April 12, 1932. S. W. ALLISON ET AL 1,853,022

AUTOMATIC DIALING CIRCUITS

Filed Oct. 8, 1930 4 Sheets-Sheet 1

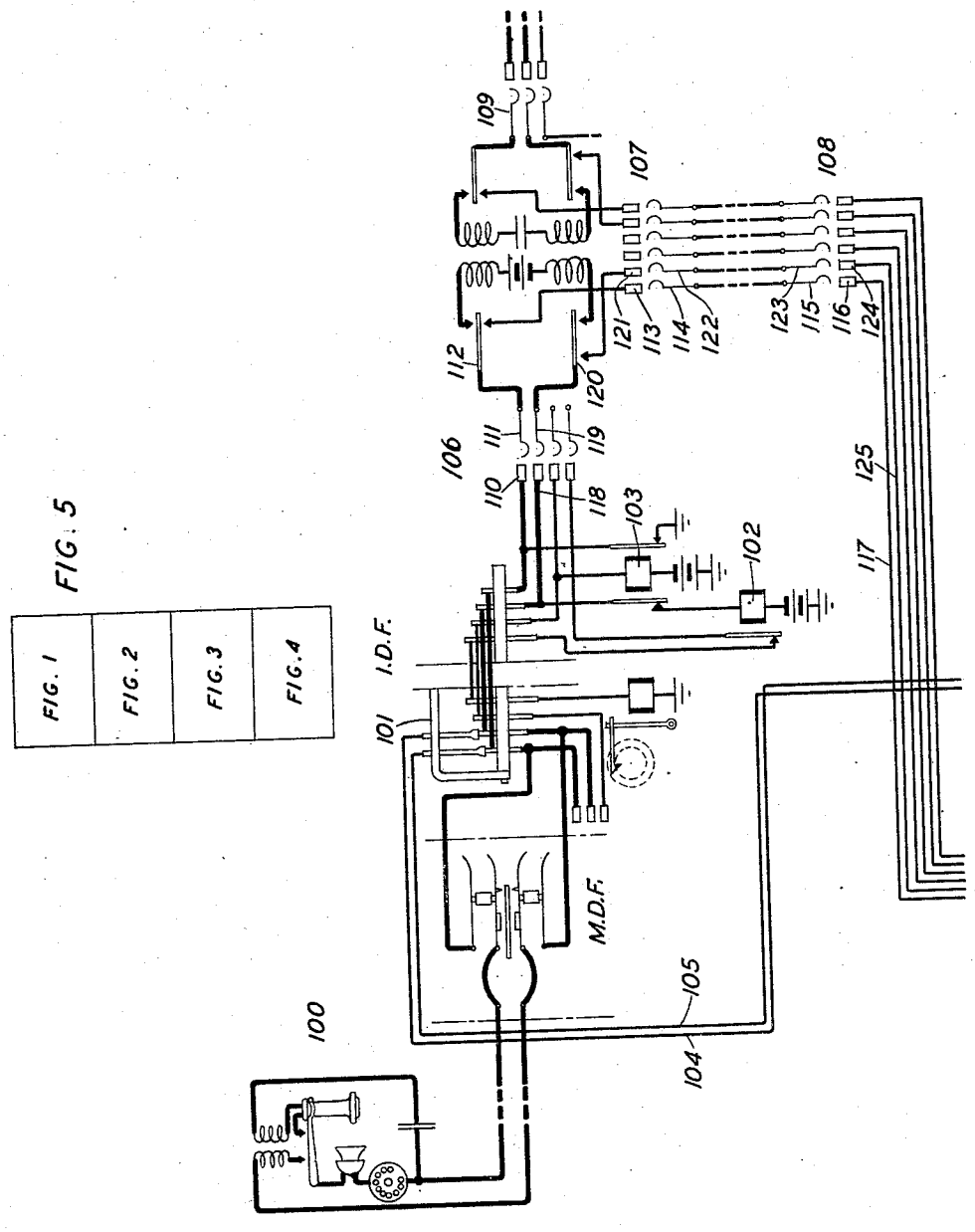

FIG. 1

FIG. 5

FIG. 1	FIG. 2	FIG. 3	FIG. 4

INVENTORS S. W. ALLISON
W. I. McCULLAGH
BY P. C. Smith

ATTORNEY

April 12, 1932. S. W. ALLISON ET AL 1,853,022

AUTOMATIC DIALING CIRCUITS

Filed Oct. 8, 1930 4 Sheets-Sheet 2

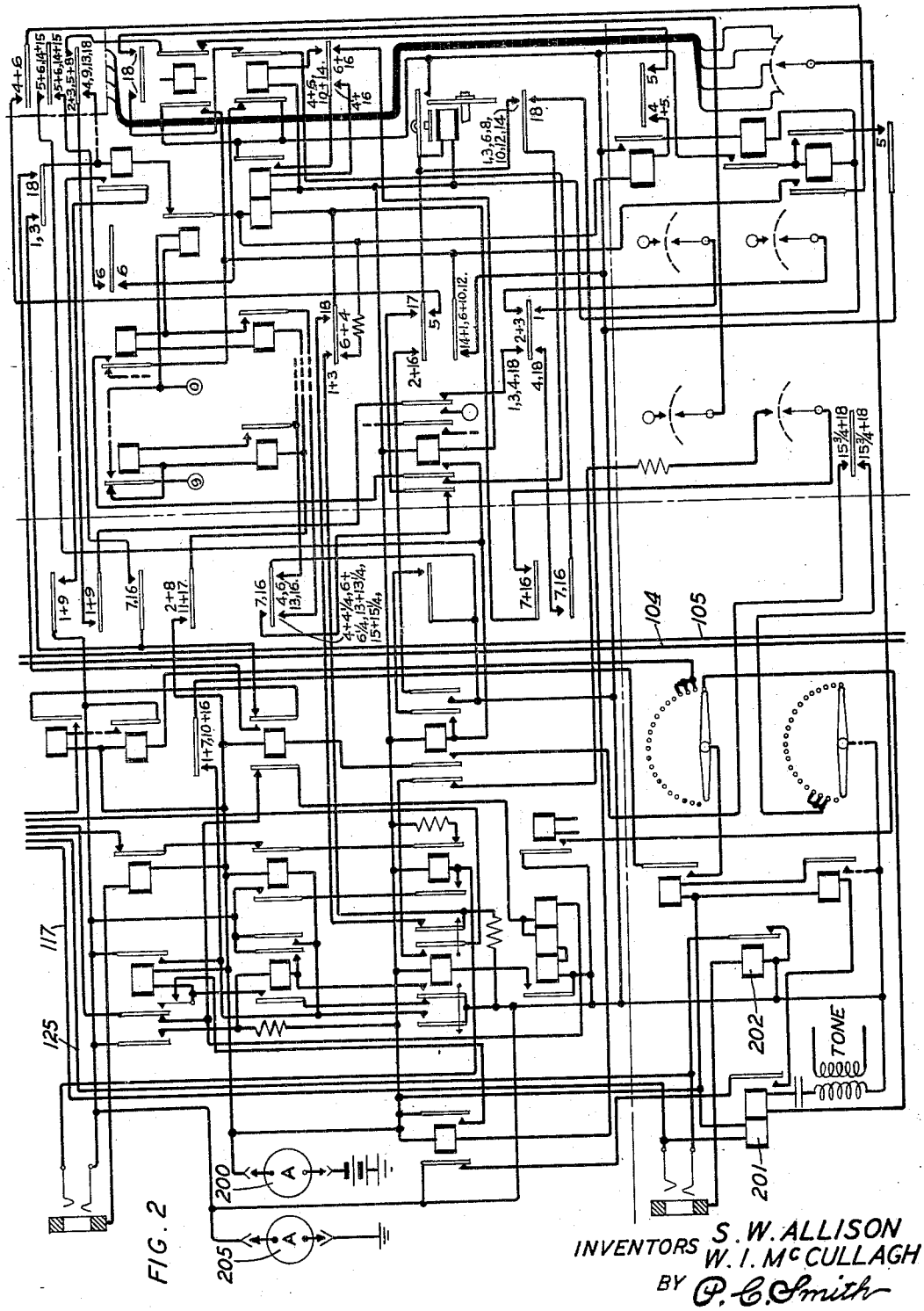

FIG. 2

INVENTORS S. W. ALLISON
W. I. McCULLAGH
BY P. C. Smith
ATTORNEY

April 12, 1932. S. W. ALLISON ET AL 1,853,022

AUTOMATIC DIALING CIRCUITS

Filed Oct. 8, 1930 4 Sheets-Sheet 3

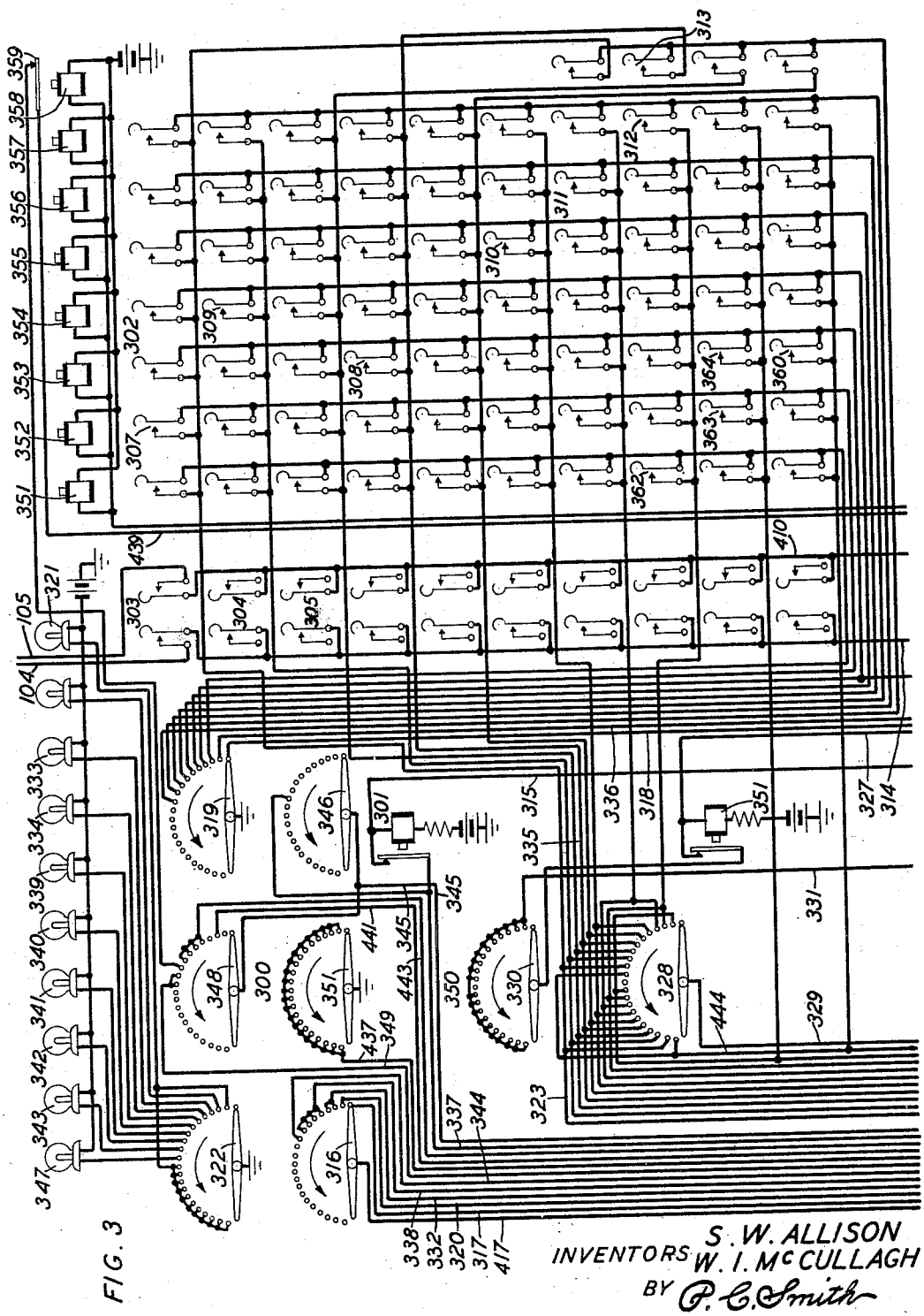

FIG. 3

INVENTORS S. W. ALLISON
W. I. McCULLAGH
BY P. C. Smith
ATTORNEY

April 12, 1932. S. W. ALLISON ET AL 1,853,022

AUTOMATIC DIALING CIRCUITS

Filed Oct. 8, 1930 4 Sheets-Sheet 4

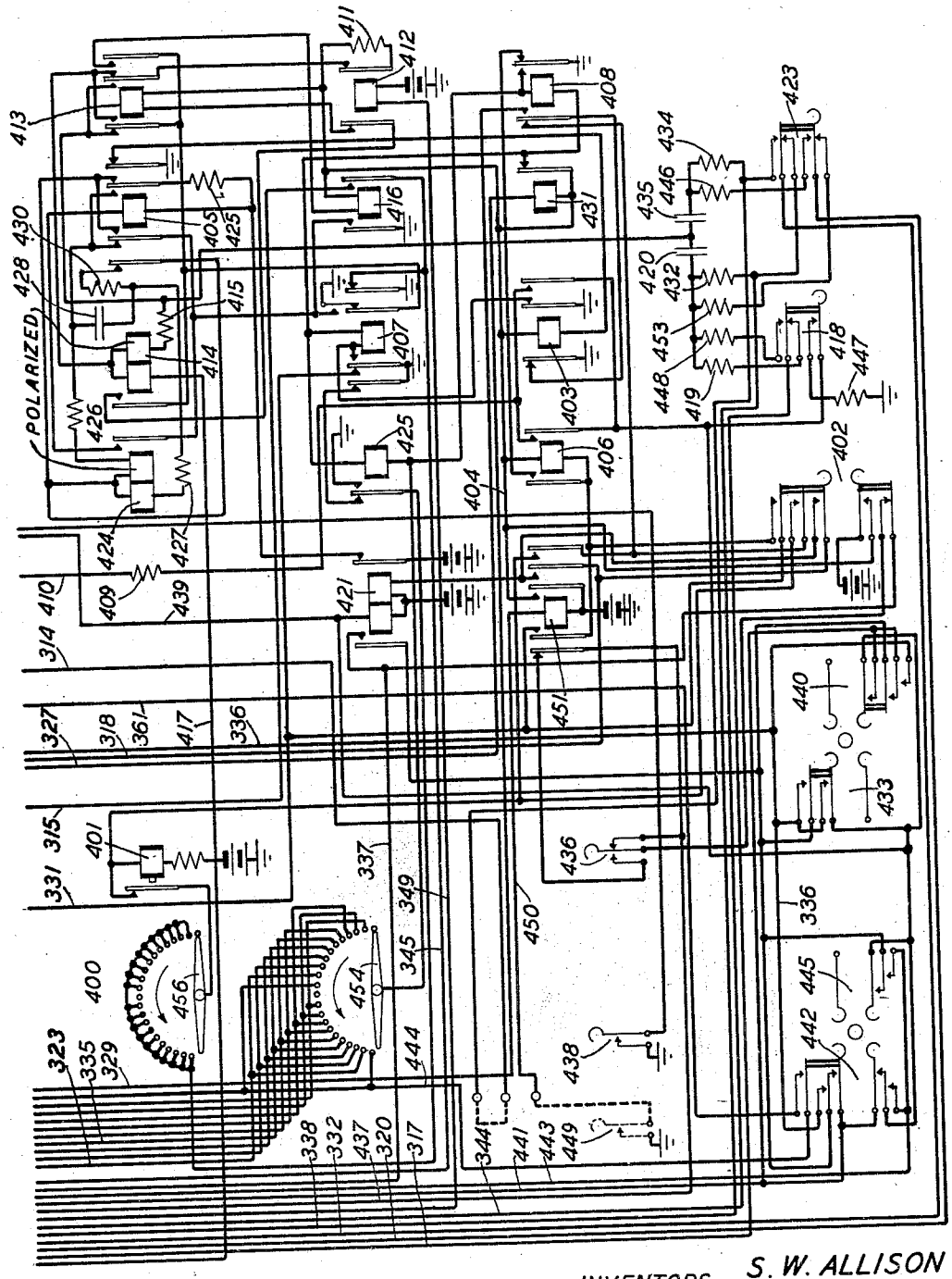

FIG. 4

INVENTORS S. W. ALLISON
W. I. McCULLAGH
BY P. C. Smith
ATTORNEY

Patented Apr. 12, 1932

1,853,022

UNITED STATES PATENT OFFICE

SEWELL W. ALLISON, OF WEST ORANGE, NEW JERSEY, AND WILLIS I. McCULLAGH, OF GREAT KILLS, NEW YORK, ASSIGNORS TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

AUTOMATIC DIALING CIRCUITS

Application filed October 8, 1930. Serial No. 487,154.

This invention relates to dial switching telephone systems and more particularly to apparatus for accurately simulating the acts of an average subscriber in initiating a call and dialing the letters or numerals of any call number which such subscriber would be desirous of making. The object of the invention is to provide mechanical dialing apparatus which accurately simulates the theoretical average times required for the average subscriber to perform all of the functions required in setting up a connection from the time of removal of his receiver from the switchhook until the completion of dialing.

In the study of selector switch performance in step-by-step type systems and the study of sender performance in panel type systems responsive to the initiation of calls and dialing by a subscriber, particularly in connection with studies of current drain, which is quite largely dependent upon the speed with which the subscriber sets up a connection, it has been found that it is difficult in the laboratory to reproduce on the standard subscriber's dial, the average subscriber operation of the dial. Obviously, a trained laboratory engineer is able to dial connections on a standard subscriber's dial much more accurately and with greater speed than would the average subscriber and therefore the laboratory operation of a dial would not be an accurate reproduction of the operation which can be expected in regular service and would not therefore provide an accurate measure for computing the current drain of apparatus dependent upon such dial operation.

In order therefore to accurately simulate the operations which a subscriber performs in setting up a connection from the time he removes his receiver from the switchhook until he completes dialing any number which he would be called upon to dial, the mechanical dialing apparatus comprising the subject matter of the present invention was devised whereby time intervals equivalent to the theoretical average time required for subscribers to perform acts incident to making calls are measured.

