

March 3, 1942.

W. P. ALBERT

2,275,039

SIGNALING DEVICE

Filed Oct. 29, 1940

2 Sheets-Sheet 1

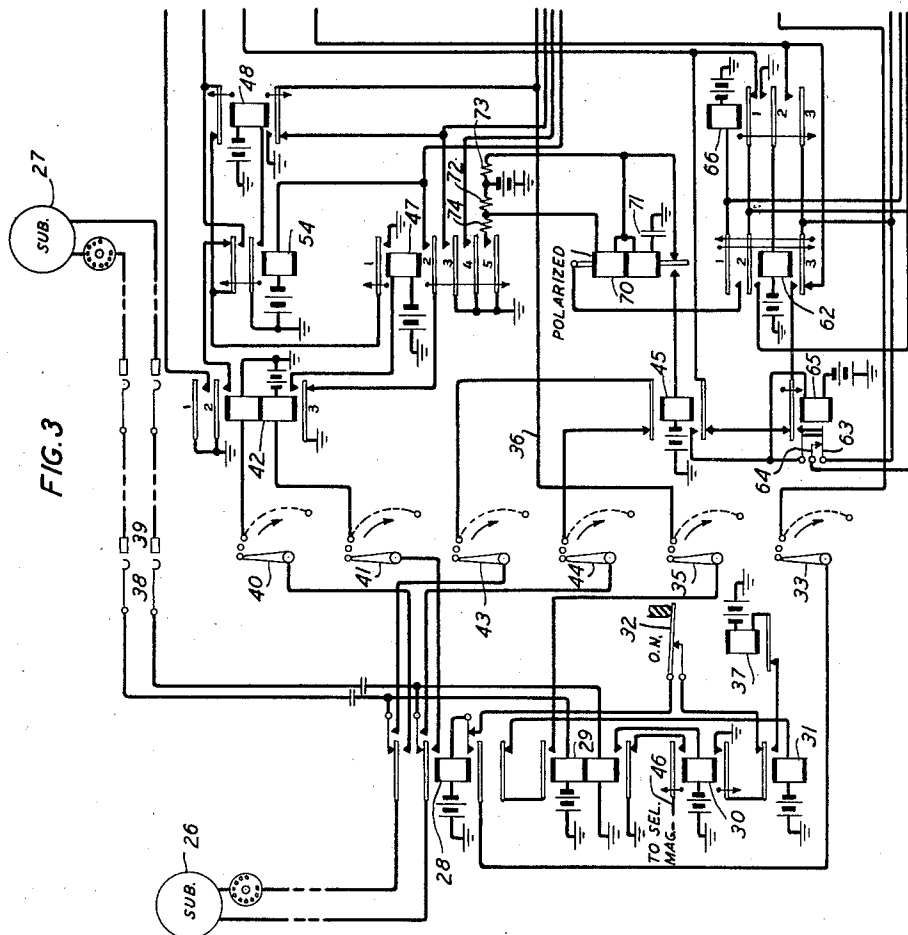
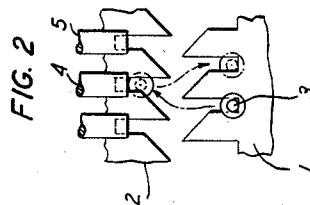
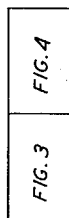


FIG. 1



INVENTOR
W. P. ALBERT
BY *John A. Hall*
ATTORNEY

March 3, 1942.

