

July 22, 1941.

F. A. HUBBARD
TELEPHONE SYSTEM

2,250,101

Filed Dec. 7, 1939

8 Sheets-Sheet 1

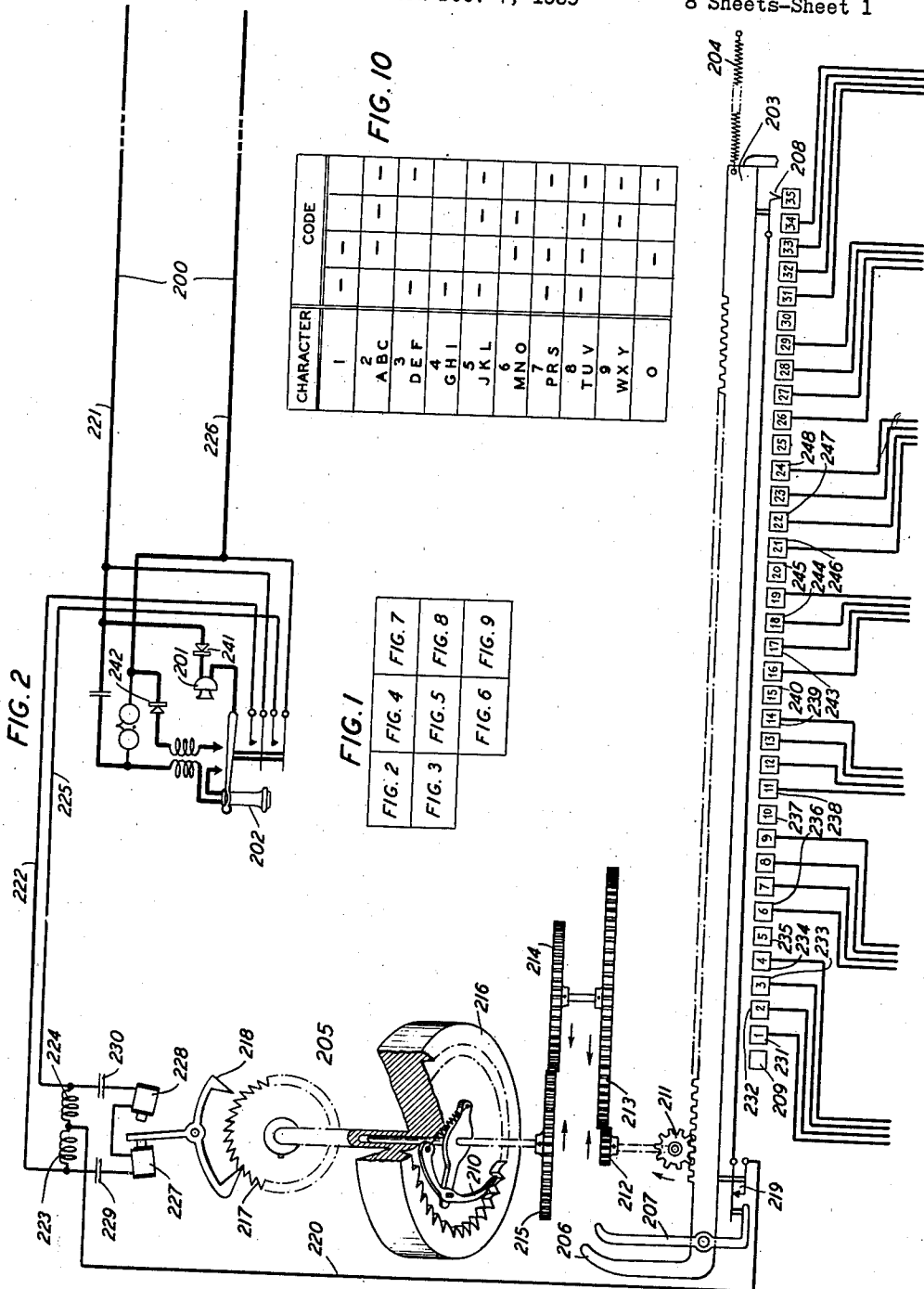


FIG. 10

CHARACTER	CODE
1	-
2	-
ABC	-
DEF	-
GHI	-
JKL	-
MNO	-
PRS	-
TUV	-
WXY	-
0	-

FIG. 1

FIG. 2	FIG. 4	FIG. 7
FIG. 3	FIG. 5	FIG. 8
	FIG. 6	FIG. 9

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8 Sheets-Sheet 2

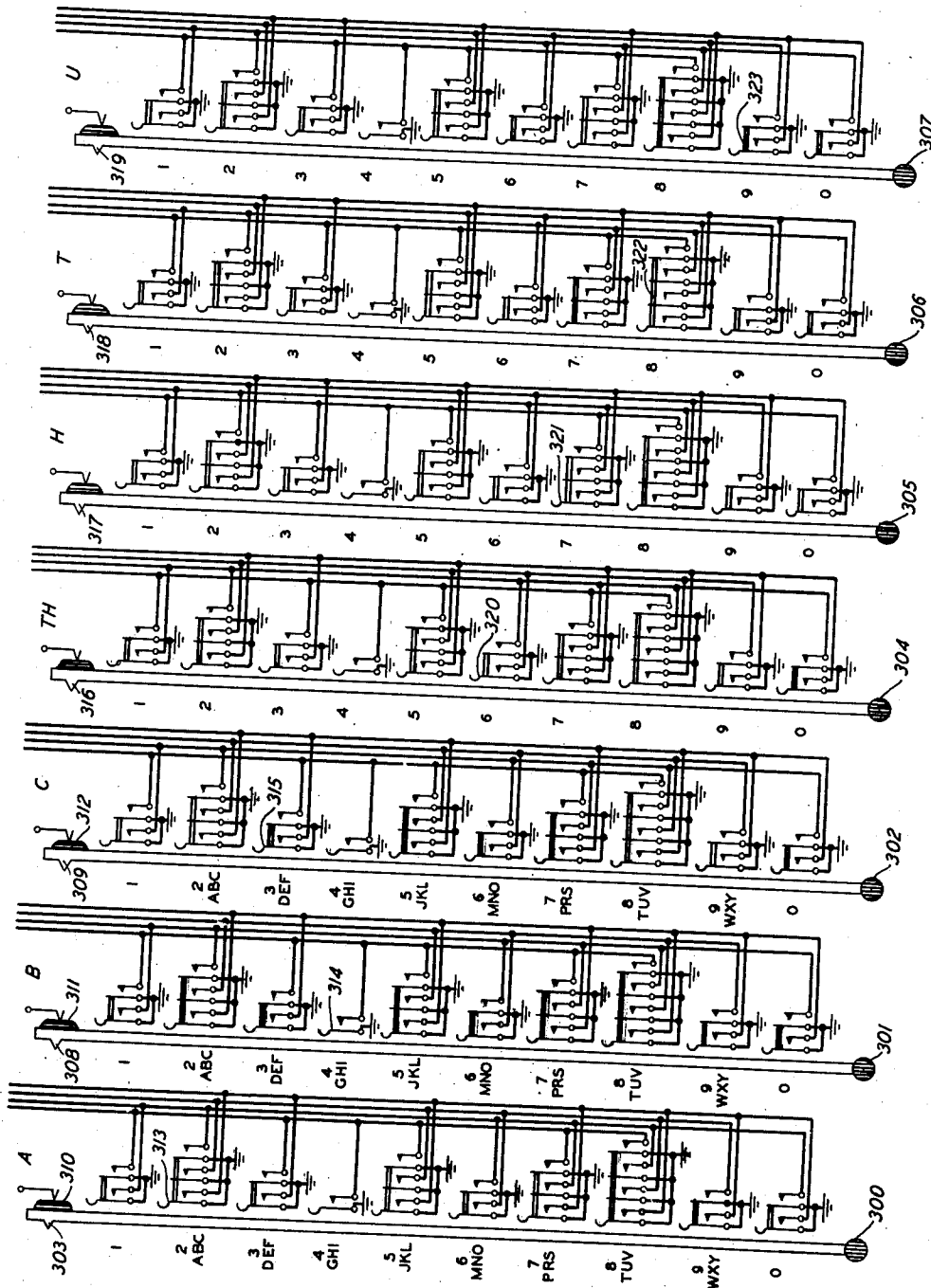


FIG. 3

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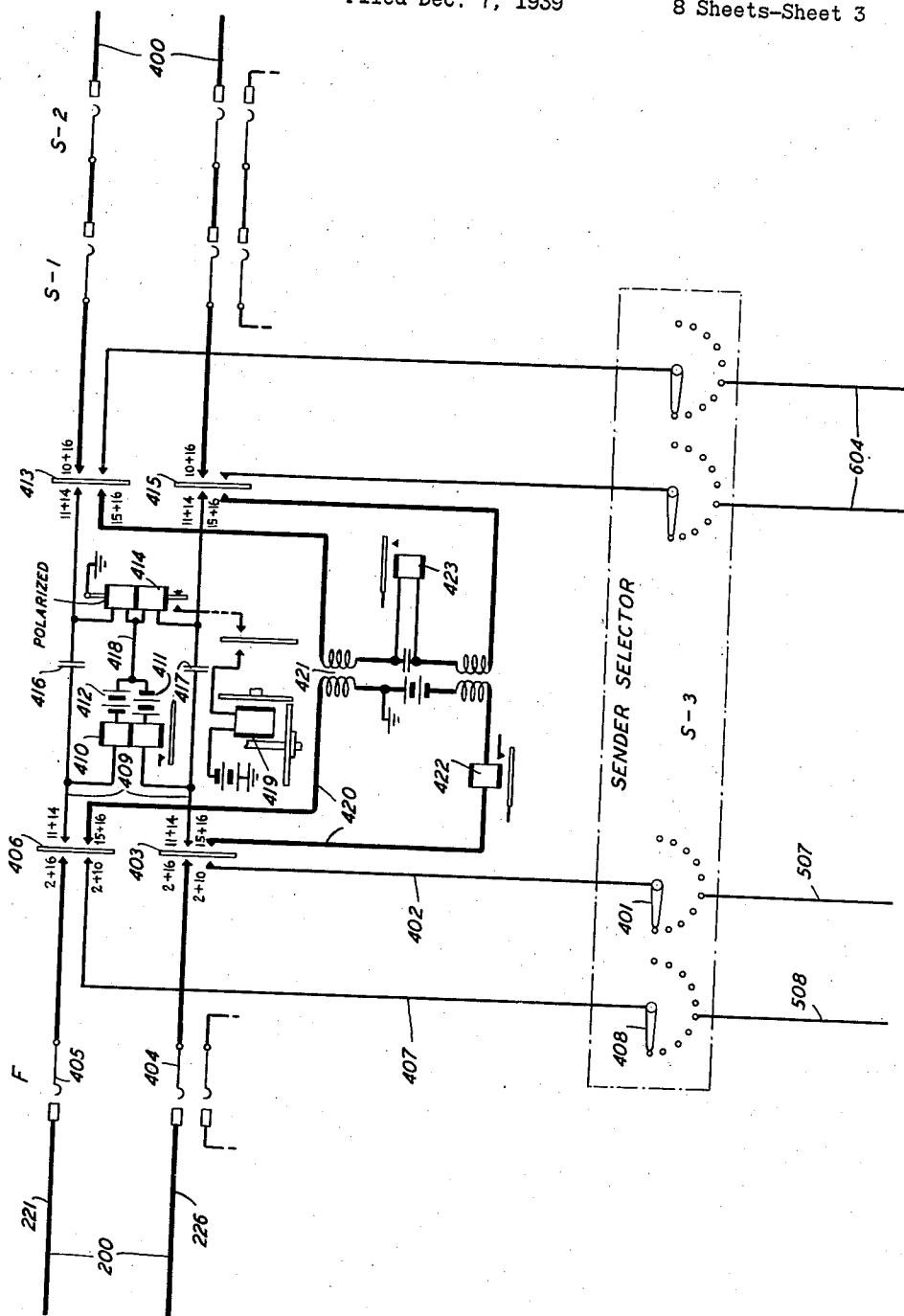
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FIG. 4



