April 5, 1932. F. B. HITCHCOCK 1,852,568

TRAIN DISPATCHING SYSTEM FOR RAILROADS

Filed April 29, 1929 4 Sheets-Sheet 1

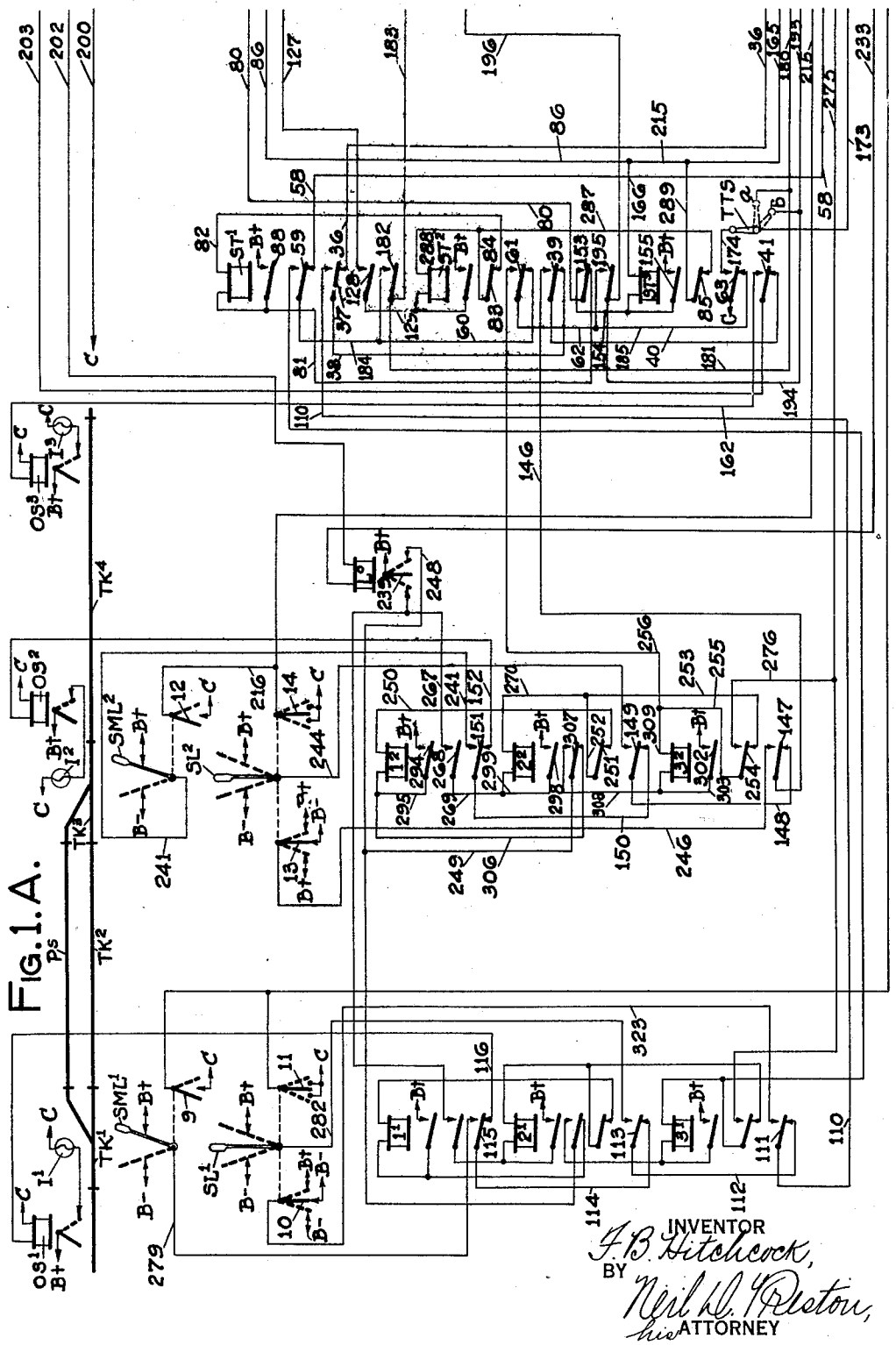

FIG. 1. A.

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TRAIN DISPATCHING SYSTEM FOR RAILROADS

Filed April 29, 1929 4 Sheets-Sheet 2

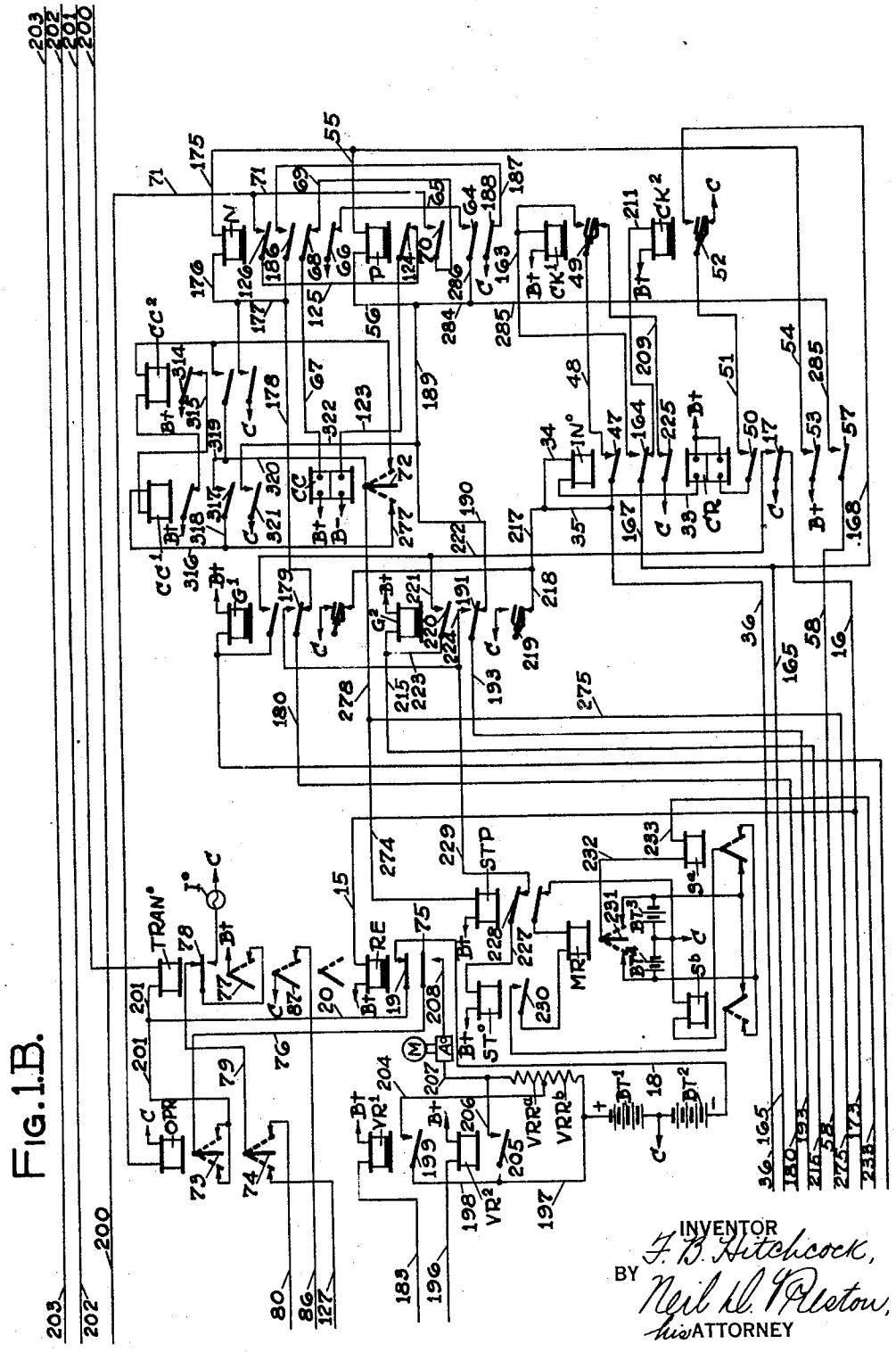

FIG. 1.B.

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TRAIN DISPATCHING SYSTEM FOR RAILROADS

Filed April 29, 1929 4 Sheets-Sheet 3

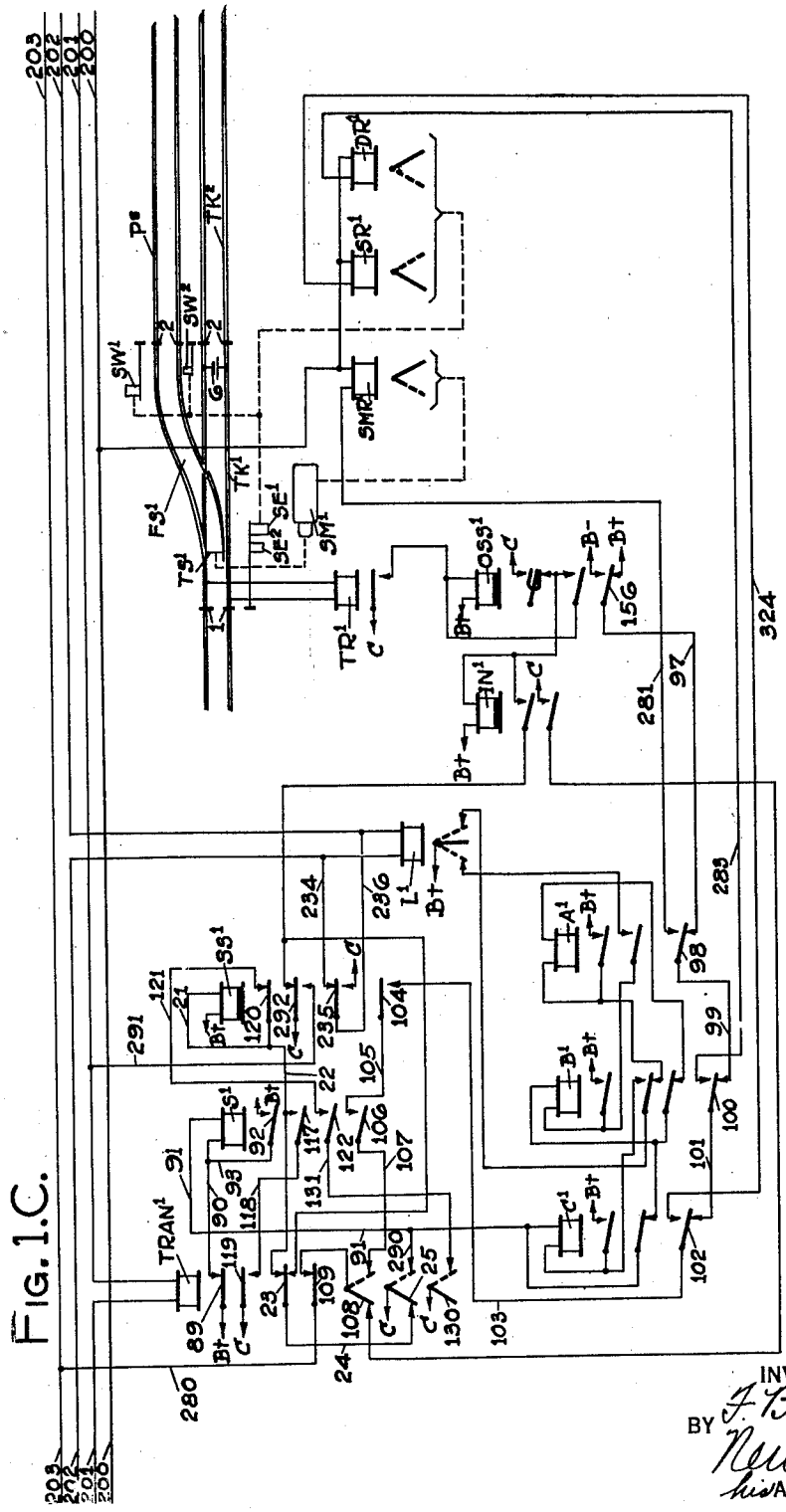

FIG. 1.C.

