

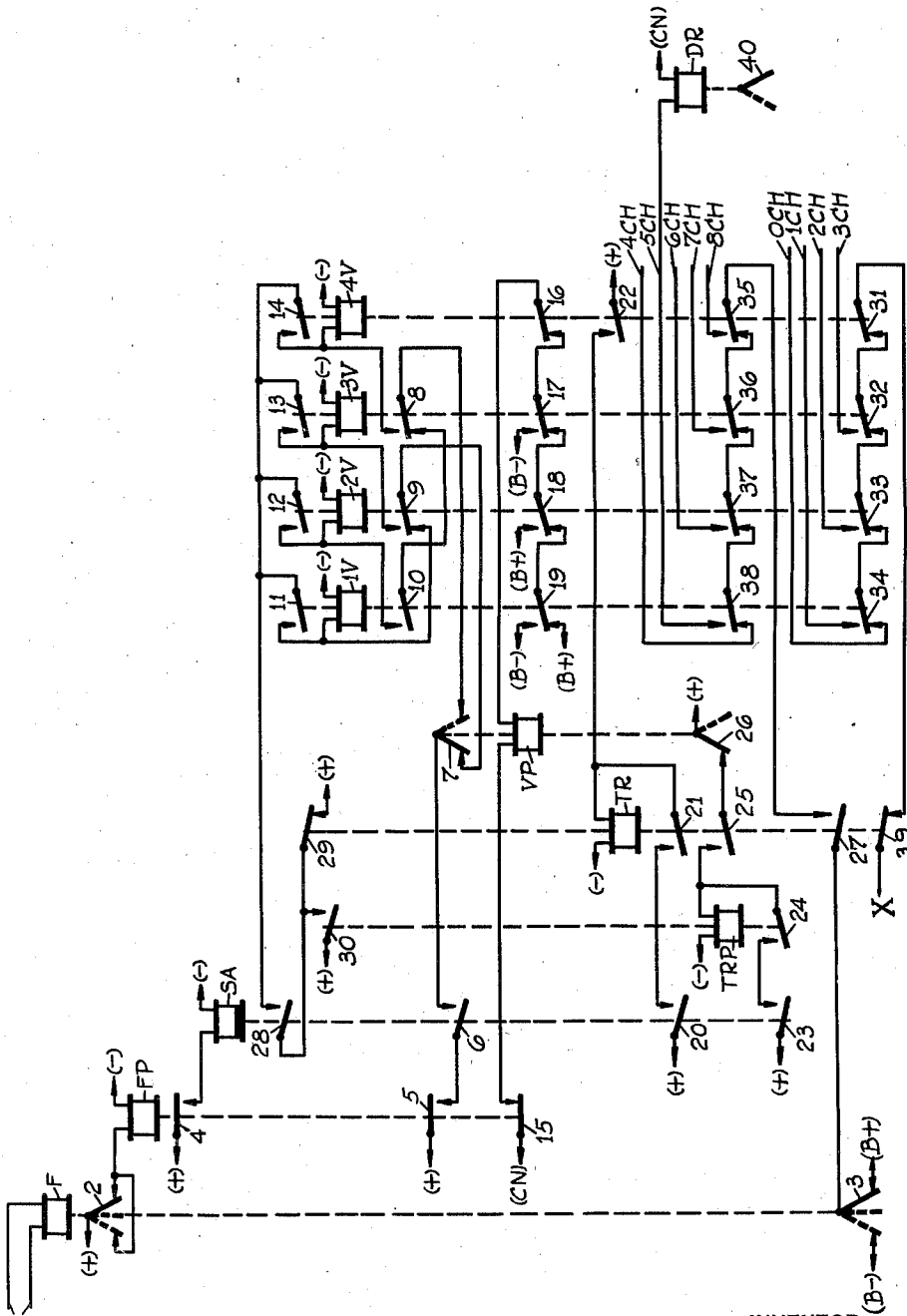
May 3, 1938.

T. J. JUDGE

2,116,173

RELAY STEPPING BANK

Filed Dec. 5, 1933



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RELAY STEPPING BANK

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Application December 5, 1933, Serial No. 701,017

3 Claims. (Cl. 177—353)

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

5 This application is a continuation in part of my copending abandoned application Ser. No. 589,783 filed January 30, 1932.

This application is also to be considered as an improvement over the prior application of N. D. Preston et al., Ser. No. 455,304, filed May 24, 1930, corresponding to Australian Patent 1501 of 1931, and no claim is made herein to subject matter common with such prior application.

