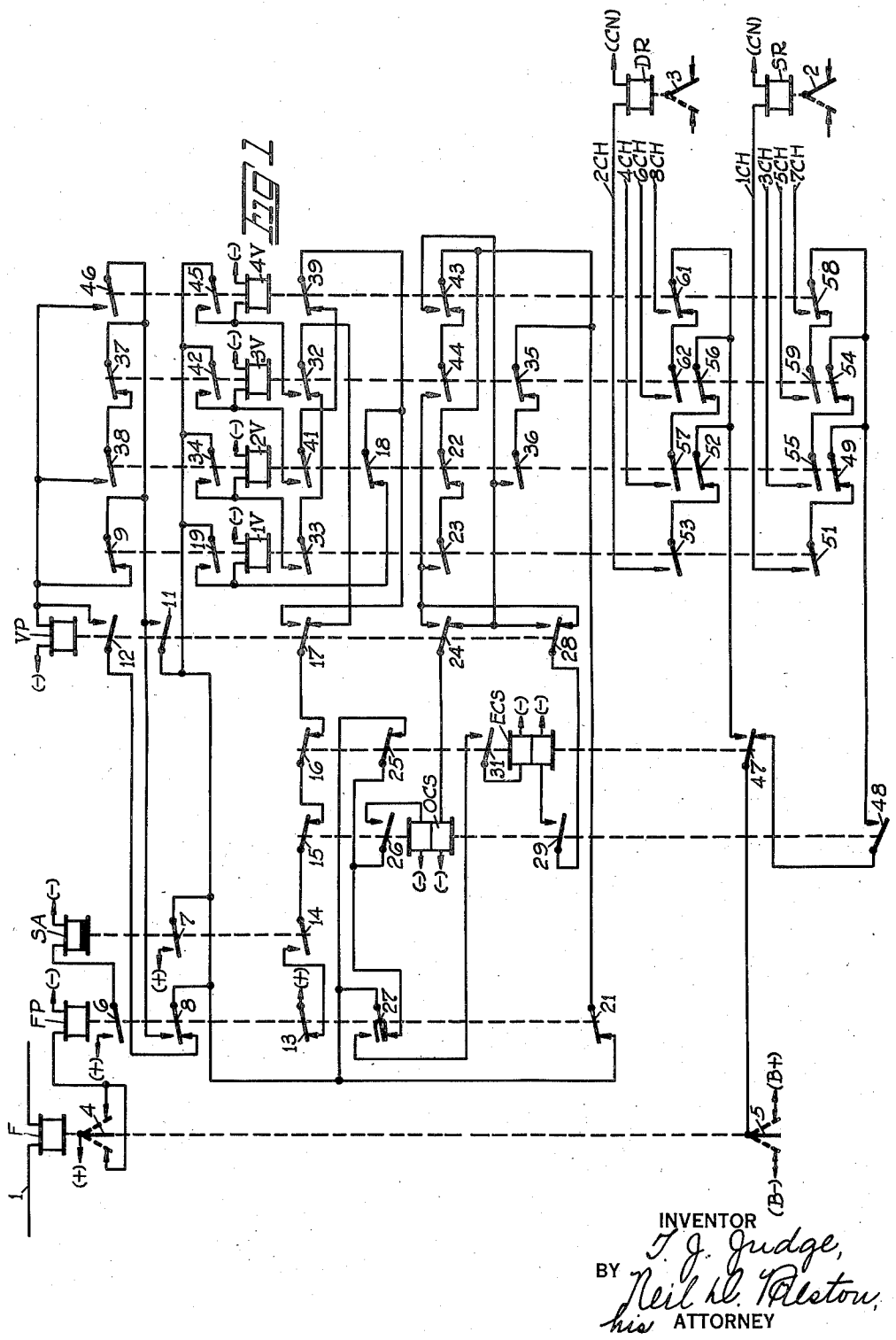
Aug. 3, 1937. T. J. JUDGE 2,088,793

CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

Filed March 24, 1933 2 Sheets-Sheet 1




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CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

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TYPICAL OPERATION CHART. Fig 2

