July 1, 1947. F. P. GOHOREL 2,423,098

AUTOMATIC SWITCHING SYSTEM

Filed July 2, 1943 5 Sheets-Sheet 1

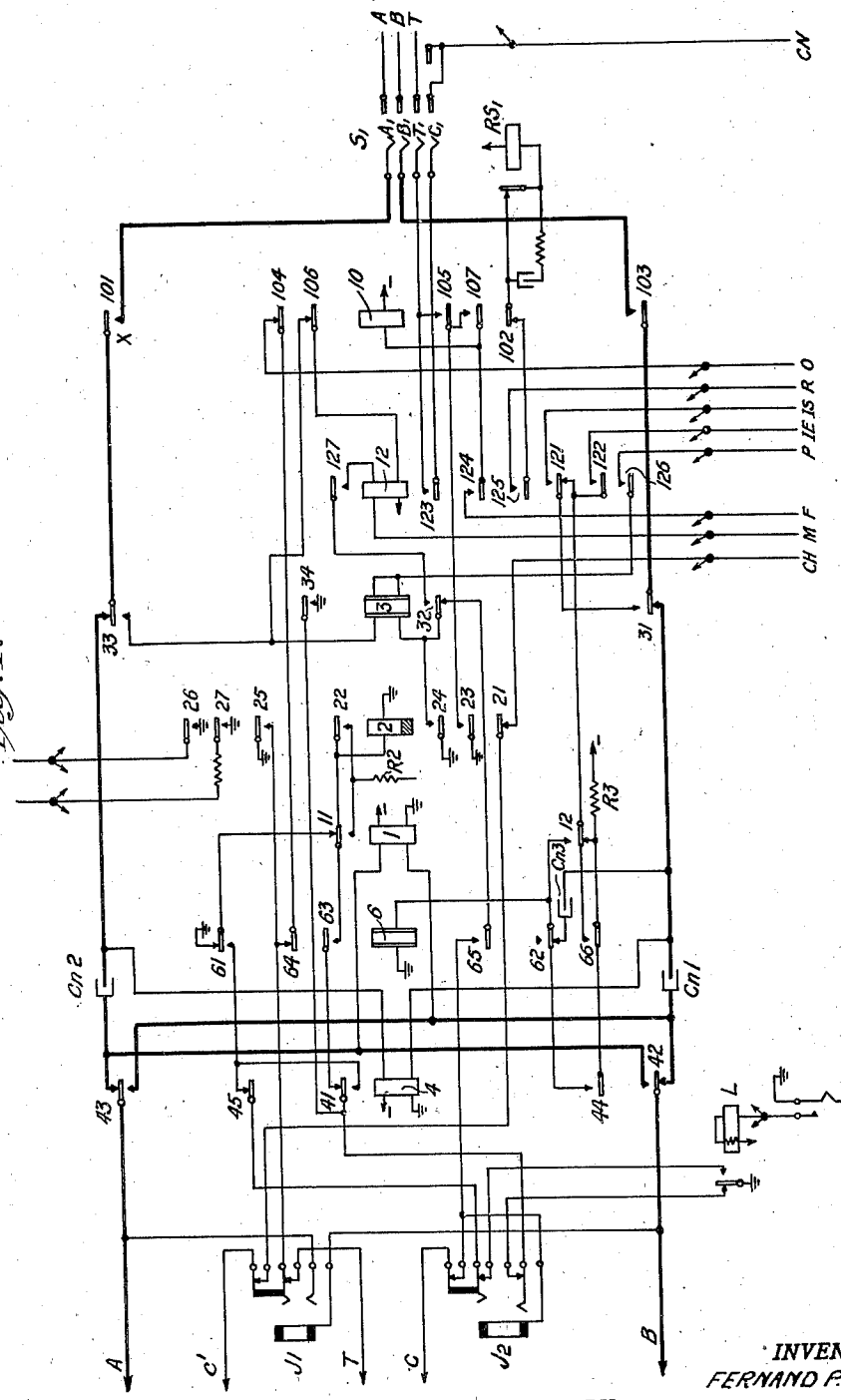


Fig. 1.