W. P. ALBERT

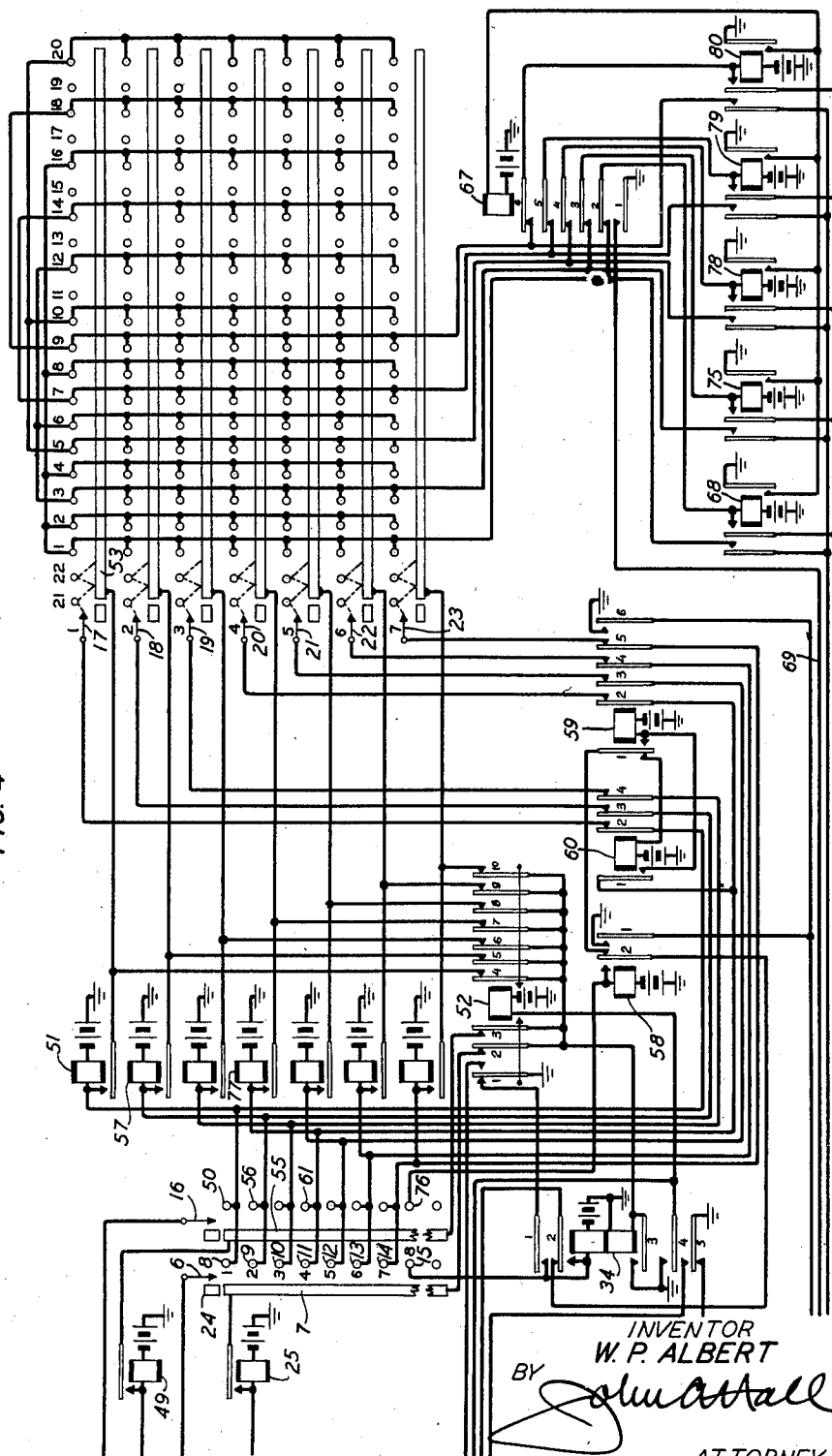
2,275,039

SIGNALING DEVICE

Filed Oct. 29, 1940

2 Sheets-Sheet 2

FIG. 4



INVENTOR
W. P. ALBERT
BY *John A. Hall*
ATTORNEY

UNITED STATES PATENT OFFICE

2,275,039

SIGNALING DEVICE

Walter P. Albert, Madison, N. J., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application October 29, 1940, Serial No. 363,274

9 Claims. (Cl. 179—18)

This invention relates to signaling systems and particularly to sending devices for transmitting trains of signal impulses.

The object of the invention is to produce an inexpensive, economical and reliable impulse sender for particular use in telephone systems which is capable of being set in a variety of ways to send a plurality of trains of digital signals.

For purposes of illustration the present invention is embodied in a register sender having incoming and outgoing terminals. Trains of digital signals are received over the incoming terminals and like trains of digital signals are transmitted over the outgoing terminals. A register sender switch per train of signals is employed together with a steering-in and a steering-out switch for successively associating the incoming and outgoing terminals respectively with said register sender switches.

A feature of the invention is the use of a single simple stepping switch per digit which will be set forward N steps to register a digit and then advanced an equal number of steps to a position 2N while sending out a corresponding digital train of impulses.

Another feature of the invention is the arrangement of the bank terminals of these digit switches, which consists in a multiple connection arrangement whereby from any terminal N a multiple connection will first be found at terminal 2N. In accordance with this feature and in the specific embodiment of the invention herein disclosed terminals 1, 2, 4, 8 and 16 are interconnected, terminals 3, 6 and 12 are interconnected, terminals 5, 10 and 20 are interconnected, terminals 7 and 14 are interconnected and terminals 9 and 18 are interconnected. Each number in the above series is followed by a number of twice its value. By this multiplying arrangement when one of these digital switches is set on any one of the terminals 1 to 10 it will thereafter have to advance a like distance before encountering a multiple connection.

In accordance with another feature of the invention the bank terminals of the plurality of digital switches are multipled to a common set of markers, so that when one of such digital switches operates to transmit a digital train of impulses it operates the common marker connected to its terminal N on to which it has been set and then advances to its terminal 2N on which it first finds the characteristic condition caused by such operation of the common marker.

