

May 5, 1931.

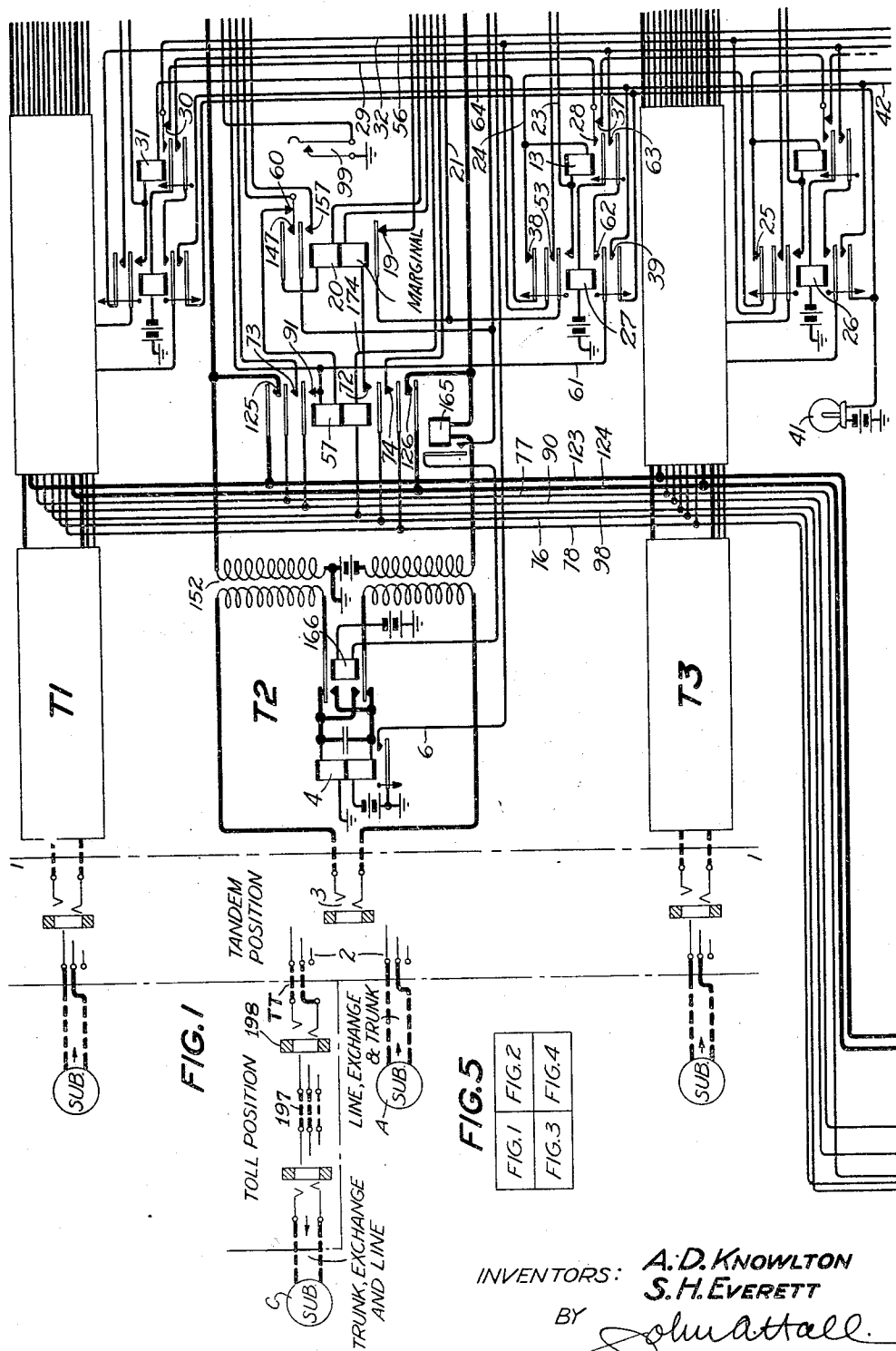
A. D. KNOWLTON ET AL

1,804,169

TELEPHONE EXCHANGE SYSTEM

Filed Nov. 21, 1928

4 Sheets-Sheet 1



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TELEPHONE EXCHANGE SYSTEM