INVENTOR
FERNAND P. GOHOREL

BY Edward D. Rainey
AGENT

July 1, 1947. F. P. GOHOREL 2,423,098

AUTOMATIC SWITCHING SYSTEM

Filed July 2, 1943 5 Sheets-Sheet 2

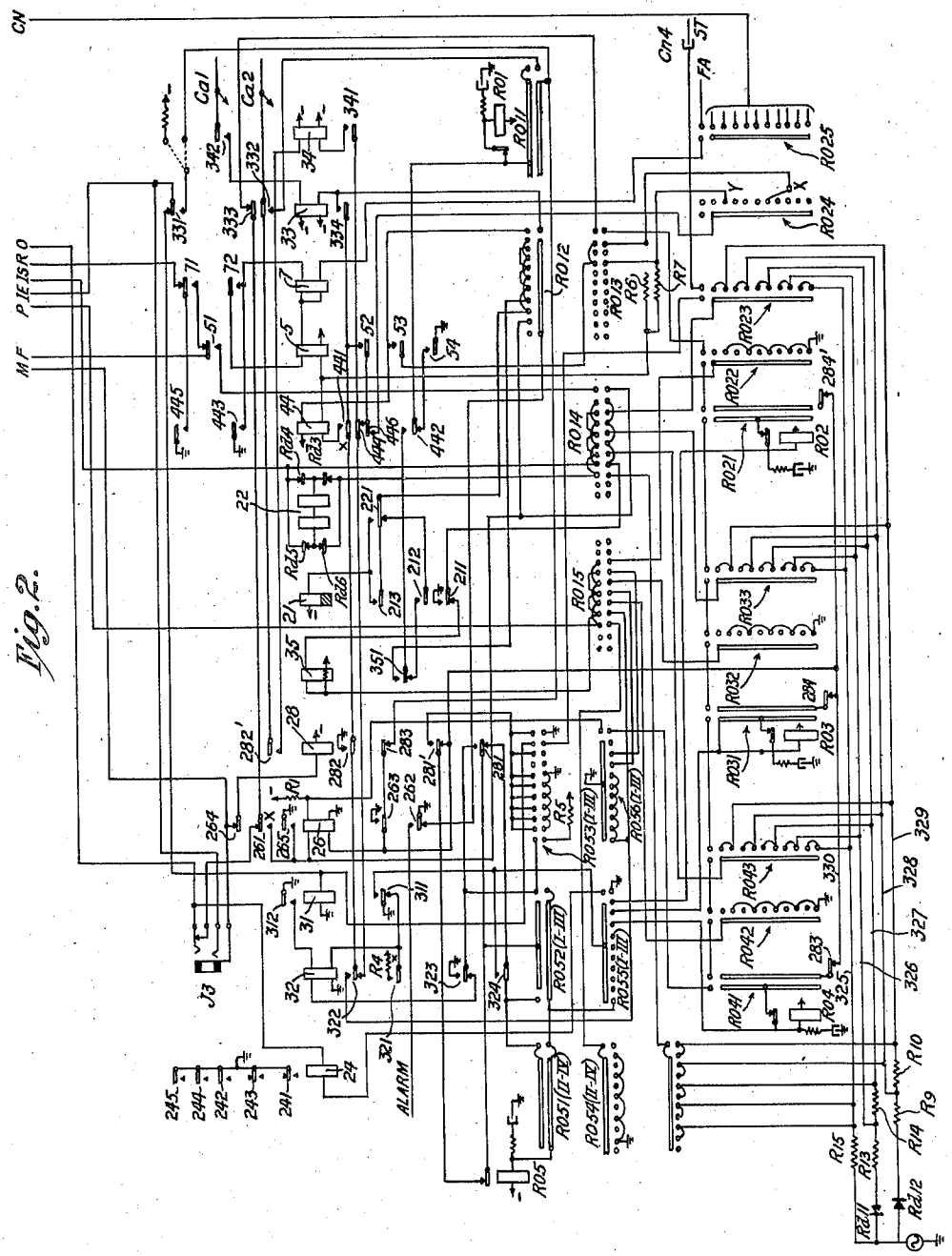


Fig. 2.

INVENTOR
FERNAND P. GOHOREL

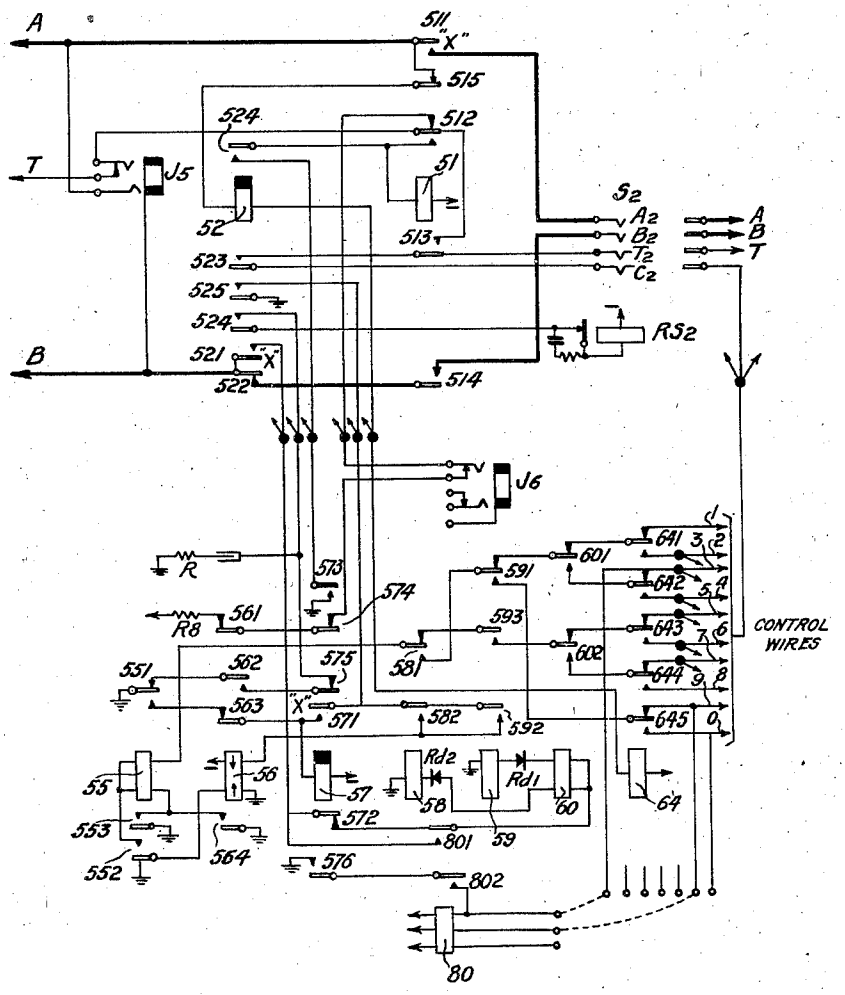
BY Edward D. Kinney
AGENT

July 1, 1947. F. P. GOHOREL 2,423,098

AUTOMATIC SWITCHING SYSTEM

Filed July 2, 1943 5 Sheets-Sheet 3

Fig. 3.



INVENTOR
FERNAND P. GOHOREL

BY Edward C. Kinney

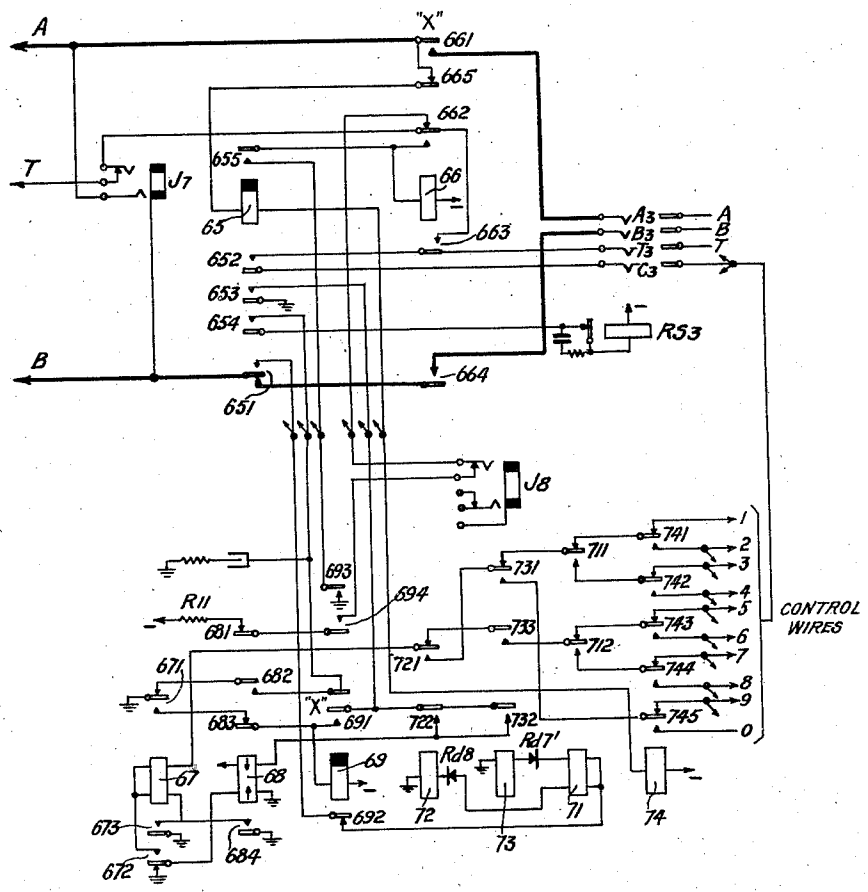
AGENT

July 1, 1947. F. P. GOHOREL 2,423,098

AUTOMATIC SWITCHING SYSTEM

Filed July 2, 1943 5 Sheets-Sheet 4

Fig. 4.



