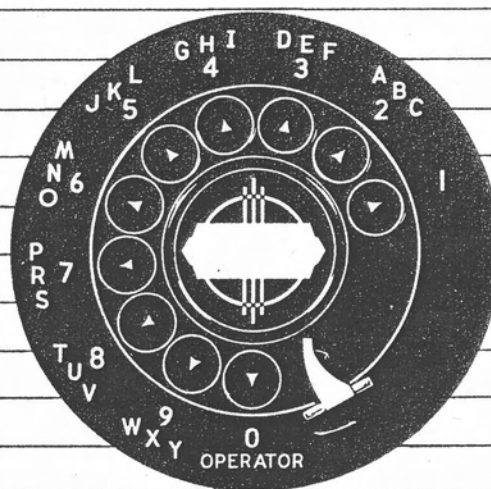


AUTOMATIC ELECTRIC TRAINING SERIES

Bulletin **817**

SWITCHING SELECTOR-REPEATER

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TABLE OF CONTENTS

	Page
1. SUBOFFICES	1
2. USE OF THE SWITCHING SELECTOR REPEATER	1
3. TYPES OF SWITCHING SELECTOR CIRCUITS	1
4. FUNCTIONS OF THE SWITCHING SELECTOR REPEATER	2
5. DESCRIPTION OF THE SWITCH	2
6. OUTLINE OF SWITCHING SELECTOR REPEATER OPERATIONS	3
6.1 Calls to a Distant Office	3
6.2 Calls to the Associated Central Office	3
6.3 Calls Within the Suboffice	4
6.4 Incoming Calls	4
7. CIRCUIT DESCRIPTION	4
7.1 Calls to Distant Offices	4
7.11 Seizure of Switch	4
7.12 Operation of the Outgoing Secondary Lineswitch	4
7.13 Vertical Operation	4
7.14 Rotary Operation	5
7.15 Repeating Impulses	5
7.16 Dialed Party Answers	5
7.17 Releasing	5
7.2 Calls to the Associated Central Office	6
7.21 Rotary Operation	6
7.22 Automatically Releasing	6
7.23 Second Vertical Operation	6
7.24 Second Rotary Operation	6
7.3 Calls Within the Suboffice	6
7.31 Second Rotary Operation	7
7.32 Switching Through	7
7.33 Release of Switches in the Central Office	7
7.34 Release	7
8. CALLS TO AN OPERATOR	7
9. OPERATION OF SWITCH WHEN OTHER GROUPS OF NUMBERS ARE ASSIGNED	7

SWITCHING SELECTOR REPEATER

1. SUBOFFICES

Central offices of an automatic multi-office exchange area are generally interconnected by groups of direct trunks, the trunks originating in first selector banks. Sometimes, however, it is desirable to depart from this plan. A comparatively small office may be located on the outskirts of an exchange area to secure a more economical outside cable plant layout than could be secured by connecting the local lines directly to the nearest large central office.

To provide a separate group of trunks from such an office to each of the other offices in the system would be a poor plan, because each group of trunks would be comparatively small resulting in low trunk efficiency. A better arrangement, insofar as the outside plant is concerned, is to carry all of the originating traffic from this branch office to the nearest central office and from there to distribute it to the remaining offices over the same trunks which carry the traffic originating in that office.

This means that the branch office first selectors must be located in the central office, so that the trunks to other offices can be selected after dialing the first digit. As far as the outgoing traffic from such a branch office, known as a satellite or a suboffice, is concerned, this could be done simply by inserting a repeater in the outgoing lineswitch trunks and extending the trunks through the outside cable to first selectors located in the central office.

Since with this simple scheme the first digit dialed by a suboffice subscriber operates a switch in the central office, it is evident that should the called subscriber also be located in the suboffice, it would be necessary to use a second trunk leading back to the suboffice to complete the connection.

