May 1, 1945. A. WEAVER 2,374,908

SELECTIVE CALLING SYSTEM

Filed Aug. 28, 1942 3 Sheets-Sheet 1

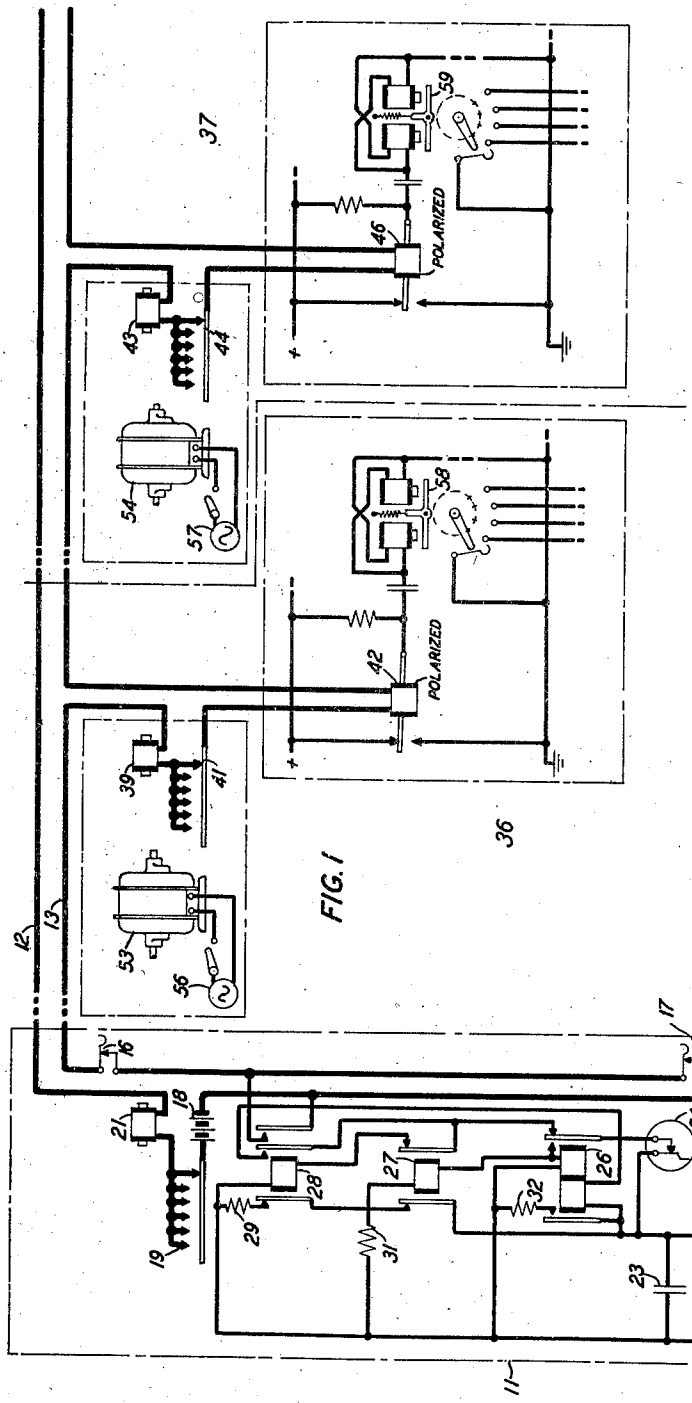

FIG. 1

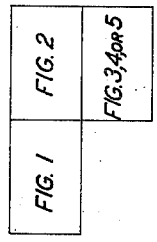

FIG. 6

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SELECTIVE CALLING SYSTEM

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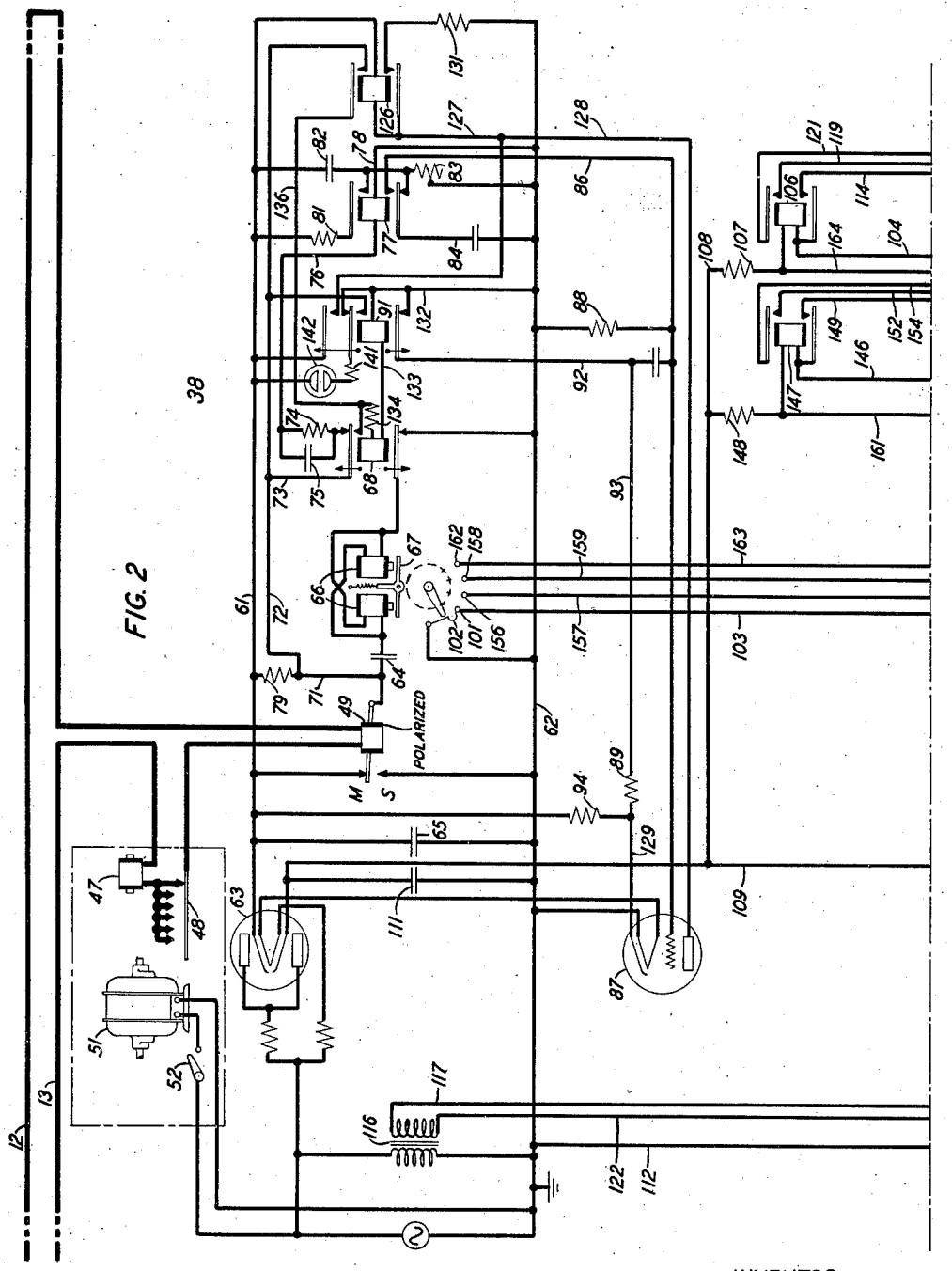