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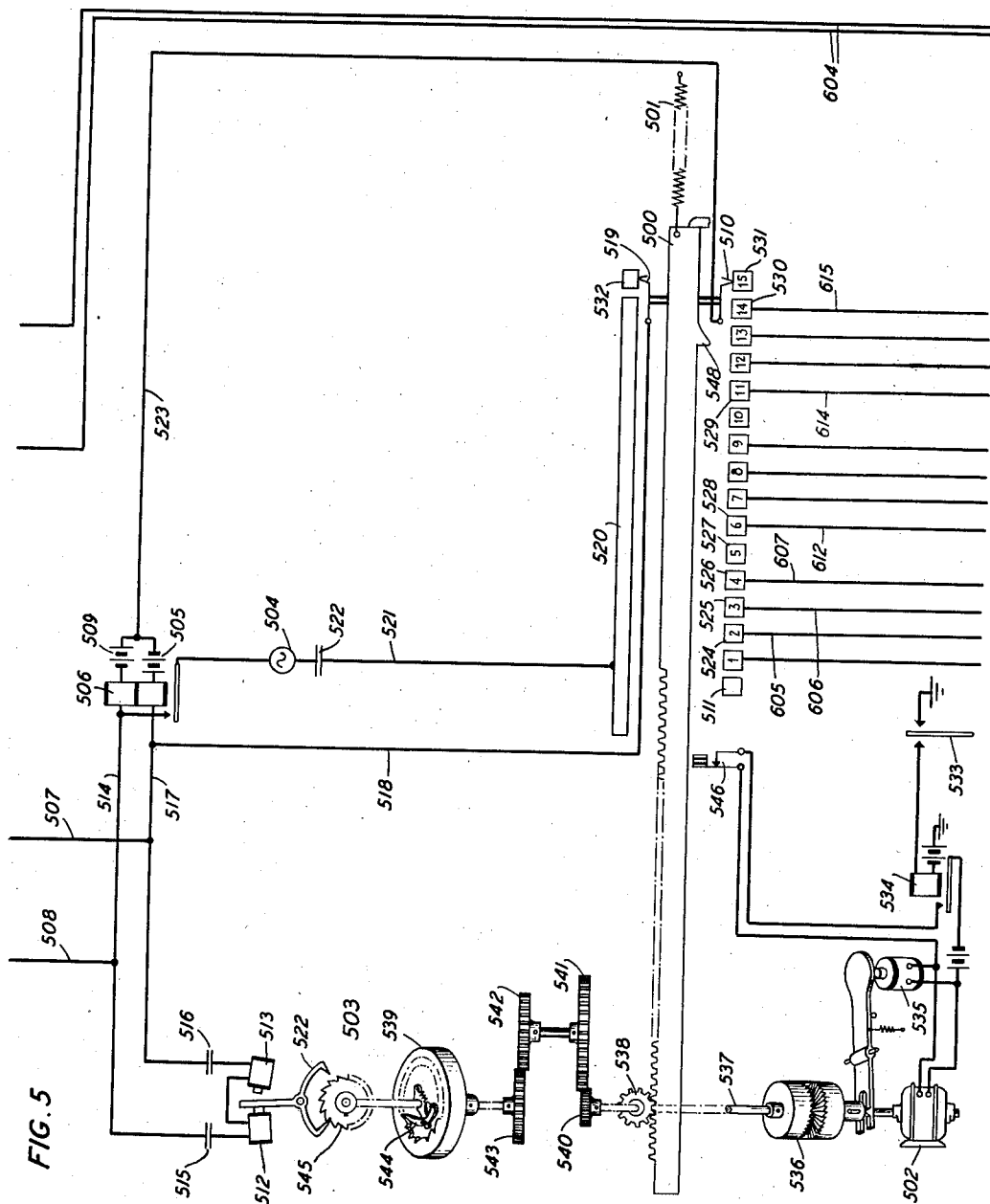
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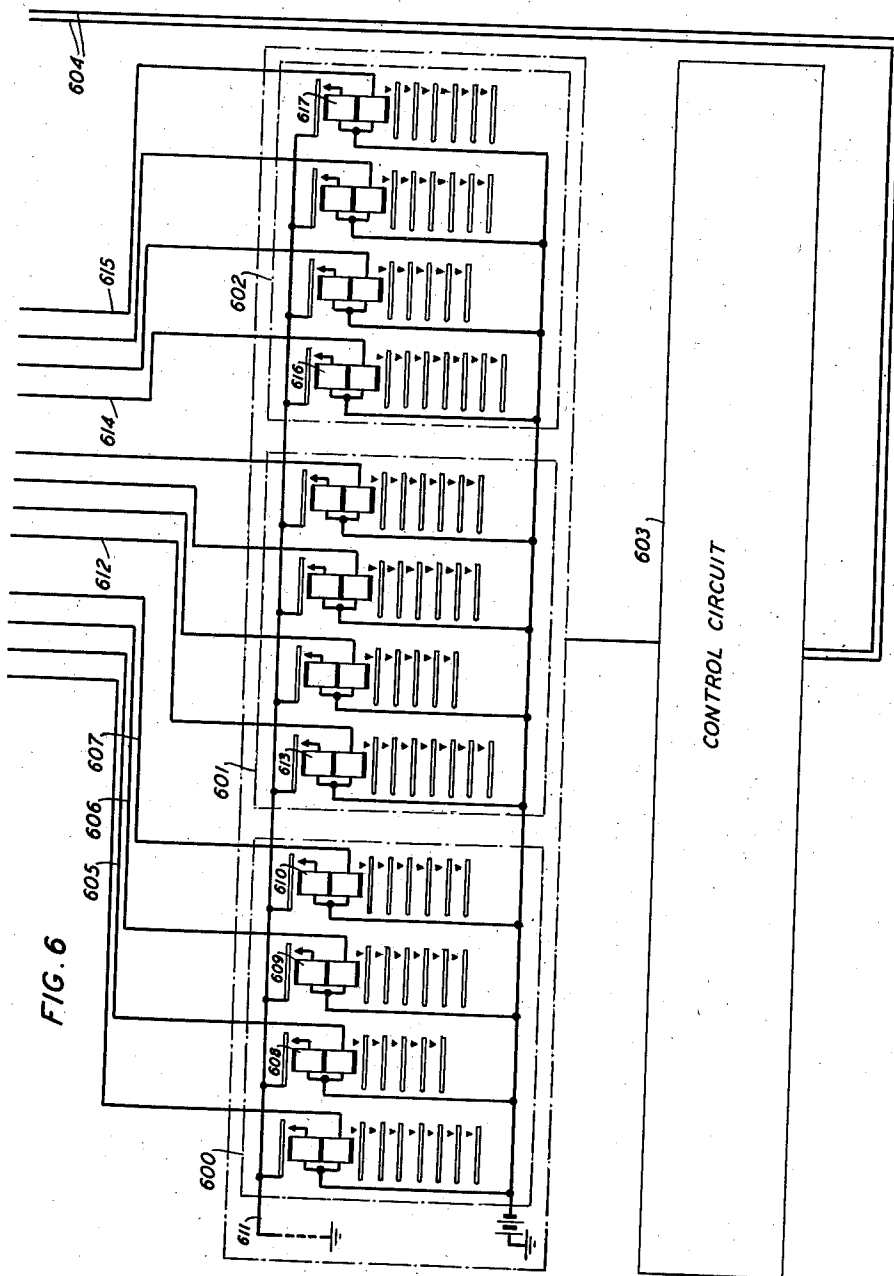