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4 Sheets-Sheet 2

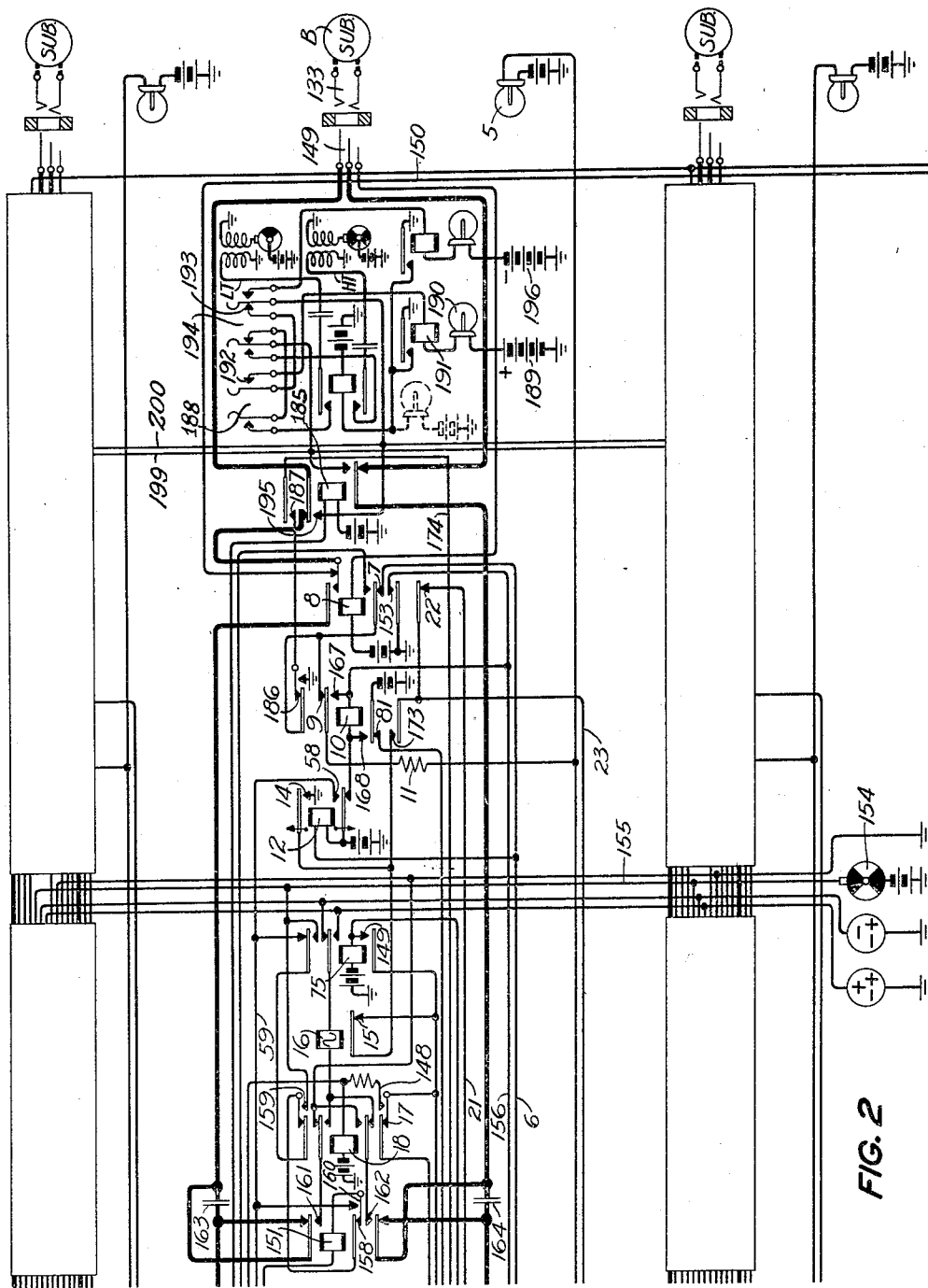


FIG. 2

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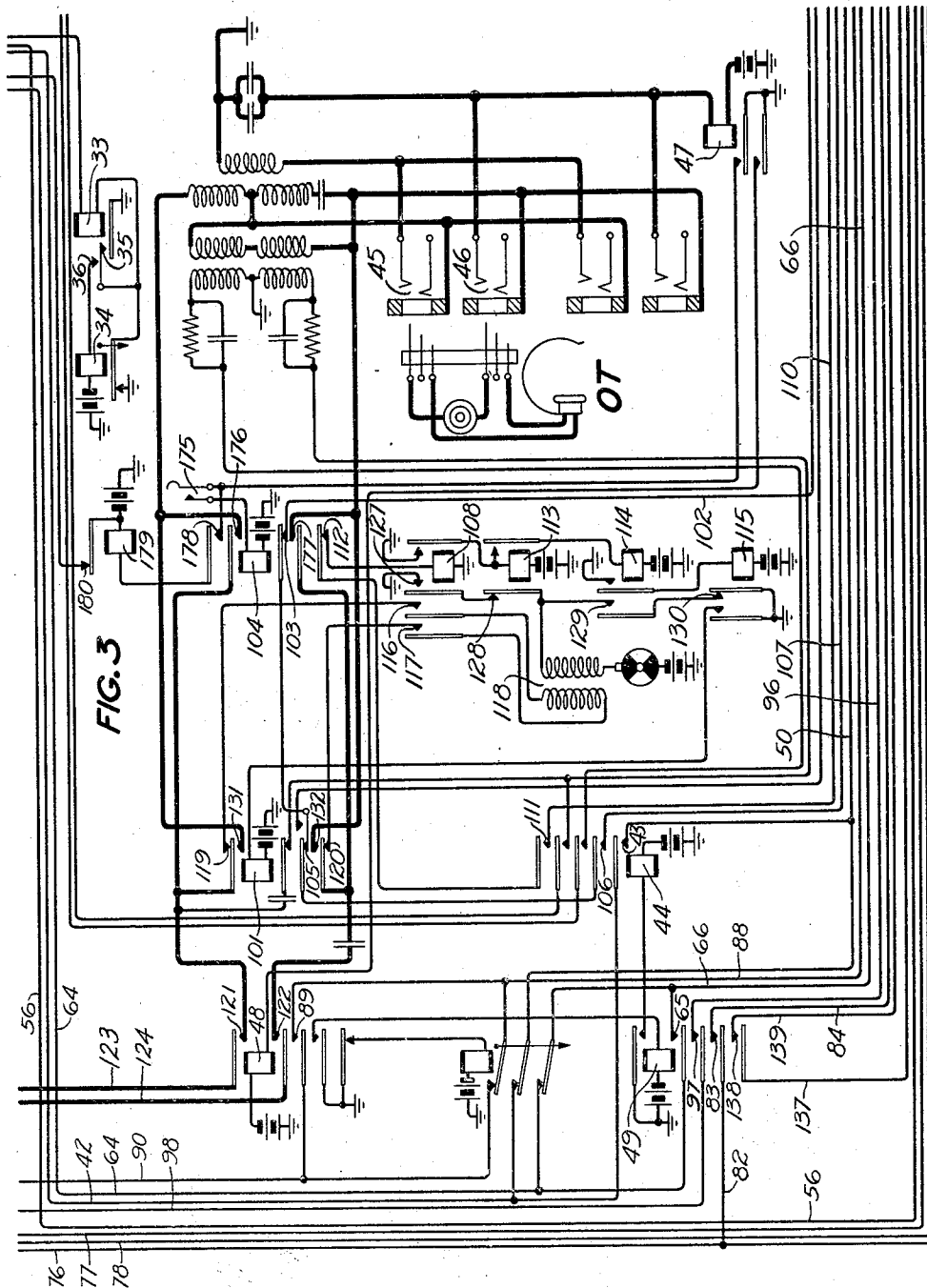
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4 Sheets-Sheet 3