| No. of Operation | Relay Reference Characters | | | | | | | No. of Channel |
|---|---|---|---|---|---|---|---|---|
| | FP | VP | OCS | ECS | 1V | 2V | 3V | 4V | |
| 1 | P.U. | P.U. | | | | | | | |
| 2 | D.A. | | P.U.$^{2}$ | | P.U.$^{1}$ | | | | 1CH |
| 3 | P.U. | D.A. | | | | | | | |
| 4 | D.A. | | | P.U. | | | | | 2CH |
| 5 | P.U. | | D.A. | | | | | | |
| 6 | D.A. | | P.U.$^{3}$ | D.A.$^{1}$ | | P.U.$^{2}$ | | | 3CH |
| 7 | P.U. | P.U. | | | | | | | |
| 8 | D.A. | | | P.U. | | | | | 4CH |
| 9 | P.U. | | D.A. | | | | | | |
| 10 | D.A. | | P.U.$^{3}$ | D.A.$^{1}$ | | | P.U.$^{2}$ | | 5CH |
| 11 | P.U | D.A. | | | | | | | |
| 12 | D.A. | | | P.U. | | | | | 6CH |
| 13 | P.U. | | D.A. | | | | | | |
| 14 | D.A. | | P.U.$^{3}$ | D.A.$^{1}$ | | | | P.U.$^{2}$ | 7CH |
| 15 | P.U. | P.U. | | | | | | | |
| 16 | D.A. | | | P.U. | | | | | 8CH |
| 17 | P.U. | | D.A. | | | | | | |
| 18 | D.A. | | | D.A. | | | | | |

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# UNITED STATES PATENT OFFICE

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## CENTRALIZED TRAFFIC CONTROLLING SYSTEM FOR RAILROADS

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Application March 24, 1933, Serial No. 662,541

11 Claims. (Cl. 177—353)

This invention relates to centralized traffic controlling systems for railroads and it more particularly pertains to a portion of the communication apparatus employed in such systems.

In a centralized traffic controlling system in which a coded type of communication is used, it is desirable to employ step-by-step mechanisms which require a minimum amount of apparatus to accomplish the required operations. Such a coded type communication system is disclosed in the pending application of Judge and Bushnell, Ser. No. 640,062, filed October 28, 1932, corresponding to British Patent 419,399.

The present invention employs a plurality of stepping relays for selecting a plurality of local channel circuits, so organized that each stepping relay which is added to the bank adds two channel circuits to the capacity of the system.

The arrangement of the stepping relay bank is such that the stepping relays are picked up in sequential order, in combination with odd channel selecting and even channel selecting relays for making up the local channel circuits. A half-step relay cooperates with the stepping relays and the channel selecting relays so that the proper coordination is obtained.

Other objects, purposes and characteristic features of the present invention will be in part obvious from the accompanying drawing and in part pointed out in the specification.

In describing the invention in detail, reference will be made to the accompanying drawings in which Fig. 1 illustrates the circuit organization and Fig. 2 comprises an operation chart illustrating the timing of the various relay operations. The reference character V is applied to the stepping relays and the associated preceding numeral marks the order of energization of these relays. For example, relays 1V, 2V, 3V and 4V are picked up in the order named. Relay VP is the half-step or repeating relay which repeats certain operations of the FP relay.

Relay OCS is the odd channel selecting relay and relay ECS is the even channel selecting relay. These channel selecting relays cooperate with the stepping relays for completing the executing circuit to the odd or even channel circuit as determined by the odd or even channel selecting relay which is picked up.

Relay F is a biased-to-neutral polar type line relay for repeating the impulses applied to the communication line. Relay FP is the line repeating relay which repeats the operations of the line relay irrespective of the polarities of the impulses repeated by line relay F. Relay SA is of the slow acting type and is used to define the bounds of an operating cycle, being picked up at the beginning of a cycle and dropped at the end of the cycle.

Associated with the stepping relay bank are two relays SR and DR of the two-position polar magnetic stick type. These relays are shown in the drawings to illustrate the manner in which the selected channel circuits may be utilized, but it will be understood that the channel circuits selected by the stepping relay bank may be employed for any purpose desired in the communication system as contemplated in the present invention. Relay SR has a polar contact 2 which is operable to either its right or left-hand position as determined by the polarity with which its winding is energized and it will be assumed that (+) potential applied to the left-hand terminal of its winding positions contact 2 to the right, while (—) potential applied to this terminal positions contact 2 to the left. Relay DR is a similar magnetic stick type relay operating its contact 3 to the right or left in the same manner discussed in connection with relay SR.

The typical operation chart illustrates the sequence of operation of the various relays, the circuits of which will be pointed out in detail.

The symbols (+) and (—) are employed to indicate the positive and negative terminals respectively of suitable batteries or other sources of direct current and the circuits with which these symbols are used always have current flowing in the same direction. The symbols (B+) and (B—) indicate connections to the opposite terminals of a suitable battery or other source of direct current which has an intermediate tap (CN) and the circuits with which these symbols are used may have current flowing in one direction or the other as determined by the particular terminal used in combination with the intermediate tap (CN).

The centralized traffic controlling system to which this invention is particularly applicable contemplates a central control office and one or more outlying field stations between which controls and indications are transmitted. The control office and each field station includes a bank of stepping relays which are operated in synchronism through operating cycles, each cycle comprising a predetermined number of steps. On these steps the control line circuit connecting the office with the station or stations is conditioned in accordance with the code combinations of impulses for the selection of a particular station and the transmission of controls to that station.