FIG. 2

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SELECTIVE CALLING SYSTEM

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FIG. 3

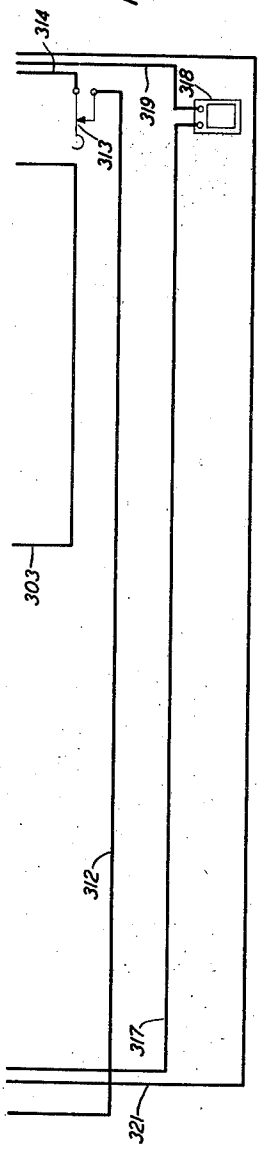


FIG. 4

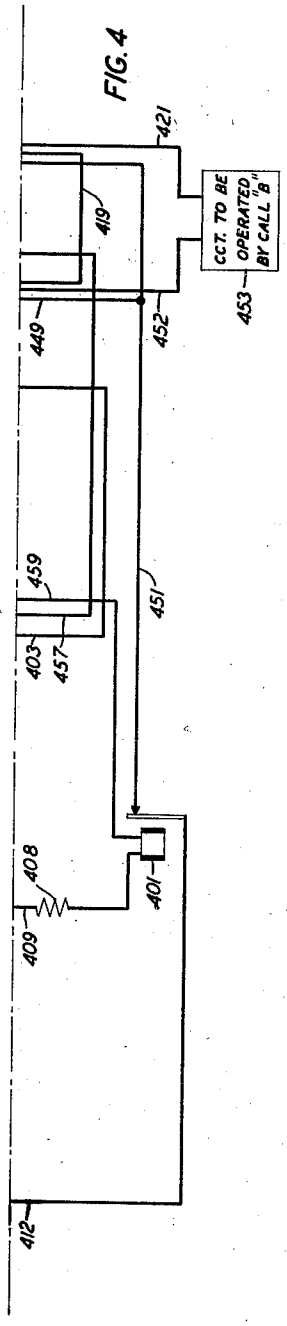
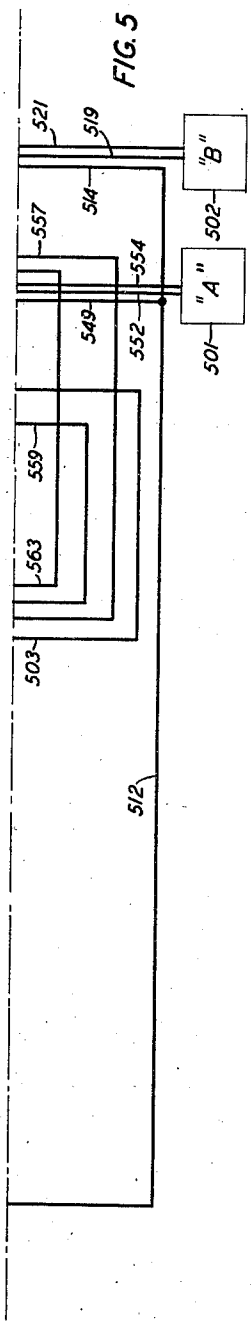


FIG. 5



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UNITED STATES PATENT OFFICE

2,374,908

SELECTIVE CALLING SYSTEM

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Application August 28, 1942, Serial No. 456,571

15 Claims. (Cl. 178—2)

This invention relates to a selective calling system and particularly to such a system in which a plurality of stations to be selectively called are associated with a common signaling channel.

An object of the invention is to transmit selective station calling signals and telegraph message signals over the same communication channel.

Another object of the invention is to render the selective station call receiving apparatus unresponsive to telegraph message signals.

The invention features at the calling station a pulsing dial and a pulse divider circuit whereby only one signaling current transition occurs on each pulsing cycle of the dial contacts.

The invention also features at each of the selectively callable stations a call responsive step-by-step selector which is disabled during intervals of idleness of the signaling channel and is also disabled during the transmission of telegraph signals on the channel and which becomes qualified to respond to selective calling signals in step-by-step manner under the control of timing apparatus which becomes effective only after a signal of a predetermined character has been impressed upon the signaling channel for a predetermined interval.

In accordance with the preferred embodiment of the invention the system includes a principal or call initiating station having station calling signal generating apparatus and also having telegraph signal transmitting and receiving apparatus, and a plurality of subordinate or outlying stations having selective station call signal receiving apparatus and also having telegraph signal receiving and transmitting apparatus. All of the stations are associated with a closed loop type of signaling channel which has at least one source of signaling potential associated therewith.

At the principal station the selective station call signal generating apparatus comprises a system of relays controlled by a pulsing dial so as to impress marking and spacing signals on the signaling channel at the rate of one transition from marking to spacing or from spacing to marking for each complete cycle of the pulsing contacts of the dial. The station also has telegraph signal transmitting contacts and the selector magnet of a printing telegraph receiving recorder associated with the signaling channel for transmitting and receiving telegraph signals.

At each of the outlying or subordinate stations a signal responsive relay, a set of telegraph signal transmitting contacts and the selector magnet of a printing telegraph receiving recorder are associated with the signaling channel. The signal receiving relay controls a step-by-step selector and also controls a timing circuit including a plurality of relays one of which is arranged to disable the step-by-step selector.

In the idle condition of the apparatus following telegraph message transmission a marking condition is impressed on the signaling channel and the step-by-step selector at each of the outlying stations is disabled. The disabling relay, when operated, is controlled by the signal receiving relay and has a slow-release characteristic so that it will be held energized by marking current on the signaling channel and will not be released until there has been a spacing signal on the channel of a duration longer than that of the longest spacing interval normally occurring in telegraph signal transmission.

In the operation of the system an attendant at the principal station desiring to call one of the outlying stations operates a break key, which impresses a spacing condition on the signaling channel, for a sufficient interval to release the selector disabling relays at all outlying stations. The attendant then transmits by means of the dial the calling code for the particular station and this code operates the step-by-step selectors at all of the outlying stations to advance the selectors, but at only one of the stations will the selector be advanced to such position that it will complete the circuit for a call indicator to inform an attendant at the particular outlying station that telegraphic communication with that station is desired.

The timing mechanism for disabling the step-by-step selectors at all stations is operable only upon reception of a marking signal following a short spacing signal. By virtue of the provision of the pulse divider in the station calling signal generator at the principal station the spacing signals involved in the calling of a station are sufficiently long that they do not cause the timing mechanism to operate the disabling relay for the step-by-step selector. Thus the selectors remain qualified to respond to signals following the transmission of the selective station calling signal. However, upon the beginning of transmission of telegraph signals, such as when an attendant at the called station operates the telegraph signal transmitting contacts thereat to transmit characters representing an answer-back, the short spacing impulses which such signals will contain are effective to cause the timing mechanism to operate the selector disabling relay at that station and at all other stations.