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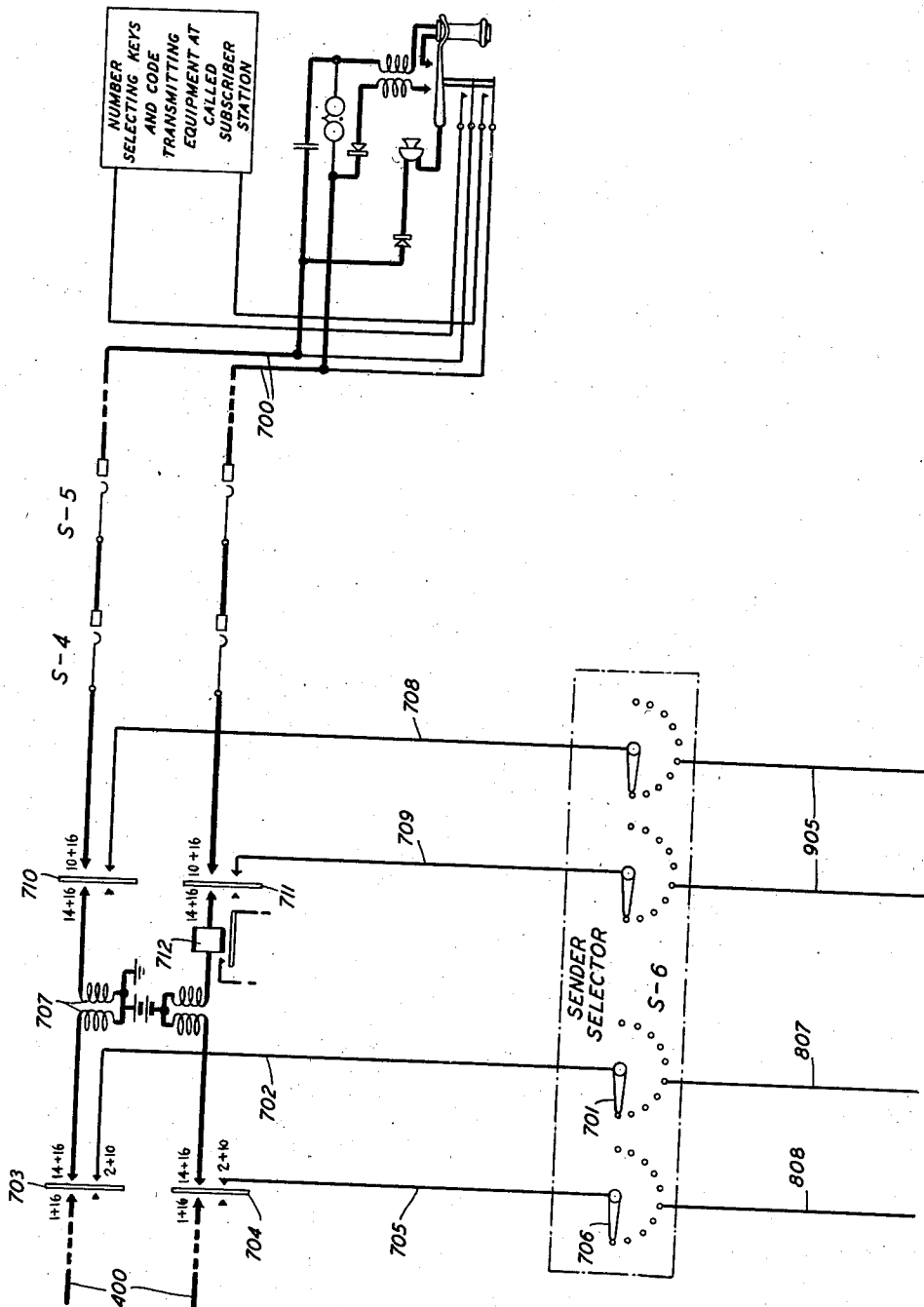
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FIG. 7



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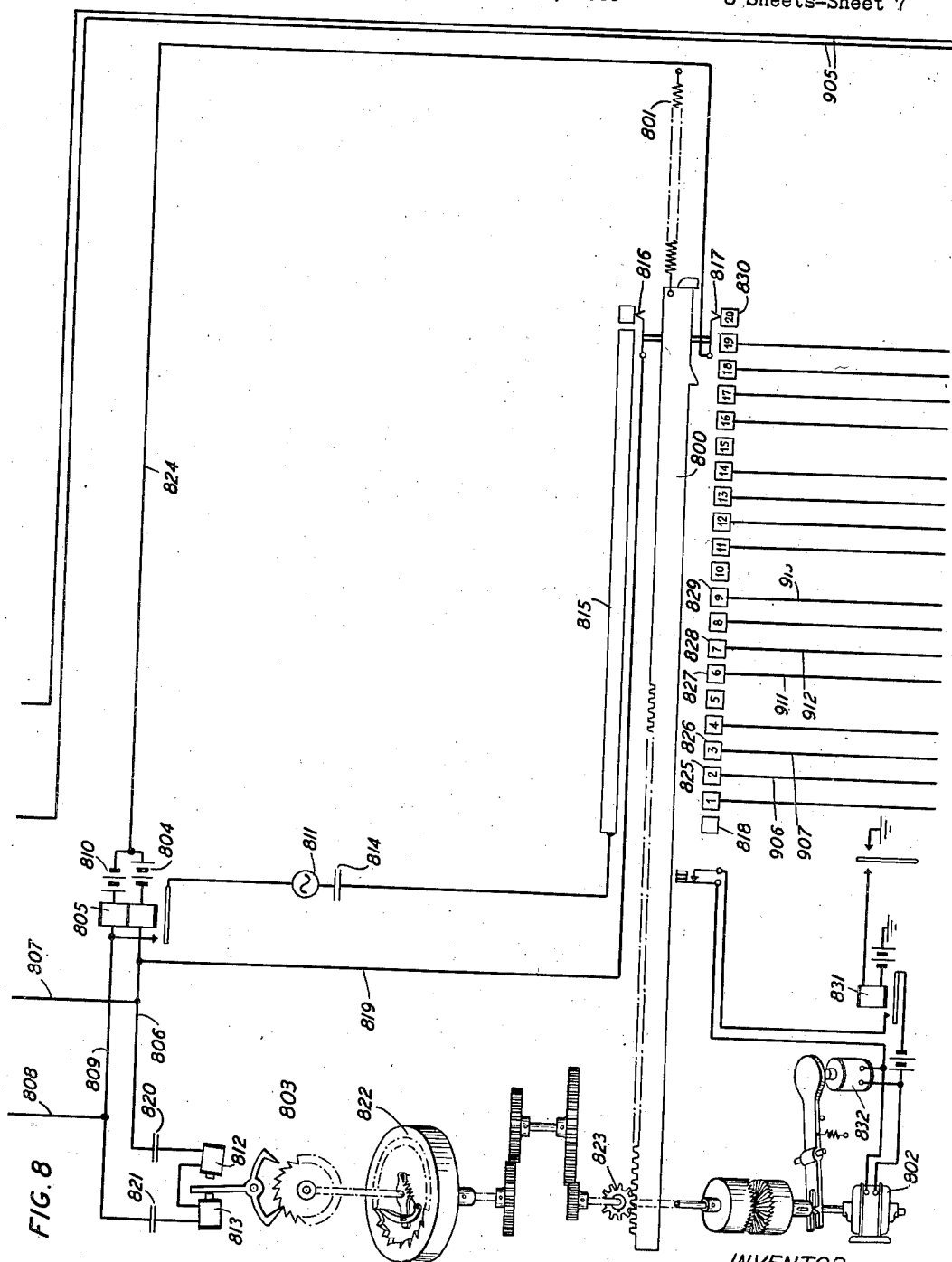


