pick up the selected lever relay SLR² through the following pick-up circuit:—beginning at the terminal (+), front contact 50 of the relay RL², wire 51, winding of the relay SLR², wire 52, back contact 53 of the relay SLR³, wire 54, back contact 55 of the relay SLR⁴, wire 56, back contact 57 of the relay SFR, to the terminal (—).

With the relay SLR² once picked up it is stuck up through the following stick circuit:—beginning at the terminal (+), back contact 58 of the relay 8, wire 59, back contact 60 of the relay 18, wires 61 and 69, front stick contact 62 of the relay SLR², wire 63, winding of the relay SLR², wire 52, back contact 53 of the relay SLR³, wire 54, back contact 55 of the relay SLR⁴, wire 56, back contact 57 of the relay SFR to the terminal (—) of the same battery.

In studying the pick up and stick circuits for the various relays SLR², SLR³, etc., it will be noted that they are so interlocked that if any one of these relays has been picked up no other relay of this same group can be picked up. Also, it will be noted that the circuits for these relays are such that relays have priority in the order from left to right, this because if two of the relays such as RL² and RL³ are picked up at the same time, the relay RL² will have a dominating effect, in that with its contact 50 raised no energy can be supplied to the relay SLR³, whereas energy can be applied to the relay SLR² so long as no other relay to the right thereof, such as SLR³ or SLR⁴, has already been stuck up.

With the relay SLR² now energized through its stick circuit, its front contact 65 is closed, thereby completing the following circuit for the starting relay CR:—beginning at the terminal (+) of the central office battery, back contact 66 of the slow acting relay I (see Fig. 1B), wire 67, winding of the starting relay CR, wire 68, front contact 65 of the relay SLR² to the terminal (—) of the same battery.

With the starting relay CR energized, the following pick-up circuit is closed for the control relay W:—beginning at the terminal (+), front contact 70 of the relay CR, wires 71 and 72, winding of the relay W to the (—) terminal of the same battery.

With the relay W once picked up it is stuck up through the following circuit:—beginning at the terminal (+) of the central office battery, back contact 58 of the relay 8 (see Fig. 1B), wire 59, back contact 60 of the relay 18, wires 61 and 73, stick contact 74 of the relay W, wire 72, winding of the relay W to the terminal (—) of the same battery.

With the control relay W energized its front contact 75 is closed, thereby closing the following energizing circuit for the master relay MR¹:—beginning at the terminal (+), front contact 75 of the relay W, wire 76, back contact 77 of the channel time relay CT, wire 78, contact 79 of the code repeater relay CRR assuming its left hand position, wire 80, winding of the master relay MR¹, wire 81, back contact 82 of the master relay MR², to the terminal (—) of the same battery.

Picking up of the master relay MR¹ effects closure of its front contact 83 included in the circuit of the channel time relay CT, but the closure of this contact does not pick up the relay CT, because this circuit is open at the front contact 66 of the relay I (see Fig. 1B).

Picking up of the contact 84 of this relay MR¹, however, applies current of negative polarity to the stepping circuit, which may be traced as follows:—beginning at the terminal (B—), back contact 85 of the master relay MR², wire 86, front contact 84 of the master relay MR¹, wire 87, front contact 88 of the control relay W, wire 89, contact 90 of the push button PB, stepping wire 91 including the line relay LR, LR², LR³, etc., which is connected to the common return wire C at the most distant way station, which common return wire C is connected to the mid-point of the central office battery 92 (see Fig. 1A), which battery also contains the terminals (B+) and (B—) mentioned in this description.

The completion and the energization of the stepping circuit with negative polarity current, as just explained, causes the line relays LR, LR², LR³, etc., to be moved to their left hand position. In the central office, movement of the line relay LR to its left hand position completes the following pick-up circuit for the relay I:—beginning at the terminal (—) of the central office battery 44, wire 94, contact 95 of the relay LR, wire 96, back contact 97 of the slow acting relay I, wires 98, 99, 100 and 101, winding of the relay I, to the terminal (+) of said battery. At way station No. 2 (see Fig. 2) movement of the contact 102 of the line relay LR² to its left hand position completes the following circuit for the relay I²:—beginning at the terminal (—) of a local battery contact 102 assuming its left hand position, wire 103, back contact 104 of the slow acting relay I², wire 105 and 106, winding of the relay I², to the terminal (+) of said battery. It may be stated here that in the modified construction illustrated in Fig. 3 of the drawings the relay I¹³ will also be picked up in response to the movement of the line relay LR³ to its left hand position, but this modified structure will be taken up separately hereinafter. Also, the relay I¹ (see bottom of Fig. 1B) is picked up because the first step of all the codes are the same, but since the relay 4 requires negative polarity on the stepping circuit and relay 14 requires positive polarity on the stepping circuit, the relay 14 will not pick up during the fourth step of the code to be presently considered, for which reason the action of the relays 11–18 will not be considered at this time.

With the relay I now assuming its energized position, for reasons just explained, this relay I will now be stuck up through the following stick circuit:—beginning at the terminal (—) of the central office battery, contact 108 of the line relay LR assuming its left hand position, wires 109, 22 and 111, back contact 112 of the relay 1A, wire 113, front stick contact 114 of the relay I, wires 99, 100 and 101, winding of the relay I to the terminal (+) of said battery. Similarly, the code responsive stepping relay I² is stuck up through the following stick circuit:—beginning at the terminal (—) of the local battery, contact 116 of the line relay LR², wires 117 and 118, back contact 119 of the half step relay 1A², wire 120, front contact 121 of the relay I², wires 122, 123 and 106, winding of the relay I² to the terminal (+) of said battery.

After a very short interval of time, but a longer

interval of time than is required for the code responsive stepping relays 1 and 12 to pick up, the slow acting relays I and I² are picked up, through circuits including respectively the contacts 125 and 126 of the relays LR and LR², which circuits are readily traced in the drawings. Picking up of the relays I and I² breaks the pick-up circuit for the relays 1 and 12, but since these relays are energized through stick circuits heretofore traced, they remain in their energized position. Picking up of the relays I and I² also effects breaking of the starting circuit and renders the message circuit available for use, by shifting of the contacts 128 and 129 of these respective relays, the function of which contacts 128 and 129 will be more particularly described hereinafter. Further, picking up of the relay I closes the following stick circuit for the transfer relay TRS:—beginning at the terminal (+) of the central office battery, front contact 66 of the relay I, wire 130 and 131, stick contact 132 of the transfer relay TRS, wire 133, the lower winding of the transfer relay TRS to the terminal (—) of said battery. Also, picking up of the slow acting relay I closes the following circuit for the channel time relay CT:—beginning at the terminal (+) front contact 66 of the relay I, wires 130, 134 and 135, front contact 83 of the master relay MR¹, wire 136, winding of the relay CT to the other terminal (—) of this battery 44. The completion of this circuit after a short time effects energization of the channel time relay CT, this relay although slightly slow acting is much quicker acting than are the relays I and I².

Attention is directed to the fact that the position of the contact 79 of the code repeater relay CRR is determined by the condition of energization of the code relay COR, and since the transfer relay TRS is energized each time a way station is controlled from the central office, and is therefore now energized through the front contact 49 of the relay SLR², its contact 140 assumes its raised position, and therefore the code relay COR is energized or deenergized depending upon whether its circuit is closed through such front contacts as 142, 145 or 147 of the relays 2, 5 and 7 respectively. That is, with relay SLR² up, as has been assumed, and during the instant when stepping relay 2 is energized the circuit for the relay COR may be traced as follows:—beginning at the terminal B+, winding of the relay COR, wire 212, front contact 140 of the relay TRS, wires 211, 210 and 209, front contact 142 of the stepping relay 2, wire 208, back contact 141 of the stepping relay 1, wire 207, front contact 206 of the relay LSR³, wire 205, back contact 204 of the relay SLR³, wire 203, back contact 202 of relay SLR⁴, wire 201, back contact 200 of the relay SLR to the midpoint C of the central office battery. In this connection, attention is directed to the fact that insofar as the first four of these code responsive stepping relays 1, 2, 3 and 4 are concerned, the code relay COR can only be energized when the corresponding lever selecting relay, that is, SLR² in the present instance, is energized, this because the front contact 206 of the relay SLR² is included in the circuits through the front contacts of these relays, such as contact 142 of relay 2. Since, with the relay 1 energized and its contact 141 in its raised position the code relay COR remains deenergized, the second impulse transmitted over the stepping circuit will be one of negative polarity, this because, with relay COR deenergized the relay CRR is energized toward the left, which selects relay MR¹ instead

of relay MR² thus resulting in energization of the line circuit 91 with current of negative polarity as follows:—beginning at the terminal B—, back contact 85 of the relay MR², wire 86, front contact 84 of relay MR¹, wire 87, front contact 88 of the relay W, wire 89, front contact 90 of the push button PB, wire 91 including the various line relays LR, LR² and LR³ to the common return wire C connected to the midpoint of the central office battery. With the channel time relay CT energized the energizing circuit for the master relay MR¹ is broken at the back contact 77 of the relay CT, so that as soon as the relay MR¹ assumed its deenergized position the following circuit for the code repeating relay CRR is completed:—beginning at the terminal (B—), back contact 150 of the relay COR, wire 151, upper winding of the relay CRR, wires 152, and 153, front contact 154 of the relay CT, wire 155, back contact 156 of the relay MR¹, wire 157, back contact 158 of the relay MR² to the middle connection C of the battery 92. The relay CRR will not be operated in response to the closure of the circuit just traced, because it already assumes its left hand negatively energized position. The master relay MR¹ having been deenergized in response to the picking up of the relay CT will of course by the dropping of its contact 83 again deenergize the channel time relay CT, and in so doing will effect reenergization of the master relay MR¹ thus causing the second impulse of negative polarity to be applied to the stepping circuit.

Bearing now in mind that the stepping circuit was momentarily deenergized, thereby causing the line relays LR, LR², LR³, etc., to temporarily assume their middle position, let us observe what transpires at both the central office and the way station shown in Fig. 2 during the period of deenergization of the stepping line. Referring first to Fig. 1B, and remembering that the code responsive stepping relay 1 is still energized through its stick circuit, deenergization of the line relay LR breaks this stick circuit at the contact 108 of the line relay LR, but another stick circuit for this relay 1 is completed which may be traced as follows:—beginning at the terminal (—) contact 108 of the line relay LR in its pendent position, wires 21 and 161, winding of the half-step relay 1A, wire 162, front contact 163 of the relay 1, wires 100 and 101, winding of the relay 1 to the other terminal (+). The completion of this auxiliary stick circuit for the relay 1, which includes the winding of the relay 1A, will of course affect energization of the relay 1A thereby closing the front contact 164 of the relay 1A. As already explained, after momentary deenergization of the stepping circuit this stepping circuit is reenergized with current of negative polarity and with the relay 1A now energized, the following circuit for the relay 2 is completed upon movement of the line relay LR to its left hand negative position:—beginning at the terminal (—), wire 94, contact 95 of the relay LR in its left hand position, wire 96, contact 97 of the relay I raised, wires 165 and 166, front contact 167 of the relay 1, wire 168, front contact 164 of the relay 1A, wire 169, winding of the relay 2, wires 170 and 25, front contact 66 of the relay I, to the terminal (+) of the same battery.

In practice, the half-step relays 1A, 2A, 3A, 4A and 5A will be slightly slower dropping than their associated relays 1, 2, 3, 4 and 5, this in order to assure that the stick circuit for the code responsive relay which does not include a half step relay cannot be reclosed before the other stick circuit

for such code responsive relay including the half-step relay is broken, this to assure dropping of the code responsive relays, such as 1, 2, 3, etc., as soon as the stepping circuit is energized after having been deenergized following the picking up of such code responsive stepping relay. In other words, movement of the line relay LR to its left hand position effects picking up of the relay 2 but also effects deenergization of the relays 1 and 1A, this because both of these stick circuits for the relay 1 are opened when the line relay LR assumes its left hand position during the second impulse of a particular code cycle.