15 The present invention proposes to provide a step-by-step mechanism for coded type communication systems, which step-by-step mechanism includes a plurality of stepping relays for preparing a plurality of local channel circuits. This bank of stepping relays is so organized that each relay adds two channel circuits to the total capacity of the stepping bank.

20 The circuit organization for the bank of stepping relays to furnish such capacity provides that the relays are sequentially picked up and maintained picked up through stick circuits until all are in picked up positions, at which time all of the stepping relays are then deenergized substantially simultaneously and then again sequentially picked up. When all of the stepping relays have been picked up the second time, they are deenergized so as to assume their normal positions and thereby complete a cycle of operation.

25 A further feature of the present invention resides in the use of but a single stepping relay for each impulse step period measured off on the line circuit, which is accomplished by the use of a single half step relay common to all of the stepping relays of the bank.

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

35 In describing the invention in detail, reference will be made to the accompanying drawing in which like reference characters designate corresponding parts, and in which a stepping relay bank, arranged in accordance with the present invention and shown as controlled over a line circuit, is illustrated in detail.

40 For the purpose of simplifying the illustration and simplifying in its explanation, the various parts constituting the embodiment of the invention have been shown diagrammatically and cer-

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

45 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 direct current source which has a central or intermediate tap designated (CN); and the circuits with which these symbols are used may have current flowing in one direction or the other depending upon the particular terminal used in combination with the intermediate tap (CN).

50 While certain features of the invention are applicable to and usable with any type of communication system for centralized traffic control, the specific embodiment of the invention has been shown in a form adapted for use with a selective communication system of the duplex coded type shown and described in detail in my copending application Ser. No. 635,062, filed September 27, 1932. Thus, before considering the structure and mode of operation of the parts constituting this invention, it becomes desirable to explain some of the features of the communication system insofar as material to an understanding of the present invention, reference being made to said application for other details of the structure and operation of such a communication system not directly related to the features of this invention.

55 The centralized traffic control system contemplated as embodying the present invention includes a central control office and a plurality of outlying field stations to which and from which controls and indications respectively are transmitted. The control office and each of the field stations includes a bank of stepping relays which are operated in synchronism through cycles of operation comprising a predetermined number of steps. On each of these steps, the control line circuit connecting the control office with the sev-

eral field stations, is conditioned in accordance with the code call and controls for the selection of a particular station and the transmission of controls to that station. Similarly, on each of these steps, a field station may be conditioning the line circuit interconnecting the control office with the several field stations, whereby that field station is registered in the control office followed by the storing of its indications.

The conditioning of the line circuit 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 through the provision of what are conveniently termed local channel circuits, certain ones of which are allotted to each step.

Although these local channel circuits are employed both for the transmission and reception of controls, and both for the transmission and reception of indications at the several locations, as required in accordance with the communication system of this character, the present invention has been shown as applied to only the step-by-step apparatus at a field station.

Description of apparatus

With reference to the accompanying drawing, a step-by-step mechanism at a typical field station of a centralized traffic controlling system is illustrated as having a three-position biased-to-neutral line relay F included in a line circuit 1. The line relay F is provided with polar contacts 2 and 3 which are operated to right hand positions by positive impulses on the line circuit 1, and which are operated to left hand positions by negative impulses on the line circuit 1.

As the stepping relay bank of the present invention has been shown as applied to a communication system of the single circuit duplex type as disclosed in my above mentioned application Ser. No. 635,062 filed September 27, 1932, in which the line circuit is normally energized while the system is at rest, the line relay F has been shown as normally energized to the right by a positive energization of the line circuit at the control office. Upon the initiation of the system into operation, the line circuit is opened causing the step-by-step mechanisms to take the first step, and after such initial opening of the line circuit a plurality of impulses distinctive by reason of their polarity are placed upon the line circuit separated by suitable time spacing periods.

A quick acting line repeating relay FP is associated with the line relay F to repeat each energization of the line relay irrespective of the polarity of such energization. This is accomplished, as the polar contact 2 of the line relay F closes the energizing circuit for the relay FP when in either polar position, as will be apparent from the drawing.

A slow acting relay SA is energized each time the quick acting line repeating relay FP is dropped away by reason of the closure of its back contact 4 included in a circuit obvious from the drawing. This slow acting relay SA is provided with such slow acting characteristics that it is slow in picking up and slow in dropping away, although it is to be understood that the drop-away period is much slower than the pick-up period, and that such drop-away period is greater than the duration of any of the impulses included in the series of impulses comprising any code applied to the line circuit. Thus, the relay SA when once energized upon the initial deenergization of the line circuit 1, remains energized

throughout the cycle of operation until the line circuit is again energized for a prolonged period of time which occurs between successive cycles of operation of the system, or for an indefinite period of time while the system is at rest when there are no controls or indications to be transmitted.