In accordance with the present invention, one embodiment of which has been disclosed by way of example, a keyset is provided upon which the letters and numerals of any call number may be set up. Such call numbers may, for example, comprise one, two or three office code letters followed by four numerical digits and in some instances by a party line letter; seven numerical digits with or without a party line letter as used in setting up step-by-step switches; three numerical digits for special operator calls; or calls to a zero operator involving a single digit zero. Other keys are also provided which may be operated to record whether the office code comprises one or two code letters, a single code number or whether all of the code digits have numerical rather than letter values, whether the number comprises but three numerical digits as for calls to special operators, whether the call is such as requires coin box operation and for other operating functions.

Two timing interrupters are also provided, one of which measures under the control of certain of the auxiliary keys an interval equivalent to the theoretical average time from the removal of a receiver from the switchhook until dialing starts which may be varied in accordance with whether the call requires the first dialing of a code letter or a code numeral and also measures intervals equivalent to the theoretical average time required for a subscriber to hunt for succeeding letters or digits on a dial. The second interrupter functions alternately with two step-by-step switches to count off periods equivalent to the time required to pull down a dial for any numerical digit or letter and the time required for a dial to run down to transmit impulses corresponding thereto, pro-

vision being made under the control of the latter interrupter to transmit impulses for setting selector switches or for setting the registers of a sender during the time that the dial run down periods are being measured. A third stepping switch is also provided which functions as a steering switch to successively associate the rows of keys of the keyboard with the first two stepping switches for determining the numerical values of the several digits of any line number which the tester may desire to transmit.

A bank of lamps is provided for indicating the progress of dialing and a remote control means is made available whereby the tester after having set up any desired called number on the keyboard, may control the starting and stopping of the equipment from a remote point, for example, from the frame on which the sender under observation is located.

A clearer conception of the scope and purpose of the invention will be obtained from a consideration of the following description taken in connection with the attached drawings in which:

Fig. 1 shows a subscriber's line terminating in a main distributing frame, an intermediate distributing frame, the diagrammatic representation of a line finder, district selector, district finder, and sender selector, and a connecting shoe by means of which a test set disclosed in Figs. 3 and 4 may be patched to the line terminals at the intermediate distributing frame;

Fig. 2 shows a skeletonized sender circuit; and

Figs. 3 and 4 taken together show the test set embodying the present invention.