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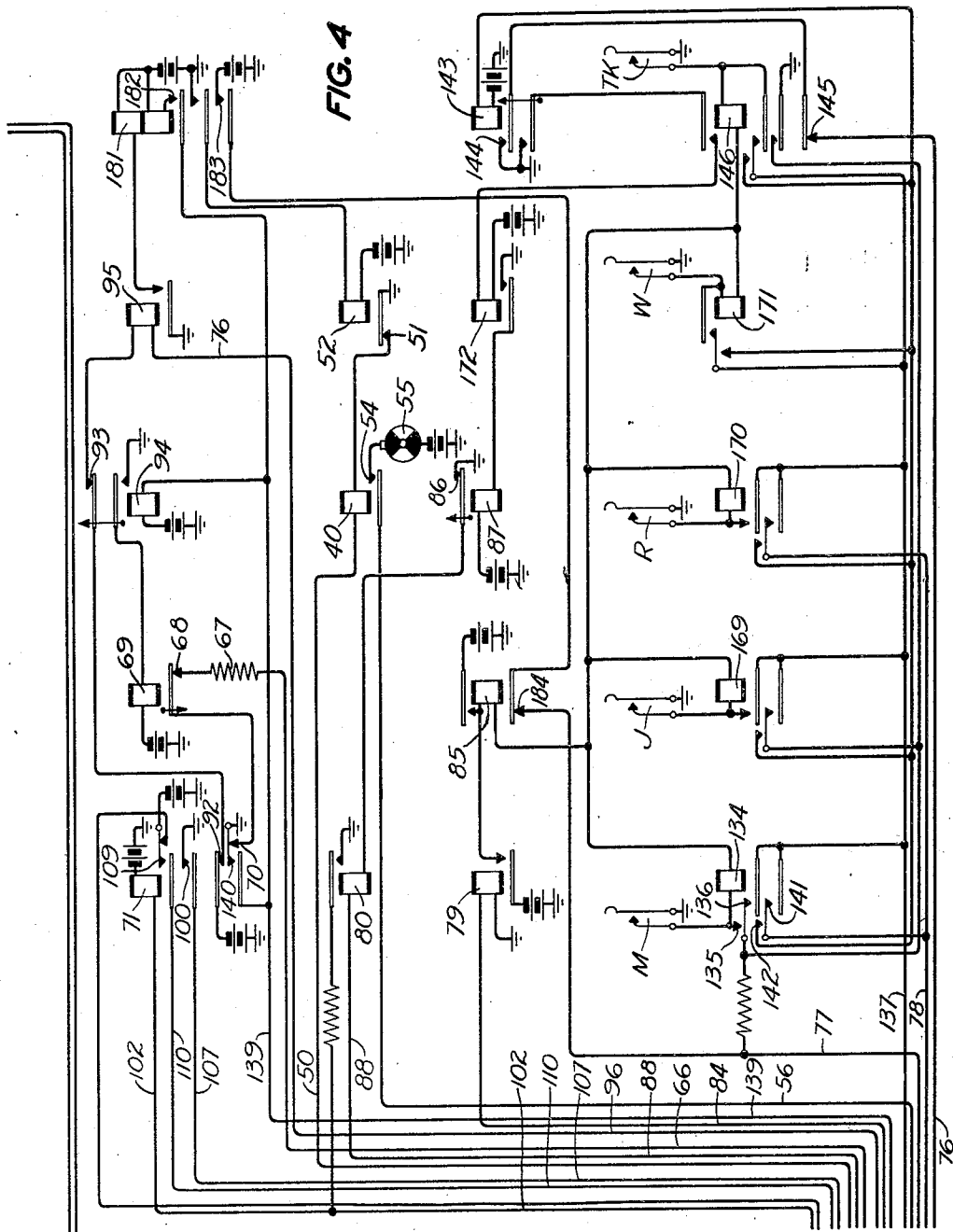
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TELEPHONE EXCHANGE SYSTEM

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4 Sheets-Sheet 4



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TELEPHONE EXCHANGE SYSTEM

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This invention relates to telephone toll systems, and more particularly to what are known as prepayment coin box station systems in which a coin must be deposited at the subscriber's station before a connection can

be established with the central office, the said coin being collected in case the desired call is completed and returned to the subscriber in case the call is not completed.

In such systems the central office operator usually controls a polarized electromagnetic device at the subscriber's station by means of current of the proper polarity applied to one conductor of the line, whereby the coin deposited by the subscriber is either caused to fall into the coin box or into a chute leading to a cup on the outside of the box, where it may be recovered by the person making the call.

The central office arrangement for performing the above function usually consists of two keys individual to each link circuit, one for collecting and the other for refunding a deposited coin. When the operator desires to collect or refund the coin she depresses the proper key associated with the link circuit connected to the coin box line. This act results in splitting the link and connecting either positive or negative high voltage direct current to the tip conductor and thence over the tip of the line to the winding of the polarized electromagnet at the calling station.

In certain switchboard positions, particularly those arranged for terminating straightforward toll switching trunks, it has been common practice to provide for individual coin collect and refund keys for each trunk. This entails considerable space and wiring which could be advantageously used otherwise by the substitution of common equipment for such individual equipment.

An object of the present invention, therefore, is to conserve keyboard space and reduce the amount of local wiring in switchboard positions for handling trunk circuits, of the character described.

In accompanying this object the principal feature of the invention is the provision of a circuit arrangement for a common collect and

refund key per position in substitution for the individual keys per trunk heretofore employed.

Another feature of the invention is the use of a key individual to a trunk which functions at one time in one manner and at another time, and under proper conditions, in another manner, in cooperation with the common collect and refund keys.

Other features will appear from the following description when read in connection with the accompanying drawings which when placed together, with Fig. 2 at the right and Fig. 3 below Fig. 1, and Fig. 4 below Fig. 2 and to the right of Fig. 3, represent a group of three straightforward tandem completing trunk circuits, together with common positional equipment, in accordance with the invention. Fig. 5 is a diagram showing the relation of Figs. 1 to 4 with respect to each other.

