Aug. 8, 1944. M. C. GODDARD 2,355,215

TELEPHONE SYSTEM

Filed Nov. 6, 1942 5 Sheets-Sheet 1

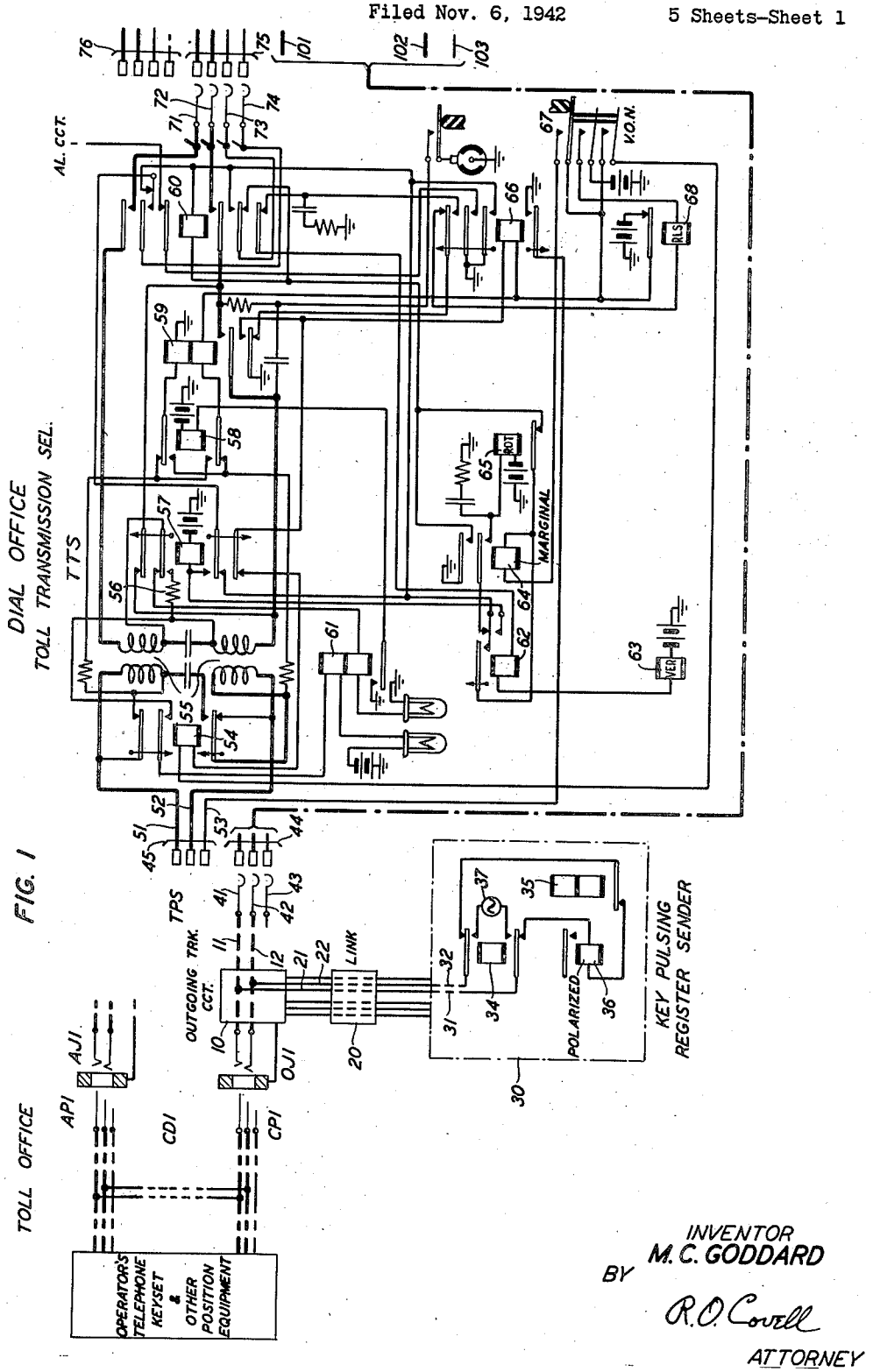

FIG. 1

INVENTOR
M. C. GODDARD

BY R. O. Covell

ATTORNEY

Aug. 8, 1944. M. C. GODDARD 2,355,215

TELEPHONE SYSTEM

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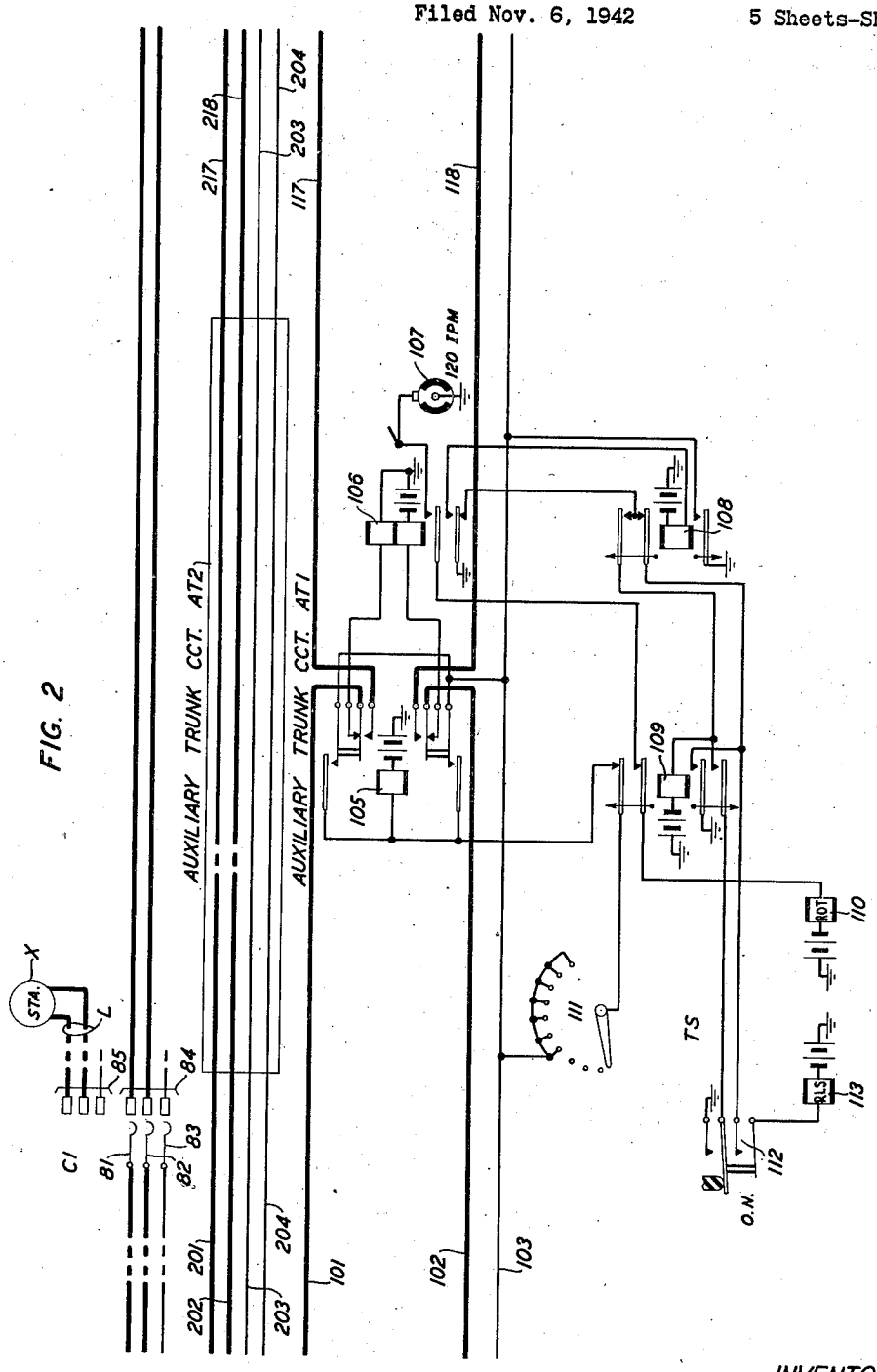

