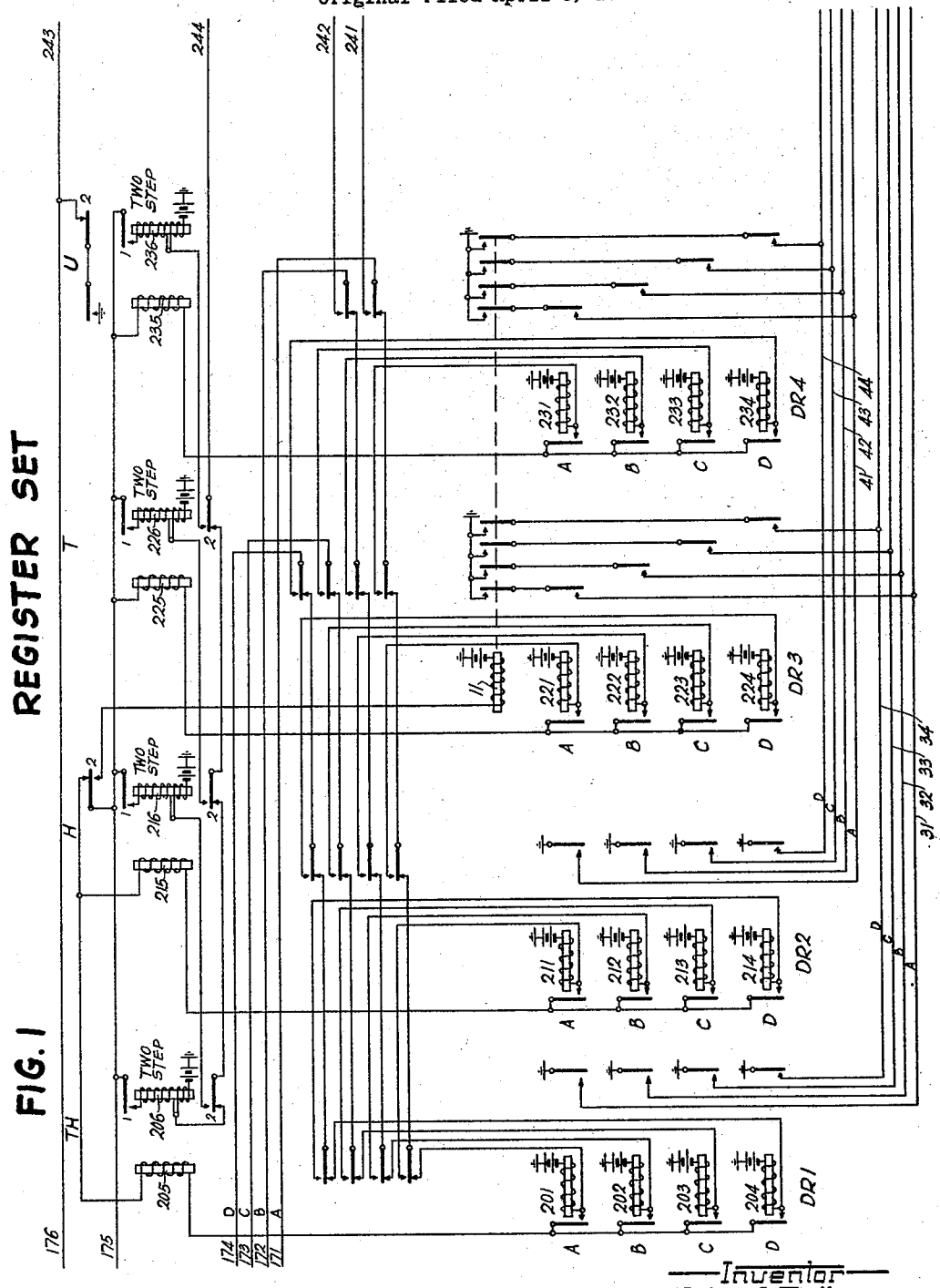
Aug. 16, 1932. J. I. BELLAMY 1,872,558

TELEPHONE SYSTEM

Original Filed April 5, 1929 4 Sheets-Sheet 1



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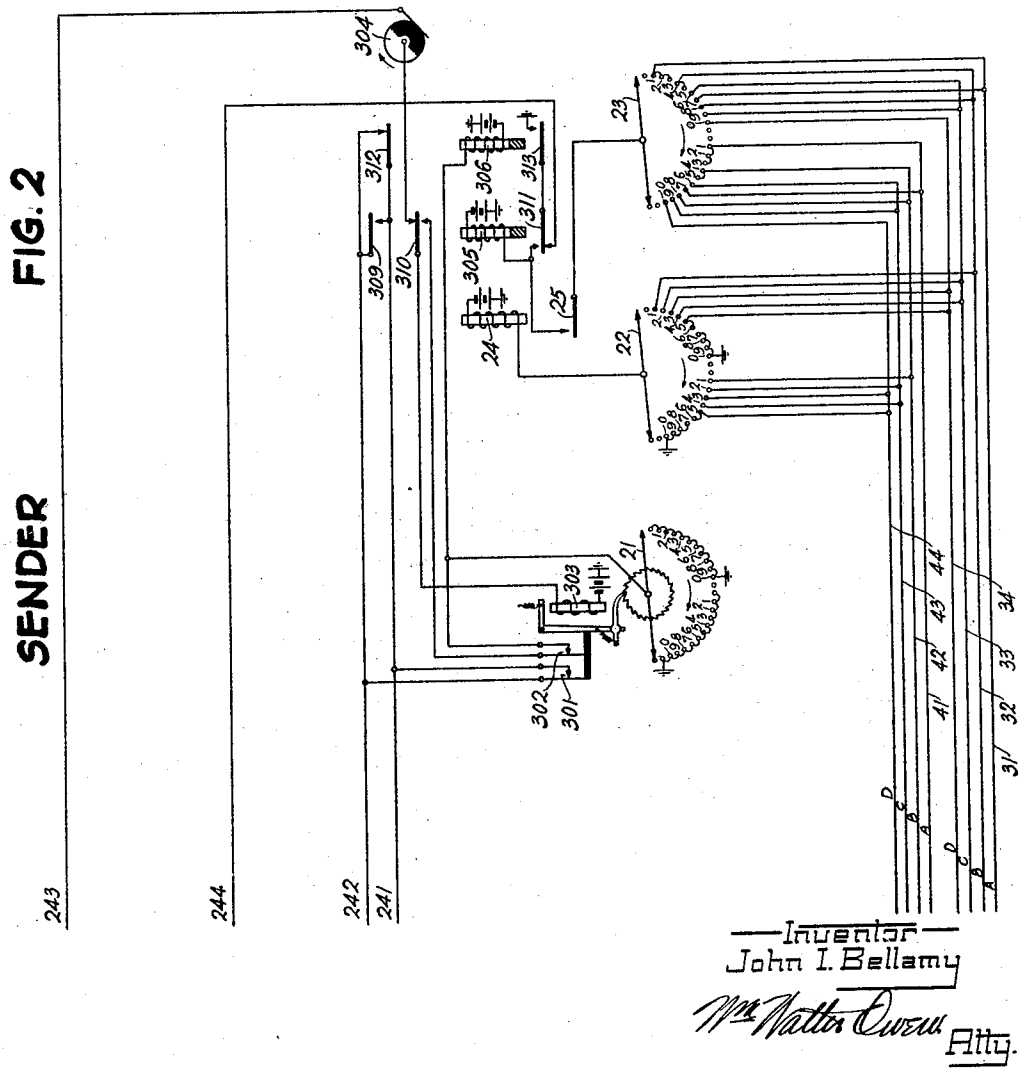
TELEPHONE SYSTEM