Another feature of the invention is the ar-

5 rangement of the appearance of the common markers. When the digit switch begins operation to transmit outgoing impulses the first terminal it touches will be terminal N. The marker connected to terminal N will thereby be operated to put a characteristic condition on terminal 2N. Between terminals N and 2N the wiper will connect with other of the common markers but no one of them more than once so that should these other markers be energized during the movement of the wiper of the digit switch the characteristic condition will only first be found at terminal 2N.

10 In accordance with still another feature of the invention the number of common markers is less than the largest number of signals in any train of impulses that will be handled. In the specific case herein disclosed where trains of one to ten impulses are to be registered only five markers will be used. If the system were worked on the duodecimal system then six markers would be used and if worked on a system using as many as twenty signals per train then ten markers would be used. Hence it may be stated as a general rule that half as many markers are used as there are impulses in the longest train employed.

15 Still another feature resides in the transient use of the common markers. No marker is energized until the first impulse of an outgoing train is about to be dispatched and as soon as the last impulse of the train has been dispatched it is released. Thus the common markers are appropriated for use by the digit switches only during the transmission of outgoing signals.

20 Another feature of the present invention is the use of a plurality of stepping switches whose bank terminals are multipled to a common set of electroresponsive devices, which said switches may be mechanically moved to and left in various selected positions without affecting said electroresponsive devices until at a later period they are caused to again move forward separately whereupon at the beginning of such secondary forward movement each will affect such one of said electroresponsive devices which has been selected by said primary mechanical movement.

25 A further feature of the invention is the use of a switch whose wiper comes into contact with its individual terminals upon the energization of its stepping magnet. Therefore when such a switch is moved to its terminal N the initial movement of the switch magnet thereafter is to cause it to establish contact with terminal N. In accordance with this feature each train of

impulses both incoming and outgoing is automatically translated into $(N+1)$ steps of the wiper of the switch. As an example, if the digit 5 is to be registered then the switch will be caused to take six steps and the wiper will be stopped before the terminal designated 5. When the digit 5 registered is to be transmitted the switch takes six more steps, the first to make contact with the terminal designated 5 where it energizes the marker connected thereto and the last where it makes contact with the terminal designated 10 to which it is locked while the interdigit timing means is operating.

Other features will be brought out in the following description.

The drawings consist of two sheets which when placed together as indicated in Fig. 1 form a complete circuit diagram illustrating the use of this invention in a telephone system. Fig. 2 is a schematic diagram illustrating the action of a stepping switch used in this invention.

The stepping switch used herein is more fully described in my copending application, Serial No. 304,461, filed November 15, 1939, now Patent No. 2,248,212, granted July 8, 1941. It consists in general of a magnet and a rotatable arm which is caused to move through a step-by-step escapement means through the energization of the magnet. In Fig. 2, the parts 1 and 2 show the formation of the mechanical teeth forming the escapement device. A contactor here shown by its cross-section 3 normally rests in the position shown and electrical contact is made between the wire 3 and the part 1, which will hereinafter be referred to as plate 1. When the magnet is energized, the wire 3 moves upward along the track indicated by the broken arrowhead line to the position where it makes contact with the individual contact 4. When the magnet is again deenergized the contactor 3 moves downwardly and comes to rest in the next right-hand position between two escapement teeth formed in plate 1. Thus this type of stepper normally makes contact with a common electrical contact piece such as plate 1 and upon its energization successively makes contact with the individual pieces such as 4 and 5.

By way of further explanation, a number of these switches are shown in Fig. 4. Thus, for instance, a switch comprising the contactor 6, the plate 7 and individual contact pieces 8 to 15, inclusive, is shown. In one position, that is, the normal position, the movable contactor 6 will be in contact with terminal 24 which is insulated from the plate 7. Each of the switches, here designated by its contactor 6 and 16 to 23, inclusive, normally has its contactor resting in this home position where it is insulated from the plate. The contactor 6, for instance, will be resting on home segment 24. Upon the first energization of the magnet 25, the contactor 6 will move from its home position into connection with the individual contact 8 and upon the deenergization of the magnet 25 this contactor 6 will move into connection with the plate 7.