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TRAIN DISPATCHING SYSTEM FOR RAILROADS

Filed April 29, 1929 4 Sheets-Sheet 4

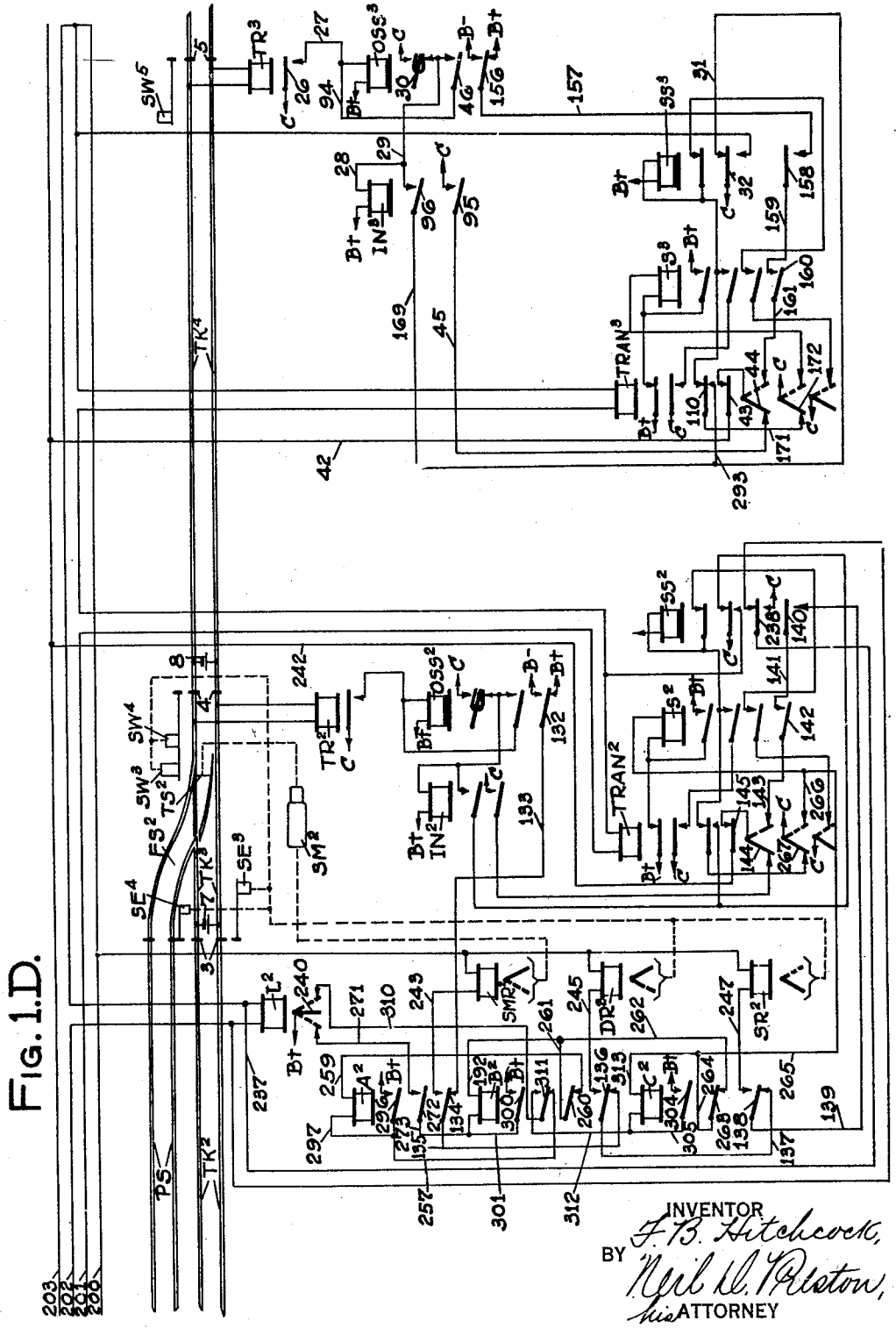

FIG. 1.D.

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UNITED STATES PATENT OFFICE

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TRAIN DISPATCHING SYSTEM FOR RAILROADS

Application filed April 29, 1929. Serial No. 359,040.

This invention relates to a train dispatching system of the type in which the dispatcher can control distant switch machines, in which trains are dispatched by wayside signal indications, and in which the control over the signals and switch machines, and the indication of the progress of trains, is transmitted over a comparatively few line wires, by apparatus of the synchronous selector type.

For the movements of trains to be properly controlled by a dispatcher, the switch machines and signals which serve as a means to direct the trains, must be under immediate control of the dispatcher. The time limit of this control must necessarily be reduced to a minimum value, when the dispatcher finds it advantageous to negotiate non-stop train meets, which is one of the advantages of a dispatching system applied in territory where excessive grades are prevalent. To facilitate in this rapid dispatching of train movements, it is necessary that the OS indications be received by the dispatcher as soon as possible.

In a synchronous selector type dispatching system, a certain period of time is required for the setting up of each message channel in succession. As the number of control impulses actually transmitted during a particular cycle of operation are few in comparison with the total number of message channels available for the transmission of control impulses, it is considered advisable, as set forth in the patent to O. H. Dicke and Neil D. Preston No. 1,794,591, dated March 3, 1931, to have the message channels which are to be used for control impulses, set up only when there is a control impulse to be transmitted. In such a system, as set forth in the above mentioned application, where the control of the dispatcher over a way-station is transferred from one way-station to another way-station successively, and where the OS indication impulses are picked up as the transfer is made from station to station, with the operation of the message channel selecting relays used only for control impulses, considerable time is saved, so that the OS indications from various way-stations are transmitted to the dispatcher in a minimum length of time.

A system which uses a transfer scheme, that is transferring the control of the dispatcher from one way-station to the next in rapid succession, has the advantage that the message channels of each way-station are isolated except at such time when they are to be used, which reduces the hazard of false indications, or continuous shorts caused by the inoperation of some mechanism at a way-station, to affect all the message channels of the system. This type of system also has the advantage, that further additions may be made to the system by simply adding more stations without altering the existing stations. If however, the central office, or dispatcher's office, has rotary mechanisms to govern the control over the way-stations, then it is necessary that the rotary mechanisms be built with spare spaces or replaced by new mechanisms in case of further extension of the system.

To alleviate the necessity for altering the existing apparatus in the dispatcher's office when a synchronous type selector system is extended, it is easily seen that, when non-mechanical rotation is utilized, which may be accomplished by successively operated relays, that further additions may be made by merely adding the necessary relays.

In the case of a railroad which has a synchronous selector type dispatching system installed, using the transfer from station to station method of control, over a long distance, it would be advisable, if it were possible, to be able to operate the system up to a break in line wires, or up to a point where a short or other defects, were causing inoperation of the dispatching system. In other words, if a dispatcher has trouble with his system, and can ascertain at what point this trouble is occurring, and can by slight manipulation of a switch or other means, acquire use of that part of the system up to that point at which the disturbance is occurring, then he would still have a chance to operate trains on part of his system automatically while a maintainer is sent to locate and remedy the trouble.

It is also readily understood, that in such a system where a great number of relays are used, that it is desirable to have the system at rest when no indications are waiting to be transmitted, to eliminate as many relay operations as possible.

In view of the above considerations and others, it is proposed to use in accordance with the present invention a self stepping synchronous selector system, which is entirely operable through the use of properly designed relay mechanisms, control levers and indicators, and having the OS and control impulses transmitted over a certain required number of message channels successively set up, so that the dispatcher from a central office may have control over the switch machines, signals, de-rails and the like, and receive OS indications, within the territory over which he has control. In accordance with the present invention, it is proposed to transmit a plurality of positive impulses to effect the transfer of the dispatcher's control over the way-stations from one way-station to the next way-station, with the control given to each station in succession with successive positive impulses, which give control over a way-station during the length of time that each positive impulse is maintained, and when such control over each way-station has been successively set up, then the original starting position shall be obtained by a negative impulse. Also, during such time that the system is transferring from one station to the next, the OS indications shall be picked up, as each station is successively under control, and the message channels used for control impulses shall be set up only at such time when a control lever has been moved to a new position, with such message channels established by the simultaneous operation of a group of relays at the dispatcher's office and a group of relays at the way-station to which the control impulse is to be transmitted, which groups of relays shall operate to set up the required message channel. The operation of these groups of relays which set up the message channels for control impulses shall be effected by the transmission of a plurality of alternate positive and negative impulses over the stepping circuit, including the stepping wire and the common return wire, of which each impulse will energize and move one of the above mentioned relays in the dispatcher's office and one in the way-station under control, during which period of time that exists between the movement of two successive relays, a control impulse from the dispatcher's office may be transmitted over the message channels thereby set up. The present invention, also includes means whereby the system shall be normally at rest, and may be initiated, either by the movement of a control lever at the dispatcher's office to a new position, or by the changing of the position of a track relay at any way-station.

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

In describing the invention in detail, reference will be made to the accompanying drawings, in which:—

Fig. 1A and Fig. 1B, when placed end to end, illustrate conventionally the equipment in the dispatcher's office for automatically shifting the control of the dispatcher from one way-station to the next in rapid succession, and automatically stopping it at a way-station to which a control impulse is to be transmitted, and automatically and sequentially operating the channel selecting relays at that station to set up the required message channel;

Fig. 1C illustrates conventionally the equipment of one way-station with the apparatus shown connected conventionally to control relays which have control over the switch machine and signals located at the west end of a passing siding;

Fig. 1D represents the equipment at a way-station similar to the way-station shown in Fig. 1C but connected so that control may be established over the east end of a passing siding; also, showing the equipment at a way-station for transmitting an OS indication at a permissive signal of an absolute-permissive-block signal system.

Description of apparatus

Although in practice, the dispatcher controls the switch machines and wayside signals of a large portion of a railway system, possibly including many passing sidings, diverging routes, draw bridges, railway crossings, and the like, the present invention has for convenience been shown as applied to the apparatus located at the east and west ends of the passing siding PS and at a permissive block signal SW^5 (see Figs. 1C and 1D). The passing siding PS connects to a main track, having sections TK^1, TK^2, TK^3 and TK^4 of a single track railway system signalled with absolute-permissive-block signalling, except at track sections, such as sections TK^1 and TK^3 which are under the control of the dispatcher. The track sections TK^1 and TK^3 contain track switches TS^1 and TS^2 respectively, which have associated therewith the usual detector track circuits. Track section TK^1, including a fouling track section FS^1, is enclosed by insulated joints 1 and 2. Likewise, the track section TK^3, including a fouling track section FS^2, is enclosed by insulated joints 3 and 4. The track section TK^4 belongs to the regular absolute-permissive-block signal system and is separated from the rest of the track by insulated joints

4 and 5. These track sections TK^1, TK^3 and TK^4 have track batteries 6, 7 and 8 respectively, associated therewith, to supply energy to their respective track relays TR^1, TR^2 and TR^3.

The starting signals for the main track and siding at the west end of the passing siding PS have been designated SW^1 and SW^2 respectively, and at the east end of the passing siding PS have been designated SE^3 and SE^4 respectively. At the west end of the passing siding PS is the main line signal and the take siding signal, SE^1 and SE^2 respectively and at the east end of the passing PS is the main line signal and the take siding signal SW^3 and SW^4 respectively. The permissive signal SW^5 is located at the east end of the track section TK^4.

In the dispatcher's office, is preferably located a miniature track layout (see Fig. 1A) corresponding in every detail to the system over which the dispatcher has control, and in the particular arrangement shown includes the passing siding *ps* and the main line track sections tk^1, tk^2, tk^3 and tk^4. This miniature track layout has indicating lamps I^1, I^2, I^3 associated therewith, which if illuminated, indicate the occupancy of the corresponding track circuits, namely, the track circuits of track sections TK^1, TK^3 and TK^4 respectively. The track switch TS^1 at the west end of the passing siding PS is preferably controlled by the switch machine relay SMR^1, which relay is in turn controlled by the lever SML^1 through the medium of the self stepping synchronous system hereinafter described. Similarly, the signals SE^1, SE^2, SW^1 and SW^2 are controlled by the signal relay SR^1 and the direction relay DR^1, through the medium of the synchronous selector system in accordance with the position of the lever SL^1 located in the dispatcher's office. Also, the track switch TS^2 and the signals SE^3, SE^4, SW^3 and SW^4 are likewise controlled in accordance with their respective control lever SML^2 and SL^2 in the dispatcher's office. The manner, in which such relays, as relays SMR^1, DR^1 SR^1, may control their respective functions, is fully set forth in pending application by S. N. Wight, Ser. No. 321,185, filed Nov. 22, 1928.

The dispatcher's office contains a number of relays, so grouped and inter-related in their respective functions, as to accomplish the operation of the system automatically. These various functions of the relays involved, serve to give them distinctive group names and distinguishing reference characters.