Likewise, on the steps of the stepping relay bank, an indication line circuit connecting the stations with the control office may be conditioned by code combinations of impulses, for registering a particular station in the control office and thereafter storing or registering the particular indications transmitted from the registered station. The conditioning of the line circuits at the control office and at the field stations as well as the reception of these conditions at the respective locations is accomplished on each step by means of local channel circuits.

Although these local channel circuits are employed at the several locations, including the control office, for the transmission and reception of controls and indications, the present invention illustrates these circuits as applied to the step-by-step apparatus at a field station for the reception of conrols transmitted to that station from the control office.

*Operation*

Referring to Fig. 1, the system is in its normal or at-rest condition and all of the relays illustrated in the drawings are in their normal deenergized conditions.

In describing the operation of the stepping relay bank and the selecting of channel circuits thereby, it is convenient to divide the operating characteristics into two portions, first a description of the pick-up and stick circuits as well as the drop-away circuit operations of the respective relays and second, the making up of the particular selected channel circuit and the executing of the control for this channel circuit.

In considering the operation of the present invention, it is convenient to assume that line relay F is included in line circuit 1 to which a plurality of different series of impulses are applied, with the polarity of each impulse selected so as to make up code combinations by means of which stations are selected and controls transmitted thereto, as disclosed for example, in the above-mentioned application Ser. No. 640,062, corresponding to British Patent 419,399.

Although each series of impulses applied to line 1 is made up of a plurality of polar impulses arranged in accordance with some code plan, such coded arrangement is immaterial for an understanding of the present invention and for convenience it will be assumed that each (+) impulse applied to line 1 so energizes relay F that it positions its polar contacts 4 and 5 to the right, while each (—) impulse applied to line 1 positions these contacts to the left.

It will also be assumed that a cycle of operations comprises a conditioning impulse and eight coded impulses separated by deenergized periods of the line circuit. For convenience, the first impulse is referred to as the conditioning "on" period and the following impulses are referred to as the first, second, third, fourth, fifth, sixth, seventh and eighth "on" periods of the cycle. The periods between the "on" periods will be referred to as the "off" periods of the cycle. It will be understood that these "off" and "on" periods are provided in the control office in a manner disclosed in the above-mentioned application Ser. No. 640,062 and that these impulses are repeated at the field station illustrated in the present drawings.

Referring to the typical operation chart, relay FP is picked up during the conditioning "on" period and also during each of the following eight "on" periods. Relay FP is dropped during each "off" period which follows the above mentioned nine "on" periods of the cycle. The picking up of relay FP during the "on" periods is noted in the chart by the abbreviation P. U. and its dropping away is noted by the abbreviation D. A. Incidentally the pick-up and drop-away operations of the other relays (except SA) is noted in the chart by the same abbreviations. The exponents associated with certain of the abbreviations indicate the order of operation of the corresponding relay, when more than one is picked up or released during the same "off" or "on" period.

It is believed that the invention may be best understood by assuming that line 1 is first energized with a conditioning impulse, followed by eight additional impulses separated by suitable "off" periods. The operation of the stepping relay bank will then be explained, after which it will be assumed that the stepping relay bank steps through the operating cycle and an explanation will be given of the selection of the local channel circuits during this operation.

The application of the first or conditioning impulse of a particular series to line 1 is repeated successively by relays F, FP and SA. The polarity of the impulse determines the position to which relay F is actuated, that is, a (+) impulse positions the contacts of this relay to the right and a (—) impulse positions them to the left. Irrespective of the polarity of the impulse, a circuit is closed for picking up relay FP which extends from (+), contact 4 of relay F in either of its energized positions and winding of relay FP, to (—). A circuit is closed for picking up relay SA which extends from (+), front contact 6 of relay FP and winding of relay SA, to (—). It will be understood that this conditioning impulse (operation No. 1 in the chart) is measured off relatively long in the control office for the purpose of providing sufficient time for the picking up of relay SA and similar relays in the control office.

Relay VP is picked up during the conditioning "on" period over a circuit extending from (+), front contact 7 of relay SA, front contact 8 of relay FP, back contact 9 of relay IV and winding of relay VP, to (—). Relay VP closes a stick circuit for itself which is effective until relay IV picks up and opens its back contact 9 and which extends from (+), front contact 7 of relay SA, front contact 11 of relay VP, back contact 9 of relay IV and winding of relay VP, to (—).

When the line circuit is deenergized by the dropping of relay F to mark the end of the conditioning "on" period and the beginning of the first "off" period, (operation No. 2 in the chart) such condition is repeated by the dropping of relay FP. Since the deenergized periods of relay FP are comparatively short, relay SA maintains its contacts in their picked up positions during all of the "off" periods until the last or "change to normal" "off" period at the end of the cycle, which is sufficiently long to allow relay SA to drop its contacts.

