Sept. 12, 1944. B. VANDER ELS 2,358,267

TELEPHONE SYSTEM

Filed Sept. 9, 1942 6 Sheets-Sheet 1

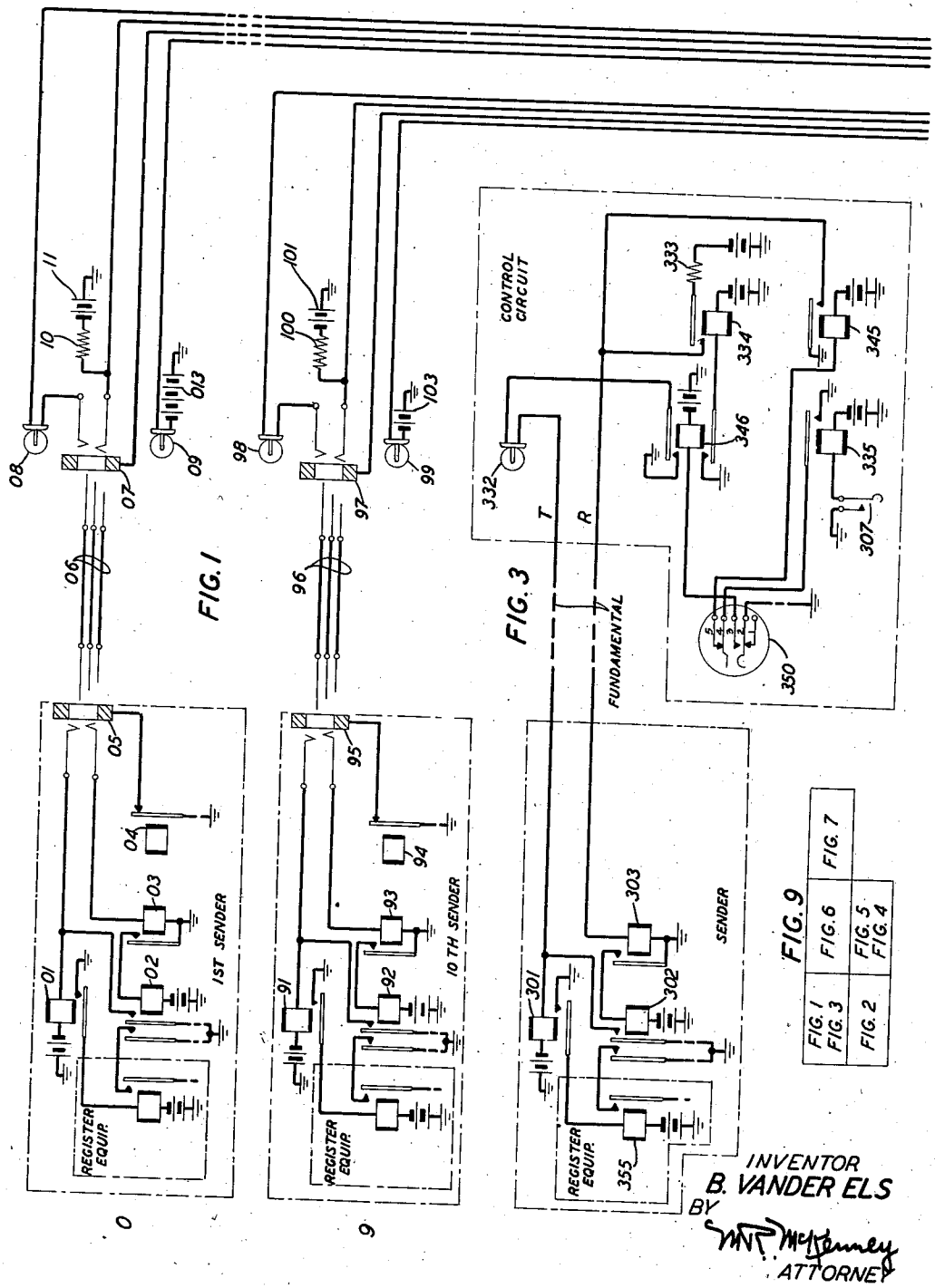


FIG. 9

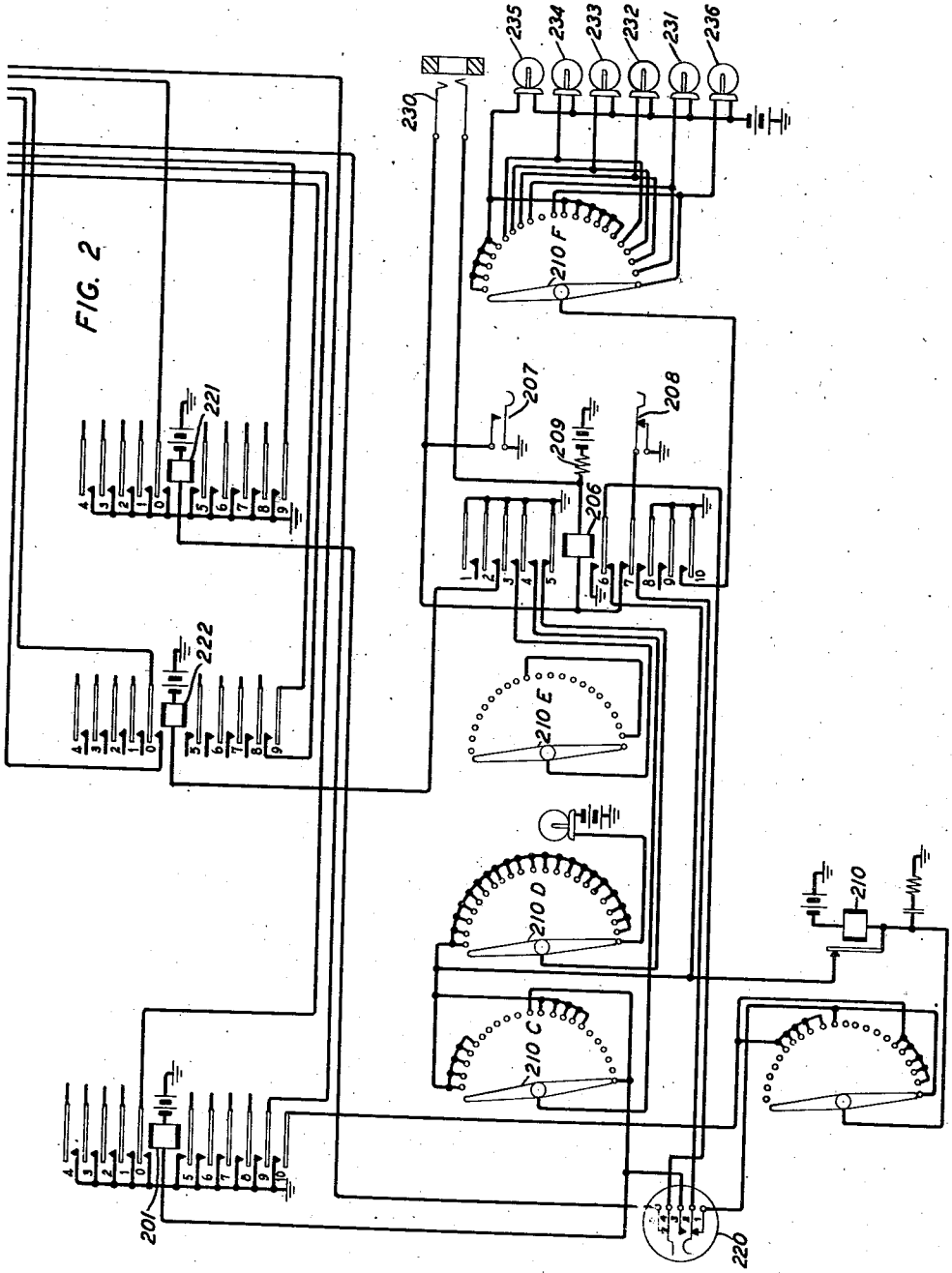
FIG. 1 FIG. 3	FIG. 2	FIG. 6	FIG. 5 FIG. 4	FIG. 7