The group of relays 1^1, 2^1 and 3^1 are the control impulse message channel selecting relays for the first way-station, in which the order of the number gives the order of sequential operation for that station, and the order of the exponent gives the order of the station. Similarly, the group of relays 1^2, 2^2 and 3^2 are the control impulse message channel selecting relays for the second way-station, with the reference characters having a like meaning. The energizing circuits for these groups of message channel selecting relays are repeated by the line relay L^0 and the particular group to be operated is selected by the station selecting relays ST^1, ST^2 and ST^3, in which the exponents represent the order of the way-station to which they are assigned. The initiating relay IN^0 and the control relay CR serve to initiate and control the duration of the sequential operation of the system respectively, in transferring the control of the dispatcher from one way-station to the next way-station, having associated therewith the cycle checking relays CK^1 and CK^2, which control the relays IN^0 and CR in such a manner, that the system shall complete two cycles of non-mechanical rotation, after each time that the initiating relay IN^0 has been energized. The transfer impulse generating group is composed of an operating relay OPR, the control checking relays CC, CC^1 and CC^2, the impulse polarity relays N and P, and the re-set relay RE. Also, the stepping impulse generating group is composed of the master relay MR, and two time spacing repeater relays S^a and S^b. This stepping impulse generating group has associated therewith the starting relay ST^0 and the stopping relay STP. The control of the stepping impulse generating group and associated relays is determined by the group selecting relays G^1 and G^2, which are in turn controlled by the movement of a control lever effected by the dispatcher. There are also two voltage regulating relays VR^1 and VR^2, which serve to shunt out portions of the voltage regulating resistance such as VRR^a and VRR^b as the dispatcher's control is transferred from one way-station to the next way-station. This is necessary, inasmuch as, each time the transfer of control is accomplished, an added transfer relay is placed in series with the line as well as an added amount of line wire. A transfer relay $TRAN^0$, serves to repeat in the dispatcher's office the conditions imposed upon the transfer control wire. An indicator lamp I^0 is included at the dispatcher's office, to indicate such time that the transfer relay ceases to function, due to an opening in the transfer control wire. An automatic cut-out A^0 is inserted in the transfer control wire circuit, which serves to open the said circuit, in case an excessive current flows through said cut-out A^0. This cut-out A^0 also has associated therewith an ampere meter M and furnishes a means whereby the operator may ascertain approximately where there is a short upon the transfer control wire. Thus, in order that the dispatcher may utilize the knowledge that he has certain trouble upon the transfer wire, a transfer

trouble switch TTS is furnished, which provides a means whereby the operator may regulate the transfer control circuits in such a manner that the system may be operated automatically to the certain point in the system at which the known trouble occurs.

For purposes of simplification, the points in the circuits which are connected to the common wire, have arrows with reference characters C.

Suitable power supply, for the transfer control impulses, is provided by the batteries BT^1 and BT^2 connected together to give negative and positive potentials respectively, in respect to the central point of the batteries connected to the common wire. Also the stepping impulse power supply, is furnished by the batteries BT^3 and BT^4 and are connected to give positive and negative potentials respectively, in respect to the central point of the batteries connected to said common wire. Various other points in the circuits which require positive and negative potentials in respect to said common wire, are indicated as (B+) and (B−) respectively, which in the dispatcher's office, may be battery BT^1 or BT^2, or other separate sources. Likewise, the indicated sources for the way-stations, are separate batteries at each way-station, which give positive or negative potentials in respect to said common wire, and are maintained charged in any suitable manner such as some trickle charge method.

The dispatcher's office is connected to the way-stations (see Figs. 1C and 1D) by four line wires, consisting of a common wire 200, a transfer wire 201, a stepping wire 202, and a message wire 203. The way-station shown in Fig. 1C, as connected to the west end of a passing siding PS, is identical to the way station shown in Fig. 1D as connected to the east end of the same passing siding PS. The way-station shown in Fig. 1D as located at the permissive block signal SW^5 has transfer equipment identical with the other two way-stations shown, but with the control impulse message channel selecting relays omitted. The relays duplicated in the several stations have like reference characters with suitable exponents distinguishing the station to which they belong. Thus, only the way-station shown in Fig. 1C will be briefly described.

This way-station shown in Fig. 1C has a transfer relay $TRAN^1$, of the polar neutral type which controls in turn and sequentially the station selecting relay S^1, and the station shunting relay SS^1. These relays composing the transfer group, give control over the message channel selecting relays A^1, B^1 and C^1, as well as effecting the transfer to the next way-station. The energizing circuit of the message channel selecting relays, is repeated by the line relay L^1 when the transfer group has selected this particular station. An OS storing relay OSS^1 is provided to hold the OS indication until the initiating relay IN^1 has initiated and operated the synchronous selector system up to this way-station, so that the said OS indication can be registered at the dispatcher's office.

It will be stated here, that all polar relays are considered to assume a right hand or positive position, with an application of positive potential to the left hand terminal of the relay, and to assume a left hand or negative position, with application of negative potential to the left hand terminal of the relay. It is also assumed, that the normal position of all relays are in their present full line position, so that when a relay is spoken of as being in a reverse or abnormal position it shall mean the dotted line position as shown in the accompanying drawings.

The relays L^0, L^1, L^2, OPR, and MR are of the biased to neutral type of polar relay. In other words, their armatures move according to the polarity applied due to the permanent magnet incorporated, but assume a neutral position when de-energized. Other polar relays are of the polar permanent magnet stick type which respond to an energy impulse of a certain polarity by moving its contacts to a position determined by that polarity, due to a permanent magnet which is incorporated within the relay. This permanent magnet holds the armature when moved to an extreme position even though the relay is then de-energized.

The neutral relays incorporated within the circuits of the system are of the usual type and are shown conventionally with heavy line bases in such cases where they have a slow releasing period.

Lever SML^1 has connected to it by mechanical means contact 9 which moves to its dotted line position when the lever SML^1 is moved to its dotted line position. Also the lever SL^1 has connected to it by mechanical means the contacts 10 and 11, which move to their right hand dotted line positions with the movement of the lever SL^1 to a left hand dotted line position with corresponding opposite movements with lever SL^1 moved to a right hand position. Similarly the levers SML^2 and SL^2 have associated therewith corresponding contacts 12, 13 and 14 respectively.

It is believed that the system will be better understood with further description being set forth from the stand point of operation.

Operation

In a train dispatching system of the synchronous counting relay type, in which successive way stations are selected one at a time, there are four distinctive characteristic conditions which the station selecting apparatus at each way station must be capable of producing, namely;

(1) A "normal at rest" condition, during

which time all the way stations shall be at rest, and during which time a circuit may be set up at any way station for initiating the system, with this "at rest" condition being immediately cancelled as soon as the system becomes initiated;

(2) A "before selection" condition, which is set up immediately after the "at rest" period, which "before selection" condition determines that all the way stations shall be idle except the first way station which is to be under control;

(3) A "selected" condition, which is maintained at the way station under operating control and which is characteristic only of such station that is under operating control;

(4) An "after selection" condition which is maintained by all way stations that have been under operating control, until the normal "at rest" condition is repeated, with such an "after selection" condition which allows the remaining way stations to be successively placed under control, maintaining those way stations which have been under control in an idle condition.

It will be noted, that the condition which is used for the "at rest" period and for initiation is the same condition which resets the way stations to a normal at rest condition. These various conditions must be duplicated at the dispatcher's office in such a manner that the apparatus at the dispatcher's office may control the conditions automatically and cause the system to work in a certain predetermined sequence of operation.

It is believed that the various conditions set up by the system and the sequential operations and functions of the mechanisms included will be best understood by a detailed description of several cycles of operation.

Normal "at rest" condition.—With the system at rest, the initiating relay IN^0 and control relay CR are de-energized, completing a circuit for the re-set relay RE, which, when energized, places negative potential upon the transfer wire 201, energizing the transfer relays $TRAN^0$, $TRAN^1$, $TRAN^2$ and $TRAN^3$, so that their polar contacts are in a negative position and their neutral contacts are in an energized position. With the transfer relays thus energized, the station shunting relays SS^1, SS^2 and SS^3 are also energized.

The circuit for relay RE is traced as follows:—from positive terminal of indicated source having suitable potential, through relay RE, wires 15 and 16, back contact 17 of relay CR, to the common wire 200.

The circuit for placing negative potential upon the transfer wire 201 is traced as follows:—negative potential from the battery BT^2, through wire 18, front contact 19, wire 20, transfer wire 201, transfer relay $TRAN^0$, transfer wire 201 to the first way station, transfer relay $TRAN^1$, through the transfer wire 201 to the second way station, transfer relay $TRAN^2$, through the transfer wire 201 to the third way station, transfer relay $TRAN^3$, to the common wire 200.

At the first way station, relay SS^1 is energized through the circuit traced as follows:—from positive terminal of indicated source having suitable potential, through the relay SS^1, wire 21, wire 22, front contact 23 of relay $TRAN^1$, wire 24, negative contact 25 of relay $TRAN^1$, to the common wire 200. Through similar symmetrical circuits, the relays SS^2 and SS^3 are held in energized positions.

Transmission of OS indications.—Let us assume, that a train travelling in a west bound direction enters the track section TK^4 at the permissive-block-signal SW^5. The OS indication, representing the presence of this train, is stored in the OS storing relay OSS^3 by accomplishing its energization as a result of the shunting of track relay TR^3. The energization of the relay OSS^3 momentarily completes a circuit for energizing the initiating relay IN^3, which remains energized due to a stick circuit, until the OS indication in the relay OSS^3 has been transmitted to the dispatcher's office. This is because the initiating relay IN^3, when energized, also closes a stick circuit for the relay OSS^3. This combination of interconnection provides a means whereby the OS indication is insured of being transmitted to the dispatcher's office, whether or not, the train leaves this particular track section before its OS indication has been transmitted, which would occur providing the track section TK^4 is exceptionally short and the train is travelling at a high rate of speed.

More specifically considering the operation, the occupancy of track section TK^4, shunts the track relay TR^3, so that its contact 26 assumes a de-energized position, which sets up an energizing circuit for the OS storing relay OSS^3 through a circuit traced as follows:—from negative terminal of indicated source having suitable potential, through relay OSS^3, wire 27, back contact 26 of relay TR^3, to the common wire 200. During the energization of relay OSS^3, a momentary energizing circuit for the relay IN^3 is completed, being traced as follows:—from positive terminal of indicated source having suitable potential, through relay IN^3, wires 28 and 29, "make before break" contact 30, to the common wire 200. As soon as, the relay IN^3 is energized, a stick circuit is completed for both the relays IN^3 and OSS^3. This stick circuit for the relay IN^3, is traced as follows:—from positive terminal of indicated source having suitable potential, through relay OSS^3, wire 94, front contact 46, wire 29, front contact 96, wires 169 and 31, front contact 32 of relay SS^3, to the common wire 200.

The initiating relay IN^0 and the control

relay CR, in the dispatcher's office, are now energized through a circuit completed by the energization of the relay IN^3 in the third way station, which circuit is included at each way station having identical and symmetrical connections, so that the system may be initiated from each and every way-station where OS indications occur. This initiating circuit for the third way station is traced as follows:—from positive terminal of indicated source having suitable potential, through upper winding of relay CR, wire 33, relay IN^0, wires 34, 35 and 36, back contact 37 of relay ST^1, wire 38, back contact 39 of relay ST^2, wire 40, back contact 41 of relay ST^3, to the message wire 203 which is connected to each way station, from the message wire 203 at the third way station through wire 42, front contact 43 and negative contact 44 of relay $TRAN^3$, wire 45, front contact 95, to the common wire 200.

With the contacts of relays IN^0 and CR in the dispatcher's office, in energized positions, circuits are completed whereby the relays N and P operate to alternately place positive and negative impulses upon the operating relay OPR, which in turn sequentially operates the station selecting relays ST^1, ST^2 and ST^3. The energizing circuits of the relay OPR are carried through the relay CC in such a manner that the contact 72 of relay CC assumes a position which is in accordance with the energization of either relay N or relay P, and in accordance with the polarity of the potential applied to the relay OPR.

With the relay CR energized, the energizing circuit for the re-set relay RE is broken at contact 17 of relay CR. At the same time, the front contact 47 of relay IN^0 closes a stick circuit for relay IN^0, being traced as follows:—from positive terminal of indicated source having suitable potential, through upper winding of relay CR, wire 33, relay IN^0, wires 34 and 35, front contact 47, wire 48, back contact 49, wire 209, front contact 225 of relay IN^0 to the common wire 200. Also, a stick circuit is completed for relay CR being traced as follows:—from positive terminal of indicated source having suitable potential, through the lower winding of relay CR, front contact 50, wire 51, back contact 52, to the common wire 200. The energization of relay CR closes a circuit for energizing the relay P being traced as follows:—from positive terminal of indicated source having suitable potential, through front contact 53 of relay CR, wires 54 and 55, relay P, wires 56, 284 and 285, front contact 57, wire 58, back contact 59 of relay ST^1, wire 60, back contact 61 of relay ST^2, wire 62, back contact 63 of relay ST^3, to the common wire 200. The energization of relay P closes its stick circuit, being traced as follows:—from positive terminal of indicated source having suitable potential, front contact 53 of relay CR, wires 54 and 55, relay P, wires 56, 284 and 286, front contact 64 of relay P, wire 65, back contact 66 of relay N, to the common wire 200. The energization of relay P places positive potential on the relay OPR through a circuit traced as follows:—from the positive terminal of indicated source having suitable potential, through upper winding of relay CC, wire 67, back contact 68, wire 69, front contact 70, wire 71, through relay OPR, to the common wire 200. The current that flows in this circuit just traced energizes the contact 72 of relay CC to a positive position, and the contacts 73 and 74 of relay OPR to a positive position.

