Nov. 13, 1928. 1,691,554

W. SAVILLE

TELEPHONE SYSTEM

Filed April 29, 1926 4 Sheets-Sheet 1

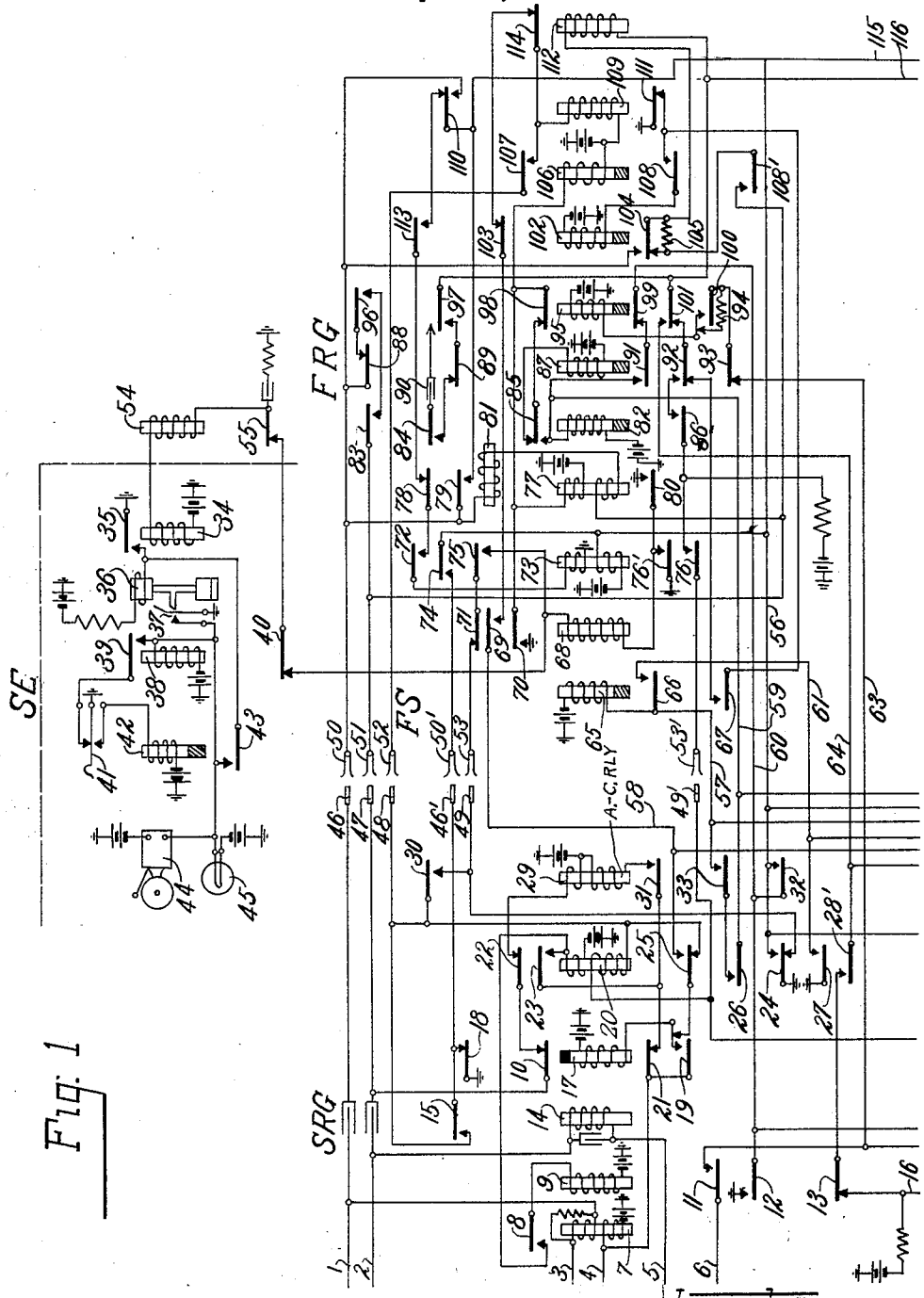


Fig. 1

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Filed April 29, 1926 4 Sheets-Sheet 2

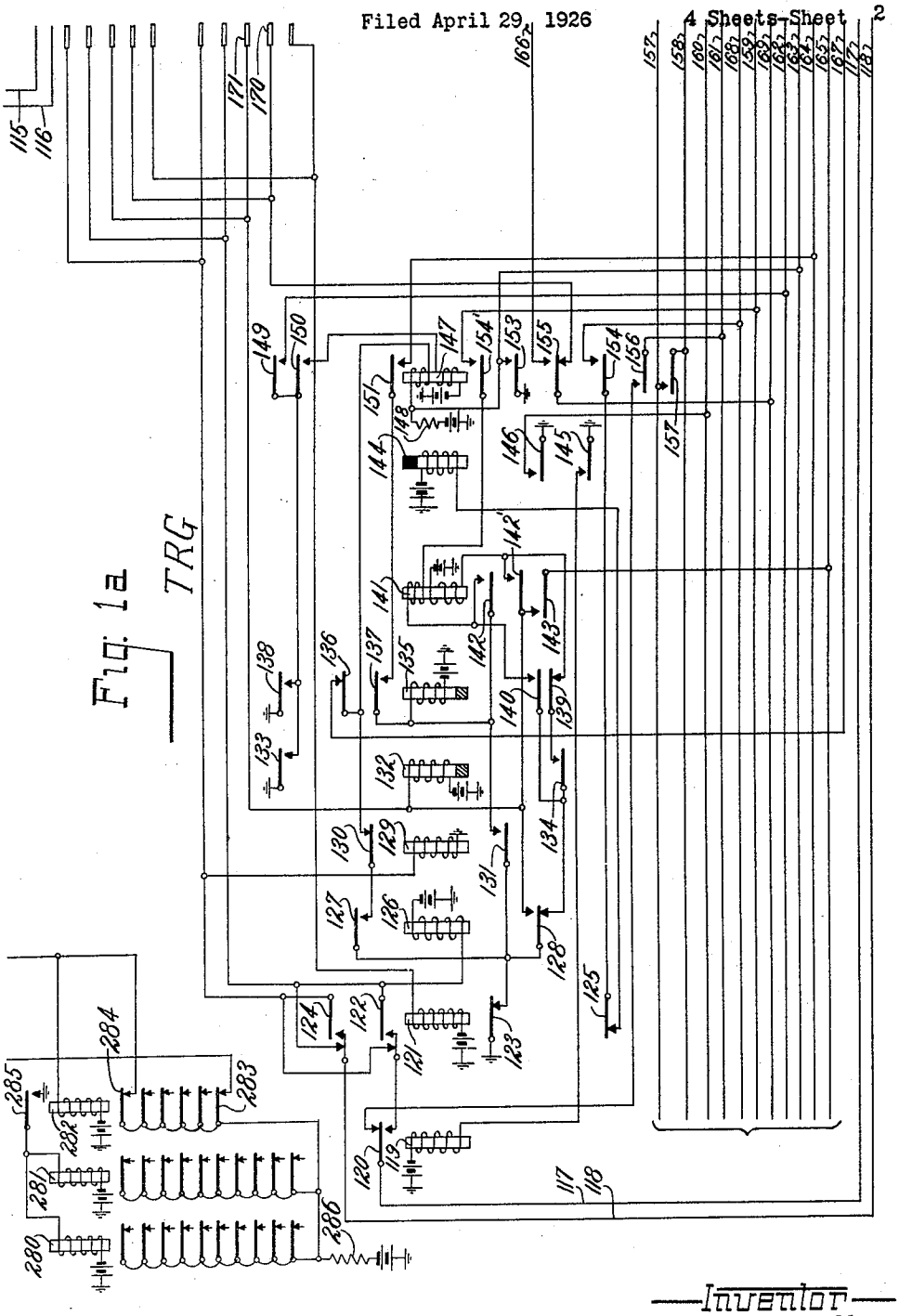


FIG. 1a

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Nov. 13, 1928. 1,691,554

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Filed April 29, 1926 4 Sheets-Sheet 3