The relay 2 having now been picked up, is stuck up through the following stick circuit:—beginning at the terminal (—), contact 108 of the relay LR in its left hand position, wires 109, 22 and 172, back contact 173 of the relay 2A, wire 174, front contact 175 of the relay 2, wires 176 and 177, winding of the relay 2, wires 170 and 25, front contact 66 of the relay 1, to the other terminal (+) of the same battery.

Referring now to Fig. 2, substantially the same operation as just explained in connection with Fig. 1B takes place. During deenergization of the line relay LR² the auxiliary stick circuit for the code responsive stepping relay 1² is completed, and may be traced as follows:—beginning at the terminal (—), contact 116 of the relay LR² assuming its pendent position, wires 180 and 181, winding of the half-step relay 1A², wire 182, front contact 183 of the relay 1², wires 123 and 106, winding of the relay 1², to the other terminal (+) of the same battery. The completion of this circuit of course results in the picking up of the half-step relay 1A² and closure of its contact 185. The apparatus at the way station of Fig. 2 remains in its present condition until the line relay LR² moves from its pendent position, and since, as has already been explained, the stepping circuit is energized with current of negative polarity on its second step causes the line relay LR² to move to its left hand position, thereby completing the following circuit for the code relay 2²:—beginning at the terminal (—), contact 102 of the line relay LR² assuming its left hand position, wire 103, front contact 104 of the relay 1², wire 186, front contact 187 of the relay 1², wire 188, front contact 185 of the relay 1A², wires 189 and 190, winding of the relay 2², wires 191 and 192, front contact 193 of the relay 1², to the terminal (+) of the same battery.

With the code responsive stepping relay 2² once energized its following stick circuit is closed to maintain it energized in spite of the dropping of the relays 1² and 1A², which occurs shortly after the line relay LR² moves from its deenergized position. This stick circuit for the relay 2² may be traced as follows:—beginning at the terminal (—) of the local way station battery, contact 116 of the relay LR² toward the left, wires 117 and 194, back contact 195 of the relay 2A², wire 196, front contact 197 of the relay 2², wires 198, 199 and 190, winding of the relay 2², wires 191 and 192, front contact 193 of the relay 1² to the other terminal (+).

Attention is now directed to the fact that had the second impulse transmitted over the stepping circuit been an impulse of positive polarity neither relay 2 nor the relay 2² would have been picked up in response to this second impulse, this because by operation of the line relays LR and LR² to the right, with the relays, 1, 1A, 1² and 1A² energized, the circuits for the relay 2 and 2² completed by movement of the contact

95 of the relay LR and contact 102 of the relay LR² to the right are not energized, because both ends of the circuit completed are connected to the same terminal, namely the terminal (+) of the battery. In other words, these code stepping relays will only step along in response to energization of the stepping circuit if the various impulses are of the proper polarity. Furthermore, if this second impulse had been an impulse of positive polarity the relays 1 and 1A of Fig. 1B and the relay 1² and 1A² in Fig. 2 would have been deenergized, the same as they were when an impulse of negative polarity was transmitted, so that no relays of these groups of stepping relays could thereafter have been energized in the same cycle, this because the relays 1 and 1² are in their raised position and with all of the stepping relays down no circuits can be completed for energizing any of the relays in these groups of code responsive stepping relays.

Referring now to Figs. 1A and 1B, attention is directed to the fact that, with the code responsive stepping relay 2 in its energized position, a circuit is completed for the code relay COR, which may be traced as follows:—beginning at the mid-point of the battery 92 (see Fig. 1A) to the common return wire C, through back contact 200 of the relay SFR, wire 201, back contact 202 of the relay SLR⁴, wire 203, back contact 204 of the relay SLR³, wire 205, front contact 206 of the relay SLR² which now assumes the energized position, wire 207, back contact 141 of the relay 1, wire 208, front contact 142 of the relay 2, wires 209, 210 and 211, front contact 140 of the transfer relay TRS (still held stick and also held through front contact 49 of relay SLR²), wire 212, winding of the code relay COR, to the terminal (B+) of the battery 92. The completion of this circuit picks up the contacts of the relays COR, but the code repeater relay CRR will not be operated until the channel time relay CT has been energized, and has opened the contact 77 to effect deenergization of the master relay MR¹ and this master relay has in turn dropped and closed its contact 156. When this occurs the following circuit for the code repeater relay CRR is closed:—beginning at the terminal (B+) of battery 92, front contact 215 of the relay COR, wire 216, lower winding of the relay CRR, wire 153, front contact 154 of the relay CT, wire 155, back contact 156 of the relay MR¹, wire 157, back contact 158 of the relay MR², to common return wire C, connected to the mid-point of the same battery.

The completion of this circuit effects operation of the code repeater relay CRR to its right hand dotted position, thereby causing closure of the following circuit as soon as the channel time relay CT again assumes its deenergized position:—beginning at the terminal (+), front contact 75 of the control relay W, wire 76, back contact 77 of the relay CT, wire 78, contact 79 of the relay CRR in its right hand position, wire 217, back contact 218 of the relay MR¹, wire 219, winding of the master relay MR², to the other terminal (—) of the same battery. As soon as the relay MR² assumes its energized position in response to the completion of the circuit just traced, the stepping line 91 is energized by current of positive polarity through the following 70 branch leading to this stepping circuit:—beginning at the terminal (B+) of the battery 92, front contact 229 of the relay MR², wire 221, back contact 84 of the relay MR¹, wire 87, front contact 88 of the control relay W, wire 89, push 75

button contact 90, through the stepping circuit 91.

With the stepping line 91 energized by current of positive polarity the line relays LR, LR² and LR³ are operated to their right hand position. Referring first to Fig. 1B, and bearing in mind that the line circuit was momentarily deenergized, and that during this time of deenergization the half-step relay 2A was picked up by completion of the following circuit:—beginning at the terminal (—), contact 108 of the relay LR assuming its pendent position, wires 21 and 224, winding of the relay 2A, wire 225, front contact 226 of the relay 2, wire 177, winding of the relay 2, wires 170 and 25, front contact 66 of the relay 1, to the other terminal (+) of the same battery. Further, that with the relay LR now moved to its right hand position the following pick-up circuit is closed for the code responsive stepping relay 3:—beginning at the terminal (+) of the central office battery, contact 95 of the line relay LR in its right hand position, wire 96, front contact 97 of the relay 1, wires 165 and 166, back contact 167 of the relay 1, wire 228, front contact 229 of the relay 2, wire 230, front contact 231 of the relay 2A, wire 232, winding of the relay 3, to the other terminal (—) of the same battery. The completion of this circuit will of course pick up the relay 3 and complete the following stick circuit for this relay:—beginning at the terminal (+), contact 233 of the relay LR assuming its right hand position, wires 234, 24 and 236, back contact 237 of the relay 3A, wire 238, front contact 239 of the relay 3, wires 240 and 241, winding of the relay 3, to the other terminal (—) of the same battery. It is of course understood that with the line relay LR now assuming its right hand position that the relays 2 and 2A will be both deenergized, and this also would have been the case had the impulse been an impulse of negative polarity.

Let us now observe how deenergization of the stepping circuit after the second impulse and reenergization of the stepping circuit by a current of positive polarity will effect energization of the code responsive stepping relay 3² in Fig. 2 of the drawings. Deenergization of the line relay LR² after the second impulse transmitted over the stepping circuit effects closure of the auxiliary stick circuit for the relay 2², which auxiliary stick circuit includes the relay 2A², and may be traced as follows:—beginning at the terminal (—), contact 116 of the relay LR² in its pendent position, wires 180 and 243, winding of the relay 2A², wire 244, front contact 245 of the relay 2², wires 199 and 190, winding of the relay 2², wires 191 and 192, front contact 193 of the relay 1², to the other terminal (+) of the same battery.

As already explained the third impulse impressed upon the stepping circuit is an impulse of positive polarity and this impulse effects energization of the code responsive stepping relay 3² through the following circuit:—beginning at the terminal (+), contact 102 of the relay LR² assuming its right hand position, wire 103, front contact 104 of the relay 1², wire 186, back contact 187 of the relay 1², wire 247, front contact 248 of the relay 2², wire 249, front contact 250 of the relay 2A², wire 251, winding of the relay 3², to the other terminal (—) of the same battery.

As thus far described the third impulse, namely an impulse of positive polarity, has been transmitted and the code responsive relays 3 and 3² have been energized in response to the trans-

mission of this impulse. Referring now to Figs. 1A and 1B attention is directed to the fact that with the relay 3 energized and the relay 2 deenergized, the circuit heretofore traced for the code relay COR is broken at the back contact 143 of relay 3, so that the relay COR assumes its deenergized position, in which position its contact 150 is reclosed, thereby tending to operate the code repeater relay CRR back to its normal left hand position, but this does not occur until the channel time relay CT has been energized and has effected deenergization of the master relay MR² and closure of its contact 158. When this occurs the code repeater relay CRR is moved to its left hand position, thereby establishing a circuit for the master relay MR¹ as soon as the channel time relay CT again assumes its deenergized position and closes its contact 17. Picking up of the master relay MR¹ will, of course, cause the application of an impulse of negative polarity to the stepping circuit, for reasons heretofore given.

Referring to Fig. 1B, the momentary deenergization of the stepping circuit just preceding the fourth impulse, of course, effected energization of the half-step relay 3A through the following circuit:—beginning at the terminal (+), contact 233 of the relay LR assuming its pendent position, wires 23 and 256, winding of the relay 3A, wire 257, front contact 258 of the relay 3, wire 241, winding of the relay 3, to the other terminal (—) of the same battery.

Similarly, this momentary deenergization of the stepping line effected picking up of the relay 3A² in Fig. 2 of the drawings through the following circuit:—beginning at the terminal plus, contact 260 of the relay LR² assuming its pendent position, wires 261 and 262, winding of the relay 3A², wire 263, front contact 264 of the relay 3², wire 265, winding of the relay 3², to the other terminal (—) of the way station battery.

Referring now again to Fig. 1B of the drawings the transmission of the fourth impulse, which is an impulse of negative polarity, completes the following pick-up circuit for the relay 4:—beginning at the terminal (—), wire 94, contact 95 of the relay LR in its left hand position, wire 96, front contact 97 of the relay 1, wires 165 and 166, back contact 167 of the relay 1, wire 228, back contact 229 of the relay 2, wire 257, front contact 263 of the relay 3, wire 259, front contact 270 of the relay 3A, wire 271, winding of the relay 4, wires 272 and 25, front contact 66 of the relay 1, to the other terminal (+) of the same battery.

Similarly, referring to Fig. 2, the code responsive stepping relay 4² is energized through the following circuit when the line relay LR² assumes its left hand position during the fourth impulse of the particular code now being transmitted:—beginning at the terminal (—), contact 102 of the line relay LR² in its left hand position, wire 103, front contact 104 of the relay 1², wire 186, back contact 187 of the relay 1², wire 247, back contact 248 of the relay 2², wire 274, front contact 275 of the relay 3², wire 276, front contact 277 of the relay 3A², wire 278, winding of the relay 4², wires 279 and 192, front contact 193 of the relay 1², to the other terminal (+) of the same battery.

The relay 4 will obviously be stuck up through the following stick circuit:—beginning at the terminal (—), contact 108 of the relay LR in its left hand position, wires 109, 22 and 280, back contact 281 of the relay 4A, wires 282, front contact 283 of the relay 4, wires 284 and 285, winding of the relay 4, wires 272 and 25, front contact 275

66 of the relay I, to the other terminal (+) of the same battery; and the relay 4² in Fig. 2 will be stuck up through the following circuit:—beginning at the terminal (—), contact 116 of the relay LR² assuming its left hand position, wires 117 and 287, back contact 288 of the relay 4A², wire 289, front contact 290 of the relay 4², wires 291 and 292, winding of the relays 4², wires 279 and 192, front contact 193 of the relay I², to the other terminal (+) of the same battery.