The line finder, district selector, district finder, sender selector and sender, which have been diagrammatically disclosed, are of the type shown in Patent No. 1,690,206, granted to A. Raynsford on November 6, 1928. For a full disclosure of the sender, reference may be had to Patent No. 1,589,402, granted to O. H. Kopp on June 22, 1926. The switches 300, 350 and 400 are of the well known rotary stepping type which are advanced step by step by the deenergization of their respective stepping magnets 301, 351 and 401 and which are restored to normal by being stepped forwardly under the control of the interrupter contacts of their stepping magnets. Switches 350 and 400 have two normal positions. The keys of keyboard 302 are of the locking type and the keys of each vertical row released by means of the release magnets shown above such vertical row.

Test with two letter office code

It will be assumed that it is desired to make a study of the current drain in the sender of Fig. 2 which serves the group of subscriber's lines in which the line 100 is located. To make this study, a recording milliammeter 200 is connected between the central office battery and the battery bus bar in the sender, and a second milliammeter 205 is connected between the central office ground and the ground bus bar of the sender, and the test set of Figs. 3 and 4 is patched by means of a cord extending from contacts of the group key 303 and terminating in shoe 101, to the tip and ring conductors of a subscriber's line such as 100 in the particular group of lines having access to the sender of Fig. 2. If tests are to be made in other groups, similar cords would be connected from the contacts of other group keys such as 304, 305, etc. It will first be assumed that a current drain test is to be made on a call for which two office code letters, four numerical digits and a station letter would be dialed by a calling subscriber, and that the test man depresses the keys 307 to 313 inclusive corresponding to the line designation WOrth 8432–J, and then depresses the start key 402, the two code letter key 433 and the group key 303.

Upon the operation of start key 402 a circuit is established for relay 403 extending from battery at the inner lower alternate contact of key 402, conductor 404, winding of relay 403, to ground at the outer right back contact of relay 405 and a circuit is established for relay 406 from battery on conductor 404 through the winding of relay 406, the upper contacts of key 402 to ground at the inner left back contact of relay 407. Relay 406 upon operating locks over its left contact to ground at the right back contact of relay 408. With relays 403 and 406 operated a loop circuit is established simulating the removal of a subscriber's receiver from the switchhook which may be traced from battery through the winding of line relay 102 of the subscriber's line to which the test set has been patched, left back contact of cut-off relay 103, ring terminals of the intermediate distributing frame, ring terminal of the shoe 101, conductor 104, left contacts of key 303, conductor 314, right front contacts of relays 403 and 406, resistance 409, conductor 410, right contacts of key 303, conductor 105, tip terminal of shoe 101, tip terminals of the intermediate distributing frame to ground at the right back contact of cut-off relay 103. Line relay 102 operates in this circuit and in the well known manner causes the line finder 106 to find the calling line, and the district finder 107 and sender selector 108 to associate an idle sender such as is shown in Fig. 2 with the calling line and with the district selector 109. Key 402 also establishes a circuit for relay 421 extending from battery through the right winding of relay 421, inner upper contacts of key 402, conductor 318 to ground at the normal terminal of brush 319 of steering switch 300.