The de-energization of the slow releasing relay RE opens the energizing circuits of the transfer relays $TRAN^0$, $TRAN^1$, $TRAN^2$ and $TRAN^3$ at the front contact 19 of relay RE, as the slow releasing period consumes enough time to permit the relays SS^1, SS^2 and SS^3 to become fully de-energized before a positive potential is placed upon the transfer wire by the contacts of relay OPR being in a positive position. This de-energization of the station shunting relays SS^1, SS^2 and SS^3 accomplished the sectionalization of the transfer line wire 201 by shunting the transfer wire at each station on the side of the transfer relay away from the dispatcher's office, to the common wire 200. This is more specifically shown by referring to the first way station, shown in Fig. 1C, where the transfer wire 201 on the right hand side of transfer relay $TRAN^1$ is connected to the common wire 200 by means of the wire 291 and the back contact 292 of relay SS^1. It will be noted that each of the other way stations have similar circuits for shunting the succeeding transfer relays out of the circuit.

The de-energization of relays $TRAN^3$ and SS^3 reroute the stick circuit of the relay OSS^3 through a back contact of relay $TRAN^3$. This stick circuit of relay OSS^3 is traced as follows:—from positive terminal of indicated source having suitable potential, through relay OSS^3, wire 94, front contact 46 of relay OSS^3, wire 29, front contact 96 of relay IN^3, wires 169 and 293, back contact 170 of relay $TRAN^3$, wire 171, negative contact 172 of relay $TRAN^3$, to the common wire 200.

As soon as the contacts of relay RE assume a fully de-energized position, a positive impulse being placed on the relay OPR, a circuit is completed which places positive potential upon the transfer wire 201. Positive potential upon the transfer wire 201, energizes the relays $TRAN^0$ and $TRAN^1$ in such a manner that the polar contacts are energized to a positive position before their neutral contacts assume an energized position, which is the natural characteristic of polar neutral relays. With the polar contacts of relay $TRAN^1$ in a positive position the relay SS^1 cannot be

picked up, hence the transfer relays $TRAN^2$ and $TRAN^3$ are shunted out of the transfer line circuit. Also, with the polar contacts of relay $TRAN^1$ in positive position, the relays S^1 is energized as soon as the natural contacts of said relay $TRAN^1$ have assumed an energized position. The energization of relay S^1 permits the energization of relay SS^1 when the relay $TRAN^1$ is de-energized. Such a combination results, that once the transfer relay $TRAN^1$ has been energized with a positive impuse and again de-energized, then the relays S^1 and SS^1 are energized and held in energized positions through their own stick circuits, which are not broken until the transfer relay $TRAN^2$ has been again energized with a negative impulse. The operation and function of the transfer group at other way stations is identical with the operation and function of the transfer group at the first way station.

The circuit for placing the positive potential upon the transferred wire 201 is traced as follows:—from the positive terminal of battery BT^1, through the resistances VRR^a and VRR^b, through the automatic cut-out A^0, back contact 75, wire 76, positive contact 73 of relay OPR, to the transfer wire 201 through transfer relay $TRAN^0$, transfer wire to the first way station, through transfer relay $TRAN^1$, to the common wire 200. This positive impulse energizes the transfer relays $TRAN^0$ and $TRAN^1$, so that their polar contacts assume a positive position and their neutral contacts assume an energized position. With the relay $TRAN^0$ thus energized a circuit is completed for energizing the station selecting relay ST^1, being traced as follows:—from the positive terminal of indicated source having suitable potential, positive contact 77 and front contact 78 of relay $TRAN^0$, wire 79, positive contact 74, wire 80, back contact 153, wire 81, relay ST^1, wire 82, back contact 83, wires 84 and 287 back contact 85, wires 289, 215 and 86, positive contact 87 of relay $TRAN^0$, to the common wire 200. Thus, the station selecting relay ST^1 is energized completing a stick circuit, which is traced as follows:—from positive terminal of indicated source having suitable potential, through front contact 88 of relay ST^1, relay ST^1, wire 82, through a circuit heretofore traced to the common wire 200.

The cycle checking relay CK^1 is energized at the same time that the station selecting relay ST^1 is energized, due to the fact, that both energizing circuits are carried through the positive contact 87 of relay $TRAN^0$. This circuit which energizes the relay CK^1 also holds, it in an energized position until the first cycle has been completed, as well as furnishing the energy for the stick circuit of the relay IN^0. This energizing circuit of relay CK^1 is traced as follows:—from positive terminal of indicated source having suitable potential, through relay CK^1, wire 163, front contact 164, wires 167, 165, 215 and 86, positive contact 87 of relay $TRAN^0$, to the common wire 200. Through the contacts of relay CK^1 in an energized position, the stick circuit for the relay IN^0 is traced as follows:—from the positive terminal of indicated source having suitable potential, through upper winding of relay CR, wire 33, relay IN^0, wires 34 and 35, front contact 47 of relay IN^0, wire 48, front contact 49 of relay CK^1, wire 163, front contact 164 of relay IN^0, wires 167, 165, 215 and 86, positive contact 87 of relay $TRAN^0$, to the common wire 200.

At the same time, that the station selecting relay ST^1 in the dispatcher's office is energized, the station relay S^1 at the first way station is energized due to the energization of the transfer relay $TRAN^1$. The relay S^1 is energized through a circuit traced as follows:—from positive terminal of indicated source having suitable potential, through front contact 89 of relay $TRAN^1$, wire 90, relay S^1, wires 91 and 290, positive contact 25 of relay $TRAN^1$, to the common wire 200. Immediately, upon energization of relay S^1, its stick circuit is closed, being traced as follows:—from positive terminal of indicated source having suitable potential, through front contact 92 of relay S^1, wire 93, relay S^1, wires 91 and 290, positive contact 25 of relay $TRAN^1$, to the common wire 200.

At the time that the relays ST^1 and S^1 are energized a message circuit is completed which allows the OS indication at the first way station, shown in Fig. 1C, to be transmitted to the dispatcher's office. This message channel is traced as follows:—from negative terminal of indicated source having suitable potential, through back contact 156 of relay OSS^1, wire 97, back contact 98 of relay A^1, wire 99, back contact 100 of relay B^1, wire 101, back contact 102 of relay C^1, wire 103, back contact 104 of relay SS^1, wire 105, front contact 106 of relay S^1, wire 107, positive contact 108 and front contact 109 of relay $TRAN^1$, wire 280, to the message wire 203, to the dispatcher's office, back contact 41 of relay ST^3, wire 40, back contact 39, wire 38, front contact 37, wire 110, back contact 111 of relay 3^1, wire 112, back contact 113, wire 114, back contact 115, wire 116, relay OS^1, to the common wire 200. The polar contact of relay OS^1 is thus energized to a negative position, allowing the indicator lamp I^1 to remain unilluminated, indicating to the dispatcher that there is no train occupying the track section TK^1.

As soon as, the relay ST^1 becomes energized, a circuit is completed, energizing the relay N which opens the stick circuit of relay P, closes its own stick circuit, and closes a circuit which will place negative potential upon the relay OPR as soon as the slow releasing relay P reaches a de-energized position.

This energizing circuit for the relay N is traced as follows:—from the positive terminal of indicated source having suitable potential, through front contact 53 of relay CR, wires 54 and 175, relay N, wires 176, 177 and 178, back contact 179, wire 180, and 181, front contact 182 of relay ST^1, wire 60, back contact 61, wire 62 and 185, back contact 63 to the common wire 200. The stick circuit for the relay N is traced as follows:—from positive terminal of indicated source having suitable potential, front contact 53 of relay CR, wires 54, and 175, relay N, wires 176 and 177, front contact 186 of relay N, wire 187, front contact 188 of relay P, to the common wire 200. Thus, there is a period of time between the end of the first positive impulse placed upon the transfer wire 201 and the beginning of the second positive impulse allowing sufficient time for the relay $TRAN^1$ to become de-energized thus picking up the relay SS^1. The energization of relay SS^1 allows the second way station to be selected as soon as the succeeding positive impulse is applied.

The relay SS^1 is energized through a circuit traced as follows:—from positive terminal of indicated source having suitable potential, through relay SS^1, wires 21 and 22, front contact 117, wire 118, back contact 119, to the common wire 200. Thus the relay SS^1 is energized which completes a stick circuit traced as follows:—from positive terminal of indicated source having suitable potential, through relay SS^1, wire 21, front contact 120 of relay SS^1, wire 121, front contact 122, wire 131, positive contact 130 of relay $TRAN^1$, to the common wire 200.

With the relay N energized and the relay P de-energized, negative potential is placed upon the relay OPR through a circuit traced as follows:—from negative terminal of indicated source having suitable potential, through lower winding of relay CC, wire 123, back contact 124 of relay P, wire 125, front contact 126 of relay N, wire 71, relay OPR, to the common wire 200. Thus, the contacts 73 and 74 of relay OPR are energized to a negative position, thus, placing a positive impulse upon the transfer wire 201, and also a positive impulse on wire 127 energizing the relay ST^2 through a circuit traced as follows:—from positive terminal of indicated source having suitable potential, through positive contact 77 and front contact 78 of relay $TRAN^0$, wire 79, negative contact 74, wire 127, front contact 128 of relay ST^1, wire 129, relay ST^2, wires 288 and 287, back contact 85, wires 289, 215 and 86, positive contact 87 of relay $TRAN^0$, to the common wire 200.

With the contact 73 of relay OPR in a negative position, a positive impulse is placed on the transfer wire 201 energizing the relays $TRAN^1$ and $TRAN^2$. With relay $TRAN^2$ energized, the relay S^2 is energized through a circuit identical with the energizing circuit of relay S^1 heretofore traced. It is likewise, in a similar manner held in an energized position through a stick circuit.

With the relays ST^2 in energized positions, a message channel is set up which allows the OS indication of the second way station to be transmitted to the dispatcher's office. This message channel is traced as follows:—from negative terminal of indicated source having a suitable potential, through back contact 132 of relay OSS^2, wire 133, back contact 134 of relay A^2, wire 135, back contact 136 of relay B^2, wire 137, back contact 138 of relay C^2, wire 139, back contact 140 of relay SS^2, wire 141, front contact 142 of relay S^2, wire 143, positive contact 144, and front contact 145 of relay $TRAN^2$, wire 242 to the message wire 203, to the dispatcher's office, back contact 41 of relay ST^3, wire 40, front contact 39, wire 146, back contact 147, wire 148, back contact 149, wire 150, back contact 151, wire 152, relay OS^2, to the common wire 200. Thus the relay OS^2 has its polar contact energized to a negative position, leaving the indicated lamp I^2 unilluminated which indicates to the dispatcher that the track section TK^3 is unoccupied.

As soon as the relay ST^2 becomes energized a circuit is completed, energizing the relay P which opens the stick circuit of relay N, closes its own stick circuit, and closes a circuit which will place positive potential on the relay OPR as soon as the slow releasing relay N reaches a de-energized position.

The energizing circuit for the relay P is traced as follows:—from positive terminal of indicated source having suitable potential, through front contact 53 of relay CR, wires 54 and 55, relay P, wires 56, 189 and 190, back contact 191 of relay G^2, wires 193 and 194, front contact 195 of relay ST^2, wire 185, back contact 63 of relay ST^3, to the common wire 200.

During the time that there is no potential on the relay OPR there is no potential on the transfer wire thus allowing the relays $TRAN^0$, $TRAN^1$ and $TRAN^2$, to assume a de-energized position. With relay $TRAN^2$ in a de-energized position, its polar contacts in a positive position, and the relay S^2 in an energized position, the relay SS^2 is energized, through a circuit being exactly symmetrical with the circuit described for the relay SS^1.

When the positive potential is placed on the relay OPR, its contacts 73 and 74 assume a positive position and a positive impulse is placed on the transfer wire 201 and on the wire 80. Thus, the station selecting relay ST^3 is energized and the transfer relay $TRAN^3$ at the third way station is energized. The relay ST^3 is energized through a circuit traced as follows:—from positive terminal of indicated source having suitable potential, through positive contact 77, and front contact 78 of relay $TRAN^0$, wire 79, positive

contact 74 of relay OPR, wire 80, front contact 153, wire 154, relay ST^3, wires 166 and 86, positive contact 87 of relay $TRAN^0$, to the common wire 200. The energization of relay ST^3 closes a stick circuit through front contact 155. The energization of the relay $TRAN^3$ energizes the relay S^3 through circuits exactly symmetrical as traced for relay S^1. As the relays ST^3 and S^3 simultaneously assume energized positions, a message channel is completed for transmitting an OS indication from the third way station to the dispatcher's office.

Inasmuch as, a train is assumed to be in the track section TK^4, the relay TR^3 is de-energized and the relay OSS^3 is energized, thus a positive potential is placed upon the message channel. The message channel for the OS of the third station is traced as follows:—from the positive terminal of indicated source having suitable potential, through front contact 156, wire 157, back contact 158 of relay SS^3, wire 159, front contact 160 of relay S^3, wire 161, positive contact 44 and front contact 43 of relay $TRAN^3$, wire 42, to the message wire 203 to the dispatcher's office, front contact 41, wire 162, relay OS^3, to the common wire 200. Thus, the relay OS^3 has its polar contact energized to its positive position, illuminating the indicator lamp I^3 with suitable potential as is obvious from the accompanying drawings. Hence, the presence of the train upon the track section TK^4 is transmitted to the dispatcher's office and indicated to the dispatcher by the illumination of indicator lamp I^3.