Referring now to Fig. 1B of the drawings, attention is directed to the fact that the lifting of contact 144 of the stepping relay 4 does not in any way effect the circuit for the code relay COR, so that this relay COR remains deenergized and effects the application of an impulse of negative polarity for the fifth step of the particular code cycle under consideration. In other words, the master relay MR¹ will be deenergized for a short period of time, thereby deenergizing the stepping circuit for a short period of time, after which the stepping circuit is again energized by current of negative polarity, and when this occurs the code responsive stepping relays 5 and 5² will be energized.

Just preceding this fifth impulse on the stepping circuit, deenergization of the stepping circuit and its line relay LR causes the half-step relay 4A (see Fig. 1B) to be energized through the following circuit:—beginning at the terminal (—), contact 108 of the line relay LR assuming its pendent position, wires 21 and 294, winding of the relay 4A, wire 295, front contact 296 of the relay 4, wire 285, winding of the relay 4, wires 272 and 25, front contact 66 of the relay I, to the other terminal (+) of the battery; and similarly this momentary deenergization of the stepping circuit causes the relay 4A² (see Fig. 2) to be energized through the following circuit:—beginning at the terminal (—), contact 116 of the relay LR² assuming its pendent position, wires 189 and 198, winding of the relay 4A², wire 299, front contact 300 of the relay 4², wire 292, winding of the relay 4², wires 279 and 192, front contact 193 of the relay I², to the other terminal (+) of the same battery.

The half-step relays 4A and 4A² have thus taken their half-step position, and the next energization of the stepping line being an impulse of negative polarity, this being the fifth impulse of the particular code under consideration, causes the code responsive stepping relays 5 and 5² to be energized. Referring to Fig. 1B the stepping relay 5 is energized through the following circuit:—beginning at the terminal (—), wire 94, contact 95 of the relay LR to the left, wire 96, front contact 97 of the relay I, wires 165 and 166, back contact 167 of the relay I, wire 228, back contact 229 of relay 2, wire 267, back contact 268 of relay 3, wire 302, front contact 303 of the relay 4, wire 304, front contact 305 of the relay 4A, wire 306, winding of the relay 5, wires 307 and 25, front contact 66 of the relay I, to the other terminal (+) of the battery. Similarly, the relay 5² (see Fig. 2) is picked up in response to the negative impulse comprising the fifth step of the particular code under consideration through the following pick-up circuit:—beginning at the terminal (—), contact 102 of the relay LR² to the left, wire 103, front contact 104 of the relay I², wire 186, back contact 187 of the relay 1², wire 247, back contact 248 of the relay 2², wire 274, back contact 275 of the relay 3², wire 308, front contact 309 of the relay 4², wire 310, front contact 311 of the relay 4A², wire 312,

winding of the relay 5², wires 313 and 192, front contact 193 of the relay I², to the other terminal (+) of the same battery.

The relay 5 now assuming its energized position will have its following stick circuit completed:—beginning at the terminal (—), contact 108 of the line relay LR assuming its left hand position, wires 109, 22 and 315, back contact 316 of the relay 5A, wire 317, front contact 318 of the relay 5, wires 319 and 320, winding of the relay 5, wires 307 and 25, front contact 66 of the relay I, to the other terminal (+) of the same battery. Similarly, the relay 5² is stuck up through the following stick circuit:—beginning at the terminal (—), contact 116 of the relay LR² to the left (see Fig. 2), wires 117 and 321, back contact 322 of the relay 5A², wire 323, front contact 324 of the relay 5², wires 325 and 326, winding of the relay 5², wires 313 and 192, front contact 193 of the relay I², to the other terminal (+).

The operation thus far described has concerned the code for the apparatus shown in the top half of Fig. 1B and shown in Fig. 2 of the drawings, which code is the twelfth code in the table heretofore given, and has been carried through its fifth step, the first two of which were negative steps, the third of which was a positive step and the fourth and fifth of which were negative steps. It may be pointed out here, that the first five impulses of the various codes given in each case constitutes the station selecting code, and that the steps thereafter need not be in code fashion but may be alternately of plus and minus polarity. This is borne out by the polarities required to pick up the relays 6, 7 and 8 and 6², 7² and 8², which require successive impulses of positive, negative and then positive polarity.

The particular way station now having been selected, namely, the way station illustrated in Fig. 2, let us see how the central office equipment applies the impulses of plus, minus and plus for energizing the relays 6², 7² and 8², respectively. Referring to Fig. 1B it is noted that with the relay 5 picked up, as is now the case, the closure of its contact 145 applies current to the code relay COR, and with this relay COR energized the code repeater relay CRR will be operated to its right hand dotted position as soon as the channel time relay CT has picked up and has effected deenergization of the master relay MR¹. As soon as this occurs current of positive polarity is applied to the stepping circuit through contacts and wires heretofore traced.

With the line relay LR now operated to its right hand position in response to the sixth impulse, it being of course understood that during deenergization of the stepping line just preceding this sixth impulse will cause the half step relay 5A to be energized through a circuit readily traced in the drawings and including the wire 328, the front contact 329 of the relay 5, and the winding of the relay 5, the relay 6 is picked up through the following circuit:—beginning at the terminal (+), contact 95 of the relay LR assuming its right hand position, wire 96, front contact 97 of the relay I, wires 165 and 166, back contact 167 of the relay I, wire 228, back contact 229 of the relay 2, wire 267, back contact 268 of the relay 3, wire 302, back contact 303 of the relay 4, wire 330, front contact 331 of the relay 5, wire 332, front contact 333 of the relay 5A, wire 334, winding of the relay 6, wire 335, back contact 336 of the relay 7 to the other terminal (—).

In the same way, the deenergization of the stepping line just preceding the sixth impulse

causes the relay 5A² to pick up and to complete the following circuit:—beginning at the terminal (—), contact 116 of the relay LR² assuming its deenergized position, wires 180 and 338, winding of the relay 5A², wire 339, front contact 340 of the relay 5², wire 326, winding of the relay 5², wires 313 and 192, front contact 193 of the relay I², to the other terminal (+). With the line relay LR² operated to its right hand position due to the sixth impulse of the particular code transmitted, this being an impulse of positive polarity, causes the relay 6² to be energized through the following circuit:—beginning at the terminal (+), contact 102 of the relay LR² assuming its right hand position, wire 103, front contact 104 of the relay I², wire 186, back contact 187 of the relay I², wire 247, back contact 248 of the relay 2², wire 274, back contact 275 of the relay 3², wire 308, back contact 309 of the relay 4², wire 341, front contact 342 of the relay 5², wire 343, front contact 344 of the relay 5A², wire 345, winding of the relay 6², wire 346, back contact 347 of the relay 7², to the other terminal (—) of the same battery.

Referring now to Fig. 1B of the drawings, it being understood that the relays 5 and 5A were deenergized in response to the energization of the relay 6, the code relay COR (see Fig. 1A) is again deenergized, this because the contact 145 of the relay 5 is now assuming its retracted position opening the following circuit for relay COR:—B+, COR, 212, 140, 211, 210, 145 and C. Under these conditions, after a momentary deenergization of the stepping circuit, and with the code relay COR now deenergized, the code repeater relay CRR is again operated to its normal left hand position, thereby causing the seventh impulse to be applied to the stepping circuit, which is an impulse of negative polarity. With the relay LR now operated to its left hand position in response to the impulse of negative polarity causes the stepping relay 7 to be picked up through the following pick-up circuit:—beginning at the terminal (—), wire 94, contact 95 of the line relay LR to the left, wire 96, front contact 97 of the relay 1, wires 165 and 166, back contact 167 of the relay 1, wire 228, back contact 229 of the relay 2, wire 267, back contact 268 of the relay 3, wire 302, back contact 303 of the relay 4, wire 330, back contact 331 of the relay 5, wire 350, front contact 351 of the relay 6, wire 352, winding of the relay 7, wire 353, back contact 354 of the relay 8, wires 355 and 25, front contact 66 of the relay I to the other terminal (+) of the same battery. Picking up of this relay 7 causes it to be stuck up through the following stick circuit:—beginning at the terminal (—), front stick contact 336 of the relay 7, wire 357, lower winding of the relay IR² (see Fig. 1A), wires 358 and 352, winding of the relay 7, wire 353, back contact 354 of the relay 8, wires 355 and 25, front contact 66 of the relay I to the other terminal (+).

It should be noted that the stick circuit for the relay 7 includes the lower winding of the indicating relay IR² (see Fig. 1A). This provision is made so that each energization of the relay 7 will cause the indicating relay IR² to be operated to its normal negative position, this relay under certain conditions being operated to its right hand position during the energization of the relay 8, which conditions involve the occupancy of the detector track circuit at the west end of the passing siding PS, all in a manner as is hereinafter described.

Referring now to Fig. 2, and bearing in mind that the relay 6² is stuck up through a stick circuit including the wire 360 and the stick contact 351 of this relay 6², the relay 7² is picked up through the following circuit during the seventh impulse of the particular code cycle, which impulse is an impulse of negative polarity:—beginning at the terminal (—), contact 102 of the line relay LR² to the left, wire 103, front contact 104 of the relay I², wire 186, back contact 187 of the relay I², wire 247, back contact 248 of the relay 2², wire 274, back contact 275 of the relay 3², wire 308, back contact 309 of the relay 4², wire 341, back contact 342 of the relay 5², wire 362, front contact 363 of the relay 6², wire 364, winding of the relay 7², wire 365, back contact 366 of the relay 8², wires 367 and 192, front contact 193 of the relay I², to the other terminal (+).

Referring now to Fig. 1B it should be noted that with the relay 7 energized, the lifting of its contact 147 completes an energizing circuit for the code relay COR (see Fig. 1A) readily traced in the drawings, and that with this code relay COR energized the code repeater relay CRR is operated to its right hand position during the momentary energization of the channel time relay CT, so that when this relay CT again assumes its deenergized position the relay MR² is energized and the stepping circuit is energized by an impulse of positive polarity.

This impulse of positive polarity operates the line relays LR, LR² and LR³ to their right hand position, thereby completing the following energizing circuit for the relay 8 (see Fig. 1B):—beginning at the terminal (+), contact 95 of the relay LR to the right, wire 96, front contact 97 of the relay 1, wires 165 and 166, back contact 167 of the relay 1, wire 228, back contact 229, wire 267, contact 268, wire 302, contact 303, wire 330, contact 331, wire 350, back contact 351, wire 369, front contact 370 of the relay 7, wire 371, winding of the relay 8, to the other terminal (—). With the relay 8 picked up it is stuck up through a stick circuit including its stick contact 354 and the front contact 66 of the relay I.

Referring now to Fig. 2 the relay 8² is picked up in response to the eighth impulse of the particular code cycle under consideration, which is an impulse of positive polarity, through the following pick-up circuit:—beginning at the terminal (+) of the local battery, contact 102 of the relay LR² to the right, wire 103, front contact 104 of the relay I², wire 186, contact 187, wire 247, contact 248, wire 274, contact 275, wire 308, contact 309, wire 341, contact 342, wire 362, contact 363, wire 373, front contact 374 of the relay 7², wire 375, winding of the relay 8², to the other terminal (—) of the same battery. With this relay 8² once picked up it is stuck up through a stick circuit including its stick contact 366 and the front contact 193 of the relay I².

With the relay 8 now energized, its back contact 58 is open and the stick circuit for the relay SLR² and the relay W (see Fig. 1A) is broken at the contact 58, so that these relays SLR² and W assume their deenergized position, thereby, among other things, breaking the stepping circuit at the contact 88 of the relay W and breaking the energizing circuit for the master relay MR² at the front contact 75 of the relay W; the relay CR was of course deenergized as soon as the relay I picked up. With the stepping circuit deenergized the relay I and I² will, after a short period of time, assume their deenergized positions and in so doing will effect deenergization 75

of the relays 8 and 8². Dropping of the relay 7 of course effected deenergization of the relay COR, prior to the deenergization of the relay CT, so that the code repeater relay CRR is returned to its normal left hand position. Dropping of the last relay of the group, namely the relay 8, also breaks the stick circuit for the transfer relay TRS causing it to be deenergized and breaks the circuit for the channel time relay CT at another point, namely at the front contact 66 of the relay I. Also, the middle winding of the transfer relay is deenergized because the relays SLR² and 5 are both deenergized.