The operation of key 402 also establishes a

circuit from battery on conductor 404 through resistance 411, the right back contact of relay 412, right back contact of relay 413, right winding of relay 414, resistance 415, left back contact of relay 413, to ground at the inner right back contact of relay 407. A circuit is also effective for the left winding of relay 414 extending from battery on conductor 404, resistance 411, right back contact of relay 412, right back contact of relay 413, left winding of relay 414, conductor 417, brush 316 and normal terminal of switch 300, conductor 317, upper normal contacts of key 418, resistance 419, condenser 420, left back contact of relay 413 to ground at the inner right back contact of relay 407. Relay 414 being differentially wound and polarized, does not operate since the current flowing through its right winding unbalances the charging current flowing through its left winding and condenser 420. When, however, condenser 420 becomes fully charged, the current flowing through its left winding unbalances the current flowing through its right winding and relay 414 operates its armature against its front contact. The time interval measured before relay 414 operates is therefore dependent upon the value of resistance 419 and condenser 420. Relay 414 upon operating closes a circuit for operating relay 413 which may be traced from battery on conductor 404, winding of relay 413, left back contact of relay 412, front contact of relay 414 to ground at the inner right back contact of relay 407. Relay 413 upon operating establishes a circuit for relay 416, extending from battery on conductor 404, winding of relay 416, outer right front contact of relay 413, to ground at the inner right back contact of relay 407 which in turn closes a circuit extending from battery through the winding of magnet 301 of steering switch 300, conductor 315, right front contact of relay 416 to ground at the outer right back contact of relay 407 preparatory to advancing switch 300 from normal into position 1.

Relay 413 upon operating also reverses the connection of battery and ground to the terminals of the windings of relay 414 and with switch 300 in normal position the circuit through the left winding of relay 414 now extends from ground at the inner right back contact of relay 407 left front contact of relay 413, left winding of relay 414, conductor 417, brush 316, normal terminal of switch 300, conductor 317, upper normal contacts of key 418, resistance 419, condenser 420, inner right front contact of relay 413, right back contact of relay 412, resistance 411 to battery. After an interval as determined by the values of resistance 419 and condenser 420, polarized relay 414 operates its armature against its back contact, opening the circuit of relay 413 which releases in turn releasing relay 416 to open the circuit of magnet 301. The steering switch is thereby advanced from normal position into position 1. With the steering switch 300 in position 1, the initial circuit of relay 421 is opened and lamp 321 lights over brush 322 to indicate to the test man that the circuit has been advanced off normal.

With the two letter code key 433 operated as previously assumed and steering switch 300 in position 1, relay 421 is held operated after switch 300 leaves normal over a circuit extending through the left winding of relay 421, lower contacts of key 433, conductor 336 to ground at brush 319. With relay 421 operated a circuit is established from ground at brush 319 over conductor 336 the upper contacts of key 433, front contact of relay 421, conductor 337 to battery through the interrupter contacts and winding of magnet 301 thus advancing switch 300 into position 2 whereupon relay 421 releases opening the circuit of magnet 301.

With relay 413 released and steering switch 300 in position 2 the circuit previously traced through the right winding of relay 414 is reestablished and a circuit is closed through the left winding of relay 414, from battery over the right back contact of relay 413, left winding of relay 414, conductor 417, brush 316 and the No. 2 terminal of its bank, conductor 332, upper normal contacts of key 423, resistance 432, condenser 420, left back contact of relay 413 to ground. As soon as condenser 420 becomes fully charged, polarized relay 414 operates its armature against its front contact, thereby again operating relay 413 which in turn operates relay 416 and stepping magnet 301. Relay 413 also reverses the connection of battery and ground to the windings of relay 414 as previously described, and after an interval measured by the time required to recharge condenser 420 in the opposite direction, relay 414 operates its armature against its back contact, opening the circuit of relay 413. Thus under the control of timing relays 413 and 414, an interval has been measured equivalent to the average theoretical time for the removal of a subscriber's receiver from the switchhook until the finger hole of the dial has been found corresponding to the first code letter.

With relay 416 operated and relay 421 normal, a circuit is established through the right winding of polarized differential relay 424 which may be traced from battery, back contact of relay 421, resistance 425, inner right back contact of relay 405, right winding of relay 424, resistance 426, inner left back contact of relay 405, left front contact of relay 416 to ground. A circuit is also established from battery through the left winding of relay 424, resistance 427, condenser 428, inner left back contact of relay 405 to ground, the left winding of relay 424 being shunted over the outer left back contact of

relay 405 through resistance 430. As soon as condenser 428 becomes fully charged, polarized relay 424 moves its armature against its front contact, thereby closing a circuit for relay 405 extending from battery at the back contact of relay 421, winding of relay 405, front contact of relay 424 to ground at the left contact of relay 416. Relay 405 upon operating reverses the connection of battery and ground through the windings of polarized relay 424 and opens the circuit of relay 403 at its outer right back contact.

Relay 403 releases and establishes a circuit for relay 407 extending from battery on conductor 404, back contact of relay 431, winding of relay 407 to ground at the inner right back contact of relay 403. Relay 407 operates and locks to ground over its inner left front contact, opens the circuit of stepping magnet 301 at its outer right back contact thereby advancing the steering switch 300 into position 3, removes operating ground from the circuit of relays 413 and 414 and supplies operating ground for relays 405 and 424 at its inner right contacts. At its left back contact relay 403 establishes an operating circuit for magnet 401 of switch 400 extending from battery, winding of magnet 401, upper intermediate contacts of key 402, left back contact of relay 408 to ground at the left back contact of relay 403 preparatory to advancing switch 400 into position 1.

With relay 405 operated, the current flowing through the windings of polarized relay 424 and condenser 428 is reversed and after condenser 428 has become fully charged in the opposite direction, relay 424 operates its armature against its back contact, thereby opening the circuit of relay 405 which thereupon deenergizes again establishing the circuit of relay 403 which in turn opens the circuit of magnet 401 to advance switch 400 into position 1. Relay 405 upon deenergizing also again reverses the direction of current flowing through the windings of relay 424, again causing it to operate its armature against its front contact to again operate relay 405 which in turn releases relay 403 and reverses the direction of current flowing through the windings of polarized relay 424. Relay 403 upon releasing closes the circuit of magnet 401 preparatory to advancing switch 400 another step. Responsive to the operation of relay 405, relay 424 again operates its armature against its back contact thereby releasing relay 405 and in turn reoperating relay 403 which opens the circuit of magnet 401 to advance switch 400 into position 2. In this manner under the control of timing relays 405 and 424, switch 400 is advanced from position to position until it reaches position 9.

It was assumed that the test man operated key 307 of the second vertical row of keys in the keyboard 302 corresponding to the letter W having a numerical equivalent of the numeral 9. With steering switch 300 in position 3 and switch 400 in position 9, a circuit is now established from ground at brush 319 and its No. 3 terminal, contacts of key 307, conductor 323, the No. 9 terminal and brush 454 of switch 400, thence in parallel through the winding of relay 408, back contact of relay 431 to battery on conductor 404 and through the winding of relay 425, back contact of relay 431 to ground on conductor 404. Relays 408 and 425 both energize, relay 408 opening at its right back contact the holding circuit of relay 406, thereby releasing this relay and locking itself operated to ground over its right front contact. Relay 425 upon operating closes a restoring circuit for switch 400, extending from battery through the winding and interrupter contacts of magnet 401, strapped off normal terminals and brush 456 of switch 400 to ground at the front contact of relay 425. Switch 400 thereupon advances to its 11th or second normal position, in which position the circuit of relay 425 is opened and relay 425 is released to open the circuit of magnet 401. The advance of switch 400 into position 9 under the control of timing relays 405 and 424 has now measured a time interval corresponding to the time required for the average subscriber to rotate the dial to the finger stop for the code letter W.