The dropping of relay FP at the beginning of the first "off" period closes a circuit for picking up relay IV but before this relay is picked up, a second stick circuit is established for relay VP extending from (+), front contact 7 of relay SA, back contact 8 of relay FP, front contact 12 and winding of relay VP, to (—). The circuit for picking up relay IV extends from (+), back contact 13 of relay FP, front contact 14 of relay SA, back contact 15 of relay OCS, back contact 16 of relay ECS, front contact 17 of relay VP,

back contact 18 of relay 2V and winding of relay 1V, to (—). Relay 1V closes a stick circuit for itself which extends from (+), front contact 7 of relay SA, front contact 19 and winding of relay 1V, to (—).

During the first "off" period a circuit is closed for picking up relay OCS which extends from (+), front contact 7 of relay SA, back contact 21 of relay FP, back contact 22 of relay 2V, front contact 23 of relay 1V, front contact 24 of relay VP and lower winding of relay OCS, to (—). Relay OCS closes a stick circuit for itself extending from (+), front contact 7 of relay SA, back contact 25 of relay ECS, front contact 26 and upper winding of relay OCS, to (—).

When relays F and FP next pick up to mark the end of the first "off" period and the beginning of the first "on" period, (operation No. 3 in the chart) relay VP is dropped because its first stick circuit is open at back contact 9 of relay 1V (now picked up) and its second stick circuit is open at back contact 8 of relay FP.

When relay FP drops at the end of the first "on" period and the beginning of the second "off" period (operation No. 4 in the chart) a second stick circuit is closed for energizing relay OCS which is independent of contact 25 of relay ECS, because this latter relay will be picked up during this second "off" period. This second stick circuit extends from (+), front contact 7 of relay SA, back contact 27 of relay FP, front contact 26 and upper winding of relay OCS, to (—). During the second "off" period a circuit is closed for picking up relay ECS which extends from (+), front contact 7 of relay SA, back contact 21 of relay FP, back contact 22 of relay 2V, front contact 23 of relay 1V, back contact 28 of relay VP, front contact 29 of relay OCS and lower winding of relay ECS, to (—).

Relay FP picks up at the end of the second "off" period and the beginning of the second "on" period, (operation No. 5 in the chart) thereby closing a stick circuit for relay ECS extending from (+), front contact 7 of relay SA, front contact 27 of relay FP, front contact 31 and upper winding of relay ECS, to (—). Relay OCS is dropped during the second "on" period because back contact 25 of relay ECS and back contact 27 of relay FP are now open.

When relay FP drops at the end of the second "on" period and the beginning of the third "off" period, (operation No. 6 in the chart) relay ECS is dropped because the circuit through its lower winding is open at open front contact 29 of relay OCS and because its stick circuit is open at front contact 27 of relay FP. Relay 2V is picked up during the third "off" period over a circuit extending from (+), back contact 13 of relay FP, front contact 14 of relay SA, back contacts 15 and 16 of relays OCS and ECS respectively, back contact 17 of relay VP, back contact 32 of relay 3V, front contact 33 of relay 1V and winding of relay 2V, to (—). Relay 2V closes a stick circuit for itself by way of its front contact 34 and front contact 7 of relay SA, to (+). Relay OCS is picked up during the third "off" period over a circuit extending from (+), front contact 7 of relay SA, back contact 21 of relay FP, back contact 35 of relay 3V, front contact 36 of relay 2V, back contact 24 of relay VP and lower winding of relay OCS, to (—). Relay OCS again closes the above described stick circuit for itself by way of back contact 25 of relay ECS.

When relay FP picks up at the end of the third "off" period and the beginning of the third "on" period, (operation No. 7 in the chart) a circuit is closed for picking up relay VP which extends from (+), front contact 7 of relay SA, front contact 8 of relay FP, back contact 37 of relay 3V, front contact 38 of relay 2V and winding of relay VP, to (—). Relay VP establishes its first stick circuit by way of its front contact 11, back contact 37 of relay 3V and front contact 38 of relay 2V to the winding of relay VP.

When relay FP drops at the end of the third "on" period and the beginning of the fourth "off" period, (operation No. 8 in the chart) the second stick circuit for relay VP is established through back contact 8 of relay FP as previously described. The stick circuit for relay OCS is again completed through back contact 27 of relay FP as described in connection with the second "off" period. Relay ECS is picked up by means of a circuit extending from (+), front contact 7 of relay SA, back contact 21 of relay FP, back contact 35 of relay 3V, front contact 36 of relay 2V, front contact 28 of relay VP, front contact 29 of relay OCS and lower winding of relay ECS, to (—).

When relay FP is picked up at the end of the fourth "off" period and the beginning of the fourth "on" period, (operation No. 9 in the chart) the stick circuit for relay ECS which was described in connection with the second "on" period is again completed. Relay OCS is dropped due to the circuit conditions previously described in connection with the second "on" period.