Referring to Fig. 1B, although the relays 11 to 18 inclusive, as well as the half-step relay 11A to 15A inclusive, were not considered during the operation of the particular code cycle heretofore considered in detail, it is desired to point out that the wiring for the control of the relays 11, 11A, 12, 12A, 13 and 13A is exactly the same as that of the wiring for the relays 1, 1A, 2, 2A, 3 and 3A, respectively, and that the relays 11, 11A, 12, 12A, 13 and 13A were sequentially energized during the first three impulses of the code considered. Attention is directed to the fact that the polarity signs to the left of the relays 11, 12 and 13 are exactly the same as that of the relays 1, 2 and 3, or in other words, the code insofar as the first three steps are concerned is the same for the series of relays shown in the lower part of Fig. 1B as that shown in the upper part of Fig. 1B. More specifically, the code for the relays in the upper part of Fig. 1B is code No. 12 of the table above given, whereas the code of the series of relays shown in the bottom part of Fig. 1B is code No. 10 in the table above given. Since the relay 14 requires an impulse of positive polarity on the stepping circuit, and requires positive potential to be applied to its left hand terminal, whereas the relay 4 requires a negative impulse on the stepping circuit and requires negative potential to be applied to its left hand terminal, makes it clear that the relay 14 did not pick up when the relay 4 picked up, and since the relays 13 and 13A dropped when the relays 3 and 3A dropped, no relays could be picked up in the relay group shown in the lower half of Fig. 1B when code No. 12, which was heretofore considered, was transmitted to the various way stations by the central office equipment. In this connection, it is of course understood that the relays 11, 12 and 13 could have been omitted and the relay 14 controlled through contacts of the relay 3. Carrying this thought a little further it is apparent that all of the stepping relays could be combined so that there would be two relays for the second step, four relays for the third step, and so on, so that there would be sixteen relays for the fifth step, thus taking care of all the codes given in the table above.

Having now explained how the code responsive stepping relays 1 to 8 and 12 and 8² are sequentially picked up when code No. 12 is applied to the stepping circuit, let us now observe how the switch machine SM² and the signals associated therewith are controlled in response to the movement of the lever SL² to the right and the lever SML² to the left, as was heretofore assumed.

It is of course understood that the relays 5 and 5² are energized simultaneously, and when this occurs the following circuit for the signal direction relay DR² (see Fig. 2) is closed:—beginning at the terminal (B+) of the battery 92, lever SL² (see Fig. 1A) to the right, wire 380,

front contact 381 of the relay 5, wire 382, back contact 383 of the relay 6, wire 384, back contact 385 of the relay 7, wire 386, back contact 387 of the relay 8, wires 388 and 389, front contact 390 of the relay CT, wire 391, back contact 392 of the relay MR¹, wire 393, back contact 394 of the relay MR², wires 395 and 396 and 126, front contact 128 of the relay I, message wire 400, wire 397 (see Fig. 2) front contact 129 of the relay I², wire 398, back contact 399 of the relay 8², wire 401, back contact 402 of the relay 7², wire 403, back contact 404 of the relay 6², wire 405, front contact 406 of the relay 5², wire 407, winding of the direction relay DR², to the common return wire C leading back to the central office and connected to the mid-point of the battery 92.

Similarly, the signal relay SR² is operated to its right hand position through the following circuit:—beginning at the terminal (B+) of the battery 92, contact 410 of the lever SL², wire 411, front contact 383 of the relay 6, wire 384, back contact 385 of the relay 7, wire 386, back contact 387 of the relay 8, wires 388 and 389, front contact 390 of the relay CT, wire 391, back contact 392 of the relay MR¹, wire 393, back contact 394 of the relay MR², wires 395, 396 and 126, front contact 128 of the relay I, message wire 400, wire 397, front contact 129 of the relay I², wire 398, back contact 399 of the relay 8², wire 401, back contact 402 of the relay 7², wire 403, front contact 404 of the relay 6², wire 412, winding of the signal relay SR² to the common return wire C connected to the mid-point of the battery 92.

Also, when the relays 7 and 7² are energized the following circuit for the switch machine relay SW² is closed:—beginning at the terminal (B-) of the battery 92, switch machine contact SML² assuming its left hand position, wire 414, front contact 385 of the relay 7, wire 386, back contact 387 of the relay 8, wires 388 and 389, front contact 390 of the relay CT, wire 391, back contact 392 of the relay MR¹, wire 393, back contact 394 of the relay MR², wires 395, 396 and 126, front contact 128 of the relay I, message wire 400, wire 397, front contact 129 of the relay I², wire 398, back contact 399 of the relay 8², wire 401, front contact 402 of the relay 7², wire 415, winding of the relay SW², to the common return wire C connected to the mid-point of the battery 92.

The successive completions of the three channel circuits just traced, effects operation of the relays SR² and SW² to their dotted positions, but leaves the direction relay DR² in its normal east bound position. Operation of the switch machine relay SW² to its left hand dotted position causes operation of the switch machine SM² to the take-siding position, and with the switch machine assuming the take-siding position and the signal relay SR² assuming its proceed position the take-siding signal 36 is cleared, thereby directing the movement of the train into the sidetrack of the passing siding PS.

It should be noted that the various channel circuits were traced through the back contacts 392 and 394 of the master relays MR¹ and MR² and through the front contact 390 of the channel time relays CT. This is done to definitely limit the channel time to the time when these contacts are closed, so that there is no possibility of an over-lap between the channel circuit branches completed by adjacent relays, such for instance as the relays 7² and 8².

Code dictation for in-coming station selection

Let us now see how an in-coming message is transmitted and let us assume that the east bound train accepts the take-siding signal 36 and moves into the sidetrack of the passing siding PS. As this train treads upon the detector track circuit containing the track relay TR², this track relay TR² is deenergized and in so doing closes its contact 417 and drops its contact 418, the latter of which results in momentary dropping of the relay M², since during the pole changing of its circuit the magnetism moves through zero allowing its contact 419 to be momentarily closed. Momentary closure of the contact 419 picks up the repeater stick relay FR², which when once picked up sticks up through the following stick circuit:—beginning at the terminal (+), back contacts 420 of the relay 8², wire 421, front contact 422, wire 423, winding of the relay FR² to the other terminal (—).

Picking up of this repeater change stick relay FR² closes the following initiating circuit for initiating the central office equipment:—beginning at the terminal (B+) of the battery 92 (see Fig. 1A), winding of the field relay FR, wire 424, push button contact PB, wire 425, back contact 128 of the relay I, message wire 400, wire 397 (see Fig. 2), back contact 129 of the relay I², wire 426, front contact 427 of the relay FR², to the common return wire C connected to the mid-point of the battery 92.

Completion of the circuit just traced picks up the relay FR (see Fig. 1A) and in turn completes the following circuit for the upper coil of the selector field relay SFR:—beginning at the terminal (+), back contact 50 of the relay RL², wire 430, back contact 431 of the relay RL³, wire 432, back contact 433 of the relay RL⁴, wire 434, front contact 435 of the relay FR, upper winding of the relay SFR to the other terminal (—) of the same battery. With the relay SFR once picked up it locks out the relays SLR², SLR³, SLR⁴, etc., and completes its following stick circuit:—beginning at the terminal (+), back contact 53 of the relay 8, wire 59, back contact 60 of the relay 13, wires 61 and 69, front contact 436 of the relay SFR, lower winding of this relay SFR to the other terminal (—).

With the relay SFR energized and its front contact 437 closed the starting relay CR is energized through the circuit heretofore traced except that it includes the front contact 437 of the relay SFR instead of the contact 65 of the relay SLR². Picking up of the starting relay CR closes the pick-up circuit for the relay W heretofore traced, which relay W is then stuck up in a manner as already explained hereinbefore. Picking up of the control relay W closes the stepping line at contact 88 and closes an energizing circuit for the master relay MR¹, which in turn through the lifting of its contact 84 applies an impulse of negative polarity to the stepping circuit, so that the line relays LR, LR², LR³, etc., are all operated to the left.

At this point in the operation of the system it should be remembered that the way stations are selected by code and that the central office equipment has not yet been informed what code is required to select the particular way station, namely, the way station shown in Fig. 2, so that this way station may transmit an indication to the central office informing the operator that the east bound train has tread upon the detector track circuit containing the track relay TR². It

may be pointed out here that the code which is to be transmitted will be dictated step by step, so to speak, by the apparatus shown in Fig. 2, this dictation of the code being accomplished by short circuiting, or not short circuiting, as the case may be, the message wire to the common return wire at a particular step when the next following impulse on the stepping line shall be respectively of plus polarity or of minus polarity. In other words, if the message circuit is short circuited on step one then step two will be of positive polarity, and if the message circuit is not short circuited on step one then step two will be of negative polarity.

Referring now to Fig. 2 it will be noted that the contact 441 has been provided for this purpose, and that lifting of the contact 440 will not short circuit the message wire to the common wire, whereas lifting of contact 441 will short circuit the message wire 400 to the common wire, so that the second impulse transmitted over the stepping circuit will be of negative polarity, whereas the third step will be of positive polarity, it being further understood that the transfer relay TRS assumes its deenergized position and that the code relay COR is included directly in series with the message circuit and a source of energy, so that had the message circuit been connected to the common return wire the code relay COR would have been up, but this was not the case so that the second impulse transmitted over the stepping circuit is of negative polarity, and the relays 2 and 2² will pick up.

With the relay 2² now picked up and the contact 427 of the field relay FR² closed, the following code-dictating circuit is completed for the code relay COR:—beginning at the terminal (B+) of the battery 92, winding of the relay COR (see Fig. 1A), wire 212, back contact 140 of the transfer relay TRS, wires 445, 396 and 126, front contact 128 of the relay I, message wire 400, wire 397 (see Fig. 2), front contact 129 of the relay I², wire 398, back contact 399 of the relay 8², wire 401, back contact 402 of the relay 7², wire 403, back contact 404 of the relay 6², wire 405, back contact 406 of the relay 5², wire 446, back contact 443 of the relay 4², wire 447, back contact 442 of the relay 3², wire 448, front contact 441 of the relay 2², wire 426, front contact 427 of the relay FR², to the common return wire C connected to the mid-point of the battery 92.

The completion of this circuit during the second step of the particular code transmitted will, when the master relay MR¹ drops close the circuit for the lower winding of the code repeater relay CRR, thereby operating it to its right hand dotted position, after which as soon as the channel time relay CT assumes its deenergized position and closes its contact 77, it will complete an energizing circuit for the master relay MR², which when energized applies an impulse of positive polarity to the stepping circuit, thereby operating the line relays to the right and picking up the relay 3 and 3², in a manner as already explained.

Picking up of the relay 3² by lifting its contact 442 does not connect the message circuit to the common return wire, and therefore the code relay COR (see Fig. 1A) remains deenergized, it having been deenergized as soon as the relay 2² dropped, from which it is readily understood that the fourth impulse transmitted will be an impulse of negative polarity, this because the code repeater relay CRR is returned to its left hand normal position during the channel time between steps 3 and 4.

Referring again to Fig. 2 of the drawings and bearing in mind that the relay 4² is next energized and since its contact 443 does not connect the message wire 400 to the common return wire C, it is apparent that the code relay COR remains de-energized and the fifth impulse transmitted is one of negative polarity.

The relays 5 and 5² are now energized, and referring to Fig. 1B attention is directed to the fact that closure of contact 450 of the relay 5 completes an energizing circuit for the transfer relay TRS, which may be traced as follows:—beginning at the terminal (+) of the central office battery, front contact 66 of the relay I (see Fig. 1B), wires 25 and 451, front contact 450 of the relay 5, wires 452 and 569, middle coil of the transfer relay TRS, to the terminal (—) of said battery. The completion of this circuit picks up the transfer relay TRS, and with this transfer relay TRS once picked up it is stuck up through its stick circuit heretofore traced and including its stick contact 132 and the front contact 66 of the relay I.