For a complete understanding of the invention, reference may be had to the following detailed description to be interpreted in the light of the accompanying drawings wherein:

Fig. 1 is a circuit diagram showing the principal station and two subordinate stations, the latter being represented symbolically;

Fig. 2 is a circuit diagram showing a third subordinate station in full detail;

Figs. 3, 4 and 5 are circuit diagrams showing alternative arrangements of apparatus to be con-

trolled by the step-by-step selector at a subordinate station; and

Fig. 6 is a diagrammatic view showing how Figs. 1, 2 and 3, Figs. 1, 2 and 4, and Figs. 1, 2 and 5 are to be interassociated to reveal the complete selective calling system provided with any of the three types of selector controlled apparatus.

Referring now to the drawings, and particularly to Fig. 1, the broken line rectangle 11 designates the principal station of the system. From the station 11 signal transmission line conductors 12 and 13 extend out to the subordinate stations, and the line conductors 12 and 13 are interconnected at the station 11 through a loop which includes break key 16, the normally closed upper pair of contacts of a dial key 17, signaling battery 18, telegraph signal transmitting contacts 19 and the selector magnet 21 of a printing telegraph recorder, which may be of the type shown in Patent 1,745,633 granted December 23, 1924, to S. Mortion et al., or may be of the type shown in Patent 1,904,164 granted April 18, 1933, to S. Morton et al.

The dial key 17 has a pair of normally open contacts, namely, the lower contacts shown in Fig. 1, through which a source of alternating current may be connected across the input terminals of a full wave rectifier 22 which provides at its output terminals a source of direct current. A filter condenser 23 is connected across the output terminals of rectifier 22 for filtering out the alternating current components at the output of the rectifier.

Upon the operation of the dial key 17 the loop interconnecting the line conductors 12 and 13 is opened at the upper dial contacts and the source of alternating current is connected across the rectifier 22 at the lower dial contacts. When the rectifier 22 has been energized, a circuit may be traced from the right-hand output terminal of the rectifier through the single pair of pulsing contacts of dial 24, which contacts are closed when the dial is at rest, through the right-hand armature and back contact of a relay 26, right-hand armature and back contact of a relay 27 and winding of a relay 28 to the left-hand output terminal of the rectifier. Over this circuit the relay 28 becomes energized.

At its outer right-hand armature and front contact the relay 28 recloses the transmitting line loop which was opened at the upper contacts of the dial key 17. At its inner right-hand armature and front contact the relay 28 prepares an energizing circuit for the left-hand or operating winding of relay 26 in series with the winding of relay 28 but the operating winding of relay 26 is at this time short-circuited by the closed dial contacts so that the operating winding of relay 26 does not become energized. At its left-hand armature and back contact, relay 28 opens a circuit from the right-hand output terminal of rectifier 22 through the left-hand armature and back contact of relay 27, left-hand armature and back contact of relay 28 and resistor 29 to the left-hand output terminal of rectifier 22. Resistor 29 and the winding of relay 28 preferably have the same resistance value so that with either the winding of relay 28 or the resistor 29 connected across the output of rectifier 22, the drain on the rectifier will be the same. It is for this season that the relay 28 upon being energized disconnects resistor 29 from across the output terminals of the rectifier 22.

The selective calling code signal generator is now in condition for the transmission of a calling signal by means of dial 24. However, in order to place the outlying stations in condition to respond properly to the selective station calling signals, it is necessary to impress a long spacing signal on the signaling lines 12 and 13 to perform operations which will be described later. The transmission of the long spacing signal may be accomplished by opening the break key 16. It is necessary to do this because although the upper contacts of the dial key 17 impressed a spacing signal on the line conductors, the relay 26 became energized and immediately shunted the open dial key contacts by means of its outer right-hand armature and front contact so that the spacing signal thus briefly impressed upon the line conductors may not be of sufficient duration to accomplish the desired result at the outlying station.

Following the reclosure of the break key 16 to terminate the long spacing signal, dial 24 is operated by rotating it in well-known manner to advance the dial to the position corresponding to the first digit of the calling code to be transmitted. The dial contacts 24 remain closed until the dial is released to permit it to return to the normal position, during which return the calling code impulses are transmitted. The dial contacts open and reclose once for each element or unit of the digit so that if the digit is 8, for example, the dial contacts will open and close eight times whereas if the digit is 5, for example, the dial contacts will open and close five times.

Upon the first opening of the dial contacts, the shunt across the operating winding of relay 26 is removed, so that the relay 26 becomes energized through its operating winding in series with the winding of relay 28 over a circuit previously traced. At its right-hand armature relay 26 transfers the dial contact connection from the armature of relay 27 through which relay 28 was originally energized and connects the now open dial contacts to one terminal of its holding winding, the other terminal of which is connected to the left-hand output terminal of rectifier 22, and also connects the dial contacts to one terminal of the winding of relay 27, the other terminal of which is connected through resistor 31 to the left-hand output terminal of rectifier 22.

At its left-hand armature and front contact the relay 26 connects a resistor 32 across the output terminals of rectifier 22 in shunt relation to the operating winding of relay 26 and the winding of relay 28, which are now in series, and whereas the placing of the operating winding of relay 26 in series with the winding of relay 28 tends to reduce the drain on the rectifier 22, the resistor 32 draws sufficient additional current to hold the total drain on the rectifier at the same value as it was when resistor 29 or the winding of relay 28 was connected across the rectifier. Since the relay 28 has remained energized, the loop across the line conductors 12 and 13 has remained closed so that no change has occurred in the condition of the line conductors as a result of the opening of the dial contacts.

Upon the first reclosure of the dial contacts the energizing circuits for the holding winding of relay 26 and for the winding of relay 27 are completed in parallel from the output terminals of rectifier 22. Thus the relay 26 remains energized and the relay 27 at its right-hand armature and back contact interrupts the energizing circuit for the operating winding of relay 26 and for the winding of relay 28. At its left-hand armature

and back contact the relay 27 opens the circuit for resistor 29, which has previously been opened at the left-hand armature and back contact of relay 28 so that the resistor 29 will not be connected across the output of rectifier 22 upon the release of relay 28 which the energization of relay 27 has caused. Three conductive paths are now connected across the output of the rectifier 22, these being the resistor 32, the holding winding of relay 26 and the winding of relay 27 with the resistor 31 in series with it. The resistance values of the holding winding of relay 26, of resistor 31 and the winding of relay 27 in series, and of resistor 32 are such that the aggregate resistance of the three parallel paths in the external circuit of rectifier 22 is equal to the resistance value of resistor 29 or of relay 28 so that the drain on the rectifier 22 remains the same.

With the release of the relay 28 the loop connection across line conductors 12 and 13 previously provided by the outer right-hand armature and front contact of the relay is interrupted so that a spacing signal is impressed on the line conductor. At the inner right-hand armature and front contact of relay 28 the circuit for the energization of the operating winding of relay 26 in series with the winding of relay 28 is interrupted so that this circuit will not be reestablished when relay 26 is released. At its left-hand armature and back contact the relay 28 again prepares for the connection of resistor 29 across the output terminals of the rectifier, the path now being open at the left-hand armature and back contact of relay 27.

Upon the second opening of the dial contacts the energizing circuits for the holding winding of relay 26 and for the winding of relay 27 are interrupted so that these relays are released. The right-hand armatures of the relays 26 and 27 again prepare the direct energizing circuit for the relay 28 through their right-hand back contacts but this energizing path is now interrupted at the open dial contact. At its left-hand armature the relay 26 disconnects resistor 32 from across the output terminals of the rectifier while at the left-hand armature and back contact of relay 27, resistor 29 is reconnected across the output terminals of the rectifier to maintain constant drain on the rectifier during the interval that none of the relays 26, 27 or 28 is energized. The condition of line conductors 12 and 13 has not been changed due to the second opening of the dial contacts because relay 28 has remained deenergized.