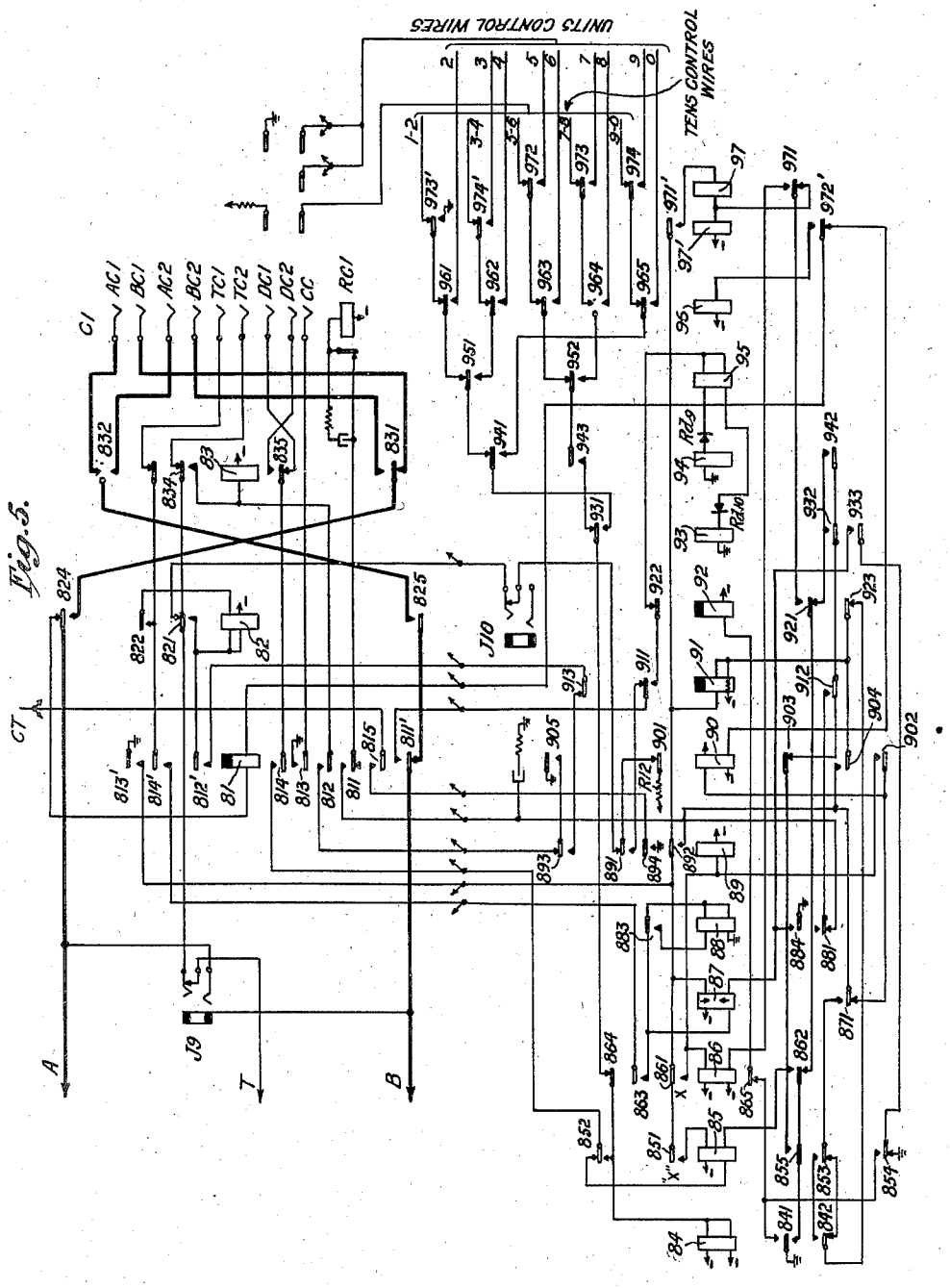
INVENTOR
FERNAND P. GOHOREL

BY Edward D. Shinner
AGENT

July 1, 1947. F. P. GOHOREL 2,423,098

AUTOMATIC SWITCHING SYSTEM

Filed July 2, 1943 5 Sheets-Sheet 5



INVENTOR
FERNAND P. GOHOREL

BY Edward D. Kinney
AGENT

Patented July 1, 1947

2,423,098

UNITED STATES PATENT OFFICE

2,423,098

AUTOMATIC SWITCHING SYSTEM

Fernand Pierre Gohorel, Antony, France, assignor to International Standard Electric Corporation, New York, N. Y., a corporation of Delaware

Application July 2, 1943, Serial No. 493,285
In France March 11, 1941

10 Claims. (Cl. 179—18)

1

The invention relates to automatic switching systems wherein the orientation or setting of a selector in a desired direction or desired group of directions, or on a line or groop of lines, is controlled by applying a given potential to one or more "marking" contacts associated with said selector and corresponding to the desired direction or to the desired group.

In such systems, one or more marking contacts represent said directions and are raised to a given potential under the control of the calling station. The control is usually effected by trains of like current pulses, the number of said current pulses being a function of the position in the selector of the desired marking contact or contact group.

According to one feature of the present invention, marking control is effected by means of current pulses which differ from one another and whose number may be either constant or not and may be reduced, e. g. to two or one.

Another feature of the invention contemplates the combination with the first feature, of a "marker" permanently associated with a selector, or common to several selectors to which it can be temporarily connected, said marker being arranged to assume as many electrical or mechanical positions as there are marking contacts or marking contact groups in the associated selector or selectors, said electrical or mechanical positions depending upon the nature and upon the order of succession (if there are more than one) of the control pulses.

According to still another feature of the invention, the different kinds of impulses may be direct current impulses having different polarity or intensity, alternating current impulses of different frequency or intensity, pulses of different duration, said pulses being transmitted from the control point to the controlled point over one or more wires with return over a common conductor, e. g. ground.

Another feature of the invention provides for the use of two wires for the transmission of the orientation pulses, said wires being utilized, after the orientation of the selectors, for communication between the calling and the called station. During the orientation of the selectors one of the two wires is utilized simultaneously for communication and for the control of said selectors.

The connection of the calling station to the called station is effected over several selectors in series and means are provided for the orientation of several of said selectors by one and the same control pulse, this pulse being of sufficient duration to act successively, and after orientation of the preceding selector, upon the markers associated with the selectors that must be oriented by the same control pulse.

2

This arrangement, particularly when the selection of the called station must be effected on a numerical basis, permits the orienting of several selectors required for the connection of the calling to the called station by a single digit of the called number.