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FIG. 3

1 = AB
2 = AC
3 = AD
4 = BC
5 = BD
6 = CD
7 = A
8 = B
9 = C
0 = D

FIG. 2



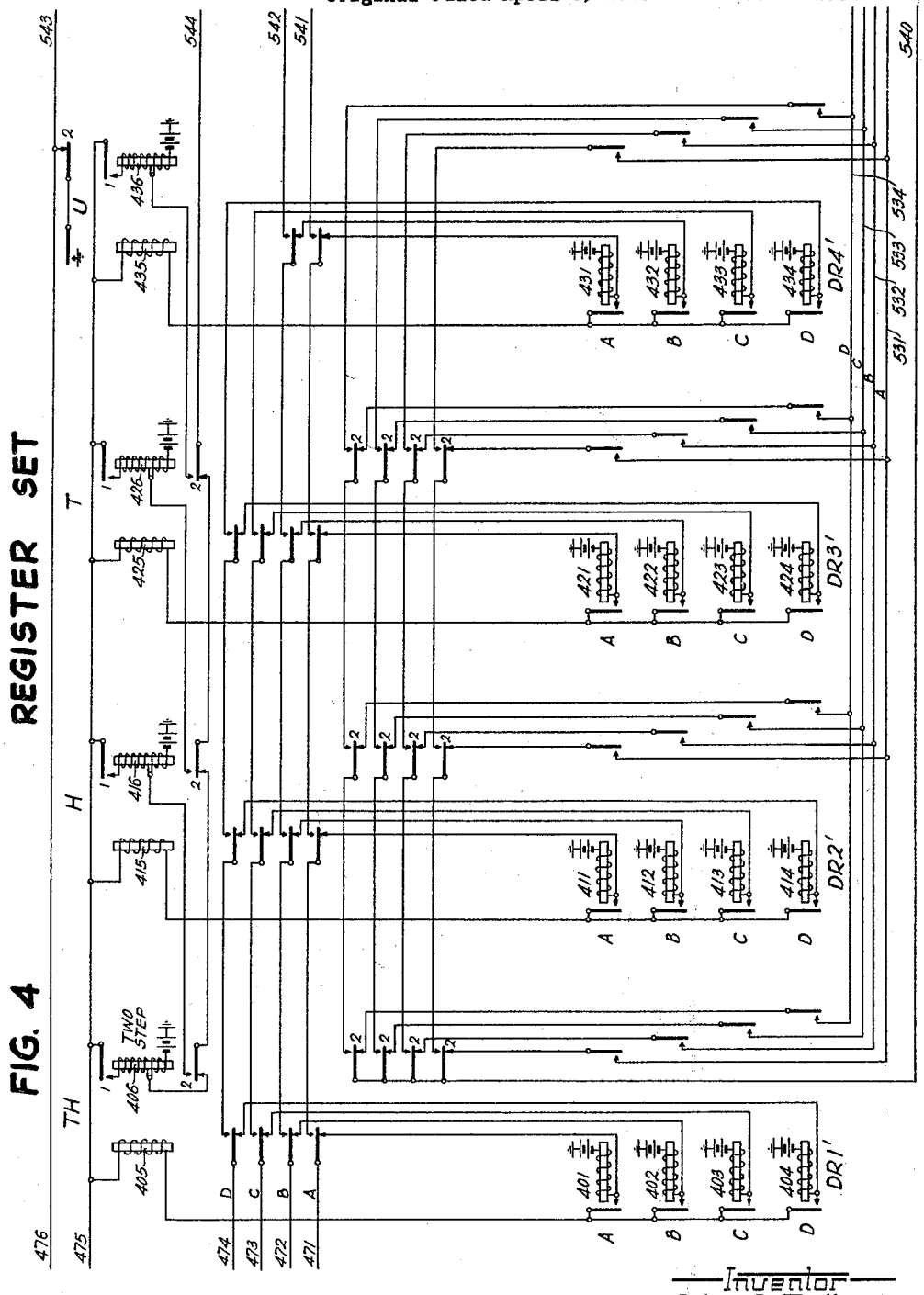
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TELEPHONE SYSTEM