Upon the second closing of the dial contacts the relay 28 becomes energized over the first described direct energizing circuit and recloses the loop across the line conductors 12 and 13. The relay 28 also disconnects resistor 29 from across the rectifier 32 and again prepares for the energization of the operating winding of relay 26 in series with the winding of relay 28. The operating winding of relay 26 is at this time shunted by the now closed dial contacts.

Upon the third opening of the dial contacts relay 26 becomes energized in series with relay 28 and again prepares for the energization of its holding winding and for the energization of relay 27. Upon the third closing of dial contacts relay 27 becomes energized to release relay 28 and relay 26 remains energized through its holding winding. Thus a second spacing signal is impressed upon the line conductors 12 and 13 due to the release of relay 28. Upon the fourth opening of the dial contacts relays 26 and 27 are released and the direct energizing circuit for relay 28 is prepared. Upon the fourth closing of the dial contacts relay 28 becomes energized to restore the line conductors 12 and 13 to marking.

From the foregoing, it will be apparent that only the closure and not the opening of the dial contacts is effective to cause a line current transition on the line conductors 12 and 13. Thus there are only half as many line current transitions as dial contact transitions, and the system may be said to be a pulse divider. It will also be apparent that odd-numbered closures of the dial contacts change the character of the signal on the line from that which existed before the dial was operated and even-numbered dial contact closures restore the line condition to that which existed before the dial was operated. Accordingly, when an odd number is dialed the line condition will be different when the dial comes to rest from that which existed before the dial was operated and when an even number is dialed the line condition will be the same when the dial comes to rest as that which existed before the dial was operated. If a calling signal consists of two digits and both are odd numbers or both are even numbers, the line conductors will be in marking condition when the dial comes to rest after the transmission of the second digit, whereas if one only of the digits is an odd number, the line conductors will be in the spacing condition when the dial returns to rest after the second digit.

Following the transmission of the selective station calling signal, which is not limited to one or two digits but may be of three or four digits, depending upon the number of stations contained in the system, the dial key 17 is restored to normal. At its upper contacts the loop across the line conductors 12 and 13 is reclosed and at its lower contacts power is disconnected from the rectifier 22 so that all relays are released and the system is restored to the initial condition. From this it will be apparent that the line conductors 12 and 13 are always in marking condition following the operation of dial key 17 in preparation for the transmission of a selective calling signal since all of the relays are normally released and only the relay 28 becomes energized upon the operation of the dial key 17, thereby shunting the open upper contacts of the dial key.

The line conductors 12 and 13 extend to a plurality of stations of which two are indicated by the reference numerals 36 and 37 in Fig. 1, these stations being indicated symbolically in simplified form, and one is designated by the reference numeral 38 in Fig. 2, the latter being shown in full detail. The line conductor 13 extends through the selector magnet 39 of a printing telegraph receiving recorder, transmitting contacts 41 and signal responsive relay 42 all in series at station 36, then through selector magnet 43, transmitting contacts 44 and signal responsive relay 46 all in series at station 37 and then through selector magnet 47, transmitting contacts 48 and signal responsive relay 49 all in series at station 38 (Fig. 2). Line conductor 13 extends on beyond station 38 and may include the selector magnets, transmitting contacts and signal responsive relays of other stations and is eventually interconnected through a loop with line conductor 12 which may also include selector magnets, transmitting contacts and signal responsive relays of other outlying or subordinate stations.

Referring now particularly to Fig. 2, the station 38 has a motor 51 for driving the printing

telegraph receiving recorder controlled by selector magnet 47 and also for operating transmitting contacts 48. Power is applied to motor 51 from a source of alternating current through a switch 52, the normal condition of which is open and which is closed by an attendant when the station is to participate in intercommunication with the principal station 11. The stations 36 and 37 have similar motors 53 and 54 controlled by switches 56 and 57, respectively.

Since the selector magnets and signal responsive relays are in series with the line conductors at all stations, these elements respond to and follow all signals, whether such signals are telegraph signals or selective station calling signals generated at the principal station 11, or whether they are telegraph signals generated at any of the outlying or subordinate stations.

At the station 38 the upper and lower contacts of the signal responsive relay 49, which are the marking and spacing contacts respectively, are connected to the positive and negative conductors 61 and 62, respectively, of a power supply comprising a half wave rectifier including the upper anode and cathode of a discharge tube 63 connected so that the discharge path between the anode and cathode is between the positive conductor 61 and one side of a source of alternating current, the negative conductor 62 being connected directly to the other side of the source of alternating current. A filter condenser 65 is connected between conductors 61 and 62 for filtering out alternating components at the output of the rectifier. The armature of signal responsive relay 49 is connected through a condenser 64 to one side of the operating magnet 66 of a step-by-step selector 67. The other side of the magnet 66 is connected to the lower armature of a relay 68.

The step-by-step selector 67 may be of the type shown in Patent 1,345,256 granted June 15, 1920, to J. C. Field and the disclosure of that patent is incorporated herein by reference as part of the present specification. Briefly, such a selector consists of a polar magnet having an armature which is rocked clockwise or counter-clockwise from a central or neutral position in response to polar impulses of current. The armature is provided with an arm which operates a pawl mechanism for stepping a contact wheel or disc and the disc is advanced two steps for each full cycle of oscillation of the armature lever, by which is meant from the neutral position to one side, then to the opposite side and back to the neutral position. The contact wheel or disc is provided with selectively located pins which will be engaged by a check pawl controlled by the armature lever when the armature lever is momentarily permitted to be at rest in the neutral position after having been operated through a plurality of cycles or half cycles, and such pawl prevents the contact disc or wheel from returning to normal position under the influence of its restoring spring. When a plurality of such selectors with differently located stop pins respond to signals consisting of current reversals, a pause in the transmission of signals will cause those which have stop pins presented to their check pawls to be held in the positions to which they have been advanced, whereas all selectors which have no stop pins in those positions will return to normal position under the influence of the disc restoring springs. When transmission of current reversals is resumed those discs which were held in advanced positions are further advanced from those positions, whereas in all of the selectors the discs of which were restored to normal, those discs are again advanced from the normal position.