When relay FP drops at the end of the fourth "on" period and the beginning of the fifth "off" period, (operation No. 10 in the chart) the holding stick circuit of relay VP is again completed in the manner previously pointed out. Relay ECS is dropped due to the circuit conditions previously discussed in connection with the third "off" period again being effective. Relay 3V is now picked up by means of a circuit extending from (+), back contact 13 of relay FP, front contact 14 of relay SA, back contacts 15 and 16 of relays OCS and ECS respectively, front contact 17 of relay VP, back contact 39 of relay 4V, front contact 41 of relay 2V and winding of relay 3V, to (—). Relay 3V closes an obvious stick circuit for itself by way of its front contact 42. Relay OCS is now picked up over a circuit extending from (+), front contact 7 of relay SA, back contact 21 of relay FP, back contact 43 of relay 4V, front contact 44 of relay 3V, front contact 24 of relay VP and lower winding of relay OCS, to (—). Relay OCS again establishes the previously described stick circuit for itself.

When relay FP picks up at the end of the fifth "off" period and the beginning of the fifth "on" period, (operation No. 11 in the chart) relay VP is dropped because its first stick circuit is open at back contact 37 of relay 3V (now picked up) and its second stick circuit is open at back contact 8 of relay FP.

When relay FP drops at the end of the fifth "on" period and the beginning of the sixth "off" period, (operation No. 12 in the chart) relay OCS is stuck up in the manner previously discussed in connection with the second "off" period. Relay ECS is now picked up over a circuit extending from (+), front contact 7 of relay SA, back contact 21 of relay FP, back contact 43 of relay 4V, front contact 44 of relay 3V, back contact 28 of relay VP, front contact 29 of relay OCS and lower winding of relay ECS, to (—).

When relay FP is picked up at the end of the sixth "off" period and the beginning of the sixth "on" period, (operation No. 13 in the chart) relay ECS is stuck up as previously described in connection with the second "on" period. Relay OCS is dropped due to the circuit conditions set up as described in connection with the second "on" period.

When relay FP drops at the end of the sixth "on" period and the beginning of the seventh "off" period, (operation No. 14 in the chart) relay ECS is dropped due to the circuit conditions previously discussed in connection with the third "off" period. Relay 4V is picked up by means of a circuit extending from (+), back contact 13 of relay FP, front contact 14 of relay SA, back contacts 15 and 16 of relays OCS and ECS respectively, back contact 17 of relay VP, front contact 32 of relay 3V and winding of relay 4V, to (—). Relay 4V closes an obvious stick circuit for itself by way of its front contact 45. Relay OCS is now picked up over a circuit extending from (+), front contact 7 of relay SA, back contact 21 of relay FP, front contact 43 of relay 4V, back contact 24 of relay VP and lower winding of relay OCS, to (—). Relay OCS closes a stick circuit for itself which was previously described in connection with the first "off" period.

When relay FP picks up, at the end of the seventh "off" period and the beginning of the seventh "on" period, (operation No. 15 in the chart) a circuit is closed for picking up relay VP which extends from (+), front contact 7 of relay SA, front contact 8 of relay FP, front contact 46 of relay 4V and winding of relay VP, to (—). Relay VP establishes its first stick circuit by way of its front contact 11 and front contact 46 of relay 4V.

When relay FP drops at the end of the seventh "on" period and the beginning of the eighth "off" period, (operation No. 16 in the chart) the second stick circuit for relay VP is again established as previously explained in connection with the first "off" period. Relay FP establishes the stick circuit for relay OCS which was previously described in connection with the second "off" period. Relay ECS is picked up over a circuit extending from (+), front contact 7 of relay SA, back contact 21 of relay FP, front contact 43 of relay 4V, front contact 28 of relay VP, front contact 29 of relay OCS and lower winding of relay ECS, to (—).

When relay FP is picked up at the end of the eighth "off" period and the beginning of the eighth "on" period, (operation No. 17 in the chart) relay ECS is stuck up by means of the circuit previously discussed in connection with the second "on" period. Relay OCS is dropped in the manner previously described in connection with the second "on" period.

Since it has been assumed that eight steps are provided for the selection of eight channel circuits, the dropping of relay FP at the end of the eighth "on" period marks the beginning of the change to normal "off" period. Relay ECS is now dropped in the manner previously discussed in connection with the third "off" period.

Since relay 4V is the last stepping relay in the bank, the line circuit is maintained open in the control office for a comparatively long interval to allow the system to return to normal. Relay FP will therefore remain down for a sufficient time to allow relay SA to drop and open its contacts 7 and 14. The opening of contact 7 deenergizes the stick circuits of relays VP, 1V, 2V, 3V and 4V resulting in the dropping of these relays. Since all relays are now in their deenergized conditions, the field station circuits are at normal or in the period of blank condition in readiness for the next cycle.