Original Filed April 5, 1929 4 Sheets-Sheet 3

FIG. 4



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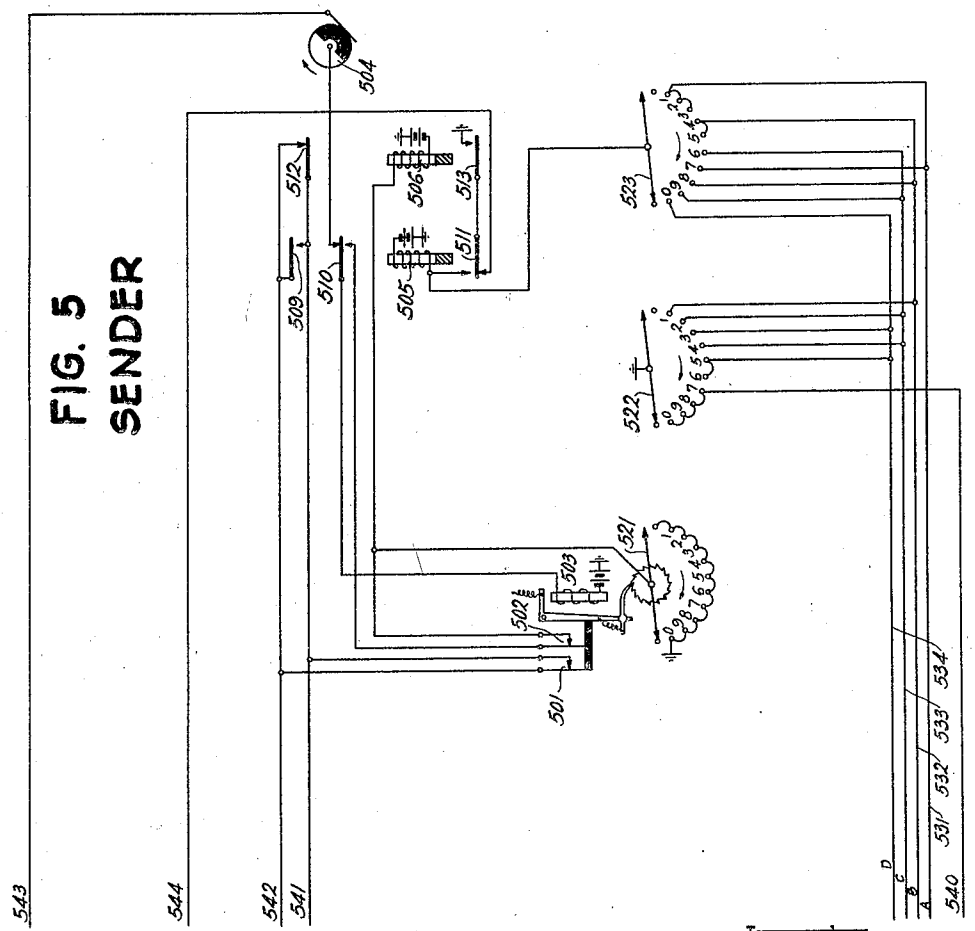
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Aug. 16, 1932. J. I. BELLAMY 1,872,558

TELEPHONE SYSTEM

Original Filed April 5, 1929 4 Sheets-Sheet 4

FIG. 5
SENDER



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UNITED STATES PATENT OFFICE

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TELEPHONE SYSTEM

Continuation of application Serial No. 352,745, filed April 5, 1929. This application filed April 13, 1931. Serial No. 529,562.

The present invention relates in general to telephone systems, but is concerned more particularly with register senders employed therein; and the broad general object is the production of new and improved circuit arrangements for register senders.

This application, which is a continuation of my application, Serial Number 352,745, filed April 5, 1929, may be considered an improvement on the arrangement disclosed in the patent to Nelson 1,665,273, granted April 10, 1928.

In the Nelson patent, each digit indicated by the depression of a key at an operator's keyboard is registered on a relay-type register comprising four relays. Each relay register is provided with a pyramid of contacts so that, when the relays are energized in a permutation, the one of the ten conductors extending to the sender which corresponds to the digit registered is rendered effective.

When considered in the light of the sender disclosed in the Nelson patent, the object of the present invention is to provide a new and improved sender especially for use in connection with permutational-relay registers, which sender may be employed to operate directly from the registration on the relays without the necessity of translating by means of a pyramid of contacts as has been the practice heretofore.