2. USE OF THE SWITCHING SELECTOR REPEATER

In order to avoid using two trunks between a central office and a suboffice for completing a local call between suboffice subscribers, a switch known as the "switching selector repeater" is used. This switch makes possible a connection between the two suboffice subscribers without holding an interoffice trunk for the entire period of a call.

As the name implies, the switching selector repeater combines the functions of both a sel-

ector and a repeater together with a means for switching from one to the other in a single mechanism. It serves as a repeater on calls to other offices, and as a selector on local calls. As shown in Fig. 2, it occupies a position in the switch train between the primary lineswitches and outgoing secondary lineswitches.

When a subscriber in a suboffice equipped with switching selector repeaters originates a call, the primary lineswitch, switching selector repeater, and outgoing secondary lineswitch operate to extend the connection to a first selector in the central office. The switching selector repeater, being included in the primary trunk, operates as an ordinary repeater to relay the dial impulses to the interoffice trunk.

If the call is for a number not in the same suboffice, the switching selector repeater retains its function as a repeater throughout the building up of the connection. In the event, however, that the call is for a subscriber in the suboffice, the switching selector repeater will, as soon as the determining digit is dialed, rotate its wipers onto the required bank level, switching the connection through its bank to a local switch. The trunk loop to the central office will be opened, thus permitting the switches which have been operated there to restore, releasing the outgoing secondary lineswitch in the suboffice, and completely freeing the inter-office trunk. From this stage on, the connection is established by means of switches located wholly within the suboffice.

3. TYPES OF SWITCHING SELECTOR CIRCUITS

Three types of switching selector repeaters have been designed with respect to the digit which distinguishes between local and interoffice calls:

(a) Where no other numbers in the system begin with the same digit as that of the suboffice, the first digit is distinctive and a first-digit switching circuit is used.

(b) Where other numbers in the system begin with the same digit as the suboffice numbers as in Fig. 1, second-digit switching circuits are employed.

(c) Where other numbers in the system begin with the same first two digits, third-digit switching circuits must be used. Which of the three types of circuits is employed depends on