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TELEPHONE SYSTEM

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TELEPHONE SYSTEM

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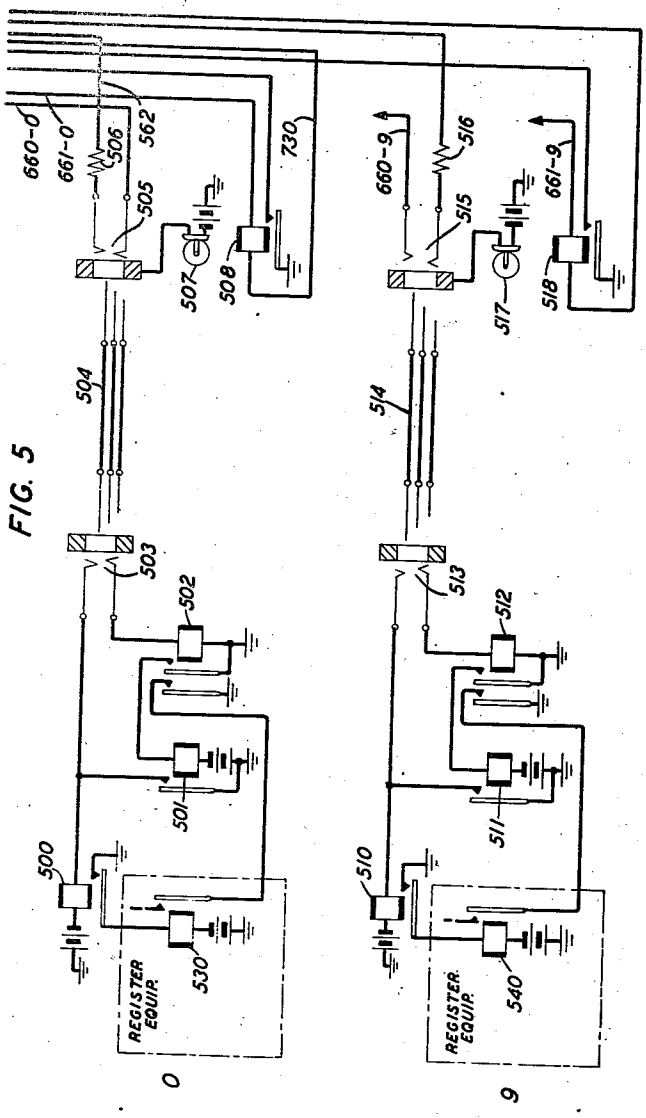


FIG. 5

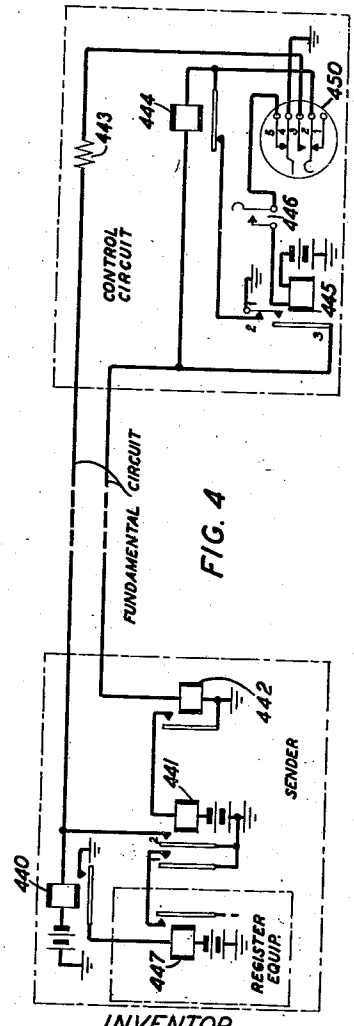


FIG. 4

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TELEPHONE SYSTEM

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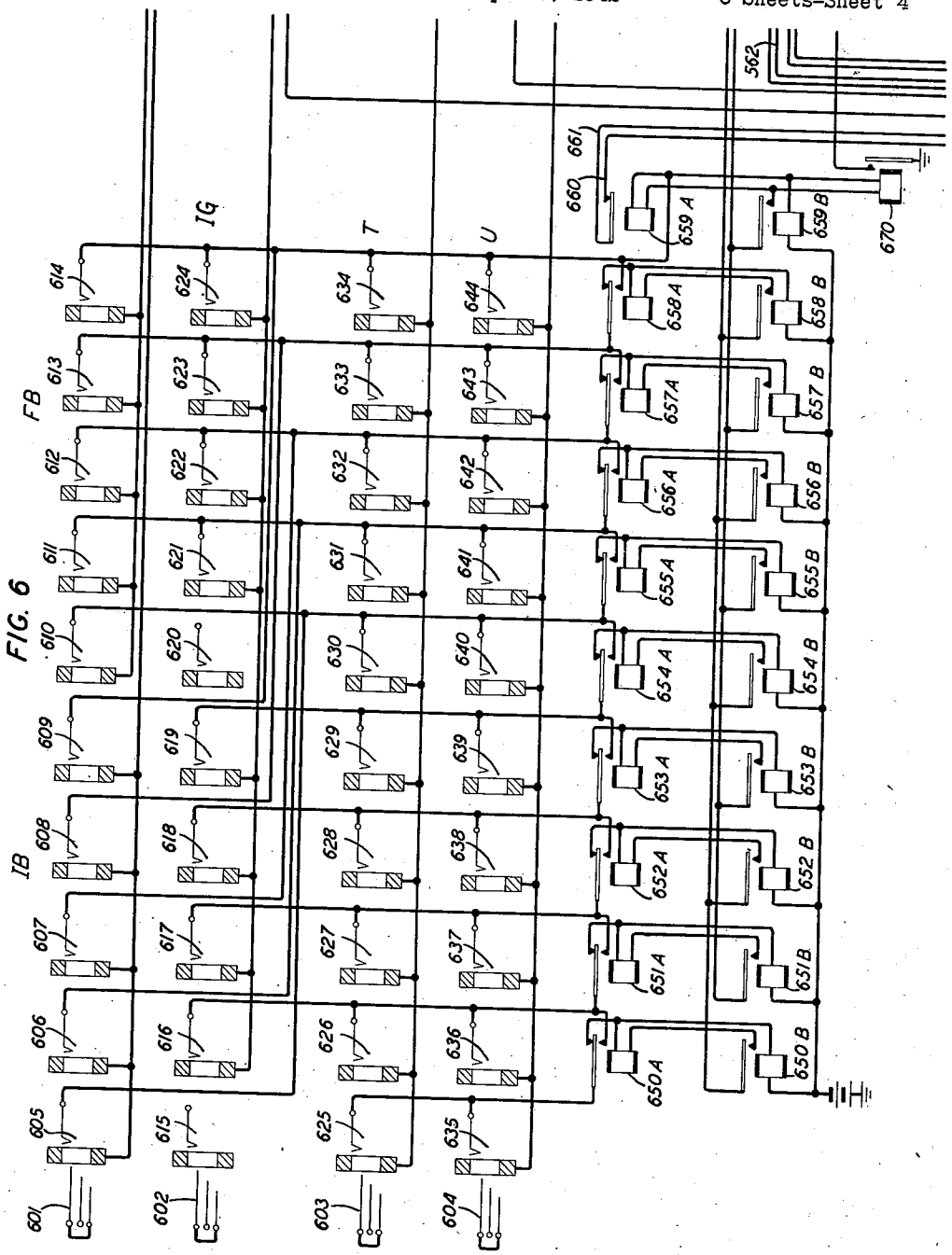


