

April 20, 1937.

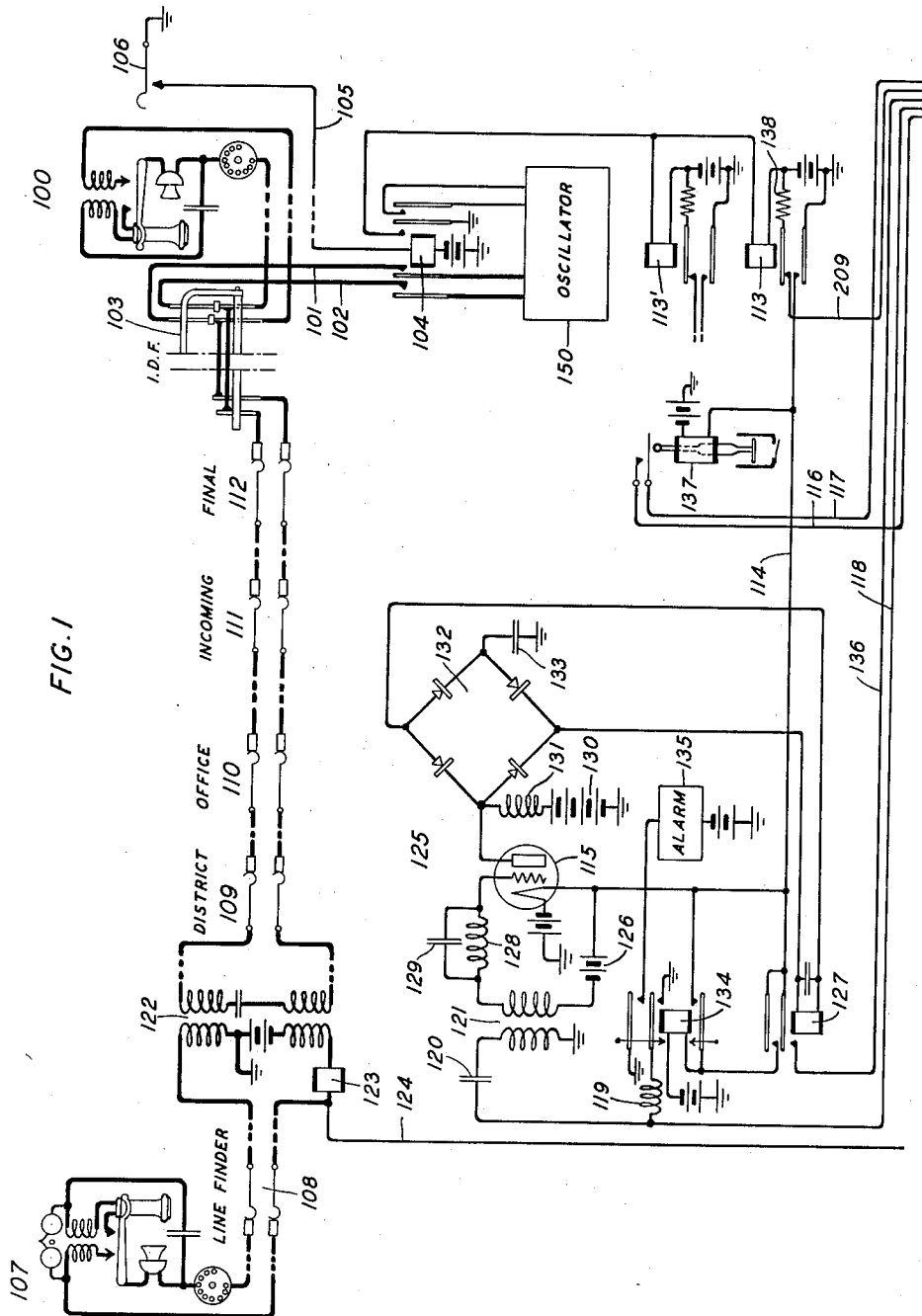
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SYSTEM FOR TRACING TELEPHONE CALLS