SWITCHING SELECTOR REPEATER

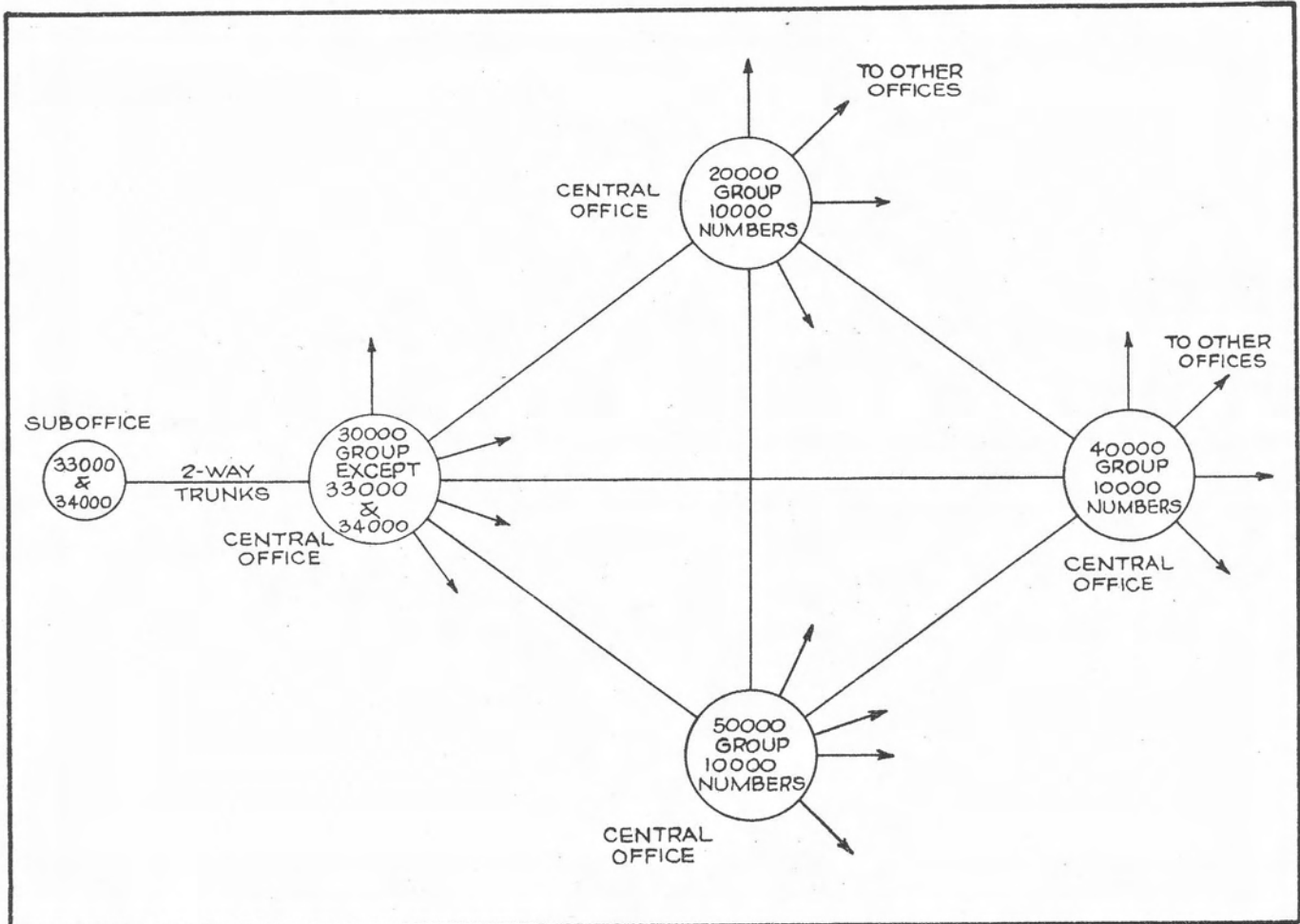


FIGURE 1. DISPOSITION OF DIRECTORY NUMBERS IN A MULTI-OFFICE AREA. SUB-OFFICE AT LEFT

the size of the telephone system and on the block of numbers reserved for the suboffice.

In a five digit system, numbers are generally reserved in blocks of 10,000 for central offices thus making the first digit an office selecting digit. Blocks of 1000 lines may then be assigned to suboffices, and hence, the second digit is commonly used to distinguish between a central office and its suboffice.

Summarizing: for a second-digit type switch, the function of the switching selector repeater is determined by the first digit if that digit be assigned to an office other than the one associated with the suboffice; the switch will then function normally as a repeater. When the first figure dialed is that assigned to the divided office, the method of operation is not determined until the second digit. Should the second digit belong to the suboffice, the function of the switch will become that of a selector.

A switching selector repeater which switches through to a suboffice on the second digit will be described in this bulletin, for it is the one which finds most frequent application in practice.

It should not be inferred that the switching selector repeater is useful only in a system embodying a number of central offices. This is not the case; it is just as applicable to a system consisting of one central and one branch office.

4. FUNCTIONS OF THE SWITCHING SELECTOR REPEATER

- (a) To act as a repeater:
 1. On calls to distant offices.
 2. On calls to the associated central office.
- (b) To act as a selector on calls within the suboffice.
- (c) To provide for connecting discriminating tones to the trunk when desired, etc.

5. DESCRIPTION OF THE SWITCH

The switching selector repeater employs the mechanism of a selector and is equipped with a 400-point bank. The fourth set of bank contacts is the "extra control," or E.C., contacts and furnish the means by which the switch differentiates between types of calls.

The first E.C. contact alone of each level is wired (in one of the four ways indicated in Fig. 3). The line and control contacts of local levels are the only other contacts which are used in the operation of the switch.