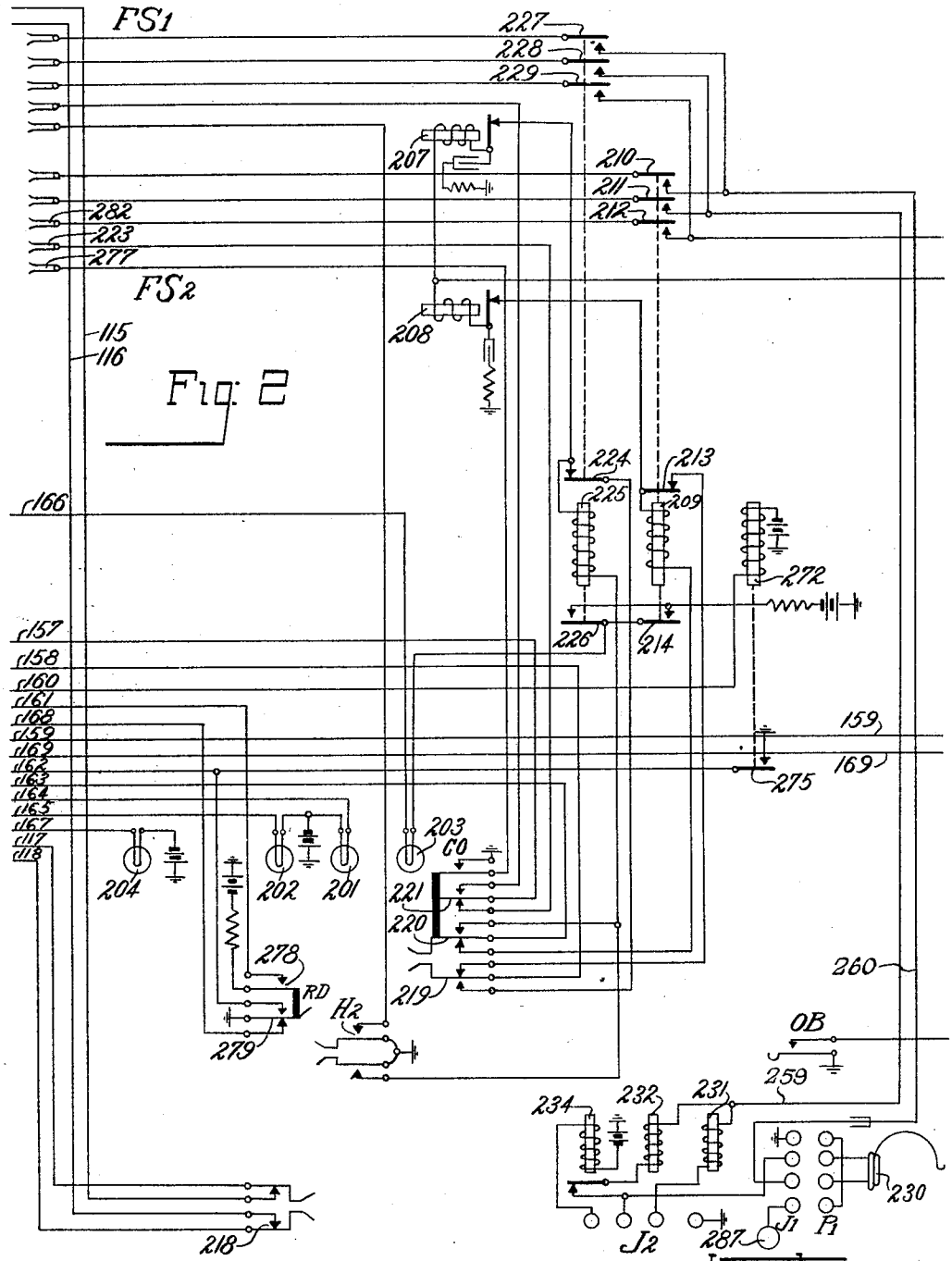


Fig. 2

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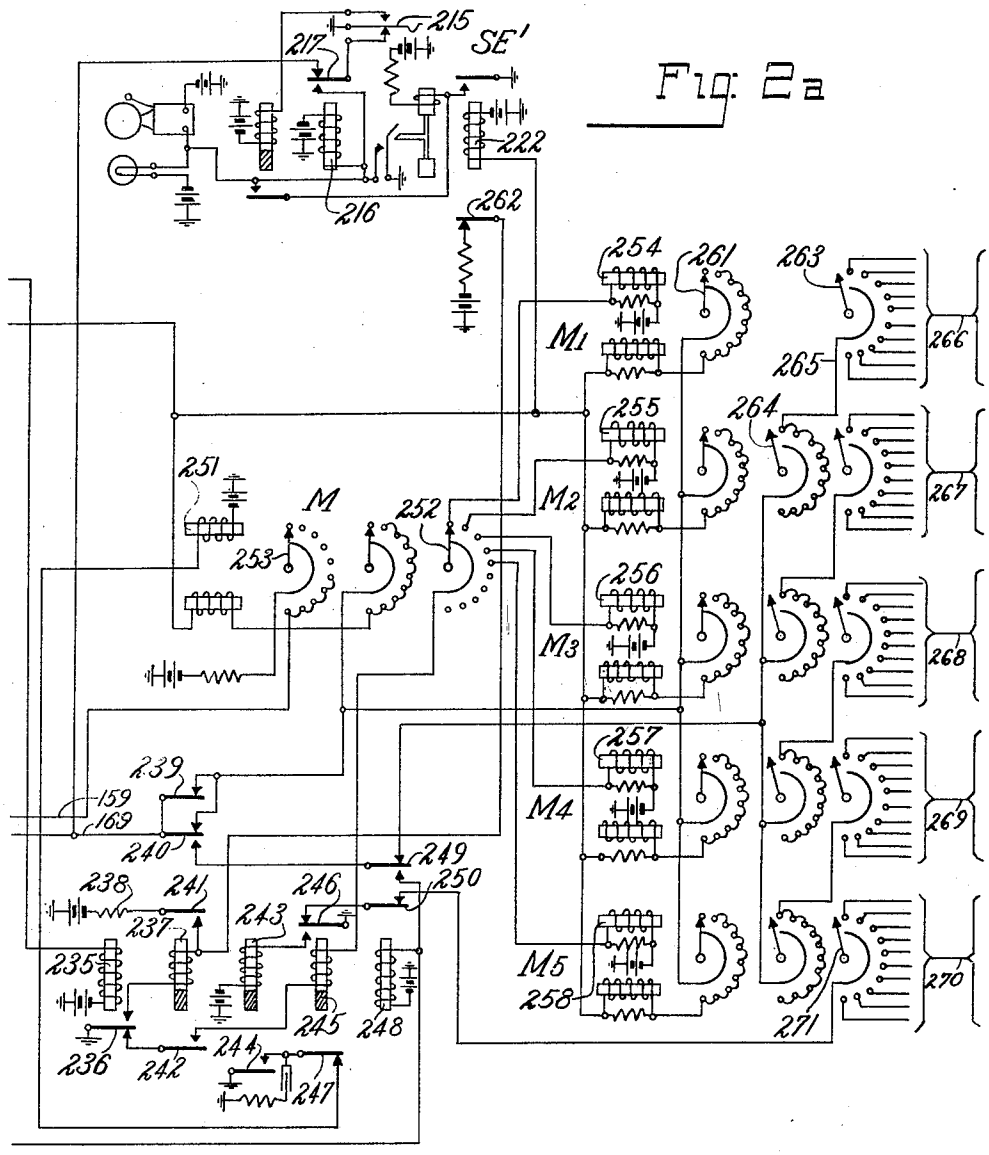
Nov. 13, 1928 1,691,554