Filed May 19, 1936

2 Sheets-Sheet 1



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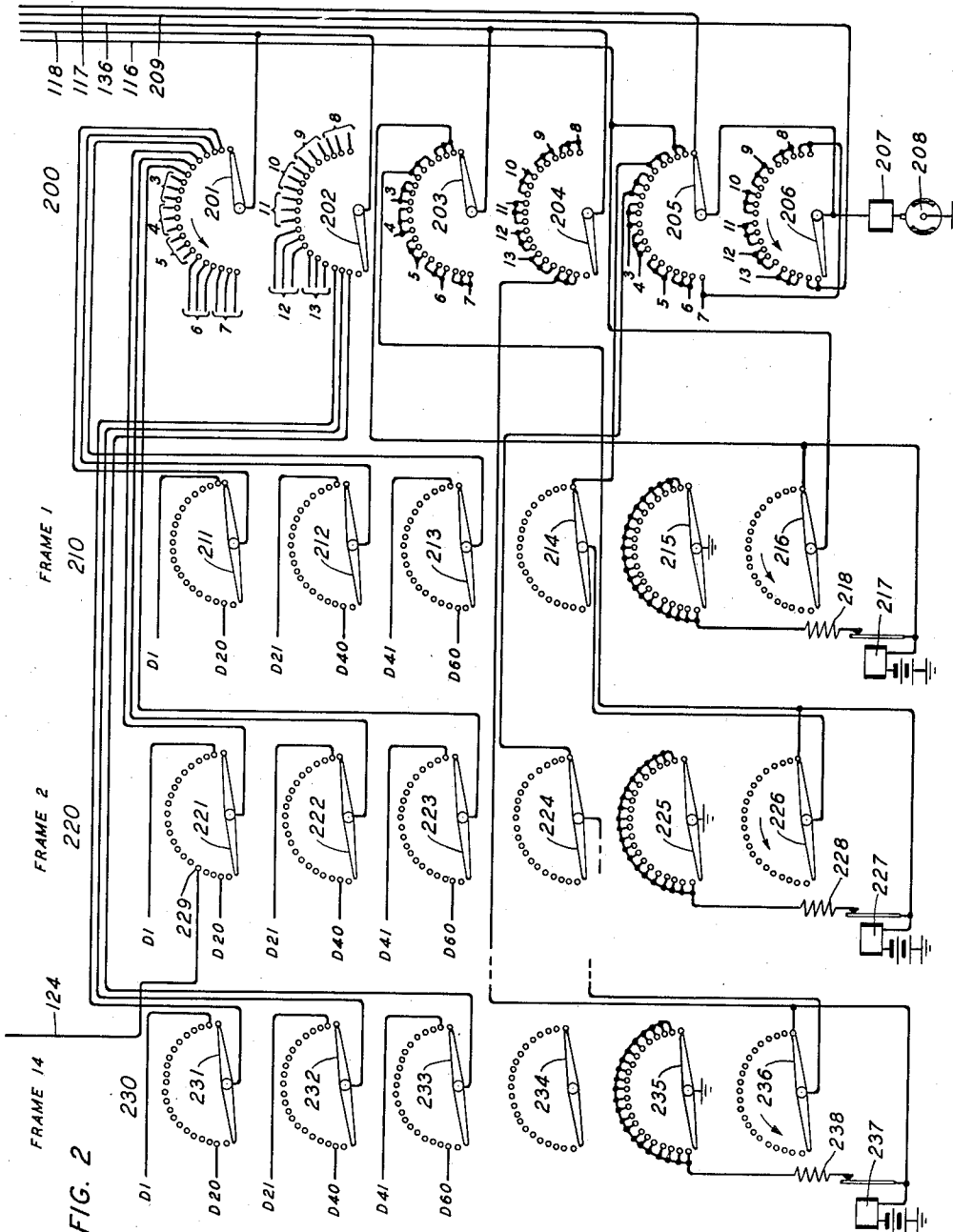
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UNITED STATES PATENT OFFICE

2,077,537

SYSTEM FOR TRACING TELEPHONE CALLS

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Application May 19, 1936, Serial No. 80,614

12 Claims. (Cl. 179—27)

This application relates to telephone systems, and more particularly to circuits for enabling the origin of calls in dial switching exchanges to be traced.