The stepping relay bank is of the type having a plurality of full step relays V with a single half step relay VP common to each of the full step relays. For example, the stepping relay bank illustrated includes the full step relays 1V, 2V, 3V and 4V together with the half step relay VP. The half step relay VP is of the two-position polar magnetic stick type, that is, it is responsive to opposite polarities, and its contacts remain in the positions to which they are last operated.

Associated with the stepping relay bank, for the purpose of causing a repeat operation within a single series of impulses applied to the line circuit, are two transfer relays, namely, a transfer relay TR and a transfer repeating relay TRP. Also associated with the stepping relay bank is a polarized relay DR which is of the two-position magnetic stick type to illustrate one manner in which the channel circuits may be utilized. However, it is to be understood that the channel circuits closed by the stepping relay bank may be employed for any purpose desired in a communication system contemplated in accordance with the present invention. The relay DR has a contact 40 which is operable to either right or left hand positions dependent upon whether it is energized either positively or negatively.

The local channel circuits are illustrated as terminating at reference characters having the distinctive letters CH, one of such channel circuits terminating in the relay DR, as more specifically described hereinafter.

It is believed that the nature of the invention, its advantages and characteristic features can be best understood from the standpoint of operation of the system.

Operation

With the system in a normal condition of rest, the line relay F, its quick acting repeating relay FP and the relay VP are energized, while all of the remaining relays are deenergized.

In describing the operation of the stepping relay bank, it is convenient to divide the operating characteristics into four divisions, namely, a description of the operation of the half step relay, a description of the pick-up and stick circuits of the full step relays, a description of the transition or transfer operation and a description of the channel circuits closed.

It is convenient to assume that the line relay F is included in a line circuit 1 having a plurality of different series of current impulses applied thereto after the initial opening or deenergization on the line circuit following a period of rest, and with the polarity of the impulses of each series so selected as to provide controls for the field stations of a centralized traffic controlling system, as disclosed, for example, in my above mentioned application Ser. No. 635,062 filed September 27, 1932.

Although each series of impulses applied to the line circuit 1 has the polarity of its impulses arranged in accordance with some definite code plan, such coded arrangement is immaterial for an understanding of the present invention except that it should be understood that each such impulse is of either positive or negative polarity so

selectively chosen as to operate a particular device in accordance therewith, as shown, although other kinds of distinctive currents may be employed if desired. Also, the first deenergization of the line circuit preceding the first impulse and following the period of rest is relatively long as compared to the time spacing separating the successive impulses applied to the line circuit. This prolonged time space is provided of sufficient length to allow for the slow acting relay SA to be picked up at the beginning of each series of impulses, but the relay SA is sufficiently slow acting to remain picked up during each of the succeeding impulse periods. Also, at the end of each series of impulses the line circuit is energized for a prolonged time period which is longer than the time period of any impulse in a series, so that the relay SA may have sufficient time in which to drop away. In brief, the relay SA is picked up at the beginning of each series of impulses and is dropped away at the end of each series.

Operation of half step relay.—While the system is at rest, the half step relay VP is energized by a circuit closed from (B+), through a circuit including back contact 19 of relay IV, back contact 18 of relay 2V, back contact 17 of relay 3V, back contact 16 of relay 4V, winding of relay VP, front contact 15 of relay FP, to (CN). This energization of the relay VP actuates its polar contacts to left hand positions, as shown.

When the line circuit is deenergized for the first deenergized period, such condition is repeated by the relays F and FP, so that the relay SA is picked up as previously mentioned. Following the picking up of the relay SA, the first stepping relay IV is picked up and stuck up, the details of which will be pointed out hereinafter.

Assuming for the present that the relay IV is picked up and maintained stuck up, then upon the application of the first impulse to the line circuit and the response of the contacts of the relay FP, a circuit is closed for the relay VP from (B-), through a circuit including front contact 19 of relay IV, back contact 18 of relay 2V, back contact 17 of relay 3V, back contact 16 of relay 4V, windings of relay VP, front contact 15 of relay FP, to (CN). It is apparent that current in this circuit flows from left to right in the winding of the relay VP, so that its contacts are actuated to the right hand dotted line positions.

The second deenergized period or time space on the line circuit is repeated by the relay FP causing the stepping relay 2V to be picked up and stuck up as will be later explained in detail.