Step-by-step selectors of the type disclosed in the patent to Field are provided with contacts which are engaged by a contact arm carried by the step-by-step wheel or disc for the completion of electrical circuits. The electrical circuits are completed through the check pawl as a circuit element, so that as the contact arm comes into engagement with a contact, as it is being advanced step by step, an electrical circuit is not completed if the advance continues but only if there is a pause in the signal train which permits the check pawl to engage a stop pin and hold the disc or wheel in the position to which it has been advanced. When selectors of this type are employed in a system, all may have their electrical contacts in the same relative positions, such as in the eleventh, thirteenth, fifteenth and seventeenth steps. Taking the thirteenth step as an example, it is not necessary to send thirteen impulses in regular succession in order to cause the selector to reach that position. The selector may be provided with one or more stop pins intermediate the rest position and the thirteenth step whereby the thirteenth step may be reached by the transmission of sets of impulses which total thirteen, with a pause between each two sets of impulses. During the pause at the end of the first set of impulses, those selectors which have stop pins in the position to which the discs of all of the selectors have been advanced will be held and the discs of the remaining selectors will be restored to normal. In a two-digit system only one disc would be so held and all of the others would be returned. In a three-digit system, a plurality of discs would be held and the remainder would be restored to normal. Upon the resumption of transmission of impulses, all of the selector discs would again be advanced, some from their initial positions and one or more from its advanced position. At the end of the second group of impulses the disc of one selector closes an electrical circuit, if the system operates on a two-digit call, and all of the remaining discs return to their normal positions, with the exception that the second set of impulses may correspond to the first digit for some other selector in the system and the disc of that selector may be held in its first digit position although it will close no electrical circuit in this position. Following the closure of the electrical circuit by the disc or wheel of the selector, the transmission of a single impulse will restore all of the selectors to normal. If the system is operable upon a three-digit call, a plurality of discs will be held at the end of the second set of impulses, the number being smaller than the number which were held at the end of the first set of impulses. At the end of the third set of impulses only one of the discs will have been advanced to a position to close an electrical circuit.

In the arrangement shown in Fig. 2, when the relay 68 is deenergized, which is the condition following the transmission of a long spacing signal preparatory to the transmission of selected station calling signals, as will be described later, one side of the operating magnet 66 of the step-by-step selector 67 is connected to the negative conductor 62 of the direct current power supply and the other side of magnet 66 is connected through condenser 64 and through the armature and marking contact of relay 49 to the positive conductor 61 of the power supply. This causes

the condenser 64 to be charged positively on the side toward the armature of relay 49 and negatively on the side toward magnet 66. When relay 49 goes to spacing, both sides of condenser 64 are now connected to the negative conductor 62, permitting condenser 64 to discharge through magnet 66 which rocks the armature to one side. If the relay 49 returns to marking before the discharging current has died out, condenser 64 will be recharged and the charging current will rock the armature to the other side of magnet 66 without any pause of the armature in the neutral position. A pause in the signaling train of either marking or spacing nature will permit the armature of magnet 66 to go to its neutral position because the charging or discharging current for condenser 64 dies out before the end of the pause. Thus the condenser 64 serves to give a polar effect to the operation of the magnet 66 although the impulses transmitted over the line conductors 12 and 13 are not polar in the arrangement shown in Figs. 1 and 2 and there is no actual reversal of battery connection across the magnet 66.

The armature of signal responsive relay 49 is connected through conductors 71, 72 and 73 to the upper armature of relay 68 which, being assumed to be released at this time, engages its back contact, from which a circuit extends through resistor 74, shunted by a condenser 75, conductor 76, winding of relay 77 and conductor 78 to the negative conductor 62 of the power supply. Over the circuit just traced the relay 77 will follow the operation of the armature of signal responsive relay 49, whether that relay is following rapid telegraph signals or the slower selective station calling signals generated by the dial controlled pulse divider circuit in Fig. 1, the relay 77 being energized when the armature of relay 49 engages the marking contact and being deenergized when the armature of relay 49 engages the spacing contact. The function of condenser 75 is to accelerate the operation of relay 77. A resistor 79 having approximately the same resistance value as the aggregate of resistor 74 and the winding of relay 77 in series is connected between positive power supply conductor 61 and the armature of relay 49 through conductor 71 to provide a drain on the power supply when the armature of relay 49 engages the spacing contact, which is connected to negative power supply conductor 62, substantially equal to the drain through resistor 74 and the winding of relay 77 when the armature of relay 49 engages the marking contact. When the latter condition of the relay 49 exists, the resistor 79 is short-circuited by the armature and marking contact.

The upper armature of relay 77 is connected to positive power supply conductor 61 through a resistor 81 and the upper front contact is connected to the same conductor through a condenser 82. The upper front contact is also connected to the lower back contact and to one terminal of a variable resistor 83, the other terminal of which is connected to the negative power supply conductor 62. It will be apparent from an examination of Fig. 2 that when relay 77 is deenergized condenser 82 is connected in series with variable resistor 83 across the power supply conductors 61 and 62 and condenser 82 will become charged. When relay 77 is energized condenser 82 will be discharged through resistor 81. The lower armature of relay 77 is connected through condenser 84 to negative power supply conductor 62 and the condenser is thus connected in parallel with resistor 83 when relay 77 is deenergized.

For the purpose of setting forth the operation of the system of condensers associated with relay 77, it will be assumed that the line conductors 12 and 13, having previously been in marking condition, have gone to spacing condition as, for example, upon transmission of the first spacing impulse of a selective calling code. Relay 49 goes to spacing and releases relay 77 which removes the low resistance shunt including resistance 81 from condenser 82 and connects condenser 84 in parallel with variable resistor 83. Condenser 82 is of relatively large capacity and a high initial charging current flows through resistor 83. This produces a relatively high potential difference across resistor 83 which is also impressed across condenser 84. As condenser 82 becomes charged, the charging current and therefore the potential difference across resistor 83 decreases and the potential difference across condenser 84 correspondingly decreases. If the relay 77 should remain released under the control of relay 49 until condenser 82 becomes fully charged, the flow of current through resistor 83 will cease and the potential difference across condenser 84 will be reduced to zero.

The front contact with which the lower armature of relay 77 is engageable when the relay is energized, is connected by conductor 86 to the grid of an electron discharge tube 87. Before the lower armature of relay 77 engages its front contact, the grid of tube 87 is at the potential of the negative power supply conductor 62 by virtue of its connection to that conductor through a resistor 88, and the cathode of tube 87 is more positive than the grid by virtue of the potential difference across a resistor 89 in a circuit from the negative power supply conductor 62, lower back contact and armature of a relay 91, conductors 92 and 93, resistors 89 and 94 to the positive power supply conductor 61, the cathode of tube 87 being connected to the point of interconnection of resistors 89 and 94. Upon the engagement of the lower armature of relay 77 with its front contact, which occurs when a marking impulse is impressed upon the line conductors 12 and 13, as for example at the beginning of a marking signal following the first spacing signal of the selected station calling code, the potential of the grid of tube 87 is raised by the potential difference across condenser 84. This potential will be smaller in magnitude the longer the interval during which charging current flowed to condenser 82 and the constants of the circuit are such that insufficient potential difference appears across condenser 84 at the end of a spacing impulse of a selective calling code to render tube 87 conductive. Accordingly, tube 87 remains non-conductive during the reception of a selective calling code and the circumstances under which the tube is rendered conductive will be described later.

During the reception of the selected calling code, the selector discs of the selectors are advanced step by step at all stations and it will be assumed that the received code causes the selector disc at the station shown in Fig. 2 to advance its contact arm to engagement with contact 101. The check pawl 102 of the selector, which engages and holds the disc in the position to which it has been advanced, is connected to the negative power supply conductor 62 so that it completes a circuit from that conductor through the contact disc and contact arm of the selector to

contact 101 and from there through conductor 103, and assuming that the selector controlled system shown in Fig. 3 is associated with the station shown in Fig. 2, through conductor 303, conductor 104, winding of relay 106, resistor 107 and conductor 108 to a positive power supply conductor 109 which derives its positive potential from the cathode of the lower diode section of tube 63, the anode of which is connected to the same side of the alternating current source as the anode of the upper diode section. From this it will be apparent that the negative power supply conductor 62 is common to the separate positive power supply conductors 61 and 109. A filter condenser 111 is connected between positive power supply conductor 109 and negative conductor 62.