A feature of the invention has to do with the production of a novel transfer arrangement which is an economical combination of the arrangement employing as many sections of the sending switch as there are digits to be transmitted; and the arrangement employing only one section of a sending switch together with a separate mechanical or relay sequence switch for shifting the control to be exercised over the sender from one register to another.

Referring now to the accompanying drawings comprising Figs. 1 to 5, they show by means of the usual circuit diagrams a sufficient amount of apparatus in a telephone system embodying the features of the invention to enable the same to be understood.

Fig. 1 shows a register set of the general type of that disclosed in Fig. 3 of the above-mentioned Nelson patent. This register set has been suitably modified to incorporate features of the present invention.

Fig. 2 shows a sender of the same general type as the sender disclosed in Fig. 4 of the above-mentioned Nelson patent. The sender has been rearranged in accordance with the features of the present invention.

Fig. 3 is a table showing how the relays of any one of the relay registers shown in Figs. 1 and 4 are set to record any one of ten digits.

Figs. 4 and 5 show a modification of the register sender of Figs. 1 and 2.

For a complete disclosure of a telephone system using the register sender disclosed in Figs. 1 and 2, Fig. 2 of the drawings in the above-mentioned Nelson patent may be placed to the left of Fig. 1 of the present drawings, with the corresponding interconnecting lines in alignment, and Fig. 1 of the Nelson patent may be similarly placed above Fig. 2 of the Nelson patent. Alternately, Figs. 5 and 6 of the Nelson patent may be employed in place of the above-mentioned Figs. 1 and 2 thereof.

The invention having been described generally, a detailed description of the operation of the apparatus shown in Figs. 1 and 2 will now be given. For this purpose it will be assumed that the register set shown in Fig. 1 is seized by a register-sender selector such as the register-sender selector RSS shown in Fig. 2 of the drawings in the Nelson patent, or the register-sender selector RSS′ shown in Fig. 6 of the said drawings. When this occurs, the combined test and hold conductor 175 is grounded through the test wiper of the seizing selector, thereby preparing certain operating and holding circuits to be hereinafter explained.

Following the seizure of the register sender, the operator proceeds to set up the desired number, which number may be assumed to be 5678.

When the operator operates her #5 key in accordance with the digit 5, conductors 172 and 174, which are the B and D conductors in accordance with the table of Fig. 3, become

grounded, closing circuits for the B and D relays 202 and 204 of the digit register DR1. Upon operating, relays 202 and 204 ground the B and D conductors 32 and 34 at their right-hand armatures, and at their left-hand armatures they close locking circuits for themselves in series with transfer relay 205 and through contacts of relay 216 to the grounded conductor 175. Relay 205 does not operate, owing to being short circuited, as long as the ground potential remains on conductors 172 and 174.

When the operator restores her key and removes the ground potential from conductors 172 and 174, the locking circuit for relays 202 and 204 through relay 205 becomes effective and relay 205 operates and transfers the incoming A—D conductors 171—174 to the relays 211—214 of the digit register DR2.

When the operator depresses her #6 key, the C and D conductors 173 and 174 are grounded, as may be seen by reference to Fig. 3, whereupon the C and D relays 213 and 214 of the digit register DR2 are operated. At their right-hand armatures, these relays ground the C and D conductors 43 and 44, and at their left-hand armatures they close locking circuits for themselves in series with relay 215.

When the key is restored, the locking circuits of relays 213 and 214 become effective and relay 215 energizes and transfers the incoming conductors to the relays of the digit register DR3.

When the operator depresses her #7 key to cause the third digit 7 to be registered, a ground potential is placed on the incoming A conductor 171, as may be seen from Fig. 3. This results in the energization of the A relay 221 of the digit register DR3. Relay 221 at its right-hand armature prepares to place a ground potential on the A conductor 31, and at its left-hand armature closes a locking circuit through relay 225.

When the key is released, relay 225 operates and transfers the incoming conductors from the digit register DR3 to the digit register DR4.

When the operator depresses her #8 key, the incoming B conductor 172 is grounded, as may be seen upon reference to Fig. 3. This closes a circuit for the B relay 232 of the digit register DR4. Relay 232 prepares to ground the associated B conductor 42 at its right-hand armature, and at its left-hand armature closes its locking circuit through relay 235.

When the key is released, relay 235 operates and at its two lower armatures disconnects the incoming A and B conductors 171 and 172 from the corresponding relays of the digit register DR4 and connects them to the impulse conductors 241 and 242 which are closed together in the sender through sending contacts 301 and the resting contact and armature 312. This operation is preparatory to the sending of impulses over conductors 241 and 242 and the incoming conductors 171 and 172.

As a further result of the energization of relay 235, conductors 176 and 243 are grounded at the upper armature of the relay through the upper armature of relay 236. When this occurs, the sender shown in Fig. 2 starts operating due to the grounding of conductor 243, and, as a result of the grounding of conductor 176, a switchover operation takes place in the register-sender selector to disconnect conductors 171 and 172 from the operator's key set and to connect them instead in the control circuit extending to the automatic switches, as is explained in the Nelson patent.