Subscribers are sometimes seriously annoyed by calls which are repeatedly made to their lines by persons whose sole object is to maliciously annoy them. At other times when calls are made to a particular line for the purpose of making blackmailing or extortional requests, it is highly desirable to be able to trace the origin of such calls. In manual exchange areas, it is a comparatively simple matter for an operator to trace the origin of any call at the request of the called party. However, in exchange areas equipped with dial switching equipment not requiring the services of an operator to establish connections, it is very difficult to trace such annoyance calls since an established connection is interrupted as soon as the calling party restores his receiver to the switchhook.

It is therefore the object of the invention to provide facilities applicable to a dial switching exchange area to enable any subscriber who has complained of being annoyed by such malicious calls to control the tracing of such calls whereby a central office switchboard attendant may quickly and easily ascertain the origin of them.

In accordance with the present invention, when a subscriber enters a complaint that he is being annoyed, a high frequency oscillator is temporarily associated with his line terminals, which is arranged to be bridged across his line at the central office under the control of a key installed at the subscriber's premises, for transmitting a high frequency tone back over the connection built up to his line from the calling line causing the annoyance. A finder circuit comprising a plurality of hunting switches connected in pyramid formation is also provided at the central office which is started in response to the operation of the key at the called subscriber's premises and successively tests for the tone at all selector switches of one of the switching stages of the office or offices of the exchange area.

When the particular selector switch over which the annoyance call has been made and on which the high frequency tone is present has been found, such switch is held by the finder circuit so that the calling subscriber may not release the connection; the finder circuit is locked in its set position and an alarm signal is operated. A switch-room attendant hearing the alarm signal may then readily trace the call since the position

assumed by the finder circuit will identify to him the particular selector switch of the first switching stage over which the call has been made and the connection may then be traced therefrom over the line-finder or line switch directly to the terminals of the calling line.

For a clearer understanding of the invention, reference may be had to the following detailed description thereof and the manner in which it functions, taken in connection with the accompanying drawings, in which

Figure 1 shows schematically a calling line, a called line to which repeated annoyance calls are assumed to have been made, selector switches over which a connection has been established; between such lines, an oscillator circuit for generating a high frequency tone current, and tone detection and alarm circuits; and

Fig. 2 shows a finder circuit for successively associating the tone detection circuit of Fig. 1 with all district selector circuits of the exchange, one such district selector circuit being disclosed in Fig. 1.

For the purposes of illustration the invention has been disclosed as applied to a dial switching telephone exchange system of the well-known panel type, although it is to be understood that the invention is equally applicable to all types of dial switching systems.

The oscillator 150 disclosed in Fig. 1 may be of the well-known vacuum tube type designed to generate a tone current of 6,000 cycles frequency. Any other well-known type of high frequency current generator might be employed capable of generating tone current of any desired frequency. Tone current detector 125 is also of the vacuum tube type and is designed to be responsive only to the high frequency generated by the oscillator 150.

In a small exchange area having few offices, one finder circuit such as is disclosed in Fig. 2, together with a detector circuit 125 disclosed in Fig. 1, would be provided in each office. This finder circuit comprises a frame finder or master switch 200 and a maximum of fourteen secondary or district finder switches 210, 220—230. These switches are of the step-by-step rotary type which advance their brushes one step upon each de-energization of their respective stepping magnets.

In offices equipped with panel type switching equipment the district selectors are mounted on frames of sixty selectors each and, since each secondary finder switch may have access to sixty district selectors or all the selectors of one frame,

as many secondary switches are provided as there are frames of district selectors. In small exchange areas having few offices, a maximum of fourteen secondary finder switches and one associated frame finder switch is adequate for each office. Each secondary finder switch is provided with three arcs of test terminals with cooperating test brushes in which arcs test conductors extending to sixty district selectors terminate, and is arranged during three half revolutions to successively establish testing circuits to the sixty district selectors. For example, secondary finder switch 210, which has access to sixty district selectors on frame No. 1, will establish testing circuits over brush 211 to twenty district selectors on that frame during its first half revolution, to twenty other district selectors over brush 212 during its second half revolution and to twenty further selectors over brush 213 during its third half revolution. The frame finder switch 200 during its step-by-step advance successively renders the several secondary finder switches effective, causes the advance of each secondary switch through three half revolutions and successively renders the three test brushes of each secondary finder effective.

In larger exchange areas where more than fourteen frames of district selectors may be required in each office, a second finder circuit, such as is disclosed in Fig. 2, together with an associated detector circuit 125, would be required in each office controlled by a second start relay 113' connected in parallel with start relay 113.