It will first be assumed that a calling subscriber A (Fig. 1) desires to be connected with a subscriber B (Fig. 2) and that an "A" operator at whose position the calling subscriber's line terminates has connected the subscriber's line by means of a cord circuit with an idle trunk circuit extending to a tandem operator's position and the tandem operator has further extended the connection to the desired distant exchange over a tandem completing trunk circuit which is represented by the equipment shown to the right of the broken vertical line 1-1 (Figs. 1 and 2) and by the common equipment shown by Figs. 3 and 4.

When the tandem operator inserts the plug end of the incoming trunk 2 in the jack 3, line relay 4 operates in an obvious circuit, which in turn lights the guard and disconnect lamp 5 in a circuit which can be traced from ground, contacts of relay 4, conductor 6, contacts 7 of relay 8, contacts 9 of relay 10, resistance 11 and lamp 5 to battery.

Relay 4 also operates relay 12 over an obvious circuit including conductor 6. Relay 12 in operating actuates the start relay 13 associated with this particular trunk, the circuit for which can be traced from ground, contacts 14 of relay 12, contacts 15 of relay 16,

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contacts 17 of relay 18, contacts 19 of relay 20, conductor 21, contacts 22 of relay 8, conductor 23, winding of relay 13, conductor 24, chain of contacts 25 of relay 26 and contacts 180 of relay 179 to battery. Relay 13 in
 5 operating completes a circuit for operating relay 27, which can be traced from battery, winding of relay 27, contacts 28 of relay 13, conductor 29, contacts 30 of relay 31, con-
 10 ductor 32, relay 33 and the normal contacts of relay 34 to ground.

Relay 33 operates in this circuit, supplies ground at its contacts 35 to lock itself in the before-traced circuit and by closing its con-
 15 tacts 36 completes an energizing circuit for slow-releasing relay 34, which in operating removes the original operating ground for the circuit first traced. The function of relay 33 and 34 will appear later in the description.

20 Relay 27 operates in series with relay 33 and is held operated by ground at contacts 35 of relay 33.

Relay 13 in operating opens at its contacts 37 the energizing circuit for relays corre-
 25 sponding to 27 associated with all the trunks having a number higher than T2, as, for example, T3.

Relay 27 in operating opens at its contacts 38 the energizing circuit for relays corre-
 30 sponding to relay 13 associated with all trunks having a lower number than T2, as, for example, T1.

Relay 27 in operating also closes its con-
 35 tacts 39, thereby completing a circuit for relay 40 (Fig. 4), which can be traced from battery through the pilot lamp 41, contacts 39 of relay 27, conductor 42, contacts 43 of relay 44, which relay is energized when the tandem completing operator is at her posi-
 40 tion, conductor 50, winding of relay 40 and contacts 51 of relay 52 to ground. It should be noted at this time that when the operator has her telephone set OT (Fig. 3) plugged into jacks 45 and 46, relays 47, 48, 49 and 44
 45 operate in sequence and remain operated as long as the operator occupies the position.

When relay 27 operated it also closed its contacts 53 which, together with the closure of contacts 54 of relay 40, completes a cir-
 50 cuit for flashing the guard and disconnect lamp 5 by periodically short-circuiting it under control of interrupter 55. This short-circuit can be traced from the upper termi-
 55 nal of the lamp 5, contacts 53 of relay 27, conductor 56 and contacts 54 of relay 40 to the interrupter 55, which in operating periodically connects battery to the upper terminal of lamp 5, which in effect short-circuits and momentarily extinguishes it.

60 The operation of relay 27 further performs the function of operating relay 57 which connects the trunk T2 into the position circuit and ultimately causes the operator's telephone set OT to be connected to
 65 the trunk.

The circuit for operating relay 57 can be traced from battery, contacts 58 of relay 12, conductor 59, contacts 60 of relay 20, upper winding of relay 57, conductor 61, contacts 62 of relay 27, contacts 63 of relay 13, con-
 70 ductor 64, contacts 65 of relay 49, conductor 66, resistance 67, contacts 68 of relay 69 and contacts 70 of relay 71 to ground.

Relay 57 in operating, as before stated, connects the trunk into the position circuit and at its contacts 72, 73 and 74 connects the
 75 trunk relays 18 and 75 over conductors 76, 77 and 78, respectively, to the common ringing key equipment shown at the bottom of Fig. 4.

Relay 57 also operates relays 79 and 80. The circuit for relay 79 can be traced from battery, contacts 81 of relay 10, lower wind-
 80 ing of marginal relay 20, contacts 72 of relay 57, conductors 76 and 82, contacts 83 of relay 49, conductor 84, and winding of relay 79 to ground. Due to the resistance of relay 79, relay 20, which is marginal, does not operate at this time. The operation of relay 79 per-
 85 forms no function at this time other than prepare a circuit for operating certain relays when any one of the master ringing keys M, J, R, W or TK is depressed to be hereinafter described.

The operating circuit for relay 80 can be traced from ground, contacts 86 of relay 87, winding of relay 80, conductor 88, contacts 89 of relay 48, conductor 90, contacts 91 of relay 57, upper winding of relay 57, contacts 60 of relay 20, conductor 59 and contacts 58
 90 of relay 12 to battery. This last traced circuit, which was completed at contacts 91 of relay 57, serves to hold relay 57 operated under control of marginal relay 20, which will not operate until a ringing key is de-
 95 pressed.

Relay 80 in operating completes an obvious circuit for operating relay 71, which in at-
 100 tracting its armature removes ground from conductors 66 and 64. In cases when the operator has reconnected her set to the trunk by means of the listening key 99, this removal of ground prevents any other trunk relays, corresponding to relay 57, from operating until the operator has finished with the pres-
 105 ent trunk and is released therefrom.

When relay 71 operated it closed, at its contacts 100, a momentary locking circuit for itself under control of relay 101, which lock-
 110 ing circuit can be traced from battery, winding of relay 71, conductor 102, contacts 103 of relay 104, contacts 105 of relay 101, contacts 106 of relay 44, conductor 107 and con-
 115 tacts 100 of relay 71 to ground.