FIG. 6

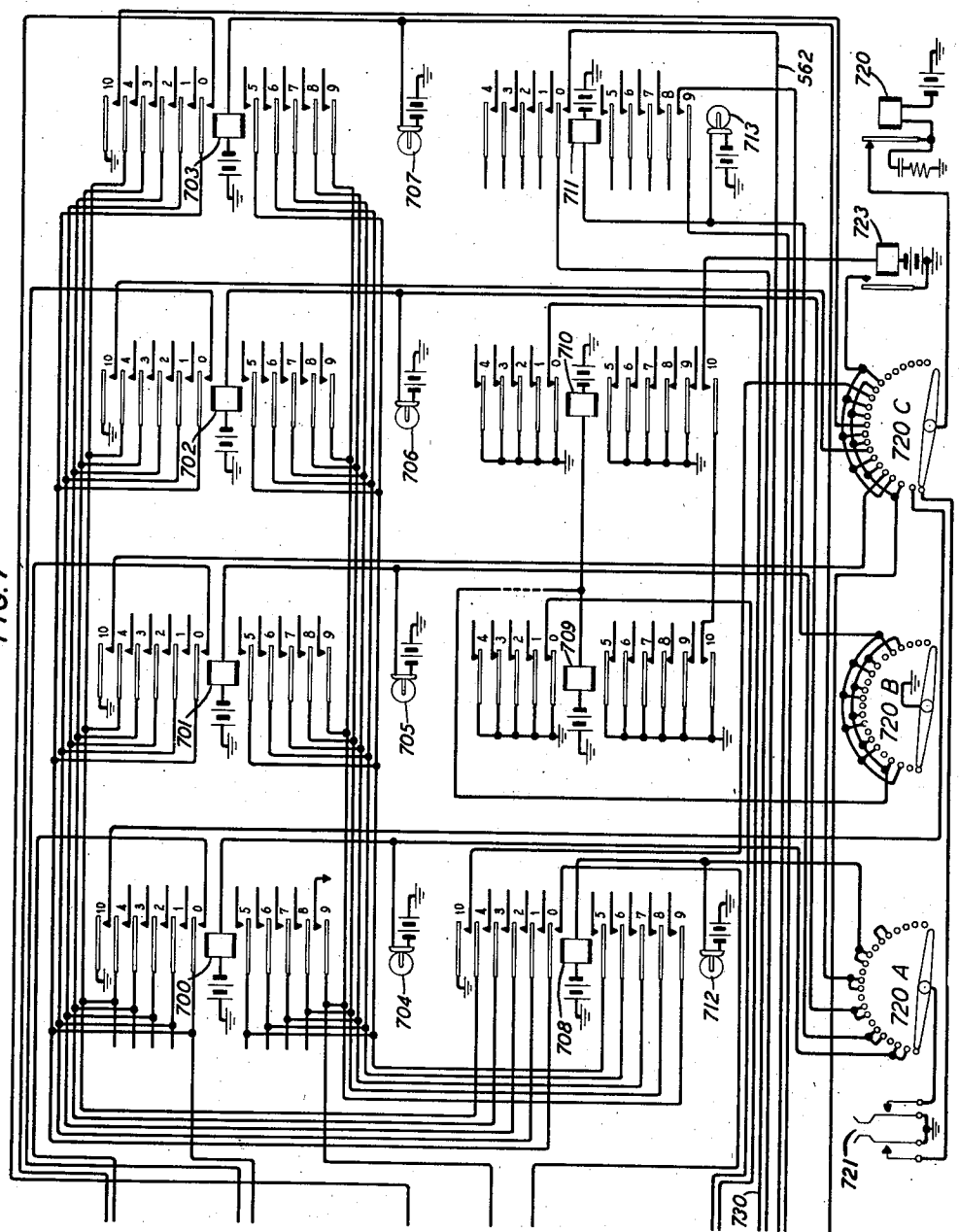
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TELEPHONE SYSTEM

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FIG. 7



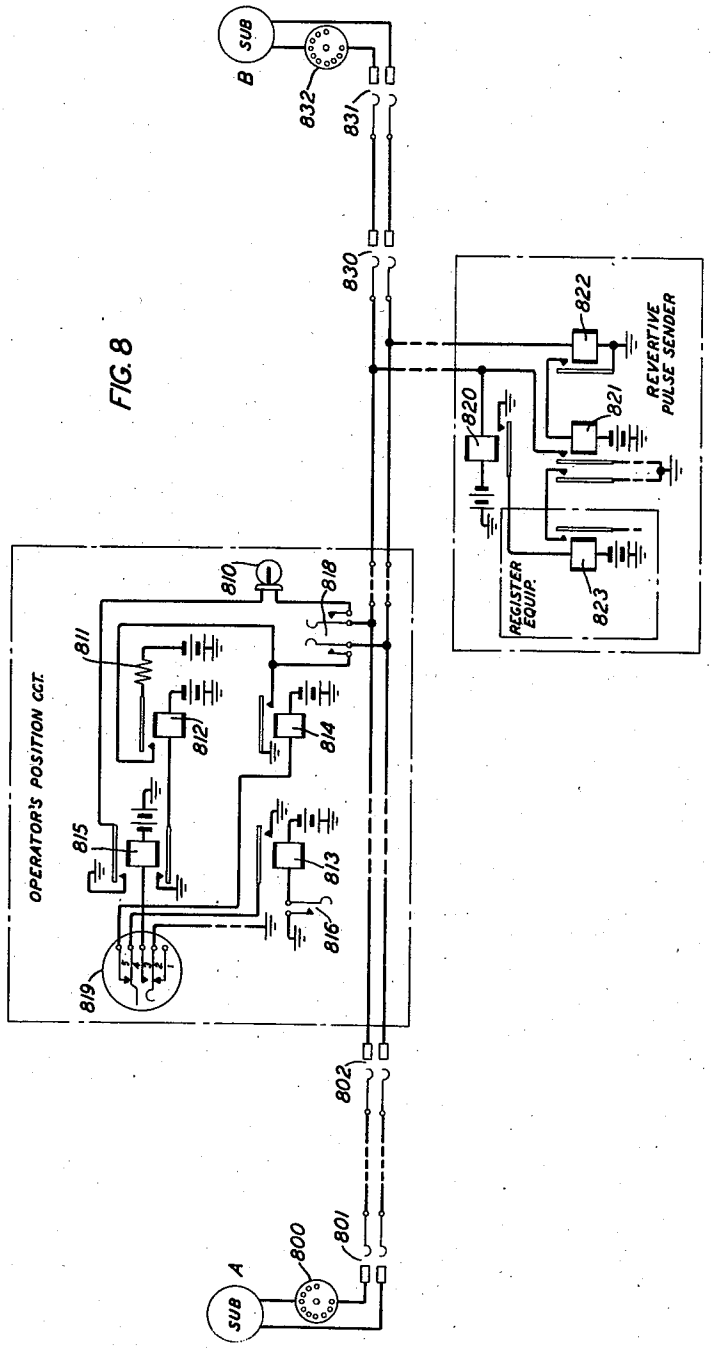
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TELEPHONE SYSTEM

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FIG. 8



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Patented Sept. 12, 1944

2,358,267

UNITED STATES PATENT OFFICE

2,358,267

TELEPHONE SYSTEM

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Application September 9, 1942, Serial No. 457,697

15 Claims. (Cl. 179—175.23)

This invention relates to automatic switching telephone systems and more particularly to the control of pulse-responsive devices for such systems.

It is the object of the invention to simplify the equipment for controlling revertive impulse-responsive devices.

Some telephone systems known in the art are controlled by the direct impulse method and others by the revertive impulse method. The direct impulse method is used for positioning step-by-step switches or other pulse-responsive devices in which the regulating factor is the pulse transmitter, such as a dial or pulse repeater. The revertive impulse method is used in large telephone offices, such as the panel or crossbar office systems, in which a fundamental circuit is formed between a control device and a pulsing device for positioning switches or registers in a sender. This pulsing device may be in the form of a switch commutator or a register controlling relay which in present systems is regulated under the control of a series of counting relays which are marked according to the number of direct pulses received by the control device having the counting relays therein. When the fundamental circuit is closed by a control circuit relay, the distantly related pulsing device operates continuously in synchronous relation with the counting relays until the fundamental circuit is opened by a particular counting relay. Ordinarily there are ten pairs of counting relays arranged to count a maximum of ten pulses.

The registers of register senders, such as shown in the crossbar system of Patent 2,089,921 issued to W. W. Carpenter, August 10, 1937, are of the type which are positioned by the revertive impulse method, a fundamental circuit being shown between the pulsing relays of the sender and the counting relays of another circuit. The same control circuit arrangement has been used for operating and testing senders and it has been found to be a matter of economy to test ten or more senders simultaneously. This requires a large number of sets of counting relays and other associated equipment for controlling the number of pulses transmitted.

It is a feature of this invention to associate a simple dial with the control part of the revertive impulse fundamental circuit to function with the pulsing equipment of a sender for the operation of the sender register equipment.

Another and related feature resides in the use of one dial in place of a large plurality of counting relays for simultaneously controlling the operation of a plurality of revertive impulse senders for testing the operation of said senders.

These and other features will be discussed more fully in the following description.