The invention is shown embodied in a telephone system where a connection is to be established from the substation 26 to the substation 27. The substation 26 in making a call establishes through well-known means a connection to the upper armatures of a relay 28 and through the back contacts of these armatures to the windings of relay 29. Relay 29 operates and causes the relay 30 to be operated in a circuit from ground through the lower armature and

front contact of relay 29 to the winding of relay 30. Upon the energization of relay 29, a circuit is established from the winding of relay 31 through the back contact and lower outer armature of relay 28 through the upper armature and front contact of relay 29, the switch brush 35, to the wire such as 36 leading to the first sender such as that shown in the right-hand portion of Fig. 3 and in Fig. 4. If this first sender is busy, the wire such as 36 will be grounded, as hereinafter will appear, whereupon relay 31 will operate and establish a circuit from ground, the front contact and lower armature of relay 30, the front contact and armature of relay 31, the back contact and armature of stepping magnet 37 to battery. Magnet 37 will operate automatically to step the brushes of this switch around just as long as relay 31 remains operated. As soon as the brush 35 makes connection with conductor 36 which is ungrounded, thereby denoting an idle sender, relay 31 will open the stepping circuit of the switch and will establish another circuit from ground, the front contact and lower armature of relay 30, the armature and back contact of relay 31, the normally closed off-normal contacts 32, the normal contacts of the inner lower armature of relay 28, the winding of relay 28 to battery. It should be noted that the off-normal contacts 32 are associated with the switch denoted by brushes 38 and terminals 39 and not with the switch denoted by brushes 33, 35, etc. Relay 28 now becomes operated and locks in a circuit through its winding, the front contact and inner lower armature of relay 28, brush 33 to the back contact and armature 5 of relay 34 which is connected to ground. As will appear hereinafter, this ground connection to the brush 33 is maintained until the sender has completed its function, whereby the cut-through relay 28 is maintained energized until the connection to subscriber station 27 has been completed. Upon the energization of relay 28, the subscriber station 26 is connected through the upper armatures of relay 28 and their front contacts to wipers 40 and 41 so that substation 26 is now supplied with battery through the windings of relay 42 and thereby causes this relay to become energized. Relay 29 is maintained energized through a connection extending through the closed alternate contacts of the upper armatures of the relay 28 through the brushes 43 and 44 to the armature and back contact of relay 45. As will be described hereinafter, the armature and back contact of relay 45 form the pulsing circuit whereby relay 29 is caused to operate to send pulses to the selector magnet over wire 46 to move the brushes 38 and the brushes of other switches in the train until the connection to the subscriber's substation 27 is completed.

Upon the energization of relay 42, relay 47 becomes energized. Relay 47 establishes a circuit from ground, front contact and armature 1 of relay 47, back contact and upper armature of relay 48, winding of magnet 49 to battery. Magnet 49 becomes operated and causes the movement of contactor 16 of the receiving director switch into connection with individual contact 50. A circuit is now established from ground, armature 1 and front contact of relay 42, contactor 16, contact 50, winding of magnet 51 to battery. Magnet 51 operates and moves contactor 17 into connection with its individual terminal 21. At this time, a circuit is established from ground, armature 3 and front contact of relay 47, winding of relay 52 to battery, whereby relay 52 is

caused to operate. This same ground is extended to the conductor 36 through the back contact and lower armature of relay 48. Also, ground through the armature 1 and front contact of relay 52 is connected to conductor 36.

The switch designated by its contactor 17 is now in condition to receive the first digit. The subscriber at substation 26 operates the dial thereat and causes relay 42 to become deenergized upon each opening of the line representing a digital impulse. If a train of these impulses is sent, each one will be represented by a break in the circuit including the contactor 16 and the magnet 51 so that this magnet will operate as follows: If the train consists of but a single impulse, magnet 51 will be deenergized once resulting in the movement of contactor 17 into connection with the plate 53. At the end of this impulse, magnet 51 will become energized again moving the contactor 17 into connection with the twenty-second contact of this switch and at the end of the train of impulses the magnet 51 will become deenergized this time moving the contactor 17 into connection with plate 53 and poised before the first contact of this switch.

In like manner, if the train of impulses consists of two impulses the contactor 17 will be left in connection with the plate 53 poised before the second contact of this switch, etc. In every case, the contactor 17 will be left in connection with the plate 53 and poised before that numbered contact of the switch which corresponds with the number of impulses in the digital train.

Upon the release of relay 42 in any digital train of impulses which may be operating relay 42, a circuit will be established from the lower armature and back contact of relay 42, armature 2 and front contact of relay 47, the winding of relay 54 to battery and ground. Relay 54 will operate and cause the operation of relay 48 whereupon the originally described circuit for magnet 49 will be opened but a substitute circuit will be found through the upper armature and front contact of relay 54. Relay 54 is slow in releasing and will remain operated throughout the sending of a digital train of impulses but will release a timed interval thereafter. Relay 48 is also slow releasing and will therefore release a timed interval after the release of relay 54. Therefore, after a train of impulses has been sent, relay 54 releases and opens the circuit of magnet 49 whereupon the contactor 16 moves out of connection with the individual contact 50 and comes to rest upon the plate 55. A short interval thereafter relay 48 becomes deenergized whereupon the originally described circuit for magnet 49 is established. Magnet 49 becoming energized now causes the contactor 16 to move into connection with the individual contact 56 so that ground is now extended to the winding of magnet 57 which energizes and moves the contactor 18 of the second switch forward one step. Upon receipt of impulses of the second digital train contactor 18 is moved to a particular contact in the same manner as contactor 17 of the first switch.