FIG. 2

INVENTOR
M. C. GODDARD
BY R. O. Covell
ATTORNEY

Aug. 8, 1944. M. C. GODDARD 2,355,215

TELEPHONE SYSTEM

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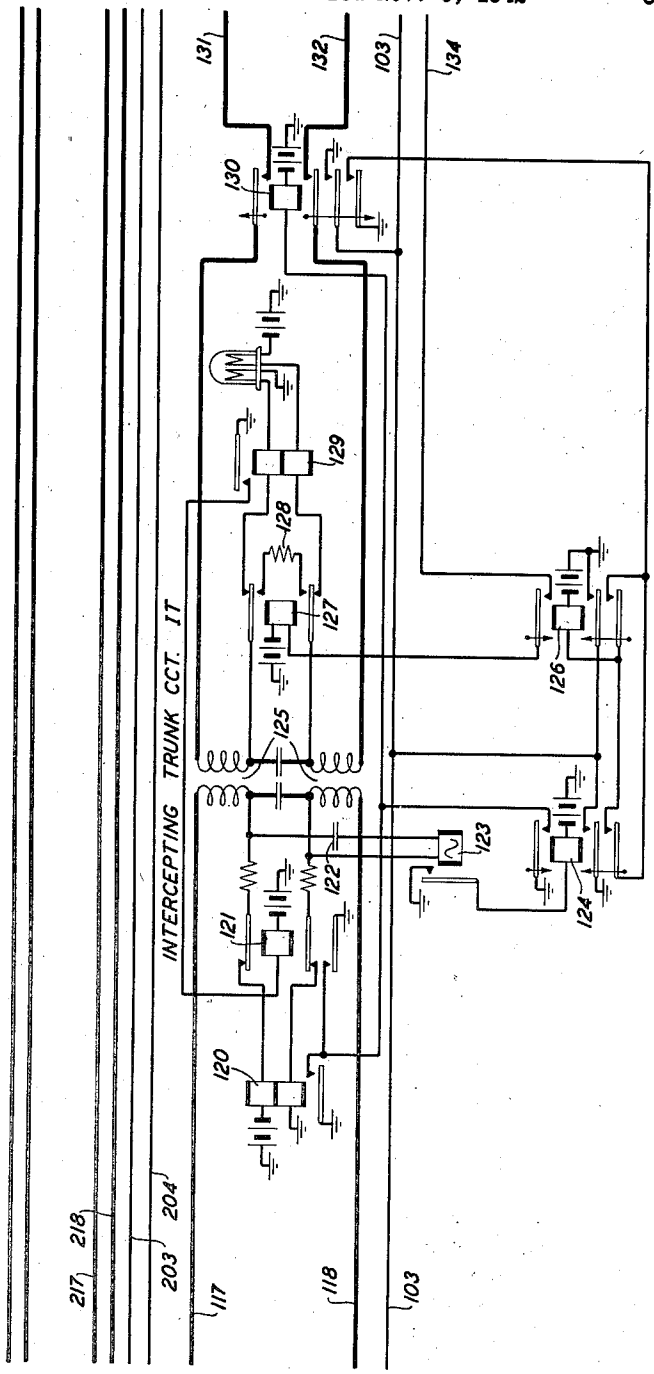

FIG. 3

INVENTOR
M. C. GODDARD

BY R. O. Covell

ATTORNEY

Aug. 8, 1944. M. C. GODDARD 2,355,215

TELEPHONE SYSTEM

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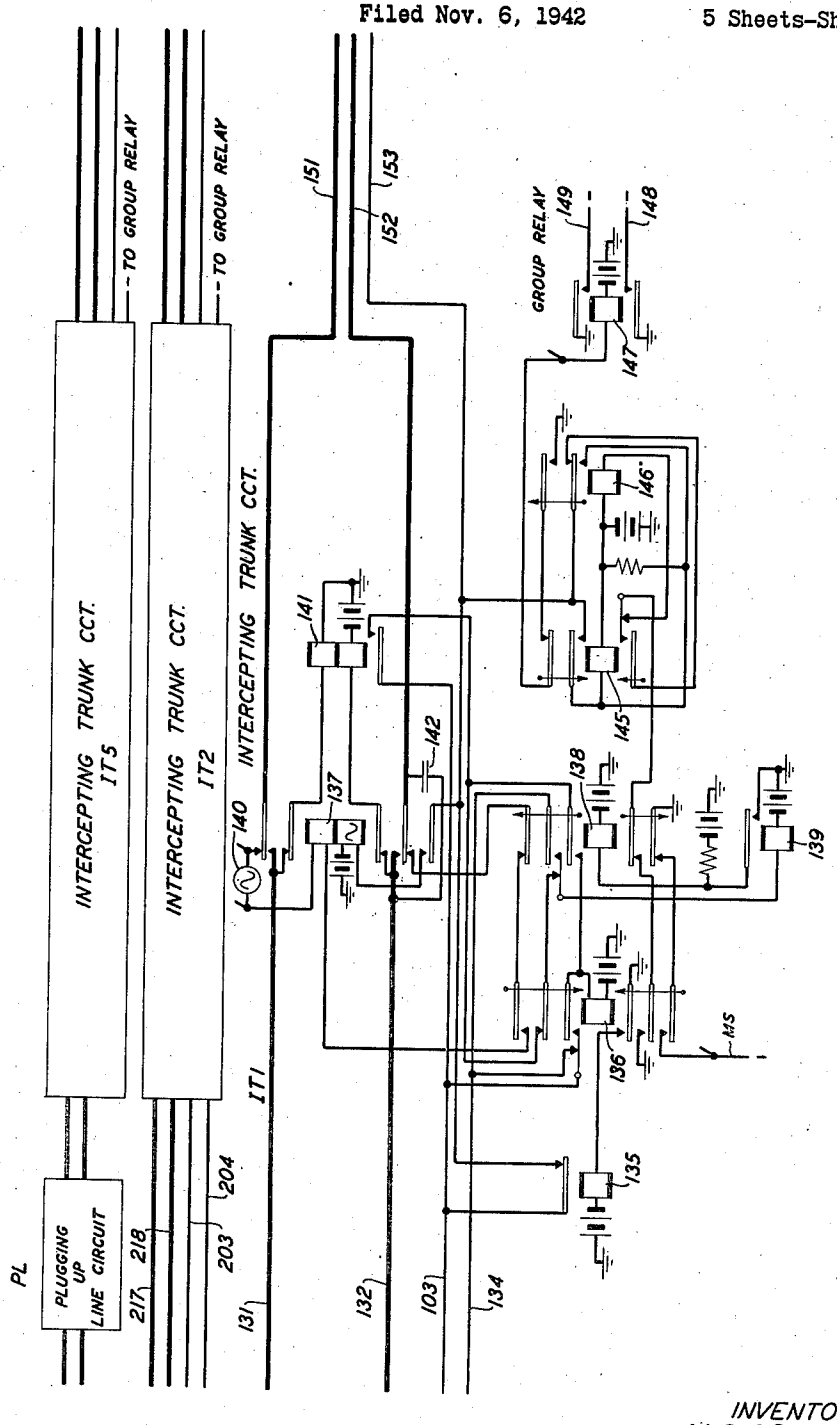