From the above description and the operation chart, it is apparent that relay VP, after being picked up in the conditioning "on" period, is dropped and picked up alternately in the odd "on" periods. In other words, relay VP picks up during the conditioning "on" period, drops during the first "on" period, picks up during the third "on" period, drops during the fifth "on" period and picks up during the seventh "on" period.

It will likewise be noted that relay OCS is picked up during the odd "off" periods and dropped during the even "on" periods. In other words, this relay picks up during the first "off" period, drops during the second "on" period, picks up during the third "off" period, drops during the fourth "on" period, picks up during the fifth "off" period, drops during the sixth "on" period, picks up during the seventh "off" period and drops during the eighth "on" period.

Relay ECS is picked up during the even "off" periods (2, 4, 6 and 8) and is dropped during the odd "off" periods except the first (3, 5, 7 and the "change to normal"). Likewise, the stepping relays are successively picked up during the odd "off" periods and remain up until the end of the cycle. Relay 1V is picked up during the first "off" period, relay 2V is picked up during the third "off" period, relay 3V is picked up during the fifth "off" period, and relay 4V is picked up during the seventh "off" period.

Although only four stepping relays have been illustrated, it will be understood that additional relays may be added and that each stepping relay in addition to those shown will be picked up during additional odd "off" periods, thus providing two additional channel circuits for each additional stepping relay added to the bank. Having thus described the stepping operation, it is now convenient to point out the manner of selecting the channel circuits.

As explained above, the stepping relays are picked up during the odd "off" periods. The odd channel selecting relay is picked up during the same periods and is dropped in the preceding "on" periods. The even channel selecting relay is picked up during the even "off" periods and is dropped in the preceding odd "off" periods. Thus, the periods between the picking up of succeeding stepping relays include two full "on" periods and the cooperation of the odd and even channel selecting relays with the stepping relays is such that, each stepping relay selects an odd and an even channel circuit when it is picked up and these two channel circuits are individually selected by means of the odd and even channel selecting relays.

The channel circuits are indicated as being energized with positive or negative potential in accordance with the right or left-hand positions of polar contact 5 of relay F. The individual channel circuits are identified with the letter reference characters CH, having preceding numerals designating the order in which these individual channel circuits are made up. The first channel circuit 1CH and the second channel circuit 2CH are prepared during the first "off" period when relay 1V is picked up. Channel circuit 1CH is selected by relay OCS being picked up

at the time relay ECS is down during the first "off" period (operation No. 2 in the chart).

The first channel circuit is completed or executed during the first "on" period (operation No. 3 in the chart) by polar contact 5 of relay F connecting (B+) or (B—) through back contact 47 of relay ECS, front contact 48 of relay OCS, back contact 49 of relay 2V, front contact 51 of relay 1V, conductor 1CH and winding of relay SR, to (CN). Contact 2 of relay SR is positioned to the right if the above described circuit extends from (B+) at contact 5 of relay F and if this circuit extends to (B—) at this contact, relay SR actuates contact 2 to the left.

The second channel circuit is executed during the second "on" period, (operation No. 5 in the chart) when relay F actuates its contact 5 to the right or left-hand position for completing an energizing circuit for relay DR. This circuit extends from contact 5 of relay F, front contact 47 of relay ECS, back contact 52 of relay 2V, front contact 53 of relay 1V, conductor 2CH and winding of relay DR, to (CN). (B+) applied to this circuit positions contact 3 of relay DR to the right while (B—) positions it to the left.

The third channel circuit is executed during the third "on" period (operation No. 7 in the chart) when contact 5 of relay F connects (B+) or (B—) through back contact 47 of relay ECS, front contact 48 of relay OCS, back contact 54 of relay 3V, front contact 55 of relay 2V, to conductor 3CH. The executing circuit is completed to the fourth channel circuit during the fourth "on" period, (operation No. 9 in the chart) this circuit extending from contact 5 of relay F, front contact 47 of relay ECS, back contact 56 of relay 3V, front contact 57 of relay 2V, to conductor 4CH.

The fifth channel circuit is energized during the fifth "on" period (operation No. 11 in the chart) by way of contact 5 of relay F, back contact 47 of relay ECS, front contact 48 of relay OCS, back contact 58 of relay 4V and front contact 59 of relay 3V, to conductor 5CH. The sixth channel circuit is executed during the sixth "on" period (operation No. 13 in the chart) when contact 5 of relay F applies (B+) or (B—) potential through front contact 47 of relay ECS, back contact 61 of relay 4V, front contact 62 of relay 3V, to conductor 6CH.

The seventh channel circuit is energized during the seventh "on" period (operation No. 15 in the chart) when relay F selectively connects (B+) or (B—) to conductor 7CH by way of back contact 47 of relay ECS, front contact 48 of relay OCS and front contact 58 of relay 4V. The eighth channel circuit is executed during the eighth "on" period (operation No. 17 in the chart) by relay F selectively connecting (B+) or (B—) by way of its contact 5, front contact 47 of relay ECS and front contact 61 of relay 4V to conductor 8CH.