In this manner each of the switches designated by the contactors 17 to 23, inclusive, is set in accordance with the digital impulses sent from the substation 26. By way of example and in accordance with practice which is standard in many localities, the designation of the substation 27 comprises seven digits, the first three of which are known as the office code. Therefore, seven individual switches are provided.

Upon the first operation of relay 47, a circuit

is established from ground, armature 4 and front contact of relay 47, armature 2 and back contact of relay 34, armature 2 and back contact of relay 58, armature 1 and back contact of relay 59, winding of relay 60 to battery. Relay 60 becomes operated and disconnects the contactors 17, 18 and 19 from the windings of magnets operating them. Thus during the setting of the contactors 17, 18 and 19, the circuits connected to them are open, therefore, the contacts of these switches will remain undisturbed by the initial movement of the contactors. After the contactor 19 has been completely set and contactor 16 moves into connection with contact 61, a circuit is established from ground, armature 1 and front contact of relay 42, contactor 16, individual contact 61, armature 1 and front contact of relay 60, winding of relay 59 to battery. Relay 59 becomes operated and locks through its front contact and armature 1 to the ground originally supplied for the energization of relay 60. Relay 60 now becomes deenergized and establishes connection between the contactors 17, 18 and 19 and their respective driving magnets. Upon the operation of relay 59 a circuit is established from ground, front contact and armature 6 of relay 59 through the armature 3 and back contact of relay 62, to the winding of magnet 25. Magnet 25 controls the contactor 6 and through its energization drives this contactor 6 into connection with individual contact 8 whereby connection is made to magnet 51 controlling contactor 17. Ground at the armature 6 of relay 59 is now extended through the springs 63 and 64 of relay 65, thence over armature 1 and back contact of relay 66 to contactor 6 through individual contact 8, and the winding of magnet 51 to battery. Magnet 51 becomes energized and moves the contactor 17 which as we have assumed is poised before the first contact of this switch, into connection with such contact. The ground for operating magnet 51 is now extended over armature 2 and back contact of relay 60 to contact 17 and since this contactor has now moved into connection with its first individual contact, this ground will be extended over the back contact and armature 2 of relay 67, thence to winding of relay 68 and battery. Relay 68 becomes operated and locks through its front contact and inner left-hand armature to the ground supplied over springs 63 and 74 of relay 65. Upon the operation of relay 68, relay 67 becomes operated through the right-hand armature and front contact of relay 68 so that the circuits for energizing the marking relays 68, 75, 78, 79 and 80 are now opened. Upon the operation of relay 67, a ground is extended over armature 1 of relay 67 to conductor 69 and thence to the winding of relay 66. Relay 66 in operating causes the operation of relay 62 through ground, front contact and armature 2 of relay 66. Relay 66 at its armature 1 opens the original circuit whereby ground was extended over the contactor 6 to the magnet 51 and contactor 17. Magnet 25, however, is maintained operated through the front contact and armature 3 of relay 66 from ground through armature 6 and front contact of relay 59. Ground on conductor 69 besides operating relay 66 is now extended over armature 1 and front contact of relay 62 to the armature of polarized relay 70.

The right-hand contact of the polarized relay connects to the junction between the upper and lower windings of the relay and hence the lower winding and condenser 71 are now short-circuited and current will flow through the upper winding

from battery, resistance 72, the upper winding of relay 70 to ground. When the condenser 71 becomes discharged, the current in the upper winding of this relay will drive its armature to the left-hand contact where the ground on the armature will cause the operation of relay 45. Removal of the short circuit about the lower winding of relay 70 and condenser 71 allows condenser 71 to again become charged whereupon the current in the upper winding now being changed due to the removal of ground from the resistance 73 will drive the armature of the polarized relay 70 back to its right-hand contact. Due to the proper proportioning of the electrical constants of the circuit for the polarized relay 70 including the resistances 72, 73 and 74 and the condenser 71 in combination with the windings of the relay 70, this relay will cause the operation of relay 45 at the particular rate which will open the circuit through the upper armature and back contact of relay 45 to transmit properly timed impulses.

Upon the operation of relay 66, the original circuit for placing ground on the contactor 6 is replaced by a circuit which may now be traced from ground, front contact and armature 6 of relay 59, armature 3 and front contact of relay 62, armature and back contact of relay 65, back contact and lower armature of relay 45, to the contactor 6. Therefore, when the polarized relay 70 is operated to begin pulsing, the movement of the lower armature of relay 45 will remove the ground from contactor 6 and hence cause the deenergization of magnet 51.