Upon the energization of relay 106, a holding circuit is completed from the negative power supply conductor 62 over conductor 112, conductor 312 in Fig. 3, normally closed key 313, conductor 314, conductor 114, front contact, lower armature and winding of relay 106, resistor 107 and conductor 108 to the positive power supply conductor 109. The selector disc contact arm leaves the contact 101 upon receipt of the next signal transition, thereby interrupting the energizing circuit of relay 106. However, the relay has already established its holding circuit, and remains energized until that circuit is released. The relay 106 also completes a circuit from one terminal of the secondary winding of a buzzer operating transformer 116, the primary of which is connected across the source of alternating current, over conductor 117, conductor 317, buzzer 318, conductor 319, conductor 119, front contact and upper armature of relay 106, conductor 121, conductor 321, and conductor 122 to the other terminal of the secondary of transformer 116. The operation of buzzer 318 indicates to an attendant at the station shown in Fig. 2 that intercommunication between the principal station 11 shown in Fig. 1 and the subordinate station 38 shown in Fig. 2 is desired. Accordingly, the attendant momentarily opens key 313 to release relay 106, thereby stopping the operation of buzzer 318, and closes switch 52 to start the operating motor 51 for the printing telegraph receiver and recorder at station 38. The attendant at the station 38 in Fig. 2 may thereupon operate transmitting contacts 48 by means of keyboard control mechanism shown in the Morton patents hereinbefore identified to transmit permutation code telegraph signals over line conductors 12 and 13 indicative of the fact that the station 38 is in condition to receive and transmit telegraph signals. Since the selected station call has caused the buzzer at station 38 in Fig. 2 only to operate, the operating motors for the telegraph recorders and transmitters at all other outlying stations should be idle and only the principal station 11 and the subordinate station 38 will be operative to transmit and record telegraph message material.

Since the permutation code telegraph signals involve spacing impulses which are much shorter than the spacing impulses of the selective station calling codes, the armature of the signal responsive relay 49 which follows the permutation code signals will engage its spacing contact for very much shorter intervals than it did during the reception of the selective station calling code, and relay 77 will be released for correspondingly shorter intervals. The charging current for condenser 82 flowing through resistor 83 during these short intervals will be relatively high and will produce a correspondingly high voltage across condenser 84 so that when the lower armature of relay 77 engages its front contact following the first short spacing signal impressed upon the line conductors 12 and 13, the potential of the grid of tube 87 will be made sufficiently positive with respect to the cathode to render tube 87 conductive. The space discharge path of tube 87 extends from positive power supply conductor 61 through the winding of a relay 126, conductors 127 and 128, anode to cathode discharge space of tube 87, conductor 129, resistor 89, conductors 93 and 92 and lower armature and back contact of relay 91 to negative power supply conductor 62. The relay 126 will become energized over this circuit and will remain energized through a holding circuit from positive power supply conductor 61 through the winding, lower armature and front contact of relay 126 and resistor 131 to the negative power supply conductor 62. At its upper armature and front contact the relay 126 prepares an energizing circuit for the relays 68 and 91 in series which may be traced from the negative power supply conductor 62 over conductor 132, winding of relay 91, conductor 133, winding of relay 68, resistor 134, conductor 136, upper armature and front contact of relay 126 and conductors 72 and 71 to the armature of signal responsive relay 49. Upon engagement of the armature of relay 49 with its marking contact following the spacing signal interval in which tube 87 was actuated, the circuit just traced is completed to the positive power supply terminal 61 and relays 68 and 91 become energized.

At its upper armature the relay 68 interrupts the circuit from its back contact through the winding of relay 77 to negative power supply conductor 62 and establishes a circuit through its front contact, resistor 134, winding of relay 68, conductor 133, winding of relay 91 and conductor 132 to negative power supply conductor 62, thus establishing a holding circuit for the relays 68 and 91. This holding circuit derives its positive power supply connection through the armature of relay 49 which oscillates in response to the signals impressed upon line conductors 12 and 13 but relays 68 and 91 have slow-release characteristics which are sufficiently slow that they will not release during the longest spacing interval normally occurring in permutation code signals but will release in response only to long spacing signals, such as may be impressed upon the line conductors by break key 16 at station 11. At its lower armature the relay 68 disconnects operating magnet 66 of the step-by-step selector 67 from the negative power supply conductor 62 so that the magnet will be prevented from attempting to operate the selector in response to the permutation code signals which signal responsive relay 49 follows, thereby estopping false and undesired operation of the step-by-step selector.

With relay 91 energized the positive power supply conductor 61 is connected over the outer upper armature and front contact to the lower armature of relay 126 which is connected to the winding of that armature, thus short circuiting the winding and releasing the relay 126. At its lower armature relay 91 interrupts the connection from the negative power supply conductor 62 to the cathode of discharge tube 87 thus preventing the further flow of discharge current through that tube. The inner upper armature of relay 91 is connected through resistor 141 and glow lamp 142 to the positive power supply

conductor 61. The back contact which the inner upper armature of relay 91 engages when the relay is released is connected through conductor 132 to the negative power supply conductor 62 so that when relay 91 was deenergized, which is the condition for operation of the step-by-step selector 67, glow lamp 142 is illuminated steadily to indicate the operative condition of step-by-step selector 67. When the inner upper armature of relay 91 engages the front contact, which is connected through conductors 72 and 71 to the armature of relay 49, lamp 142 will flash in accordance with the oscillation of the armature of relay 49 in response to permutation code signals. The flashing of lamp 142 serves to indicate that the line conductors 12 and 13 are in use for the transmission of permutation code telegraph signals. During idle intervals when no signals are being transmitted over line conductors 12 and 13, and relays 68 and 91 are held energized in response to the rest condition of the apparatus following the transmission of the telegraph signals, lamp 42 will be extinguished, since with relay 91 energized the lamp 142 receives operating current only when the armature of relay 49 engages the spacing contact to provide a negative power supply connection over conductors 71 and 72. By way of recapitulation the lamp 142 has three conditions, namely, extinguished to indicate that the line conductors are idle and the step-by-step selector is disabled, flashing to indicate that telegraph signals are being transmitted and the step-by-step selector is disabled, and steadily illuminated to indicate that the step-by-step selector is conditioned to be operated or is being operated.

The previously mentioned removal of relay 77 from control by signal responsive relay 49 due to the energization of relay 68 results in the release of relay 77 whereby condenser 82 becomes fully charged and remains charged during the interval of telegraph signal transmission, so that current ceases to flow through resistor 83 and there is no potential difference across condenser 84. Condenser 82 will not be discharged until relays 68 and 91 have been released by the reception of a long spacing signal and relay 49 has been restored to marking following such signal. Discharge tube 87 will not be activated upon the reenergization of relay 77 following such long spacing signal because condenser 84, which thereupon becomes connected to the grid of tube 87 contains no charge.

The previously mentioned release of relay 126 upon the energization of relay 91 results in the opening of the holding circuit for the relay 126 at its lower armature and front contact. At its upper armature the relay 126 interrupts the original energizing circuit for the relays 68 and 91, which has no effect on the relays 68 and 91 since they are now held under the control of the armature of relay 49 through the upper armature and front contact of relay 68.