Picking up of the transfer relay TRS shifts its contact 140 so that the code relay COR is no longer controlled by the condition of the message circuit but is controlled in accordance with the contacts of the relays 5, 6 and 7 as shown in Fig. 1B of the drawings, in exactly the same manner as the code relay COR was controlled by these relays 5, 6 and 7 when the system was initiated by a lever movement. In other words, when a particular way side station is to be selected in response to a lever movement the entire code is determined by contacts on the central office group of relays corresponding to that way station. When, however, a particular way station is to be selected in response to initiation from the field, the code that is sent out is dictated one step at a time during the way station selecting portion of the code, namely the first five impulses in the particular arrangement shown of the code which select the way station, and thereafter since the corresponding group of central office relays have been definitely determined the code is thereafter determined by the channel selecting relays, such as the relays 5, 6, 7 and 8 of the central office equipment.

Let us now see how the central office is informed of the fact that the track relay TR² is deenergized. It is, of course, understood that the relays 8 and 8² are simultaneously energized during the eighth impulse of the particular code under consideration, and at this time the following message circuit for controlling the indicating relay IR² (see Fig. 1A) is closed:—beginning at the terminal (B+) of the battery 92, upper winding of the indicating relay IR², wire 455, front contact 387 of the relay 8, wires 388 and 399, front contact 390 of the relay CT, wire 391, back contact 392 of the relay MR¹, wire 393, back contact 394 of the relay MR², wires 395, 396 and 126, front contact 128 of the relay I, message wire 400, wire 397 (see Fig. 2), front contact 129 of the relay I², wire 398, front contact 399 of the relay 8², wire 456, back contact 417 of the relay TR² to the common return wire C connected to the mid-point of the battery 92. The completion of this circuit operates the indicating relay IR² to its right hand dotted position, thereby closing an energizing circuit for illuminating the indicating lamp IW, readily traced in the drawings. In this connection it should be remembered that the relay IR², as hereinbefore explained, is operated to its left hand position upon each

energization of the relay 7, this because the lower winding of the indicating relay IR² is included in series with the stick circuit for the relay 7, from which it appears that with the track relay TR² energized the indicating relay IR² will be operated to and remain in its left hand position.

Code superiority for in-coming station selection

Having now explained how the apparatus at a particular way station, the way station shown as Fig. 2, having been used as an example, may dictate the code for selecting that particular way station to transmit an in-coming message, let us now observe what would happen if several way stations were trying to transmit a change of indication and dictate a code at the same time. Let us bear in mind that if a way station does nothing toward dictating a plus impulse, a negative impulse will be applied to the stepping circuit in the next succeeding step, but if a way station connects the message wire to the common wire the next impulse will be of positive polarity. Let us also bear in mind, that each series of code responsive stepping relays is so constructed that if a particular impulse in a code is of the wrong polarity the entire series of relays will be rendered inoperative and will not again be able to respond to an impulse until a new code cycle of impulses is initiated. With these facts in mind, it is of course apparent that the particular way stations which dictate a positive impulse for the next step, will be accommodated by an impulse of plus polarity resulting in the picking up of their next code relay, and since the next code relay of the other way stations under consideration require an impulse of negative polarity, such other way stations will drop out, thus leaving the way stations which have dictated a positive impulse in a condition to dictate a succeeding impulse. In this way more and more way stations will be eliminated, until finally the dominating one of the way stations endeavoring to transmit an indicating to the central office will be selected.

Referring now to the table of codes heretofore given, it is apparent that code No. 1 which dictates four positive impulses for the second, third, fourth and fifth step during its first, second, third and fourth step, respectively, will dominate code No. 2 in that the second code dictates only three positive impulses for the second, third and fourth step during the first, second and third step, respectively, this second code requiring an impulse of negative polarity for the fifth step. The same theory applies to every succeeding code with respect to its adjacent code, as can be readily ascertained by observing the number and order of plus and minus impulses in each code. For instance, code No. 15 is superior to code 16 in that it dictates a code of positive polarity during the fourth step, so that the 5th step will be one of positive polarity, whereas code No. 16 is satisfied if all the impulses are of negative polarity, this being the most inferior code.

In this connection, let us particularly observe codes No. 12 and No. 10, the apparatus for which is shown in Figs. 2 and 3 respectively. It will be noted that if these two way stations were trying to indicate at the central office a change in traffic conditions simultaneously, their apparatuses would be initiated simultaneously. With both of the change stick relays FR² and FR³ up, the contacts 441 (see Fig. 2), 438 and 439 (see Fig. 3), will be able to control the code relay COR and call for a positive impulse for the next

step of the code. During the second step of the code under consideration (which code is not yet definitely determined) the contacts 438 and 441 of relays 2² and 12³, respectively, will be up energizing the relay COR, thus dictating an impulse of positive polarity for the third step. During the third step the contact 439 of relay 13³ will be up, effecting energization of the relay COR, thus dictating an impulse of positive polarity for the fourth step. This impulse of positive polarity, constituting the fourth step, will effect picking up of the relay 14³ (in a manner as hereinafter described) but will not effect picking up of the relay 4², as is also true of the relays 14 and 4, respectively. It is thus seen that the apparatus of Fig. 3 is connected to respond to a superior code (code No. 10) than is the apparatus shown in Fig. 2 (which responds to code No. 12). In other words the code dictating contacts, such as contacts 438, 439 and 441, are all connected in multiple, when their respective change relays FR³ and FR² are up, so that the closing of such contact is a superior condition to the opening of such contact, in that upon contact closure the desired result is obtained whereas if left open the desired result may or may not be obtained.

Modified way station apparatus

Attention is directed to the fact that each of the way station selecting code relays of Fig. 2, such as the relays 1², 2², etc. have each associated therewith a half-step relay, such as 1A², 2A², etc. In the arrangement shown in Fig. 3 of the drawings these half-step relays have been omitted, and a half-step group of relays comprising the even relay E, the odd relay O, and the polar relay P has been provided. This group of relays E, O and P may be said to be a group of relays which keeps track of the fact whether a particular impulse is an odd impulse or an even impulse in the particular code cycle of impulses transmitted. It is believed that the apparatus in Fig. 3 can be best understood by considering the operation of the apparatus.

Operation of structure in Fig. 3

It is believed sufficient to point out that the apparatus shown in the lower half of Fig. 1B is a series of relays which respond to the tenth code, and which in response to depression of the push button PB³ causes transmission of the tenth code, comprising a code of minus, minus, plus, plus and minus. Furthermore, suffice it to say that the relays in the lower half of Fig. 1B are connected exactly the same as are the corresponding relays in the upper part of Fig. 1B, except that the polarity of the right hand terminal of relay 14 is connected to the minus terminal of the central office battery, whereas the right hand terminal of the relay 4 is connected to the positive terminal of the same battery, and that the two stick circuits leading from the left side of the relay 4 go to a left hand and a neutral contact of the line relay LR connected to the negative terminal of the battery, whereas the two stick circuits leading from the left hand side of the relay 14 terminate at the right hand side and the neutral point, respectively, of a contact of the line relay LR connected to the positive terminal of the same battery. Furthermore, that only the contact 142 of the upper series of relays is capable of picking up the code relay COR, whereas in the group in the lower half of Fig. 1B the contacts 458 and 459 are capable of picking up the code relay COR. The rea-

son for this is obvious in view of explanations heretofore made.

Referring now to Fig. 3 of the drawings, let us observe how the tenth code of impulses is capable of selecting the apparatus shown in Fig. 3. The first impulse of this code is one of negative polarity, and with the line relay LR³ operated toward the left the following circuit for the odd relay O is completed:—beginning at the terminal (+), contact 460 of the relay LR³ assuming its left hand position, wires 461, 462 and 463, winding of the relay O, wires 464 and 465, back contact 466 of the relay E, wire 467, contact 468 of the relay P to the other terminal (—). The completion of this circuit picks up the relay O thereby completing the following stick circuit for the relay O:—beginning at the terminal (+), contact 460, wires 461, 462 and 463, winding of the relay O, wires 464 and 471, stick contact 470 to the terminal (—). Also, picking up of the relay O operates the relay P to its left hand dotted position through a circuit including its front contact 472. It is noted that the relay E could not pick up when the relay O was picked up because its pick-up circuit was then open at the contact 468 of the relay P, and that the relay E could not pick up when the relay P operated to its dotted position, because its pick-up circuit was then broken at the back contact 473 of the relay O.

Also, operation of the line relay LR³ to its left hand position completes the following pick-up circuit for the first code responsive stepping relay, namely the relay 11³:—beginning at the terminal (—), contact 475 of the relay LR³ to the left, wires 476 and 477, back contact 478 of the relay I³, wires 479 and 480, winding of the relay 11³, wires 481 and 482, front contact 483 of the relay O to the other terminal (+) of the same battery. It is of course understood that the stepping wire is momentarily deenergized between the first and the second impulse, both of which are negative, and when this occurs the stick circuit for the odd relay O is broken at the contact 460 of the relay LR³, so that the relay O is deenergized. Also, with this relay O now deenergized and its contact 483 open and with the slow acting cycle demarking relay now picked up, the relay 11³ is still stuck up through the following stick circuit:—beginning at the terminal (+), front contact 485 of the relay I³, wire 486, contact 487 of the relay P assuming its left hand position, wires 482 and 481, winding of the relay 11³, wire 480 and stick contact 488 of the relay 11³.

Movement of the line relay LR³ to its left hand position in response to the second impulse of the code under consideration, closes a circuit for the even relay E, which may be traced as follows:—beginning at the terminal (+), contact 460 of the relay LR³ toward the left, wires 461, 462 and 463, winding of the even relay E, wires 490 and 491, back contact 473 of the relay O, wire 492, contact 468 of the relay P, to the other terminal (—) of the same battery. With the relay E now energized and with the contact 475 assuming its left hand position the following pick-up circuit for the relay 12³ is completed:—beginning at the terminal (—), contact 475 of the relay LR³ to the left, wires 476 and 477, contact 478 of the relay I³ to its attracted position, wire 493, front contact 494 of the relay 11³, wire 495, winding of the relay 12³, wires 496 and 497, contact 498 of the relay E, to the other terminal (+) of the same battery. The relay 12³ as soon as it is picked up will of course be stuck up through a circuit readily traced and including its front stick

contact 499. Picking up of the relay E will of course cause the relay P to be operated to its left hand position through the medium of a circuit including the front contact 509 of the relay E, so that deenergization of the line relay LR³, and in turn the even relay E, still leaves a stick circuit for the relay 12³ which includes the stick contact 499 of the relay 12³, the contact 487 of the relay P assuming its right hand position and the contact 485 of the relay I³.

The third impulse of the tenth code is an impulse of positive polarity and effects operation of the line relay LR³ to its right hand position, and when this occurs the odd relay O is again energized for reasons heretofore given and effects operation of the relay P to its left hand position, and further operation of the line relay LR³ toward the right completes the following pick-up circuit for the relay 13³:—beginning at the terminal (+), contact 475 of the relay LR³, wires 476 and 477, contact 478 of the relay I³, wire 493, back contact 494 of the relay 11³, wire 501, front contact 502 of the relay 12³, wire 503, winding of the relay 13³, wires 504 and 505, front contact 506 of the relay O to the terminal (—) of the local battery. With the relay 13³ once picked up it is stuck up through a circuit readily traced and including its stick contact 507. Deenergization of the line relay LR³ now effects deenergization of the odd relay O, but since the relay P has in the meantime been operated to its left hand position, the following stick circuit for the relay 13³ is still intact:—beginning at the terminal (+), front contact 507 of the relay 13³, wire 538, winding of the relay 13³, wires 504 and 505, contact 509 of the relay P assuming its left hand position, wire 510, front contact 511 of the relay I³ to the other terminal (—) of the local battery. Deenergization of the line relay LR³ after the third impulse of course drops the odd relay O, and since the fourth impulse of the particular code under consideration is also plus the line relay LR³ is again operated to its right hand position, and in so doing picks up the even relay E, which effects operation of the polar relay P to the right hand position and with the line relay LR³ in the right hand position closure of the following pick-up circuit for code responsive stepping relay 14³ is effected:—beginning at the terminal (+), contact 175 of the line relay LR³ toward the right, wires 476 and 477, contact 478 of the relay I³, wire 493, back contact 494, wire 501, back contact 502, wire 513, front contact 514 of the relay 13³, wire 515, winding of the relay 14³, wires 516 and 517, front contact 518 of the relay E and to the other terminal (—) of the battery. The relay 14³ will of course be stuck up through a stick circuit readily traced in the drawings and including its stick contact 519 and contact 518 of the relay E. Dropping of the relay E upon deenergization of the line relay LR³ will of course still leave another stick circuit for the relay 14³, which includes its stick contact 519, the contact 509 of the relay P to the right and the contact 511 of the relay I³.