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TELEPHONE SYSTEM

Filed April 29, 1926 4 Sheets-Sheet 4

Fig. 2a



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UNITED STATES PATENT OFFICE.

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TELEPHONE SYSTEM.

Application filed April 29, 1926, Serial No. 105,382, and in Great Britain May 26, 1925.

The present invention relates to telephone systems and is more particularly concerned with what is known as service observation equipment, that is to say, apparatus for studying the class of service which is given on a particular subscriber's line and thus investigating and possibly forestalling complaints.

The arrangement according to the present invention is intended to be particularly applicable to the observation of subscribers' lines connected to satellite exchanges, from a central position at the main exchange over two-conductor junctions specially set aside for this purpose, for instance, one for each satellite.

According to one feature of the invention, a subscriber on initiating a call is connected automatically to an observing operator's position in a different exchange over a two-conductor trunk line.

According to another feature of the invention, in a telephone system having subscribers' lines adapted to be connected automatically to an observing operator's position, the connection is effected by a special circuit completed temporarily when a trunk extending to the operator's position is seized, which circuit is ineffective unless the operator's position is free when the circuit is completed.

A further feature of the invention is that in a telephone system having subscribers' lines adapted to be connected automatically to an observing operator's position over one or more non-numerical switches, a subscriber when once connected up to the observer's equipment is again connected up when next he makes or receives a call.

These features and others not specifically mentioned above will be better understood from the following description of one method of carrying the invention into effect, taken in conjunction with the accompanying drawings. It will be understood that this particular embodiment is given by way of example only and that the scope of the invention includes detail modifications which will be readily apparent to these skilled in the art.

The drawings comprising Figs. 1, 1a, 2, 2a, when arranged with Fig. 1 above 1a, Fig. 2 to the right of Fig. 1a and Fig. 2a to the right of Fig. 2 with corresponding lines in alignment, show sufficient details to enable a clear understanding of my invention.

Referring now to the drawings, Fig. 1 shows the apparatus located in a satellite exchange. Fig. 1a shows a trunk relay group located at the incoming end of an observation trunk. Figs. 2 and 2a show the apparatus at the observing operator's position, which, as already pointed out, is located at the main exchange. The arrangement is such that the operator of the main exchange can make observations on subscriber's lines connected to a number of satellite exchanges, a single two-conductor trunk line being used in each case to enable these observations to be made.

Considering first the apparatus in Fig. 1, for each line to be observed there is provided a subscriber's relay group SRG which is connected up in place of the usual jumpers at the main distributing frame. All these relay groups are wired to the contacts of a finder switch FS which is associated with the observation trunk leading to the main exchange, and associated with which also is a finder relay group FRG for receiving signals sent over the trunk line and for controlling the operation of the finder. Each trunk line extends to a disconnect key such as 218 at the observing operator's position and thence to a trunk relay group such as TRG shown in Fig. 1a.

The operator's equipment consists essentially of a number of supervisory lamps and controlling keys and also a bank of indicating lamps adapted to display the number dialled by a calling party. As far as possible this apparatus is common to all the incoming observation trunks and connection is made with a particular one over the finder switch FS^2, or in case this should become faulty, over the auxiliary finder switch FS^1.

The sequence of operations which take place when a subscriber under observation initiates a call will now be traced through in detail. In Fig. 1 the leads 1 and 2 are connected to the subscriber's line, leads 3 and 5 are the speaking conductors extending to his line switch and the bank of the connector, conductor 4 is the release trunk conductor also extending to the line switch and connecter, and conductor 6 extends to the meter. It is assumed in the arrangement described that metering is effected over a separate conductor, but in case booster battery metering is employed, conductors 5 and 6 will be strapped together and slight modifications will be made to the circuits in the finder relay group FRG.

Let first be considered the case in which the finder switch FS is not in use and all the equipment shown is in normal position. When the calling party removes his receiver, a circuit is completed over his loop for the line relay of the line switch, the upper winding of the polarized relay 7 and the relay 14 in series. Relay 7 being polarized does not operate at this time but the line switch commences to hunt in known manner and relay 14 is also energized, thereby operating its armature 15. The effect of this is to complete circuits which extend from earth, armature 18 and its back contact, armature 15 and its front contact, back contact and armature 25, normally closed springs controlled by armature 19, winding of relay 17 to battery, and parallel thereto, by way of lower winding of relay 20, back contact and armature 283, resistance 286 to battery. Relay 20 accordingly operates; at armature 22 disconnects relay 29 from conductor 2 to improve transmission; at armature 23 completes a locking circuit for its upper winding, which circuit extends by way of back contact and armature 21 to the release trunk conductor 4 to which ground is now connected from the line switch; at armature 24 connects ground to conductor 56; at armature 25 opens the original energizing circuit and prepares a further circuit for relay 17; at armatures 26 and 27 prepares energizing and locking circuits for relay 65, which, however, will not become operative in this case, since the observed party is calling, and at armature 28′ prepares a control circuit which will be explained in detail subsequently. Relay 17 is slow to pull up, and relay 20 has operated and opened its circuit at armature 25, before it could operate and open the locking circuit of relay 20 at armature 21. The connection of ground to lead 56 completes a circuit for the relay 282 which is one of a group of relays provided common to a group of 25 subscribers' lines, this being the capacity of the finder switch FS. The function of this relay group is to remove the battery feed from the lower windings of the relays such as 20 to prevent any other subscriber under observation obtaining access to the observation equipment while it is in use. Relay 282 upon operating, at armature 285 completes circuits for relays 280 and 281 which operate and perform the above mentioned function. Relay 282 also at armature 283 removes battery from relay 20 and at armature 284 disconnects battery from lead 56 so as not to cause an unnecessary drain.