When conductor 243 is grounded, a circuit is closed through the interrupter 304 and the resting contact and armature 310 for the stepping magnet 303 of the sender. Accordingly, magnet 303 starts to operate and restore under the control of interrupter 304. Each time it operates, it prepares to advance the wipers 21—23, which it does upon restoring. Each time it operates it opens the bridge across conductors 241 and 242 at contacts 301, but a substitute bridge is normally closed through the resting contact and armature 312. As a result, no impulse is sent upon the first operation of magnet 303. Upon the first restoration of the armature of magnet 303, the wipers 21—23 are advanced one step and the pick-up wiper 21 engages a grounded contact, closing a circuit for pick-up relay 306. Relay 306 operates and at armature 312 opens the substitute bridge, leaving the control circuit over conductors 241 and 242 under the direct control of contacts 301. At armature 313, relay 306 prepares a locking circuit for relay 305 and closes a circuit through armature 311 and its resting contact and over conductor 244, for the lower winding of the two-step transfer relay 206. Relay 206 operates and locks itself up through its upper winding to conductor 175, but no current flows through the upper winding for the time being on account of the fact that the upper winding is short circuited by the initial circuit of the lower winding.

Upon each energization of magnet 303 following the first step of the wipers 21 to 23, the switch control circuit through conductors 241 and 242 is interrupted at contacts 301, sending an impulse to the automatic switching apparatus.

Upon the advance of the wipers following the sending of the first impulse, wiper 22 engages a contact connected with the B conductor 32 and wiper 23 engages a contact connected with the A conductor 31, so as to terminate the digit as the digit 1 in case the A and B conductors 31 and 32 are both grounded. In the present case, the A con-

ductor 31 is not grounded because the A relay 201 is not energized, but the B conductor 32 is grounded and relay 24 operates as a result and connects up relay 305 to wiper 23 at armature 25, but relay 305 does not operate because conductor 31 is not grounded.

Upon the next step of the wipers, following the next impulse, wipers 23 and 22 encounter the A and C conductors 31 and 33, but neither of these conductors is grounded.

Upon the next step of the wipers, wipers 23 and 22 encounter the A and D conductors 31 and 34 in order to terminate the digit if the digit being sent is the digit 3. Relay 24 operates at this time over the D conductor 34 which is grounded by the D relay 204, and connects up relay 305 at armature 25 but relay 305 does not operate because the A conductor is not grounded.

Upon the advance of the wipers following the transmission of the fourth impulse at contacts 301, wiper 22 connects relay 24 to the C conductor 33, but relay 24 does not operate over the C conductor owing to the fact that the C conductor is not grounded. Accordingly, relay 305 is not connected up to wiper 23.

When the wipers advance at the end of the transmission of the fifth impulse at contacts 301, wiper 22 engages a contact connected to the grounded D conductor 34, which is grounded by the D relay 204. Relay 24 operates and at armature 25 connects relay 305 to the wiper 23 which is in engagement with a contact connected to the B conductor 32 which is grounded by the B relay 202. As a result, relay 305 energizes for the first time and terminates the digits by placing an additional bridge across conductors 241 and 242 at armature 309. At armature 311, relay 305 removes ground from conductor 244 and closes a locking circuit for itself. When the ground potential is removed from conductor 244, the upper winding of the two-step relay 206 energizes in series with the lower winding, operating the relay fully to transfer the operating conductor 244 to relay 216.

As a further result of its operation, relay 305 at armature 310 disconnects stepping magnet 303 from the interrupter 304 and connects it to the restoring wiper 21 through the self-interrupting contacts 302. As a result, the magnet 303 operates in a buzzer-like manner and advances the wipers 21—23 until the wiper 21 comes into engagement with the ungrounded contact following the digit 0 position. When this occurs, the advance of the wipers 21—23 stops and the circuit of the slow-acting pick-up relay 306 is opened.

Relay 306 falls back after a slight interval and opens the locking circuit of the stop relay 305. Relay 305 falls back after a short interval and again shifts the magnet 303 from wiper 21 to the interrupter 305. As a result, the magnet 303 starts energizing and deenergizing again under the control of interrupter 304.

It will be observed that the second half of the bank of wiper 23 is connected to the A to D conductors 41 to 44 in the same way as the first half of the bank is connected to the A to D conductors 31 to 34, and that the second half of the bank of wiper 22 is connected to the second set of conductors in the same way that the first half is connected to the first set of conductors. Accordingly, the wipers 22 and 23 advance over the second half of their respective banks, making the tests described in connection with the transmission of the first digit, but relay 305 is unable to energize until the end of the transmission of the sixth impulse. It will be observed that relay 24 pulls up over the C conductor 43 at the end of the second and fourth impulses and connects up relay 305, but relay 305 does not respond at such times on account of the fact that the A and B conductors are not grounded.

When wipers 22 and 23 advance at the end of the sixth impulse and land upon the contacts connected to the D conductor 44 and the C conductor 43, relay 24 pulls up over the D conductor 44, which is grounded by the D relay 214, and connects up relay 305 at armature 25 to wiper 23, whereupon relay 305 pulls up over the C conductor 43, which is grounded at the C relay 213. Upon operating, relay 305 terminates the digit in the manner hereinbefore described.

Due to the combined action of relays 306 and 305, hereinbefore explained, an impulse of current is delivered over conductor 244 during the transmission of the digit, with the result that relay 216 is operated through its first step at the beginning of the digit and operates through its second step at the end of the digit. Upon operating through its second step, relay 216 transfers the operating circuit to relay 226 at its lower armature, and at its upper armature it opens the circuit of the transfer relays 205 and 215, whereupon these relays fall back, as do the register relays 202, 204, 213, and 214. As a further result of the operation of its upper armature, relay 216 connects the grounded conductor 175 to relay 11, whereupon relay 11 operates and grounds the right-hand armatures of the relays of the digit registers DR3 and DR4.