By opening its contacts 92, relay 71 re-
 120 moves battery from the circuit extending through contacts 93 of relay 94, winding of relay 95, conductor 96, contacts 97 of relay 49, conductor 98, lower winding of listening relay 57 and conductor 174, to the open con-
 125
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tacts 187 of relay 185 controlled by emergency listening key 99, thereby preventing the operation of any other relay, corresponding to relay 57, in case the listening key 99 of another trunk should be actuated before the operator is released from the present trunk.

Relay 71 in operating also closes a circuit to energize relay 108, which can be traced from battery, contacts 109 of relay 71, conductor 110, contacts 111 of relay 44, contacts 112 of relay 104 and winding of relay 108 to ground. Relay 108 in operating causes the consecutive operation of relays 113, 114, 115 and 101, the operating circuits of which are obvious.

When relay 108 operates it closes its contacts 116 and 117, which connect the secondary or left hand winding of transformer 118 to the trunk over contacts 119 and 120 of relay 101, contacts 121 and 122 of relay 48, conductors 123 and 124, and contacts 125 and 126 of relay 57. Relay 108 also closes, at its contacts 127, a circuit for interrupted battery through the primary or right hand winding of transformer 118 to ground, thereby causing induced alternating current of audible frequency to be generated, and transmitted over the previously traced circuit to the trunk.

A short interval after relay 108 operates relay 113 operates, which opens, at its normally closed contacts 128, the interrupted battery circuit through the right hand winding of transformer 118, which discontinues the induced current. Relay 113 also closes the operating circuit for relay 114, which in turn closes, at its contacts 129, a new and obvious circuit to ground for the interrupted battery associated with transformer 118, which thereupon generates a second A. C. impulse which is transmitted to the trunk. Relay 114 also closes, at its inner contacts, a circuit to energize relay 115 which opens its contacts 130 and disconnects ground from the transformer primary, thereby cutting off the induced current a second time.

The connection and disconnection of alternating current of audible frequency to the trunk, twice repeated by the consecutive operation of relays 108, 113, 114 and 115, gives the effect of the two short "zips" of tone flowing back over the trunk to the calling local exchange as a signal to the calling operator to pass the number of the desired subscriber.

Relay 115 also closes its outer left contacts thereby completing an obvious energizing circuit for relay 101 which operates and disconnects, at its contacts 119 and 120, the transformer 118 from the trunk and substitutes the operator's set OT by closing its contacts 131 and 132, whereupon the calling local exchange operator and the tandem com-

pleting trunk operator are in direct telephonic communication.

After the tandem completing trunk operator has received the number and party designation, if any, of the called subscriber, she proceeds to set up the proper circuit combination to cause ringing current to actuate the bell of the desired subscriber.

Let it be assumed that the called subscriber is party M on line 133. The trunk operator will, therefore, depress ringing key M which connects ground to cause the operation of relay 134 in a circuit which includes the winding of relay 85 and contacts of operated relay 79 to battery. Relay 85 operates in series with relay 134 and both relays are locked up in the following circuit: Battery, upper contacts and winding of relay 85, winding and contacts 135 and 136 of relay 134, conductor 137, contacts 138 of relay 49, conductor 139 and contacts 140 of relay 71 to ground.

When relay 134 operated it closed its contacts 136 and 141, thereby connecting ground, supplied over conductor 137 from relay 71, to conductors 77 and 78, which causes the operation of relays 18 and 75 in the trunk circuit. Relay 18 locks up over its contacts 148, contacts 15 of relay 16, and contacts 14 of relay 12 to ground, and relay 75 locks up at its contacts 149 over the same circuit. Relays 18 and 75 are therefore held up under control of the tripping relay 16.

Relay 134 also closes its contacts 142, which connects ground, supplied over conductor 137, to operate relay 143, which relay in operating closes its contacts 144, and connects ground, over contact 145 of relay 146, to conductor 76 leading to the trunk circuit where it passes over contacts 72 of relay 57, lower winding of marginal relay 20, and contacts 81 of relay 10 to battery. Relay 20, which is marginal and not operated heretofore, now operates and locks up in the following circuit. Battery, contacts 58 of relay 12, conductor 59, contact 147, upper winding of relay 20, contacts 15 of relay 16 and contacts 14 of relay 12 to ground.

Both relays 18 and 20 open the circuit previously traced for energizing relay 13 which now releases and in turn releases relay 27. Relay 27 thereupon opens its contacts 39 which deenergizes relay 40, thereby removing the flashing condition from lamp 5 and permitting it to burn steadily.

Relay 20, by opening its contacts 60, causes relay 57 to release, which opens its multiple contacts 125, 73, 91, 72, 74 and 126 and disconnects the trunk from the position equipment including the operating telephone, as shown in Figs. 3 and 4. Relay 20 also causes the release of relays 80, 71, 94, 69, 108, 113, 114, 115 and 101.

The trunk operator now makes the usual busy test by touching the tip of plug 149

to the sleeve of jack 133 and, if she hears no click, inserts the plug into the jack, whereupon sleeve relay 8 operates in an obvious circuit. Relay 8 disconnects the busy test conductor 150 from the trunk and connects the tip of the trunk plug through contacts of relay 151 to the upper half of the right hand winding of repeating coil 152. Relay 8 also opens its contacts 7, thereby extinguishes the guard and disconnect lamp 5, and by closing its contacts 153, prepares a circuit for operating ringing relay 151, which is energized when the "pick-up" interrupter 154 connects battery to conductor 155.

The circuit for relay 151 can be traced from ground, contacts 153 of relay 8, conductor 156, contacts 157 of relay 20, winding of relay 151, contacts 158 of the same relay contacts 159 of relay 18, and conductor 155 to battery when the commutator of interrupter 154 is in the proper position.

Relay 151 locks up, at its contacts 160, over conductor 59 and contacts 58 of relay 12 to battery.

Positive pulsating ringing current is now connected to the tip-side of the called line at contacts 161 of relay 151 and ground is connected to the ring-side at contacts 162, which causes the polarized armature of the "M" party ringer on the called line to vibrate. When the called subscriber's receiver is removed from the switchhook tripping relay 16 operates in the usual manner due to increased current flowing through its winding.