In case the common equipment is in use when a call is initiated there is no battery feed for relay 20 and, accordingly, relay 17 is operatively energized. On operating, relay 17 at armature 18 removes ground from the winding of relay 20, at armature 10 disconnects relay 29 from speaking conductor 2, at armature 19 completes a locking circuit for itself to release trunk conductor 4, and at armature 21 opens the locking circuit of relay 20. Relay 17 thus remains locked up for the remainder of the connection and there is no possibility of the calling party subsequently obtaining access to the observation equipment when it becomes free until he makes a further call.

To return now to the consideration of the sequence of operations in the present instance, a further effect of the connection of ground to lead 56 is the completion of a circuit for the lower winding of relay 73 which relay accordingly operates and closes at armature 76′ a circuit by way of relay 68, back contact and armature 40, interrupter contact 55, driving magnet 54 and supervisory relay 34 to battery, while at armature 75 test wiper 53 is connected to the junction of magnet 54 and relay 68, so that the finder switch FS commences to hunt in known manner for the contact 49, associated with the calling line, from which ground was removed by the operation of armature 24.

The ground on lead 56 is also extended over back contact and armature 108′, back contact and armature 104, relay 112, trunk conductor 116, normally closed spring of key 218, conductor 118, normally closed springs controlled by armature 124, winding of relay 126 to battery. Relays 112 and 126 operate in this circuit, and the former at armature 114 opens a point in the further circuit for relay 17. Relay 126 upon energizing, at armature 128 completes a circuit for relay 132, and at armature 127 completes a circuit through resistance 148 for relay 147. A branch of this circuit extends over armature 136 and its back contact, lead 167, calling lamp 204 to battery. The lighting of the calling lamp notifies the observing operator that a subscriber is about to be connected to the observation equipment and since the lamp 204 is individual to the trunk shown, the particular trunk to be used is indicated.

Assuming that the observation equipment is not already in use, in which case there will be no ground on lead 163, relay 147 will operate, completing at armature 150 a locking circuit for itself over its lower winding, and connecting at armature 153 ground to lead 163 to protect the equipment against seizure over any other trunk. Relay 147 moreover at armature 154 completes a circuit for relay 144, at armature 154′ prepares a circuit for relay 141, at armature 155 prepares a circuit for the engaged lamp 203 and removes ground from test contact 170, and at armature 156 prepares a circuit for connecting ground to lead 118. When relay 144 operates it completes a circuit for relay 119 which energizes and connects conductor 117 to relay 129. Relay 144 also completes a circuit over lead 160 for relay 272 and this, by connecting

ground to lead 162, completes an additional locking circuit for relay 147. The connection of ground to lead 163 completes a circuit for relay 209 and rotary magnet 208 in series, this circuit including also the spring 220 of the change-over key CO and the supervisory relay 222. Moreover, at armature 157 test wiper 223 is connected to the junction of magnet 208 and relay 209 by way of the spring 221 of the key CO, front contact and armature 157, spring 219 and armature 213, to start the finder switch FS^2 hunting for the trunk relay group TRG over which the call requiring observation has been initiated. When the switch has completed its hunting operation, relay 209, being no longer short-circuited, operates in known manner, thereby at armatures 210, 211 and 212 connecting up the line and pulsing wipers, at armature 213 opening the circuit of magnet 208, and at armature 214 completing a circuit which extends from battery, front contact and armature 155, lead 169, back contact and armature 217 and normally closed springs of the key 215 in the supervisory equipment SE′ to ground. The engaged lamp 203 therefore lights to indicate which trunk is engaged on observation. Moreover, a circuit is now completed from ground, armature 123 and its back contact, armature 128 and its front contact, contact 171, wiper 282, armature 212 and its front contact, winding of relay 235 to battery. The operation of relay 235 prepares a circuit for relay 237 which is completed to battery over armature 262 if the supervisory relay 222 is not operated and relay 237 then energizes and prepares the recording apparatus for operation, locking itself up at armature 241.

Returning now to the operation of the finder switch FS, when this switch comes to rest with its wipers in engagement with the calling subscriber's line, relay 68 is operated, thereupon at armature 69 closing another point in the circuit of relay 17, at armature 71 opening the circuit of magnet 54, and at armature 70 completing circuits for relays 77, 87 and 106. Relay 77 is a polarized relay and does not operate in response to the energization of its upper winding alone, but relay 87 operates and prepares a number of circuits none of which however is effective at the moment. Relay 106 also operates and at armature 107 completes a circuit for relay 109 which extends from ground, armature 18 and its back contact, armature 15 and its front contact, bank contact 48, wiper 52, armature 107 and its front contact, winding of relay 109 to battery. Relay 109 at armature 111 opens the circuit completed just previously for relay 102 and at armature 110 in conjunction with armature 108′ completes a loop circuit across the two conductors 115 and 116 of the observation trunk. This circuit extends as follows: battery, relay 126, normally closed springs controlled by armature 124, conductor 118, lower springs of key 218, conductor 116, relay 112, armature 104 and its back contact, armature 108′ and its front contact, lower winding of relay 77, retardation coil 81, front contact and armature 110, conductor 115, upper springs of key 218, conductor 117, armature 120 and its front contact, normally closed springs controlled by armature 122, winding of relay 129 to ground. Relays 126, 112 and 129 are now energized in series in this circuit but relay 77 does not energize since its two windings now produce flux in opposite directions. Relay 129 upon operating, at armature 130 opens the initial energizing circuit for relay 147 and also the circuit of the calling lamp 204, and at armature 131 completes a circuit for relay 135. Upon operating, relay 135 at armature 136 opens another point in the circuit of the lamp 204 and at armature 137 completes a circuit over lead 164 for the observer's lamp 201. It should be mentioned that the lamps 201 and 202 are common to all the observation trunks and perferably lamp 201 is white and lamp 202 is red. Lamps 203 and 204 on the other hand are individual to the particular trunk shown and consequently there are as many similar lamps as there are trunks. The observer will now be able to hear dial tone connected to the calling party's line, the circuit to his receiver 230 extending over the plug P^1, jack J^1 retardation coil 232, conductors 259 and 260, armatures 210 and 211, line wipers of the switch FS^2, normally closed springs controlled by armatures 122 and 124, conductors 117 and 118, contacts of key 218, conductors 115 and 116, armatures 110 and 108′, wipers 50 and 51 of the switch FS and contacts 46 and 47 on which they are standing, to conductors 3 and 5. The apparatus is now in a condition for the calling party to dial and it will be noted that the observer's white lamp 201 is glowing and also the engaged lamp 203 associated with the particular trunk in use.