To illustrate the invention and the economy in the use of the invention, reference may be had to the accompanying drawings, in which:

Fig. 1 illustrates a plurality of senders diagrammatically in the left portion of the figure associated with a digit control circuit in the right and lower portion of this figure;

Fig. 2 illustrates the remainder of this digit control circuit;

Figs. 3 and 4 diagrammatically illustrate modifications of the fundamental circuit using a dial in the digit control portion of this circuit;

Figs. 5, 6, and 7 illustrate digit control circuits using counting relays for simultaneously operating a plurality of senders shown diagrammatically in the left portion of Fig. 5;

Fig. 8 illustrates a telephone system having an operator's position equipped with a dial for controlling a revertive impulse sender;

Fig. 9 illustrates the order of assembling the sheets of the drawings.

In order to make a comparison from the viewpoint of economy and improvement between the digit control circuit of the invention and other digit control circuits for revertive impulse systems, a short description is given in the following paragraphs of the arrangement now in general use.

A sender of the character operated by revertive impulses is disclosed and described in Patent 2,089,921 issued to W. W. Carpenter, August 10, 1937. This sender is shown in Figs. 29, 30 and 37 and described in detail in pages 20, 21, 22 and 23 of the specification. The fundamental circuit extends from a control circuit which may be in another sender, over leads **5819** and **5820** shown in Fig. 58 of this patent. The incoming conductor **5819** may be traced to conductors **5826** and **3726** thence through a contact on relay **3700**, a contact on relay **3701**, winding of what is generally known as the L relay **3015** to battery. The incoming conductor **5820** may be traced to conductors **5825** and **3725** and thence through a contact on relay **3700**, a contact on relay **3701**, through the winding of what is generally known as the stepping or pulsing relay **3000** to ground. The L relay **3015** is the equivalent of relay **01** or **91** shown in Fig. 1, **500** or **510** shown in Fig. 5, **340** shown in Fig. 3 and **440** shown in Fig. 4. The stepping or pulsing relay **3000** is the equivalent of relay **03** or **93** shown in Fig. 1, **502** or **512** shown in Fig. 5, **342** shown in Fig. 3 and **442** shown in Fig. 4.

The fundamental for a control circuit which may be connected with conductors 5819 and 5820 of Patent 2,089,921 is shown in sender circuit Patent 2,106,360 to R. Raymond, January 25, 1938. The latter patent includes counting relays 1220 to 1234 and a control circuit stepping relay 1202 in Fig. 12 which are connected in the fundamental circuit extending through equipment, as described, to conductors 328 and 329 of Fig. 3 of the Raymond patent. Conductors 328 and 329 may be connected to the above-mentioned conductors 5819 and 5820 of the Carpenter patent for controlling the number of pulses transmitted by the sender pulsing relay for registering digits. The fundamental circuit and the method of operating the counting relays in Patent 2,106,360 may be traced from the description given on page 5, column 2, lines 11 to 74 of this patent, and need not be again described herein.

Again referring to Patent 2,089,921, it may be seen that a test operation of the sender can be made by inserting a test circuit plug in the jack shown in the left upper portion of Fig. 37 of the drawings for this patent. The tip spring of this jack is connected through a contact on relay 3701, winding of the L relay 3015 to battery. The ring spring of this jack is connected through a contact of relay 3701, winding of the stepping relay 3000 to ground. As herein stated, the operation of the sender, the transmission of revertive pulses and the pulse recording by the crossbar registers shown in Fig. 29 are fully described on pages 20, 21 and 22 of this patent and need not be again described herein. In the drawings of this application, Figs. 1, 3, 4 and 5, and the register equipment diagrammatically shown may be the same as shown in the Carpenter patent.

A testing circuit following the practice used at the present time for operating senders of the character shown in Patent 2,089,921 is disclosed in Figs. 5, 6 and 7 of the illustrated embodiment for this application. In order that the senders of an office may be rapidly tested, this circuit is arranged to simultaneously operate ten senders and for this purpose ten circuits, Fig. 6, are used, only one being shown. The control equipment used for Fig. 6, therefore, amounts to 200 counting relays, 400 jacks, 50 plugs and other equipment for progressively operating this circuit. Two senders are diagrammatically shown in Fig. 5 which represent the first and last of ten senders of the character shown in the aforementioned patent to Carpenter. The jacks 503 and 513 represent the jacks of ten senders herein referred to as in Fig. 37 of the patent. These jacks are connected by patching cords, such as 504 and 514, to jacks 505 and 515 representing ten jacks of the control testing circuit. Relays 508 and 518 are the digit control circuit stepping relays in each of ten fundamental circuits extending between the senders and the digit control circuit. Each relay in Fig. 7 has ten contacts for simultaneously establishing ten circuits when operated. The jacks in the upper portion of Fig. 6 are arranged to control the number of pulses for each of the digits which will be herein known as incoming brush, incoming group, final brush, final tens and final units, for operating the sender registers in successive order as the stepping switch 720 rotates its brushes. Only sufficient contacts are shown on switch 720 to give an idea of the method of progressively operating the control circuit for successively registering different digits. A plug, such as 601, is inserted in any of the jacks 605 to 609 as required for marking the counting relays to control the number of counting relays to be operated for the incoming brush digit. A similar plug is inserted in one of jacks 616 to 624 to control the number of pulses in the incoming group digit. In the same manner similar plugs are inserted in jacks 610 to 614 for the final brush digit, in one of jacks 625 to 634 for the tens digit, and in one of jacks 635 to 644 for the units digit.

The procedure in simultaneously operating ten senders for testing purposes is first to connect patching cords, such as 504 to 514, from the digit control circuit jacks 505 to 515 with sender jacks 503 to 513. It may be assumed that the ten senders thus patched to the control circuit are not in use at this time. Plugs such as 601 to 604 are inserted in jacks, such as 605 to 644, one plug being used for incoming brush in one of jacks 605 to 609, another plug being inserted in one of jacks 610 to 614, a plug in one of jacks 616 to 624, a plug in one of jacks 625 to 634 and a plug in one of jacks 635 to 644. As shown on the drawings, these jacks are grouped for properly marking the starting point of operation of the counting relays in order that the correct number of pulses be counted by the counting relays for each digit, and as shown on the drawings, these plugs regulate the number of pulses for the incoming brush, incoming group, final brush, final tens and final units digits which are successively regulated by the control testing circuit as switch 720 rotates. For starting the operation of this test control circuit the start key 721 is operated. This establishes a circuit for moving switch 720 from its normal position and advancing it to its second terminal. The circuit for advancing the switch from its normal position may be traced from ground through the start key 721, terminal 1 and brush of switch arc 720C, contact and winding of the switch magnet 720 to battery. Upon reaching terminal 2 a circuit is established for the incoming brush relay 700 which extends from battery through its winding, terminal 2 and brush of arc 720A to ground on the start key 721. A circuit for lamp 604 is also established to this same ground to provide an indication of the progressive operation of the control circuit. The lamps 705, 706, 707 and 712 are lighted when the associated relays are operated to show the successive registration of the various digits. The operation of relay 700 establishes circuits through its contacts 0 to 9 for controlling ten sets of counting relays, one set being shown in Fig. 6, and also connects ground through its contact 10, No. 2 contact and brush of switch arc 720C, contact and winding of the magnet 720 to battery which causes the switch brushes to step from terminal 2 to terminal 3. Relay 700 remains operated since a circuit is also established in position 3 for this relay. The fundamental circuit between ten senders and the control circuit is now made effective by the operation of relay 711. The circuit for this relay may be traced from battery through its winding, contact 3 of switch arc 620B to ground through the brush of this switch arc. At this time the pulsing relays of the ten senders are automatically operated until such time as the fundamental circuit is opened by the end counting relays in each of the ten sets of counting relays.