FIG. 4

INVENTOR
M. C. GODDARD

BY R. O. Covell

ATTORNEY

Aug. 8, 1944. M. C. GODDARD 2,355,215

TELEPHONE SYSTEM

Filed Nov. 6, 1942 5 Sheets-Sheet 5

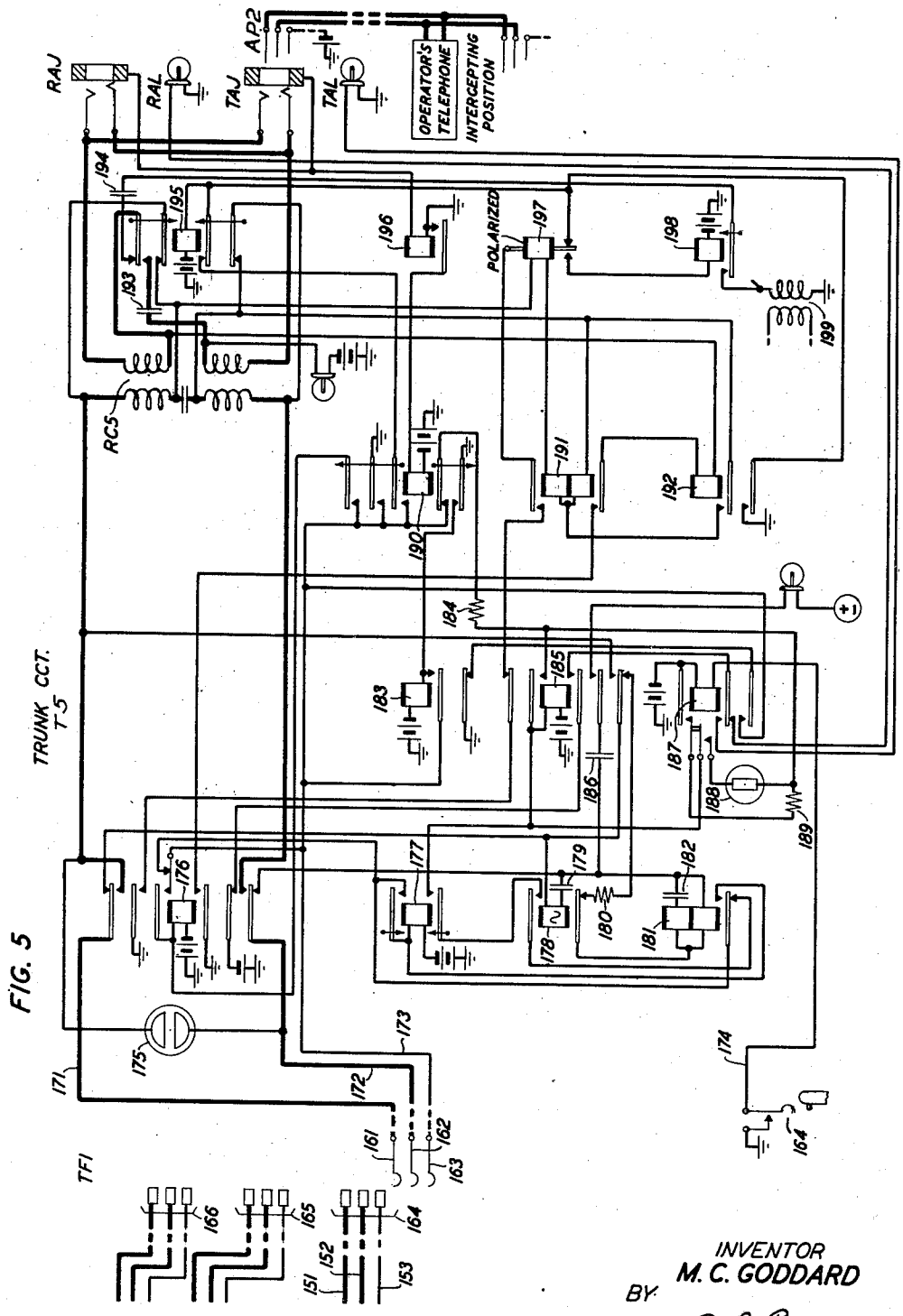

FIG. 5

INVENTOR
M. C. GODDARD
BY
R. O. Covell
ATTORNEY

Patented Aug. 8, 1944 2,355,215

UNITED STATES PATENT OFFICE

2,355,215

TELEPHONE SYSTEM

Myron C. Goddard, Garden City, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application November 6, 1942, Serial No. 464,811

8 Claims. (Cl. 179—27)

This invention relates to telephone systems and particularly to systems comprising impulse controlled automatic switches for completing connections between calling and called lines.

Objects of the invention are the improvement of call intercepting equipment in automatic telephone systems and the provision of means for intercepting unassigned code calls at the banks of impulse controlled selectors which are used in establishing connections under the control of a registered sender.