When the subscriber dials the first series of impulses, the interruptions in his loop will operate the line relay of the first selector seized by his line switch and also the relay 14 in the subscriber's relay group SRG. Relay 14 therefore releases intermittently and on each release the circuit of relay 109 is opened so that it pulses in synchronism with relay 14. When relay 109 releases, a circuit is completed over armature 111 and its back contact for relay 102, which energizes and being slow to release remains energized throughout the train of impulses. At armature 103 relay 102 opens a point in the circuit of relay 17 to prevent the operation of this relay over armature 114 when relay 112 deenergizes following the impulses. At armature 104 relay 102 short circuits retardation coil 81 and the lower winding of relay 77 in order to give better im-

pulsing conditions, and at armature 113 it closes a point in the circuit of the upper winding of relay 73. Resistance 105 is added for supplying sufficient current to relays 112, 126 and 129, to maintain them energized while armature 104 is passing between its back and front contacts. At armature 110 the circuit for relays 126 and 129 in the trunk relay group is opened intermittently and these relays accordingly de-energize and repeat the impulses to the observer's equipment. Each time relay 126 de-energizes the previously traced circuit for relay 235 is opened at armature 128 and accordingly relay 235 is de-energized. Upon each de-energization of relay 235, a circuit is completed as follows: ground, armature 236 and its back contact, armature 242 and its front contact, winding of series relay 245, wiper 252 of the impulse distributing switch M, first contact in its bank, winding of magnet 254 to battery, and accordingly wipers 261 and 263 of the first digit register M^1 are advanced a number of steps corresponding to the number dialled by the subscriber. Relay 245 is energized throughout the train of impulses and at armature 246 completes a circuit for relay 243 which is also slow to release. Consequently when relay 245 deenergizes on the termination of the impulses, a circuit is completed from ground, armature 244 and its front contact, armature 247 and its back contact, winding of magnet 251 to battery, so that the wipers of the switch M are advanced one step. The next series of impulses is accordingly transmitted to the second digit register M^2. This operation is repeated between subsequent digits so that the complete number, which in this case is assumed to consist of 5 digits, is eventually recorded on the switches M^1 to M^5. When the switch M^2 goes off normal, a circuit is completed as follows: ground, key 215 in normal position, armature 217 and its back contact, armature 240 and its front contact, armature 249 and its back contact, wiper 264 and the contact on which it is resting, lead 265, wiper 263, and the contact on which it is resting, and the corresponding conductor in the cable represented by 266 to battery through an indicating lamp (not shown) at the operator's position. This arrangement ensures that the digit lamps shall not flash while the digit registers are being set, but that the number will be displayed as soon as the next series of impulses commences. The circuit for the display of the last digit extends from ground, armature 246 and its back contact, armature 250 and its back contact and by way of wiper 271 over the appropriate conductor in cable 270 so that the corresponding lamp is operated as soon as relay 245 falls back at the end of the last series of impulses. The observation operator now has a complete record of the number dialled by the calling party and she may note it for reference purposes in case the subscriber complains that he is not getting the numbers he dials. The operator may now hear the ringing induction which is connected back to the calling party's line to indicate that the wanted party is being rung.

When the wanted party replies, current is reversed over the established connection in known manner and is now in such a direction as to permit the operation of relay 7, which accordingly energizes and at armature 8 completes a circuit for relay 9 from the ground on release trunk conductor 4. Relay 9 upon operating at armature 12 completes a circuit from ground over conductor 60, armature 99 and its back contact, armature 91 and its front contact for relay 82. Relay 82 accordingly operates; at armature 85 opens the circuit of relay 87 and completes a locking circuit for itself and at armature 86 completes a circuit which extends as follows: battery, armature 86 and its front contact, front contact and armature 92, back contact and armature 101, conductor 116, key 218, conductor 118, normally closed springs controlled by armature 124 to relay 126 short circuiting relay 126 and thus causing its deenergization. A circuit is thereupon completed as follows: ground, armature 123 and its back contact armature 128 and its back contact, armature 140 and its front contact, upper winding of relay 141, armature 154′ and its front contact, lead 159, sixth contact in the bank of wiper 253 and said wiper to battery. Relay 141 accordingly operates, at armature 142 completes a locking circuit for itself, and at armature 143 prepares a circuit for the observer's red lamp 202. Relay 87 is slow to release and therefore holds up for an instant after its circuit is opened. When it finally deenergizes the following circuit becomes operative: ground on the metering conductor 6, armature 11 and its front contact, conductor 63, back contact and armature 93, resistance 94, normally closed springs controlled by armature 100, winding of relay 95 to battery. Relay 95 accordingly energizes; at armature 98 opens the circuit of relay 82; at armature 99 opens a further point in the circuit of relay 82; at armature 101 prepares a supervisory circuit which will become operative subsequently and removes the short circuiting battery from conductor 116; and at armature 100 closes a locking circuit for itself cutting out the resistance 94. With this condition, that it to say, with relays 82 and 95 operated and relay 87 de-energized, a circuit is completed from a tone source over the small condenser 90, armature 84 and its front contact, back contact and armature 89, front contact and armature 97, conductor 116 and thence over the wipers of the switch FS^2 to the operator's headset so that she hears a tone which indicates that metering is taking place satisfactorily. In order that the subscriber may not hear

this tone, armatures 83, 88 and 96 co-operate to place a direct short circuit across the subscriber's line. In response to the removal of battery from conductor 116, relay 126 again energizes and at armature 128 completes the circuit previously prepared at armature 143 for the operator's red lamp 202. When relay 82 finally releases due to the opening of its circuit, the tone is removed but the observer's red lamp remains operated. The observer may now, if she wishes, ascertain that the conversation is proceeding satisfactorily and that the calling party has obtained the wanted subscriber. In case the observing operator finds that the number obtained by the calling party is not the same as that dialled and set up on her lamps, she will take the necessary steps to have the matter attended to.

It will be assumed, however, that the call goes through satisfactorily and that the subscribers complete their conversation. When the called party replaces his receiver the current flow over the loop is restored to normal and relays 7 and 9 de-energize. Accordingly, the circuit to relay 95 is opened and it commences to de-energize. Owing to the slug on its core it does not de-energize at once, and while it remains energized, the following circuit is completed: battery on lead 16, back contact and armature 13, front contact and armature 28′, lead 64, front contact and armature 101 to lead 116. Consequently, relay 126 is again shorted out and de-energizes. At armature 128 the circuit for the observing operator's red lamp 202 is opened and this lamp extinguishes. When relay 95 finally deenergizes, the connection of battery to lead 116 is removed at armature 101 and relay 126 again energizes, again lighting lamp 202.

When the calling party replaces his receiver relay 14 is de-energized and at armature 15 opens the circuit for relay 109 which consequently de-energizes also and at armature 110 opens the loop across the observation trunk. The circuit of relay 20 is also opened at armature 15 and its locking circuit when ground is removed from release trunk conductor 4, and relay 20 releases. Relay 73 however, is held up in the circuit: ground, armature 18 and its back contact, bank contact 46′, wiper 50′, front contact and armature 74, lower winding of relay 73 to battery, and relay 73 accordingly maintains relays 68, 87, 106 and 282 energized. Consequently, battery feed is maintained disconnected from all other relays such as 20 in subscribers' relay groups to which the finder FS has access.