Relay 16 releases relays 20, 75 and 18 and the release of relay 20 opens the holding circuit of relay 151, which releases and disconnects ringing current from the called line.

When relay 151 releases it retracts its armatures and short-circuits condensers 163 and 164, thereby completing a circuit for supplying battery to the called line and operating supervisory relay 165. Relay 165 causes reversing relay 166 to operate, which reverses the current flow in the calling end of the trunk, thereby giving supervision to the "A" operator at the originating office in the usual manner.

When the receiver at the called station is replaced on the switchhook, supervisory relay 165 releases, which in turn releases relay 166 to again reverse the current flow in the trunk, thereby giving the "A" operator at the originating office the usual signal that the called subscriber has hung up.

When the tandem operator disconnects trunk circuit 2 from the tandem completing trunk jack 3, upon receiving a disconnect signal from the local "A" operator, relay 4 releases which in turn releases relay 12. Relay 12 released, closes an energizing circuit for relay 10, which can be traced from battery, lower back contacts of relay 12,

winding of relay 10 and contacts 153 of relay 8 to ground. Relay 10 operated lights lamp 5 as a disconnect signal. This circuit can be traced from ground, contacts 153 of relay 8, contacts 167 of relay 10, resistance 11 and lamp 5 to battery. Relay 10 also locks up in the following circuit: battery, contacts 168, winding of relay 10, and contacts 153 of relay 8 to ground.

When the trunk operator withdraws plug 149, relay 8 releases which releases relay 10. Relay 10 in turn extinguishes lamp 5 and restores the circuit to normal.

In case the trunk operator is requested to ring J instead of M she operates ringing key J, whereupon relays 18 and 169 operate over circuits heretofore traced. Relay 18 in operating causes relays 13, 27 and 40 to release in the order mentioned. The release of relay 27 disconnects the interrupter 55 from the lamp 5, thus permitting it to burn steadily.

Relay 169 also operates relay 143 which in turn operates relay 20 which opens the locking circuit previously traced for relay 57 which now releases and disconnects the trunk from the common equipment shown in Figs. 3 and 4. Relay 20 in operating also causes relays 80, 71, 94, 69, 108, 113, 114, 115, and 101 to release.

With relay 18 only operated negative pulsating current is connected to the tip of the called line and relay 151 operates as previously described.

In case party R is desired key R is depressed, which causes the operation of relay 170, which in turn operates relays 75 and 143. The effect of the operation of relay 143 is the same as previously described.

Relay 75, being operated alone, connects positive pulsating current to the ring side of the called line when relay 151 operates as previously described.

If the W party is desired the operation of key W causes the operation of relays 171 and 143 in sequence. Relay 171 has no effect on either relay 18 or 75 and therefore relay 151, when operated, is effective to connect negative pulsating current to the ring side and ground to the tip of the called line.

If instead of being connected to a subscriber's line the tandem completing trunk T2 is to be further extended over another trunk circuit, not shown, ringing on the outgoing trunk should be prevented and, therefore, for this purpose a fifth key, designated TK, is provided which when operated causes the operation of relay 146. Relay 146 operates relay 18, which releases relays 13, 27 and 40. The release of relay 27, as previously mentioned stops the flashing of lamp 5. Relay 146 also operates relay 143, which causes relay 172 to be energized, which in turn operates relay 87. Relay 87 operated causes the release of relays 80, 57, 71, 94, 69, 108, 113, 114, 115 and 101. The release of

relay 57 disconnects the common equipment including the ringing circuit and operator's telephone, as previously described.

When the operator plugs into the outgoing trunk the sleeve relay 8 will operate as usual, thereby extinguishing the lamp 5. However, ringing relay 151 cannot operate as before for the reason that its circuit is open at contacts 157 of relay 20, this relay having been prevented from operating by the opening of contacts 145 when relay 146 operated in response to the actuation of the trunk or non-ringing key TK. Ringing is, therefore, prevented under the foregoing condition by the non-operation of relay 151.

It may happen that the tandem completing trunk operator receives an order to extend the calling trunk to a line which is marked in such a manner as to indicate, for example, that the line is out of order, the number has been changed, or service is denied, etc. and under this condition the switching operator is instructed to plug the calling trunk into what is known as an intercepting trunk leading to a special operator who inquires the number being called and endeavors to either arrange for completion of the call or to explain to the calling subscriber why the call cannot be completed.

If, for example, the called subscriber's number has been changed, the special operator will ascertain the present number and pass it to the switching operator over a "loop-back" circuit, not shown, whereupon the switching operator will disconnect from the intercepting trunk and make connection with the called subscriber's new number.

When the tandem completing operator plugged into the intercepting trunk, she operated the non-ring key TK, thereby operating relay 18 in the calling trunk circuit which at once locked itself to relay 12 under control of relay 16.

Due to the fact that the operating circuit for relay 151 is open at contacts 157 of relay 20, which relay is not operated under the "no-ring" condition, relay 151 is not energized to connect ringing current to the line and, therefore, tripping relay 16 is not operated when the called operator answers. Under this condition relay 18 would remain locked up until the tandem operator disconnects, except for the provision of some other release means, which will now be described.

The release of relay 18 after disconnection of the tandem completing trunk from an intercepting trunk is accomplished in the following manner: After the intercepting operator informs the tandem completing operator as to the proper routing of the call, as, for example, the new number of the called subscriber, the tandem completing operator depresses the emergency key 99 associated with the trunk over which the call arrived and holds this key operated while withdrawing

plug 149 from the intercepting trunk jack. Relay 185 is thereby operated over an obvious circuit.

When the plug is withdrawn sleeve relay 8 releases, thereby completing the circuit prepared for the operation of relay 57 in the trunk circuit and relay 95 in the common ringing key circuit (Fig. 4). This circuit can be traced from ground at line relay 4, conductor 6, contacts 7 of relay 8, contacts 186 of relay 10, contacts 187 of relay 185, conductor 174, lower winding of relay 57, contacts of key 99, conductor 98, contacts 97 of relay 49, conductor 96, winding of relay 95, contacts 93 of relay 94, and contacts 92 of relay 71 to battery. Relay 57 operates to connect the common equipment to the trunk once more and locks in the following circuit: battery, contacts 58 of relay 12, conductor 59, contacts 60 of relay 20, upper winding and contacts 91 of relay 57, conductor 90, contacts 89 of relay 48, conductor 88, winding of relay 80, and contacts 86 of relay 87 to ground.