By the above operation, all the relays of the first two digit registers are restored and ground is connected to the armatures of the second pair of digit registers preparatory to controlling the sender in transmitting the third and fourth digits.

The wipers 21 to 23 of the sending switch are advanced over the second half of the bank at the end of the second digit, and in the same manner described in connection

with their advance at the end of the first digit. Following this, relays 306 and 305 fall back, and magnet 303 is again placed under the control of interrupter 304. The wipers are accordingly advanced again over the first half of the contact bank, but relay 305 is unable to energize in any one of the first six stop positions owing to the fact that only one of the conductors 31 to 34, the A conductor 31, is grounded.

When the wipers 22 and 23 advance to the seventh stop position at the end of the transmission of the seventh impulse in the third digit, relay 24 operates through wiper 22 because the last four stop positions are permanently grounded, and relay 305 operates through wiper 23 when it is connected up at armature 25. The circuit of relay 305 includes the seventh stop position in the first half of the bank and the A conductor 31 which is grounded by the A relay 221 of the digit register DR3 through contacts of relay 11. Upon the energization of stop relay 305, the wipers 21—23 are advanced to the resting position between bank sections in which position wiper 21 encounters the ungrounded contact.

The transfer relay 226 is operated through its first step at the beginning of the third digit and operates through its second step at the end of the third digit when its circuit over conductor 244 is opened by stop relay 305. At its lower armature, relay 226 transfers the operating circuit to relay 236.

The sending operation starts after relays 306 and 305 have both fallen back, and the operation continues throughout the advance of the wipers over the first seven stop positions, and when the wipers 22 and 23 arrive at the eighth stop position in the second half of the bank at the end of the eighth impulse in the fourth digit, relay 24 is energized from the local ground connection and connects up relay 305 at armature 25 with the result that relay 305 energizes through wiper 23 and its eighth-position contact, over the B conductor 42, which is grounded by the B relay 232 of the digit register DR4 through contacts of relay 11.

Upon the operation of relay 305, the fourth digit is terminated in the usual manner at armature 309 and the magnet 303 is connected through the self-interrupting contacts 302 to the restoring wiper 21. The wipers 21—23 are accordingly advanced to the position shown in the drawings.

Relay 236 is operated over conductor 244 through its first step at the beginning of the last digit and operates through its second step when the stop relay 305 energizes to terminate the digits. Upon operating through its second step, relay 236, at its uppermost armature, removes the ground potential from conductors 243 and 176, resulting in the release of the register sender by the register sender selector in the manner described in the Nelson patent hereinbefore referred to.

Regarding the sender, it may be pointed out that it is necessary to assign the code so that the digits represented by one energized relay come at the end as shown in Fig. 3 rather than in the first or intermediate positions. For example, if the letter A indicated the digit 1 and the letters A and B indicated the digit 2, the sender would transmit the digit 1 no matter whether the digit 1 or the digit 2 were stored on the register.

In case a code is used employing three characters per digit, corresponding to three energized relays for certain of the digits, it is necessary to provide three wipers for testing purposes instead of the two wipers 22 and 23 now employed for testing purposes. The added wiper would connect to a relay similar to relay 24 and the circuit of relay 305 would include series contacts on the added relay.

As an alternative to the circuit arrangement shown in connection with the sender, each test wiper may connect to a relay like relay 24 and the circuit of relay 305 may be completed locally from ground through series contacts on all of the test relays instead of being completed through one of the test wipers.

Referring now to the modified register sender shown in Figs. 4 and 5, it may be pointed out that the parts in Figs. 4 and 5 corresponding to parts shown in Figs. 1 and 2 have been given similar reference characters, except that the four hundred series of numbers is used in Fig. 4, the five hundred series of numbers has been used in Fig. 5, and the designations on the registers of Fig. 4 have been primed.

The register sender of Figs. 4 and 5 has been modified from the showing in Figs. 1 and 2, so that a single bank section is used for each of the wipers of the sender of Fig. 5 instead of the two bank sections for each wiper as in Fig. 2. This lowers the cost of the sender and permits all of the registers of Fig. 4 to be connected to the testing banks of the sender by means of the same four conductors, 531—534, instead of the two groups of multipled conductors employed in Figs. 1 and 2. It will be noted, however, that the arrangement used to transfer the control of the sender from one digit register to another is somewhat more elaborate in Fig. 4 than the simple one shown in Fig. 1 involving relay 11. It will be noted that the two-step transfer relay 406 has four lower armatures which are arranged to transfer the control from the digit register DR1′ to the digit register DR2′ after the first digit has been retransmitted. In the same way, relay 416 transfers the control from the digit register DR2′ to the digit register DR3′, and the two-step relay 426 transfers the control from the

digit register DR3′ to the digit register DR4′ after the third digit has been retransmitted.