It is usual in automatic telephone systems comprising impulse controlled selector and connector switches to connect intercepting trunk circuit equipment to the terminals which are selected in response to the dialing of unassigned codes and to provide trunk finders for connecting seized intercepting trunks to an operator's position in the same or another office. It is also known to so arrange the intercepting equipment and circuits that the signaling of the intercepting operator is effected responsive to ringing current transmitted from the connector on calls intercepted in the banks of connectors, the ringing being tripped at the same time that the calling signal is operated. If now, an impulse controlled selector switch selects a set of terminals connected to an intercepting trunk under the control of impulses being transmitted from another office by a register sender for instance on a call from a toll operator's position at which a key-set is provided for registering the called number, it is necessary to provide means individual to a seized intercepting trunk circuit for absorbing the trains of impulses transmitted by the register sender after the selector has seized the intercepting trunk and before the connection is extended by a trunk finder to an intercepting operator's position. If the selector which seizes an intercepting trunk is a toll preceding selector, the operation of a trunk finder to extend the connection to an intercepting operator's position may be effected responsive to ringing current transmitted by the register sender after the digit impulses have been transmitted, in which case, the operation of the signal at the intercepting position may be effected by ringing current transmitted from the intercepting trunk circuit, the ringing being tripped at the same time that the signal is operated prior to answer of the call by the intercepting operator. If the selector which seizes an intercepting trunk is a toll transmission selector, the operation of a trunk finder to extend the connection to an intercepting operator's position may be effected immediately after all of the digit impulses have been transmitted by the register sender, the transmission of ringing current by the intercepting trunk to operate the calling signal at an intercepting operator's position being controlled by the selector in the same manner in which the selector controls the application of ringing current by a connector to a called line.

This invention is an intercepting trunk circuit connected to terminals corresponding to unassigned codes in the banks of selectors in a dial office, which selectors are employed in completing calls including calls established under the control of a register sender, as in the case of calls from a toll operator's position equipped with a key-set. A feature of the invention is a trunk circuit arranged to measure off a predetermined minimum interval of time after seizure before extending the connection, to interrupt the measurement of the interval of time responsive to a train of dial impulses, to start the measurement of a new interval at the end of a train of impulses, and to extend the connection when the measurement of an interval is completed without interruption.

Another feature of the invention is an intercepting trunk circuit arranged to absorb trains of digit impulses and to effect the extension of the connection to an intercepting operator's position in response to ringing current received after the last train of impulses.

A clear and complete understanding of the invention will be facilitated by considering a system in which the invention and its features are embodied, one such system being represented schematically in the drawings which form a part of this specification. The invention is, however, not limited in its application to the particular system shown in the drawings, but is generally applicable to automatic telephone systems and the intercepting equipment therein.

Referring to the drawings,

Fig. 1 shows a toll office comprising an operator's telephone set and other position equipment, a cord circuit CD1, jacks AJ1 and OJ1, outgoing trunk circuit 10, a link circuit 20 and a key-pulsing register sender 30; Fig. 1 also shows a dial office comprising a toll preceding selector TPS and a toll transmission selector TTS;

Fig. 2 shows in the dial office a connector C1, a called subscriber's line L and station X, and two auxiliary intercepting trunk circuits AT1 and AT2;

Fig. 3 shows an intercepting trunk circuit IT;

Fig. 4 shows a plugging up line circuit PL and intercepting trunk circuits IT1, IT2 and IT5; and

Fig. 5 shows a trunk finder TF1 and a trunk

circuit T5 terminating at an intercepting operator's position.

The operator's telephone, key-set and other position equipment, the cords CD1, outgoing trunk circuit 10, link 20 and key-pulsing register sender 30 may be similar to corresponding equipment disclosed in the patent to I. H. Henry No. 1,916,760 of July 4, 1933. Each of the selector circuits TPS and TTS, the connector C1 and trunk finder TF1 comprises a switch of the two-motion step-by-step type. Reference may be had to pages 53 to 65, inclusive of the second edition of Automatic Telephony by Smith and Campbell for a clear and complete description of the structure and operation of such switches when used as selectors and connectors. Reference may be had to the patent to R. L. Stokely No. 1,799,654 of April 7, 1931, for a description of a two-motion step-by-step switch when used as a finder switch. The banks of each of these step-by-step switches is represented in the drawing by two or three sets of terminals. The toll preceding selector circuit TPS may be similar to the selector circuit shown in Fig. 3 of the patent to R. L. Stokely No. 1,474,008 of November 13, 1923. The toll transmission selector circuit TTS shown in Fig. 2 is arranged for immediate ringing; but the intercepting trunk circuits AT2 and IT2 are also adapted for use with toll transmission selectors which are arranged for delayed ringing under control of the toll operator. Reference may be had to the aforementioned patent to R. L. Stokely for disclosure of a toll transmission selector in which ringing is started by the operation of a ringing key at a calling toll operator's position. The plugging up line circuit PL and intercepting trunk circuit IT5 are similar to like designated circuits disclosed in detail in the patent to E. D. Butz, No. 2,021,286, granted November 19, 1935. The intercepting trunk circuit IT2 is similar to the trunk circuit IT1 and the auxiliary trunk circuit AT2 is similar to the trunk circuit AT1.

Assume now that an operator in the toll office answers an incoming call by connecting the answering plug AP1 of cord CD1 to the answering jack AJ1, that the calling plug CP1 is connected to jack OJ1 of outgoing trunk circuit 10, that the trunk circuit 10 is connected through a link 20 to a register sender 30, and that the called number is registered by operation of the operator's key-set in the register sender, all in the manner described in the aforementioned patent to I. H. Henry. Assume further that the toll preceding selector TPS is operated under the control of the first train of impulses transmitted by the impulse transmitting contact of relay 35 of the register sender to select a corresponding level of the terminal bank and is automatically operated to select a set of terminals therein connected to an idle trunk or idle toll transmission selector, that the selected level corresponds to an unassigned code, and that the selected terminals 44, which represent such a level, are connected to the auxiliary intercepting trunk circuit AT1.