At the time relay 405 deenergized to cause the advance of switch 400 into position 9 it again reversed the connection of battery and ground to the windings of polarized relay 424, causing relay 424 to operate its armature against its front contact, thereby operating relay 405 to again release relay 403. Since at this time relay 408 is operated, the release of relay 403 closes a circuit from battery, winding of stepping magnet 351 of switch 350, conductor 327, left front contact of relay 408 to ground at the left back contact of relay 403 preparatory to advancing switch 350 from normal. Relay 405 also again reverses the connection of battery and ground to the windings of relay 424 which after an interval operates its armature against its back contact thereby releasing relay 405. Relay 405 upon releasing again reverses battery and ground to the windings of relay 424 and reestablishes the circuit of relay 403 which in turn opens the circuit of magnet 351 to advance switch 350 into position 1. In this manner under the control of timing relays 405 and 424, switch 350 advances from position to position into position 9.

With steering switch 300 in position 3 and switch 350 in position 9, a circuit is established from ground at brush 319 over the contacts of key 307, conductor 323, the 9th position terminal and brush 328 of switch 350, conductor 329, winding of relay 431, to battery on conductor 404 thus operating re-

lay 431 which in turn releases relays 408 and 407. Relay 407 upon releasing closes a circuit extending from battery, winding and interrupter contacts of magnet 351, brush 330 and strapped terminals of switch 350, conductor 331 to ground at the inner left back contact of relay 407. Magnet 351 advances switch 350 into its 11th or second normal position, in which position the circuit of relay 431 is opened and relay 431 releases. Relay 407 at its inner right contact also removes operating ground from the circuits of timing relays 405 and 424 and restores operating ground to the circuits of timing relays 413 and 414, and at its inner left back contact establishes the previously traced operating circuit for relay 406 which now operates and locks over its left front contact to ground at the right back contact of relay 408. The advance of switch 350 under the control of timing relays 405 and 424 has now measured a time interval corresponding to the time required for the dial to run down for transmitting impulses corresponding to the code letter W. During these operations with switch 300 in position 3, the progress lamp 333 has been illuminated in a circuit over brush 322 indicating the transmission of impulses corresponding to the first code letter.

It will be noted that during the advance of switch 350 under the control of timing relays 405 and 424, relay 406 was released and upon each energization of relay 405 relay 403 was released. With relay 406 released upon each deenergization of relay 403, the circuit previously traced over the patching cord conductors 104 and 105 is opened. This circuit following the association of the sender with the calling line extends over the terminal 110 and brush 111 of the line finder 106, lower contact of cam 112, terminal 113 and brush 114 of district finder 107, brush 115 and terminal 116 of sender selector 108, conductor 117, left winding of sender pulsing relay 201, through the milliammeter 200 to battery and over terminal 118 and brush 119 of line finder 106, left contact of cam 120, terminal 121 and brush 122 of district finder 107, brush 123 and terminal 124 of sender selector 108, conductor 125 to ground over the back contact of relay 202 through milliammeter 205. Thus upon each deenergization of relay 403, this circuit is opened and pulsing relay 201 of the sender in response thereto causes the setting of its A code register in the sender in the manner fully set forth in the patent to Kopp above referred to. Since it has been assumed that the code letter W was selected by the test man and the switch 350 was therefore advanced nine steps, relay 403 transmits nine impulses to the sender to set the A code register.

With relay 407 released as above described, upon the termination of pulsing for the first code letter, a circuit is established for timing relay 424 which may be traced from battery on conductor 404, resistance 411, right back contact of relay 412, right back contact of relay 413, right winding of relay 414, resistance 415, left back contact of relay 413 to ground at the inner right back contact of relay 407 and from battery as traced through the left winding of relay 414, conductor 417, brush 316 in position 3, conductor 332, upper normal contact of key 423, resistance 432, condenser 420, to ground at the back contact of relay 407. As soon as condenser 420 becomes fully charged, relay 414 operates its armature against its front contact establishing the previously traced circuit for relay 413 which reverses the connection of battery and ground to the windings of polarized relay 414 and closes the previously traced circuit for relay 416. Relay 416 in turn closes the circuit of stepping magnet 301 preparatory to advancing switch 300 into position 4. Upon the reversal of current through the windings of relay 414 following the operation of relay 413, relay 414 operates its armature against its back contact in the manner previously described, releasing relay 413. Relay 416 also upon operating starts the operation of timing relays 405 and 424 as previously described, relay 405 upon operating opening the circuit of relay 403 which in turn closes the circuit of magnet 401 of switch 400 and the circuit of relay 407 which operates and locks as previously described. The operation of relay 407 releases magnet 301 which advances switch 300 into position 4 and performs the other functions previously described. The advance of switch 300 from position 3 to position 4 under the control of timing relays 413 and 414 has thus measured a theoretical time interval equivalent to the time required for the average subscriber to find the finger hole of the dial corresponding to the second code letter of the line designation. With switch 300 in position 4 the progress lamp 334 is lighted in a circuit extending over brush 322 to indicate to the test man that the test circuit is functioning to transmit impulses to the sender corresponding to the second code letter of the line designation.

With relay 405 operated, the current flowing through the windings of polarized relay 424 and condenser 428 is reversed and after condenser 428 has become fully charged in the opposite direction, relay 424 operates its armature against its back contact, thereby opening the circuit of relay 405 which thereupon deenergizes, again establishing the circuit of relay 403 which in turn opens the circuit of magnet 401 to advance switch 400 into position 1. In the manner previously described, timing relays 405 and 424 operate to advance switch 400 step by step until it reaches position 6 when a circuit is established from ground over brush 319 at its

fourth position terminal. Contacts of key 308, conductor 335, brush 454 and its sixth position terminal, thence to battery in parallel through the windings of relays 425 and 408. Relay 408 locks as previously described under the control of relay 431 and releases relay 406, and relay 425 establishes the previously traced restoring circuit for advancing switch 400 to its next normal position. With switch 400 in normal position, relay 425 releases. The advance of switch 400 into position 6 under the control of timing relays 405 and 424 has thus measured off a time interval equivalent to the time required for a subscriber to pull down his dial for the code letter O.

At the time relay 405 energized to cause the advance of switch 400 into position 6, it again reversed the connection of battery and ground to the windings of polarized relay 424 causing relay 424 to operate its armature against its front contact, thereby operating relay 405 to again release relay 403. Since at this time relay 408 is operated, the release of relay 403 closes a circuit from battery through the winding of stepping magnet 351 of switch 350, conductor 327, left front contact of relay 408 to ground at the left back contact of relay 403 preparatory to advancing switch 350 from normal. Relay 405 also again reverses the connection of battery and ground to the windings of relay 424 which after an interval operates its armature against its back contact, thereby releasing relay 405. Relay 405 upon releasing again reverses battery and ground to the windings of relay 424 and reestablishes the circuit of relay 403 which in turn opens the circuit of magnet 351 to advance switch 350 into position 1. In this manner, under the control of relays 405 and 424, switch 350 advances from position to position into position 6.

With steering switch 300 in position 4 and switch 350 in position 6, a circuit is established from ground at brush 319 over contacts of key 308, conductor 335, the sixth position terminal and brush 328 of switch 350, conductor 329, winding of relay 431 to battery on conductor 404, thus operating relay 431 which in turn releases relays 408 and 407. Relay 407 performs the functions previously described including the advance of switch 350 to its normal position and the preparation of circuits for controlling the operation of timing relays 413 and 414. The advance of switch 350 into position 6 has now measured a time interval corresponding to the time required for a dial to run down for transmitting impulses corresponding to the code letter O. During the advance of switch 350, since relay 406 was deenergized and relay 403 operated intermittently under the control of relay 405 for each step of switch 350, a series of six impulses was transmitted to the sender for setting the B code register thereof.