It will be assumed that the subscriber whose substation 100 is disclosed in the right portion of Fig. 1 has entered a complaint that he is being annoyed. For the purpose of tracing the origin of such annoyance calls the output circuit of the oscillator 150 is associable by conductors 101 and 102 and a connection shoe 103 with the tip and ring conductors of the subscriber's line on the line side of the distributing frame, and the circuit of relay 104 is extended over a spare conductor 105 of the cable in which the subscriber's line is located to the subscriber's premises where it terminates in the contacts of a key 106 placed in proximity to the subscriber's substation telephone set.

It will also be assumed that thereafter an annoyance call is made from the substation 107 and is completed to the called subscriber's line in the usual manner over the line-finder 108, district selector 109, office selector 110, incoming selector 111 and final selector 112. The called subscriber upon recognizing the call as of the annoyance type will operate the key 106 and keep the calling party in conversation. Upon the operation of key 106 the circuit of relay 104 is completed over conductor 105 thereby closing the start circuit of the oscillator 150 over its outer right contacts, connecting the output circuit of the oscillator over its left contacts and conductors 101 and 102 to the tip and ring terminals of the called line and closing a start circuit for start relay 113 of the finder circuit of Fig. 2 which will be assumed to be in the office in which the call originated and, if required, in parallel to the winding of relay 113' of a second finder circuit in the originating office similar to Fig. 2 and also in parallel to the windings of similar start relays of similar finder circuits located in the other offices of the exchange. The circuit of relay 113 may be traced from ground over the inner right contact of relay 104 to battery through the winding of relay 113.

Relay 113 upon operating connects ground over its front contact to conductor 114 to light the filament of the detector tube 115, to operate dash-pot relay 137 and to supply operating and locking ground for the relay equipment of the detector circuit 125. Relay 137 is made slow to operate to allow sufficient time for the filaments of the tubes of oscillator 150 and detector tube 115 to become heated and when fully operated establishes an operating circuit for the stepping magnet 207 of the frame finder switch 200. This circuit may be traced from ground through the interrupter 208, winding of magnet 207, brush 205 of frame finder switch 200 and the first terminal of its associated terminal arc, conductor 117, contacts of relay 137, conductor 116, brush 216 and normal terminal of finder switch 210 to battery through the winding of stepping magnet 217 of finder switch 210.

As a result of the closure and opening of this circuit by the interrupter 208, both switches 200 and 210 advance one step whereupon the stepping circuit is opened by the movement of brush 216 from its normal bank terminal and switch 200 is arrested with its brushes in engagement with the next terminals of their respective arcs. However, when switch 210 has advanced its brushes one step, an intermittent stepping circuit is established for switch 210 which may be traced from battery through the winding and interrupter contacts of stepping magnet 217, through resistance 218, the off-normal strapped terminals of the arc with which brush 215 cooperates, brush 215 to ground, and switch 210 continues to advance through a complete half revolution, or until the brush 215 leaves the last terminal of its arc.

As the brush 211 successively engages the terminals of its arc, test circuits are established from the ring conductors of the first twenty district selectors of frame No. 1, over brush 211, the second terminal of the arc upon which brush 201 of frame finder switch 200 is now positioned, brush 201, conductor 118, condenser 120 and the primary winding of transformer 121 to ground, but without effect since it will be assumed that the calling line 107 has established a connection to the called line 100, over a district selector switch on frame No. 2 and the high frequency current from oscillator 150 is present only on district selector No. 17 of frame No. 2.

When the brush 216 again engages the normal terminal of its arc after completing a first half revolution, a stepping circuit is established from interrupter 208 through the winding of stepping magnet 207 and the second terminal of the arc upon which brush 205 of frame finder switch 200 is now resting, brush 216 and the normal terminal of its arc, winding of stepping magnet 217 to battery. Switch 200 is now advanced another step and finder switch 210 is advanced one step off normal, opening the stepping circuit just traced and arresting the further advance of switch 200. Finder switch 210, however, continues to advance through a second half revolution under the control of the local stepping circuit established over brush 215, the brush 212 during this half revolution extending test circuits from the second twenty district selectors on frame No. 1 over the third terminal of the arc with which brush 201 of switch 200 cooperates, thence as traced through the primary winding of transformer 121 but without effect.