Operation of the cut-through relay (not shown) of selector circuit TPS completes a circuit from battery through the lower winding of relay 106, lower back contact of relay 105, conductor 102, middle terminal of the terminal set 44 and brush 42 of selector TPS, conductor 12 of outgoing trunk circuit 10, conductor 22 of link circuit 20, conductor 32 of register sender 30, upper back contact of relay 34, contact of impulse transmitting relay 35, winding of polarized relay 36, lower back contact of relay 34, conductors 31, 21 and 11, brush 41 and engaged terminal of terminal set 44, conductor 101, upper back contact of relay 105 and upper winding of relay 106, to ground. The line relay 106 is operatively energized by the current in this circuit but polarized relay 36 of the register sender is not operated since the current is not in the operating direction. The operation of relay 106 connects the brush of the 120 impulse per minute interrupter 107, through a back contact of relay 109, to the winding of the rotary stepping magnet 110 of the timing switch TS, the magnet 110 being thereby periodically operated to advance the brush 111 of this switch one step every thirty seconds. The aforementioned operation of relay 106 also closes a circuit for operating relay 108; and relay 108 connects ground to conductor 103 to hold the toll preceding selector TPS in usual manner. The off-normal springs 112 are actuated when the brush 111 moves out of normal position. Before brush 111 reaches the fourth terminal of its bank, relay 35 of register sender 30 starts to send the next train of impulses, thereby causing the alternate release and reoperation of relay 106. The release of relay 106 in response to the first impulse, closes a circuit for operating relay 109. Relay 109 locks to ground at the upper contact of the off-normal springs 112, opens the circuit for operating relay 105, opens the circuit for operating the rotary stepping magnet 110 to prevent further advance of the brush 111, and closes a circuit through the lower contact of off-normal springs 112 for operating the release magnet 113 to restore the brush 111 to normal. Being slow in releasing, relay 109 remains operated until all of the impulses in the train have been received by relay 106. Relay 108 is also slow in releasing so as to remain operated during the response of relay 106 to impulses. When relay 109 releases at the end of the train of impulses, it again closes the circuit for operating the rotary stepping magnet 110 under the control of the interrupter 107; whereby the brush 111 is again advanced step by step, one step every thirty seconds. When the next train of impulses is transmitted by relay 35 of register sender 30, relay 106 again responds causing the reoperation of relay 109 and the restoration of the brush 111 to normal. Thus each digit transmitted by the register sender is absorbed by the trunk circuit AT1. When all of the impulses have been transmitted, the advance of brush 111 under the control of the interrupter 107 continues without interruption. When the brush 111 reaches terminal 4, relay 105 operates. Relay 105 locks to conductor 103; disconnects conductors 101 and 102 from the windings of relay 106 to cause the release of relay 106; and connects conductors 101 and 102, through conductors 117 and 118, the left windings of repeating coil 125 of trunk circuit IT and the back contacts of relay 121, to the windings of relay 120. Relay 120 operates in series with the contact of impulse transmitting relay 35 and the winding of polarized relay 36 in the register sender 30, the current in this circuit being in a direction to also effect the operation of relay 36. The operation of relay 120 closes a circuit for operating relay 130. Relay 130 connects ground to conductor 103 to maintain the operation of relay 105 of trunk circuit AT1 and to hold the toll preceding selector TPS. Relays 106 and 108 re-

lease in succession, thereby closing the circuit for operating release magnet 113 to restore brush 111 and springs 112 to normal. Since relay 108 is slow in releasing, the release of relay 108 does not occur until after relay 130 has operated; so that the connection of ground potential to conductor 103 is maintained without interruption upon extension of the connection to trunk circuit IT. The aforementioned operation of relay 130 connects the windings of relay 129, through back contacts of relay 127, right windings of repeating coil 125, front contacts of relay 130, conductors 131 and 132, and back contacts of relay 137 of trunk circuit IT1 to the windings of relay 141, neither relay 129 nor relay 140 being thereby operated.

All of the digit impulses having been transmitted by the register sender, the operation of polarized relay 36 effects the operation of relay 34 as described in the aforementioned patent to I. H. Henry to connect the ringing current generator 37 to conductors 31 and 32 to cause the operation of relay 123 of trunk circuit IT. After a measured interval of time, the ringing generator 37 is disconnected from conductors 31 and 32 and a talking connection is closed through trunk circuit 10 between the conductors of jack OJ1 and conductors 11 and 12 in the manner set forth in the aforementioned patent to I. H. Henry. The operation of relay 123 closes a circuit for operating relay 124. The operation of relay 124 closes a circuit for operating relay 126, closes a holding circuit for relay 130, and connects ground to conductor 103. Relay 126 locks under control of relay 130 and connects ground to conductor 103. Relay 120 releases while ringing current is being received and reoperates after the talking connection is closed through trunk circuit 10. Relays 124 and 125 are slow in releasing so as to prevent the release of relay 130 while relay 120 is released. The aforementioned operation of relay 126 also closes a circuit for operating relay 127, this circuit being traced from the winding of relay 127, through the upper front contact of relay 126, conductor 134, inner upper back contact of relay 136 of trunk circuit IT1, and conductor 103, to ground at the middle lower front contact of relay 130. The operation of relay 127 connects resistor 128, through the right windings of repeating coil 125 and front contacts of relay 130, across conductors 131 and 132 thereby effecting the operation of relay 141 of trunk circuit IT1. The operation of relay 141 closes a circuit for operating relay 139, this circuit being traced from the winding of relay 139, through the continuity back contact of relay 138, a back contact of relay 136, front contact of relay 141 and conductor 103, to ground at a front contact of relay 130. The operation of relay 139 closes a circuit for operating relay 138. The operation of relay 138 opens the operating circuit and closes a holding circuit for relay 139, the holding circuit being traced through the continuity front contact of relay 138, inner upper back contact of relay 136, and conductor 103 to ground at a front contact of relay 130. The operation of relay 138 closes a circuit through its inner upper front contact and the front contact of relay 141 for operating relay 136. Relay 136 locks to conductor 103, closes a circuit for operating relay 135, and opens the connection between conductors 103 and 134 thereby causing the release of relay 127 of trunk circuit IT and the release of relay 139. The operation of relay 135 opens the connection between conductor 103 and sleeve conductor 153. The release of relay 127 disconnects resistor 128 from, and reconnects the windings of relay 129 to, conductors 131 and 132 thereby causing the release of relay 141. The release of relay 139 causes the release of relay 138. The release of relay 138 connects ground through the outer lower front contact of relay 136 to motor start conductor MS to start the ringing generator and ringing interrupter, if not already in operation; and closes a circuit at its inner lower back contact for operating relay 146. The operation of relay 146 closes a circuit for operating group relay 147, and connects the winding of relay 145 to conductor 153. The operation of group relay 147 connects ground to start conductor 148 to operate the start relay (not shown) of the first idle trunk finder having access to trunk circuit IT1; and connects ground to conductor 149 to mark the level of the trunk finder bank in which the terminals connected to trunk circuit IT1 are located. When the brushes of the trunk finder TF1, thus started in operation, engage the terminals 164, relay 145 is operated by the current in a circuit from battery through its winding, inner front contact of relay 146, conductor 153, brush 163 of trunk finder TF1, to ground (not shown) in the trunk finder circuit. The closure of this circuit is also effective to stop the further advance of the brushes of the trunk finder, and to effect the operation of the cut-through relay in the usual manner, the cut-through relay not being shown in the drawing. Relay 145 locks to conductor 153 and opens the operating circuit of relay 146. The release of relay 146 causes the release of group relay 147 unless there is another trunk in the same subgroup awaiting extension to an intercepting operator. The release of relay 146 closes a connection from ground at the middle lower front contact of relay 136, through the inner lower back contact of relay 138, lower front contact of relay 145 and back contact of relay 146 to conductor 153.