When the relay $TRAN^3$ is energized with a positive impulse the stick circuits for the relays OSS^3 and IN^3, as heretofore traced, are broken. Thus, during the time that the relay OSS^3 is being de-energized, the OS indication must be transmitted, which requires that the releasing time of an OS storing relay, and relay OSS^3 in particular, must have a release period greater than the sum of the pick up periods of the relays $TRAN^3$ and S^3.

Also, the relay IN^3 must have a release period less than the sum of the pick-up periods of the relays $TRAN^3$ and S^3, and greater than the drop away period of the relay $TRAN^3$. In other words, when the system is at rest, the relay IN^3 has a stick circuit, (as heretofore traced) which is closed through front contact 32 of relay SS^3, but when the system is initiated and begins operation the neutral armature of relay $TRAN^3$ drops away closing the stick circuit of relay IN^3 through back contact 170 of relay $TRAN^3$, and opening the stick circuit at front contact 32 of relay SS^3. However, the relay SS^3 is slightly slow releasing so that, as the stick circuit for relay SS^3 when the system is at rest is closed through front contact 170 of relay $TRAN^3$, and the stick circuit of relay IN^3 is closed through the said back contact 170, then the time consumed by the contact 170 to change from an energized to a de-energized position is consumed by the release period of relay SS^3. But to insure that the relay IN^3 shall not drop away in case the release period of SS^3 was not sufficiently long enough, the relay IN^3 should have a release period greater than the release period of relay $TRAN^3$. Now as the control is transferred from one way station to another way station, the stick circuit for the relay IN^3 is opened as soon as the contact 170 of relay $TRAN^3$ is energized and is not again closed, until the relay S^3 has been energized, the relay $TRAN^3$ de-energized and the relay SS^3 energized. Thus if the release period of relay IN^3 is less than the sum of the pick up periods of relay $TRAN^3$ and S^3, there is sufficient time allowed in the release period of relay $TRAN^3$ and the pick up period of relay SS^3 to insure that the relay IN^3 is entirely dropped away. Also, as soon as control is transferred from this way station, the stick circuit for relay IN^3 is closed at the contact 32 of relay SS^3 that should the OS-ing conditions change, the circuits would again be ready to stick relay IN^3 energized.

Although, the relay IN^3 is de-energized, the relay OSS^2 is still energized, due to the fact that the track relay TR^3 is still de-energized. Hence, it is seen that, after the first time that the system is initiated, due to the presence of an OS indication, that it is not again initiated, although that track section is still occupied. In other words, so long as a train remains upon the same track section the system operates through two cycles only.

It is to be understood that the transfer relay $TRAN^0$ has the same operating time characteristic as all other transfer relays and that the station selecting relays ST^1, ST^2 and ST^3 have the same operating characteristics as the relays S^1, S^2 and S^3. Thus, the slow release periods of the relays N and P allow plenty of time for the transmission of OS indications, as corresponding station selecting relays and station relays have been energized before another condition is set up, even through the station selecting relays immediately close circuits to positively cause the next condition in sequence to occur.

With the energization of relay ST^3, a circuit is closed for energizing the re-set relay RE. This circuit for energizing said relay RE is traced as follows:—from positive terminal of indicated source having suitable potential, through relay RE, wires 15 and 173, switch TTS in its present normal position, wire 174, front contact 63 of relay ST^3 to the common wire 200. The energization of the re-set relay RE, places negative potential upon the transfer control wire 201, which energizes the polar contacts of all transfer relays to a negative position and their neutral contacts to an energized position establish-

ing the "at rest" condition for the way stations only.

The movement of the polar contacts of relay $TRAN^0$ to a negative position opens, the stick circuit for the relays CK^1, IN^0 and ST^3, which immediately drop. The relay P is still in an energized position due to the fact, that its stick circuit has not been opened, so that, as soon as the re-set relay RE assumes a de-energized position as its energizing circuit is opened by the de-energization of relay ST^3, a positive impulse will be placed upon the transfer line 201. Thus, with the contacts 73 and 74 of the relay OPR in a positive position, positive potential is placed on the transfer relays $TRAN^0$ and $TRAN^1$ and the station selecting relay ST^1. The system then proceeds to operate in a sequential manner as heretofore described for the first cycle, successively placing the way stations under control of the dispatcher's office.

It will be noted here, that the voltage regulating relays VR^1 and VR^2 are energized by the energization of station selecting relays ST^1 and ST^2 respectively. The relay VR^1 is energized through a circuit traced as follows:—from the positive terminal of indicated source having suitable potential, through relay VR^1, wire 183, front contact 182 of relay ST^1, wire 60, back contact 61 of relay ST^2, wires 62 and 185, back contact 63 of relay ST^3, to common wire 200. The energizing circuit for the relay VR^2 is traced as follows:—from positive terminal of indicated source having suitable potential, through relay VR^2 wire 196, front contact 195 of relay ST^2, wire 185, back contact 63 of relay ST^3 to the common wire 200.

It will be noted, that the circuit for energizing the transfer relays $TRAN^0$ and $TRAN^1$ connected in series is carried through the resistances VRR^a and VRR^b. When the relay ST^1 is energized, closing the energizing circuit for relay VR^1, the resistance VRR^b is shunted out so that the circuit for energizing the transfer relays $TRAN^0$, $TRAN^1$ and $TRAN^2$ is traced as follows:—from the positive terminal of battery BT^1, through wires 197 and 198, front contact 199 of relay VR^1, wire 204, resistance VRR^a, wire 207, through the automatic cut-out A^0, wire 208, back contact 75 of relay RE, wire 76, to the contact 73 of relay OPR, through the transfer wire 201 and relay mechanisms to the common wire 200 as heretofore explained. When the relay ST^2 is energized, energizing the relay VR^2, the resistance VRR^a is shunted out energizing the transfer relays $TRAN^0$, $TRAN^1$, $TRAN^2$, and $TRAN^3$, through a circuit traced as follows:—from a positive terminal of battery BT^1, through wire 197, front contact 205 of relay VR^2, wires 206 and 207, automatic cut-out A^0, wire 208, back contact 75 of relay RE, wire 76, to the contact 73 of relay OPR, to the transfer wire 201 as heretofore explained. The relay VR^1 is made to have a slow releasing period so that the shunting of resistance VRR^a is accomplished before the shunt for resistance VRR^b is opened. In this manner, additional voltage is applied, as additional transfer relays are placed in the series transfer circuit.

The second cycle of operation is the same as the first cycle, except the energization of the cycle checking relay CK^2 which takes place immediately upon the energization of the relay $TRAN^0$ for selecting the first way station. During the second cycle the relay IN^0 is de-energized, so that a circuit is completed for energizing the relay CK^2 as soon as the relay $TRAN^0$ has become energized. This circuit for energizing relay CK^2 is traced as follows:—positive terminal of indicated source having suitable potential, through relay CK^2, wire 211, back contact 164 of relay IN^0, wires 167, 165, 215 and 86, positive contact 87 of relay $TRAN^0$ to the common wire 200. The energization of relay CK^2, re-routes the stick circuit of the relay CR, which is traced as follows:—from the positive terminal of indicated source having suitable potential, through the lower winding of relay CR, front contact 50 of relay CR, wire 51, front contact 52 of relay CK^2, wires 168, 165, 215 and 86, positive contact 87 of relay $TRAN^0$, to the common wire 200.

It is now easily understood that, as soon as the relay ST^3 is energized, energizing the relay RE, and in turn energizing the relay $TRAN^0$ with negative potential, the stick circuit for the relay CR is opened at the contact 87 of relay $TRAN^0$. With the de-energization of relay CR, the relay CK^2 is de-energized and the stick circuit for the relays N and P is opened. Also, the energizing circuit for the relay RE is maintained, thus, holding the system in the "at rest" or normal condition, as heretofore described.

Transmission of control impulses.—Now let us assume that, the train which OS-ed at the signal SW^3, has now proceeded to the west end of track section TK^4, and is ready to accept either signal SW^3 or SW^4. The dispatcher, desiring to route this train upon the passing siding PS, must reverse the track switch TS^2 and clear the signal SW^4, which he may do by moving the levers SML^2 and SL^2 to left hand positions. However, for convenience in describing the operation of the system in response to the movement of a control lever, the various functions and operations of the system will be described first for the lever SML^2 moved to a left hand position.

The lever SML^2 is moved to a left hand position, during the movement of which, the contact 12, mechanically connected to lever SML^2, completes a momentary circuit for energizing the relay G^2. This momentarily made circuit, which is completed when any

control lever for the second way station is moved to new position, has two functions, namely, first to register that a control lever for that particular way station has been moved to a new position, which is accomplished by the energization of a group selecting relay, such as relay G^2; second, to initiate the system, which is accomplished by having make-before-break contacts on the group selecting relay controlling circuits in such a manner, that, when said group selecting relay is energized, that these make-before-break contacts momentarily complete a circuit for energizing the initiating relay IN^0 and the control relay CR.

With the initiating relay IN^0 and the control relay CR, both energized, the system operates to transfer the dispatcher's control from one way station to the next way station in the usual manner, until the way station is reached to which a control impulse is to be transmitted, which station, is determined by the energization of its group selecting relay, which in this particular case is relay G^2. After the station selecting relay ST^2 is energized, a potential would ordinarily be placed on relay P for effecting the transfer of control to the next way station. However, with relay G^2 energized, this potential does not go to relay P, but is given to the starting relay ST^0, which causes the stepping impulse group to operate and place alternate positive and negative impulses upon the stepping line 202, which cause the relays 1^2, 2^2, and 3^2 in the dispatcher's office to operate sequentially and in synchronism with the relays A^2, B^2 and C^2 at the second way station. As soon as these relays have completed their sequential operation, the relay 3^2 completes a circuit for energizing the stopping relay STP, which causes the stepping impulses to immediately cease. At the same time, a potential is placed on either relay CC^1 or relay CC^2 depending upon the position of contact 72 of relay CC, which contact is in a position as determined by the polarity of potential then placed upon relay OPR for selecting the way station then under control. The potential is placed upon the relay CC^1, in this particular illustration, due to the contact 72 of relay CC being in a negative position, which energizes the contacts of relay CC^1, so that its stick circuit is closed, as well as a circuit for energizing the relay P. This circuit for energizing the relay P is continued, until the next way station has been selected, at which time the system operates to select further way stations in the normal OS-scanning manner as heretofore described. Instead of re-routing the potential, which holds the starting relay ST^0 energized, to effect the next transfer impulse, it is cut off by the stopping relay STP so that said potential will produce the energization of relay ST^0 during the second cycle of operation.

The second cycle of operation is similar to the first, at the end of which the control relay CR is de-energized, which opens the stick circuit for the group selecting relay G^2. During the de-energization of relay G^2, a momentarily made circuit re-energizes the initiating relay IN^0. This causes the system to further operate through two complete cycles, insuring that all control indications and OS indications have been brought up to date, which is particularly desirable in systems where OS indications giving the positions of controlled mechanisms are used.

More specifically, the lever SML^2 being moved to a left hand position, results in a momentarily made circuit for energizing the relay G^2, being traced as follows:—from the positive terminal of indicated source having suitable potential, through relay G^2, wires 215 and 216, contact 12, to the common wire 200. The energization of relay G^2, results in a momentarily made circuit for energizing the relays IN^0 and CR, which may be traced as follows:—from positive terminal of indicated source having suitable potential, through upperwind of relay CR, wire 33, relay IN^0, wires 34, 217 and 218, make before break contact 219, to the common wire 200. As the momentarily made circuit for energizing the relays IN^0 and CR, is completed while the relay G^2 is but partly energized, and also relay G^2 is slightly slow releasing, then the relay CR has time to reach an energized position to close the stick circuit for relay G^2, being traced as follows:—from positive terminal of indicated source having suitable potential, through relay G^2, wire 223, front contact 220, wires 221 and 222, front contact 17 of relay CR, to the common wire 200.

With the energization of the initiating relay IN^0 and the control relay CR, the system is initiated as heretofore described, and the system operates to select the first way station, automatically picking up the OS indication at that way station, and automatically leaving the first way station to place control over the second way station. Thus far, the automatic control of the system is identical with the operation heretofore described. However, as soon as the second way station is selected the OS indication is transmitted to the dispatcher's office indicating that the track section TK^3 is still unoccupied, during which time, the energization of relay ST^2 in the dispatcher's office has completed a circuit for initiating the impulses to be placed upon the stepping wire 202, used to operate the control impulse message channel selecting relays.

In response to the energization of relay ST^2 a circuit is completed for energizing the relay ST^0 instead of transferring to the third way

station, because the relay G^2 is energized and remains energized through its stick circuit. This circuit for energizing relay ST^0 is traced as follows:—from positive terminal of indicated source having suitable potential, through relay ST^0, wire 227, back contact 228 of relay STP, wires 229 and 224, front contact 191 of relay G^2, wires 193 and 194, front contact 195 of relay ST^2, wire 185, back contact 63 of relay ST^3, to the common wire 200.