Various other features of the invention will appear from the description that follows, given as a non-limitative example and based on the accompanying drawings, in which:

Fig. 1 is a diagram of a connecting circuit—calling side;

Fig. 2 is a diagram of a register pulse-sender wherein the sending of pulses is effected in accordance with the features of the invention;

Fig. 3 is a diagram of a selector-dedoubler of a new type;

Fig. 4 is a diagram of a standard selector; and

Fig. 5 is a diagram of a switch constituting the connecting equipment-called side.

In the descriptions that follow, the contacts closed when the relay with which they are associated is in normal position are indicated by prefixing the letter "R" to the reference number of the contact, and those closed when the relay is in operated position are indicated by prefixing the letter "T" to the reference number.

Switch R05 of Fig. 2 is an 11-point rotary switch equipped with a certain number of wipers so arranged as to come into contact with their bank during different quarter revolutions, the order of which is indicated by Roman numerals following the reference number of the wiper.

The recording of the call signal will be described first with reference to Figs. 1 and 2.

It will be assumed that a subscriber P1 connected to the exchange removes the handset of his station. A finder of any suitable type (not shown) hunts for the calling line and connects the line to a free connecting circuit, such as that of Fig. 1, associated with a free register, such as that of Fig. 2.

A free connecting circuit associated with a free register is characterized by a battery potential applied to test wire T (Fig. 1) over circuit: wire T, back contact of jack J1, R64, R104, wire O, back contact of jack J3 (Fig. 2), R261, R333, wiper R013 of rotary switch R01, wiper R022 of rotary switch R02, wiper R021, wipers R033, R032, R031 of rotary switch R03, wipers R043, R042, and R041 of rotary switch R04, wiper R056 of rotary switch

R05, all these wipers being in their normal position, resistance RL, and battery.

The calling line is connected to the free equipment of Fig. 1, and relay 1 is energized over conductors A and B of the calling station loop. At T11 it closes the circuit of relay 2 over: ground, winding of 2, T11, resistance R2, battery.

At T25, relay 2 applies a ground to test wire T to maintain in operating position the finder engaged with the calling line. At T24 it completes the following circuit for relays 3 and 12: ground, series windings of 3, R106, lower winding of 12, T24, battery.

Relays 12 and 3 become energized. At R21, relay 2 opens the circuit of wire CH. Relay 12 connects the register of Fig. 2 to the equipment of Fig. 1.

At T127, relay 12 completes its holding circuit and the circuit of relay 28 of the register over: ground, T24, T32, T127, upper winding of 12, wire M, R264, winding of 28, battery.

Relay 28 completes the following circuit for switch R05: battery, magnet R05, sector of wiper R051, sector and wiper R052 in normal position, T281, contact of magnet R05, T281', back contact and wiper R053, ground.

Magnet R05 attracts its armature, breaks the circuit through its contact, and in returning to normal causes the switch wipers to advance to position 1, whereupon the ground of wiper R053 is disconnected.

The ringing tone is thereupon sent to the calling subscriber over the circuit: wire ST (Fig. 2), condenser Cn4, wiper R023 in normal position, wiper R053 in position 1, R331, wire IE, T122, T12, R62, condenser Cn3, condenser Cn1, conductor B, subscriber station loop, conductor A, R43, upper winding of relay 1, battery.

It will be noted that owing to the fact that wiper R056 is in position 1, the battery is disconnected from the test wires of all the connecting circuits associated with the register to mark said register busy.

The calling subscriber having received the dialing tone, dials the called number, e. g. 2369. Pulse relay 1 repeats the pulses to relay 31 over: battery, resistance R3, R12, T122, wire LE, winding of relay 31, ground. Relay 31, under the control of the pulses received, causes the first recording switch R02 to advance to position 2. Energizing circuit of magnet R02: ground, T311, wiper R055 in position 1, magnet R02, battery. Upon the first holding of relay 31 (Fig. 2), relay 32 is energized over: ground, T312, upper winding of 32, R323, T281, wiper R052 in position 1, sector of wiper R051, winding of magnet R05, battery. At T321, relay 32 completes a circuit over its lowering winding across resistance R4. This winding is short-circuited at each release of relay 31, whereby relay 32 is rendered slow-releasing and holds during the reception of a pulse train.

At T323, relay 32 completes the following circuit for magnet R05: ground, T323, T281, wiper R052 off normal position, sector of wiper R051, winding of R05, battery.

When relay 32 releases at the end of the reception of a pulse train, it opens at T323, the circuit of magnet R05 which releases its armature and causes the switch wipers to advance to position 2. In this position the pulse circuit of relay 31 is connected to magnet R03 across wiper R055.

The second pulse train, 3 in the example considered, is received by magnet R03, which causes its wipers to advance to position 3. Upon the release of relay 32 at the end of the reception of the second pulse train, magnet R05 causes its wipers to advance to position 3. The pulse circuit is connected then to magnet R04, which receives the third pulse train and causes its wipers to advance to position 6.

As many pulses as necessary can thus be recorded in switches such as R02, R03, and R04, provided for the purpose.

When the last but one pulse has been received, the third in the example considered, magnet R05 causes its wipers to pass to position 4. The following circuit for said magnet is then completed: ground on contacts 4 to 9 of wiper R053, wiper R053, T281', contact of R05, wiper R052, winding of R05, battery. Through the action of its contact, magnet R05 causes its wipers to advance to position 10.

The first pulse of the fourth pulse train is then received by switch R05 over: ground, T311, wiper R055 in position 10, magnet R05, battery. Magnet R05 causes its wipers to advance one step. The first quarter turn of rotation being over, wipers R052, R053, R055, and R056 are released from the contact banks with which they are associated, and wipers R051 and R054 engage their contact banks.

The remaining pulses of the fourth train are then received over: ground, T311, T324, wipers R051, magnet R05, battery. Relay 32 becomes energized upon the reception of the first pulse of the last train, over: ground, T312, upper winding of 32, R323, wiper R053 in postion 10, resistance R5, battery.

During the recording of the call, the register orients selector S_1 of Fig. 1 by retransmitting the pulses. According to the invention, this is accomplished not by repeating the pulse trains as has been customary hitherto, but by producing pulses, the number of which can be constant, regardless of the digit to be retransmitted, differentiation between the digits being by the nature or the intensity of the current or currents transmitted.

In the example shown in Fig. 2 it is assumed that the return of the registered digits is effected by sending a pulse over one of the conductors, either alternating current or current of given polarity, or pulses of greater or lesser intensity, etc. These different currents are applied over wires 325 to 329 (Fig. 2). It will be seen that it is thus possible to obtain five different current pulses. For certain digits a second pulse is sent over the other conductor which causes in the receiving circuit a routing different from that of the pulse previously indicated. It is thus possible to multiply by two the markings obtained by the five preceding pulses and to obtain the ten markings required for discriminating among the ten pulses making up the various digits of the subscriber's number.