FIG. 8

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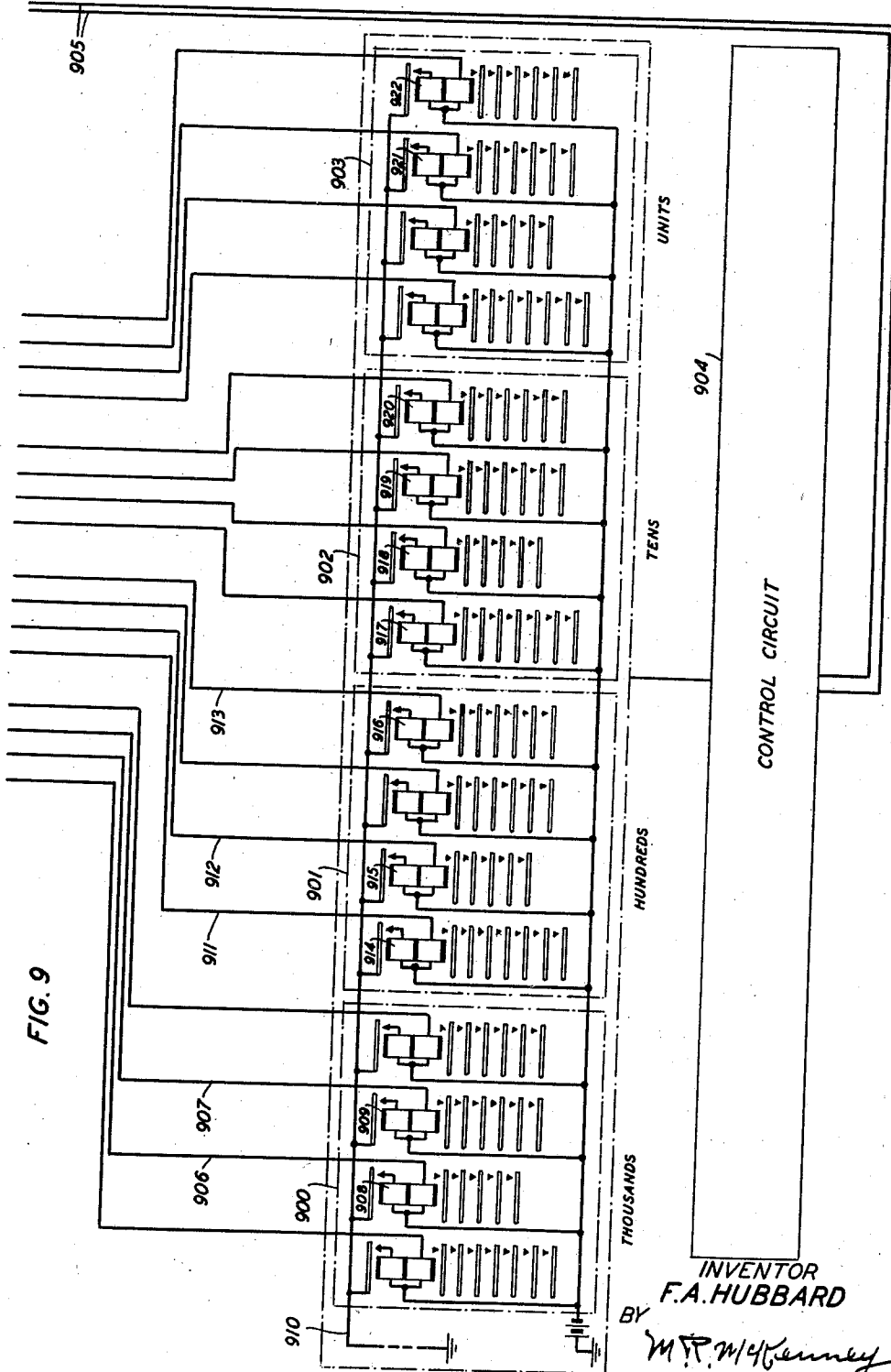
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F. A. HUBBARD
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2,250,101

Filed Dec. 7, 1939

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UNITED STATES PATENT OFFICE

2,250,101

TELEPHONE SYSTEM

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Application December 7, 1939, Serial No. 308,036

16 Claims. (Cl. 179—18)

This invention relates to telephone systems and particularly to those in which automatic switches are used for establishing conversational connections.

The objects of the invention are to simplify the acts necessary on the part of the subscriber in transmitting designations; to reduce the time required for sending the designations from the subscriber's station to the central office; to reduce the holding time of common equipment in the central office; and to secure other improvements in systems of this character.

The objects of this invention are realized by means of a system for transmitting telephone designations from a subscriber's station to the central office in which each of the several characters of a designation is represented by a relatively small number of current impulses transmitted in code form. The code impulses representing the successive characters are transmitted by a distributor at the substation driven in synchronism with a corresponding distributor at the central office, which receives the code impulses transmitted and causes them to operate digital registers, which in turn serve to control the selective operation of the automatic switches. The subscriber's station is also provided with a preset designation keyboard which enables the subscriber to set up the entire designation, including the office code and line number, prior to the transmission of any impulses over the line. As soon as the full designation is set up, the synchronized distributors are started, and the code impulses representing the successive characters are transmitted over the line and registered in the central office in a brief space of time.

One of the advantages and features of this invention is the efficient use of the equipment made possible by employing a preset transmitter and a designation code requiring a limited number of impulses for each character of the designation. The preset transmitter makes it possible for the entire designation to be prepared at the subscriber's leisure without the wasteful seizure and holding of any common equipment in the central office; and the use of the abbreviated impulse code makes it possible to transmit the designation in a minimum space of time, thus reducing as much as possible the time during which the common central office equipment is held for the purpose of receiving a record of the wanted designation.

Another feature of the invention is a more advantageous use of the common register senders which control the automatic switches in the

central office. According to this feature it is possible to transmit the office portion of the designation to an originating sender in the central office and then to pause until the originating sender controls the automatic switches to selectively extend the calling line forward to the terminating sender either in the same office, in the event of a local call, or to a distant office, in the event of an interoffice call. Thereupon the transmission of the designation is resumed, and the numerical part of the designation is sent over the line and over the partially extended connection to the terminating sender where it is received and registered. The terminating sender then controls the final switches to complete the connection to the called subscriber's line. An advantage of this feature is that the originating sender need receive only that part of the designation which it requires in extending the connection to the terminating equipment, the numerical part of the designation being sent directly to the terminating sender, whose function it is to control the switches that finally complete the connection.

These and other features of the invention will be described in detail hereinafter.