Thus, the application of the second impulse to the line circuit and the resulting response of the relay FP causes the relay VP to be again actuated by reason of a circuit closed from (B+), through a circuit including front contact 18 of relay 2V, back contact 17 of relay 3V, back contact 16 of relay 4V, windings of relay VP, front contact 15 of relay FP, to (CN). This energization of the relay VP causes its contacts to be again actuated to their left hand positions.

The third deenergized period or time space on the line circuit is repeated by the relay FP causing the relay 3V to be picked up and stuck up, as will be later explained in detail.

Thus, the application of the third impulse to the line circuit and the resulting response of the relay FP causes the relay VP to be energized by a circuit closed from (B-) through a circuit including front contact 17 of relay 3V, back contact 16 of relay 4V, windings of relay VP, front contact 15 of relay FP, to (CN). This energization

of the relay VP causes its contacts to be actuated to right hand positions.

The fourth deenergized period or time space on the line circuit is repeated by the relay FP causing the relay 4V to be picked up and stuck up, as will be later explained in detail, until the transfer relay TR is picked up at which time the stick circuits for all the stepping relays are opened and all of the stepping relays thus assume dropped away positions, as will be later explained more in detail, all of which occurs during the fourth deenergized period.

Thus, the application of the fourth impulse to the line circuit 1 and the resulting response of the relay FP causes the relay VP to be again actuated to the left by reason of a circuit closed with all of the stepping relays deenergized, as previously pointed out in detail.

The fifth deenergized period or time space on the line circuit is repeated by the relay FP causing the relay IV to be picked up and stuck up, as will be later explained in detail.

Thus, the application of the fifth impulse to the line circuit 1 and the resulting response of the relay FP causes the relay VP to be energized from (B-) through a front contact 19 of the relay IV so that its contacts are actuated to right hand positions.

The sixth deenergized period or time space on the line circuit is repeated by the relay FP causing the stepping relay 2V to be picked up and stuck up, as will be later explained in detail.

Thus, the application of the sixth impulse to the line circuit 1 and the resulting response of the relay FP causes the relay VP to be energized from (B+), through front contact 18 of relay 2V, as previously explained, thereby actuating its contacts to the left.

The seventh deenergized period or time space on the line circuit is repeated by the relay FP causing the stepping relay 3V to be picked up and stuck up, as will be later explained in detail.

Thus, the application of the seventh impulse to the line circuit 1 and the resulting response of the relay FP causes the relay VP to be energized from (B-) through front contact 17 of relay 3V, as previously explained, so that its contacts are actuated to right hand positions.

The application of the eighth and last impulse of the cycle or series does not result in the change in position of the relay VP, as no more operations are required. The relay VP remains in its right hand position until all of the stepping relays are dropped away upon the dropping away of the relay SA for the prolonged eighth impulse marking the end of the cycle of operation. It might be noted in this connection that the character of the eighth impulse may not be the character of the normal energization of the line circuit, so that a slight interruption of the line circuit is required in such cases for reversal to the normal polarity, but this is immaterial insofar as the operation of the stepping bank is concerned.

As the series of impulses assumed for the embodiment of the present invention is considered to comprise eight impulses and eight time spaces, it is apparent that the series of impulses has operated each of the stepping relays V twice, and between each such operation one operation of the relay VP has occurred. It is to be noted in this connection that an even number of stepping relays is preferable, so as to position the relay VP properly just prior to the transfer, as will be explained more in detail hereinafter.

Although the relay VP has been illustrated as

being of the polar magnetic stick type for the specific embodiment of this invention, it is to be understood that any other type of VP relay may be employed, such as a differential relay, or just a neutral relay with suitable control circuits.

Operation of stepping relays.—The manner in which the stepping relays 1V, 2V, 3V and 4V are caused to be picked up successively and then dropped away substantially simultaneously followed by a repeated successive picking up, will now be explained in detail.

The first deenergized period on the line circuit results in the picking up of the stepping relay 1V following the response of the relay SA by reason of a circuit closed from (+), through a circuit including back contact 5 of relay FP, front contact 6 of relay SA, polar contact 7 of relay VP in a left hand position, back contact 9 of relay 2V, windings of relay 1V, to (—). The response of the contacts of the relay 1V closes its stick circuit from (+), through a circuit including back contact 29 of relay TR, front contact 28 of relay SA, front contact 11 of relay 1V, windings of relay 1V, to (—).

With the stepping relay 1V picked up during the first deenergized period of the line circuit 1, the application of the first impulse causes the contacts of the relay VP to be actuated to right hand positions, as previously described.