It is assumed that the first registered digit which causes the orientation of selector S_1, could either serve solely for this orientation or else be retransmitted after having caused it. For this purpose, the contacts of the right-hand bank associated with wiper R024 are connected either to terminal Y or else to terminal X. Assuming that the first digit registered, 2, should not be retransmitted, the second bank contact of wiper R024 is connected to terminal Y.

When wiper R024 stops on the bank contact, the following circuit is completed: battery, lower winding of relay 5 (Fig. 2), resistance R7, termi-

nal Y, bank contact 2 and wiper R024, R446, R444, R322, T282, ground.

Relay 5 closes at T54 the circuit of switch R01 across R442. Magnet R01 is energized and causes its wipers to advance. When wiper R013 arrives in the third position after the normal position, the following circuit is completed: battery, upper winding of relay 44, T53, wiper R013, terminal Y, wiper R024, R446, T52, T282, ground. Relay 44 closes its contact T441 before opening R446. Relays 5 and 44 remain energized over their lower windings via T441, T282, ground.

At T445 relay 44 completes the circuit of magnet RS1 of selector S_1 (Fig. 1): ground, T445, R71, wire R, T125, R102, contact and winding of magnet RS1 to battery. When wiper C1 reaches the bank contact corresponding to the bank contact on which wiper R025 is stopped (Fig. 2), the following circuit is completed over a free selector of the group of lines corresponding to the digit registered by switch R02: ground, T443, windings of relay 7, wiper R025, wire CN, bank contact of selector S_1 and wiper C_1, T123, wiper T1, wire T, back contact of jack J5 (Fig. 3), R512, back contact of jack J6, R574, R551, resistance R8, battery. Relay 7 (Fig. 2) opens at R71 the stepping circuit of magnet RS1 of selector S_1 which stops.

The first digit causing the orientation of selector S_1 is not retransmitted to the selector of Fig. 3. When required, it would be retransmitted as follows:

Relay 7 (Fig. 2) closes at T72 the upper winding of relay 5 in parallel to its own upper winding. The flow of current in the upper winding of 5 being opposed to the flow in the lower winding, the armature of relay 5 falls back. The ground is placed on wire F and the following circuit is completed: ground, T445, T71, R51, wire F, T124, winding of relay 10, battery. At T107 relay 10 completes its holding circuit over the ground at T23; at T105 it places a ground on the test wire to mark the busy condition over the selector of Fig. 3; at R104 it opens the circuit of wire O, at R106 it opens the circuit of relay 12, which holds over its upper winding; at T101 and T103 it prepares the switching of the subscriber's line to the next selector.

The following circuit of relay 52 (Fig. 3) is completed: ground, T24 (Fig. 1), series windings of relay 3, T33, T101, wiper A1 of S1, conductor A, R515 (Fig. 3), winding of 52, winding of 64, battery. Relay 52 operates, but relay 64, owing to its low resistance, remains unoperated.

Relay 35 (Fig. 2) energizes over: Battery, series windings of 35, R211, wiper R014 in third working position, wire IS, T121 (Fig. 1), T31, T103, wiper B1 of S1, wire B, T521 (Fig. 3), R572, upper winding of relay 60, rectifier Rd1, winding of relay 59, ground. Only relay 35 is energized over this circuit, relays 59 and 60 not being energized owing to the characteristics of their winding.

At T351 relay 35 completes the following circuit for magnet R01: ground R262, wiper R012 in third working position, T351, T442, contact and magnet R01, battery. Magnet R01 attracts its armature, breaks the circuit over its contact, and causes its wipers to advance one step into the fourth working position.

The pulses will now be sent to cause at the next selector or selectors, the marking corresponding to the second digit registered, 3 in the example considered.

It is assumed that the selector of Fig. 3 is of the so-called dedoubler type. The second digit will, therefore, cause the orientation of the selectors of Figs. 3 and 4.

When the wipers of R01 reach the fourth working position, the stepping circuit of the magnet is opened. The following circuit is completed: ground, alternating current generator G (Fig. 2), positive polarities across rectifier Rd12, resistance R9, third working contact of the contact bank associated with wiper R033, wiper R033, fourth working contact of the contact bank associated with wiper R014, rectifier Rd3, series windings of relay 22, rectifier Rd5, wire IS, T121 (Fig. 1), T31, T103, wiper B1 of S1, and second bank contact, conductor B, T521, R572, lower winding of relay 60, rectifier Rd2, winding of 58, ground. The value of resistance R9 is such, that relays 22, 60 and 58 become energized. At T582 relay 58 completes the following circuit for relay 56: battery, upper winding of 56, T582, T525, ground.

In the selector of Fig. 3, the marking is effected over the control wire corresponding to digit 3 via: ground, T564, windings of relay 55, T581, R591, T601, R642, control wire 3.

It will be noted that the digits corresponding to a dedoubling level, i. e. the digits that must be retransmitted, have their marking wire associated with a winding of relay 80. It has been assumed that digit 3 should be retransmitted. In the case considered, relay 80 energizes and closes its contact T801.

Switch S2 is first moved to a free line in the level corresponding to digit 3. The following circuit for magnet RS2 of S2 is completed: ground, R551, T562, R575, T524, contact and magnet RS2. When the selector wipers reach the contacts connected to a free line leading to the next selection stage, which will be assumed to be the selector of Fig. 4, the following circuit is completed: ground, T564, series windings of relay 55, T581, R591, T601, control wire 3, wiper C2, T523, wiper T2, wire T, back contact of jack J7 (Fig. 4), R662, back contact of jack J8, R694, R681, resistance R11, battery. Relay 56 opens at R551 the circuit of magnet RS2. The wipers of S2 stop.

The lower winding of relay 56 (Fig. 3) is connected over T552, in parallel with the lower winding of relay 55. The flow of current in this circuit is opposed to that flowing in the upper winding and the relay falls back. The circuit of relay 57 is completed over R563, T551, and ground. This relay opens at R572 the circuits of relays 22 (Fig. 2), 60, and 58 (Fig. 3). However, another circuit for said relays is completed over T801.

The circuit of relay 51 (Fig. 3) is completed over T524, T573, and ground, and it closes its holding circuit at T512 over the ground of wire T coming from Fig. 1, as has been indicated; at T513 it places this ground on wiper T2 and wire T to busy the selector of Fig. 4; at T511 and T514 it transfers conductors A and B to the selector of Fig. 4; at R515 it opens the circuit of relay 52, which releases.

It will be noted that contact R522 of relay 52 closes before the opening of contact 521. In this way, the circuit of relay 22 (Fig. 2) and of wire IS is completed by T651 (Fig. 4), R692, lower winding of relay 71, rectifier Rd3, relay 72, ground. Relay 22 will not release during the passage from the selector of Fig. 3 to the selector of Fig. 4.