As soon as the finder switch 210 completes its second half revolution, the local stepping circuit

through magnet 217 is opened at brush 215 and the previously traced stepping circuit from interrupter 208 is again completed through the winding of stepping magnet 207 and the third terminal of the arc upon which brush 205 of switch 200 is now resting, brush 216 and the normal terminal of its arc and the winding of stepping magnet 217 to battery. Switch 200 is now advanced another step and finder switch 210 is advanced one step off normal, opening the stepping circuit just traced and arresting the further advance of switch 200. Finder switch 210, however, continues to advance through a third half revolution under the control of its stepping circuit established over brush 215, the brush 213 during this half revolution extending test circuits from the third twenty district selectors on frame No. 1 over the fourth terminal of the arc with which brush 201 of switch 200 cooperates, thence as traced through the primary winding of transformer 121 but without effect.

When finder switch 210 completes its third half revolution, the local stepping circuit through magnet 217 is opened at brush 215 and a stepping circuit is established from interrupter 208 through the winding of stepping magnet 207 and the fourth terminal of the arc upon which brush 205 of switch 200 is now resting, the normal terminal of the arc of finder switch 210 upon which brush 214 is now resting, the normal terminal of the arc of finder switch 220 upon which brush 226 is now resting, winding of stepping magnet 227 to battery. Switch 200 is now advanced another step and finder switch 220 is advanced one step off normal, opening the stepping circuit just traced and arresting the further advance of switch 200. Finder switch 220, however, continues to advance through a first half revolution over a local circuit extending from battery, winding and interrupter contacts of magnet 227, resistance 228, strapped terminals and brush 225 to ground, successively completing test circuits from the first twenty district selectors on frame No. 2 over the terminals of its upper arc and brush 221, the fifth terminal of the arc with which brush 201 of switch 200 cooperates, thence as traced through the primary winding of transformer 121.

It was assumed that the No. 17 district selector of frame No. 2 was used in the establishment of the annoyance call to the subscriber's substation 100 and that, therefore, the high frequency tone from oscillator 150 is present at this district selector, flowing from the oscillator over the inner left contact of relay 104, conductor 101, ring brushes of selectors 112, 111, 110 and 109, right windings of repeating coil 122 at the district selector 109, returning over the tip brushes of selectors 109, 110, 111 and 112, conductor 102, outer left contacts of relay 104 to the oscillator. This tone current is therefore induced in a circuit which is established when the test brush 221 of finder switch 220 engages its seventeenth terminal 229 which may be traced as follows: Grounded battery, lower left winding of repeating coil 122 at the district selector 109, winding of supervisory relay 123, conductor 124, terminal 229, brush 221, the fifth terminal upon which brush 201 of switch 200 is resting, thence as traced to ground through the primary winding of transformer 121.

This high frequency tone current is now induced upon the secondary winding of transformer 121 and upon the grid of the detector tube 115. The grid of tube 115 is normally negatively biased

by the battery 126 and blocks the flow of space current through the tube. When, however, the high frequency tone current from the oscillator 150 is impressed on the grid of the tube through the band filter comprising impedance 128 and condenser 129, which is tuned to pass only the particular frequency generated by the oscillator 150, the negative bias on the grid of tube 115 is reduced or made sufficiently positive to increase the space current flowing through the tube. Space current now flows from the positive terminal of battery 130 through choke coil 131, anode and cathode of tube 115 to ground on conductor 114. The high frequency tone current now finds a conductive path through the tube and being blocked by the choke coil 131 flows through the copper oxide rectifier 132 and condenser 133 operating relay 127 which is connected across the rectifier 132.

Relay 127 upon operating closes a circuit for relay 124 extending from ground on conductor 114 over its upper contact, winding of relay 134 to battery, thereby operating relay 134 which locks over its lower front contact to ground on conductor 114, independently of relay 127. Relay 127 also establishes a circuit from ground on conductor 114 over its inner upper front contact, conductor 136, brush 203 of master switch 200 and the fifth terminal of the arc upon which it is resting, winding of stepping magnet 227 to battery, thereby holding magnet 227 energized and preventing the further advance of the brushes of finder switch 220. Since the operation of tube 115 and the consequent operation of relay 127 has occurred immediately upon the engagement of brush 221 with terminal 229, the brushes of finder switch 220 are stopped with the brush 221 resting upon terminal 229.