Thus, upon the second deenergization of the line circuit 1, as repeated by the relay FP, the pick-up circuit for the relay 2V is closed from (+), through a circuit including back contact 5 of relay FP, front contact 6 of relay SA, polar contact 7 of relay VP in a right hand position, back contact 8 of relay 3V, front contact 10 of relay 1V, windings of relay 2V, to (—). The response of the contacts of the relay 2V closes its stick circuit from (+), through a circuit including back contact 29 of relay TR, front contact 28 of relay SA, front contact 12 of relay 2V, windings of relay 2V, to (—).

With the stepping relay 2V picked up during the second deenergized period of the line circuit 1, the application of the second impulse causes the actuation of the contacts of the relay VP to left hand positions, as previously described.

Thus, when the third deenergized period or time space marked off on the line circuit 1 is repeated by the relay FP, the pick-up circuit for the relay 3V is closed from (+), through a circuit including back contact 5 of relay FP, front contact 6 of relay SA, polar contact 7 of relay VP in a left hand position, front contact 9 of relay 2V, windings of relay 3V, to (—). The response of the contacts of the relay 3V closes its stick circuit from (+), through a circuit including back contact 29 of relay TR, front contact 28 of relay SA, front contact 13 of relay 3V, windings of relay 3V, to (—).

With the stepping relay 3V picked up during the third deenergized period marked off on the line circuit, the application of the third impulse causes the actuation of the contacts of the relay VP to be actuated to right hand positions, as previously described.

When the fourth deenergized period or time space marked off on the line circuit is repeated by the relay FP, the pick-up circuit for the relay 4V is closed from (+), through a circuit including back contact 5 of relay FP, front contact 6 of relay SA, polar contact 7 of relay VP in a right hand position, front contact 8 of relay 3V, windings of relay 4V, to (—). The response of the contacts of the relay 4V closes its stick circuit

from (+), through back contact 29 of relay TR, front contact 28 of relay SA, front contact 14 of relay 4V, windings of relay 4V, to (—).

With the stepping relay 4V picked up, the transfer relay TR is energized opening the stick circuits of the stepping relays V at back contact 29 so that they are all deenergized. This causes the transfer operation.

Transfer operation.—The picking up of the stepping relay 4V energizes the transfer relay TR by a circuit closed from (+), through a circuit including front contact 22 of relay 4V, windings of relay TR, to (—). The response of the transfer relay TR closes its stick circuit from (+), through a circuit including front contact 20 of relay SA, front contact 21 of relay TR, windings of relay TR, to (—).

It is to be noted in this connection that the picking up of the transfer relay may be dependent upon the reception of the proper code at a field station during the first group of steps, so that in the event of the failure of the code call assigned to that field station, the relay TR does not pick up and the stepping operation at such field station is discontinued. This has not been shown in the present disclosure, but it is to be understood that such control may be inserted in connection with the present invention without departing therefrom, by suitably controlling the positive energy (+) applied to the contact 22 of relay 4V with code responsive means as shown for example in the copending application of N. D. Preston, et al, Ser. No. 455,304, filed May 24, 1930 and corresponding to the French Patent No. 717,105, published January 4, 1932.

The picking up of the transfer relay TR opens the stick circuits of the stepping relays 1V, 2V, 3V and 4V at its back contact 29. It is noted that the relays 1V, 2V and 3V are deenergized simultaneously and therefore drop away substantially simultaneously, but as the transfer relay is picked up during the same period as the picking up of the stepping relay 4V, the pick-up circuit for the relay 4V remains closed until the stepping relay 3V drops away. This results in the sequential dropping away of the relays 3V and 4V during this fourth time space period.

Upon the application of the fourth impulse to the line circuit, the contacts of the relay VP are actuated from right hand positions to left hand positions, as previously described. As soon as the contact 26 of relay VP assumes a left hand position, a pick-up circuit is closed for the transfer repeating relay TRP, as the transfer relay TR is now picked up. This circuit for the relay TRP is closed from (+), through a circuit including polar contact 26 of relay VP in a left hand position, front contact 25 of relay TR, windings of relay TRP, to (—). Upon the response of the contacts of the relay TRP, a circuit is closed from (+), through a circuit including front contact 23 of relay SA, front contact 24 of relay TRP, windings of relay TRP, to (—).

The response of the relay TRP upon the fourth impulse period, for example, prepares the stick circuits for the stepping relays for the remaining part of the cycle of operation by the closure of its front contact 30.