Relay 65 has held over conductor A via the circuit previously indicated for relay 52 (Fig. 3) when relay 51 has closed its contact T511, this contact being closed before the operation of the other contacts of said relay.

When relay 52 is released, all the relays, excepting relay 51, of the selector of Fig. 3 release. Relay 57 releases after relay 52, its holding circuit being open at T525, and relay 60 releases after 57, its holding circuit being open at T576.

Relays 71 and 72 of the selector of Fig. 4 hold over the circuit previously indicated.

It will be assumed that the digit retransmitted up to the selector of Fig. 4 must effect only the orientation of this selector and need not be retransmitted.

When relays 71 and 72 are energized, relay 68 is energized over its upper winding via T22 and T653. A ground is placed on control wire 3 over: ground, T664, windings of 67, T721, R731, T711, R742, wire 3.

The circuit of magnet RS3 is completed over: T554, R695, T682, R671, ground. Switch S3 will advance to find a free line in the level marked by wire 3. It will be assumed that this line is connected to the connector of Fig. 5.

When the wipers of S3 reach a line of the connector of Fig. 5, the following circuit is completed: ground, T684 (Fig. 4), windings of relay 67, T721, R731, T711, R742, control wire 3, wiper C3 on contact 3, T652, wiper T3, wire T, back contact of jack J9 (Fig. 5), R821, back contact of jack J13, R891, R901, resistance R12, battery. Relay 67 opens at R671 the circuit of magnet RS3, whereupon switch S3 stops. Relay 68, whose lower winding is energized in parallel with the lower winding of relay 67, releases its armature, its two windings being in opposition. Relay 69 is energized over R683, T671, and ground. At R692 it opens the circuit of relays 72 and 71, in series with relay 22 (Fig. 2).

When relay 22 is energized over the circuit previously indicated it completes the following circuit for relay 21: battery, winding of 21, T221, wiper R012 in fourth working position, R262, ground. Relay 21 closes at T213 its holding circuit.

When relay 69 (Fig. 4) opens the circuit of its contact R692, relay 22 releases and completes the following circuit for magnet R01: ground, R262, wiper R012 in fourth working position, R221, T212, R351, T442, contact and magnet R01, battery. Magnet R01 attracts its armature, opens its contact and thus causes the wipers to advance one step, whereupon the armature falls back. The wipers pass to the fifth working position. The circuit of relay 21 being open in the bank contacts of wiper R012, said relay releases.

When relay 69 (Fig. 4) operates, it completes the circuit of relay 66 to the ground of T693 via T655. At T661 and T664 relay 66 transfers conductors A, B to the connectors of Fig. 5; at R665 it opens the circuit of relay 65, which releases, causing the release of all the relays of the marking device.

When contact T661 of relay 66 (Fig. 4) closes, the following circuit for relay 81 (Fig. 5) is completed: ground, T24 (Fig. 1) windings of 3 in series, T33, T101, wiper A1, conductor A, T511 (Fig. 3), wiper A2, conductor A, T661 (Fig. 4), wiper A3 of S3, conductor A R824 (Fig. 5) relay 81, R972', lower winding of relay 90, battery. At T813' relay 81 completes the circuit of relay 91.

Relay 3 (Fig. 1), the new circuit of which is closed before the opening of its circuit over relay 65 (Fig. 4), remains energized, as does relay 81. Relay 90 remains unoperated owing to the value of its lower winding.

The following circuit is now completed: battery, winding of relay 35 (Fig. 2), R211, fifth working position of the bank of wiper R014, wiper R014, wire IS, T121, T31, T103, wiper B1 of S1, conductor B, R522 (Fig. 3), T514, wiper B2 of S2, conductor B, R651 (Fig. 4), T664, wiper B3 of S3, conductor B, T811' (Fig. 5), T911, R922, rectifier Rd3, winding of relay 94, ground. Relay 94 does not, but relay 35 becomes energized and completes the following circuit for magnet R01; ground, R262, wiper R012 in fifth working position, T351, T442, contact and magnet R01, battery. Magnet R01 attracts its armature and causes its wipers to advance one step into the sixth working position. The circuit of the magnet is opened.

When the wipers of switch R01 are stopped in the sixth working position, the third digit registered over switch R04 will be returned. The returns of this third digit, which is assumed to be 6, will be effected by sending two pulses to the connector of Fig. 5. One of these is constituted by a ground placed on conductor A across the low resistance upper winding of relay 3 (Fig. 1), over: ground, wiper R042 in sixth working position, wiper R015 in sixth working position, wire P, T126, upper winding of relay 3, T33, and conductor A.

The current flowing in the circuit of relays 81 (Fig. 5) and 90 is sufficient to operate relay 90. At R901, relay 90 removes the battery across R12 over wire T; at T905, it completes the circuit of relay 83 over; ground, T905, R893, T812, winding of 83, battery. Relay 83 connects at T832 and T831 conductors A and B to wipers AC2 and BC2 corresponding to the scanning of the even tens whereof digit 6 forms part, and at T834 it closes its holding circuit over the ground of wire T.

When relay 81 operates, the circuit of relay 91 is completed over: battery, windings of 91, T813, ground. Relay 87 holds over its upper winding.

A second pulse is sent by the register of Fig. 2 over: ground, alternating current generator G, negative polarities across rectifier Rd11 and resistances R13 and R14, wiper R043 in sixth working position, wiper R014 in sixth working position, rectifier Rd3, relay 22, rectifier Rd4, wire IS, T121, T31, T103, wiper B1 of S1, conductor B across Figs. 3 and 4, T811' (Fig. 5), T911, R922, upper winding of relay 95, rectifier Rd9, relay 94, ground. The value of resistances R13 and R14 in series is such, that only relays 22 (Fig. 2) and 94 (Fig. 5) operate. The tens marking wire for digit 6 is connected via: battery, windings of 84 in parallel, R864, R931, T943, R952, R963, R972, control wire of tens 6.

The circuit of magnet RC1 is completed: ground, R841, R862, R921, T942, T912, R881, T811, contact and magnet RC1. Magnet RC1 causes the wipers of C1 to advance. When the wipers of C1 reach the level of tens 6, the previously indicated marking circuit is completed via: control wire 6, contact of the bank associated with wiper CC, T813, ground.

Relay 84 opens at R841 the circuit of magnet RC1, and connector C1 stops; at T841, it completes over R865 the circuit of relay 92. At R922, relay 92 opens the circuit of relay 22 (Fig. 2), which releases and causes magnet R01 to advance one step, as previously indicated. The wipers of said switch pass to the seventh working position. Relay 94 (Fig. 5) releases, its circuit being thus opened at R922, and opens at T943 the circuit of relay 84, which releases. The circuit of magnet RC1 is open then at T942. The circuit of relay

97' is completed over: ground, R841, R862, T921, R971, winding of 97', and battery, relay 92, slow to release, releasing after the opening of T841.