Let it be assumed that plug 601 was inserted in jack 607 marking the counting relays for incoming brush selection. The counting relay circuit may thus be traced through a particular path

as the relays of the fundamental circuit are actuated. It is believed sufficient to trace the fundamental circuit for operating the zero sender since the fundamental circuits for the other nine senders are the same and, therefore, need not be traced. It may be assumed that ten plugs, such as 601, are all inserted in a jack of the same number in ten sets of like jacks for operating the ten senders in the same manner. From battery, extending through the winding of L relay 500, the fundamental may be traced over the tip spring of jack 503, tip conductor of the patching cord 504, tip spring of jack 505, resistance 506, lead 662, contact 0 of cut-in relay 711, lead 730, winding of the control circuit stepping relay 508, lead 661, contact of the end counting relay 659A, lead 660, ring spring of jack 505, ring of patching cord 504, ring spring of jack 503, winding of the sender pulsing or stepping relay 502 to ground. The sender L relay 500, the sender pulsing relay 502 and the control circuit stepping relay 508 operate in the circuit traced. The operation of relay 508 establishes a circuit for the operation of a counting relay which may be traced from battery, through counting relay 657B, spring of jack 607, plug 601, sleeve of jack 607, contact 0 of incoming brush relay 700 to ground on the contact of the stepping relay 508. In the sender the L relay 500 operates relay 530 and thus establishes an operating circuit for register equipment and the pulsing of stepping relay 502 transmits a first pulse to the sender register equipment. The stepping relay 502 also operates relay 501 which holds the L relay 500 operated and shunts the sender stepping relay 502 and the control circuit stepping relay 508, causing their release. Counting relay 657A is shunted while relay 508 is operated, but upon the release of relay 508 it is operated in series with counting relay 657B from battery, through the windings of relays 657B and 657A, contact of relay 657B to ground on the contact of relay 710. The release of relay 502 releases relay 501 and the fundamental circuit is again established for operating the sender pulsing relay 502 and the control circuit stepping relay 508 to transmit a second pulse and operate another counting relay 658B. Counting relay 658B operates through the inner contact of relay 657A to ground on the contact of stepping relay 508 over the circuit as previously traced through jack 607. As relay 502 transmits a second pulse to the register equipment, it also operates relay 501 which again shunts the stepping relays 502 and 508 causing their release. This removes the shunt around the winding of counting relay 658A which now operates in series with relay 658B, as described for the operation of relay 657A. Relay 501 again releases thus permitting a third operation of stepping relays 502 and 508 for transmitting a third pulse to the sender register equipment and for operating a third counting relay 659B. The operation of relay 502 again operates relay 501 which holds the L relay 500 and shunts stepping relays 502 and 508 causing their release. Relay 508 in releasing removes the shunt from the end counting relay 659A which now operates from battery through the winding of relays 659B and 659A, contact of relay 659A to ground on contact 0 of relay 710. The operation of relay 659A opens the fundamental circuit. This is also true of the other nine fundamental circuits which are opened by the end counting relay in equivalent sets of counting relays.

Relay 670 is in multiple with the end counting relay 659A and operates in series with relay 659B at the same time relay 659A is operated. There is, of course, one relay 670 for each of the ten sets of counting relays. Thus, while the fundamental is held open, a circuit is established from ground on the contact of relay 670, through the third contact and brush of switch arc 720C, contact and winding of the switch magnet 720 to battery for advancing the switch brushes to terminal 4. Relays 700 and 711 are released and a circuit is established for relays 709 and 710 upon the rotation of the switch brushes from terminal 3 to terminal 4. The release of cut-in relay 711 opens the ten fundamental circuits extending through the contacts 0 to 9 so that the fundamental circuits will remain open after the counting relays have been released. The operation of relays 709 and 710 opens the holding circuits extending through their contacts 0 to 9 for all counting relays which were operated causing the release of the counting relays. Relays 709 and 710 establish a circuit through contact 10 of both relays for operating the slow-release relay 723, the latter relay establishes an obvious circuit for moving the switch brushes from position 4 to position 5. In switch position 5 a circuit is established for incoming group relay 701 and progress lamp 705. This circuit extends from battery, through the winding of the relay and lamp, terminal 5 and brush of switch arc 720A to ground on the contact of start key 721. The operation of the incoming group relay 701 establishes a circuit for moving the switch brushes to terminal 6 which may be traced from ground on contact 10 of relay 701, terminal 5 and brush of arc 720C, contact and winding of the switch magnet 720 to battery. It will be noted that in switch position 6 the circuit for the incoming group relay 701 remains established.

In switch position 6 a circuit is established for cut-in relay 711 which is the same as previously traced. The fundamental circuits are now established for incoming group pulses from the ten senders to the control circuit through the ten contacts of relay 711. The counting relay control for group selection extends over circuits through plugs, such as 602 inserted in one of jacks 616 to 624, in each of the ten sets of like jacks. Assuming that the plugs were inserted in jack 618 the first operation of the ten control stepping relays 508 to 518 in series with ten sender pulsing relays 502 to 512 establishes circuits from ground through the contacts of the control stepping relays, contacts 0 to 9 of incoming group relay 701, thence through ten jacks, such as jack 618, and ten plugs, such as 602, winding of counting relays, such as 653B to battery which operates the ten counting relays to start the control of the sender pulsing which proceeds in the same manner as previously described until the fundamental is opened by the end counting relays such as 659A.

The operation of the ten senders for setting the registers under the control of the counting relays as the switch 720 advances is the same for final brush, final tens and final units and it is believed that this operation will be well understood from the description herein given so that the description of Figs. 5, 6 and 7 may be terminated at this point. Other devices, not shown, are used for observing the operation of the senders and for restoring switch 720 to normal when a test is completed.

Figs. 1 and 2 diagrammatically show two of the same character of senders as shown in the aforementioned Patent 2,089,921 to Carpenter and represent the first and last of ten senders to be

simultaneously controlled and tested by the digit control and testing circuit shown in these figures of the drawings. This control circuit provides full control of the senders over the usual fundamental circuit without the use of a large plurality of counting relays and a large plurality of jacks such as shown in the control circuit of Figs. 5, 6 and 7. In the arrangement of Figs. 1 and 2 the operation of the plurality of senders for setting the sender registers is under the control of a single dial and a progressively operable switch.

The ten senders of Fig. 1 are connected to the control circuit by inserting patching cords and plugs 06 to 96 in the sender jacks 05 to 95 and control circuit jacks 07 to 97 in the same manner as described for connecting the senders of Fig. 5 with the control circuit of Figs. 5, 6 and 7. The start key 207 is then operated which provides an obvious operating circuit for the start relay 206. This start relay provides ground circuits for various operations which will be apparent in the description. Relay 222 is operated from battery through its winding to ground on contact 2 of start relay 206. This relay provides signaling paths for lamps 09 to 99 to indicate that the testing circuit is associated with ten idle senders. This circuit extends from battery through lamp 09, contact 0 of relay 222, sleeve of jack 07, sleeve of patching cord 06, sleeve of jack 05 to ground on the contact of the sender relay 04. A similar circuit may be traced for lamp 99 through contact 9 of relay 222. Other similar circuits extend through the contacts of this relay. Relay 221 is energized from battery through its winding, contacts 5 and 4 of dial 220, to ground on contact 6 of the start relay 206. Relay 221 places a shunt ground through its contacts to the ring conductor of all senders which causes the release of the sender pulsing or stepping relays 03 to 93. It will be apparent that relay 21 is released and operated a number of times during the backward movement of the dial after the dial has been moved forward to a particular position by the engagement of a particular finger notch. The stepping magnet 210 is energized from battery through its winding, brush and contact 1 of switch arc 210A, contacts 1 and 2 of the dial to ground on contact 8 of the start relay 206. The switch does not, however, step its brushes to terminal 2 until this circuit is opened by the forward movement of the dial, since the switch is what is known as a backstroke switch. Lamp 236 is connected to the first terminal as a signal showing that the switch is in the correct position to begin the control of the senders. The circuit for lamp 236 is from battery, through the filament of the lamp, terminal 1 and brush of switch arc 210F, contact 10 of start relay 206 to ground.