6. OUTLINE OF SWITCHING SELECTOR REPEATER OPERATIONS

Fig. 1 is a diagram of the numbering scheme of a five-digit system in which one office has a suboffice which uses second-digit type switching selector repeaters. Ten thousand numbers are reserved for each office, but the office containing the 30,000 series has its numbers divided between a central office and a suboffice. In this instance, it has been found desirable to reserve 2000 numbers for the satellite, these numbers taking in the 33,000 and 34,000 series.

Three types of calls can be made from the sub-office:

- (a) A call to a distant office---distinguished by the first digit.
- (b) A call to the associated central office---distinguished by the second digit.
- (c) A suboffice call---also marked by the second digit.

The connections between the suboffice and the central office are indicated schematically in Fig. 2.

6.1 Calls to a Distant Office

These can be distinguished from local calls or calls to the associated central office on the first digit and hence the switch operates as a repeater. Upon the removal of the handset, the primary lineswitch extends the line to the switching selector repeater, which, in turn, causes its associated outgoing secondary lineswitch to seize a trunk to the central office. Ground, placed over a local circuit from the secondary lineswitch to the suboffice incoming

selector attached to the trunk just seized, operates a cut-off relay, on the selector, to remove the switch from the trunk.

The first digit operates the line relay of switching selector repeater, which repeats the impulses over the trunk, operating the first selector in the central office. The shaft of the switching selector repeater is simultaneously elevated the same number of steps and then rotated to the first set of bank contacts. Ground through 500 ohms is found on the E.C. contact of the level dialed, which ground operates a relay (the K relay, Fig. 3) opening the circuit to both the vertical magnet and the rotary interrupter relay. The shaft remains elevated, while succeeding digits are repeated by the switch which continues to function as a repeater to the conclusion of the call.

6.2 Calls to the Associated Central Office

Since both the suboffice and the associated central office have the same first digit, a call to the associated central office cannot be distinguished from a local call on the first digit, hence an arrangement is provided for selecting on the second digit. The switching selector repeater steps up on the first digit to the third level and then rotates in one step, as in the preceding example, but this time, it encounters direct ground on the E.C. contact. This is sufficient not only to operate relay K as before but also the release magnet which returns the switch to normal.

The switch wipers step up on the second digit and upon again encountering ground through 500-ohms on the E.C. contact cause relay K to operate. The release magnet is not operated even if direct ground were found, because relay D operated when the switch shaft returned to normal (between the dialing of the first and second digits), the operation of D opened the