With the brushes of trunk finder TF1 in engagement with terminals 164, a circuit is closed for operating the ring-up relay 178 of trunk circuit TC1, this circuit being traced from ringing generator 140, through back contacts of relay 137, conductors 151 and 152, brushes 161 and 162 of trunk finder TF1, conductors 171 and 172 of trunk circuit T5, back contact of relay 176, condenser 179 and the winding of relay 178. While the operator is being signaled, ringing tone is transmitted through condenser 142 to the calling operator. When the ringing current ceases during the silent part of the ringing cycle, relay 178 releases and the silent period tripping battery is effective to energize the windings of relay 181. As soon as condenser 182 becomes charged, relay 181 is operated by the energization of its lower winding. Relay 181 closes a circuit for operating the slow to operate relay 177; this circuit includes the front contact of relay 181, continuity back contact of relay 176, conductor 173, brush 163, conductor 153, back contact of relay 146, lower front contact of relay 145, a back contact of relay 138 and the middle lower front contact of relay 136. Relay 177 locks through conductor 173 and brush 163 to ground on conductor 153. When the silent period ends and ringing current is again transmitted, relay 181 releases and relay 178 operates. With relay 177 operated and relay 181 released, the operation of relay 178 connects the winding of relay 185, through front contacts of relays 177 and 178, back contact of relay 181,

a back contact of relay 176, conductor 173, brush 163, conductor 153, back contact of relay 146, lower front contact of relay 145, inner lower back contact of relay 138, to ground at the middle lower front contact of relay 136. Relay 185 locks in series with resistor 184 and a back contact of relay 190 to conductor 173; closes a circuit for lighting the answering lamp RAL, opens the circuit path through the windings of relay 181; and connects the gas-filled tube 175 across conductors 171 and 172. The tube 175 is energized by the applied ringing voltage, thereby causing the operation of ringing trip relay 137 of trunk circuit IT1. Relay 137 locks through conductor 153 to ground at the middle lower front contact of relay 136, disconnects the ringing source from conductors 151 and 152 and connects conductors 131 and 132 to conductors 151 and 152. After relay 137 operates, ringing tone is transmitted to the calling operator by the connection of ringing potential through a front contact of relay 185, condenser 186, and a back contact of relay 176 to conductor 172. As soon as the ringing source 140 is disconnected, the tube 175 deenergizes, thereby preventing operation of relay 129. When an operator at the intercepting position connects a plug AP2 to answering jack RAJ, relay 196 is operated. The operation of relay 196 closes a circuit for operating relay 190. Relay 190 closes circuits for operating relays 183 and 176, causes the release of relay 185 and connects ground to sleeve conductor 173. The release of relay 185 extinguishes lamp RAL and ends the transmission of ringing tone to the calling operator. The operation of relay 176 disconnects relays 178 and 181 from conductors 171 and 172, and closes the talking connection between conductors 171 and 172 and repeating coil RC5. With relay 176 operated, the windings of relay 191 and relay 197 are connected through conductors 171 and 172 and conductors 151 and 152 to the windings of relay 129. Since the call in question is a call from a toll operator, the current through the winding of polarized relay 197 is in the operating direction so that both of relays 191 and 197 are operated. Being marginal, relay 129 does not operate in series with both windings of relay 191. The operation of relay 191 connects ground through a front contact of relay 176, winding of relay 192, and a winding of repeating coil RC5, to the tip conductor of the answering jack to extinguish the answering cord supervisory lamp which is not shown in the drawings. Relay 192 is marginal and does not operate at this time. The operation of relay 197 closes a circuit including a front contact of relay 191, a back contact of relay 185 and a front contact of relay 176 for operating relay 198. Relay 198 connects tone source 199 through condenser 194, a back contact of relay 195 and the right upper winding of repeating coil RC5 to the tip conductor of the answering jack to give, to the answering operator, a tone indication that the call is from a toll operator. When the answering operator actuates the tone removal key (not shown) a low impedance bridge is connected across the tip and ring conductors of the answering cord, thereby effecting the operation of relay 192. Relay 192 closes a circuit for operating relay 195. Relay 195 locks under control of relay 190; disconnects the tone source 199; bridges the talking condenser 193 across the tip and ring conductors of the answering jack; and opens the short circuits across the left windings of repeating coil RC3, thereby completing the talking connection between the calling toll operator and the answering operator. With relay 192 operated, the high impedance winding of relay 191 is short-circuited to operate relay 129 of trunk circuit IT. The operation of relay 129 closes a circuit for operating relay 121, thereby disconnecting the windings of relay 120 from conductors 117 and 118 to effect the extinguishing of the toll operator's cord supervisory lamp (not shown). Relay 121 also closes a circuit for holding relay 130 operated.

If the answering operator disconnects first, relays 192 and 196 release. The release of relay 196 causes the release of relay 190; and the release of relay 190 causes the release of relay 195. Relays 183 and 176 are held operated through conductors 173 and 153, back contact of relay 146, lower front contact of relay 145, inner lower back contact of relay 138, to ground at a front contact of relay 136. The release of relay 195 reconnects toll identification tone source 199 to the tip conductor of jack RAJ and short-circuits the left windings of repeating coil RC3. The release of relay 192 opens the short circuit across the high impedance winding of relay 191 to cause the successive release of relays 129 and 121 and reoperation of relay 120. The toll operator's cord supervisory lamp is thereby lighted as a disconnect signal. If the answering operator again connects an answering cord to jack RAJ, relays 196 and 190 are reoperated and the toll identification tone is given to the answering operator. Operation of the tone removal key effects the reoperation of relays 192 and 195 to disconnect the tone and reestablish the talking connection. If the calling operator disconnects while the answering operator is connected, the switch TPS is restored to normal but trunk circuits AT1, IT, IT1 and TC1 are not affected until the answering operator disconnects, relay 130 being held operated under the control of relays 121, 129 and 192 in tandem. When the answering operator disconnects, relays 192, 196, 190 and 195 release The release of relay 192 causes the successive release of relays 129, 121 and 130. The release of relay 130 releases relay 126 and disconnects ground from conductor 103 thereby causing the release of relays 105, 136 and 135. The release of relay 136 disconnects ground from conductor 153, releasing relays 137, 145, 176 and 183 and releasing the trunk finder TF1 which is thereupon restored to normal in the usual manner.

Assume now that the toll preceding selector TPS selects a level in which the terminals are connected to toll transmission selector circuits and that the terminals 45 representing this level and connected to selector TTS are seized by the trunk hunting operation of selector TPS. Upon extension of the connection from conductors 11 and 12 through brushes 41 and 42 of elector TPS to conductors 51 and 52, the line relay 59 of selector TTS is operated, the windings of this relay being normally connected through back contacts of relays 58 and 54 to conductors 51 and 52. Relay 59 closes a circuit for operating the slow-to-release relay 66; and relay 66 connects holding ground potential through conductor 53 to the terminal engaged by brush 43 of selector TPS to hold the selector TPS in operated position. When the next train of impulses is transmitted by impulse relay 35 of the register sender 30, relay 59 is alternately released and reoperated as many times as there are impulses in the train. The release of relay 59 in response to the first impulse closes a circuit from ground through its lower back contact, a