In order to still further reduce the cost of the sender of Fig. 5, the relays of the sender have been reduced from 3 to 2 by employing a testing arrangement which omits relay 24, Fig. 2. With this modified testing arrangement, ground potential is connected to wiper 522 instead of relay 24, and stop relay 505 is connected directly to wiper 523. In addition, the ground potential on the contacts in the bank of wiper 522 corresponding to the digits 7 to 0 has been removed, and the ground potential has been removed from the armatures of the register relays of Fig. 4. The points from which the above-mentioned ground connections are removed are all connected together by means of conductor 540, and ground connections are made to the control conductors 531—534 only by way of wiper 522.

When the sender of Fig. 5 is operating to retransmit a number set up on the register set of Fig. 4, and assuming that the sender is retransmitting the digit set up on the digit register DR1′, a simple series circuit is completed for stop relay 505 by way of the pair of conductors 531—534 which has been connected up by the corresponding pair of the relays 401—404 of the register set DR1′ in case the digit registered has a value of from 1 to 6 (see Fig. 3). It will be noted that wiper 522 applies ground potential to one of the conductors 531—534 in each position corresponding to any digit from 1 to 6. It will be noted further that wiper 523 is connected to another one of the conductors 531—534 in each of the above digit positions. Accordingly, with the armatures of relay 401—404 normally connected together through the contacts of relay 406, the ground potential applied through wiper 522 is encountered by wiper 523 to operate relay 505 when the test position corresponding to the registered combination is reached.

In case the digit registered has value of from 7 to 0, only one of the relays 401—404 is operated, as may be seen upon reference to Fig. 3, in which case the series circuit over two of the conductors 531—534 is not completed. In this case, the advance of wipers 522 and 523 continues until the seventh digit position is reached, whereupon, ground potential is applied by wiper 522 over conductor 540 to each of the armatures of register relays 401—404 by way of the contacts of relay 406. Under this condition, stop relay 505 is able to energize through wiper 523 and over any one of the conductors 531—534 which is connected up, at the contacts of the corresponding one of the relays 401—404, to conductor 540 and ground at wiper 522.

After the first digit has been sent out and terminated by the operation of stop relay 505, and relay 406 has operated through its second step to transfer the control from the digit register DR1′ to the digit register DR2′, the armatures of register relays 411—414 are connected together and to conductor 540, through the operated armatures of relay 406 and the unoperated armatures of relay 416. In a similar manner, the control is shifted successively to the digit register DR3′ and to the digit register DR4′ by the two-step relays 416 and 426, respectively.

It will be understood that the remaining part of the apparatus shown in Figs. 4 and 5 operates as described in connection with Figs. 1 and 2.

Many other modifications may suggest themselves to those skilled in the art.

What is claimed is:

1. In a register sender, a plurality of conductors, registering means for making connections to said conductors in permutations, and counting means for progressively testing said conductors in corresponding permutations.

2. In combination, a plurality of conductors, means for making connections to any desired combination of said conductors, and means for progressively testing said conductors in combinations to determine the combination.

3. In combination, a plurality of conductors, means for registering a digit by rendering alive a predetermined combination of said conductors, and progressively operable testing means for determining the digit registered by determining the combination of conductors alive.

4. In a register sender, a plurality of groups of registers, each register comprising a plurality of relays, means for setting the relays of each register in permutations to record digits, each relay having a single sender-control contact, and a sender controlled directly through the sender control contacts of said relays to transmit the registered digits.

5. In a register sender, a group of conductors, a register arranged to record a digit by making a connection to any pair of said conductors or to any one of said conductors, and a sending device controlled over said conductors in accordance with the connection made thereto by said register.

6. In combination, a plurality of conductors and a testing device, means for operating said testing device to successively make a plurality of tests of said conductors, the arrangement being such that certain tests are made of a given number of said conductors simultaneously, while subsequent tests include a smaller number of said conductors, and means associated with said testing device for transmitting a series of impulses varying in number depending upon the condition of said group of conductors as determined by the successive tests.

7. In a sending device wherein a series of impulses is transmitted whose length depends upon the condition of a group of conductors, means for performing a plurality of tests of said conductors successively while the impulses are being transmitted, certain of said tests being made of a given number of said conductors simultaneously, other tests being made of a smaller number of said conductors.

8. In a sending device wherein a series of impulses is transmitted whose length depends upon the condition of a group of conductors, means for performing a plurality of tests of said conductors successively, certain of said tests being made of a given number of said conductors simultaneously, other tests being made of a smaller number of said conductors, the arrangement being such that all tests involving a given number of conductors are performed before the tests involving a smaller number of conductors are performed.

9. In a step-by-step combined sending and counting device arranged to operate under the control of a group of conductors and including progressively movable wipers and contact banks therefor in which said conductors terminate, said conductors being connected in a predetermined order to all the contacts in a given section of the bank of one wiper and connected in a predetermined order to a lesser portion of the corresponding section of the bank of another wiper.

10. In a counting device for use in counting transmitted impulses, said device having two wipers and a contact bank for each wiper, a plurality of control conductors for controlling said counting device, said conductors being multipled into corresponding sections in the banks of both wipers.

11. In a counting device for use in counting transmitted impulses, said device having two wipers and a contact bank for each wiper, a plurality of control conductors for controlling said counting device, said conductors being multipled into corresponding sections in the bank of both wipers, and means including registering apparatus for making connections to said conductors in accordance with desired series of impulses.