The energization of relay ST^0 places potential upon the relay MR in accordance with the position of relay S^b, which is in a position in accordance with the position of relay S^a, with said relay S^a in a position in accordance with the last position to which the relay MR has been operated. The non-mechanical rotation of the relays MR, S^a and S^b is explained in great detail in pending application of F. B. Hitchcock et al. Ser. No. 345,667, filed March 9, 1929. This reference application, also, describes the manner in which the message sent over message channels, may be placed upon the channel during a central period of time. The same principle of controlling the message circuits may be used in the present invention but for the sake of clearness and simplicity has been omitted.

With the contact 230 of relay ST^0 in an energized position, and conditions as assumed, the relay MR places positive potential upon the stepping wire 202 through a circuit traced as follows:—from positive terminal of battery BT^3, through positive contact 231 of relay MR, wire 232, relay S^a, wire 233, relay L^0, through the stepping wire 202 to the first way station, through wire 234, front contact 235 of relay SS^1, wire 236, through the stepping wire 202 to the second way station, through relay L^2, wire 237, back contact 238 of relay SS^2, to the common wire 200. It is assumed that the relay S^a responds to the positive impulse and relay S^2 is energized with a negative impulse, thus energizing relay MR with a negative impulse, as explained in application Ser. No. 345,667, and obvious from the drawings. With contact 231 of relay MR in a negative position, a negative impulse is placed upon the stepping wire 202 from the battery BT^4 through the circuit heretofore traced. Thus, each time that the contact 231 of relay MR moves to a positive position, a positive impulse is placed upon the stepping wire 202 and moves the relay S^a to a new position, which in turn moves the relay S^b to a new position, which in turn energizes the relay MR to an opposite position. This non-mechanical rotation of the stepping impulse generating group continues so long as the circuit for the relay MR is completed.

The stepping impulses placed upon the stepping wire 202 are repeated by the line relay L^0 in the dispatcher's office, and by line relay L^1 at the first way station, when the first way-station is selected for control impulses. When the second way station is selected, the line relay L^2 repeats these stepping impulses but the line relay L^1 does not operate due to the fact that it is shunted out through a circuit heretofore traced. It is thus seen, that whenever a station is selected for receiving control impulses, the relays S^a and L^0 operate in series with the line relay of the particular way station then selected.

The energization of relay ST^1 selects the control impulse message channel selecting relay bank composed of relays 1^1, 2^1 and 3^1 so that they are sequentially operated when the line relay L^0 is operated. Also, when the relay ST^2 is energized the control impulse message channel selecting relay bank composed of relays 1^2, 2^2 and 3^2 are selected so that they operate sequentially when the line relay L^0 is operated. Thus, it is seen that the station selecting relay ST^1 selects the message channel relay bank of way station one, and the station selecting relay bank ST^2 selects the message channel selecting relay bank for way station two.

As the relay ST^2 is now energized and the contact 239 of relay L^0 moves to a positive position then a circuit is completed for energizing relay 1^2 being traced as follows:—from positive terminal of indicated source having suitable potential, through positive contact 239 of relay L^0, wires 248 and 249, back contact 307 of relay 2^2, wire 306, through relay 1^2, wire 250, back contact 251, wires 252 and 253, back contact 254, wires 255 and 256, front contact 61 of relay ST^2, wires 62 and 185, back contact 63, to the common wire 200. With contact 294 of relay 1^2 in an energized position, a stick circuit is closed for said relay 1^2, being traced as follows:—from positive terminal of indicated source having suitable potential, through front contact 294, wire 295, relay 1^2, wire 250, back contact 251 of relay 2^2, wires 252 and 253, back contact 254, of relay 3^2, wires 255 and 256, front contact 61 of relay ST^2, wires 62 and 185, back contact 63 of relay ST^3, to the common wire 200.

The relay A^2 at the second way station is energized by the movement of contact 240 of relay L^2, to a positive position, through a circuit traced as follows:—from positive terminal of indicated source having suitable potential, through positive contact 240 of relay L^2, wire 310, back contact 311 of the relay B^2 wires 257 and 297, through relay A^2, wire 259, back contact 260, wires 261 and 262, back contact 263, wires 264, 265 and 266, positive contact 267, to the common wire 200. With contact 296 of relay A^2 in an energized position, a stick circuit is closed for said relay A^2, being traced as follows:—from positive terminal of indicated source having suitable potential, through front contact 296 of relay A^2, wire 297, relay A^2, wire 259, back contact 260 of relay B^2, wires 261 and 262, back con-

tact 263 of relay C^2, wires 264, 265 and 266, positive contact 267 of relay $TRAN^2$, to the common wire 200.

With the energization of relay 1^2 and A^2 a message channel is set up which allows negative potential to be placed upon the switch machine relay SMR^2 in accordance with the position of the lever SML^2, which at this time is in a left hand position. This message channel for the switch machine relay SMR^2 is traced as follows:—from negative terminal of indicated source having suitable potential, through lever SML^2, through wire 241, front contact 151 of relay 1^2, wire 150, back contact 149, wire 148, back contact 147, wire 146, front contact 39 of relay ST^2, wire 40, back contact 41, to the message wire 203 to the second way station, through wire 242, front contact 145. and positive contact 144 of relay $TRAN^2$, wire 143, front contact 142 of relay S^2, wire 141, back contact 140 of relay SS^2, wire 129, back contact 138 of relay C^2, wire 137, back contact 136 of relay B^2, wire 135, front contact 134, of relay A^2, wire 243, relay SMR^2, to the common wire 200. This negative potential placed upon the relay SMR^2 moves its polar contact to a negative position, thus controlling the switch machine SM^2 in such a manner that the track switch TS^2 will be moved to a reverse position which will allow a train to pass onto the passing siding PS.

The movement of contact 231 of relay MR to a negative position, places a negative impulse upon the stepping wire 202 moving the contact 239 of relay L^0 to a negative position, completing a circuit for energizing relays 2^2 and B^2 respectively.

With contact 239 of relay L^0 in a negative position in response to a negative impulse placed upon stepping wire 202, and energizing circuit for relay 2^2 is completed, being traced as follows:—from positive terminal of indicated source having suitable potential, through negative contact 239, wire 267, front contact 268 of relay 1^2, wire 269, through relay 2^2, wires 270 and 253, back contact 254, wires 255 and 256, front contact 61 of relay ST^2, wires 62 and 185, back contact 63, to the common wire 200. With contact 298 of relay 2^2 in an energized position, a stick circuit is completed for relay 2^2, being traced as follows:—from positive terminal of indicated source having suitable potential, through front contact 298 of relay 2^2, wire 299, through relay 2^2, wires 270, and 253, back contact 254, of relay 2^2, wires 255 and 256, front contact 61 of relay ST^2, wires 62 and 185, back contact 63 of relay ST^3, to the common wire 200. The energization of relay 2^2 breaks the stick circuit of relay 1^2 at the back contact 251 of relay 2^2.

With the contact 240 of relay L^2 in a negative position, a circuit is completed for energizing relay B^2, being traced as follows:—from positive terminal of indicated source having suitable potential, through negative contact 240, wire 271, front contact 272, wire 273, through relay B^2, wires 192 and 262, back contact 263, wires 264, 265 and 266, positive contact 267 of relay $TRAN^2$, to the common wire 200.

With the contact 300 of the relay B^2 in an energized position a stick circuit is completed for relay B^2 being traced as follows:—from positive terminal of indicated source having suitable potential, through front contact 300, wire 301, relay B^2, wires 192 and 262, back contact 263 of relay C^2, wires 264, 265 and 266, positive contact 267 of relay $TRAN^2$, to the common wire 200. The energization of relay B^2 breaks the stick circuit of relay A^2 at the back contact 260 of relay B^2.

The movement of contact 231 of relay MR to a positive position, places a positive impulse upon the stepping wire 202, which is repeated by the line relays L^0 and L^2, which in turn energize relays 3^2 and C^2 respectively.

With contact 239 of relay L^0 in a positive position in response to a negative impulse placed upon the stepping wire 202, an energizing circuit for relay 3^2 is completed being traced as follows:—from positive terminal of indicated source having suitable potential, through positive contact 239 of relay L^0, wires 248 and 249, front contact 307 of relay 2^2, wire 308, relay 3^2, wires 309 and 256, front contact 61 of relay ST^2, wires 62 and 185, back contact 63 of relay ST^3, to the common wire 200. With contact 302 of relay 3^2 in an energized position, a stick circuit is completed for said relay 3^2 being traced as follows:—from positive terminal of indicated source having suitable potential, through front contact 302 of relay 3^2, wire 303, relay 3^2, wires 309 and 256, front contact 61 of relay ST^2, wires 62 and 185, back contact 63 of relay ST^3, to the common wire 200. The energization of relay 3^2 opens the stick circuit of relay 2^2 at the back contact 254 of relay 3^2.

With the contact 240 of relay L^2 in a positive position a circuit is completed for energizing relay C^2 being traced as follows:—from positive terminal of indicated source having suitable potential, through positive contact 240 of relay L^2, wire 310, front contact 311 of relay B^2, wire 312, relay C^2, wires 313 and 265 and 266, positive contact 267 of relay $TRAN^2$, to the common wire 200. With contact 304 of relay C^2 in an energized position, a stick circuit is completed of said relay C^2 being traced as follows:—from positive terminal of indicated source having suitable potential, through front contact 304, wire 305, relay C^2, wires 313, 265 and 266, positive contact 267 of relay $TRAN^2$, to the common wire 200. The energization of relay C^2 opens the stick circuit of B^2 at the back contact 263 of relay C^2.

As soon as the relay 3^2 is in an energized

position, a circuit is completed for energizing the relay STP, which stops the stepping impulse generating group of relays MR, S^a and S^b, and also at the same time, the relay 3^2 closes a circuit for energizing either relay CC^1 or relay CC^2 in accordance with the position of contact 72 of relay CC.

The circuit for energizing the relay STP is traced as follows:—from positive terminal of indicated source having suitable potential, through relay STP, wires 274, 275 and 276, front contact 254 of relay 3^2, wires 255 and 256, front contact 61 of relay ST^2, wires 62 and 185, back contact 63 of relay ST^3, to the common wire 200, thus the energy which held the contact 230 of relay ST^0 in an energized position, is broken at the contact 228 of the relay STP resulting in the discontinuation of the stepping impulses.

At this time the relay OPR is energized with negative potential through a circuit including the lower coil of relay CC, causing the contact 72 of relay CC to be in a negative position, which results in the energization of relay CC^1 through a circuit traced as follows:—from positive terminal of indicated source having suitable potential, through back contact 314 of relay CC^2, wire 315, relay CC^1, wires 316 and 277, negative contact 72 of relay CC, wires 278, 275 and 276, front contact 254 of relay 3^2, wires 255 and 256, front contact 61 of relay ST^2, wires 62 and 185, back contact 63, of relay ST^3, to the common wire 200. As soon as the contact 317 of relay CC^1 reaches a fully energized position the contact 72 of relay CC is shunted out by means of wire 318, front contact 317, wires 319 and 320, to the wire 278, thus completing a stick circuit for relay CC^1 so long as the relay ST^2 remains energized. With the contact 321 of relay CC^1 in an energized position a circuit is completed for energizing the relay P being traced as follows:—from positive terminal of indicated source having suitable potential, through front contact 53 of relay CR, wires 54 and 55, relay P, wires 56, 189 and 322, front contact 321 of relay CC^1 to the common wire 200.

With the relay P energized, the stick circuit for the relay N is opened, and the energizing circuit for the relay OPR is opened so that the contact 72 of relay CC and the contact 73 of relay OPR assume neutral positions, until the relay N becomes fully deenergized, at which time a positive impulse will be placed upon the relay OPR through circuits heretofore described. Thus the next way station in succession will be selected and the system will proceed under the normal OS-scanning operation.

In this particular embodiment of the present invention, the next way station in succession is the third and last way station, hence the energization of relay ST^3 results in the deenergization of the relay ST^2, which opens the circuits for relays CC^1, 3^2 and STP and closes the circuit for the reset relay RE. The system will now operate through the second cycle as heretofore described in a similar manner to the first cycle, at the end of which the control relay CR is deenergized which opens the stick circuit for the group selecting relay G^2. The deenergization of the relay G^2 completes a momentarily made circuit for reenergizing the relay IN^0, which results in the further operation of the system through two complete cycles, during which only OS indications are transmitted, unless some control lever has been moved in the meantime.

Let us now assume, that the system is again at rest and the dispatcher moves the lever SL^2 to a left hand position, as a result of which the system will be stepped along to such points in the cycles of sequential operation that control impulse message channels will be set up for controlling the relays DR^2 and SR^2.