front contact of relay 66 and a back contact of relay 60, for operatively energizing relay 62 and vertical stepping magnet 63. The operation of stepping magnet 63 advances brushes 71, 72, 73 and 74 up to the first level of the terminal bank, the vertical off-normal springs 67 being actuated as soon as the brush shaft moves out of normal position. The operation of relay 62 closes a circuit for operating relay 57; and relay 57 locks under control of relay 60 to ground at the inner upper front contact of relay 66. With relay 62 operated and the vertical off-normal springs 67 actuated, a circuit is closed for operating relay 64, this circuit being traced from battery at the back contact of release magnet 68 through the upper front contact of vertical off-normal springs 67, winding of relay 64, and front contact of relay 62 to ground at the inner upper front contact of relay 66. Relay 64 locks under control of the rotary stepping magnet 65 to ground at its outer front contact. When relay 59 reoperates at the end of the first impulse, the vertical stepping magnet 63 releases; but relay 62 is slow in releasing so as to remain operated until after relay 59 has reoperated at the end of the last impulse of the train. Relay 66 is also slow in releasing so as to remain operated during the response of relay 59 to impulses. Each operation of the vertical stepping magnet 63 advances the brushes of the selector one step, thereby selecting the level of the terminal bank corresponding to the number of impulses in the train received from the register sender. When relay 62 releases after all of the impulses in the train have been received, a circuit is closed for operating the rotary stepping magnet 65, this circuit being traced from battery through the winding of magnet 65, inner upper front contact of relay 64, back contact of relay 62, to ground at a front contact of relay 66. The operation of stepping magnet 65 steps the brushes 71, 72, 73 and 74 into engagement with the first set of terminals in the selected level and opens the circuit for energizing the winding of relay 64; and the release of relay 64 opens the circuit for energizing the winding of rotary stepping magnet 65. If the first set of terminals in the selected level is connected to a busy trunk, busy selector or busy connector circuit, the terminal engaged by brush 73 is connected to ground, thereby effecting the reoperation of relay 64 in a circuit from battery through the back contact of release magnet 68, upper front contact of vertical off-normal springs 67, winding of relay 64, back contact of rotary stepping magnet 65, inner lower back contact of relay 60 and through brush 73 to the engaged grounded test terminal. The reoperation of relay 64 again closes the circuit for operating rotary stepping magnet 65, thereby advancing the brushes to the next set of terminals in the level. Relay 64 and rotary stepping magnet 65 cooperate to advance the brushes step by step until a set of terminals which is not marked by a busy potential are engaged, whereupon relay 60 is operated in a circuit traced from battery through the back contact of release magnet 68, upper contact of vertical off-normal springs 67, winding of relay 64, back contact of rotary stepping magnet 65, and winding of relay 60, to ground at a front contact of relay 66. Being marginal, relay 64 is not operatively energized in series with the winding of relay 60. The operation of relay 60 immediately closes a connection from ground at the inner upper front contact of relay 66, through the outer lower front contact of relay 60, and brush 73, to the sleeve terminal of the selected trunk circuit so as to prevent the selection of this trunk circuit by any other selector which has access thereto. The operation of relay 60 connects the locking contact of relay 57 to brush 74 so that the continued operation of relay 57 depends upon the connection of ground potential to the terminal engaged by brush 74.

Assume that the train of impulses received by relay 59 from the register sender effects the selection of a level representing a non-used code, such a level being represented by the set of terminals 75 connected to intercepting trunk circuit AT2. The trunk circuit AT2 is similar to trunk circuit AT1 except that it has an additional conductor which is connected to the terminal engaged by brush 74. The trunk circuit AT2 absorbs the trains of impulses transmitted by relay 35 of register sender 30 in the same manner that trunk circuit AT1 absorbs trains of impulses as above described. When all trains of impulses have been received, the relay of trunk circuit AT2 which corresponds to relay 105 of trunk circuit AT1 is operated to connect conductors 201 and 202 to conductors 217 and 218 of trunk circuit IT2. Since trunk circuit IT2 is similar to trunk circuit IT1, the operations of trunk circuit IT2 involved in starting a trunk finder are similar to those of trunk circuit IT1 hereinbefore described. After relay 60 operates, the locking circuit of relay 57 is traced through a front contact of relay 60, brush 74 and engaged terminal, conductor 204, continuity back contact of the relay of trunk circuit IT2 which corresponds to relay 136 of trunk circuit IT1, conductor 203, terminal and brush 73, and a front contact of relay 60, to ground at a front contact of relay 66. When the relay of trunk circuit IT2 which corresponds to relay 136 of trunk circuit IT1 operates, relay 57 of toll transmission selector TTS releases. The release of relay 57 connects ground through its inner lower back contact, continuity front contact of relay 60 and brush 74 to conductor 204. Since the selector TTS is arranged for immediate ringing, relay 57 is slow in releasing to insure the release of the relay of trunk circuit IT2 which corresponds to relay 139 before the release of relay 57 connects ground to conductor 204. (If the trunk IT1 were seized by a toll transmission selector arranged for delayed ringing under the control of the toll operator, the connection of ground to conductor 204 in the selector circuit would occur soon enough to prevent the release of the relay corresponding to relay 139; in which case this relay would remain operated until the toll operator rings.) The release of the relay corresponding to relay 139 causes the release of the relay corresponding to relay 138 to effect the starting of a trunk finder TF1 in the manner hereinbefore described on the call through trunk circuit IT1. When a trunk finder TF1 extends the connection from trunk circuit IT2 to a trunk circuit T5 terminating at an operator's position, the various operations of trunk circuits IT2 and T5 are similar to those above described on a call through trunk circuit IT1.

When the toll operator releases the connection, relay 59 releases, causing the release of relay 66. The release of relay 66 causes the release of relay 60, disconnects ground from conductor 53 to cause the toll preceding selector TPS to restore to normal, disconnects ground from brush 73 to cause the release of the relay of trunk circuit IT2 corresponding to relay 136

of trunk circuit IT1, and closes a circuit for operating release magnet 68. The operation of magnet 68 allows the brushes of selector TTS to restore to normal; and when the brushes reach normal, the vertical off-normal springs 67 are restored to normal to effect the release of release magnet 68. The trunk circuits AT2 and T5 and trunk finder TF1 are restored to normal when the answering operator disconnects, in the manner hereinbefore set forth. The trunk circuit IT2 is restored to normal in similar manner to that in which trunk circuit IT1 is restored to normal as hereinbefore described.