Stepping operation continued.—With the contacts of the relay VP in left hand positions by reason of the closure of its circuit, previously pointed out, with all of the stepping relays deenergized and the front contact 15 of the relay FP closed during the fourth impulse period, then upon the fifth deenergized period or time space

marked off on the line circuit, the pick-up circuit for the relay IV is again closed, as previously described. The response of the relay IV then closes its stick circuit from (+), through a circuit including front contact 30 of relay TRP, front contact 28 of relay SA, front contact 11 of relay IV, windings of relay IV, to (-).

With the stepping relay IV picked up during the fifth deenergized period of the line circuit, the application of the fifth impulse causes the relay VP to actuate its contacts to right hand positions, as previously described.

When the sixth deenergized period or time space marked off on the line circuit is repeated by the relay FP, the relay 2V is picked up by reason of the closure of its pick-up circuit, as previously described, and is then stuck up through its stick circuit including front contact 30 of relay TRP.

With the stepping relay 2V picked up during the sixth deenergized period of the line circuit 1, the application of the sixth impulse causes the relay VP to actuate its contacts to left hand positions, as previously described.

When the seventh deenergized period or time space marked off on the line circuit is repeated by the relay FP, the pick-up circuit for the relay 3V is closed, as previously described, and upon the response of its contacts, its stick circuit is closed including front contact 30 of relay TRP.

With the stepping relay 3V picked up during the seventh deenergized period of the line circuit 1, the application of the seventh impulse causes the relay VP to actuate its contacts to right hand positions, as previously described.

When the eighth deenergized period or time space marked off on the line circuit is repeated by the relay FP, the pick-up circuit for the relay 4V is closed, as previously pointed out, and upon the response of its contacts its stick circuit is closed including front contact 30 of relay TRP.

As there is no energy applied to front contact 16 of relay 4V, then upon the application of the eighth impulse to the line circuit, the contacts of the half step relay remain in their last operated positions, namely, to the right. Thus, should there be an abnormal number of impulses applied to the line circuit by reason of some uncontrollable and abnormal condition, all that would happen would be repeated energization of the pick-up circuit of the relay 4V.

As the eighth impulse period marks the end of the series of impulses, it is prolonged for a predetermined time, even though a succeeding series of impulses may be immediately placed upon the line; or it is prolonged indefinitely if the system goes into a period of rest when there are no controls or indications to be transmitted. This causes the relay SA to drop away after a predetermined period of time thereby deenergizing the stick circuits of all of the stepping relays at its contact 28. In this connection it may be noted that the eighth impulse may be followed by a very short deenergization of the line circuit in order to reverse the polarity to the normal polarity for a period of rest, but this does not effect the operation of the stepping bank, as such reversal of polarity including a short deenergization of the line circuit would occur after the dropping away of the relay SA, and could do nothing because of its short duration.

The deenergization of the relay SA also opens the pick-up circuits of the stepping relays at its front contact 6, as well as the stick circuits of the relays TR and TRP at front contacts 20 and 23 respectively. It is noted that the transfer relay

does not drop away until the stepping relay 4V has dropped away, thereby opening its pick-up circuit, but the transfer repeating relay is immediately deenergized upon the opening of front contact 23 as the front contact 26 of the relay VP is in a right hand position upon the deenergization of the relay SA and does not assume its left hand normal position until all of the stepping relays have become deenergized. This provides sufficient time for the relay TRP to drop away. Thus, it will be seen that the relays TR and TRP are successively picked up in that order but are successively deenergized in the opposite order.

Having thus described the stepping operation, it is convenient to now point out the closure of the channel circuits.

Channel circuits.—As explained above, the half step relay VP operates during the energized periods of the line circuit; while the full step relays V assume new positions during the deenergized periods. Thus, the shift from one channel circuit to the other by the relays V is accomplished during the deenergized periods of the line circuit.

The control for certain of the channel circuits is undisclosed, as it may be provided in accordance with the requirements of practice, but for the purpose of showing one use of channel circuits, certain other channel circuits are energized with positive or negative potential in accordance with right or left hand positions of the polar contact 3 of the line relay F. The channel circuits are indicated as terminating at letter reference characters CH having preceding numerals designating the order in which these channel circuits are made up. For example, the normal channel circuit is designated by zero or OCH and is completed during the time that the system is at rest. The first channel circuit is designated by 1CH and is completed during the first energized period or impulse period following the response of the relay SA to the initial opening of the line circuit, and therefore includes a front contact 34 of the stepping relay IV.