It is of course understood that the channel circuits may be employed for various purposes other than the reception of code impulses as illustrated. It will be noted that the channel circuits are selectively prepared during the "off" periods, (even numbered operations in the chart) preceding the "on" periods in which the circuits are to be energized and that the continuity of the selected channel circuits is not disturbed during the "on" period during which execution takes place. Thus the actuation of contact 5 of relay F for applying (+) or (—) potential to these circuits positively completes and maintains the energizing circuits to the channel conductors, because no relay operations take place during these "on" periods (odd numbered operations in the chart) for switching channel conductors.

A stepping relay bank has been shown and described which employs each stepping relay to close two channel circuits, by reason of the selective operation of the common odd and even channel selecting relays OCS and ECS. This produces an increased number of channel circuits by providing a type of relay selection which does not require the addition of a stepping relay for each additional channel circuit, as has been the case in certain prior systems.

Having thus described a stepping relay bank for use in selector type communication systems, it is desired to be understood that this form is selected to facilitate in the disclosure of the invention rather than to limit the number of forms which it may assume and it is to be further understood that various modifications, adaptations and alterations may be applied to the specific form shown to meet the requirements of practice without in any manner departing from the spirit or scope of the present invention except as limited by the appended claims.

What I claim is:—

1. In combination, an impulse relay intermittently operated in response to a series of time spaced impulses applied thereto, a plurality of stepping relays, means controlled by said intermittent operations for operating said stepping relays, circuits interconnecting said impulse relay and said stepping relays, means responsive to the operation of said stepping relays and including said circuits for selecting a group of odd and even channel circuits, an odd channel selecting relay for selecting the odd channel circuit of said group, an even channel selecting relay for selecting the even channel circuit of said group, means controlled by said stepping relays for selecting said odd and even channel selecting relays, and means for preventing the actuation of any stepping relay to its group selecting position when either of said channel selecting relays is in its channel selecting position.

2. In combination, an impulse relay intermittently operated in response to a series of time spaced impulses applied thereto, a plurality of stepping relays, means controlled by said intermittent operations for operating said stepping relays, circuits interconnecting said impulse relay and said stepping relays, means responsive to the operation of said stepping relays and including said circuits for selecting groups of odd and even channel circuits, an odd channel selecting relay for selecting the odd channel circuit of each of said groups, an even channel selecting relay for selecting the even channel circuit of each of said groups, means controlled by said stepping relays for selecting said odd and even channel selecting relays, and means for preventing the actuation of any stepping relay to its group selecting position when either of said channel selecting relays is in its channel selecting position.

3. In combination, an impulse relay intermittently operated at a predetermined frequency in response to a series of impulses and the spaces between said impulses, a plurality of stepping relays, circuits interconnecting said impulse relay and said stepping relays, means responsive to the odd numbered spaces between said impulses and including said circuits for sequentially operating said stepping relays, a half-step relay, a plurality

of pick up circuits for said half-step relay including a front contact of said impulse relay, a stick circuit for said half-step relay including its own front contact and a back contact of said impulse relay, means controlled by the intermittent operation of said impulse relay and including said pick up and stick circuits for intermittently operating said half-step relay at a frequency substantially less than said predetermined frequency, and means controlled by said half-step relay for sequentially selecting said stepping relays.

4. In combination; an impulse relay which is alternately operated to picked up and released positions by a series of impulses; a series of stepping relays which assume picked up or released positions depending upon whether or not their windings are energized; circuits for sequentially energizing the windings of said stepping relays, one for each odd numbered release operation only of said impulse relay; stick circuits for holding said stepping relays operated; a plurality of relays common to said stepping relays, said common relays assuming picked up or released positions depending upon whether or not their windings are energized; circuits for sequentially energizing the windings of said common relays, one for each operation of said impulse relay; a plurality of channel circuits; means including said stepping relays and said common relays for selecting a separate one of said channel circuits in response to each release operation of said impulse relay; and means responsive to the termination of said series of impulses for releasing said stepping relays by breaking their stick circuits.

5. In combination; an impulse relay which is alternately operated to picked up and released positions by a series of impulses; a series of stepping relays which assume picked up or released positions depending upon whether or not their windings are energized; circuits for sequentially energizing the windings of said stepping relays, one for each odd numbered release operation only of said impulse relay; stick circuits for holding said stepping relays operated; a plurality of relays common to said stepping relays, said common relays assuming picked up or released positions depending upon whether or not their windings are energized; circuits for sequentially energizing the windings of said common relays, one for each operation of said impulse relay; stick circuits for holding said common relays operated; a plurality of channel circuits; means including said stepping relays and said common relays for selecting a separate one of said channel circuits in response to each release operation of said impulse relay; and means responsive to the termination of said series of impulses for releasing said stepping relays and said common relays by breaking their respective stick circuits.