Relay 124 upon operating closes an obvious circuit for the alarm device 135 and connects ground through impedance 119 to conductor 118. The connection of ground to conductor 118 establishes a holding circuit for the supervisory relay 123 of the district selector 109 which may be traced from ground on conductor 118, brushes 201 and 221, conductor 124, winding of relay 123, lower left winding of repeating coil 122, to grounded battery, thus preventing the release of relay 123 and the release of the established connection should the calling subscriber restore his receiver to the switchhook.

The switchboard attendant at the office in which the call originated hearing the alarm device 135 is apprised of the fact that an annoyance call has been originated and detected. He may then readily trace the call by first noting the position in which the frame finder of switch 200 is standing, thereby indicating the particular secondary finder switch locked in an off-normal position and as a consequence the particular frame of district selectors in which the district selector employed in the connection is located. The attendant may then note the position assumed by the secondary finder switch, in the case assumed switch 220, and thereupon ascertain that either the 17th, 37th or 57th district selector on the No. 2 district frame is involved in the connection. For this purpose the master switch 200 and the finder switches may be equipped with indicators, not shown, provided with numbers corresponding to the district selector frame and the identification of the district selectors on each frame.

Having located the district selector as one of three on the No. 2 district frame and since all selectors employed in the establishment of the

connection have been locked against release, the attendant may by an inspection of these three district selectors readily determine the line-finders associated therewith and trace the connection to the terminals of the calling line at the bank of the line-finder 108.

Having traced the origin of the connection, the attendant may communicate with the called subscriber in any desired manner and the called subscriber may then proceed to release the finder circuit by releasing key 106, thereby releasing relay 104 to disconnect the oscillator 150 from the terminals of his line and releasing relay 113. Relay 113 upon releasing removes ground from conductor 114, thereby opening the filament circuit of detector tube 115 and releasing relay 134. Relay 134 upon releasing opens the circuit of alarm device 135 and opens the previously traced circuit over conductor 118, brushes 201 and 221 of finder switches 200 and 220 and conductor 124 by which the district selector 109 was held from releasing. As soon as both the calling and called subscribers return their receivers to their switch-hooks the established connection over selector switches 108, 109, 110, 111 and 112 becomes released in the usual manner.

When the oscillator 150 became disconnected from the called line through the release key 106, the detector tube 115 was rendered ineffective to maintain relay 127 operated and relay 127 released. With ground removed from conductor 114 and relay 127 released, the circuit previously traced over conductor 136 and brush 203 of frame finder switch 200 by means of which the district finder 220 was held in its operated position is opened and finder switch 220 is now advanced to complete its first half revolution by a self-interrupting circuit extending from battery through the winding and interrupter contacts of magnet 227, resistance 220, over the strapped terminals of the arc associated with brush 225 and brush 225 to ground.

As soon as the finder switch 220 completes its half revolution the local stepping circuit through magnet 227 is opened at brush 225 and a stepping circuit from interrupter 208 is again completed through the winding of stepping magnet 207 and the fifth terminal of the arc upon which brush 205 is now resting, brush 214 and its normal terminal, brush 226 and its normal terminal, winding of magnet 227 to battery. Switch 200 is now advanced another step and finder switch 220 is advanced one step off-normal, opening the stepping circuit just traced and arresting the further advance of switch 200. Switch 220, however, continues to advance through a second half revolution under the control of its local stepping circuit. When the finder switch 220 completes its second half revolution, the local stepping circuit is opened at brush 225 and a stepping circuit is established from interrupter 208 through the winding of stepping magnet 207 and the sixth terminal of the arc upon which brush 205 is now resting, the normal terminal of the arc of finder switch 210 upon which brush 214 is now resting, winding of stepping magnet 227 to battery. Switch 200 is now advanced another step and finder switch 220 is advanced one step off normal, opening the stepping circuit just traced and arresting the further advance of switch 200. Finder switch 220, however, advances through a third half revolution by reason of its local stepping circuit until brush 225 reaches its normal position.