Referring now to the situation in which a subordinate or outlying station is equipped with selector controlled apparatus according to the showing of Fig. 4, a conductive path is extended from contact 101 of the step-by-step selector 67 through conductors 103, 403 and 146, winding of relay 147, resistor 148, and conductor 108 to the positive power supply conductor 109. When a circuit is completed from the negative power supply conductor 62 through the check pawl 102, the step-by-step disc and contact arm of selector 67 to the contact 101 an energizing circuit for the relay 147 is completed. At the lower armature and front contact of relay 147, a holding circuit for the relay is completed through the front contact over conductors 149, 449 and 451, back contact and armature of a relay 401 and conductors 412 and 112 to the negative power supply conductor 62. The upper front contact of relay 147 is connected by conductors 152 and 452 to one terminal of a control circuit or device 453 which may be any instrumentality that it may be desired to control remotely from the principal station 11 such as, for example, a relay circuit for closing the switch 52 which controls motor 51. The other terminal of the remotely controllable device 453 is connected by conductors 421 and 121 to the upper armature of relay 106 which is normally released. The upper armature of relay 147 is connected by conductors 154, 419 and 119 to the upper front contact of relay 106. From this it will be apparent that the relay 147 merely prepares a circuit for effecting the operation of the remotely controllable device 453 and that it is necessary to effect the operation of relay 106 in order to complete the controlling circuit for the remotely controllable device 453. This necessitates the transmission from the principal station 11 of a supplemental selective calling signal for advancing the selector 67 from contact 101 to contact 156 if the selector disc of the selector 67 has not been permitted to return to normal position, or the transmission of a selective calling signal which will advance the selector disc to the contact 156 from the normal position, if the disc has been permitted to return to normal position following the energization of relay 147. Upon advancing the selector disc contact arm to contact 156 and retaining it there by means of check pawl 102, a circuit is completed from negative power supply conductor 62 through the check pawl, selector disc and contact arm of the selector, contact 156, conductors 157, 457 and 104, winding of relay 106, resistor 107 and conductor 108 to the positive power supply conductor 109 whereby relay 106 will be energized. The lower armature of relay 106 completes a holding circuit for the relay through the lower front contact, conductors 114 and 451, through the armature and back contact of relay 401 in parallel with the holding circuit for the relay 147 so that relay 106 will remain energized when the selector contact arm is moved out of engagement with contact 156 as upon restoration of the selector disc to normal. At its upper armature the relay 106 completes the controlling circuit for remotely controllable device 453 whereby that device will be operated to accomplish the control for which it has been provided.

Assuming that the remotely controllable device 453 operates the switch 52 for controlling motor 51, the relays 147 and 106 should remain operated to hold the device 453 operated until after telegraphic communication between stations 11 and 38 has been concluded, whereupon the device 453 should be disabled to effect the opening of switch 52. Accordingly, at the conclusion of telegraphic transmission break key 16 at station 11 should be opened for a sufficient interval to release relays 68 and 91 and should then be reclosed. As previously set forth this will condition the selector 67 to respond to selective calling signals. Thereupon a selective calling signal should be transmitted by means of dial 24 to advance the selector disc contact arm of selector 67 to contact 158 where a circuit

will be completed from negative power supply conductor 62 through check pawl 102 and the selector disc contact arm, conductors 159 and 459, winding of relay 401, resistor 408, conductor 409 to positive power supply conductor 109 whereby relay 401 will be energized to interrupt the holding circuit for relays 147 and 106 which will release, thereby interrupting at two points the controlling circuit for remotely controllable device 453.

It will be understood that remotely controllable device 453 may have some other function than controlling motor switch 52 and it may be desired that such other operation be initiated and terminated before telegraphic communication begins, in which case such operation may be terminated under the control of the attendant at station 11, after the operation has been in process of performance for a suitable interval, by the transmission of the necessary selective calling code for advancing the selector disc contact arm to contact 158 before the transmission of telegraph signals has been started and therefore before selector 158 has been disabled. For example, the operation to be performed might be the completion of a buzzer circuit for notifying the attendant at station 38 to operate motor switch 52 manually. Instead of having the disablement of the buzzer controlled locally at station 38 as in Fig. 3, the buzzer could be released by the release of relays 147 and 106 under the control of relay 401 after it had been permitted to operate for an interval which the attendant at station 11 considered adequate.

When a subordinate station is equipped with selector controlled apparatus as shown in Fig. 5, the operation of two remotely controllable devices may be selectively initiated and terminated. For this purpose, a conductive path extends from selector contact 101 over conductors 103, 503 and 146 to the winding of relay 147, and when the selector disc contact arm is advanced into engagement with contact 101 the energizing circuit for relay 147 will be completed. The lower armature of relay 147 completes a holding circuit over conductors 149, 549, 512 and 112 to negative power supply conductor 62. The upper armature and front contact of relay 147 complete an operating circuit for a remotely controllable device 501, over conductors 152 and 552 to one terminal of device 501 and over conductors 154 and 554 to the other terminal of that device.

From the contact 156 a conductive path extends over conductors 157, 557 and 104 over which the energizing circuit for relay 106 may be completed. The lower armature of relay 106 completes a holding circuit over conductors 114, 514, 512 and 112 to negative power supply conductor 62. The upper armature of relay 106 completes an operating circuit for a remotely controllable device 502 over conductors 119 and 519 to one terminal of device 502 and over conductors 121 and 521 to the other terminal of device 502.

For releasing relay 147 to terminate the operation of remotely controllable device 501, contact 158 of selector 67 is connected over conductors 159, 559 and 161 to the positive terminal of the winding of relay 147, and when the selector disc contact arm is advanced by appropriate selective calling signals into engagement with contact 158, a circuit is completed from the negative power supply conductor 62 in shunt relation to the holding circuit for relay 147, whereby the relay is released to terminate the operation of remotely controllable device 501. Similarly a contact 162 of selector 67 is connected through conductors 163, 563 and 164 to the positive terminal of relay 106, so that when the selector disc contact arm is advanced into engagement with contact 162 the holding circuit for relay 106 is shunted by a direct connection to the negative power supply conductor 62, relay 106 is released and the operation of selectively controllable device 502 is terminated.

It will be understood that other outlying stations in the system, such as the stations 36 and 37 shown in Fig. 1, are identical with the station shown in Fig. 2 and will have, in addition to the step-by-step selectors 58 and 59 at the stations 36 and 37, respectively, electron discharge tube and relay systems for controlling the conditioning and disablement of the selectors. It will also be understood that such other stations may be equipped with selector controlled apparatus according to Fig. 3, Fig. 4 or Fig. 5 as desired.

Although particular embodiments of the invention have been shown in the drawings and described in the foregoing specification, it will be understood that the invention is not limited to such specific embodiments but is capable of modification and rearrangement without departing from the spirit of the invention and within the scope of the appended claims.

What is claimed is:

1. In a selective station calling system, a first station including means for transmitting rapid telegraph signals and means for transmitting slower station calling signals, a second station including a relay responsive to both of said types of signals, a selector mechanism controlled by said relay, a slow-release relay energizable to disable said selector mechanism and releasable in response to a long spacing signal to restore said selector mechanism to operative condition, and means operable in response to rapid telegraph signals for operating said slow-release relay.

2. In a selective station calling system, a first station including means for transmitting rapid telegraph signals and means for transmitting slower station calling signals, a second station including a relay responsive to both of said types of signals, a selector mechanism controlled by said relay, a slow-release relay operable to disable said selector and releasable to restore said selector to operative condition, a timing relay operable by said signal responsive relay, and means controlled by said timing relay in response to rapid telegraph signals for operating said slow-release relay.