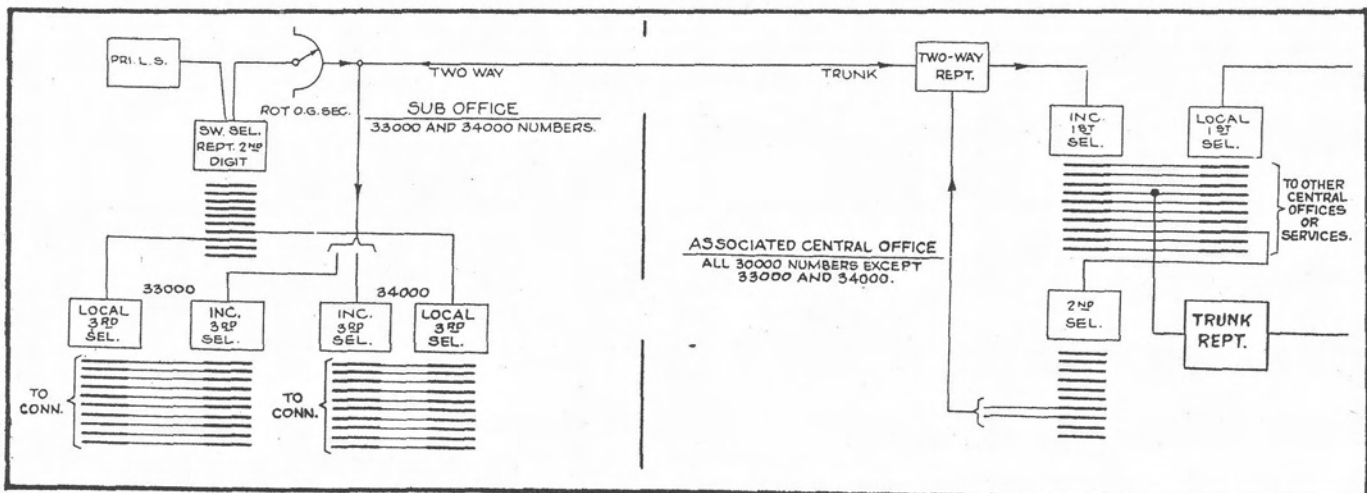


FIGURE 2. TRUNKING DIAGRAM SHOWING USE OF SWITCHING SELECTOR REPEATER, SECOND DIGIT TYPE

SWITCHING SELECTOR REPEATER

circuit to the release magnet. The switch continues to operate as a repeater.

6.3 Calls Within the Suboffice

In this example, the suboffice has numbers 33,000 and 34,000. Thus, second digits of "3" and "4" identify the call as belonging to the suboffice. The action of the switch on the first digit is, in this instance, identical with that in the preceding case. The operation of relay D opens all connections to the E.C. contacts of local levels. When the switch is stepped up by the impulses of the second digit, no potential is encountered by the E.C. wiper, relay K is not operated, and the switch rotates over the bank, in regular selector manner, under the control of the C wiper, G relay, and rotary magnet. A connection is made through the bank contacts to a local third selector and from thence to a connector.

The operation of the switching through relay H opens the circuit to relay A, which, in turn, releases the interoffice trunk and central office switches.

6.4 Incoming Calls

A call from any other office passes through the bank of a second selector in the central office associated with the suboffice, through an outgoing repeater, over a two-way trunk to an incoming third selector in the suboffice. The operation of the release relay on the incoming selector places ground on the control contacts of the outgoing secondary lineswitch banks to protect the trunk. The incoming first selector in the central office is removed from the trunk by the operation of a cut-off relay in the two-way repeater.

7. CIRCUIT DESCRIPTION

The circuit explanation is divided into three parts; namely, (7.1) calls to the distant offices, (7.2) calls to the associated central office, and (7.3) calls within the suboffice. The initial explanation of the circuit is based upon the assumption that the suboffice numbers are the 33,000 and 34,000 group, as marked on Figs. 1, 2 and 3. The operation of the switch for other numbering schemes is explained by the notes and supplementary drawing on Fig. 3 and the final section of the circuit explanation.

7.1 Calls to Distant Offices

These calls begin with digits other than "3." The switching selector repeater recognizes them on the first rotary step after the wiper shaft has stepped up by finding "ground through 500 ohms" on the E.C. contact. The shaft is held while the switch operates as a repeater.

7.11 Seizure of Switch

The switch is seized by the operation of a primary lineswitch in the local office. Relay A operates through the break contacts of relays J and H, bank contacts of the primary lineswitch, and over the line to the calling telephone, where the loop is completed.

Relay A operates relay B and also closes the circuit to the outgoing secondary lineswitch from (+) ground, winding of relay A-1 of the outgoing secondary lineswitch, break contact of relay B-1, "+" line, make contact of relay A, 100-ohm winding of relay J, 500-ohm winding of relay E, break contact of relay C, "-" line, break contact of B-1, non-inductive winding of B-1, break contacts of the group busying relay C-1 to (-) battery. Relays A-1 and E both operate at this time.

Relay B also completes a circuit from ground at the make contact of relay E to the 900-ohm winding of relay J. Both windings of relay J are now energized but in such a way that their magnetic fields oppose each other with the result that J does not operate.