With relay 407 released, a circuit is now established for timing relay 414 which may be traced from battery on conductor 404, resistance 411, right back contact of relay 412, right back contact of relay 413, right winding of relay 414, resistance 415, left back contact of relay 413, to ground at the inner right back contact of relay 407 and from battery as traced to the left winding of relay 414, conductor 417, brush 316 in position 4, conductor 338, resistance 434, condenser 435 to ground at the right back contact of relay 407. As soon as condenser 435 becomes fully charged, relay 414 operates its armature against its front contact, establishing the previously traced circuit for relay 413 which reverses the connection of battery and ground to the windings of relay 414. From this point the timing relays 413 and 414 function in the manner previously described in connection with the transmission of impulses corresponding to the first two code letters, these timing relays operating to advance steering switch 300 into position 5 and timing relays 405 and 424 functioning to first advance switch 400 to a position indicated by the depressed thousands key 309 and then to advance switch 350.

It is to be noted in this connection that resistance 434 and condenser 435 have been substituted in the circuit of timing relay 414 for the resistance 432 and condenser 420 for the purpose of reducing the time required for relay 414 to operate, thereby reducing the interval measured by the advance of switch 300. This is done to simulate the time required for a subscriber to hunt for the finger hole of the dial corresponding to a numerical digit. Since a numerical digit is easier to find on the dial than a letter, the time interval measured is correspondingly shortened.

In a similar manner the switch 300 is advanced from position to position into position 8, measuring in each advance a time interval corresponding to the time required for a subscriber to find a numerical digit, time intervals being thus measured for the subscriber to find the hundreds, tens and units digits. Switches 400 and 350 are also alternately operated to positions indicated by the depressed keys 309, 310, 311 and 312, and impulses are transmitted during the successive operations of switch 350, as previously described for setting the thousands, hundreds, tens and units registers of the sender.

As steering switch 300 advances from position to position, progress lamps 339, 340, 341 and 342 are operated in circuits extending over brush 322 to indicate when the test circuit is functioning to transmit the thousands, hundreds, tens and units digit impulses to the sender.

When relay 431 operates upon the termination of the setting of switch 350 for the units

digit, relay 407 releases and the timing relays 413 and 414 again operate for measuring a time interval corresponding to the time required for a subscriber to find the required stations letter on the dial. At this time, steering switch 300 will be in position 8 and consequently resistance 432 and condenser 420 will be connected into the circuit through the left winding of relay 414 over brush 316 of switch 300 and conductor 344 and the time interval measured will therefore be the same as the intervals measured in connection with the first two code letters. Steering switch 300 will be advanced from position 8 to position 9 under the control of timing relays 413 and 414 as previously described, in which position the stations progress lamp 343 will be lighted and switches 400 and 350 will be controlled by timing relays 405 and 424 in the manner previously described. During the advance of switch 350, impulses will be sent to the sender to set the stations register thereof into a position corresponding to the depressed stations key 313.

When relay 431 operates upon the termination of the setting of switch 350 for the stations digit, relay 407 releases and at its outer right back contact establishes a circuit extending over conductor 345, brush 346 and its No. 9 terminal, interrupter contacts and winding of magnet 301 for advancing steering switch 300 into position 10. In position 10 the OK progress lamp 347 is lighted in a circuit over brush 322 indicating the completion of the test. At the sender as soon as the complete line designation has been recorded and it has controlled the establishment of a connection in accordance therewith, the sender becomes dismissed in the well known manner.

In positions 9 and 10 of switch 300, a circuit is established from ground at the outer right back contact of relay 407 over conductor 345, brush 348, conductor 349 to battery through the winding of relay 412. Relay 412 upon operating opens the battery lead extending to the windings of timing relays 413 and 414 thereby preventing the further operation of these relays. The operator, noting the illumination of OK lamp 347 may now restore the operator's start key 402 and the key 433. The restoration of key 402 now establishes a restoring circuit for the steering switch 300 extending from battery through the winding and interrupter contacts of magnet 301, conductor 337, lower normal contacts of key 402, normal contact of key 436, conductor 437 to ground over the strapped terminals and brush 351 of switch 300. When switch 300 leaves position 10, the progress lamp 347 is extinguished and when the switch reaches normal, its restoring circuit is opened. If the test man does not wish to set up another call at this time, the depressed keys of the keyboard 302 may be released through the momentary operation of releasing key 438 which establishes an obvious circuit for the key restoring magnets 351 to 358 inclusive.

In the previous discussion it was assumed that the line designation set up on the keyboard 302 included a stations letter. If, however, a designation is set up not including a stations letter, no stations key will be operated and therefore when relay 407 releases upon the termination of the setting of switch 350 for the units digit, a circuit will be closed for relay 421 extending from battery, left winding of relay 421, conductor 439, contacts 359 which are closed when no stations key is operated, No. 8 terminal and brush 348 of steering switch 300, conductor 345 to ground at the outer right back contact of relay 407. Relay 421 upon operating, removes operating battery from the windings of timing relays 405 and 424 to prevent their further operation. Timing relays 413 and 414 will, however, function as previously described to advance the steering switch into position 9. Since timing relay 405 does not operate, the circuit of relay 403 is maintained, and relay 407 does not operate at this time. When therefore, steering switch 300 reaches position 9, relay 412 operates over the previously traced circuit to prevent any further operation of timing relays 413 and 414 and steering switch 300 is advanced into position 10 to light the OK lamp 347. At this point the circuits are restored to normal in the manner previously described.

Test with three letter office code

Had the test set been patched to a subscriber's line terminating in an office equipped with senders of the type requiring the dialing of a three-letter code, for example, a sender of the general type disclosed in Patent 1,505,171, granted August 19, 1924 to F. A. Stearn, then the test man would have operated keys in the first three vertical rows of the keyboard 302 in accordance with the office designation and then keys of the remaining rows for the numerical and stations designations. In this case, however, the key 433 would not be operated, and following the advance of steering switch 300 into position 1 to measure a theoretical time interval corresponding to the time required for the average subscriber to remove his receiver, the switch 300 would not advance directly into position 2, but would await the further operation of timing relays 413, 414, 405 and 424, and in position 2 would control the transmission of impulses corresponding to the first code letter as indicated by the depressed key of the first vertical row of the keyboard. Thereafter, the test set would function as previously described.

Test with single letter office code

If the test man desires to test the current drain of a sender for a call involving but a single code letter followed by the numerical digits and stations letter, he will depress keys in the third to eighth vertical rows of the keyboard, thus registering the single code letter on the third vertical row of keys and will also operate the key 440. In this case, after the steering switch 300 advances into position 1 as previously described, relay 421 is held energized in a circuit through its left winding, the upper and lowermost contacts of key 440, conductor 336 to ground at brush 319. With relay 421 held operated, a circuit is established from ground at brush 319 over conductor 336, the three lower contacts of key 440, left contact of relay 421, conductor 337 to battery through the interrupter contacts and winding of magnet 301, thus advancing switch 300 into position 2. In position 2 of switch 300, relay 421 is held operated in a circuit extending from battery through its left winding, the upper contacts of key 440, conductor 441, brush 348 and its No. 2 terminal, conductor 345 to ground at the outer right back contact of relay 407. With relay 421 operated, a circuit is established for advancing switch 300 directly into position 3 extending from ground on conductor 345, brush 348 and its No. 2 terminal, conductor 441, intermediate contacts of key 440, front contacts of relay 421, conductor 337, to battery through the interrupter contacts and winding of magnet 301. With steering switch 300 in position 3, the transmission of impulses under the control of the depressed key in the third vertical row of keyboard is controlled and from this point the test circuit functions in the manner previously described.