3. In a selective station calling system, a first station including means for transmitting rapid telegraph signals and means for transmitting slower station calling signals, a second station including a relay responsive to both types of signals, a selector mechanism controlled by said relay, a slow-release relay energizable to disable said selector and releasable to restore said selector to operative condition, a timing relay controlled by said signal responsive relay, timing means controlled by said timing relay, and means controlled by said timing means in response to rapid telegraph signals for operating said slow-release relay.

4. In a selective station calling system, a first station including means for transmitting rapid telegraph signals and means for transmitting slower station calling signals, a second station including a relay responsive to both of said types of signals, a selector controlled by said relay, a

slow-release relay energizable to disable said selector and releasable to restore said selector to operative condition, a timing relay controlled by said signal responsive relay, timing means controlled by said timing relay, a normally non-conductive discharge tube rendered conductive by said timing means, and means controlled by said discharge tube for operating said slow-release relay.

5. In a selective station calling system, a first station including means for transmitting rapid telegraph signals and means for transmitting slower station calling signals, a second station including a relay responsive to both of said types of signals, a selector controlled by said relay, a slow-release relay energizable to disable said selector and releasable to restore the selector to operative condition, a timing relay controlled by said signal responsive relay, timing means including a normally non-conductive electron discharge tube controlled by said timing relay in response to rapid telegraph signals for rendering said tube conductive, and a relay operable by said tube for energizing said slow-release relay.

6. In a selective station calling system, a first station including means for transmitting rapid telegraph signals and means for transmitting slower station calling signals, a second station including a relay responsive to both of said types of signals, a selector controlled by said relay, a slow-release relay energizable to disable said selector and releasable to restore said selector to operative condition, a timing relay controlled by said signal responsive relay, timing means including a normally non-conductive electron discharge tube controlled by said timing relay for rendering said tube conductive in response to rapid telegraph signals, a relay operable by said discharge tube for energizing said slow-release relay, means controlled by the relay operated by said tube for establishing its own holding circuit, a relay energizable concurrently with said slow-release relay, and means controlled by said concurrently energizable relay for disabling said holding circuit.

7. In a selective station calling system, a first station including means for transmitting rapid telegraph signals and means for transmitting slower station calling signals, a second station including a relay responsive to both of said types of signals, a selector controlled by said relay, a slow-release relay energizable to disable said selector and releasable to restore said selector to operable condition, a timing relay operable by said signal responsive relay, timing means including a normally non-conductive electron discharge tube controlled by said timing relay in response to rapid telegraph signals for rendering said tube conductive, a relay controlled by said tube for energizing said slow-release relay, and a relay energizable concurrently with said slow-release relay for interrupting the conducting path of said tube.

8. In a selective station calling system, a first station including means for transmitting rapid telegraph signals and means for transmitting slower station calling signals, a second station including a relay responsive to both of said types of signals, the selector controlled by said relay, a slow-release relay energizable to disable said selector and releasable to restore said selector to operative condition, a timing relay controlled by said signal responsive relay, timing means including a normally non-conductive electron discharge tube controlled by said timing relay to render said tube conductive in response to rapid telegraph signals, a relay controlled by said tube for energizing said slow-release relay, a relay energizable concurrently with said slow-release relay, and an indicating instrumentality controlled by said concurrently operable relay so as to operate according to one characteristic when said relay is energized and according to another characteristic when said relay is released.

9. In a selective station calling system, a first station including means for transmitting rapid telegraph signals and means for transmitting slower station calling signals, a second station including a relay responsive to both of said types of signals, a selector mechanism controlled by said relay, a slow-release relay energizable to disable said selector and releasable to restore said selector to operative condition, means controlled by said signal responsive relay in response to rapid telegraph signals for energizing said slow-release relay, an indicator lamp, a source of operating current for said lamp, and means associated with said slow-release relay for connecting said lamp to said source of current steadily when said slow-release relay is released and for connecting said lamp to said source of current through and under the control of said signal responsive relay when said slow-release relay is energized whereby the operation of said lamp corresponds to the operation of said signal-responsive relay.

10. In a communication system, a first station including means for transmitting rapid telegraph signals and means for transmitting slower station calling signals, a second station including a relay responsive to both of said types of signals, a signal responsive selector mechanism controlled by said relay, a slow-release relay energizable to disable said selector mechanism and releasable to restore said selector mechanism to operative condition, said slow-release relay having a releasing time longer than spacing intervals normally occurring in said rapid telegraph signals, means controlled by said signal responsive relay in response to rapid telegraph signals for completing the energizing circuit of said slow-release relay, and means associated with said slow-release relay for establishing a holding circuit therefor through the armature of said signal responsive relay to the marking contact whereby said slow-release relay is released only upon response of said signal responsive relay to a continuous spacing signal of a duration at least as long as the release time of said slow-release relay.

11. In a selective station calling system, a first station including means for transmitting rapid telegraph signals and means for transmitting slower station calling signals, a second station including a relay responsive to both of said types of signals, a selector controlled by said relay, a slow-release relay energizable to disable said selector and releasable to restore said selector to operable condition, a condenser having a resistor in series therewith, said condenser being chargeable through said resistor and dischargeable independently of said resistor under the control of said signal responsive relay, a second condenser chargeable in accordance with the current through said resistor, a normally non-conductive electron discharge tube operable by said second condenser upon charging and discharging of said first-mentioned condenser under control of said signal responsive relay when responsive to rapid telegraph sig-

nals, and a relay operable by said tube for energizing said slow-release relay.

12. In a selective station calling system, a station having means for transmitting rapid telegraph signals and slower station calling signals, a station having a relay responsive to both types of signals, a slow-release relay having a holding circuit releasably by said signal responsive relay, a selector mechanism operable by said signal responsive relay through a back contact of said slow-release relay, and means responsive to rapid telegraph signal operation of said signal responsive relay and unresponsive to slower station calling signal operation of said signal responsive relay for energizing said slow-release raly whereby to disable said selector mechanism.

13. In a selective station calling system, a station having means for transmitting rapid telegraph signals and slower station calling signals, a station having a relay responsive to both types of signals, a slow-release relay having a holding circuit including an armature and front contact thereof and the armature and marking contact of said signal responsive relay, a selector mechanism operable by said signal responsive relay through an armature and back contact of said slow-release relay, and means responsive to rapid telegraph signal operation of said signal responsive relay and unresponsive to slower station calling signal operation of said signal responsive relay for energizing said slow-release relay whereby to disable said selector mechanism.

14. In a selective station calling system, a station having means for transmitting rapid telegraph signals and slower station calling signals, a station having a relay responsive to both types of signals, a selector mechanism controllable by said signal responsive relay, a relay energizable to disable said selector mechanism and releasable to restore said selector mechanism to operability, a direct current relay operable by said signal responsive relay, means controlled by said direct current relay for accumulating electrical potentials in inverse relation to the duration of pulses received by said signal responsive relay, and means operable by an accumulated potential corresponding to a received pulse of short duration for causing said disabling relay to be energized.

15. In a selective station calling system, a station having means for transmitting rapid telegraph signals and slower station calling signals, a station having a relay responsive to both types of signals, a selector mechanism controllable by said signal responsive relay, a relay energizable to disable said selector mechanism and releasable to restore said selector mechanism to operability, a direct current relay operable by said signal responsive relay, a resistance and condenser network associated with the contacts of said direct current relay, and means controlled by a condenser of said network upon rapid operation of said relay in response to rapid telegraph signal operation of said signal responsive relay for energizing said disabling relay.

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