With switch 220 in its normal position and

switch 200 in position 7, a circuit is now established from interrupter 208 through stepping magnet 207 over brush 205 and the seventh terminal of its arc, brush 224 of finder switch 220 and its normal terminal, and thence over the normal terminal and brush of the next finder, corresponding to brush 226, and the stepping magnet of such finder to battery, whereupon the frame finder 200 is advanced one step and the next district finder is moved one step off normal. In the manner previously described, each of the remaining district finders including finder 230 is advanced through three half revolutions and the frame finder is advanced step by step. It will be noted in this connection that when the district frame finder is standing with its brush 205 in position 22, the district finder, not shown, serving the No. 7 district frame will be started on its first half revolution and the frame finder 200 will advance its wipers one step, thereby positioning brush 206 on the first terminal of its arc. The advance of the No. 7 district finder to complete its second and third half revolutions will now be controlled over brush 206 of the district frame finder 200 and the advance of subsequent district finders including finder 230 will also be controlled over brush 206 of district frame finder 200.

When the last district finder 230 is advanced off normal to start its third and last half revolution, the frame finder 200 is advanced one step to position wiper 206 on the twenty-first terminal of its arc, whereupon a circuit is established from the interrupter 208, winding of stepping magnet 207, brush 206 and the twenty-first and twenty-second terminals of its arc strapped together, conductor 209, back contact of relay 113, now released, resistance 138 to battery. Switch 200 is now advanced two steps, whereupon the stepping circuit just traced is opened at brush 206 and brushes 201, 203 and 205 are advanced into engagement with the first position terminals of their arcs. All of the apparatus of the finder circuit is now in normal condition preparatory to enabling the tracing of a subsequent call.

In office areas wherein certain offices may be located at such distances from other offices as to render difficult the transmission of the tone current over the interoffice trunks in sufficient volume for detection in the originating office, finder and detector circuits of the character disclosed could then be installed in the office in which the line of the annoyed called subscriber terminates and the finder circuit would then have access to the incoming selector switches of the terminating office. Upon the testing of an incoming selector switch on which the tone current was found to be present, the finder switch could then apply another source of tone to the interoffice trunk and start the finder circuit of the originating office to search for the district selector of the originating office to which such second source of tone current was transmitted over the interoffice trunk.

What is claimed is:

1. In a system for tracing the origin of telephone calls, a plurality of switching stages over which calls may be established from calling lines to called lines, each stage comprising a plurality of selector switches, a source of tone current, a tone current detector, a finder circuit for associating said detector in rotation with each selector switch of one of said switching stages, and means controlled from a called line for connecting said

source of tone current to the central office terminals of said called line and for causing said finder circuit to search for the selector switch of said one switching stage over which a call has been established to said called line.

2. In a system for tracing the origin of telephone calls, a plurality of switching stages over which calls may be established from calling lines to called lines, each stage comprising a plurality of selector switches, a source of tone current, a tone current detector, a finder circuit for associating said detector in rotation with each selector switch of the first switching stage, and means controlled from a called line for connecting said source of tone current to the central office terminals of said called line and for causing said finder circuit to search for the selector switch of the first switching stage over which a call has been established to said called line.

3. In a system for tracing the origin of telephone calls, a plurality of switching stages over which calls may be established from calling lines to called lines, each stage comprising a plurality of selector switches, a source of tone current, a tone current detector, a finder circuit for associating said detector in rotation with each selector switch of one of said switching stages, means controlled from a called line for connecting said source of tone current to the central office terminals of said called line and for causing said finder circuit to search for the selector switch of said one switching stage over which a call has been established to said called line, and an alarm device operated by said detector when said particular selector switch has been found.

4. In a system for tracing the origin of telephone calls, a plurality of switching stages over which calls may be established from calling lines to called lines, each stage comprising a plurality of selector switches, a source of tone current, a tone current detector, a finder circuit for associating said detector in rotation with each selector switch of one of said switching stages, means controlled from a called line for connecting said source of tone current to the central office terminals of said called line and for causing said finder circuit to search for the selector switch of said one switching stage over which a call has been established to said called line, and means controlled by said detector for arresting the hunting movement of said finder circuit in the position to which it has advanced when the selector switch of said one switching stage on which the tone current is present has been selected.