It was previously assumed that the switch having contactor 17 was set for one impulse. Merely by way of example, it will be assumed that the designation to be recorded on these digit switches will be 123—4567. When relay 59 became deenergized then magnet 25 was energized as described and contactor 6 was driven into engagement with its first contact (so numbered). Now as relay 66 becomes energized and causes the energization of relay 62 there is a slight interval due to the slow acting characteristic of relay 62 during which the connection to contactor 6 is opened. Therefore, magnet 51 becomes deenergized and moves contactor 17 into engagement with plate 53 and poised before the second contact of this switch. Upon the energization of relay 62 to cause the polarized relay 70 to begin pulsing the circuit for contactor 6 is again closed and contactor 17 moves into engagement with the second contact whereupon a locking circuit is established, extending from ground, front contact and armature 6 of relay 59, contacts 63 and 64 of relay 65, armature 2 and front contact of relay 62, outer left-hand armature and front contact of relay 68, multiple connections to contacts 1 and 2 of the digit switches, contactor 17 now resting on its second contact, back contact and armature 2 of relay 60, winding of magnet 51. This ground is also extended back to contact 8, contactor 6 to the lower armature of relay 45 so that when relay 45 is energized to transmit the first pulse a circuit will be extended to the winding of relay 65 to stop further pulsing. Relay 65 will lock in a circuit which may be traced from ground, the front contact and armature 6 of relay 59, armature 3 and front contact of relay 62, armature and front contact of relay 65 to battery and ground. Relay 65, therefore, opens the circuit to the contactor 6 so that when relay 45 returns to its unoperated position, ground will not be again connected to the contactor 6. Contacts

63 and 64 are now operated and result in the removal of ground from the inner left-hand armature of relay 68 whereby this relay is allowed to become deenergized. Relay 68 in turn removes the ground causing the operation of relay 67 so that this relay becomes deenergized. Relay 67 removes ground from conductor 69 which, therefore, in turn removes ground from the polarized relay 70 and stops the pulsing of this relay. At the same time, relay 66 is deenergized. This relay being slow to release, therefore after an appropriate interval opens the connection between its armature 3 and its front contact whereby the stepping magnet 25 becomes deenergized and the contactor 6 is driven into connection with the plate 7. Relay 66 also opens the winding of relay 62 and this relay is also somewhat slow to release whereby the magnet 25 is allowed to deenergize between the interval after the release of relay 66 and before the release of relay 62. When, however, relay 62 becomes fully released the circuit for magnet 25 will be again established and the contactor 6 will be driven into connection with the individual contact 9. When relay 65 releases it recloses its contacts 63 and 64 thereby connecting ground to contactor 6 thence to the magnet 52 which energizes and causes the contactor 18 which, in this case, we have assumed is poised before the second contact of its switch, to be driven into connection with this contact.

The timing of sequence release of relays 66, 62, and 65, provides the proper interdigit space so that the trains of impulses being sent out from this device not only will be properly timed by the action of relay 70 but will be properly spaced by the action of relays 66, 62 and 65.

When the contactor 18 is moved into connection with its second contact, relay 68 is again operated in the manner hereinbefore described since the first and second contacts of all switches are multipled together. The next multiple appearance for relay 68 after contact 2, however, is on the fourth contact therefore relay 70 and consequently relay 45 will be operated twice before relay 65 operates to stop this set of impulses. Hence, when the contactor 18 is originally poised before the contact 2, it will automatically take two steps until the fourth contact is reached and thereby cause the transmission of two impulses.

In the same manner if we assume that the contactor 19 has been originally poised before the third contact of its switch then when it is moved into connection with this contact, it will cause the operation of relay 75 and will therefore take three steps before reaching another appearance of the relay 75 at the sixth contact before it will be stopped. Hence, in this case, relay 45 will have been operated three times to send out a train of three impulses.

It has been described herein how the transmission of impulses may be started as soon as the first three digits having the contactors 17, 18 and 19 have been set and hence the transmission of these three digits may be going on while the remaining switches having the contactors 20 to 23, inclusive, are being set. If the transmission of the digit registered on the switch having the contactor 19 is accomplished before the next four digits have been registered, then there will be a pause in the transmission by the relay 45. When the registration has been completed, however, the contactor 16 of the receiving director switch will be driven to its individual contact 76 whereupon the relay 58 will be energized and will lock