The fifth impulse of the code under consideration is an impulse of negative polarity, and with the line relay LR³ now operated toward the left, it will of course effect picking up of the odd relay O, for reasons heretofore given and will also complete the following pick-up circuit for the relay 15³:—beginning at the terminal (—), contact 475 of the relay LR³ toward the left, wires 476 and 477, front contact 478, wire 493, back contact 494, wire 501, back contact 502,

wire 513, back contact 514, wire 520, front contact 521, wire 522, winding of the relay 15³, wires 523 and 482, front contact 483 of the odd relay O. Picking up of the relay 15³ will of course complete a stick circuit readily traced and including its stick contact 524. Also picking up of the relay O will operate the relay P to its left hand position, and with the line relay LR³ assuming its left hand position, the relay 15³ is stuck up through a stick circuit including its stick contact 524, contact 487 of the relay P assuming its left hand position and the front contact 485 of the relay I³. Deenergization of the relay LR³ will of course deenergize the odd relay O, so that the even relay E may pick up during the next impulse.

The next impulse for the particular code under consideration is an impulse of positive polarity and operates the line relay LR³ to the right, thereby causing energization of the even relay E and closes the following pick-up circuit for the relay 16³:—beginning at the terminal (+) of the local battery, contact 475 of the relay LR³ to the right, wires 476 and 477, front contact 478 of the relay I³, wire 493, back contact 494, wire 501, back contact 502, wire 513, back contact 514, wire 520, back contact 521, wire 526, front contact 527 of the relay 15³, wire 528, winding of the relay 16³, back contact 529 of the relay 17³ and to the other terminal (—) of the battery. With the relay 16³ once picked up it is stuck up through the following stick circuit:—beginning at the (+) terminal of the way station battery, front contact 530 of the relay I³, wires 531 and 532, stick contact 533, winding of this relay 16³, back contact 529 of the relay 17³ and to the other terminal (—) of the battery.

During the channel time following the sixth impulse, the relay LR³ will of course be deenergized thereby dropping the even relay E, and since the seventh impulse is one of negative polarity, the code responsive relay 17³ will be picked up through the following pick-up circuit, the odd relay O having been picked up in the meantime:—beginning at the (—) terminal of the local battery, contact 475 of the relay LR³, wires 476 and 477, front contact 478 of the relay I³, wire 493, back contact 494, wire 501, back contact 502, wire 513, back contact 514, wire 520, back contact 521, wire 526, back contact 527, wire 535, front contact 536 of the relay 16³, wire 537, winding of the relay 17³, back contact 538 of the relay 18³, wires 539 and 531, front contact 530 of the relay I³ and to the other terminal plus of the local battery. The relay 17³ will of course be stuck up through a stick circuit readily traced and including its stick contact 529.

Deenergization of the line relay LR³ following the seventh impulse of the particular code under consideration will drop the odd relay O and the eighth impulse being one of positive polarity will pick up of the relay 18³ through the following pick-up circuit, the even relay E having been picked up in the meantime:—beginning at the terminal (+) of the way station battery, contact 475 of the relay LR³ to the right, wires 476 and 477, front contact 478 of the relay I³, wire 493, contact 494, wire 501, contact 502, wire 513, contact 514, wire 520, contact 521, wire 523, contact 527, wire 535, contact 536, wire 540, front contact 541, wire 542, winding of the relay 18³ and to the other terminal (—) of the same battery. The relay 18³ will of course be stuck up through a circuit readily traced and including its stick contact 538.

A short interval of time after the relay 18³ has been picked up and stuck up, the stepping circuit will be deenergized at the local office, for reasons heretofore given, thereby deenergizing the various slow acting relays including the relay I³ and thereby breaking the stick circuit for the relay 18³ at the front contact 530 of this slow acting relay I³. Also, dropping of the relay I³ through the medium of its contact 530 will restore the polar relay P to its right hand position, so that upon initiation of a new series or code of impulses the odd relay O will be the first one of the relays O and E to be picked up, so that the relays O, E and P will count off the even and odd impulses in the same manner as heretofore explained.

Attention is now directed to the fact that the relays DR³, SR³ and SW³ may be controlled respectively during the channel time when the relays 15³, 16³ and 17³ are energized, and that the indicating relay IR³ (see Fig. 1A) may be controlled through the channel circuit which is closed when the relays 18 and 18³ are energized, all in a manner as already hereinbefore described in connection with relay IR².

Simultaneous communication by the central office with all of the way stations

The operator in the central office has of course the necessary information with respect to train movements that he could conveniently announce at any particular way station, or at a ticket office near such way station, the fact whether or not trains are moving according to their time table schedule, whether they are on time or not, whether any special trains or double sections are operating, and in accordance with the present invention the operator may do so by getting in communication with such ticket offices through the medium of the selector system embodying the present invention. In the local office (see Fig. 1A) there is a suitable transmitter 545, which may be either a telephone transmitter or a printing telegraph transmitter, and at each way station (see Figs. 2 and 3) there is provided a receiver 546² and 546³, which receivers in the case of audible communication is employed is a loud speaker of the usual construction, whereas if printing telegraph communication is employed these receivers may be printing telegraph receivers of any suitable construction, either printing on tape as does the usual stock ticker or printing successive lines as is done by the ordinary typewriter.

Let us assume that the operator wishes to make an announcement to the various ticket offices, and in order to do so he presses the push button PB (see Fig. 1A). Depression of this push button PB opens the circuit for the relay FR and also breaks the usual stepping circuit at the contact 90 of this push button PB, and movement of the contact 90 to its lower position connects the terminal (B+) of the battery 92 to the stepping line 91, thereby operating all the line relays LR, LR² and LR³ to their right hand position. Movement of the contacts of relays LR² and LR³ to their right hand position, completes the following pick-up circuit for the announcer relays AR² and AR³:—beginning at the terminal (+) of the way station battery (see Fig. 2), contact 102 of the line relay LR² to the right, wires 103 and 550, back contact 551 of the relay I², wires 552 and 553, winding of the relay AR² and to the other terminal (—) of the way station battery. The circuit for the relay AR³ has been traced by

the same reference characters with distinctive exponents 3.

The relay AR² is then stuck up through a stick circuit readily traced in the drawings and including a stick contact 554 of this same relay, as is also true of the relay AR³. The various slow acting relays I, I² and I³ will of course pick up after a short interval of time, but in spite of this the announcer relays AR² and AR³ remain in their attracted position. The transmitter 545 (see Fig. 1A) is now connected to the various receivers 546² and 546³ in multiple, through the following circuit:—beginning at the terminal (B+) of the battery 92, transmitter 545, wire 556, contact 557 of the push button PB, wires 558 and 126, front contact 128 of the relay I, message wire 400, wire 397 (see Fig. 2), front contact 129 of the relay I², wire 398, contacts 399, 402, 404, 406, 443, 442, 441 and 440 of the relays 8², 7², 6², 5², 4², 3², 2² and 1², respectively, wire 559, front contact 560 of the relay AR², wire 561, the receiver 546² and to the common return wire C connected to the mid-point of the battery 92, the receivers in the other way stations being connected in multiple with the receiver 546² by identical circuits, readily traced see, for instance Fig. 3 of the drawings.

The operator may thus speak or telegraph by telephone or telegraph printers to each of the various station agents simultaneously, and may thereby inform them in a convenient manner the conditions of train performance. The operator, so long as he is communicating with these various station agents, maintains the push button PB depressed, and as soon as this push button PB is released, the field starting relay FR is again conditioned so that any change of indications which have materialized and accumulated in the meantime may initiate the system and cause it to indicate such change in the central office equipment.

Attention is particularly directed to the fact that the system under consideration requires no lock-out between the various way stations, in spite of the fact that a plurality of these way stations may dictate a code to get in communication with the central office simultaneously. The reason that no lock-out is required resides in the fact that each code is either superior or inferior to every other code, so that there is only one code of the codes of a plurality of way stations which want to connect with the central office at a particular time, which dominates the codes of all the other way stations. Another reason for not requiring an interlock, is that the slow acting or cycle demarking relays such as I² and I³ require the various way stations to take their first step simultaneously, since after a particular slow acting relay is once energized the first relay of the particular code responsive relay group can not be picked up. Attention is also directed to the fact that if desired the relay groups employed in the central office may be constructed like the relay group illustrated in Fig. 3 of the drawings, that is, may use the even and odd relays instead of employing the half-step relays as shown in Fig. 2 of the drawings and as employed in the relay groups illustrated in Fig. 1B of the drawings.

Applicant has thus provided a rather unique system of centralized traffic control, which employs only three line wires leading to a large number of distributed way stations, through the medium of which he may control apparatus at such way stations and receive indications from

such way stations in such rapid sequence that all of the control functions and indications which may be required on a railway system extending for a distance as of as much as a hundred miles, or even more. In this system codes of impulses are employed in which the number of distinctive codes available is equal to two to the n th power where n represents the number of steps per cycle, that is 4 steps afford 2^4 codes, namely 16, 5 steps afford 2^5 or 32 codes, and so on. The system is such that the central office equipment determines the code when a distant way station is to be controlled from the central office equipment, the system being so organized, however, that when a way station wants to transmit an indication to the central office, the way station will initiate the central office equipment and will then dictate the code step by step, the apparatus being so constructed that if two or more way stations endeavor to dictate the code step by step, the way station having the largest number of dominating steps in prior order will be able to dictate the selection of its own code by the central office. Each way station, as above described, has a series of stepping relays which will be energized successively providing the code impressed on the stepping circuit is proper, this series of stepping relays discontinuing their stepping as soon as a particular step in the code is of the wrong polarity, the advantage of this characteristic resides in the fact that if the portion of the code which has already been transmitted is wrong for a particular way station, this way station drops out, so to speak, and is thereafter unable to dictate the nature of the code to be transmitted by the central office equipment. The system under consideration retains the advantage of having multiple message circuits connecting the central office and a large number of way stations, these message circuits ordinarily being completed sequentially, but if desired may be completed simultaneously to enable simultaneous communication, such as the operation of a plurality of printing telegraphs or loud speakers, at all of the way stations, these message circuits also permitting the reading of battery voltages at different way stations sequentially, if desired. The proposed system is exceedingly simple in that no lock-out is required between the various way stations, the system being so organized that where a plurality of way stations desire to communicate with the central office at the same time, these way stations will have their code cycles synchronized, so to speak, in that they will all take their steps synchronously, this being accomplished by a channel defining or demarking relay which requires that all way stations take their first step, and successive steps, synchronously. Also, the system is very fast in its operation in that a comparatively few steps in a particular cycle enable one of a very large number of way stations to be selected. Other advantages and characteristic features are understood from the drawings and the preceding description.