5. In a system for tracing the origin of telephone calls, a plurality of switching stages over which calls may be established from calling lines to called lines, each stage comprising a plurality of selector switches, a source of tone current, a tone current detector, a finder circuit for associating said detector in rotation with each selector switch of one of said switching stages, means controlled from a called line for connecting said source of tone current to the central office terminals of said called line and for causing said finder circuit to search for the selector switch of said one switching stage over which a call has been established to said called line, and means controlled by said detector for preventing the calling subscriber from releasing the connection established to said called line.

6. In a system for tracing the origin of telephone calls, a plurality of switching stages over which calls may be established from calling lines

to called lines, each stage comprising a plurality of selector switches, a source of tone current, a tone current detector, a finder circuit for associating said detector in rotation with each selector switch of the first switching stage, means controlled from a called line for connecting said source of tone current to the central office terminals of said called line and for causing said finder circuit to search for the selector switch of the first switching stage over which a call has been established to said called line, and means controlled by said detector for preventing the calling subscriber from releasing the connection established to said called line.

7. In a system for tracing the origin of telephone calls, a plurality of switching stages over which calls may be established from calling lines to called lines, each stage comprising a plurality of selector switches, a supervisory relay in each switch of said first stage controllable by a calling subscriber to govern the maintenance of a connection established from the calling line, a source of tone current, a tone current detector, a finder circuit for associating said detector in rotation with each selector switch of said first switching stage, means controlled from a called line for connecting said source of tone current to the central office terminals of said called line and for causing said finder circuit to search for the selector switch of said first switching stage over which a call has been established to said called line, and means controlled by said detector over said finder circuit for locking the supervisory relay of said selector switch to prevent the calling subscriber from releasing the connection established to said called line.

8. In a finder circuit for selecting any one of a plurality of circuits which are arranged in main groups divided into a plurality of subgroups, a plurality of finder switches each individual to a main group of said circuits and having access to the subgroups of said main group of circuits over different testing brushes and associated arcs of terminals, a master switch for selecting said finder switches in rotation, and means controlled by said master switch for rendering the brushes of each selected finder switch successively effective to test the subgroups of circuits to which they have access.

9. In a finder circuit for selecting any one of a plurality of circuits which are arranged in main groups each divided into a plurality of subgroups, a plurality of finder switches each individual to a main group of said circuits and having access to the subgroups of said main group of circuits over different testing brushes and associated arcs of terminals, a master switch for selecting said finder switches in rotation, and means controlled by said master switch for causing a plurality of revolutions of each finder switch following its selection and for rendering the brushes of that finder switch successively effective upon successive revolutions to test the subgroups of circuits to which they have access.

10. In a finder circuit for testing any one of a plurality of circuits which are divided into a plurality of subgroups, a finder switch operable through a plurality of cycles and having access to said subgroups, a master switch, a stepping magnet for each of said switches, an operating circuit for said magnets effective upon each closure thereof to advance said master switch one step and to cause said finder switch to advance through one complete cycle, and means controlled by said master switch in its successive

positions for rendering said finder switch effective to test a different subgroup of said circuits during each operating cycle thereof.

11. In a finder circuit for testing any one of
5 a plurality of circuits which are divided into a plurality of subgroups, a finder switch operable through a plurality of cycles and having access to said subgroups, a master switch, a stepping magnet for each of said switches, an operating
10 circuit for said magnets effective upon each closure thereof to advance said master switch and said finder switch one step, means effective upon each advance of said finder switch off normal to advance it through one complete cycle, and means
15 controlled by said master switch in its successive positions for rendering said finder switch effective to test a different subgroup of said circuits during each operating cycle thereof.

12. In a finder circuit for testing any one of
20 a plurality of circuits which are arranged in main groups each divided into a plurality of subgroups, a plurality of finder switches each individual to

a main group of said circuits each operable through a plurality of cycles and having access to a different one of said subgroups during each of its operating cycles, a master switch, a stepping magnet for each of said switches, means
5 for repeatedly establishing an operating circuit through the magnet of said master switch and in rotation through the magnet of each of said finder switches whereby, upon each closure thereof, said master switch and one of said finder
10 switches are each advanced one step, means effective upon each advance of a finder switch off normal to advance it through one complete cycle, means effective after each finder switch has completed a predetermined number of cycles
15 to extend said operating circuit to the magnet of the next succeeding finder switch, and means controlled by said master switch in its successive positions for rendering said finder switches effective to test different subgroups of said circuits
20 during successive operating cycles thereof.

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