In the drawings accompanying the specification Figs. 2 to 9, inclusive, when arranged in the order illustrated in Fig. 1, disclose sufficient parts of a telephone exchange system to illustrate the present invention.

Figs. 2 and 3 disclose the equipment at a subscriber's station, including the telephone instrument, a keyboard transmitter, and a sending distributor for transmitting code impulses to the central office;

Fig. 4 discloses diagrammatically the switches associated with the originating equipment in the central office. This figure also illustrates a sender selector for making connection with one of the common register senders;

Figs. 5 and 6 illustrate one of the originating register senders in the central office, including a receiving distributor switch and register relays;

Fig. 7 discloses the automatic switches associated with the terminating equipment in a central office together with a sender selector for seizing one of the common terminating register senders;

Figs. 8 and 9 disclose one of the terminating senders, including a receiving distributor and register relays; and

Fig. 10 shows a table of codes suitable for the transmission of the designations.

The invention is applicable particularly to sys-

tems in which the digital information for a call is registered in a common register sender in the central office, the registered information being utilized to control the selective switches to establish the desired telephone connection. To this end the system chosen to illustrate the invention is one in which the central offices are equipped with automatic switches of the well-known panel type. It will be understood, however, that other forms of switches, such as step-by-step switches and cross-bar switches, could be used to establish the connections. In the system shown in the drawings many details have been omitted, such as the structure and circuits of the selective switches, the manner in which the sender selectors seize idle senders in response to incoming calls, the manner in which the registers function to control the operation of the selector switches, and numerous other details of operation. For a better understanding of these details reference may be had to many patents in the prior art relating to systems of this general character and in particular to the following patents: Stearn et al. No. 1,395,977 of November 1, 1921; Stearn No. 1,505,171 of August 19, 1924; and Raymond et al. No. 1,862,549 of June 14, 1932.

Referring to the drawings, the subscriber's line 200 is equipped at the substation with the usual transmission elements, including the talking transmitter 201 and the receiver 202. The designation transmitter, which is also provided at the substation instead of the customary dial, includes a designation keyboard comprising a plurality of manually operable digit bars by means of which the subscriber may set up the code and numerical designation of a wanted subscriber's line. The keyboard illustrated in the drawings is arranged for designations having three code letters and four numerical digital places. The digit bars 300, 301 and 302 and their associated rows of contact keys serve to select the various combinations of code letters representing the different offices in the exchange area to which the subscriber has access. Eight digit bar, such as the bar 300, has ten operative positions, in each of which it closes a different combination of key contacts. By seizing the bar 300 and pulling it downwardly the subscriber may adjust the index pointer 303 to any of the ten positions, each of which represents one or more of the available code letters. Similarly the digit bars 304, 305, 306 and 307 and their associated rows of keys serve to select the thousands, hundreds, tens and units digits for any subscriber's line in any exchange of ten thousand lines. To set up any desired designation, therefore, the subscriber moves the code and numerical digit bars until their index pointers are opposite the successive characters representing the designation. These bars remain in their adjusted positions until the subscriber moves them to new positions. Thus it is possible for the subscriber to preset the designation he wishes to call and to keep a visual record of it until he is ready to make a new call.

The subscriber's designation transmitter also includes a synchronously driven code transmitting distributor comprising an operating bar 203 and a series of distributing segments, which are wired as illustrated to the contacts of the code and number keys of the keyboard. The operating distributor bar 203 is driven by a spring 204 which is tensioned manually by the subscriber and released in a stepping movement by means of an escapement mechanism 205.

The subscriber's line 200 appears in the bank of a line finder switch F' at the central office, and the finder F is connected to a first or district selector switch S-1. The switch S-1 has access to an office selector S-2 which in turn has access to trunks, such as the trunk 400, leading either to the switches of the terminating equipment in the same central office or to the corresponding switches in a distant central office. The switching link comprising the line finder F and the selector S-1 is provided with a sender selector switch S-3 for associating the link with an idle originating sender.

The originating sender, such as the one disclosed in Figs. 5 and 6, comprises a synchronously driven receiving distributor including the operating bar 500 and the associated row of distributing segments. The bar 500 is operated by a driving spring 501, which is automatically tensioned by a motor 502. The bar is released in its operating movement by an escapement mechanism 503. The escapement mechanism 503 and the escapement mechanism 205 of the transmitting distributor at the subscriber's station are driven in synchronism by a source of alternating current 504 of suitable frequency when the sender has been attached to the calling line and the equipment is ready for the transmission of the code impulses. The distributing segments of the receiving distributor are wired to the respective relays of the three office code registers 600, 601 and 602. The incoming code impulses received by the distributor cause the operation of these relays in different combinations to register the three code characters representing the name of the called office. These registers, when positioned, cooperate with the reverteive impulse controlling mechanism 603 and the fundamental circuit 604 to cause the selective operation of the switches S-1 and S-2 to extend the calling line over the trunk 400 to the terminating equipment of the called office.

The trunk 400 terminates in an incoming selector switch S-4 having access to the final selector S-5, which in turn has access to the called subscribers' lines, such as line 700. The incoming trunk 400 also terminates in the brushes of a sender selector switch S-6, which has access to the terminating senders.

These terminating senders, such as the one illustrated in Figs. 8 and 9, are similar to the originating sender shown in Figs. 5 and 6. The terminating sender also includes a receiving distributor comprising the operating bar 800 driven by a spring 801 which is tensioned automatically by the motor 802. The bar is released in a stepping movement by the escapement mechanism 803. Since the terminating sender receives the numerical registration, including four digital characters, the distributing segments are wired to four registers, the thousands register 900, the hundreds register 901, the tens register 902, and the units register 903. The relays of these registers are operated in combinations corresponding to the code impulses received and, in cooperation with the controlling mechanism 904 and the fundamental circuit 905, determine the selective operation of the incoming selector S-4 and the final selector S-5 to complete the extended connection to the called subscriber's line.

The operation of the system will now be described in detail, assuming for this purpose that the subscriber line 200 desires to call the subscriber of line 700 and that the designation of the line 700 is CHE-6789. First the calling sub-

scriber presets the desired designation on his transmitter. To do this he moves the code bars 300, 301 and 302 until their index pointers 303, 308 and 309 are opposite the characters C, H and E, respectively. In these positions the insulating cams 310, 311 and 312 close respectively the contacts of keys 313, 314 and 315. Also he moves the numerical digit bars 304, 305, 306 and 307 until their respective pointers 316, 317, 318 and 319 are opposite the numerical characters 6, 7, 8 and 9. In these positions the numerical digit bars close the contacts of keys 320, 321, 322 and 323. Next the calling subscriber seizes the operating bar 203 by its handle 206 and lever 207 and draws the bar against the tension of spring 204 until the distributor brush 208 is in engagement with the preliminary segment 209. During the setting movement of the bar 203 the spring-pressed pawl 210, driven by the rack on bar 203, which rotates the pinion 211 and intermediate gears 212, 213, 214 and 215, overrides the teeth on the ratchet wheel 216. The ratchet wheel 216, which is formed integrally with the escapement wheel 217, is held against rotation by the escapement lever 218 during the setting of the operating bar 203. During the setting movement of the bar 203 the lever 207 opens the contacts 219 to disconnect the distributor brush 208 from conductor 220.

Finally the calling subscriber, having preset the key-board and having conditioned the distributor for operation, removes his receiver 202 from the switchhook. The removal of the receiver closes a direct current loop at the substation which may be traced from conductor 221, switchhook contacts, conductor 222, through coils 223 and 224, conductor 225, switchhook contacts to the other line conductor 226. The line relay (not shown) at the central office operates in response to the closure of this loop, and the line finder switch F is set in motion to seize the terminals of the calling line 200. As soon as the line finder finds the calling line and the sender selector switch S-3 has seized an idle sender, a circuit is closed from the positive pole of battery 505 to the lower winding of relay 506, conductors 517 and 507, brush 401, conductor 402, thence through the left contacts of the spring 403 of the controlling sequence switch 419 associated with the link interconnecting the finder F and selector S-1, brush 404, over conductor 226, thence through the loop closed through the coils 223 and 224 and returning over conductor 221, brush 405, closed contacts of sequence switch spring 406, conductor 407, brush 408, conductors 508 and 514 through the upper winding of relay 506 to the negative pole of battery 509, the other poles of batteries 505 and 509 being connected together. The relay 506 operates in this circuit and closes a circuit for applying current from the source 504 to the escapement mechanisms 503 and 205. Although the subscriber's transmitter 201 is connected across the conductors 221 and 226 at this time, the receiver 202 being off the switchhook, the transmitter is prevented from acting as a low-resistance shunt across the line by the insertion of rectifiers 241 and 242. These rectifiers are poled in such a direction that current flowing over the line from the batteries 505 and 509 does not pass in any substantial quantity through the microphone 201.