Responsive to the opening of the loop across the observation trunk, relays 112, 126 and 129 deenergize and bring about the release of relays 132, 135 and 141. Relay 144 however remains locked up from ground on spring 279 of the repeat disconnect key RD and maintains relays 119 and 272, and the latter holds relay 147 locked up. The removal of ground from contact 171 opens the circuit for relay 235 and this relay releases, opening the circuit of relay 237 which de-energizes after a short interval. At armatures 239 and 240 circuits are now completed for the register switches M^1—M^5 and the distributor switch M. These switches accordingly restore to normal, and the lamps indicating the dialled number are extinguished. Moreover by the release of relay 126 the red lamp 202 is extinguished and by the release of relay 135 the white lamp 201 is disconnected also. Since relays 147 and 209 are not released however, the circuit is still maintained for the engaged lamp 203 and it continues to glow.

It will thus be appreciated that the trunk relay group remains definitely associated with the observation operator's equipment and access is denied over other observation trunks. Moreover the finder switch FS is definitely associated with the relay group SRG shown and hence the subscriber last under observation comes up again for observation on his next call. Other subscribers making or receiving calls during this period will have their relays corresponding to relay 17 operated as described above.

In case the operator's equipment is in use when the initial circuit is completed for relay 126, in which case lead 163 is grounded, relay 147 is unable to operate. Hence no circuit is completed for relay 119 and the loop across conductors 117 and 118 is not completed at the main exchange. Consequently when relays 106 and 109 operate there is no longer a circuit for relay 112 and it releases. A circuit is then completed as follows: ground, armature 18 and its back contact, armature 15 and its front contact, bank contact 48, wiper 52, armature 107 and its front contact, armature 114 and its back contact, back contact and armature 103, front contact and armature 69, lead 58, front contact and armature 25, normally closed springs controlled by armature 19, winding of relay 17 to battery. Relay 17 operates and locks up to release trunk conductor 4, thus definitely preventing the energization of relay 20 during that particular call.

The case in which the party under observation is the called party rather than the calling party shall now be considered. In this case the operation of the observation equipment is initiated when ringing current is connected to the wanted line, and the circuit extends from the connector bank over lead 5, condenser shunting relay 14, condenser in lead 2, armature 10 and its back contact, armature 22 and its back contact and upper winding of relay 29 to battery. Relay 29 is specially designed so as to respond to alternating current and consequently now operates. This property of the relay is indicated

on the drawing by the reference "A.—C. RLY". At armature 30, relay 29 completes a circuit for the lower winding of relay 20 so that if the switch FS is not in use or locked upon the line last observed, relay 20 attracts its armatures and energizes relay 73 which initiates the operation of the finder switch FS in the manner previously described. Relay 29 also at armature 31 completes a locking circuit for itself by way of its lower winding and armature 21 to release trunk conductor 4, and at armature 32 connects ground from lead 56 to lead 60 thereby preparing a circuit for relay 82. The connection of ground to lead 56 and hence to lead 116 as before initiates the operation of the finder switch FS^2 at the observing operator's position, assuming that this is not already in use, and the calling lamp 204 is lighted.

When relay 68 operates, at armature 70 it completes a circuit for relay 106 which, upon operating, at its armature 107 prepares a circuit for relay 109 and at its armature 108 completes a circuit for relay 102. The latter energizes, thereby cutting in resistance 105. At armature 70 a circuit is also completed for relay 87 which thereupon at armature 91 completes the previously prepared circuit for relay 82. Relay 82 upon energizing, at armature 85 opens the circuit of relay 87 and completes a locking circuit for itself, and at armature 86 completes the following circuit:—battery, armature 86 and its front contact, front contact and armature 92, back contact and armature 101, lead 116, contacts of key 218, lead 118, normally closed springs controlled by armature 124 to the winding of relay 126. As this circuit is only completed during the time that relay 87 is deenergizing, relay 126 is only momentarily short circuited and thereupon at armature 128 completes a circuit for relay 141 over armatures 134 and 139, and this relay at its armature 143 prepares a circuit for the operator's red lamp 202 and at armature 142′ prepares a locking circuit for itself. Hence, when relay 126 again pulls up, the lamp 202 is lighted and remains glowing owing to relay 141 now being locked over the front contact of armature 128. The operation of relay 87 also completes a circuit which extends from the front contact of armature 91, lead 59, armature 26 and its front contact, armature 33 and its front contact, lead 57, winding of relay 65 to battery. Upon operating, relay 65 at its armature 66 locks itself to ground at armature 27 and at armature 67 prepares a circuit which on the deenergization of relay 87 is completed as follows: ground, armature 111 and its back contact, armature 67 and its front contact, back contact and armature 92, back contact and armature 101 to lead 116, so that this ground connection is operative for energizing relay 126 again. Relay 112 is at this time shorted out but no circuit is completed for relay 17 in the subscriber's relay group since this circuit is opened at armature 103 of operated relay 102. No further circuit changes take place until the observed subscriber responds to the ringing of his bell.

When he removes his receiver, relay 14 is energized and by connecting ground to contact 48 at armature 15 completes a circuit for relay 109 which at armature 111 opens the circuit of relay 102 and at armature 110 completes the loop across the trunk conductors in the manner previously described. Relay 129 of the trunk relay group TRG now energizes and completes a circuit for relay 135, whereupon at armature 136 the calling lamp 204 is extinguished and at armature 137 the white lamp 201 is lighted. Thus while the conversation is in progress, the lamps 201, 202, and 203 are lighted and the operator can as before ascertain if she wishes whether conversation is proceeding satisfactorily.

When the observed subscriber hangs up at the end of the conversation, relay 14 will again be de-energized and will accordingly open the circuit for relay 109. Relay 109 upon de-energizing, at armature 110 opens the loop, but at armature 111 completes an auxiliary circuit for relay 126 so that only relay 129 de-energizes. Accordingly relay 135 is now de-energized and at its armature 137 opens the circuit for the observer's white lamp 201; the red lamp 202 and the engaged lamp 203 however, remain lighted until the calling party hangs up, whereupon ground is removed from the release trunk conductor 4 and relays 20 and 29 de-energize. The conditions now established are the same as those at the end of a call initiated by the observed party, namely that in default of a special operation on the part of the operator as shortly to be described, the apparatus is locked up to the line last observed and this is again connected up for observation when next a call is made or received over it.