through its front contact and inner right-hand armature over the back contact and armature 2 of relay 34, front contact and armature 4 of relay 47 to ground. Relay 58 through a front contact and armature 1 provides a ground as a substitute for that supplied over the front contact and armature 6 of relay 59 and through the movement of its armature 2 opens the locking circuit of relay 59. As soon as relay 59 is released, the transmission of the last four digits will commence. As the contactor 6 is driven into connection with its individual contact 11 magnet 77 is operated, thereby moving the contactor 20 into connection with what we will now assume to be its fourth contact. This action may proceed or follow the release of relay 59 but either condition will await the other before one of the marking relays 68, 75, etc., can be energized in order to resume sending out pulses which is dependent upon the grounding of lead 69 by the operation of relay 67. As soon as magnet 77 is energized and relay 59 becomes released, however, ground will be placed on contactor 20 which is now in connection with its fourth contact whereby relay 68 is again operated. At this time the contactor 20 will have to advance to its eighth contact before it finds another appearance of the relay 68 and hence the polarized relay 70 and the relay 45 will cause the transmission of four impulses before the movement of the contactor 20 is stopped. In a similar manner, the contactors 21, 22 and 23 will be successively advanced. If we assume that the contactor 21 has been driven to the fifth contact, it will cause the operation of relay 78 and then take five more steps to the tenth contact before it finds another appearance of this relay. If we assume that contactor 22 has been driven to the sixth contact it will then cause the operation of relay 75 and will be driven forward another six steps until it finds a multiple connection on the twelfth contact of relay 75. If we assume that the contactor 23 has been driven to its seventh contact then it will cause the operation of relay 79 and will be driven automatically thereafter another seven steps until it finds the first multiple connection to relay 79 on its fourteenth contact.

Special attention is called to the multiple connection arrangement to the contacts of these digit switches. It will be noted that contacts 1, 2, 4, 8 and 16 are connected together to control and be controlled by relay 68. Contacts 3, 6 and 12 are multiplied together to control and be controlled by relay 75. Contacts 5, 10 and 20 are multiplied together to control and be controlled by relay 78. Contacts 7 and 14 are multiplied together to control and be controlled by relay 79 and, lastly, contacts 9 and 18 are multiplied together to control and be controlled by relay 80. Thus any digit switch which is driven by incoming impulses to a particular contact will in controlling the transmission of outgoing impulses be driven automatically an equal number of steps so that the train of outgoing impulses is the same in number as the train of incoming impulses.

It should be noted that the upper armature and back contact of relay 45 control a circuit passing through wipers 43 and 44 to the windings of relay 29. Relay 29 on its back contacts controls a circuit to conductor 46 leading to the selector magnet of the switch and this represents schematically the means whereby the outgoing impulses affect the train of switches to cause the connection between the subscriber's substation 26 and the subscriber's substation 27. It will be

understood that this portion of the showing is of a highly schematic nature since the invention is contained within the circuit leading from the contacts accessible to the wipers 33, 35 and 40 to 44, inclusive.

When the last train of impulses has been completely transmitted, the contactor 6 will move into connection with its individual contact 15 whereupon relay 34 will become operated. Relay 34 now locks through its front contact and armature 2 to the front contact and armature 4 of relay 47 which is connected to ground. Upon the operation of relay 34 and the movement of its armature 5 ground is removed from the contact connected to wiper 33 whereupon the cut-through relay 28 is released and the winding of relay 42 is opened. Relay 42 becoming open allows, in time, the release of relays 47, 48 and 54.

The switches are stepped to their respective normal condition by the joint operation of relays 34 and 52. The release of relay 47 opens the locking ground for relay 34 and it releases which in turn releases relay 52 as the former energization circuits for relay 52 are opened by the release of relay 47 and the operation of relay 48. As soon as relay 52 releases, it closes battery from all the switches through the contactors which are resting on their respective common plates through the lower high resistance winding of relay 34 to ground. Relay 34 becoming energized locks on its upper winding to the back contact and armature 1 of relay 52 and closes ground directly to all magnet windings through the back contacts of relay 52. Relay 34 closes ground to the winding of relay 54 which being slow in releasing will not release during the pulsations of relay 34 so that relay 48 is maintained energized which in turn keeps the conductor 36 continuously grounded to prevent reselection. All magnets of switches having contacts on the common plate will energize. Before the contactors break their plate connections, relay 34 closes a circuit to operate relay 52 but relay 52 is slightly slow to operate to give the slowest of the magnets such as 51, 57 and 77 time to fully operate. When relay 52 operates, it simultaneously opens the circuit for all magnets and they release taking a step and again resting their contactors on their common plates. The operation of relay 52 unlocks relay 34 which releases followed thereafter by the release of relay 52. The above operation is then repeated and each switch again stepped toward its home or normal position represented by a break in the plates such as 29 to which there is no connection. As each switch reaches its home position, it will remain there but relays 34 and 52 will continue pulsing until all switches are normal. When all switches are at normal no battery will be connected through the common plates to energize relay 34 when relay 52 releases. Hence relay 54 will shortly release followed by the release of relay 48 which removes ground from conductor 36 as an indication that the circuit is available for another call.