Test on a call to zero operator

For testing the sender current drain on a call to the zero operator for which the single digit 0 is dialed, the operator depresses the key 442 and no keys in keyboard 302. In this case after the steering switch 300 advances into position 1 as previously described, relay 421 is held energized in a circuit through its left winding, the inner lower and three inner upper contacts of key 442, conductor 336 to ground at brush 319. With relay 421 operated, a circuit is established from ground at brush 319 over conductor 336, the intermediate upper contacts of key 442, front contact of relay 421, conductor 337, to battery through the interrupter contacts and winding of magnet 301, thus advancing switch 300 into position 2. In position 2 of switch 300, relay 421 is held operated in a circuit extending from battery through its left winding, the inner lower contacts of key 442, conductor 441, the No. 2 terminal and brush 348 of switch 300, conductor 345 to ground at the outer right back contact of relay 407. With relay 421 operated, a circuit is established for advancing switch 300 directly into position 3, extending from ground on conductor 345, brush 348 and its No. 2 terminal, conductor 441, the inner upper contacts of key 442, front contact of relay 421, conductor 337 to battery through the interrupter contacts and winding of magnet 301. With steering switch 300 in position 3, the transmission of impulses under the control of the depressed key 442 is controlled. The circuit for controlling the positioning of switches 350 and 400 in response to the timing relays 405 and 424 now extending from ground at brush 319 in position 3, conductor 361, the uppermost contacts of key 442, conductor 444 to the tenth position terminals of switches 400 and 350.

When steering switch 300 advances into position 4 following the transmission of this series of impulses, relay 421 is operated in a circuit extending from battery through its left winding, the lowermost contacts of key 442, conductor 443, the strapped Nos. 4, 5, 6 and 7 terminals and brush 348 of switch 300, conductor 345 to ground at the outer right back contact of relay 407 as soon as relay 407 releases upon the completion of impulsing. With relay 421 held operated, a circuit is established for advancing switch 300 directly into position 8, extending from ground on conductor 345, brush 348 and the strapped terminals 4, 5, 6 and 7, conductor 443, the lower and inner upper contacts of key 442, front contact of relay 421, conductor 337, to battery through the interrupter contacts and winding of magnet 301. Since no station key was depressed, the steering switch 300 is advanced out of position 8 into position 9 and thence into position 10 to light the OK lamp 347 in the manner previously described in connection with the test involving a line designation having no stations letter.

Inasmuch as the numeral 0 used for calls to the zero operator is included in a finger hole of a subscriber's dial which is clearly marked "Operator", it is much easier for a subscriber to find than a code letter and therefore the time interval measured by the timing relays 413 and 414 corresponding to the theoretical time required for a subscriber to find this finger hole should be less than that measured for a subscriber to find a code letter. For the purpose of shortening the time measured for advancing switch 300 from position 3 to position 4, the test man in addition to operating key 442 also operated key 423. Thus the operating circuit through the left winding of timing relay 414 is extended from battery on conductor 404, resistance 411, right back contact of relay 412, right back contact of relay 413, left winding of relay 414, conductor 417, brush 316 in position 3, conductor 332, upper alternate

contacts of key 423, resistance 434, condenser 435, left back contact of relay 413 to ground at the inner right back contact of relay 407. Since the condenser 435 is of such a value that it charges more quickly through resistance 434 than condenser 420, the interval measured for the advance of switch 300 from position 3 to position 4 is thus shortened.

Test on calls to executive offices having three numeral numbers

Certain calls to executive lines of a telephone office are made by dialing a three-number code, for example, 211, involving no code letters. For such a call, the keys 445 and 423, and keys 362, 363 and 364 of the keyboard 302 are operated. With these keys operated, the test set functions in much the same manner as for the call first described up to the point where switch 300 is advanced into position 4, thus transmitting three series of impulses to the sender under the control of depressed keyboard keys 362, 363 and 364, except that with key 423 operated, the timing relays 413 and 414 advance steering switch 300 from position 1 to position 2, from position 2 to position 3, and from position 3 to position 4 at a faster rate as determined by the operation of timing relay 414 under the control of resistances 434 and 446 and condenser 435. When steering switch 300 advances into position 4 under the control of timing relays 413 and 414 for the transmission of the third of these series of impulses, relay 421 is operated in a circuit extending from battery through its left winding, the contacts of key 445, conductor 443, the strapped Nos. 4, 5, 6, and 7 terminals and brush 348 of switch 300, conductor 345, to ground at the outer right back contact of relay 407 as soon as relay 407 deenergizes upon the completion of the transmission of impulses for the third digit 1 of the three numeral designation 211. With relay 421 operated, a circuit is established for advancing switch 300 directly into position 8 extending from ground on conductor 345, brush 348 and the strapped terminals of its bank, conductor 443, the lowermost contacts of key 445, front contact of relay 421, conductor 337 to battery through the interrupter contacts and winding of magnet 301. Since no station key was operated, the steering switch is advanced out of position 8 into position 9 and thence into position 10 to light the OK lamp 347 in the manner previously described.

Test on a call when coin box operation is required

The test set may also be employed to simulate the initiation of a call from a subscriber's line equipped with a coin box by depressing key 418. It will be assumed that the test man desires to set up the same call previously described, WO 8432–J, and operates the keys 402, 433, 307 to 313 inclusive, and in addition, the coin key 418. With key 418 operated, ground through resistance 447 is connected over the lower contact of key 418 to the tip side of the calling line 100 to which the test set is connected, thus simulating the deposit of a coin in the coin box and the connection of a coin box magnet to the tip side of the calling line. Key 418 at its upper contacts, substitutes resistance 448 for resistance 419 in the path previously traced through condenser 420 and the left winding of timing relay 414. The substitution of resistance 448 is for the purpose of lengthening the operating time of relay 414 for measuring a longer period corresponding to the time required for the average subscriber to remove his receiver and to deposit a coin, since obviously the deposit of a coin will consume additional time, and thus increase the holding time of the sender, otherwise the test set functions in the same manner as previously described for the assumed call WO 8432–J.

Test on calls involving all numerical digits

In addition to testing current drain in senders of panel type systems, the invention may be employed to test the drain in selector switches of step-by-step systems by similarly connecting the test set to a subscriber's line terminating in an office equipped with such selector switches. Since all of the digits dialed in such a system may be numerical in character, no office code letters being employed, the test man would for such a call, operate the key 423. Consequently during the period when the timing relays 413 and 414 function to measure time intervals corresponding to the time required for a subscriber to hunt for the digits of a line designation, the resistances 446 and 434 are connected through condenser 435 in the circuit previously traced through the left winding of timing relay 414 in place of resistances 453 and 432 and condenser 420 and consequently the timing relays 413 and 414 measure shorter time intervals corresponding to the time required for the average subscriber to hunt for the line designating digits.

Remote control of test set

If the test man desires to control the test set for a particular type of call from a remote point, for example from the sender frame in order that he may remain at the sender frame for observation purposes, he may set up the test set for the desired call and then depress the remote control key 436 instead of the start key 402 to control the starting and restoration of the test set. He may then operate the key 449 which he may carry with him to the sender frame and which is connected by an extension line 450 to the winding of relay 451 in the test set.

The operation of key 449 now controls relay 451, the contacts of which are connected in parallel with the contacts of start key 402, the relay 451 thus performing all of the functions of the start key 402.

In making any of the above described tests, readings are first taken from the milliammeters 200 and 205 before the test is initiated and then readings are taken as soon as the sender becomes dismissed following the establishment of the test call being made. From the readings thus taken the sender current drain may easily be computed. For more accurate computation of the current drain for any particular type of call, ten calls of the same character may be made between readings of the milliammeters and the difference between the readings divided by ten.

What is claimed is:

1. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the letters and numerical digits of called line numbers, means for successively transmitting series of impulses in accordance with the record set up on said key set, a time measuring device for simulating the time elapsing between the removal of a subscriber's receiver from the switchhook and the dialing of a first digit, and means for varying the action of said time measuring device in accordance with whether the first series of impulses to be transmitted is in accordance with an office code letter or a numerical digit.

2. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the letters and numerical digits of called line numbers, means for successively transmitting series of impulses in accordance with the record set up on said key set, a time measuring device including a relay for simulating the time elapsing between the removal of a subscriber's receiver from the switchhook and the dialing of a first digit, resistances and condensers for insertion in the circuit of said relay for governing the speed of its operation, and a key for varying the amount of resistance and capacitance in accordance with whether the first series of impulses to be transmitted is in accordance with an office code letter or a numerical digit.

3. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the letters and numerical digits of called line numbers, means for successively transmitting series of impulses in accordance with the record set up on said key set, a time measuring device for simulating the time elapsing between the removal of a subscriber's receiver from the switchhook and the dialing of a first digit, and means for varying the action of said time measuring device in accordance with whether a call from a message rate line or from a coin box line is being simulated.

4. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the letters and numerical digits of called line numbers, means for successively transmitting series of impulses in accordance with the record set up on said key set, a time measuring device including a relay for simulating the time elapsing between the removal of a subscriber's receiver from the switchhook and the dialing of a first digit, resistances and a condenser for insertion in the circuit of said relay for governing the speed of its operation, and a key for increasing the amount of resistance to prolong the time period measured if a call from a subscriber's line having a coin box in which the subscriber must deposit a coin before dialing, is being simulated.

5. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the letters and numerical digits of called line numbers, means for successively transmitting series of impulses in accordance with the record set up on said key set, a time measuring device operable prior to the transmission of each successive series of impulses to simulate the time required for a subscriber to hunt for the finger hole of his dial corresponding to the next character to be transmitted, and means for varying the action of said time measuring device in accordance with whether the character is an office code letter or a numerical digit.

6. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the letters and numerical digits of called line members, means for successively transmitting series of impulses in accordance with the record set up on said key set, a steering switch for successively placing said transmitting means under the control of the operated keys of said key set, a time measuring device operable prior to the transmission of each successive series of impulses to successively advance said steering switch and to measure for each such advance a time interval simulating the time required for a subscriber to hunt for the finger hole of his dial corresponding to the next character to be transmitted, and means controlled by said steering switch for varying the action of said time measuring device in accordance with whether the character to be transmitted in an office code letter, a numerical digit, or a stations letter.

7. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the letters and numerical digits of called line numbers, means for successively transmitting series of impulses in accordance with the record set up on said key set, a steering switch for suc-

cessively placing said transmitting means under the control of the operated keys of said key set, a time measuring device operable prior to the transmission of each successive series of impulses to successively advance said steering switch and to measure for each such advance a time interval simulating the time interval required for a subscriber to hunt for the finger hole of the dial corresponding to the next character to be transmitted, means controlled by said steering switch for varying the action of said time measuring device in accordance with whether the character to be transmitted is an office code letter or a numerical digit, and a key for rendering the operation of said time measuring device invariable if all the characters recorded are numerical digits.

8. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the office code, numerical and stations digits of any called line number, means for transmitting series of impulses in accordance with the digits of the recorded line number, a start key for initiating the cycle of operation of said apparatus, and keys for determining whether said apparatus shall complete its cycle of operation after transmitting the maximum number of series of impulses for which it is designed to transmit or particular lesser numbers of series of impulses.

9. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the office code letters and numerical digits of any called line number, means for successively transmitting series of impulses in accordance with the record set up on said key set, a steering switch for successively placing said transmitting means under the control of the operated keys of said key set, a start key for initiating the cycle of operation of said apparatus, and a plurality of keys for initially advancing said steering switch one or more positions dependent upon whether a two or one-letter office code has been recorded on said key set.

10. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the office code letters and numerical digits of any called line number, means for successively transmitting series of impulses in accordance with the record set up on said key set, a steering switch for successively placing said transmitting means under the control of the operated keys of said key set, a time measuring device operable prior to the transmission of each successive series of impulses to successively advance said steering switch and to measure for each such advance a time interval simulating the time required for a subscriber to hunt for the finger hole of his dial corresponding to the next character to be transmitted, and a key operable when a single digit zero is recorded for a call to a zero operator for initially advancing said steering switch through a plurality of transmitting control positions, to then speed the action of said time measuring device to measure a time interval simulating the time required for a subscriber to find the finger hole marked "Operator" and to then further advance said steering switch through its remaining transmitting control positions following the transmission of the single series of impulses corresponding to the single digit recorded.

11. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the office code letters and numerical digits of any called line number, means for successively transmitting series of impulses in accordance with the record set up on said key set, a steering switch for successively placing said transmitting means under the control of the operated keys of said key set, a time measuring device operable prior to the transmission of each successive series of impulses to successively advance said steering switch and to measure for each such advance a time interval simulating the time required for a subscriber to hunt for the finger hole of his dial corresponding to the next character to be transmitted, means controlled by said steering switch for varying the action of said time measuring device in accordance with whether the character to be transmitted is an office code letter or a numerical digit, a key for rendering the operation of said time measuring device invariable if all of the characters recorded are numerical digits, and a key for advancing said steering switch through the remainder of its transmission controlling positions if a three numerical digit operator's code has been recorded on said key set.

12. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording a digit of a called line number, a time measuring device, means operated by said time measuring device to measure first a time interval simulating the time required for a subscriber to pull down his dial in accordance with the recorded digit and then a time interval simulating the time required for the dial to run down for the corresponding digit, and means controlled by said time measuring device to transmit a series of impulses corresponding to the recorded digit.

13. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording a digit of a called line number, a time measuring device, a first switch, means under the control of said time measuring device for advancing said switch a number of steps in accordance with the digit recorded to measure a time interval simulating the time required for a subscriber to pull

down a dial in accordance with the recorded digit, a second switch, means under the control of said time measuring device following the setting of said first switch for advancing said second switch a number of steps in accordance with the digit recorded to measure a time interval simulating the time required for the dial to run down for the corresponding digit, and means controlled by said time measuring device to transmit a series of impulses corresponding to the recorded digit during the setting of said second switch.

14. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the digits of any called line number, a time measuring device, means for successively operating said time measuring device in accordance with the several digits of the recording line designation, said time measuring device operating for each digit recorded to first measure a time interval simulating the time required for a subscriber to pull down his dial for that digit and then to measure a time interval simulating the time required for the dial to run down for that particular digit, and means controlled by said timing device for successively transmitting series of impulses corresponding to the recorded line designation.

15. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the digits of a called line designation, a time measuring device, a first switch, a second switch, means for successively operating said time measuring device to alternately advance and restore said first and second switches in accordance with the several digits of the recorded line, designation, said time measuring device operating for each digit recorded to first measure a time interval simulating the time required for a subscriber to pull down his dial for that digit during the advance of said first switch and then to measure a time interval simulating the time required for the dial to run down for that particular digit during the advance of said second switch, and means controlled by said timing device to successively transmit series of impulses corresponding to the recorded digits during the successive settings of said second switch.

16. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the digits of any called line number, means for measuring a time interval simulating the time required for the subscriber to remove his receiver from the switchhook and prepare to dial, means for measuring time intervals simulating the times required for a subscriber to locate each digit of the line number recorded on the key set, and means for measuring time intervals simulating the pull-down and run-down periods of a dial for each digit recorded whereby the total time measured is an accurate measure of the average theoretical time required for any subscriber to complete the dialing of the recorded line number.

17. In an automatic dialing apparatus for simulating the operation of a subscriber's dial, a key set for recording the digits of any called line number, means for transmitting series of impulses in accordance with the digits of the recorded line number, and remote control means for at will causing said apparatus to function through one or more cycles of operation.

In witness whereof, we hereunto subscribe our names this 6th day of October, 1930.

SEWELL W. ALLISON.
WILLIS I. McCULLAGH.