The purpose and method of operation of the various keys at the observing operator's position will now be considered. Suppose firstly that she discovers that the observation train connected up at a certain time is faulty in some respect, she will operate the change-over and hold key CO. The effect of this is to connect ground to wiper 277 of the switch FS^2, whence it is extended to relay 121. Relay 121 therefore operates and at its armatures 122 and 124 reverses the connection of relays 126 and 129 to the leads 117 and 118, and at its armature 123 opens the circuits for relays 132 and 135 and the various lamps so that the connection of the relay group TRG with the operator's equipment is released. At the front contact of armature 123 moreover a locking circuit is completed for relay 119 so that it remains energized and maintains

the loop when its initial circuit is opened by the release of relay 144 which has its circuit opened at armature 125. Furthermore at armature 146 the circuit of relay 272 is opened and it de-energizes to interrupt the locking circuit of relay 147 so that this de-energizes also and permits calls from other trunk relay groups to come in to the operator's position. In order that these may be dealt with, the switch FS^2 is cut out and the switch FS^1 substituted at the springs 219, 220 and 221 of the key. In the finder relay group FRG, the polarized relay 77 now operates and at its armature 79 shunts armature 110 and its front contact so as to maintain the loop across the observation trunk, at armature 78 opens a point in a control circuit for relay 73 and at armature 80 supplies an additional holding ground for relay 68, thereby preventing movement of the switch FS. Thus the switches used in connecting the observed subscriber to the operator's position are maintained in operated position, and it is therefore readily possible to trace a fault which has occurred.

It will be seen from the drawings that the switches FS^1 and FS^2 are alternative, their banks being multipled together and their wipers connected together through the contacts of their respective switching relays. Consequently all the operations above described may be carried out over the switch FS^1 in a similar manner to that just described in connection with the switch FS^2. Should it now happen that faulty switches should be encountered while observation is taking place over the switch FS^2, the observer may lock up the faulty train by operating the hold key H^2. The effect of this is to connect ground to the lower wiper of the switch FS^1 and hence to operate the relay corresponding to relay 121. Ground is also connected to lead 163 to prevent other calls coming in since there is now no means of dealing with them, and this ground is removed when the key CO is restored.

It will probably happen in a number of cases that the observer will not wish to remain connected to an observed subscriber's line for the whole length of the call but will wish to release herself as soon as she has seen the call satisfactorily set up. In this case she will operate the disconnect key 218 which is individual to the observation trunk shown. The effect of this is to open the loop so that relays 126 and 129 de-energize thereupon initiating the release of the observer's equipment in the usual manner. Relay 112 at the satellite exchange is de-energized, whereupon a circuit is completed for relay 17 as previously traced. Relay 17 upon operating, at armature 18 opens its own energizing circuit and also the locking circuit for relay 73, at armature 19 locks itself up to release trunk conductor 4 and at armature 21 opens the circuit for relays 9 and 20. These relays therefore de-energize and release the operated apparatus in the finder relay group FRG in the manner previously described so that it may be taken into use by another party under observation. Relay 17 however remains locked up until ground is removed from release trunk conductor 4 and it is clearly impossible for relay 20 to be again energized until the call is terminated.

The circuit changes which occur when the repeat disconnect key RD is operated shall now be considered. This key is provided to render ineffective the arrangement by which the subscriber last under observation is connected to the observation equipment when he makes his next call. When the key RD is operated, at springs 279 the circuit of the relay 144 is opened and it deenergizes thereby releasing relays 119 and 272. The release of the latter relay however does not remove the locking ground for relay 147 since it is now provided over spring 279 in operated position. When relay 119 deenergizes, the following circuit is completed: battery, spring 278 of the key RD, lead 161, armature 156, and its front contact, back contact and armature 120, conductor 117, key 218, conductor 115, armature 110 and its back contact, front contact and armature 113, back contact and armature 78, front contact and armature 72, upper winding of relay 73 to ground. The upper winding of relay 73 opposes the lower winding and the relay consequently de-energizes, thereby removing ground from lead 53 and allowing relays 280, 281 and 282 to restore and to reconnect battery feed to the relays such as 20. When the key RD is restored, the holding ground for relay 147 is removed and it restores, thereby freeing all the equipment and opening the circuit of relay 144 which is somewhat slow to pull up and hence does not now energize. Thus all the apparatus is now free to be taken into use by any subscriber under observation who will then in his turn become locked up to it until the key RD is again operated.

The key OB is used when it is required to cancel or prevent the lighting of the lamps on which the number dialled is set up. As will be seen, when this key is operated, relay 248 energizes and at its armature 249 and 250 opens the energizing circuits for the display lamps, at the same time at armature 249 completing a locking circuit for itself, which remains closed until the equipment is released by the de-energization of relay 237.

A short description may now be given of the supervisory equipment associated with the finder switch FS in the satellite and conveniently serving also for protecting the magnets of the switches used in setting up speaking connections. As already explained, these magnets obtain their battery through the low resistance supervisory relay 34 which

is thus energized whenever any magnets is receiving current. The operation of relay 34 closes a circuit at armature 35 for the dashpot relay 36 which thus commences to operate. If this circuit remains continually closed for some length of time, which will only occur for instance if one of the switches is connected to current for a long period due to some fault, contacts 37 are eventually closed and relay 38 is then energized. Thereupon at armature 39 it locks itself up to the test and release key 41 and at armature 40 opens the magnet battery feed circuit to prevent damage to the faulty magnet. When contacts 37 close a circuit is also completed for the bell 44 and the lamp 45, signaling the attendant so that he may take steps to remedy the trouble. Relay 38 and the signals 44 and 45 continue to operate until released by the operation of the key 41, whereby the maintaining ground is removed. Key 41 is also used for testing purposes, the effect of its operation under normal conditions being to energize relay 42, which completes a circuit from front contact of armature 35 for bell 44 and lamp 45; hence when key 41 is operated, if any magnet should be stepping, as will generally be the case, the bell and lamp will be operated and thus serve to show that the supervisory apparatus is in proper condition. The equipment SE′ at the main exchange shown in Fig. 2, operates in substantially the same manner, though in this case it is the release magnets rather than the stepping magnets which require protection since the latter are operated by impulses.

It will be noticed that the observing operator's headset 230 is connected up when the plug P^1 is inserted in the jack J^1, this circuit including the retardation coil 232. The terminal 287 is used for feeding ground to all the supervisory equipment and consequently it will be appreciated that if the plug P^1 is not in the jack J^1, it will be impossible for any of the equipment to operate, and thus there is no useless functioning when the operator is not present. The jack J^2 serves to take a duplicate plug, and when such a plug is inserted, relay 234 is operated thereby cutting out the retardation coil 232 so that the two receivers are connected to the leads 259 and 260 in series with the retardation coil 231, which has a different resistance from the retardation coil 232.

It may be desirable in some cases to know not only over which trunk observation is proceeding, which is indicated by the engaged lamp which lights but also to know which particular subscriber in a certain satellite exchange is being observed. For effecting this, one suitable arrangement is to provide three further switches at the satellite exchange; the first a position marking switch which operates in synchronism with the finder switch FS and is arranged always to take up a similar position, the second a tens sender, and the third a units sender. The function of the position marker could also be taken care of by providing additional wipers on FS and also a single sender switch could be used for both tens and units, though the control in this case is rather more complicated.