Relay 80 is effective through the operation of relay 71 to start the tone relays 108, etc. in operation and to cause the ultimate connection of the operator's telephone OT to the trunk as previously described.

Relay 95 (Fig. 4) which operated in series with relay 57 when key 99 was depressed and 185 operated, operates relay 181. Relay 181 locks itself operated over contacts 182 to ground at contacts 140 of relay 71 which operated in response to the operation of relay 80.

Relay 181 also closes its contacts 183 thereby short-circuiting relay 18 in the trunk circuit and causing it to release. This circuit can be traced from battery, contacts 183 of relay 181, contacts 184 of relay 85, conductor 77, contacts 73 of relay 57, to one terminal of the winding of relay 18 the other terminal of which is also connected to battery.

The circuit is now in readiness for a new setting of the common ringing key circuit.

If however the operator, had already operated one of the ringing keys M, J, R, or W, and plugged into the intercepting trunk, either relay 18 would not be operated in the case of R or W, or would operate when key M or J was operated. In this case the intercepting trunk is so arranged that the ringing will be automatically tripped when the intercepting operator answers thereby causing the circuit to function in the usual manner and release relay 18 if operated.

It should be noted that pilot lamp 41, under normal conditions, is steadily lighted in response to connection of the operator's set to a calling trunk in conjunction with the flashing of the guard and disconnect lamp 5. However, in the case of intercepting service when the operator has reconnected herself

to a trunk, by operating key 99, relay 181 is operated which in turn operates relay 52 to hold open the energizing circuit for flashing relay 40 which circuit also includes the pilot lamp 41. This prevents pilot lamp 41 from being lighted when the operator reconnects to the trunk as the lighting of this lamp, under these conditions, would give a misleading indication to a supervising operator of the manner in which the operator was handling calls at her position.

If the trunk operator plugs into the jack of the called line before pressing a ringing or the "non-ring" key, lamp 5 will continue to flash as an indication to the operator that she has not set the ringing combination. When a ringing or non-ring key is operated the lamp 5 is extinguished and the operator's telephone and common ringing key equipment, as shown in Figs. 3 and 4, are disconnected from the trunk by the release of relay 57 which is brought about by the operation of relay 20 or relay 87, depending upon whether a ringing or non-ring key is operated.

If after the called subscriber has hung up and the tandem operator has disconnected the tandem trunk 2 from the tandem completing trunk and before the completing trunk operator has removed the plug 149 from the called line, the tandem operator reselects the trunk T2 by again connecting a trunk 2 with the jack 3, the relay 10 having been operated and locked when the tandem operator disconnected, relays 13, 27 and 57 are operated and the circuit functions as previously described due to the fact that relays 4 and 12 reoperate in response to reselection of the trunk. The operating circuit for relay 13 extends from ground, contacts 14 of relay 12, contacts 173 of relay 10, conductor 23, winding of relay 13, conductor 24, contacts 25 of relay 26 to battery.

In case the completing operator should, through force of habit, operate one of the ringing keys after receiving the new order and before disconnecting the trunk from the previously called line, such action will be ineffective to set the ringing and release relays 13, 27, etc. for the reason that the operating circuit for relay 79 is held open at contacts 81 of relay 10. With relay 79 normal, the operating path for relays 134, 169, 170, 171 and 146 is open and nothing happens until the plug 149 is freed from the jack, whereupon relay 8 is released, followed by relay 10, which in turn operates relay 79 which prepares a circuit for the proper functioning of the master ringing key equipment.

The lamp 5 which started flashing as soon as relay 27 operated, continues to flash after plug 149 is removed from jack 133, and until a ringing key is operated.

In case the sequence relays 13, 27, etc. are not operating for some reason or when it is

desired to reestablish immediate connections with a trunk which has previously been released, the operator may operate emergency trunk listening key 99 which completes an obvious circuit for operating relay 185 which in turn completes an auxiliary operating circuit for relay 57 which can be traced from ground, contacts of relay 4, conductors 6, contacts 7 of relay 8, contacts 186 of relay 10, contacts 187 of relay 185, conductor 174, lower winding of relay 57, conductor 98, contacts 97 or relay 49, conductor 96, winding of relay 95, contacts 93 of relay 94, and contacts 92 of relay 71 to battery. The operation of relay 57 will connect the operator's telephone and the common ringing equipment to the trunk in the same manner as before described in connection with automatic listening except that lamp 5, if lighted by reason of a waiting call, will not flash due to the fact that relay 27 is not operated. When relay 57 operates it locks up in the before described circuit, which includes relay 80. Relay 80 operates and closes a circuit to operate relay 71, which last relay disconnects, at its contacts 92, the battery previously supplied over conductor 98 to all the armature contacts 187 of such relays as 185. This prevents two trunks from being simultaneously connected to the common listening circuit by actuation of a second emergency listening key. In case the tone relays 109, 113, 114, 115 and 101 are not functioning properly and it is desired to operate the entire position on an emergency listening basis for an indefinite period, it may be considered advisable to disable both the tone relays in the position and the sequence relays of all the trunks incoming to the position. This is accomplished by operating the position key 175 which locks in its depressed position and closes a circuit to operate relay 104 which opens, at its contact 112, the emergency circuit for the first of the tone relays 108 and, at its contact 103, opens conductor 102 thereby preventing relay 71 from locking up when it is operated in response to the operation of a trunk listening key such as 99.

Relay 104 also connects, at its contacts 176 and 177, the operator's telephone set to the armature side of contacts 125 and 126 of relay 57 over contacts 121 and 122 of relay 48 and conductors 123 and 124. When relay 57 is operated by the actuation of key 99, the operator's set is connected to the trunk.

In addition to the foregoing functions relay 104 closes contacts 178 thereby energizing relay 179, ground for which can be traced from the inner contacts of relay 47.