Having thus shown and described two rather specific embodiments of the present invention it is desired to be understood that the particular embodiments illustrated have been selected for the purpose of conveniently describing the underlying principles of the invention, as well as its operating characteristics and the advantages afforded thereby, and that the particular forms of the invention illustrated have not been selected as the exact construction preferably employed

in practicing the invention and should not be interpreted as a limitation of the invention and it is further desired to be understood that various changes and modifications may be made to adapt the invention to the particular problem encountered in practicing the same, all without departing from the spirit or scope of the invention or the idea of means underlying the same, except as demanded by the scope of the following claims.

What I claim as new is:—

1. In a centralized traffic controlling system for railroads, the combination with a stepping circuit and a message circuit connecting a central office and a plurality of way stations, coding means in the central office for impressing a code of impulses upon the stepping circuit to select a particular way station irrespective of whether such way station is to be controlled from said central office or whether an indication is to be transmitted from such way station to said central office, means in the central office having its operation manually initiated for determining the character of the code impressed by said coding means at times when a way station is to be controlled from said central office, and means at each way station operable at other times for dictating through the medium of said message circuit the character of the code to be impressed by said coding means when such way station is in condition to transmit a new indication to the central office.

2. In a centralized traffic controlling system for railroads, the combination with a stepping circuit and a message circuit connecting a central office and a plurality of way stations, coding means in the central office for impressing a code of impulses upon the stepping circuit to select a particular way station irrespective of whether controls are to be transmitted to such way station from said central office or whether an indication is to be transmitted from such way station to said central office, control means in the central office for determining the character of the code impressed by said coding means when a way station is to be controlled from said central office, means at each way station and operable only if said control means is not effective for dictating through the medium of said message circuit the character of the code to be impressed by said coding means to select such way station when such way station is in condition to transmit a new indication to the central office, and means for transmitting an indication through the medium of said message circuit when such way station has been selected.

3. In a centralized traffic controlling system for railroads, the combination with a stepping line circuit and a message line circuit connecting a central office and a way station, a series of relays in said central office operated successively step by step in response to a particular code impressed upon said stepping circuit, means associated with said series of relays for in response to one step in said code dictating the character of and impressing the code impulse for the next step on said stepping line circuit, and means at said station rendered available by said particular code on said stepping line circuit for indicating in said central office and over said message circuit the condition of traffic at that particular distant way station.

4. In a centralized traffic controlling system for railroads, the combination with a line circuit connecting a central office and a plurality of way

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stations, a series of relays in said central office operated successively in response to a particular code impressed on said circuit, means associated with said series of relays for in response to one distinctive impulse of a code on said stepping circuit dictating the character of the next distinctive impulse on said stepping circuit, and code responsive means at a distant way station responsive to the code so dictated.

5. In combination a central office and a plurality of way stations along a railway track; a circuit connecting said office and way stations and including a three-position polar relay at said office and at each of said way stations; a relay at each way station and a corresponding relay for each way station at said central office, means for energizing said circuit by a series of impulses, the impulses of each series being separated by short periods of deenergization, each of said impulses being positive or negative following a positive or negative impulse, and each series defining a code different than the code defined by any other series; and means at each way station and at said central office and controlled by the associated three-position relay for energizing said relay at only a particular station and a corresponding relay in the control office for said particular station in response to and at the end of a particular series of impulses.

6. In a centralized traffic controlling system for railroads; a control office; a plurality of field stations; a line circuit connecting said control office and said field stations; means in said control office for automatically impressing any one of a plurality of codes on said line circuit, each of said codes being impressed in response to a single manual act, and each of said codes comprising a characteristic series of positive and negative impulses such that each series differs from every other series by the polarity of at least one impulse of the series and wherein the total number of different series of impulses is equal to two raised to the power of the total number of impulses for any one series; and station selecting means at each field station, each of said station selecting means rendered effective to select its station only in response to a particular one of said plurality of characteristic series of code impulses.

7. In a centralized traffic controlling system for railroads; the combination with a selecting line circuit and a message line circuit connecting a central office and a plurality of way stations and each having an individual line wire, of a plurality of code means in the central office, each for impressing a code of positive or negative impulses sequentially and these impulses being arranged in combination distinctive from any other combination impressed upon said selecting line circuit; station selecting means at each of the way stations responsive only to a single one of said distinctive codes to select a particular one of said stations; and means for controlling apparatus at said particular selected station over said message line circuit from said central office.

8. In a centralized traffic controlling system for railroads; a control office; a plurality of field stations; a pair of line wires constituting a line circuit connecting said control office and said field stations, said line circuit including at said control office a source of energy and a relay and being open at its remote end; step-by-step means at said control office and at each of said field stations operable to mark off a predetermined number of steps comprising a cycle of operation, said

steps being taken in synchronism; and means at each of said field stations capable of connecting or leaving disconnected said line wires at that station on each step taken by its step-by-step means in accordance with a distinctive code belonging to that station, whereby said relay in said control office is selectively deenergized or energized on each step depending upon whether all of said stations allow said line circuit to be open on that step or any one of said stations closes said line circuit on that step.

9. In a centralized traffic controlling system for railroads, a control office, a field station, a stepping circuit and a message circuit connecting said control office and said field station, step-by-step means at said control office and at said field station operated in synchronism by impulses on said stepping circuit, means at said station for selectively opening or closing said message circuit on each step, and means in said control office allowing said message circuit to be closed only during that part of a step during which said stepping circuit is deenergized.

10. In a centralized traffic controlling system for railroads in which selective communication is established between a control office and a plurality of field stations by impulsing a line circuit, means for impressing a series of time spaced distinctive impulses on a line circuit comprising impulsing means for impressing an impulse of either of two distinctive characters on the line circuit, step-by-step means caused to take one step for each impulse impressed on the line circuit, character determining means for determining on each step the character of the next impulse, and storing means controlled by the character determining means only during the time space of each step, said storing means controlling said impulsing means to determine the particular distinctive character of the next succeeding impulse of the series.

11. In a centralized traffic controlling system for railroads; a control office; a plurality of field stations; a selector type communication system operable through cycles of operation to allow either the transmission of messages to a selected field station from the control office or the transmission of messages from a selected field station to the control office during any particular cycle of operation; and means determining the direction of message transmission comprising at least two relays, means picking up one of said relays to cause said communication system to transmit messages from said control office, means picking up the other of said relays to cause said communication systems to transmit messages to said control office, and means interlocking said relays so that only one can be energized at a time.

12. In a centralized traffic controlling system for railroads, a plurality of stations connected by a line circuit, means at one of said stations for impressing potentials of opposite polarities on said line circuit, means at each of said stations responsive to one polarity on said line circuit to establish telephone communication between the stations, and means at each of said stations responsive to the other polarity on said line circuit to establish code communication between the stations.

13. In a centralized traffic controlling system for railroads; a plurality of stations connected by a line circuit; means at one of said stations for impressing different series of impulses of positive and negative characters on said line to establish code communication between said one station and the remaining station, the first impulse of every series being of a particular character

acter; means at said one station for at times impressing an impulse of a character opposite to the character of the first impulse of each of said series of impulses; and means at each of said stations responsive to an impulse of said opposite character to establish telephone communication between the stations.

14. In a centralized traffic controlling system for railroads, a plurality of stations connected by a line circuit, means at one of said stations for applying positive or negative potential to said line circuit, a three-position polar relay included in said line circuit at each of said stations, a slow acting neutral relay picked up whenever said polar relay is energized to either polar position, and means selectively controlled by the polar position of said three-position polar relay only during the pick-up period of said slow acting relay for establishing code communication when one polarity is applied to said line circuit and for establishing telephone communication when the opposite polarity is applied to said line circuit.

15. In a centralized traffic controlling system for railroads, the combination with two line circuits connecting a control office and a plurality of field stations, of code transmitting means in the control office for impressing any one of a plurality of different series of positive and/or negative impulses on one of the line circuits to comprise a distinctive code; station selecting means at each of the field stations, each of said station selecting means being responsive only to a particular one of said different series of positive and/or negative impulses; and means at each of said stations for at times communicating to said control office over the other line circuit the particular distinctive code to be transmitted by said code transmitting means.

16. In a centralized traffic controlling system for railroads; a control office; a plurality of field stations; a stepping circuit and a normally open message line circuit connecting said control office and said field stations, said message line circuit including at said control office a source of energy and a relay; means at said control office including said relay for impressing a series of impulses on said stepping circuit having distinctive characters dependent upon the successive energized or deenergized conditions of said relay; step-by-step means at said control office and at each of said field stations operable to mark off a predetermined number of steps comprising a cycle of operation in response to impulses on said stepping circuit, said step-by-step means at said field station being selectively responsive so as to complete a cycle of operation only when said impulses on said stepping circuit from a code corresponding to the code assigned to that station; and means at each of said field stations capable of selectively closing or not closing said message line circuit on each step taken by its step-by-step means, whereby said relay in said control office is selectively de-energized or left energized on each step depending upon whether all of said stations allow said message line circuit to be open on that step or any one of said stations closes said message line circuit on that step.

17. In combination, a line circuit having different series of positive and/or negative impulses impressed thereon, a polarized relay included in said line circuit for repeating the impulses of each series, a slow acting relay controlled by said polarized relay to be picked up at the beginning of each series of impulses and to be

dropped at the end of each series of impulses, a series of stepping relays, and means for controlling said stepping relays by said polarized relay and said slow acting relay so as to be successively picked up only by the impulses of a particular series and to be dropped away as soon as the impulses of a series fails to correspond to a code pattern predetermined for that series or to be dropped away whenever said slow acting relay is dropped away at the end of every series.

18. In combination, a line circuit having codes impressed thereon, each code comprising a predetermined number of elements, and each of said elements characterized by an impulse of positive or negative polarity; a polarized relay included in said line circuit for repeating each impulse of every code; a slow acting relay controlled by said polarized relay to be picked up at the beginning of each code and to be dropped at the end of each code; a number of stepping relays equal to said predetermined number of elements in each code; and means for successively picking up said stepping relays, one for each of said code elements, said means being effective only if the polarity of the impulse for that element is in correspondence with the code allotted to said stepping relay and only during a predetermined short interval after the response of said polar relay to such impulse, said short interval being measured for the first stepping relay by said slow acting relay.

19. In combination, a line circuit having different series of positive and/or negative impulses impressed thereon; a polarized relay included in said line circuit for repeating each impulse of each series; a series of stepping relays; a pick-up circuit for each of said stepping relays including a front contact of the next preceding stepping relay, a front contact of said polar relay in one position or the other depending upon the code allotted to said stepping relays, and means for allowing such pick-up circuit to be closed only a predetermined time; and a stick circuit means for each stepping relay energized only until the next impulse in the series is repeated by said polarized relay; whereby said stepping relays are selectively responsive only to a particular series of impulses on said line circuit.

20. In a centralized traffic controlling system of the coded type for railroads; a line circuit connecting a central office with a plurality of field stations; means at the central office for impressing different series of impulses on said line circuit, each series including a predetermined number of positive and/or negative impulses; a series of counting relays at each station energized successively in accordance with the successive energization of said line circuit by said impulses; and means at each station for discontinuing the successive energization of said counting relays at that relay in the series where the polarity of the impulse for that step is opposite to the polarity required in accordance with a predetermined code pattern, said means being effective until the next series of impulses is impressed on said line circuit.

21. In a centralized traffic control system governing the operation of switches and signals at a field station from a central office, a stepping line circuit extending from the central office to the field station, electro-responsive means at the field station in said line circuit, a group of neutral stepping relays governed by said electro-responsive means and energized sequentially one

at a time in response to the successive energizations of said line circuit, said stepping relays establishing circuits for the control of a switch and signals, a relay governed by said electro-responsive means and responsive to the polarity of energization of the line circuit at a particular time for rendering said stepping relays operable by subsequent impulses applied to said line circuit, a relay in the central office acting when energized to apply one polarity of energization to said line circuit and when deenergized the opposite polarity, and a manually operable switch in the control office for controlling said relay.