It should be noted at this point that the operating bar 500 of the receiving distributor is

normally standing with its distributor brush 510 on the preliminary segment 511. The manner in which the bar 500 is driven to its set position with the brush 510 on the segment 511 will be explained hereinafter.

The circuit for supplying current from the source 504 to the magnets 512 and 513 of the escapement 503 may be traced from the upper pole of the source 504, contacts of relay 506, conductor 514, condenser 515 through the windings of magnets 512 and 513, condenser 516, conductor 517, conductor 518, brush 519, segment 520, conductor 521 and condenser 522 to the other pole of the source 504. Simultaneously with the closure of this circuit a parallel circuit is closed for the magnets 227 and 228 of the escapement mechanism at the subscriber's station. The circuit for these magnets may be traced from conductor 514, thence over conductor 508 and as previously explained over the subscriber's loop to conductor 222, condenser 229, magnets 227 and 228, condenser 230, conductor 225 and returning to the central office by way of conductor 226 and thence over conductors 402 and 507 to conductor 517. The escapement pawls 218 and 522 are operated in synchronism with each other by the alternating current from the source 504, and the distributor brushes 208 and 510 are stepped together over the successive segments in their respective rows. The power for moving the bar 500 is supplied by the tensioned spring 501, and the stepping movement of the bar is controlled by the escapement 503 which is connected through the pawl and ratchet wheel 539 and intermediate gears 543, 542, 541 and 540 to the pinion 538, the latter engaging the rack on bar 500.

It will be noted that the segments of the sending distributor are arranged in groups of four, the successive groups being wired to the corresponding rows of key contacts in the keyboard. Each of the digital characters of the designation is, therefore, determined by a code of four units only. Accordingly, it is possible to transmit the entire designation within a brief interval of time, since the distributor brush may be driven at a relatively high speed and since a comparatively small number of impulses are required to represent each of the successive characters of the designation. The different codes for the different letters and numerals are obtained by transmitting current impulses during one or more of the four unit intervals representing each character and by varying these current combinations to represent the total number of characters required. While the invention is not limited to any particular code, one that is suitable for this purpose is illustrated in Fig. 10. The table here shown gives the impulse codes for the different letter characters used for the office designations which are selected by the first three bars 300, 301 and 302. The table also shows the codes for the ten numerals 1 to 0 used for the numerical designations of the lines in an office. It will be noted that each of the positions of the code bars 300, 301 and 302 represents a numeral as well as certain letters. This permits an office designation to be expressed by a combination of letters and numerals, such as two letters followed by one numeral. An inspection of the wiring of the key contacts of the keyboard transmitter of Fig. 3 will show that it is arranged to transmit the letters and numerals in accordance with the codes given in Fig. 10.

When the distributor brush 208 passes over the first four segments 231, 232, 233 and 234, three

code impulses representing the letter "C" are transmitted over the line to the central office. The circuits for these three impulses may be traced from ground through the closed contacts of key 313, thence over segments 232, 233 and 234 in succession, brush 208, contacts 219, conductor 220 to the mid-point of coils 223 and 224 and thence over the simplex circuit including both of the line conductors 221 and 226 to conductors 514 and 517 through the windings of relay 506, conductor 523, brush 510, thence in succession through segments 524, 525 and 526 and conductors 605, 606 and 607 through the lower winding of register relays 608, 609 and 610 to battery. These relays operate and lock through their upper windings and contacts to ground over the holding conductor 611. After passing the first group of four segments, the brushes 208 and 510 of the distributors encounter intermediate idle segments 235 and 527 in which no impulses are transmitted. As the brushes proceed over the next group of four segments a code of one impulse, representing the character "H," is transmitted to the central office. The circuit for this impulse may be traced from ground through the closed contacts of key 314, thence over the first segment 236 of the group, over the simplex circuit to the central office and through the brush 510 and segment 528, conductor 612 through the lower winding of register relay 613 to battery. Relay 613 operates and locks through its upper winding and contact to the grounded conductor 611. After passing the intermediate segment 237 the brush 208 next moves over the third group of four segments corresponding to the letter "E" in the third digital place in the office code. In passing over these segments the brush 208 transmits two code impulses over circuits that may be traced from ground through the closed contacts of key 315, thence over segments 238 and 239 successively, brush 208 and thence over the line to the receiving distributor brush 510, over segments 529 and 530 in succession, conductors 614 and 615 to the windings of register relays 616 and 617 to battery. These relays operate and lock through their upper windings through the grounded conductor 611.

The three office code letters C, H, E, have now been transmitted and registered in the central office sender. Following the transmission of the third letter character the brush 208 of the sending distributor advances to the idle segment 240, and the brush 510 of the receiving distributor advances to the idle segment 531. When the receiving distributor reaches this position, the brush 519 disengages the continuous segment 520 and passes on to the idle segment 532. Thereupon the circuits from the source 504 to the escapement magnets of mechanisms 205 and 503 are opened, and these escapement mechanisms cease to operate. Thus the distributor brush 208 is brought to rest following the transmission of the office code designation, and a pause is introduced at this point during which the sender in the central office controls the selector switches to extend the subscriber's line to the terminating equipment in the called office. To this end the control elements of the sender prepare for the selective operation of the district and office selectors S—1 and S—2 immediately that the office code designation is registered on the registers 600, 601 and 602. The revertive impulse control circuit 603, which usually includes a chain of counting relays, becomes effective to control the selecting movements of the switches S—1 and

S—2, by way of the fundamental circuit 604, in accordance with the settings of the registers. As soon as the sender has completed its controlling functions, it restores to normal, and the controlling sequence switch 419 associated with the line finder F and selector S—1 advances to some suitable position where it extends the calling line 200 over the control link 409 through the brushes of switches S—1 and S—2 to the trunk 400.

During the releasing stages of the sender the controlling sequence switch in the sender closes a circuit at spring 533 for operating relay 534. The purpose of operating relay 534 is to rewind the receiving distributor and condition it for the next operation. To accomplish this, the relay 534 closes an obvious circuit for the motor 502 and clutch magnet 535. Magnet 535 operates the clutch 536 to couple the shaft of motor 502 to the winding shaft 537. The shaft 537, through the pinion 538, draws the operating bar 500 back to its normal position with the brush 510 resting on the idle segment 511. During the rewinding movement of the bar 500, the ratchet wheel 539 is turned by the intermediate gears 540, 541, 542 and 543, this turning movement being permitted by the overrunning pawl 544, which is secured to the escapement wheel 545. As soon as the bar 500 is restored to its normal position against the tension of spring 501, contacts 546 are opened by shoulder 548 to disconnect power from the motor 502 and magnet 535. The bar 500 is held in its advanced position by the escapement wheel 522.

When the sequence switch of the district selector advances into position to include the control link 409 in circuit with the calling line following the selection of trunk 400, the relay 410 is connected in series with the calling line in place of the relay 506 of the sender which has now been released. The circuit for relay 410 may be traced from the positive pole of battery 411, lower winding of said relay through the upper contacts of sequence switch spring 403, thence over the subscriber's line through coils 223 and 224 and returning over the other side of the line through the upper contacts of spring 406 and the upper winding of relay 410 to the negative pole of battery 412, the other poles of batteries 411 and 412 being connected together as shown. Relay 410 operates in this circuit and may serve as a supervisory relay under the control of the calling subscriber's switchhook. The flow of current from the batteries 411 and 412 over the line 200 is, however, still in such a direction that it is excluded from the subscriber's transmitter 201 by the rectifiers 241 and 242.