In order to avoid interfering with observation as ordinarily carried out, the position indication is preferably only sent when a special key for instance the key CO is operated. The additional contacts for initiating the sending of the position indicating impulses may then be carried by the relay 77 or a relief relay associated with it. The operation of this relay connects up the tens impulse sender which is started stepping synchronously with the transmission of impulses over the observation trunk. This impulse sending continues until the tens sender wiper encounters a contact marked in accordance with the position of the position marker, and the tens sender then steps on automatically. Just before it reaches normal position it energizes a relay which transfers the control to the units sender and initiates its operation. During the pause while the tens sender is rotating home, relay 243 will de-energize so that the next series of impulses will be recorded on the second bank of lamps by the operation of switch M^2. Hence by means of the control of the position marker, the number representing the bank contact on which the subscriber's finder is standing is displayed on the lamps normally used for recording the number dialled and the operator may thus readily ascertain on which line she is observing.

Having now particularly described and ascertained the nature of the invention and in what manner the same is to be performed, I declare that what I claim is:—

1. In a telephone system, a plurality of exchanges, subscribers' lines thereat, an observation operator's position in one of said exchanges, two-conductor trunk lines extending from said position to said exchanges, a non-numerical switch for connecting said position with any one of said trunk lines, means for automatically operating said switch to establish connection between said position and a subscriber's line in any one of said exchanges when said line initiates or receives a call, for the purpose of observing the progress thereof, and means for preventing the establishment of said observation connection if said position is engaged in observing the progress of another call while a call is initiated or received by said subscriber's line.

2. In a telephone system, a plurality of exchanges, subscribers' lines thereat, an observation operator's position in one of said exchanges, two-conductor trunk lines extending from said position to said exchanges, a non-numerical switch for connecting said position with any one of said trunk lines for

the purpose of observing the progress of calls initiated or received by certain subscribers in said exchanges, means for automatically operating said switch when a call is initiated or received by one of said subscribers to establish said connection provided said position is free to observe said call, means at said position and said switch for receiving impulses transmitted by a calling line under observation, an indicating device, and means for displaying the wanted number on said indicating device.

3. In a telephone system, a plurality of exchanges, subscribers' lines thereat, an observation operator's position in one of said exchanges, two-conductor trunk lines extending from said position to said exchanges, a non-numerical switch for automatically connecting said position with any one of said trunk lines for the purpose of observing the progress of calls initiated or received by certain lines in said exchanges, means for operating said switch when a call is initiated or received by one of said lines to establish said connection provided said position is free to observe said call, an indicating device at said position, means for receiving impulses transmitted by a calling line under observation, and means for displaying the wanted number on said indicating device.

4. In a telephone system, a plurality of exchanges, subscribers' stations thereat, an observation operator's position in one of said exchanges, two-conductor trunk lines extending from said position to said exchanges, means for automatically connecting any one of said stations with said position over one of said trunk lines when a call is initiated or received at said station, and means for maintaining said station in connection with said position at the termination of a call for the purpose of observing the progress of subsequent calls from and to said station.

5. In a telephone system, a plurality of exchanges, subscribers' stations thereat, an observation operator's position in one of said exchanges, two-conductor trunk lines extending from said position to said exchanges, means for automatically connecting any one of said stations with said position over one of said trunk lines when a call is initiated or received at said station, an indicating device at said position, means for displaying on said device the designation of the trunk line connected with and the number of a station wanted by a calling party under observation, and means for maintaining a station in connection with said position for the purpose of observing subsequent calls from and to said station.

6. In a telephone system, a plurality of exchanges, subscribers' stations, thereat, an observation operator's position in one of said exchanges, two-conductor trunk lines extending from said position to said exchanges, means for automatically connecting any one of said stations with said position over one of said trunk lines when a call is initiated or received at said station, means for displaying the designation of the trunk line connected with, and automatic means for displaying the number of a station wanted by a calling party under observation.

7. In a telephone system, a plurality of exchanges, subscribers' stations thereat, an observation operator's position in one of said exchanges, two-conductor trunk lines extending from said position to said exchanges, means for automatically connecting any one of said stations with said position over one of said trunk lines when a call is initiated or received at said station, an indicating device, means for displaying the designation of the trunk line connected with, automatic means for displaying the number of a station wanted by a calling party under observation, and means for maintaining a station in connection with said position for the purpose of observing subsequent calls from and to said station.

8. In a telephone system, a plurality of exchanges, subscribers' stations thereat, an observation operator's position in one of said exchanges, means for automatically connecting any one of said stations with said position for the purpose of observing the progress of calls from and to said station, said means being operative upon the initiation or upon the receipt of a call at said station, means for displaying the desired party's number if the station under observation is calling, means for holding said station for further observation, and means operable by the attendant at said position for disconnecting a station under observation from said position without interfering with the progress of a call extended from or to said station.

9. In a telephone system, a plurality of exchanges, subscribers' stations thereat, an observation operator's position in one of said exchanges, means for automatically connecting any one of said stations with said position upon the initiation of a call at said station, and means responsive to ringing current for automatically connecting any one of said stations to said position when said station is being called.

10. In a telepone system, a plurality of exchanges, subscribers' stations thereat, an observation operator's position in one of said exchanges, means for automatically connecting any one of said stations with said position upon the initiation of a call at said station, means responsive to ringing current when a station is being called for automatically connecting said called station with said position, and means for holding any station connected to said position for the purpose of observing the progress of subsequent calls from and to said station.

11. In a telephone system, a plurality of exchanges, subscribers' stations thereat, an observation-operator's position in one of said exchanges, means for automatically connecting any one of said stations with said position upon the initiation of a call at said station, means responsive to ringing current when a station is being called for automatically connecting said called station to said position, means for holding a station connected to said position for the purpose of observing the progress of subsequent calls, and means operable by the attendant for disconnecting any connected station at will from said position to permit the observation of other stations.

12. In a telephone system, a plurality of exchanges, subscribers' stations thereat, an observation operator's position in one of said exchanges, means for automatically connecting any one of said stations with said position for the purpose of observing the progress of calls extended to and from said stations, said means being operable upon initiation or upon receipt of a call at a station, means for holding a station under observation connected with said position for observing further calls, and means operable by the attendant at said position for preventing the release of equipment taken into use by a calling station in extending a call in case said equipment does not perform satisfactorily.

13. In a telephone system, a main exchange, a sub-exchange, subscribers' lines terminating in said sub-exchange, a two-conductor trunk line connecting said two exchanges, an observation operator's position in said main exchange accessible to said subscribers', lines over said trunk line, means for automatically connecting said observation position to any one of said lines over said trunk when a call is initiated to observe the progress of that call, means for preventing the connection of said observation position, means at said position for registering the progress of the call, and means for furnishing said position with a tone if metering is properly taking place.

14. In a telephone system, a main exchange, a sub-exchange, subscribers' lines terminating in said sub-exchange, a two-conductor trunk line connecting said two exchanges, an observation operator's position in said main exchange accessible to said subscribers' lines over said trunk line, means for automatically connecting said observation position to any one of said lines over said trunk when a call is initiated to observe the progress of that call, means for preventing the connection of said observation position, means at said position for registering the progress of the call, means for furnishing said position with a tone if metering is properly taking place, and means for preventing the connection of said tone to the subscriber's line under observation.

In witness whereof, I hereunto subscribe my name this seventh day of April, A. D. 1926.

WILLIE SAVILLE.