22. In a communication system for centralized traffic control, a control office, a plurality of signals located at different field stations, a stepping line circuit for connecting the control office and said field stations, a line electro-responsive means at each station energized over said line circuit, a plurality of levers in control office for governing said signals and arranged in groups corresponding with the location of said signals at the respective field stations, a number of stepping relays in the control office associated with said levers and relating to station identification, a manually operable switch associated with each group of levers, means controlled by each of said switches and the associated stepping relays for determining the polarity of the current impulse applied at a particular time to said stepping line circuit, a series of stepping relays at each field station establishing circuits for the controls of the associated signals, and station identification means at each field station controlled by the line electro-responsive means at that station in accordance with the polarity of energization of the line circuit for rendering the stepping relays at that particular station operable by subsequent impulses applied to the stepping circuit.

23. In a communication system for centralized traffic control governing the operation of traffic controlling devices at a remote station from a control office, a stepping line circuit connecting the control office with the field station, a line relay in said line circuit at the field station, a group of stepping relays at the station at times energized sequentially by the energization of said line circuit for establishing circuits selectively for the control of said traffic controlling devices, a conditioning relay energized in response to the energization of said stepping line circuit at a time preceding the energization causing operation of said stepping relays, a station identifying relay having an energizing circuit including a front contact of said conditioning relay and energized only when said line circuit is energized with a particular polarity, and manually operable means at the control office for determining the polarity of such energization of the line circuit to energize at times said station identifying relay and cause operation of said stepping relays.

24. In a centralized traffic control system, a control office, a plurality of traffic controlling devices located at different field stations along a railroad track, a stepping line circuit for connecting the control office and said field stations, a line relay at each field station energized over said stepping circuit, a series of stepping relays at each station at times energized sequentially by operation of said line relay and establishing circuits for controlling said traffic controlling devices at that station, station identification means at each station responsive to the polarity of energiza-

tion of said line circuit for determining whether or not the stepping relays at that station shall be energized by subsequent operation of the corresponding line relay, a plurality of levers in the control office for governing the traffic controlling devices and arranged in groups corresponding with the location of said devices at the respective field stations, a polarity determining relay acting when energized or deenergized to energize said line circuit with opposite polarities, and manually operable means associated with each group of levers for controlling said polarity determining relay to cause energization of said stepping line circuit with a polarity to condition the station identifying means at the corresponding field station and cause operation of the stepping relays at the station.

25. Control office equipment for centralized traffic control systems comprising, in combination with a stepping line circuit, a line relay in said line circuit, a series of stepping relays controlled by said line relay, energizing circuits for certain alternate relays of said series including contacts of said line relay closed upon energization thereof, energizing circuits for the other relays of said series including contacts of said line relay closed upon deenergization thereof, said relays being energized sequentially by their energizing circuits one at a time as said line relay is successively energized and deenergized, a source of current for energizing said line circuit, and means governed by contacts of said alternate stepping relays of said series for controlling the connections between said source and said line circuit to determine the polarity of the next energization of said line circuit.

26. In a centralized traffic controlling system for railroads, the combination with a stepping line circuit and a message line circuit connecting a central office and a plurality of way stations and each line circuit having a line wire individual to that line circuit, coding means in the central office for impressing any one of a plurality of series of positive or negative impulses and these impulses of each series being arranged to characterize a distinctive code for a station including like or unlike adjacent impulses upon the stepping circuit, said plurality of series being equal in number to two raised to the power of the number of impulses in any one series, station selecting means at each way station responsive only to a particular one of said distinctive codes to select that particular way station, indication apparatus at the central office, changeable devices at each field station, and means governed by said station selecting means for controlling said indication apparatus at said central office over said message line circuit in accordance with the conditions of said changeable devices at said selected way station.

27. In a centralized traffic controlling system for railroads, the combination with a stepping line circuit and a message line circuit connecting a central office and a plurality of way stations, coding means in the central office for impressing any one of a plurality of series of distinctive impulses sequentially and the impulses of each series being arranged to characterize a distinctive code including like or unlike adjacent impulses upon the stepping line circuit, said plurality of series being equal in number to two raised to the power of the number of impulses in any one series, means at each way station responsive only to a particular one of said distinctive code to select that particular way station, indication means at

the central office, control levers at the central office, traffic controlling means at the field station, means acting through the medium of said message line circuit for controlling said indicating means at said central office in accordance with traffic conditions at the selected way station, and means acting through the medium of said message line circuit for controlling said traffic controlling means at said selected way station in accordance with the position of said control levers at said central office.

28. In a centralized traffic controlling system, the combination with a stepping line circuit connecting a central office and a plurality of way stations and having a series of distinctive impulses impressed thereon; a line relay in said stepping line circuit at the control office at each of the way stations; and step-by-step means associated with each line relay comprising an even impulse denoting relay; an odd impulse denoting relay; a series of stepping relays; a pick-up circuit for each even stepping relay which circuit is energized only if the impulse corresponding to that relay is of a particular distinctive character, the next preceding stepping relay is attracted, and said even impulse denoting relay, which can only be attracted during an even impulse, is attracted; and a pick-up circuit for each odd stepping relay which is energized only if the impulse impressed on the stepping circuit corresponding to that relay is of a particular character, the next preceding stepping relay is attracted, and said odd impulse denoting relay, which can only be attracted during an odd step, is attracted.

29. In a traffic controlling system for railroads, the combination with electrically operated means operable to impress a code comprising a plurality of distinctive steps of like or unlike adjacent impulses on a stepping line circuit, a cycle demarking relay, means for causing said cycle demarking relay to assume its energized position on the first impulse of such code and to remain energized until the end of the last impulse of that code, a series of stepping relays, a pick up circuit for the first of said stepping relays which can only be closed if the cycle demarking relay is deenergized, a pick-up circuit for the others of said stepping relays which can only be closed if the next preceding stepping relay and said cycle demarking relay are in their energized positions, and the proper character of impulse is impressed on the stepping line circuit, and means including a contact of a particular stepping relay for transmitting a control impulse when that particular one of said stepping relays is assuming its energized position.

30. In a system for transmitting distinctive influences from any one of a large number of way stations a plurality of which are in condition to transmit such influences, code transmitting apparatus at a central office capable of transmitting a plurality of distinctive impulses to all of said way stations to characterize a particular code, receiving apparatus at each way station responsive to said distinctive impulses transmitted from the central office only so long as the particular code transmitted is correct for that particular way station, transmitting apparatus at each way station controlled by said receiving apparatus at its respective station so as to be effective to dictate to the central office the character of the next impulse transmitted from said central office so long as said receiving means at that station is still responsive to the code being transmitted from said central office, and means at the central office

responsive to the transmitting means of each station so as to register the dominating influence transmitted by any way station and causing said code transmitting means at said central office to transmit the next impulse proper for that way station which transmitted the dominating influence, whereby the code assigned to a way station having the largest number of prior dominating influences will be transmitted by the transmitting means at said central office and thereby select that way station, and means at each station rendered effective when that station is selected to then transmit indication influences to said central office.

31. Code transmitting apparatus comprising a transmitter for forming consecutive code elements, a plurality of starting contacts one for each code, means for closing any of said contacts, means effective when any starting contact becomes closed for starting the transmitter, means effective if a closed starting contact is connected to the transmitter to cause a code element to have a particular character, means controlled by the transmitter for repeatedly connecting the closed starting contact to the transmitter to form a distinctive code, said means being so arranged that if a plurality of starting contacts are closed at the same time the corresponding codes will be transmitted one at a time in order, and means effective when a code is completed for opening the starting contact which controlled its transmission.

32. Code transmitting apparatus comprising a transmitter for forming consecutive code elements, a plurality of starting contacts one for each code, means for closing any of said contacts, a plurality of circuits each including said closed starting contact and each effective when closed to control said transmitter, means for closing said circuits in sequence to repeatedly control said transmitter to form the code corresponding to said contact, and means operating upon completion of said code to open said contact.

33. Code transmitting apparatus comprising a transmitter for forming consecutive code elements, a plurality of starting contacts one for each code, means for closing any of said contacts, means effective when any starting contact becomes closed for starting the transmitter, means effective if a closed starting contact is connected to the transmitter to cause a code element to have a particular character, means controlled by said transmitter for registering each transmitted code, and means controlled by said code registering means for repeatedly connecting said closed contact to said transmitter to form the code corresponding to said contact.

34. Code transmitting apparatus comprising a transmitter for forming consecutive code elements, a plurality of starting contacts one for each code, means for closing any of said contacts, a series of contacts adapted to be closed one at a time to register consecutive code elements, means effective when any starting contact becomes closed to start the transmitter, means effective if a closed starting contact becomes connected to the transmitter to cause a code element to have a particular character, and means controlled by the transmitter for connecting the closed starting contact to said transmitter over each of a plurality of the contacts of said series to form the code corresponding to said contact.

35. Code transmitting apparatus comprising a transmitter for forming consecutive code elements, a plurality of starting contacts one for each code, means for closing any of said contacts,

a series of contacts adapted to be closed one at a time to register consecutive code elements, means effective when any starting contact becomes closed to start the transmitter, means effective if a closed starting contact becomes connected to the transmitter to cause a code element to have a particular character, means controlled by the transmitter for connecting the closed starting contact to the transmitter over one of said contacts to form the first element of particular character, means selectively responsive to a code element of particular character to connect said starting contact to the transmitter over a succeeding contact of said series to form a succeeding element of particular character, and means responsive to the final element of particular character for opening said starting contact.

36. In a centralized traffic controlling system, the combination with a stepping line circuit connecting a control office and a plurality of field stations, means in the control office operable to energize said line circuit with different series of distinctive impulses, each series of impulses forming a code combination, line relay means at each field station responsive to the distinctive character of each energization of said line circuit for any series of impulses, a series of stepping relays at each field station, a pick-up circuit for each of the stepping relays including a front contact of the next preceding stepping relay and energized by operation of the line relay means in response to one particular character of energization of the line circuit, each of said series of relays having their pick-up circuits arranged in accordance with a particular code combination, and means for establishing a stick circuit for each of said relays in turn to maintain that relay energized only during the energization period for the next succeeding stepping relay, whereby all of the relays of a series are de-energized whenever the code transmitted differs from the code for which such series is connected.

37. In a centralized traffic controlling system of the coded type for railroads, the combination with a stepping line circuit connecting a control office and a plurality of field stations, means in the control office operable to apply to said line

circuit any one of a plurality of series of impulses, each series comprising different combinations of impulses of distinctive character, a cycle demarking relay at each field station assuming its energized condition upon the first impulse of each series and remaining energized until the end of such series, a series of stepping relays at each field station, a pick-up circuit for the first of said stepping relays closed only while the cycle demarking relay is deenergized, a pick-up circuit for each of the other stepping relays including a front contact of the next preceding stepping relay, the pick-up circuits for each series being arranged to be energized only by a particular combination of distinctive characters of impulses, and means for maintaining each of said relays energized, if energized by an impulse on said line circuit, only until the next succeeding impulse, whereby the last relay of only one series of stepping relays for one station is energized at the end of the transmission of a given combination.

38. In a centralized traffic controlling system of the character described, a line circuit connecting a control office and a plurality of field stations, code transmitting means in the control office operable to apply to the line circuit any one of a series of impulses each variable in character to select any one of the plurality of field stations and transmit a control code to the selected station, each of said series having its first impulse of a predetermined character, and manually operable means in the control office for changing the first impulse to another character, receiving apparatus at each field station including a slow release cycle marking relay energized on the first impulse of a series irrespective of its character and maintained energized throughout such series, said receiving apparatus being responsive to a series of code impulses having the first impulse of said predetermined character, electro-responsive means at each field station, means for operating said electro-responsive means in response to the changed character of the first impulse of a series prior to the energization of said slow release cycle marking relay.

OSCAR H. DICKE.

DISCLAIMER

2,129,168.—*Oscar H. Dicke*, Rochester, N. Y. CENTRALIZED TRAFFIC CONTROL SYSTEM. Patent dated September 6, 1938. Disclaimer filed March 1, 1939, by the assignee, *General Railway Signal Company*.

Hereby enters this disclaimer to claim 4 of said Letters Patent.
[*Official Gazette March 21, 1939.*]