12. In a register sender, a plurality of registering devices, a sending device having a progressively movable wiper and a contact bank therefor, said bank comprising two sections, connections from the contacts of the first register to the first section of said bank, connections from the contacts of the second register to the second section of said bank, the register contacts of the remaining odd-numbered registers being multipled with the register contacts of the first register, the register contacts of the remaining even-numbered registers being multipled with the contacts of the second register, and means effective after the sender has operated over both sections of its bank under the control of the first two registers for rendering the first two registers ineffective and for rendering the next two registers effective.

13. In a register sender system, two pairs of registers and means for setting them, a sender arranged to operate successively under the control of the two registers of the first pair and to then operate successively under the control of the two registers of the second pair, and means effective upon the completion of the operation of the sender under the control of the second register of the first pair for releasing the first pair of registers and for placing the sender under the control of the registers of the second pair.

14. In a register sender system, a plurality of registers, a sender having a wiper and a bank of contacts therefor, said bank of contacts being divided into two sections, the odd-numbered registers being multipled into one section, the even-numbered registers being multipled into the other section and means for associating said registers with the sender in pairs.

15. In a register sender, a register comprising four registering devices, means for operating desired ones of said devices in combinations or individually to store any desired digit on said register, a sender, means for operating said sender to transmit a series of impulses, and means consisting of direct individual connections from said registering devices, respectively, to said sender for controlling the number of impulses in the series in accordance with the value of the stored digit.

16. In a register sender, a register comprising a plurality of relays, means for setting the relays of the register in combinations or individually to record digits, each relay having the same number of sender control contacts, and a sender controlled directly through the sender control contacts of said relays for transmitting the registered digits.

17. In combination, a register comprising a plurality of relays, means for setting the relays of said register in combinations to register digits, a testing device, a plurality of conductors extending from said register to said testing device, and means for operating said testing device to test every possible pair of said conductors to determine the digit registered.

18. In a registered sender, a plurality of groups of registers, each register comprising a plurality of relays, means for setting the relays of each register in combinations to record digits, each relay having a single sender control contact, means for rendering the contacts of said groups effective successively, and a sender controlled directly through the sender control contacts of said

relay groups, successively, as they are rendered effective, to transmit the registered digits.

19. In a register sender, a plurality of register relays, a plurality of control conductors, a sender having two wipers and associated banks, means for operating said register relays in pairs or singly to register a digit by making connections to a pair of said control conductors, and means for controlling said sender over a series circuit including both wipers and banks of said sender and said pair of control conductors to transmit the registered digit.

20. In a register sender, a register comprising a plurality of registering devices, means for operating desired ones of said devices in combinations or individually to store any desired digit, a sender, means for operating said sender to transmit a series of impulses, and means for testing said registering devices successively while impulses are being transmitted by said sender, certain of said tests being made of pairs of said registering devices simultaneously, other tests being made of individual registering devices.

21. In a register sender, a register comprising a plurality of relays, means for setting the relays of said register in combinations or individually to record digits, each relay having the same number of sender control contacts, and a sender controlled over series circuits extending from said sender through the sender control contacts of said relays and back to said sender for transmitting the registered digit.

22. In combination, a register comprising a plurality of registering devices, means for setting the devices of said register in pairs to register, a digit, a testing device, and means for operating said testing device to successively test every possible pair of said registering devices to determine the digit registered.

23. In combination, a register comprising a plurality of registering devices, means for setting the devices of said register in pairs to register a digit, a testing device, conductors connecting said testing device with said registering devices, respectively, and means for operating said testing device to successively test every possible pair of said registering devices by way of said conductors to determine the digit registered.

24. In a register sender, a register consisting of a plurality of registering devices, means for setting the devices of said register in pairs to store a digit, a testing device comprising a plurality of wipers and associated banks, one of said wipers being connected to ground and the other wiper being connected to battery in series with a stop relay, and means including said wipers and banks for successively connecting said relay and ground with said registering devices in pairs to determine the digit stored.

25. In a register sender, a register consisting of a plurality of registering devices, means for setting the devices of said register in pairs to store a digit, a testing device comprising a plurality of wipers and associated banks, one of said wipers being connected to ground and the other wiper being connected to battery in series with a stop relay, and means including said wipers and banks for successively testing said registering devices in pairs to determine the digit stored, said stop relay being operated over a circuit including both of said wipers and banks when the digit stored is determined.

26. In combination, a plurality of registering devices, means for operating any pair of said devices to register a digit having a value depending upon the pair of registering devices operated, and means for determining the digit registered comprising means for testing said devices in different pairs successively until the operated pair is tested.

27. In combination, a plurality of registering devices, means for operating any pair of said devices to register a digit having a value depending upon the pair of registering devices operated, means for determining the digit registered comprising means for testing said devices in different pairs successively until the operated pair is tested, and test conductors extending from the testing means to said devices, respectively, the tests of said registering devices being performed over said conductors.

28. In combination, a plurality of registering devices, means for operating any pair of said devices to register a digit having a value depending upon the pair of registering devices operated, means for determining the digit registered comprising means for testing said devices in different pairs successively until the operated pair is tested, and test conductors extending from the testing means to said devices, respectively, the tests of said registering devices being performed over said test conductors, said test conductors corresponding in number to the number of registering devices provided.

29. In combination, a plurality of registers, each comprising a plurality of registering devices, means for setting the devices of each of said registers in pairs to register digits, and a testing device operated successively to test all possible pairs of said registering devices in each of said registers to determine the digit registered thereon.

In witness whereof, I hereunto subscribe my name this 6th day of April, A. D. 1931.

JOHN I. BELLAMY.