The channel circuits are sequentially prepared by the stepping bank and may be employed for the various purposes required in a code type system of the type contemplated in accordance with the present invention. The channel circuits OCH, 1CH, 2CH and 3CH include the back contact 39 of the transfer relay TR; while the channel circuits 4CH, 5CH, 6CH, 7CH and 8CH include the front contact 27 of the transfer relay TR.

More specifically, the first channel circuit is closed from the time the relay IV picks up until the relay 2V picks up and is shown as a circuit from X and including back contact 39 of relay TR, back contact 31 of relay 4V, back contact 32 of relay 3V, back contact 33 of relay 2V, front contact 34 of relay IV, to 1CH.

It is noted that the channel circuit 4CH includes all of the stepping relays deenergized but includes the transfer relay TR picked up. This channel circuit is closed for the fourth impulse period and is prepared in plenty of time, as the stepping relays are deenergized and the transfer relay TR is picked up during the fourth deenergized period on the line circuit.

During the fifth deenergized period the channel circuit 5CH is prepared, so that upon the fifth impulse the relay DR can be controlled in accordance with that impulse. More specifically, upon the application of the fifth impulse, the channel

circuit 5CH is energized with positive or negative potential from (B+) or (B-) depending upon the position of contact 3 of the line relay F, through a circuit including front contact 27 of relay TR, back contact 35 of relay 4V, back contact 36 of relay 3V, back contact 37 of relay 2V, front contact 38 of relay IV, windings of relay DR, to (CN). The polar contact 40 of relay DR is operated to a right or a left hand position depending upon whether the relay DR is energized with positive or negative potential respectively.

This control of the relay DR on the channel circuit 5CH in accordance with the character of the fifth impulse illustrates how a similar magnetic stick type relay may be controlled on each of the channel circuits in accordance with the respective impulses for such channel circuits. These impulses on the line circuit 1 may be suitably selected in accordance with a code, or the like, and control these magnetic stick type relays selectively in accordance with such code over the channel circuits formed by the stepping relay bank which operates through its cycle of operation irrespective of the character of such impulses. In other words, the present invention shows how impulses of selected polarity on a line circuit may cause the operation of a stepping relay bank irrespective of their character, while a relay for each of the impulses may be positioned in accordance with the character of its respective impulse. This is but one use of the channel circuits, and it is to be understood that the channel circuits provided by the present invention may be employed for any purpose desired in a selector or code type system in accordance with the usual practices.

For the purpose of summarizing the usage of the term channel circuit in this application, it is desired to state that the channel circuit of a stepping relay bank is considered to be a circuit which is prepared or closed upon the operation of one stepping relay and opened upon the operation of the succeeding stepping relay of the bank and not again closed until a succeeding cycle of operation of the stepping relay bank, which channel circuit thus prepared is always prepared upon each repeated operation of the stepping relay bank, to thereby provide an arrangement which corresponds to a rotary selector wherein distinctive circuits are prepared by the selector in each of its different positions. It is of course understood that the zero or normal channel circuit is completed when the stepping relays are in their normal at rest positions, similarly as a distinctive circuit may be prepared by a rotary selector when it is at rest.

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

What I claim is:

1. In combination, a line circuit having a series of time spaced impulses applied thereto, a repeating relay responsive to the impulses of said series so as to be picked up for each impulse and to be dropped for each time space, a cycle demarking relay responsive to the impulses of said series so as to be picked up at the beginning of said series and dropped at the end of said series, a number of stepping relays equal to one-half the number of impulses in said series, a single half-step relay, a pick up circuit for each of said stepping relays, circuit means for actuating said half-step relay to an opposite position for each picking up of said repeating relay, means including said repeating relay in a dropped away position and said half-step relay in said opposite positions alternately for successively energizing said pick up circuits of said stepping relays, a stick circuit for each of said stepping relays including a front contact of said cycle demarking relay, 15 means only momentarily opening said stick circuits when the last stepping relay is picked up said means acting independently of said cycle demarking relay, whereby said stepping relays are all dropped away and are again successively picked up during the remaining impulses of said series, and circuit means closing a different channel circuit each time a stepping relay is picked up during said series of impulses.