The seizure of the trunk 400, which terminates in the brushes of the incoming selector switch S—4, initiates the operation of the sender selector switch S—5 to extend the trunk 400 to an idle terminating sender, such as the one shown in Figs. 7 and 8. As soon as the sender has been seized, a circuit is closed from the negative pole of battery 804, lower winding of relay 805, conductors 806 and 807, brush 701, conductor 702, contacts of spring 703 of the sequence switch (not shown) associated with the incoming selector S—4, thence over the upper conductor of trunk 400 through the brushes of selectors S—2 and S—1, uppermost contacts of spring 413, windings of polarized relay 414 through the uppermost contacts of spring 415, brushes of switches S—1 and S—2, lower conductor of trunk 400 through the contacts of sequence

switch spring 704, conductor 705, brush 706, conductors 808 and 809, through the upper winding of relay 805 to the positive pole of battery 810, the other poles of batteries 804 and 810 being connected together. Relay 805 operates, but the direction of current in this circuit is such that the polarized relay 414 does not close its operating contacts. Relay 805 closes circuits for supplying current from the alternating current source 811 to the escapement magnets 812 and 813 of mechanism 803 and also to the magnets 227 and 228 of the escapement mechanism 205 at the subscriber's station. The circuit for magnets 812 and 813 may be traced from the lower terminal of source 811, condenser 814, commutator bar 815, brush 816, which is in engagement with the commutator bar 815, since the operating bar 800 is assumed to be in its set position with the distributor brush 817 resting on the normal position terminal 818, thence over conductor 819, conductor 806, condenser 820, magnets 812 and 813, condenser 821, conductor 809 through the contacts of relay 805 to the other terminal of source 811. The parallel circuit for magnets 227 and 228 at the subscriber's station extends by way of conductor 807, brush 701, conductor 702 thence over the upper conductor of trunk 400 through selector switches S-2 and S-1, contacts of spring 413, condenser 416, contacts of spring 406, brush 405, thence over the subscriber's line and returning through brush 404, contacts of spring 403, condenser 417 through contacts of spring 415, brushes of switches S-1 and S-2 over the lower conductor of trunk 400 to conductor 705 through brush 706 and conductor 808 to conductor 809. The escapement mechanism 803 is operated in response to the current alternations from source 811 and, through the ratchet wheel 822, the intermediate gear wheels and the pinion 823, permits the tensioned spring 801 to restore the bar 800 in a stepping movement. Simultaneously therewith the escapement mechanism 205 permits the bar 203 to resume its restoring movement to advance the brush 208 over the four remaining groups of segments corresponding to the thousands, hundreds, tens and units digits.

In passing over the four segments representing the thousands digit, the brush 208 closes circuits for transmitting two code impulses, characterizing the digit 6, to the terminating sender in the called office. The circuits for these impulses may be traced from ground through the contacts of key 320, segments 243 and 244, brush 208 thence over the simplex circuit through the brushes 404 and 405 of the line finder switch F. From these brushes the simplex circuit continues through the upper contacts of springs 403 and 406, windings of relay 410, batteries 411 and 412, conductor 418, windings of relay 414, upper contacts of springs 413 and 415, thence over the conductors of trunk 400, contacts of springs 703 and 704, conductors 702 and 705, brushes 701 and 706, conductors 807 and 808, windings of relay 805, batteries 804 and 810, conductor 824, brush 817, segments 825 and 826, conductors 906 and 907 through the lower winding of the thousands register relays 908 and 909 to battery. Relays 908 and 909 operate and lock through their upper windings and contacts to ground over the holding conductor 910. Next the brush 208, having passed the intermediate terminal 245, passes over the four segments relating to the hundreds digit. Since the hundreds digit is assumed to be 7, three code impulses are transmitted, and

the circuits therefor may be traced from ground through the contacts of key 321, segments 246, 247 and 248 and thence as previously traced to the distributor brush 817, thence over segments 827, 828 and 829, conductors 911, 912 and 913 to the lower windings of relays 914, 915 and 916 of the hundreds register to battery. These register relays operate and lock through their upper windings and contacts to the grounded conductor 910. In a similar manner the distributor brushes 208 and 817 pass over the remaining two groups of segments representing the tens and units digits of the called number. Since these digits are assumed to be 8 and 9, respectively, it will be found by inspection of the drawing that four code impulses are transmitted for the tens digit and two code impulses for the units digit resulting in the operation of relays 917, 918, 919 and 920 of the tens register and relays 921 and 922 of the units register.

The brush 817 of the receiving distributor now passes on to the idle segment 830, the brush 816 disengages the continuous segment 815, and the escapement mechanisms 803 and 205, being deprived of operating current, cease to operate. The terminating sender now proceeds to control, through the medium of the reverte impulse mechanism 904 and the fundamental circuit 905, the selective operation of the incoming and final selectors S-4 and S-5 to extend the connection through to the called subscriber's line 700. Thereafter the terminating sender restores to normal and in the process of doing so closes a circuit for relay 831, which energizes the motor 802 and clutch magnet 832 to reset the operating bar 800 of the distributor to its normal position with the distributor brush 817 resting on the normal position segment 818.

As the controlling sequence switch (not shown) of the incoming selector S-4 advances to prepare the connection for conversation, it disconnects the trunk 400 from conductors 702 and 705 and extends said trunk through to the repeating coil 707. A circuit is now closed from the positive pole of battery through the upper left winding of coil 707, contacts of spring 703 and thence as previously traced through the windings of polarized relay 414, over the other side of the connection through the contacts of spring 704 and the lower left winding of coil 707 to the negative pole of battery. Current in this circuit flows in the reverse direction through the windings of relay 414, and the relay operates to perform any desired control of supervisory function. For example, the operation of this relay may be utilized at this time for the purpose of advancing the sequence switch 419 to some suitable position, such as positions 15 and 16, to exclude the control link 409 and to substitute therefor the transmission link 420. With the transmission link 420 included, the circuit for supplying talking current to the subscriber's line 200 may be traced from the positive pole of battery through the upper left winding of repeating coil 421, contacts of spring 406, brush 405 thence over the subscriber's line and returning to the central office through brush 404, contacts of spring 403, winding of supervisory relay 422, lower left winding of coil 421 to the negative pole of battery. The current supplied from the transmission link 420 flows in such a direction over the subscriber's line that it passes readily through the rectifiers 241 and 242 at the substation and energizes the subscriber's transmitter 201 for speech transmission. Current also flows through the coils 223

and 224, but the resistance of these coils is high enough to prevent any appreciable loss of energizing current in the transmitter, and their impedance to voice currents is sufficiently high to prevent any substantial loss of transmission. The supervisory relay 423 of the transmission link 420 is now included in a transmission circuit extending to the repeating coil 707 in the called office. This circuit may be traced from battery through the upper left winding of coil 707, contacts of sequence switch spring 703, over the upper conductor of trunk 400 through the selectors S—2 and S—1, contacts of sequence switch spring 413 through the upper right winding of repeating coil 421, winding of relay 423, lower right winding of coil 421, contacts of spring 415 and thence over the lower side of the connection through the contacts of spring 704 and the lower left winding of coil 707 to battery. Relay 423 may serve in the well-known manner to receive supervisory signals transmitted from the terminating equipment in response to operations by the called subscriber's switchhook. Also when the controlling sequence switch of the incoming selector S—4 advances into the talking position it disconnects the control conductors 708 and 709 and extends the talking circuit from the right windings of the repeating coil 707 through contacts of springs 710 and 711 thence over the brushes of switches S—4 and S—5 to the called subscriber's line 700.

At the end of conversation the subscribers replace their receivers, and the supervisory relays 422, 712 and 423 respond to cause the release of the connection.

When the subscriber's line 200 is seized on an incoming call, the polarity of the current supply source is such that current readily flows through the rectifiers 241 and 242 to energize the transmitter 201. This relation is shown in Fig. 7, the polarity of the current supplied from repeating coil 707 being such that it energizes the transmitter of the called line 700.

From the foregoing description it will be noted that each central office in the exchange system is provided with an originating equipment comprising district and office switches and an originating sender and with a terminating equipment comprising incoming and final selectors and a terminating sender. The originating equipment in any office responds uniformly to incoming calls and operates in accordance with the office code designation to extend these calls to the desired terminating equipment, either in the same office, in the event of a local call, or in a distant office, in the event of an inter-office call. The transmitter at the calling subscriber's station, although preset for the entire designation, sends the office code and then pauses in all cases until the originating equipment has extended the connection to the terminating equipment in the desired office. Thereupon the sender resumes its operation automatically and transmits the remainder of the designation to the register sender associated with the terminating equipment. With this plan of registration each of the senders employed in the establishment of a connection is required to register only that part of the designation which it needs for performing its functions. The practice of registering a designation in one sender and retransmitting it to another sender where it is finally utilized is, therefore, avoided, and a considerable saving is realized in the holding time of the senders.

What is claimed is:

1. In a telephone system, a central office, a calling subscriber's line terminating therein, a signal transmitter at the calling substation capable of being preset by the subscriber in accordance with a desired called line designation, a distributor at the substation for sending over the line code impulses representing the preset designation, a distributor at the central office driven in synchronism with said first distributor, registers operated by said central office distributor in accordance with the code impulses received for registering the desired designation, and automatic switches controlled in accordance with the registered designation for extending said calling line.