The message channel for relay DR^2 is traced as follows:—from negative terminal of indicated source having suitable potential, through lever SL^2, wire 244, front contact 149 of relay 2^2, wire 148, back contact 147 of relay 3^2, wire 146, front contact 39 of relay ST^2, wire 40, back contact 41 of relay ST^3, to the message wire 203 to the second way station through wire 242, front contact 145 and positive contact 144 of relay $TRAN^2$, wire 143, front contact 142 of relay S^2, wire 141, back contact 140 of relay SS^2, wire 139, back contact 138 of relay C^2, wire 137, front contact 136 of relay B^2, wire 245, relay DR^2 to the common wire 200.

The message channel for the relay SR^2 is traced as follows:—from the positive potential terminal of indicated source having suitable potential, through positive contact 13, wire 246, front contact 147 of relay 3^2, wire 146, front contact 39 of relay ST^2, wire 40, back contact 41 of relay ST^3, to the message wire 203 to the second way station, through wire 242, front contact 145 and positive contact 144 of relay $TRAN^2$, wire 143, front contact 142 of relay S^2, wire 141, back contact 140 of relay SS^2, wire 139, front contact 138 of relay C^2, wire 247, relay SR^2, to the common wire 200.

The energization of relay DR^2 with negative potential effects the movement of its polar contact to a negative position and the placing of positive terminal on relay SR^2 effects the movement of its polar contact to a positive position, resulting in the clearing of signal SW^4, so that the train may pass onto track section TK^3 and over the passing siding PS.

If the synchronous selecting dispatching system as herein described comes to rest before the train enters track section TK^3, then the occupancy of track section TK^3 will initiate the system and cause it to operate

through two cycles of operation for transmitting the OS indication to the dispatcher's office. The transmission of this OS indication is accomplished through the system herein described over a message channel heretofore described, placing negative potential upon the relay OS^2, so that its polar contact assumes a positive position illuminating the indicator lamp I^2, announcing to the dispatcher that the train has passed onto track section TK^3. Immediately upon the exit of the rear end of the train from track section TK^4 the fact will be transmitted to the dispatcher by the placing of negative potential upon the relay OS^2 moving its polar contact to a negative position and extinguishing the illumination of indicator lamp I^3. Also, with the train completely on the passing siding, as it has cleared the following section of the passing siding, the fact will be transmitted to the dispatcher by energizing the relay OSS^2 with negative potential over a message channel heretofore described, resulting in the extinguishing of the illumination of indicator lamp I^2.

It is of course understood that the synchronous selector dispatching system operates in accordance with the preceding description, thus eliminating the necessity for further stating when the system is initiating and when it stops, assuming that the message channels are set up and that indications are transmitted in accordance therewith.

The dispatcher, desiring to route this train back onto the main track must reverse the track switch TS^1 and clear the signal SW^1, which may be accomplished by moving the levers SML^1 and SL^1 to left hand positions.

The message channel for the control of relay SMR^1 is traced as follows:—from negative terminal of indicated source having suitable potential, through lever SML^1 in a left hand position, wire 279, front contact 115 of relay 1^1, wire 114, back contact 113 of relay 2^1, wire 112, back contact 111 of relay 3^1, wire 110, front contact 37 of relay ST^1, wire 38, back contact 39 of relay ST^2, wire 40, back contact 41 of relay ST^3, to the message wire 203 to the first way station, through wire 280, front contact 109 and positive contact 108 of relay $TRAN^1$, wire 107, front contact 106 of relay S^1, wire 105, back contact 104, wire 103, back contact 102 of relay C^1, wire 101, back contact 100 of relay B^1, wire 99, front contact 98 of relay A^1, wire 281, relay SMR^1, to the common wire 200. Thus, the polar contact of relay SMR^1 is moved to a negative position resulting in the movement of track switch TS^1 to reverse position allowing the passage of the train onto the track section TK^1 and onto the main track as soon as the signal SW^1 shows a proceed indication.

The message channel for the relay DR^1 is traced as follows:—from negative terminal of indicated source having suitable potential, through lever SL^1 in a negative position, through wire 282, front contact 113 of relay 2^1, wire 112, back contact 111, of relay 3^1, wire 110, front contact 37 of relay ST^1, wire 38, back contact 39 of relay ST^2, wire 40, back contact 41 of relay ST^3, to the message wire 203 to the first way station, through wire 280, front contact 109, and positive contact 108 of relay $TRAN^1$, wire 107, front contact 106 of relay S^1, wire 105, back contact 104 of relay SS^1, wire 103, back contact 102 of relay C^1, wire 101, front contact 100 of relay B^1, wire 283, relay DR^1, to the common wire 200.

The message channel for the relay SR^1 is traced as follows:—from positive terminal of indicated source having suitable potential, through positive contact 10, wire 323, front contact 111 of relay 3^1, wire 110, front contact 37 of relay ST^1, wire 38, back contact 39 of relay ST^2, wire 40, back contact 41 of relay ST^3, to the message wire 203 to the first way station, through wire 280, front contact 109, and positive contact 108 of relay $TRAN^1$, wire 107, front contact 106 of relay S^1, wire 105, back contact 104 of relay SS^1, wire 103, front contact 102 of relay C^1, wire 324, relay SR^1, to the common wire 200.

With negative potential upon the relay DR^1 its polar contact is moved to a negative position, and with positive potential upon the relay SR^1 its polar contact is moved to a positive position, the combination of which, clears the signal SW^1, allowing the train to pass onto the main track. The passage of the train over the track section FS^1 and TK^1 results in an OS indication being transmitted to the dispatcher, which is accomplished by a positive potential being placed upon the relay OS^1 moving its polar contact to a positive position resulting in the illumination of indicator lamp I^1. As soon as the train is entirely on the track section TK^1 the indicator lamp I^1 becomes un-illuminated due to a negative potential being placed upon the relay OS^1.

The dispatcher may now return the control levers to their normal positions, or leave them in their present positions, allowing following trains to be routed over the same track, either of which may be done at the option of the dispatcher.

It will be stated here, that if the dispatcher moves one or more control levers at one time, then the system operates through two complete cycles for transmitting the control impulses, and through two complete cycles for clearing up all OS indications. Also, if one control lever is moved to a new position and then another is moved to a new position some time before the system comes to the end of the second cycle for transmitting control impulses, then the system is insured of at least one complete cycle of operation after the movement of the said second lever. The same

is true, should the second lever be thrown some time during the two cycles of operation for clearing the OS indications, or in other words during the third and fourth cycles.

Emergency transfer control.—Let us assume, that the third way station becomes inoperable, due to the fact, that the transfer line wire 201 between the second and third stations becomes severed, or open circuited. Then, after the selection of the second way station, the third way station cannot be selected because of open circuit, therefore the transfer relay TRAN^0 will not be energized. However, as the contact 77 of relay TRAN^0 has been assuming a positive position for the transfer from previous way stations and the contact 78 of relay TRAN^0 remains de-energized, then the indicator lamp I^0 will remain continuously illuminated as is obvious from the drawing showing Fig. 1B. The continuous illumination of said indicator lamp I^0 will make the operator aware of this fact and he will then cause the system to operate automatically for the first two way stations only, by moving the switch TTS from its present normal position to the dotted line position *a*. The system will now operate as formerly described with the exception of the elimination of the third way station.

In practice there would probably be more than three way stations, on the assumption of which, let us consider the effect of a short circuit from the transfer wire 201 to the common wire 200, somewhere between the second and third way stations. When the second way-station is selected, the additional voltage is applied for selecting the third way station, so that when the third way station is selected and the additional voltage for selecting the fourth way station is applied, there are two units of additional voltage applied to the transfer wire. By way of illustration, assuming that the additional units of voltage applied for the selection of each succeeding way station are equal, and that the automatic cut-out A^0 opens the circuit when one and one-half units of additional voltage are applied, then upon the selection of the fourth way station, the cut-out A^0 opens the circuit, de-energizing the relay TRAN^0 and causing the indicator lamp I^0 to be illuminated. The operator knowing that the system is arranged to stop on the selection of the way station beyond that one which is made inoperable by the short circuit, then turns the switch TTS to such a position that the system resets on the way station at which the short circuit trouble occurs thus giving the operator automatic control over the part of his system up to the trouble.

Where the additional units of voltages are not equal then the cut-out A^0 could be set to open the circuit upon some predetermined voltage greater than the largest unit added. Then, by closing the automatic cut-out A^0, inserting the ampere meter M in the circuit, and resetting the system, the operator could compare the readings obtained with a standard chart of readings and ascertain at what point the automatic cut-out A^0 opens, after which the operator may control the switch TTS accordingly.

Summary

Some of the basic principles will now be set forth, which have not been clearly brought out by explanation of the operation of the system.

It is highly desirable that all message channels be synchronized at the end of each cycle, which is an inherent characteristic of the present invention. By reference to Fig. 1C, it is seen that the last operated control impulse message channel selecting relay C^1 is held energized, until the system is reset or restored to the normal "at rest" condition, at which time its stick circuit is opened at the positive contact 25 of relay TRAN^1.

With this arrangement of circuits, it is seen, that, should the contact 235 of relay SS^1 fail and the line relay L^1 operate simultaneously with line relay L^2 at the second way station, the relays A^1, B^1 and C^1 could not be operated because of relay C^1 being held energized through a stick circuit. Also, the message channel circuit is open, due to the contact 104 of relay SS^1 being in an energized position. Again, failure in shunting the line succeeding the way-station under control, does no harm, as the polar contacts of the transfer relay are in negative positions, leaving the energizing circuit for the control indication message channel selecting relays open. Thus, a complete isolation of message channels is accomplished.

It is also noted, that synchronization of station selection is accomplished at the end of each cycle by the application of a negative impulse, regardless of whether some extraneous influence has caused the transfer control to be ahead or behind the station selecting relays ST^1, ST^2 and ST^3 in the dispatcher's office. If the transfer line 201 is sectionalized, the negative impulse on the first way station results in the energization of relay SS^1, causing the transfer line 201 to be made continuous to the second way station, which in turn results in the energization of relay SS^2 making the transfer line continuous to the third way station and so forth to the end of the line. If the control over the way station is ahead of the station selecting relays ST^1, ST^2 and ST^3, then when the end of the system is reached, nothing can happen until the apparatus in the dispatcher's office catches up, at which time the negative impulse resets the system for the normal "at rest" period.

It is also noted, that there are no contacts in the transfer line circuit, and that all transferring functions are made continuously

effective, after control at a particular station has ceased, by energized stick relays. This means greater assurance of operation for the way stations farthest away from the dispatcher's office. By way of illustration, the contact of relay SS which shunts the line relay L is a front contact, which is not likely to be opened by the vibrations of a passing train, as might a back contact.

As the apparatus in the dispatcher's office is the automatic control of the system, the way stations are spoken of as keeping in synchronism with it, hence, the action of the automatic central office control must be positive in action, which is another inherent feature of the present invention.

Although the specific embodiment shown, illustrates the automatic control and transfer equipment for scanning a single OS indication at each way station, it is to be understood that where more than one OS indication is to be transmitted from one way station, that the system may either be adapted to operate through the OS channels each cycle, or a test circuit, such as set forth in a pending application by N. D. Preston Ser. No. 348,336, filed March 19, 1929, may be incorporated without departing from the present invention.

Having thus shown, and described, one specific embodiment of a rather involved and comprehensive system for carrying out certain functions, it is desired to be understood that the particular arrangement of devices and circuits illustrated need not be adhered to, but that many changes, modifications and additions may be made, in the individual devices as well as in their co-ordination with each other, without departing from the scope or spirit of the invention as demanded by the scope of the appended claims.

What I claim is:—

1. In a train dispatching system of the synchronous counting relay type, the combination with a dispatcher's office and a plurality of way stations, station selecting means at each way station, a series of station selecting counting relays in the dispatcher's office one relay for each way station, a message wire, an OS channel circuit for each way station rendered available when such way station is selected and its counting relays are inactive including contacts of the station selecting means and a station selecting counting relay, a group of channel selecting counting relays at each way station, a corresponding group of channel selecting counting relays at the dispatcher's office, said station selecting means, station selecting counting relays and channel selecting relays being normally at rest, means for initiating said way station selecting means and way station selecting counting relays when a changed condition at a way station is to be manifested at the dispatcher's office, and means for causing the channel selecting relays at a particular way station, when selected, to operate being rendered active in response to the operation of a control lever in the dispatcher's office.

2. In a train dispatching system of the synchronous counting relay type, a dispatcher's office, a plurality of way stations, station selecting means at each way station, apparatus at the dispatcher's office for controlling said station selecting means to render channel circuits passing through such way stations available for use, means at the dispatcher's office for indicating failure of operation of a station selecting means, and means at the dispatcher's office manually operable to alter said apparatus at the dispatcher's office for controlling said station selecting means for operating said station selection means and said apparatus only for the way stations between the dispatcher's office and the point of failure.

3. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, the combination with a dispatcher's office and a plurality of way stations, of a transfer line connecting said dispatcher's office and said way stations, a four condition polar transfer relay at each way station, a stepping line connecting said dispatcher's office and each of said way stations, line relays connected in series in said stepping line one line relay for each way station, and means for rendering said line relays active to control their associated apparatus one at a time sequentially by alternate application and removal of positive potential on said transfer wire including two interconnected slow-dropping relays the time of dropping of which determines the period of time during which said transfer line is de-energized and the time of energization of which determine the period of time a particular way station is selected.

4. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, the combination with a dispatcher's office and a plurality of way stations, of a transfer line connecting said dispatcher's office and said way stations, a four condition polar transfer relay at each way station, a stepping line connecting said dispatcher's office and each of said way stations, line relays connected in series in said stepping line one line relay for each way station, means for rendering said line relays active to control their associated apparatus one at a time sequentially by alternate application and removal of positive potential on said transfer wire including two interconnected slow-dropping relays the time of dropping of which determines the period of time during which said transfer line is de-energized and the time of energization of which determines the period of time a par-

ticular way station is selected, and a group relay rendered active when a particular way station is selected for increasing the period of time during which one of said slow-dropping relays is energized.

5. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, the combination with a dispatcher's office and a plurality of way stations, of a transfer line connecting said dispatcher's office and said way stations, a polar-neutral transfer relay at each way station, a stepping line connecting said dispatcher's office and each of said way stations, line relays connected in series in said stepping line one line relay for each way station, means for rendering said line relays active to control their associated apparatus one at a time sequentially by alternate application and removal of positive potential on said transfer wire including two interconnected slow-dropping relays the time of dropping of which determines the period of time during which said transfer line is de-energized and the time of energization of which determines the period of time a particular way station is selected, a group relay rendered active when a particular way station is selected for increasing the period of time during which one of said slow-dropping relays is energized, and means for restoring the condition of said line relays to normal responsive to the application of negative potential to said transfer line.

6. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, the combination with a dispatcher's office and a plurality of way stations, of a stepping line including a plurality of line relays one for each way station and all connected in series and the most distant relay connected to a common return wire, means for placing said stepping line and line relays in their reset condition in which each element of the stepping line connecting two adjacent line relays is connected by a shunt to said common return wire, and means for successively removing said shunts and shunting said line relays individually in a manner to leave one relay unshunted, whereby said line relays are rendered active successively one at a time.

7. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, the combination with a dispatcher's office and a plurality of way stations, of a stepping line including a plurality of line relays one for each way station and all connected in series and the most distant relay connected to a common return wire, means for placing said stepping line and line relays in their reset condition in which each element of the stepping line connecting two adjacent line relays is connected by a shunt to said common return wire, two stations selecting relays at each way station the first of which if energized renders the line relay at such way station active and the second of which if energized renders such line relay inactive even though said first station selecting relay is energized, and means for successively energizing said station selecting relays.

8. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, the combination with a dispatcher's office and a plurality of way stations, of a stepping line including a plurality of line relays one for each way station and all connected in series and the most distant relay connected to a common return wire, means for placing said stepping line and line relays in their reset condition in which each element of the stepping line connecting two adjacent line relays is connected by a shunt to said common return wire, a transfer line including a plurality of transfer relays one for each way station all connected in series and the most distant transfer relay connected to said common return wire, two normally de-energized station selecting relays at each way station controlled by the transfer relay of the corresponding way station the first of which when energized renders the associated line relay active and the second of which if de-energized makes a connection to connect the transfer line between said way station and the next distant way station to said common return wire and which if energized breaks said connection and renders said line relay inactive, whereby repeated energization of said transfer line causes said line relays to be rendered active successively one at a time.

9. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, the combination with a dispatcher's office and a plurality of way stations, of a stepping line including a line relay for each way station connected with said stepping line, and the most distant line relay connected to a common return wire, means for connecting each element of the stepping line connecting two adjacent line relays by a shunt to said common return wire, whereby the line relay nearest the dispatcher's office may be rendered active, and means for successively removing said shunts and shunting said line relays individually, whereby as said line relays are successively and individually shunted, said line relay nearest the dispatcher's office which has not been individually shunted may be rendered active.

10. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, the combination with a dispatcher's office and a plurality of way stations, of a

stepping line including a line relay for each way station connected in series and the most distant line relay connected to a common return wire, and means for rendering said line relays active successively one at a time comprising, a transfer line including a plurality of transfer relays one for each way station all connected in series and the most distant transfer relay connected to said common return wire, two station selecting relays at each way station controlled by the transfer relay of the corresponding way station the first of which is energized when said transfer relay associated therewith is energized with positive potential but cannot be energized when said transfer relay is energized with the negative potential and the second of which is energized by the de-energization of said transfer relay after the energization of said transfer relay with positive potential, and which is energized when said transfer relay is energized by negative potential, means for continuing the energization of said station selecting relays after their energization following the energization and deenergization of said transfer relay by positive potential, means for discontinuing the energization of said first station selecting relay by energization of said transfer relay by a negative potential means for discontinuing the energization of said station selecting relays following the deenergization of said transfer relay by a negative potential, means for segregating said transfer line between said way station and the next distant way station when said second station selecting relay is deenergized, rendering said transfer relay at said station in an active condition, means for rendering said transfer line continuous when said second station selecting relay is energized, means for connecting the element of said stepping line connecting said line relay of said way station to the line relay at the next distant way by a shunt to said common return wire when said second station selecting relay is deenergized, and means for removing said shunt and shunting said line relay individually when said second station selecting relay is energized, whereby repeated energization of said transfer line by positive potential causes said line relays to be rendered active successively one at a time, and whereby energization of said transfer line by negative potential causes a reset condition which makes possible another cycle of successive selection of said line relays one at a time.

11. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, the combination with a dispatcher's office and a plurality of way stations, of a transfer line connecting said dispatcher's office and said way stations, a polar neutral transfer relay at each way station connected in series with said transfer line, a stepping line connecting said dispatcher's office and each of said way stations, a line relay at each way station connected in series with said stepping line, means for rendering said line relays active to control their associated apparatus one at a time successively by the alternate application and removal of positive potential on said transfer wire including two interconnected slow-dropping relays the time of dropping of which determines the period of time during which said transfer line is deenergized and the time of energization of which determines the period of time a particular way station is selected, an energized group relay rendered active when a particular way station is selected for preventing the energization of the next of said slow dropping relays to be energized until said line relay at said station has controlled its associated apparatus, and means for causing the energization of the next of said slow dropping relays to be energized without deenergization of said group relay.

12. In a train dispatching system of the synchronous counting relay type, a dispatcher's office, a plurality of way stations, station selecting means at each way station responsive to the application of positive potential for selecting said way station after the application of negative potential, non-responsive to the application of positive potential after a former application of positive potential, and responsive to the application of negative potential for establishing the normal at rest reset condition after one application or repeated applications of positive potential, and also after one application or repeated applications of negative potential, and apparatus at the dispatcher's office for controlling said station selecting means to render channel circuits passing through such way stations available for use.

13. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, the combination with a dispatcher's office and a plurality way stations, a transfer line connecting said dispatcher's office and said way stations, station selecting means at each way station, associated with said transfer line, whereby potentials of certain polarities in a particular sequence applied to said transfer line render said way stations selected one at a time and in predetermined sequence and render it possible to repeat said predetermined sequential selection, and apparatus at said dispatcher's office for applying certain polarity potentials to said transfer wire for controlling said station selecting means to render channel circuits through such way stations available for use including two interconnected slow dropping relays either of which may be energized irrespective of the other, either of which closes its own stick circuit when the other is deenergized,

and either of which opens the stick circuit of the other when energized, a group relay at the dispatcher's office representing each way station rendered active when said way station is selected, which group relay either permits or prevents the energization of the next in sequence of said slow dropping relays to be energized according to whether or not channel circuits through such way station that said group relay represents, are to be made available for use, and means for causing the energizations of the next in sequence of said slow dropping relays to be energized in opposition to said group relay after said channel circuits for said station have been made available.

14. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, the combination with a dispatcher's office and a plurality of way stations, a transfer line connecting said dispatcher's office and said way stations, station selecting means at each way station, associated with said transfer line, whereby potentials of certain polarities in a particular sequence applied to said transfer line render said way stations selected one at a time and in predetermined sequence and render it possible to repeat said predetermined sequential selection, and apparatus at said dispatcher's office for applying certain polarity potentials to said transfer wire for controlling said station selecting means to render channel circuits through such way stations available for use including two interconnected slow dropping relays either of which may be energized irrespective of the other, either of which closes its own stick circuit when the other is deenergized, and either of which opens the stick circuit of the other when energized, a group relay at the dispatcher's office representing each way station rendered active when said way station is selected, which group relay either permits or prevents the energization of the next in sequence of said slow dropping relays to be energized according to whether or not channel circuits through such way station that said group relay represents, are to be made available for use, and means for causing the energizations of the next in sequence of said slow dropping relays to be energized in opposition to said group relay after said channel circuits for said station have been made available, including three interconnected circuit choosing relays, the first of which is energized to one of two extreme positions according to which of said slow dropping relays is energized, and either the second or third of which is energized in accordance with the position of first of said circuit choosing relays, whereby the first of said slow dropping relays is energized as a result of the energization of the second of said circuit choosing relays, whereby the second of said slow dropping relays is energized as a result of the energization of the third of said circuit choosing relays, and whereby message channels through certain way stations, as determined by said group relay may be rendered active in response to the operation of a control lever in the dispatcher's office for more than one cycle of successive selection of said way stations.

15. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, a dispatcher's office, a plurality of way stations, a transfer line, a transfer relay at each way station connected in series with said transfer line, a common return wire, means being controlled by said transfer relay at each way station for causing said transfer relay at such way station to be responsive to an application of negative potential on said transfer line, and means being controlled by said transfer relay at such way station for causing said transfer relay to be responsive to an application of positive potential on said transfer line only when the order of the application of positive potential following an application of negative potential corresponds to the order of the way station, whereby successive cycles of successive station selection are accomplished.

16. In a train dispatching system of the synchronous counting relay type in which successive way stations are successively selected one at a time, a group of message channel selecting relays at each way station, a corresponding group of message channel selecting relays at the dispatcher's office representing each way station, station selecting means at each way station, station selecting means at the dispatcher's office, a message channel circuit for each way station rendered available when said way station selecting means at both the dispatcher's office and at such way station are inactive, said station selecting means and message channel selecting relays being normally at rest, means for initiating said way station selecting means at said dispatcher's office and at said way stations, only when the system is at rest, means for causing said group of message channel selecting relays at a particular way station and said corresponding group of message channel selecting relays at said dispatcher's office to be rendered active in response to the operation of a control lever, when that particular way station is selected, and means manually operable to cause the automatic operation of the system to include all way stations or to include only some lesser number at the will of an operator.

17. In a train dispatching system of the synchronous counting relay type in which successive way stations are selected one at a time, a dispatcher's office, a plurality of way

stations, station selecting means at each way station, apparatus at the dispatcher's office for controlling said station selecting means, to render channel circuits passing through such way stations available for use, means at the dispatcher's office for indicating failure of operation of station selecting means, means at the dispatcher's office for ascertaining at what particular way station the selecting means failed, and means manually operable to cause the automatic operation of the system to include only the way stations between the dispatcher's office and the point of failure.

18. In a centralized traffic controlling system for railroads, a dispatcher's office, a plurality of way stations, station selecting means at each way station, automatic apparatus at the dispatcher's office for controlling said station selecting means to establish communication between the dispatcher's office and each of the way stations, and means at the dispatcher's office manually operable to render said automatic apparatus ineffective to control certain of said station selecting means.

19. In a centralized traffic controlling system for railroads, a dispatcher's office, a plurality of way stations, a transfer line extending from the dispatcher's office to the several stations, a message line extending from the dispatcher's office to the several stations, and station selecting means at each station effectively actuated to establish communication over said message line between the dispatcher's office and that station by an application of impulses of one polarity to said transfer line equal in number to the order of that station, said station selecting means effectively actuated to break communication with any station by an application of an impulse of the opposite polarity.

20. In combination, a four-condition polar-neutral relay, two neutral stick relays, a pick-up circuit energizing one of said stick relays when said polar-neutral relay is energized with one polarity, a pick-up circuit for energizing the other of said stick relays when said polar-neutral relay is energized with the opposite polarity, a stick circuit for said other stick relay completed until said polar-neutral relay is energized with said one polarity, a pick-up circuit for said one stick relay completed with said other stick relay energized and said polar-neutral relay deenergized, and a stick circuit for said one stick relay completed until said polar-neutral relay is energized with said one polarity.

21. In a centralized traffic controlling system for railroads, a dispatcher's office, a plurality of way stations, a transfer line extending from the dispatcher's office to the several way stations, station selecting means at each station, means in the dispatcher's office for governing said station selecting means to select said stations successively one at a time by application of impulses on said transfer line, and voltage compensating means at the dispatcher's office, whereby, as successive impulses on said transfer line successively select said stations, additional voltage is supplied for each successive impulse in accordance with the length of said transfer line extending to the station to be selected by that impulse.

In testimony whereof I affix my signature.

FOREST B. HITCHCOCK.