If the selector TTS is operated to select a set of terminals 76 connected to a connector C1, the next two trains of impulses transmitted by relay 35 of register sender 30 effect the operation of the connector to select a set of terminals 85 connected to the called subscriber's line L; and, in this case, relay 57 is held operated until the called line is selected, the transmission of a ringing signal from the register sender being without effect. The release of relay 57 connects ground to brush 74 and connects talking battery through the windings of relay 61 and repeating coil 55 to the talking conductors of connector C1. Relay 57 is slow in releasing so that there is an interval between the disconnection of ground from conductor 74 and the reconnection of ground to conductor 74 by the release of relay 57. The connector then operates in the usual manner to transmit ringing current to operate the ringer at the called station. When the call is answered, relay 61 operates, causing the operation of relay 58, whereby the current through conductors 51 and 52 is reversed as an answering supervisory signal. If the called subscriber replaces the receiver, relays 61 and 62 release to again reverse the current as a disconnect signal. When the calling operator disconnects, relay 59 releases, causing the release of relay 66. The release of relay 66 disconnects ground from conductor 53 to cause the toll preceding selector TPS to restore to normal, disconnects ground from brush 73 to cause the release of relay 60 and to cause the connector C1 to restore to normal, and closes a circuit for operating release magnet 68 to restore the brushes of selector TTS to normal. When the shaft and brushes of selector TTS reach normal, the vertical off-normal springs 67 are restored to normal to effect the release of release magnet 68.

If the connector C1 selects the terminals 84 of a line which is out of order, the plugging up line circuit PL and intercepting trunk circuit IT5 effect the starting of a trunk finder in the manner described in the aforementioned patent to E. D. Butz, No. 2,021,286. In this case, the normal post springs 164 of the trunk finder TF1 are actuated when the brushes are stepped up to the level in which the terminals 166 are located, thereby connecting ground to conductor 174 to operate relay 187 of trunk circuit TC1. Relay 187 connects the lamp TAL for operation instead of lamp RAL; connects ground from the back contact of relay 183 to conductor 173 to hold the trunk finder until the call is answered; and connects thermistor 188 in series with the winding of relay 185, in parallel with resistor 189, through a back contact of relay 190, to grounded conductor 173, the temperature of the thermistor being raised by the current therethrough. Relays 181, 177 and 178 are operated in the manner hereinbefore described to effect the operation of relay 185 to light the lamp TAL. If the call is abandoned before relay 185 is operated, relay 185 is operated in series with thermistor 188 as soon as the temperature of the thermistor has been sufficiently increased to effect a material decrease in the resistance of the thermistor. When the lamp TAL is lighted and an intercepting operator connects a cord to jack TAJ, relays 196, 190 and 183 are successively operated and the other operations involved on this call are similar to those above described on a call through a set of terminals representing an unassigned number. If the call has been abandoned before the operator answers, the operator disconnects from the answering jack and the trunk circuits and trunk finder are restored to normal.

What is claimed is:

1. In an automatic telephone system, a trunk circuit comprising normally disconnected incoming and outgoing conductors, timing means for measuring a predetermined interval of time, means responsive to seizure of said incoming conductors for starting the operation of said timing means, means operated at the end of the measurement of said predetermined interval of time by said timing means to interconnect said incoming and outgoing conductors, means effective in response to a train of impulses received over said incoming conductors prior to completion of the measurement of said interval of time for preventing the interconnection of said conductors, and means effective at the end of a train of impulses received over said incoming conductors to again start the operation of said timing means.

2. In an automatic telephone system, a trunk circuit comprising normally disconnected incoming and outgoing conductors, a timing switch, means responsive to seizure of said incoming conductors for starting the operation of said timing switch, means operated when said timing switch reaches a predetermined position to interconnect said incoming and outgoing conductors, and means responsive to a train of impulses received over said incoming conductors prior to the time said switch reaches said position for effecting the return of said timing switch to normal.

3. In an automatic telephone system, a trunk circuit comprising normally disconnected incoming and outgoing conductors, a timing switch, means responsive to seizure of said incoming conductors for starting the operation of said timing switch, means operated when said timing switch reaches a predetermined position to interconnect said incoming and outgoing conductors, and means responsive to a train of impulses received over said incoming conductors prior to the time said switch reaches said position for effecting the return of said timing switch to normal, said switch being again started in operation at the end of said train of impulses.

4. In an automatic telephone system comprising impulse controlled switches for establishing connections between calling and called lines, a trunk circuit connected to a set of terminals representing an unassigned code in the banks of certain switches, said trunk circuit comprising incoming and outgoing conductors, timing means for measuring a predetermined interval of time, means responsive to seizure of said trunk circuit for starting the operation of said timing means, means for stopping the operation of said timing means in response to the first impulse of each train of impulses received over said incoming conductors, means effective at the end of each train of impulses received over said incoming conductors for again starting the operation of said

timing means to measure said predetermined interval of time, and means effective when no impulses are received over said incoming conductors while said interval is being measured for interconnecting said incoming and outgoing conductors.

5. In an automatic telephone system comprising impulse controlled switches and impulse transmitting control means for controlling the operation of said switches to establish desired connections, a trunk circuit connected to a set of terminals representing an unassigned code in the banks of certain of said switches, said trunk circuit comprising incoming and outgoing conductors, timing means for measuring a predetermined interval of time, means responsive to seizure of said incoming conductors for starting the operation of said timing means, means responsive to the first impulse of a train of impulses received over said incoming conductors for stopping the operation of said timing means, means effective after receipt of the last impulse of a train of impulses received over said incoming conductors for again starting the operation of said timing means, and means effective when said timing means completes the measurement of said predetermined interval of time without interruption to interconnect said incoming and outgoing conductors.

6. In an automatic telephone system comprising impulse controlled switches and impulse transmitting control means for controlling the operation of said switches to establish desired connections, a trunk circuit connected to a set of terminals representing an unassigned code in the banks of certain of said switches, said trunk circuit comprising incoming and outgoing conductors, means for absorbing trains of impulses received over said incoming conductors, and means for interconnecting said incoming and outgoing conductors a predetermined interval of time after the last train of impulses is received over said incoming conductors.

7. In an automatic telephone system, impulse controlled switches, control means effective to transmit trains of impulses to operate said switches to establish desired connections, a trunk circuit connected to a set of terminals representing an unassigned code in the bank of one of said switches, means in said trunk circuit responsive to a train of impulses transmitted by the control means after seizure of said set of terminals for absorbing said impulses, means in said control means for transmitting a ringing signal after all of the trains of impulses required for the establishment of a connection have been transmitted, signal receiving means individual to said trunk circuit for responding to a ringing signal, and means effective a predetermined interval of time after the last train of impulses transmitted by said control means has been received by said trunk circuit for connecting said signal receiving means to receive said ringing signal.

8. In an automatic telephone system, impulse controlled switches, control means effective to transmit trains of impulses to operate said switches to establish desired connections, a trunk circuit connected to a set of terminals representing an unassigned code in the bank of one of said switches, means in said trunk circuit responsive to the train of impulses transmitted by the control means after seizure of said set of terminals for absorbing said impulses, means in said control means for transmitting a ringing signal after all of the trains of impulses required for the establishment of a connection have been transmitted, signal receiving means individual to said trunk circuit for responding to a ringing signal, means effective a predetermined interval of time after the last train of impulses transmitted by said control means has been received by said trunk circuit for connecting said signal receiving means to receive said ringing signal, an intercepting operator's position, and means including switching means operative in response to the operation of said signal receiving means for effecting the connection of said trunk circuit to said operator's position.

MYRON C. GODDARD.