If any switch is moved off normal manually while the circuit is idle the battery from its magnet through its common plate will energize relay 34. This operates relays 48 and 54 to make the circuit busy and proceeds to return the switch to normal by the interaction of relays 34 and 52. Relays 54 and 48 will then release freeing the circuit. An abandoned call is handled in about the same manner and all off-normal switches are returned while the circuit is held busy by ground on lead 36.

What is claimed is:

1. An impulse transmitter comprising a stepping switch having a wiper and a series of terminals, said terminals being multiplied by having the 1st, 2nd, 4th, 8th and 16th terminals interconnected, the 3rd, 6th and 12th terminals interconnected, the 5th, 10th and 20th terminals interconnected, the 7th and 14th terminals interconnected and the 9th and 18th terminals interconnected whereby a condition placed on a terminal to which said wiper has been moved will be first found an equal number of steps therebeyond.

2. An impulse transmitter comprising a stepping switch having a wiper and a series of terminals, said terminals being multiplied by having the 1st, 2nd, 4th, 8th and 16th terminals interconnected, the 3rd, 6th and 12th terminals interconnected, the 5th, 10th and 20th terminals interconnected, the 7th and 14th terminals interconnected and the 9th and 18th terminals interconnected whereby a condition placed on a terminal to which said wiper has been moved will be first found an equal number of steps therebeyond.

3. An impulse transmitter comprising a stepping switch having a wiper and a series of terminals, means for selectively setting said switch, said terminals being multiplied at terminals N and 2N and having a marking device for registering a condition on the multiples of such a terminal before which said wiper has been selectively placed, whereby a marking condition placed on a terminal will be first found an equal number of steps therebeyond.

4. An impulse transmitter comprising a stepping switch having a wiper and a series of terminals and having a capability of sending trains of one to ten impulses, means for selectively setting said switch before a terminal N corresponding to the numerical value of a train of impulses to be transmitted, said terminals being multiplied at terminals N and 2N, and a plurality of marking devices connected to said multiplied terminals responsive to the said selective setting of said switch before terminal N for placing a characteristic condition on the terminals multiplied to terminal N whereby said wiper in further advancing to transmit impulses will first encounter said characteristic condition on terminal 2N.

5. A register sender having incoming and outgoing terminals and means for transmitting over said outgoing terminals trains of impulses corresponding to trains of impulses received over said incoming terminals comprising a register sender switch per train of impulses, said register sender switches having their bank terminals multiplied at terminals N and 2N whereby each said register sender switch will take as many steps in transmitting impulses over said outgoing terminals as it was caused to take by the impulses received over said incoming terminals.

6. A register sender having incoming and outgoing terminals and means for transmitting over said outgoing terminals trains of impulses corresponding to trains of impulses received over said incoming terminals comprising a register sender switch per train of impulses, said register sender switches having their bank terminals

multiplied to a common set of markers less in number than the maximum number of impulses in any train of impulses and arranged so that said markers are multiplied at terminals N and 2N whereby each said register sender switch will take as many steps in transmitting impulses over said outgoing terminals as it was caused to take by the impulses received over said incoming terminals.

7. A register sender having incoming and outgoing terminals and means for transmitting over said outgoing terminals trains of impulses corresponding in number of impulses to trains of impulses received over said incoming terminals comprising a register sender switch per train of impulses, means for advancing a register sender switch a number of terminals corresponding to the number of impulses in an incoming train and means for thereafter advancing said register sender switch an equal number of terminals and for transmitting a number of outgoing impulses corresponding to the number of incoming impulses used in setting said switch.

8. A register sender having incoming and outgoing terminals and means for transmitting over said outgoing terminals trains of impulses corresponding to trains of impulses received over said incoming terminals comprising a register sender switch per train of impulses, a steering-in switch for successively associating said incoming terminals with said register sender switches, a steering-out switch for successively associating said register sender switches with said outgoing terminals, said register sender switches having their bank terminals connected alike and multiplied to a common set of markers at terminals N and 2N whereby each said register sender set before terminal N by an incoming train of impulses will under control of said steering-out switch operate one of said markers to place a characteristic condition upon multiples of said terminal and whereby said register sender switch in sending a train of impulses into said outgoing terminals will advance to terminal 2N where said characteristic condition will first be found.

9. A register sender having incoming and outgoing terminals and means for transmitting over said outgoing terminals trains of impulses corresponding to trains of impulses received over said incoming terminals comprising a register sender switch per train of impulses, said register sender switches having their bank terminals multiplied at terminals N and 2N whereby each said register sender switch will take as many steps in transmitting impulses over said outgoing terminals as it was caused to take by the impulses over said incoming terminals, electroresponsive markers connected to said multiplied terminals, means for mechanically registering a plurality of number designations and means for subsequently affecting said electroresponsive markers while transmitting said outgoing impulses.

WALTER P. ALBERT.