2. In a telephone system, a central office, a calling subscriber's line terminating therein, a transmitter at the calling substation, means for presetting said transmitter in accordance with the designation of a called line, a distributor at the calling substation, a distributor at the central office, means for driving said distributors in synchronism to transmit over the line to the central office code impulses representing the designation preset on said transmitter, means at the central office controlled by the distributor thereat for registering the designation, and automatic switches controlled in accordance with the registered designation for establishing a telephone connection.

3. In a telephone system, a central office, a calling subscriber's line, a transmitter at the substation of said line, means under the control of the subscriber at said station for presetting said transmitter in accordance with the several characters of a wanted designation, a distributor at the substation, a distributor at the central office, means under the control of the subscriber at the substation following the presetting of said transmitter for starting said distributors and driving them in synchronism to send code impulses over the line representing the preset designation, means in the central office for registering the designation transmitted thereto, and automatic switches controlled in accordance with the registered designation for establishing the telephone connection.

4. A telephone system in which each of the designations of the wanted lines includes a plurality of digital places, and in which the characters in said digital places vary in value among said lines, comprising a central office, a calling line terminating therein, a signal transmitter and a distributor at the substation of said calling line, means for setting said transmitter in accordance with the digital characters of a called designation, a distributor at the central office, means for operating said distributors in synchronism to transmit over the calling line codes of impulses representing the successive characters in the desired designation, the number of impulses for each code being small in comparison with the possible number of values of the digital character, means controlled by the distributor at the central office for registering the characters of the transmitted designation, and automatic switches controlled by said registering means.

5. In a telephone system, a central office, a calling subscriber's line, a signal transmitter and a distributor at the substation of said line, a plurality of distributors in said central office, means controlled by the subscriber at said substation for presetting said transmitter in accordance with a wanted designation, means for

selecting an idle one of the distributors at the central office, means for operating the selected distributor at the central office and the distributor at said substation in synchronism to transmit codes of impulses over said line representing the designation set on said transmitter, means at the central office responsive to the distributor thereat for registering the transmitted designation, and automatic switches controlled by said registering means.

6. A telephone system in which each of the designations of the wanted lines includes a plurality of digital places, the characters of said digital places varying among the different lines by as many as ten different values, comprising a central office, a calling line extending to said central office and having a transmitter at the substation thereof, means controlled by the subscriber for variably presetting said transmitter in accordance with the designation of any desired line, an impulse sender at the substation, and means for driving the same through a cycle of operation following the setting of said transmitter to send over the line code impulses representing the successive characters of the preset designation, the code for any character requiring not more than four impulses, an impulse receiving device at the central office driven in synchronism with said impulse sender for receiving said code impulses, and means controlled by said receiving device for registering the characters of the transmitted designation.

7. In a telephone system, central offices having register senders therein, a calling line appearing in one of said offices, a designation transmitter for said line for transmitting the designation of a wanted line to the central office, means for connecting one of said register senders to the calling line to receive and register a portion of the designation transmitter thereover, means for connecting a second register sender to the calling line to receive and register another portion of the transmitted designation, and automatic switches controlled by said register senders in accordance with the registered designation to establish a telephone connection.

8. In a telephone system, central offices having register senders therein, a calling line appearing in one of said offices, a designation transmitter for said line for transmitting the designation of a wanted line to the central office, means for connecting a first one of said register senders to the calling line to receive and register a portion of the designation transmitted over said line, automatic switches controlled by said first sender to establish a partial telephone connection, means for connecting a second register sender to the calling line to receive and register another portion of the designation transmitted over said line, and other automatic switches controlled by said second sender for completing the establishment of said telephone connection.

9. In a telephone system, a calling subscriber's line having a designation transmitter at the substation thereof, means controlled by the subscriber for presetting said transmitter in accordance with the designation of a wanted line, a register sender and means for connecting the same to the calling line, means for operating said transmitter to transmit a portion of the preset designation over said line to said register sender, a second register sender, and means for connecting the same to said calling line, means for further operating said transmitter to transmit the remaining portion of the preset designation over

the calling line to said second register sender, and automatic switches controlled by said senders for establishing the desired telephone connection.

10. In a telephone system, a central office, a calling subscriber's line, a signal transmitter at the substation of said line, means for presetting said transmitter in accordance with the designation of a wanted line, two register senders in said central office, means for connecting said senders in succession to said calling subscriber's line, means effective while the first sender is connected to the calling line for partially operating said transmitter to transmit a portion of the preset designation over the line to the connected sender, means effective while the second sender is connected to said line for further operating said transmitter to transmit the remaining portion of the preset designation over the calling line to said second register sender, and automatic switches controlled by said register senders for establishing a telephone connection.

11. In a telephone system, an originating office, a calling subscriber's line terminating therein, a designation transmitter at the substation of said line, means for setting said transmitter in accordance with a wanted designation, a register sender in said originating office, a terminating office having a register sender therein, means for connecting said first register sender to the calling line, means for operating said transmitter to transmit a portion of the wanted designation over the line to said first register sender, automatic switches in the originating office controlled by the register sender therein for extending said calling line to said terminating office, means for connecting the register sender in the terminating office to said calling line, means for further operating said transmitter to transmit another portion of the wanted designation over the extended connection to the register sender in said terminating office, and automatic switches in the terminating office controlled by the register sender therein for further extending the connection from said calling line.

12. A telephone system in which line designations have a portion for identifying the office and a portion for identifying the number of the line comprising a calling line, a designation transmitter for said line having a cycle of operation for transmitting impulses representing a wanted designation over said line, means for presetting said transmitter in accordance with the office and numerical portions of the wanted designation, a register sender, means for connecting said sender to said line to receive the office portion of the designation transmitted by said transmitter, means for causing said transmitter to pause following the transmission of the office portion of the designation, a second register sender, means for connecting said second register sender to said line, and means for causing said transmitter to resume its operation to transmit the remaining portion of the designation over the line to said second register sender, and automatic switches controlled by said register senders for establishing a telephone connection.

13. In a telephone system, an originating office, a calling subscriber's line terminating therein, a designation transmitter at the substation of said line, means for setting said transmitter in accordance with a wanted designation, a register sender in said originating office, a terminating office having a register sender therein, means for connecting said first register sender to the calling line, means for operating said transmitter to

transmit a portion of the wanted designation over the line to said first register sender, an impulse transmission link in said originating office, automatic switches in the originating office controlled by the register sender therein for extending said calling line over said impulse transmission link to said terminating office, means for connecting the register sender in the terminating office to said calling line, means for further operating said transmitter to transmit another portion of the wanted designation over the extended connection to the register sender in said terminating office, automatic switches in the terminating office controlled by the register sender therein for further extending the connection from said calling line, a speech transmission link in said originating office, and means for substituting said speech transmission link for said impulse transmission link in the completed connection.

14. In a telephone system, a central office, a calling subscriber's line terminating therein, a transmitter at the calling substation, means for presetting said transmitter in accordance with the designation of a called line, a distributor at the calling substation, a distributor at the central office, a source of alternating current at the central office for driving said distributors in synchronism to transmit over said line to the central office code impulses representing the designation preset on said transmitter, means at the central office controlled by the distributor thereat for registering the designation, and automatic switches controlled in accordance with the registered designation for establishing a telephone connection.

15. In a telephone system, a central office, a calling subscriber's line terminating therein, a

transmitter at the calling substation, means for presetting said transmitter in accordance with the designation of a called line, a distributor at the calling substation, a distributor at the central office, an impulse transmitting circuit including said line, a source of direct current in said impulse transmitting circuit, a source of alternating current for driving said distributors in synchronism to produce in said impulse transmitting circuit code impulses from said direct current source representing the designation preset on said transmitter, means at the central office responsive to said code impulses for registering the designation, and automatic switches controlled in accordance with the registered designation for establishing a connection.

16. In a telephone system, a central office, a calling subscriber's line terminating therein, a transmitter at the calling substation, means for presetting said transmitter in accordance with the designation of a called line, a distributor at the calling substation, a distributor at the central office, a source of alternating current, a circuit including said source of alternating current and the conductors of said subscriber's line in series for driving said distributors in synchronism, a source of direct current, an impulse transmitting circuit including said source of direct current and the conductors of said subscriber's line in parallel, said impulse transmitting circuit and said distributors cooperating to send code impulses representing the designation preset on said transmitter, means at the central office controlled in accordance with the transmitted impulses for registering the designation, and automatic switches controlled in accordance with the registered designation.

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