6. In combination, an impulse relay intermittently operated to distinctive positions in response to a series of time spaced distinctive impulses applied thereto, a stepping relay bank operable through a cycle in response to said intermittent operations, circuits interconnecting said impulse relay and said stepping relay bank, means controlled by said impulse relay and including said circuits for causing a first plurality of relays of said bank to operate in response to the time spaces following even impulses only, means controlled by said impulse relay and including said circuits for causing a second plurality of relays of said bank to operate in response to odd and even impulses and the time spaces between, means including said first and said second plurality of relays for selecting a separate channel circuit for each step, and means controlled by said impulse relay in its distinctive positions for distinctively energizing each selected channel circuit.

7. In combination, an impulse relay intermittently operated to distinctive positions in response to a series of time spaced impulses applied thereto, a stepping relay bank operable through a cycle in response to said intermittent operations, circuits interconnecting said impulse relay and said stepping relay bank, means controlled by said impulse relay and including said circuits for causing a first plurality of relays of said bank to operate in response to the time spaces following even impulses only, means controlled by said impulse relay and including said circuits for causing a second plurality of relays of said bank to operate in response to odd and even impulses and the time spaces between, means including one of said first plurality of relays for selecting an odd and an even channel circuit at one step, means including said second plurality of relays for selecting the odd or even channel circuit at said one step, and means controlled by said impulse relay in its distinctive positions for distinctively energizing said selected odd or even channel circuit.

8. In combination; an impulse relay intermittently operated to alternate positions in response to a first series of impulses for producing a second series of impulses and a third series of impulses respectively; a plurality of counting relays and a common steering relay; a plurality of groups of channel circuits; means responsive to alternate impulses of said second series for causing a separate one of said counting relays to operate; means responsive to alternate impulses of said third series for causing said steering relay to be actuated to opposite positions; channel selecting relays; means responsive to each of said second series of impulses for effecting an operation of one or another of said channel selecting relays; means controlled by said steering relay for steering said second series of impulses to said counting relays in rotation; means controlled by the operation of said counting relays for selecting a plurality of channel circuits, one in each of said groups; and means controlled by the operation of said channel selecting relays for selecting a single channel circuit of said plurality.

9. In combination; an impulse relay intermittently operated to alternate positions in response to a first series of impulses for producing a second series of impulses and a third series of impulses respectively; a plurality of counting relays and a common steering relay; a plurality of groups of channel circuits; means responsive to alternate impulses of said second series for causing a separate one of said counting relays to operate; means responsive to alternate impulses of said third series for causing said steering relay to be actuated to opposite positions; channel selecting relays; means responsive to each of said second series of impulses for effecting an operation of one or another of said channel selecting relays; means controlled by said steering relay for steering said second series of impulses to said counting relays in rotation; means controlled by the operation of said counting relays for selecting a plurality of channel circuits, one in each of said groups; means controlled by the operation of said channel selecting relays for selecting a

single channel circuit of said plurality; and means responsive to the next impulse following the selection of said single channel circuit for energizing said single channel circuit.

10. In combination; an impulse relay intermittently operated to alternate positions in response to a first series of impulses of variable character for producing a second series of impulses and a third series of impulses respectively; a plurality of counting relays and a common steering relay; a plurality of groups of channel circuits; means responsive to alternate impulses of said second series for causing a separate one of said counting relays to operate; means responsive to alternate impulses of said third series for causing said steering relay to be actuated to opposite positions; channel selecting relays; means responsive to each of said second series of impulses for effecting an operation of one or another of said channel selecting relays; means controlled by said steering relay for steering said second series of impulses to said counting relays in rotation; means controlled by the operation of said counting relays for selecting a plurality of channel circuits, one in each of said groups; means controlled by the operation of said channel selecting relays for selecting a single channel circuit of said plurality; and means responsive to the character of the next impulse following the selection of said single channel circuit for characteristically energizing said single channel circuit.

11. In combination; an impulse relay intermittently operated to alternate positions in response to a first series of impulses for producing a second series of impulses and a third series of impulses respectively; a plurality of counting relays and a common steering relay; a plurality of groups of channel circuits; means responsive to alternate impulses of said second series for causing a separate one of said counting relays to operate; means responsive to alternate impulses of said third series for causing said steering relay to be actuated to opposite positions; channel selecting relays; means responsive to each of said second series of impulses for effecting an operation of one or another of said channel selecting relays; means controlled by said steering relay for steering said second series of impulses to said counting relays in rotation; means controlled by the operation of said counting relays for selecting a plurality of channel circuits, one in each of said groups; means controlled by the operation of said channel selecting relays for selecting a single channel circuit of said plurality; and means controlled by said channel selecting relays for permitting or preventing said steering relay steering said second series of impulses to said counting relays.

THOMAS J. JUDGE.