The senders may now be controlled for incoming brush selection by the manipulation of the dial 220. It should be here pointed out that one pulse is registered in the sender when a jack of the sender is connected by the patching cord to the jack in the control circuit since at that time battery through resistance 10 or through resistance 100 is connected through the winding of the sender pulsing relays 03 and 93 which operates these relays. The operation of the pulsing relays operates relay 02 and relay 92 which in this instance operate the L relays 01 and 91 cause a pulse to be transmitted to the register equipment of the senders. The dial must therefore be manipulated accordingly so that the dial notch 4 will be used if the sender pulsing relay is to operate five times. Assuming that the dial notch 4 is used for incoming brush selection, the circuits are established in the following order when the dial is moved off-normal. The forward movement of the dial opens the dial spring contacts 1 and 2 which open the circuit for switch magnet 210 causing the brushes to be stepped forward to position 2. The forward movement of the dial causes the engagement of dial contact 2 with dial contact 3 which establishes a circuit for the fundamental relay 201 from battery through the winding of this relay, contacts 2 and 3 of the dial to ground on contact 8 of start relay 206. The latter dial contacts remain closed and relay 201 remains operated until the dial returns to its normal position. The operation of relay 201 connects ground through its contacts 0 to 9, lamps 08 to 98, tip springs of jacks 07 to 97, patching cords 06 to 96, tip springs of jacks 05 to 95, windings of L relays 01 to 91 to battery. This circuit maintains the L relay 01 operated during the non-pulsing periods of relays 03 and 02 and maintains the L relays of the other nine senders operated during the non-pulsing periods of the other pulsing relays in the fundamental circuits. Upon the backward movement of the dial after it has been moved forward to the finger stop and released, the spring contacts 4 and 5 are opened a number of times depending upon the finger notch engaged for forward movement. The opening of dial contacts 4 and 5 during the return movement of the dial opens the circuit for relay 21 causing it to release. The release of relay 221 removes the ground shunt from pulsing relays 03 to 93 which operate over circuits to battery through resistances 10 to 100 during the progress from notch 4 to its normal position which causes relay 221 to be released and operated four times. The release of relay 221 removes the ground shunts from the operating circuits for the pulsing relays 03 to 93. The operation of relays 03 to 93 causes the operation of relays 02 to 92 which transmit pulses to their respectively associated registers and maintain operating circuits for other respectively associated L relays 01 to 91 during this pulsing period. The operating circuit for the L relays 01 to 91 from ground on their respectively associated relays 02 to 92 shunts the current supply for lamps 08 to 98 during the pulsing period and thus indicates to an observer the number of pulses transmitted as the dial returns to its normal position. Each operation of relay 221 establishes a shunt for pulsing relays 03 to 93 which causes the release of these relays and the release of relays 02 to 92. The return of the dial to its normal position opens the circuit for the relay 201 which opens the ten fundamental circuits. The L relays 01 to 91 now release so that the sender register equipment may be automatically adjusted for receiving the pulses of the next successive digit.

During the time that relay 201 was operated, which is equivalent to the forward and backward movement of the dial for controlling a series of pulses comprising a digit, a circuit is established through contact 10 of relay 201, terminal 2 and brush of switch arc 210A, switch magnet 210 to battery. The return of the dial to its normal position separates dial contacts 2 and 3 which restores relay 201 and opens the circuit extending through the winding of the switch magnet, thus causing the switch to advance its brushes from terminal 2 to terminal 3.

The second manipulation of the dial controls the sender pulsing relays for incoming group

selection in the manner as described for incoming brush selection and the switch advances one terminal upon the return of the dial to its normal position. The third manipulation of the dial controls final brush selections, the fourth manipulation of the dial controls final tens selections, and the fifth manipulation of the dial controls final units selections. These are the same selections as described for the control circuit of Figs. 5, 6, and 7 in which the counting relays controlled the number of pulses transmitted by the sender pulsing relays into the sender registers instead of having the number of pulses controlled by the simple dial **220**. The lamps **231** to **235** indicate the progress of the control circuit in a similar manner to the signal lamps such as **604** associated with the relays of Fig. 7.

Fig. 3 illustrates a modification of the fundamental circuit shown in Figs. 1 and 2. The sender equipment is disclosed in the left portion and the control circuit in the right portion of this figure. For this diagrammatic showing of the fundamental, the progress switch is not provided. The particular difference between the control circuit of Fig. 3 and the control circuit of Figs. 1 and 2 resides in the use of relay **334** which is operated from a contact of relay **346**. Relay **346** may be assumed to be the same as relay **201** of Fig. 2. Relay **345** may be assumed to be the same as relay **221** of Fig. 1. A relay, such as relay **222**, is not shown. It may be assumed that the senders are connected with the control circuit by attaching cords in the same manner as shown in Fig. 1. Thus the sender in the left portion of Fig. 3 is connected to the control circuit in the right portion of this figure. The start relay **335**, which may be substantially the same as the start relay **206** of Fig. 2, is operated by the start key **307**. The operation of the start relay connects ground through contacts **4** and **5** of the dial **350**, winding of relay **345** to battery, operating the latter relay. This places a shunt on the pulsing relay **303** so that it will not be operated until such time as the contact of relay **345** is open upon the return movement of the dial after it has been moved to the finger stop and released. When the dial is moved forward from its normal position, a circuit is closed for relay **346** which connects ground through lamp **332**, winding of the L relay **301** to battery, operating the L relay. The operation of the L relay establishes circuit for operating relay **355** to prepare the register equipment for receiving pulses when the pulsing relays **303** and **302** are operated. The operation of relay **346** also establishes a circuit for operating **334**. The operation of relay **334** connects battery through resistance **333** to the ring conductor of the fundamental, but since at this time ground is connected to the ring conductor of the fundamental, through the contact of relay **345**, the pulsing relay **303** will not operate. After the dial has been moved forward to the finger stop and released, contacts **4** and **5** are intermittently open as the dial returns to its normal position. The opening of contacts **4** and **5** causes the release of relay **345** which removes the ground shunt from ring conductor of the fundamental. Thus a circuit is established for the pulsing relay **303** from ground through its winding over the ring conductor, contact of relay **334**, resistance **333** to battery. Relay **303** establishes an obvious circuit for relay **302** which transmits a pulse to the register equipment and associates ground with the tip conductor for establishing a holding circuit for the L relay **301** during the pulsing period. As the dial restores to normal, a number of pulses are counted equivalent to the finger notch used in moving the dial forward to the finger stop. It will be noted that by the use of this modification, the pulsing relay **303** does not operate until the return movement of the dial and, therefore, a preliminary pulse is not registered by the register equipment.

Fig. 4 illustrates another modification of the fundamental circuit shown in Figs. 1 and 2. The sender equipment is disclosed in the left portion and the digit control circuit in the right portion of this figure. For this diagrammatic showing of the fundamental, the progress switch is not provided. A stepping relay **444** is used in Fig. 4 which is not required in the digit control circuits of Figs. 1 and 2 but is used in this modification as a synchronizing medium in the fundamental circuit. A stepping relay of this character is used in the digit control circuit shown in Figs. 5, 6 and 7 for operating the counting relays through its contact. It may be assumed that the same type of patching cords as shown in Fig. 1 are used for associating the digit control circuit of Fig. 4 with the senders of Fig. 4. The operation of the locking start key **446** energizes relay **445** which associates ground with the fundamental circuit between the windings of control relay **444** and the sender pulsing relay **442**. When the dial is moved forward from its normal position, the fundamental circuit is closed through contacts **2** and **3** of the dial, winding of relay **444**, contacts **1** and **3** of relay **445** to ground. The sender L relay **440** and relay **444** are thus energized from battery through the winding of relay **440**, resistance **446**, contacts **2** and **3** of dial **450**, winding of relay **444** to ground through contacts **3** and **1** of relay **445**. At this time relay **442** is shunted by ground from the contacts of relay **445**. The operation of the L relay **440** establishes an operating circuit for relay **447** to prepare the registering equipment for receiving pulses later when relays **442** and **441** are operated.

When the dial is moved forward to the finger stop and released, the dial contacts **4** and **5** are open causing the first release of relay **445**. Relay **444** remains operated and its contact remains open and consequently the sender pulsing relay **442** operates in series with relay **444** to battery, through the winding of the L relay **440** which also remains operated. The operation of relay **442** energizes relay **441** which transmits a pulse into the register equipment and associates ground with the tip lead through the winding of the L relay **440** to battery, holding the L relay operated during the pulsing period. Connecting this ground with the tip lead also shunts relay **444** and relay **442** causing their release and the release of relay **441**.

Relays **442** and **444** operate and release very rapidly and, therefore, an arrangement is provided to prevent these relays from operating again if relay **445** has not been operated by the time relays **442** and **444** have been released after relay **441** has transmitted the first pulse. If the dial contacts **4** and **5** have not again closed, and again operate relay **445** when relay **444** is released, a circuit is established from ground through contacts **1** and **2** of relay **445** and the contact of relay **444** to shunt relays **444** and **442** and maintain an operating circuit for the L relay **440**. Upon the next closure of contacts **4** and **5**, relay **445** again operates which causes relay **444** to again operate from ground through contacts **1** and **3** of relay **445** to battery, through the wind-

ing of the L relay 440. The operation of relay 444 opens its contact so that the pulsing relay 442 operates again in series with relay 444 when dial contacts 4 and 5 open and release relay 445.