2. In combination, a line circuit having a series of time spaced impulses applied thereto, a repeating relay responsive to the impulses of said series so as to be picked up for each impulse and to be dropped for each time space, a cycle demarking relay responsive to the impulses of said series so as to be picked up at the beginning of said series and dropped at the end of said series, a number of stepping relays equal to one-half the number of impulses in said series, a single half-step relay, a pick up circuit for each of said stepping relays, circuit means for actuating said half-step relay to an opposite position for each picking up of said repeating relay, means including said repeating relay in a dropped away position and said half-step relay in said opposite positions alternately for successively energizing said pick-up circuits of said stepping relays one for each time space of said series of impulses, a transfer relay, a transfer repeating relay, a stick circuit for each of said stepping relays including a front contact of said cycle demarking relay in series with a back contact of said transfer relay, circuit means for picking up said transfer relay when said last stepping relay is picked up, whereby said stick circuits are all opened, circuit means for picking up said transfer repeating relay a short time after the picking up of said transfer relay, a front contact of said transfer repeating relay connected in multiple with said back contact of said transfer relay, whereby the stick circuits for said stepping relays are opened only momentarily, and whereby said stepping relays are successively picked up during the remaining impulses of said series, stick circuit means for said transfer and transfer repeating relays including front contacts of said cycle demarking relay, channel circuits completed by said stepping relays including a back contact of said transfer relay, and other channel circuits completed by said stepping relays including a front contact of said transfer relay.

3. In combination; a line circuit having a series of equally time spaced impulses applied thereto; a repeating relay responsive to the impulses of said series so as to be picked up for each of said impulses and dropped away for each of said time spaces; a cycle demarking relay responsive to the impulses of said series so as to be picked up at the beginning of said series and dropped away at the end of said series; a bank of stepping relays equal to one-half the number of impulses in said series, a single half-step relay, a pick up circuit for each of said stepping relays, circuit means for actuating said half-step relay to an opposite position for each picking up of said repeating relay, means including said repeating relay in a dropped away position and said half-step relay in said opposite positions alternately for successively energizing said pick-up circuits of said stepping relays one for each time space of said series of impulses, a transfer relay, a transfer repeating relay, a stick circuit for each of said stepping relays including a front contact of said cycle demarking relay in series with a back contact of said transfer relay, circuit means for picking up said transfer relay when said last stepping relay is picked up, whereby said stick circuits are all opened, circuit means for picking up said transfer repeating relay a short time after the picking up of said transfer relay, a front contact of said transfer repeating relay connected in multiple with said back contact of said transfer relay, whereby the stick circuits for said stepping relays are opened only momentarily, and whereby said stepping relays are successively picked up during the remaining impulses of said series, stick circuit means for said transfer and transfer repeating relays including front contacts of said cycle demarking relay, channel circuits completed by said stepping relays including a back contact of said transfer relay, and other channel circuits completed by said stepping relays including a front contact of said transfer relay.

4. In combination; a line circuit having a series of equally time spaced impulses applied thereto; a repeating relay responsive to the impulses of said series so as to be picked up for each of said impulses and dropped away for each of said time spaces; a cycle demarking relay responsive to the impulses of said series so as to be picked up at the beginning of said series and dropped away at the end of said series; a bank of stepping relays equal to one-half the number of impulses in said series, a single half-step relay, a pick up circuit for each of said stepping relays, circuit means for actuating said half-step relay to an opposite position for each picking up of said repeating relay, means including said repeating relay in a dropped away position and said half-step relay in said opposite positions alternately for successively energizing said pick-up circuits of said stepping relays one for each time space of said series of impulses, a transfer relay, a transfer repeating relay, a stick circuit for each of said stepping relays including a front contact of said cycle demarking relay in series with a back contact of said transfer relay, circuit means for picking up said transfer relay when said last stepping relay is picked up, whereby said stick circuits are all opened, circuit means for picking up said transfer repeating relay a short time after the picking up of said transfer relay, a front contact of said transfer repeating relay connected in multiple with said back contact of said transfer relay, whereby the stick circuits for said stepping relays are opened only momentarily, and whereby said stepping relays are successively picked up during the remaining impulses of said series, stick circuit means for said transfer and transfer repeating relays including front contacts of said cycle demarking relay, channel circuits completed by said stepping relays including a back contact of said transfer relay, and other channel circuits completed by said stepping relays including a front contact of said transfer relay.

relays having a number of relays equal to one-half the number of impulses of said series; a pick up circuit for each of said stepping relays; means including said repeating relay for energizing said pick up circuits sequentially one at a time and only one for each time said repeating relay is dropped away, said means being effective so long as there are any of said stepping relays which remain to be picked up; stick circuits for said stepping relays including a front contact of said cycle demarking relay; means for momentarily opening said stick circuits for said stepping

relays when and only when all of said stepping relays have been picked up, whereby all of said stepping relays are dropped away so that said means for energizing said pick up circuits can again cause the sequential energization of said pick up circuits in response to the remaining successive impulses of the series; and means for closing a different channel circuit each time a stepping relay is picked up during said series of impulses.

THOMAS J. JUDGE.

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