When relay 92 is released, the following circuit is completed for relays 97' and 97: battery, relay 97', relay 97, T971', T813', and ground. Relay 97' remains energized and relay 97 pulls up. At T972', relay 97' closes the circuit of relay 81 over relay 96; relay 81, being slow to release, does not release during this transfer.

The circuit of relay 35 (Fig. 2) is completed via: battery, winding of 35, R211, wiper R014 in seventh working position, wire IS, T126, wire IS, T121, T31, T103, wiper B1, conductor B, across Figs. 3 and 4, T811' (Fig. 5), T911, R922, rectifier Rd9, winding of 94, ground. Relay 35 causes switch R01 to advance one step, as has been indicated previously. The wipers of said switch pass to the eight position.

The fourth digit or units digit registered over switch R05 will be retransmitted. It has been assumed that this digit was 9.

The following circuit is completed: ground, alternating current generator G, resistance R15, wiper R057 in ninth position, wiper R014 in eighth working position, rectifier Rd6, relay 22 and rectifier Rd4 for the negative polarities, and rectifier Rd3, relay 22, rectifier Rd5 for the positive polarities, wire IS, T121, T31, T103, wiper B1, conductor B across Figs. 3 and 4, T811' (Fig. 5), T911, R922, upper winding of relay 95, rectifier Rd9, relay 94, ground, for the negative polarities, lower winding of relay 95, rectifier R18, relay 93, and ground for the positive polarities. Relays 93 and 94 hold. Relay 95 does not pull up on account of the value of resistance R15.

The marking of digit 9 is effected over the units control wire via: battery, winding of relay 84, R864, T931, T941, R965, T974, and wire 9. The circuit of magnet RC1 is completed via: ground, R841, R862, R921, T932 and T942, T912, R891, T811, contact and magnet RC1, battery. Magnet RC1 causes the wipers of C1 to hunt for the called subscriber's line. When they reach the subscriber's line, the circuit of relay 84 is completed via: control wire of unit 9, wiper CC, T813, and ground. Relay 84 holds and opens at R841 the rotary circuit of connector C1, which stops.

At T841, relay 84 completes the circuit for relay 92, which opens at R922 the circuit of relays 93 and 94, which release. Relay 84 releases, its circuit being open at T943. The following circuit for relay 96 is completed: ground, R841, R862, T921, T971, lower winding of 86, battery. Relay 92, slow to release, does not release but a short instant after the opening of T841. Relay 96 closes at T951 the circuit over its upper winding via the ground of T813'. At R864, it breaks the circuit of 84 and at R865, the circuit of 92, and at T861 it completes the circuit of relay 89.

Relay 88 energizes over: ground, lower winding of 88, T863, T814', T833, wiper TC2, and battery over the test wire of the line equipment if the subscriber is free. At T864, it completes the circuit of the lower winding of relay 87. If no equipment such as that of Fig. 5 is associated with the subscriber's line, the flow in the lower winding of relay 87, which opposes that in the upper winding, causes the release of the armature of said relay.

The circuit of the upper winding of relay 90 is completed via: R871, T892, and ground on T813'. Relay 91, whose winding is short-circuited by T904, T892, T813', and ground, releases after a

short instant. The circuit of relay 82 is completed via: ground, T905, T893, R913, T812', lower winding of relay 82, battery. At T824 and T825, it connects conductors A and B to the called subscriber's line; at T821, it completes its holding circuit over the ground of wire T; at T822, it connects a battery to wiper TC2, across its windings in series; at R824, it opens the circuit of relay 81, which releases. The disconnection of the ground at 813' causes the release of the elements of the marking device. Relay 3 (Fig. 1), which was in series with 81, releases.

The ringing of the subscriber, the answer, and the release at the end of the call are effected in the well-known manner.

If the subscriber's line is busy, a ground is placed on wire Tc2 across the low resistance upper winding of a relay such as 82. The intensity of the current flowing in the lower winding of relay 87 is such, that this relay energizes. The circuit of the upper winding of 90 remains open at R871. A battery is placed then on conductor B via; battery, resistance R12, R901, T891, R911, T811', conductor B. This battery received over Fig. 1 causes the operation of relay 6 over: T103, T31, R121, T12, winding of 6. At T63, relay 6 causes the short-circuiting of relay 2 via the ground at the contact of relay 1. Relay 2 releases and suppresses at T25 the ground on test wire T, which causes the sending, to the calling subscriber, of the busy signal, according to the known method.

The remaining operations in the register, after the marking and the orientation of the connector have been effected, will now be explained.

When relay 92 (Fig. 5) operates for the second time, the circuit of relay 22 is opened. Said relay releases and causes the wipers of R01 to advance one step, as has been explained previously. The wipers arrive in the ninth working position. The following circuit for relay 26 is completed: battery, resistance R1, upper winding of 26, ninth bank contact of wiper R012, wiper R912, R262, ground. Relay 26 closes its holding circuit at T265 before the opening of R262. At R264, it opens the circuit of 28, which releases. Switch R01 returns to its normal position over: ground, T263, R283, sector of wiper R011, contact and magnet R01, battery. The circuit is opened when wiper R011 reaches the normal position. Switch R05 returns to its normal position over: ground, T263, R281', contact of magnet R05, and on the one hand, R281, wiper R051, magnet R05 and, on the other hand, wiper R052 and magnet R05. Switches R04, R03, R02 return to normal over the ground placed on wire 330 at T263, contacts R283, R284, and R284', associated with relay 28, being closed. The relays held in the register all return to normal when contact T282 of 28 is opened. Relay 12 (Fig. 1) releases upon the opening of R264.

The register is now free and can be seized by some other equipment such as that of Fig. 1.

In the cases where, the register having been seized, the calling subscriber does not follow up the call, the release of the register is brought about by cams Ca1 and Ca2 acting upon relays 33 and 34.

In the above description it has been assumed that the first digit stored in the register over switch R02 merely caused the orientation of selector S1 of Fig. 1, but was not retransmitted. However, this digit could be retransmitted after having effected that orientation. The manner in which that retransmission is effected will now

be explained. In this case the bank contact associated with wiper R024 and corresponding to the digit to be retransmitted is connected to terminal X. Let it be, for example, digit 6, corresponding to the sixth working contact of R02.

When wiper R024 stops on the sixth bank contact, the following circuit is completed: battery, lower winding of relay 5, resistance R6, terminal X, bank contact and wiper R024, R446, R444, R322, T82, ground. Relay 5 causes the stepping of switch R01 over T54 and R442. When wiper R013 reaches the first working position, the following circuit is completed: battery, upper winding of relay 44, T53, wiper R013 in first working position, terminal X, wiper R024, R446, T52, T282, ground. Relay 44 closes its contact T441 before opening R446 and R442. Relays 5 and 44 remain energized over their lower windings via T441, T282, ground.