The pulsing continues in this manner for setting the registers, and the digit control circuit equipment is maintained in synchronism with the pulsing equipment of the sender until the dial has returned to its normal position where the fundamental circuit extending to the L relay 440 is opened by dial contacts 2 and 3 causing the release of the L relay so that the register equipment may be automatically adjusted for receiving the next digit. Relay 445 remains operated until the dial is again moved forward and released for intermittently opening the dial contacts 4 and 5 to register the next digit and during this time shunts the pulsing relay 442 from ground through its contacts 1 and 3. The dial is thus moved forward and released as many times as required for controlling the fundamental pulsing equipment to register a certain number of digits in the sender. The start key may then be released for releasing relay 445 after the last digit has been registered.

A telephone system is shown in Fig. 8 having a dial in a telephone operator's position circuit, with associated equipment in a revertive pulse fundamental extending to the revertive pulsing equipment of a sender for setting the registers of this sender.

In some automatic telephone systems many telephone calls are handled by an operator which for certain reasons are not routed from one point to another by automatically operable equipment, such for example, as telephone traffic from DSA switchboards, test desks and manual switchboards. It has been the customary practice to equip such switchboard positions with a dial arranged for the direct pulsing method the same as a subscriber's station dial or with a key pulsing key set, neither of which are arranged for controlling a revertive pulse sender. Therefore, when revertive pulse senders are associated with an operator's position, it has been the practice to place another sender between the operator's position and the revertive pulse sender.

The sender which is used between the operator's position and the revertive pulse sender may be of the type disclosed in Patent 2,106,360 to R. Raymond, January 25, 1938, to which reference has already been made, or other senders of this character shown in the art which are set from direct dial pulses or by pulsing key sets and which are arranged to convert or translate the digits registered from direct pulses for controlling a revertive pulse sender of the character shown by W. W. Carpenter in the aforementioned Patent 2,089,921.

The use of the revertive pulse digit control circuit of the invention in the operator's position circuit as shown, eliminates the requirement for a group or plurality of senders of the type shown by Raymond between the operator's position and the revertive pulse senders, the latter senders being controlled directly by the operator's digit control circuit which includes a dial adaptable for such control instead of the direct pulsing dial. The revertive pulse sender diagrammatically shown in Fig. 8 may be of the type shown in the aforementioned patent to Carpenter and the revertive pulse digit control circuit may be arranged as shown in either Figs. 1 and 2, or the modifications Fig. 3 or 4.

An incoming call from subscriber's station A may operate a line finder 801 and selecting switch 802 of the usual type known in the art, for connecting the subscriber A with the operator's position and the calling subscriber is challenged by the operator in the operator's position to ascertain the destination of the call. Various characters of telephone equipment are contemplated for connecting the calling party with the operator's position. When the destination of the call requires the use of a revertive pulse sender for setting the outgoing switches 830 and 831, an outgoing circuit is selected by a plug or a switch extending to a link for connecting a revertive pulse sender with the outgoing circuit from the operator's position. Key 818 is actuated for connecting the digit control circuit with the fundamental circuit and start key 816 is actuated which establishes an obvious circuit for relay 813. The operation of relay 813 establishes an operating circuit for relay 814 through contacts 4 and 5 of the dial 819. Relay 814 connects a shunt ground with one leg of the fundamental extending toward the winding of stepping relay 822 of the revertive pulse sender.

The switchboard operator manipulates the dial 819 when an idle sender has been connected to the operator's position circuit for regulating the number of revertive pulses comprising the first digit. The movement of the dial 819 away from its normal position closes the dial contacts 2 and 3 which establishes an obvious operating circuit for the fundamental closing relay 815. The latter relay connects ground through its upper contact, lamp 810, right contact of key 818, winding of the L relay 820 to battery which operates the L relay 820 and lights lamp 810. The L relay 820 now establishes an operating circuit for relay 823 which establishes a circuit between relay 821 and the sender registers over which a pulse is transmitted upon each operation of the sender pulsing relays 822 and 821. Relay 815 also establishes an obvious circuit through its lower contact for operating relay 812. The latter relay connects battery through resistance 811 and the relay contact, winding of relay 822 to ground. This circuit is however not effective for operating relay 822 until relay 814 is released to remove the shunt ground from this conductor of the fundamental circuit.

The dial contacts 4 and 5 are opened after the switchboard operator has moved the dial to the finger stop by engaging a particular finger grip and the dial has been released so that it may return to its normal position. A finger grip is engaged by the operator according to the number of pulses to be counted for the digit. The opening of dial contacts 4 and 5 releases relay 814 which removes the ground shunt from the associated leg of the fundamental circuit. Relay 822 now operates from ground through its winding, contact of relay 812, resistance 811 to battery. Relay 822 operates relay 821 over an obvious circuit and the latter relay transmits the first pulse through the contact of relay 823 to the sender registers. The dial contacts 4 and 5 are intermittently opened and closed as the dial restores to its normal position. The closure of these contacts reoperates relay 814 which again connects the ground shunt through its contact to the fundamental circuit causing the release of relay 822 which releases relay 821. The pulsing relays of the sender thus operate each time the shunt ground is removed by the release of relay 814 to transmit the number of pulses to the sender registers equivalent to the num-

ber of times the dial contacts 4 and 5 are opened as the dial returns to its normal position.

When the dial has restored to normal, contacts 2 and 3 are opened causing the release of relay 815 which opens the operating circuit for the sender L relay 820. The release of relay 820 signals the sender that the last pulse of the digit has been transmitted and adjusts the registering equipment for receiving the pulses of the succeeding digit which are registered upon the next operation of the dial. Successive operations of the dial set the registers of the sender in the manner described, for controlling switching connections after the last digit is recorded as shown in the aforementioned patent to W. W. Carpenter, for connecting the calling subscriber A to the called subscriber B.

It is not contemplated that the invention be limited to the specific uses illustrated since there are other telephone system arrangements in which this revertive pulse control circuit may be used to effect considerable economies.

What is claimed is:

1. In a telephone switching system, a switch controlling circuit, a digit controlling circuit, a revertive impulse fundamental circuit extending from said switch controlling circuit to said digit controlling circuit, the switch controlling circuit portion of said fundamental circuit comprising a relay operable by said digit controlling circuit during non-pulse periods for arranging said switch controlling circuit for receiving pulses, and a pulsing device for operating said switch controlling circuit and for holding said relay operated during the pulse transmitting periods, and means including a dial for closing said fundamental circuit when said dial is moved forward from its normal position, for regulating the number of pulses transmitted by said pulsing device on its backward motion and for opening said fundamental circuit upon arriving in its normal position.

2. In a telephone switching system, a sender having registers for controlling switching operations, a digit controlling circuit, a revertive impulse fundamental circuit extending from said sender to said control circuit, the sender portion of said fundamental circuit comprising a relay operable by said control circuit during the non-pulsing period for arranging said registers for receiving pulses, and a pulsing device for operating said registers with means in said pulsing device for holding said relay operated during the pulse transmitting period, and means including a dial for closing said fundamental circuit when said dial is moved forward from its normal position, for regulating the number of pulses transmitted by said sender pulsing device to said registers on its backward motion and for opening said fundamental circuit upon arriving at its normal position.

3. In a telephone switching system, a plurality of switch controlling circuits, a digit controlling circuit, a revertive impulse fundamental circuit extending from each of said plurality of switch controlling circuits to said digit controlling circuit, the switch controlling circuit portion of each fundamental circuit comprising a relay operable by said digit controlling circuit during non-pulsing periods for arranging each switch controlling circuit for receiving pulses, and a pulsing device in each switch controlling circuit for operating said switch controlling circuits and for holding said relays operated during the pulse transmitting periods, and means including a single dial for causing the closure of said plurality of fundamental circuits when said dial is moved forward from its normal position, for regulating on its backward motion the number of pulses transmitted by the pulsing devices in each of said switch controlling circuits and for causing the opening of said plurality of fundamental circuits upon arriving in its normal position.

4. In a telephone switching system, a switch controlling circuit, a digit controlling circuit, a revertive impulse fundamental circuit extending from said switch controlling circuit to said digit controlling circuit, the switch controlling circuit portion of said fundamental circuit comprising a relay operable by said digit controlling circuit during non-pulsing periods for arranging said switch controlling circuit for receiving pulses, and a pulsing device for operating said switch controlling circuits and for holding said relay operated during the pulse transmitting period, the digit controlling circuit portion of said fundamental circuit comprising a dial having springs thereon which are open when the dial is in its normal position and closed when the dial is moved from its normal position, and other springs which are intermittently opened and closed during the backward movement of said dial, means for closing said fundamental circuit and operating said relay by the closure of said first springs with the dial moved from its normal position, and means for regulating the number of pulses transmitted by said pulsing device by the movement of said other springs during the backward movement of said dial to normal where said fundamental circuit is again opened responsive to the opening of said first springs.