Relay 179 disconnects battery from lead 180 thereby preventing any of the trunk sequence relays 13, 31, etc., from operating in response to a call over its associated trunk circuit.

It will now be assumed that the outgoing

end of tandem completing trunk T2 is represented by jack 3 located at a tandem switching operator's position and is accessible to a tandem trunk TT the outgoing end of which is located at a completing toll operator's position, this operator's duties being to complete and supervise connections between calling and called subscribers for which a toll charge is assessed and that, in the present instance, it is assumed that the calling subscriber is "B" shown at the right of Fig. 2 and the called subscriber "C" (Fig. 1). It will be further assumed that subscriber "B's" substation is provided with a prepayment coin box.

If "B" initiates a call for subscriber "C", in a distant exchange which is reached through a toll operator, the call is received by a local operator (not shown) in the exchange in which "B's" line terminates whereupon the calling subscriber's line will be extended over trunk circuits, also not shown, to a recording toll operator who notes the details of the call, including the calling subscriber's line number and exchange, on a slip of paper called a ticket after which the subscriber is told to replace his receiver on the hook and that he will be called when the connection is ready.

The recording operator then passes the ticket to the completing toll operator, previously referred to, who thereupon obtains connection with the called subscriber and at the same time plugs the calling end of a cord circuit 197 into the outgoing jack 198 of what is called a tandem trunk TT which terminates in a plug 2 at a tandem switching operator's position.

By means of apparatus not shown the operator at the tandem switching position is automatically connected to the incoming end of trunk TT in response to seizure of the outgoing end by the toll operator and, upon instructions from the toll operator, insert plug 2 into jack 3 of the tandem completing trunk T2, which terminates in plug 149 (Fig. 2) before a tandem completing operator in the exchange serving the subscriber "B" who made the toll call, whereupon the trunk operator's telephone OT, shown in Fig. 3, is automatically connected to the trunk T2 in a manner hereinbefore described.

The toll operator then requests connection with subscriber "B" and the completing trunk operator inserts plug 149 into the subscriber's line jack 133 and presses the proper ringing key M, J, R, or W, shown on Fig. 4, whereupon the bell of "B's" telephone is rung.

Removal of the receiver at station "B" causes tripping relay 16 to operate in the usual manner. Relay 16 releases relays 20, 75 and 18 and the release of relay 20 opens the holding circuit of relay 151 which releases and disconnects ringing current from the line.

When relay 151 releases it retracts its arma-

ture and short-circuits condensers 163 and 164 thereby completing a circuit for supplying battery to subscriber "B" and operating supervisory relay 165 which causes relay 166 to operate. This causes a reversal of current in the calling end of trunk T2 thereby eventually causing the toll operator's cord supervisory lamp to be extinguished as an indication that a conversational connection now exists between her cord circuit and the calling subscriber "B".

The manner in which the toll operator's supervisory signal is operated forms no part of the present invention and is not shown.

The toll operator upon noting the supervisory signal speaks with subscriber "B" and tells him she is ready with his party and that he must deposit the amount of the toll charge in his coin box. When this is done the calling and the called subscribers are connected.

When the conversation is completed the toll operator immediately communicates with the completing trunk operator, over an idle circuit, which we will assume to be T1, and requests the trunk operator to "collect" on the line 133 extending to subscriber "B". We will further assume that plug 149 is still in jack 133 due to the fact that the toll operator has not disconnected from jack 198 at the toll office which action would be necessary in order to relight lamp 5 at the completing office as a disconnect signal. The trunk operator upon receiving this request simultaneously depresses the emergency listening key 99 and the positional coin collect key 188 associated with trunk T2.

Key 99 which has heretofore been described as an emergency listening key, is ineffective at this time to cause the operator's set OT to be connected to the trunk T2 for the reason that plug 149 is still in jack 133 thereby holding the sleeve relay 8 operated and preventing relay 57 from operating. Relay 185 operates, however, and connects the positive terminal of high voltage (110 volts) battery 189 to the tip conductor of the calling subscriber's line in a circuit which may be traced from battery 189, resistance lamp 190, relay 191, contacts 192 of collect key 188 and normal contacts 193 of refund key 194, contacts 195 of relay 185, the tip of plug 149 and tip spring of jack 133 to the line. This high voltage causes actuation of the polarized magnet at the subscriber's station, in a manner well understood, to cause the coins deposited by the subscriber to fall into the coin compartment.

In case the toll operator requests the trunk operator to "refund" on the calling subscriber's line 133 the trunk operator will simultaneously depress keys 99 and 194 thereby applying negative high voltage battery 196 to the tip of the subscriber's line which causes the polarized magnet at the subscriber's station to move in the opposite direction from

that caused by positive battery thereby causing the coins to fall into a chute leading to the outside of the coin box.

It will, therefore, be observed that only one collect and one return key is required per position and that this common equipment is associated with any desired trunk, over conductors 199 and 200, by means of the individual key 99 associated with that trunk when the trunk is plugged into a subscriber's line at which time the key 99 is ineffective as an emergency listening key.

What is claimed is:

1. In a telephone system, an operator's position, a subscriber's line outgoing therefrom, a plurality of link circuits at said position adapted to connect with said line, a toll device associated with said line, said device being arranged to operate in any one of a plurality of manners, operator controlled switching means at said position common to and associated with said link circuits for selectively controlling the operation of said device, and means comprising a listening key individual to each of said link circuits for individually associating said common means therewith.

2. In a telephone system, an operator's position, an operator's set thereat, a subscriber's line outgoing therefrom, a plurality of link circuits at said position adapted to connect with said line, a key individual to each of said link circuits operable before connection is made with said line for establishing a connection between said operator's set and said link, a toll device associated with said line, said device being arranged to operate in any one of a plurality of different manners, operator controlled switching means at said position common to and associated with said link circuits for selectively controlling the operation of said device, and means under control of said key after connection is made with said line for individually associating said common means therewith.

In witness whereof, we hereunto subscribe our names this 20th day of November, 1928.

ALFRED D. KNOWLTON.
SAMUEL H. EVERETT.