The orientation of selector S1 and the seizure of a selector such as that of Fig. 3 are effected as has been indicated in the preceding case. Finally, relay 35 is energized and causes switch R01 to advance one step. The wipers of said switch pass to the second working position.

The pulses are then sent to the selector of Fig. 3 to cause the marking corresponding to the digit recorded over switch R02, digit 6 in the example considered. A positive polarity pulse is sent via: ground, wiper R022, wiper R015, wire P, low resistance upper winding of relay 3, T33, T101, wiper A1, conductor A, R515, winding of relay 52, winding of relay 64, battery. Relay 64 switches the marking circuit over to the marking wires of even digits. A second pulse is sent via: ground, generator G, negative polarities across rectifier Rd11, resistances R13 and R14, wire 327, wiper R023, wiper R014, rectifier Rd6, relay 22, rectifier Rd4, wire IS, T121, T31, T103, wiper B1, conductor B, T521, R572, upper winding of relay 60, rectifier Rd1, relay 59, ground. Relay 59 operates but on account of the value of resistance R14, relay 60 remains unoperated.

The marking circuit is then completed over: ground, T564, winding of 55, R581, T593, R602, T643, and marking wire of digit 6. The remaining operations are effected as indicated previously, switch R01 advancing one step upon the release of relay 22.

It will be seen, therefore, that the marking of the central wires is effected in the intermediate or final receiving equipments through the action of relays such as relays 64, 60, 59, and 58 of Fig. 3. The operation of these relays is controlled as follows:

For digit 1—Sending by the register of a positive polarity across a high resistance over conductor B. Relay 58 operates, relay 60 remains unoperated.

For digit 2—Sending of a positive polarity over conductor A, which causes the operation of relay 64. Sending of a positive polarity across a high resistance, over conductor B. Relay 58 operates, relay 60 remains unoperated.

For digit 3—Sending of a positive polarity across a low resistance, over conductor B, relays 60 and 58 operate.

For digit 4—Sending, in addition to the polarity of digit 3, of a positive polarity over conductor A, which causes the operation of 64.

For digit 5—Sending of a negative polarity across a high resistance. Relay 59 operates, relay 60 remains unoperated.

For digit 6—Sending, in addition to the polarity of digit 5, of a positive polarity over conductor A, which causes the operation of relay 64.

For digit 7—Sending of a negative polarity across a low resistance. Operation of relays 58 and 59.

For digit 8—Sending, in addition to the polarity of digit 7, of a positive polarity over conductor A, which causes the operation of relay 64.

For digit 9—Sending, in addition to the polarities of digit 9, of a positive polarity over conductor A. Operation of relay 64.

For digit 0—Sending, in addition to the polarities of digit 9, of a positive polarity over conductor A. Operation of relay 64.

The above combinations have been given only as non-limitative examples and, without exceeding the scope of the invention, it would be possible to use any other combinations, provide for the sending of any number of pulses to differentiate the various digits, replace the sending of polarities with the sending of predetermined frequencies and frequency combinations, combine the marking devices thus obtained with any orientation system whatever in order to obtain the routing of calls, controls, or signallings, and replace the rotary switches with relay combinations or vice versa.

What is claimed is:

1. In a telephone exchange system, numerically designated lines, means including selectors arranged in a plurality of numerical stages for establishing a connection between the calling and called lines, a register at the exchange variably operable in accordance with the digits of the called number, means associated with the register to generate potentials differing from one-another in character, means controlled by the register for applying a particular potential to a selector, and means responsive thereto for numerically operating the selector.

2. In a telephone exchange system, numerically designated lines, means including selectors arranged in a plurality of numerical stages for establishing a connection between the calling and called lines, a register at the exchange, a dial for each line adapted to send impulses varying in number depending on the digits of the called number for variably operating the register, a sender associated with the register and adapted to generate impulses differing from one-another in character, means for associating said sender with said selector, means controlled by the register for determining the sending of a particular impulse by the sender, and means responsive thereto for operating a selector in the establishment of said connection.

3. In a telephone exchange system, numerically designated lines, means including selectors arranged in a plurality of numerical stages for establishing a connection between the calling and called lines, a register at the exchange variably operable in accordance with the digits of the called number, means associated with the register to generate potentials differing from one-another in character, a marker switch common to a plurality of selectors of one stage, said marker switch having a plurality of positions in each of which a different potential is applied to the selectors of said one stage, means for selecting for operation one of the last mentioned characters, means controlled by the register for variably operating said marker switch, and means for stopping the selector in a position designated by the marker switch.

4. In a telephone exchange system, numerically

designated lines, means including selectors arranged in a plurality of numerical stages for establishing a connection between the calling and called lines, a register at the exchange variably operable in accordance with the digits of the called number, means associated with the register to generate potentials differing from one-another in character, a marker switch for each selector to control the moving of the selector into various numerical positions, said marker switches having a plurality of positions, each corresponding to a different numerical position of the associated switch, and means controlled by the register for variably controlling the marker switches.

5. A telephone system according to claim 1, and in which a two-conductor control circuit extends from the register towards said selectors, means controlled by the register for applying a certain potential to one of said conductors and means controlled by the register for applying a potential to the other conductor, the numerical operation of a selector being determined by the potentials applied to said conductors.

6. A telephone system according to claim 1, and in which a two-conductor control circuit extends from the register towards said selectors, means controlled by the register for applying one of five different potentials to one of said conductors and a potential to the other conductor, and means responsive thereto for setting a selector into the desired numerical position.

7. A telephone system according to claim 1, and in which the selectors have terminals and wipers cooperating therewith, control wires leading to the terminals of a selector, relays associated with said selector for establishing a circuit over any one of said wires to stop the selector wipers on

certain terminals as determined by said wires, and means controlled by said register for variably operating said relays by applying thereto one of said potentials.

8. A telephone system according to claim 1, and in which the selectors have terminals and wipers cooperating therewith, two sets of control wires leading to the terminals of a selector, relays associated with the selector for establishing a circuit over any one of said wires to operate the selector in accordance with two digits of the called number, and means controlled by said register for variably operating said relays by applying thereto certain potentials.

9. In a telephone exchange system, numerically designated lines, means including selectors arranged in a plurality of numerical stages for establishing a connection between a calling and a called line, a register at the exchange variably operable in accordance with the digits of the called number, and means controlled by said register for operating selectors of two successive stages in accordance with a single digit of the called number.

10. In a telephone exchange system, numerically designated lines, means including selectors arranged in a plurality of numerical stages for establishing a connection between the calling and called lines, a register at the exchange variably operable in accordance with the digits of the called number, means associated to generate potentials differing from one-another in character, and means controlled by the register for applying the same particular potential to selectors of two successive stages for controlling their numerical operations.

FERNAND PIERRE GOHOREL.