5. In a telephone switching system, a switch controlling circuit, a digit controlling circuit, a revertive impulse fundamental circuit extending from said switch controlling circuit to said digit controlling circuit, the switch controlling circuit portion of said fundamental circuit comprising a relay operable by said digit controlling circuit during non-pulsing periods for arranging said switch controlling circuit for receiving pulses and a pulsing device for operating said switch controlling circuit and for holding said relay operated during said pulse transmitting period, the digit controlling circuit portion of said fundamental circuit comprising a dial and means to close said fundamental circuit by movement of said dial away from its normal position which establishes an operating circuit for the relay in said switch controlling circuit before the pulsing circuit in said fundamental is established, and other means for establishing a circuit for the pulsing device and for regulating the number of pulses in a digit during its backward movement to its normal position where said fundamental circuit is again open by said first means.

6. In a telephone switching system, a switch controlling mechanism, registers, a digit controlling mechanism, a revertive impulse fundamental circuit extending from said switch controlling mechanism to said digit controlling mechanism, pulsing devices in the switch controlling portion of said fundamental circuit for transmitting pulses to said registers and for transmitting equivalent revertive pulses over said fundamental circuit for controlling said pulsing devices, a dial in said digit controlling mechanism, a synchronizing device in said control mechanism under the control of said rever-

tive pulses and said dial and means in said dial in combination with means in said synchronizing device for regulating the number of pulses in each digit.

7. In a telephone switching system, a plurality of switch controlling senders having digit registers therein, a digit controlling circuit, revertive impulse fundamental circuits extending from said plurality of switch controlling senders to said digit controlling circuit, pulsing devices in the switch controlling portion of each of said fundamental circuits for transmitting pulses to said respective registers and for transmitting equivalent revertive pulses over said respective fundamental circuits for controlling said pulsing devices, a single dial in said digit controlling circuit, a synchronizing device in said control mechanism under the control of said revertive pulses and said dial and means in said dial in combination with means in said synchronizing device for regulating the number of pulses for each digit for setting the registers in said plurality of switch controlling senders.

8. In a telephone switching system, switches, incoming lines, outgoing lines, a telephone operator's position, means for connecting an incoming line with said operator's position, a revertive pulse sender having registers therein for controlling switching connections to connect an incoming line to an outgoing line, a revertive pulse digit controlling mechanism in said operator's position, a revertive pulse fundamental circuit extending from said digit controlling mechanism to said sender, means for connecting said digit controlling mechanism to said fundamental circuit, pulsing devices in the sender portion of said fundamental circuit for transmitting pulses to said sender registers, and means including a dial in said digit controlling mechanism for closing said fundamental circuit to establish circuits for said pulsing devices and for regulating the number of revertive pulses in each digit to set the registers of said sender for establishing a connection between said incoming line and a particular outgoing line under the control of an operator in said operator's position.

9. In a telephone switching system, switches, incoming lines, outgoing lines, a telephone operator's position, means for connecting an incoming line with said operator's position, a revertive pulse sender having registers therein for controlling switching connections to connect an incoming line to an outgoing line, a revertive pulse digit controlling mechanism in said operator's position, a revertive pulse fundamental circuit extending from said digit controlling mechanism to said sender, a key for connecting said digit controlling mechanism to said fundamental circuit, pulsing devices in the sender portion of said fundamental circuit for transmitting pulses to said sender registers, a dial in said digit controlling mechanism, means including said dial for controlling said revertive pulse fundamental circuit to establish circuits for said pulsing devices when said dial is moved forward away from its normal position, and after it has been moved forward and released, for regulating the number of pulses in a digit transmitted by said sender pulsing devices for setting the registers of said senders for controlling the switching connection between said incoming line and a particular outgoing line.

10. In a telephone switching system, register mechanism, a revertive pulse fundamental circuit of the type having pulse transmitting devices controlled by the shunt method and having a relay which is operable when the fundamental circuit is closed, said relay establishing a connecting circuit between said register mechanism and said pulsing devices for setting said registers responsive to the operations of said pulsing devices, a digit pulse controlling mechanism for said fundamental circuit having a telephone dial, means in said dial for causing the closure of said fundamental circuit when moved away from its normal position, a shunt device, and other means in said dial intermittently operated as said dial restores to its normal position for controlling said shunt device for regulating the number of operations of said pulsing devices for a digit for setting said registering mechanism.

11. In a telephone switching system, a sender having registers for controlling switching operations, a revertive pulse fundamental circuit of the type having a stepping relay and a pulsing relay controlled by the shunt method and having a line relay which is operable when the fundamental circuit is closed, said line relay establishing a connecting circuit between said sender registers and said pulsing relay for setting the registers responsive to the operations of said stepping and pulsing relays, a digit pulse control mechanism for said fundamental circuit having a telephone dial, means in said dial for causing the closure of said fundamental circuit when moved away from its normal position, a shunt device and other means in said dial intermittently operated as said dial restores to its normal position for controlling said shunt device for regulating the number of operations of said stepping and pulsing relays for a digit for setting the registers of said sender.

12. In a telephone switching system, a plurality of switch controlling senders each having registers, a revertive pulse fundamental circuit for each sender of the type having pulse transmitting devices controlled by the shunt method and having a relay which is operable when the fundamental circuit is closed, the relay of each fundamental circuit establishing a connecting circuit between the register mechanism and the pulsing devices in each sender for setting the registers responsive to the operations of said pulsing devices, a single digit pulse control mechanism for said plurality of fundamental circuits having a single telephone dial, means in said dial for causing the closure of said fundamental circuits when moved away from its normal position, a shunt device in said control mechanism and other means in said dial intermittently operated as said dial restores to its normal position for controlling said shunt device for regulating the number of operations of said pulsing devices for a digit for setting the registering mechanism of all of said plurality of senders.

13. In a telephone switching system, a switch controlling circuit having registers, a digit controlling circuit, a revertive pulse fundamental circuit extending from said switch controlling circuit to said digit controlling circuit, the switch controlling circuit portion of said fundamental circuit comprising a relay operable by said digit controlling circuit during non-pulsing periods for arranging said switch controlling circuit for receiving pulses, a pulsing device for operating said switch controlling circuits and for holding said relay operated during the pulse transmitting period, the digit controlling portion of said fundamental circuit comprising a telephone dial, contact springs in said dial which are open when

the dial is in its normal position and closed when the dial is moved away from its normal position, other contact springs in said dial which are intermittently opened and closed during the restoring movement of said dial, means under the control of said first springs for closing said fundamental circuit when said dial is moved away from its normal position, and a shunt device under the control of said other springs for controlling the number of operations of said pulsing devices for a digit for setting the registers of said switch controlling circuit.

14. In an automatic telephone system, a sender register control mechanism connected to a revertive pulse fundamental circuit of the type in which relays including a stepping relay are operated when the fundamental circuit is closed for transmitting pulses to a register and the stepping relay is released by the application of a shunt to a leg of the fundamental circuit as each pulse is transmitted, a digit pulse controlling telephone dial, contacts in said dial connected with said fundamental circuit for closing the fundamental circuit when said dial is moved away from its normal position and other contacts in said dial intermittently opened and closed on its return movement to its normal position for regulating the number of times said stepping relay is operated and released for the pulses of a digit and a relay under the control of said shunt and said dial for synchronizing the cycle of operation and release of said stepping relay with the closed and opened cycle of said latter dial contacts.

15. In an automatic telephone system, a sender register control mechanism connected to a revertive pulse fundamental circuit of the type in which relays including a stepping relay are operated when the fundamental circuit is closed for transmitting the pulses to a register and the stepping relay is released by the application of a shunt to a leg of the fundamental circuit as each pulse is transmitted, a digit pulse controlling telephone dial, contacts in said dial connected with said fundamental circuit for closing the fundamental circuit when said dial is moved away from its normal position and other contacts in said dial intermittently opened and closed on its return movement to its normal position for regulating the number of times said stepping relay is operated and released for the pulses of a digit, a synchronizing relay in said fundamental circuit released by said shunt simultaneously with the release of said stepping relay and a contact on said synchronizing relay in a circuit controlled by said other dial contacts for synchronizing the operations of said stepping relay with the operations of said other dial contacts.

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