7.12 Operation of the Outgoing Secondary Lineswitch

The lineswitch will rotate in the usual manner until an idle trunk to the central office is found. At this time, relay B-1 will operate, switching the lines through to an incoming selector in the central office. This selector will place dial tone on the trunk and back over the line to the dialing telephone.

If all the trunks to the central office had been busy at the time this call was originated, the group busying relay C-1 would have been held operated, thus preventing the operation of relay A-1. Since relay A-1 could not operate, there would be no shunt around relay B-1, and the latter would operate immediately after the operation of relay A, completing a circuit from the busy and dial tone lead through a break contact of A-1, make contact of B-1, and over the line. Dial tone is then placed on the dialing line to inform the subscriber that he may proceed with the call, as he might desire to establish only a local connection.

7.13 Vertical Operation

On this call to an office other than the one associated with the satellite, the first digit dialed is the office selecting digit and determines to which of the distant offices the call is to be routed, as well as determining at once that the switch is to continue to operate as a repeater.

Relay A follows the impulses of the first digit, operating both the switching selector repeater and the selector in the main office. Relay C

operates and shunts out the windings of relays J and E from the impulsing circuit and also shunts H. Relay E falls back removing the direct ground from the 900-ohm winding of relay J, but relay J remains at normal with the 900-ohm winding energized from ground at the induction coil.

The shafts of both switches are raised simultaneously to the dialed level. In this example, all levels except the third correspond to the first digits of the numbers of distant offices or of services located in distant offices.

The off-normal springs close during the first vertical step and complete the circuit to relay F which operates and switches busy tone onto the dial-and-busy-tone lead in place of dial tone. Busy tone, however, will be connected to the calling line at the end of the first series of impulses only if all the trunks to the central office are busy.

Relay F also closes the initial circuit to relay G, which operates through the contacts of relays B, C, F and K, and the cam springs. Relay G locks itself and thus holds prepared the circuit to the rotary magnet. It also completes a short-circuit around the winding of relay H to prevent the operation of the latter after relay C falls back.

7.14 Rotary Operation

After the last impulse of the series, relay C releases, transferring the trunk loop circuit from the low impedance loop to the high impedance loop. (The 2000-ohm resistance across the contacts of C prevents the interruption of the loop circuit during the transfer.)

Relay C also removes one short-circuit from relay H, breaks the operating circuit to relay G, and closes the circuit to the rotary magnet. The rotary magnet rotates the shaft, moving the wipers onto the first set of bank contacts on the dialed level, and also opens the locking circuit to relay G, which restores and opens the circuit to the rotary magnet.

The E.C. wiper engaging with the first E.C. contact completes a circuit from (+) ground through the 500-ohm resistance, the winding of relay K to (-) battery. Relay K operates, opening the operating circuit to relay G and the vertical magnet, so that these circuits will not be closed during the next series of impulses; and closes the circuit to the operating winding of relay D in series with the release magnet.

The release magnet does not operate, due to the high resistance of D. Relay D operates, opening its operating circuit and closing its locking circuit through a make contact of relay B to ground at the contact of E and the 11-ohm winding of the induction coil. The 500-ohms, in

series with the E.C. contact, prevents the operation of the release magnet from ground at this source and also prevents the formation of a short circuit around relay D.

As can be seen in Fig. 3, all of the E.C. bank contact levels, with the exception of No. 3, are initially connected to ground through a 500-ohm resistance. This is the condition which determines that the switch shall act as a repeater to a distant office.

7.15 Repeating Impulses

Relay A follows the impulses of each succeeding series from the dial and, when at normal, opens the trunk loop circuit to the trunk repeater in the main office which was selected by the incoming selector on the first digit. A closes the circuit to relay C. Relay C, operating, transfers the trunk loop circuit from the high impedance to the low impedance loop. Relay G and the vertical magnet are prevented from operating by relay K, which remains operated until the switch is released. The trunk repeater in the main office repeats the impulses to the switches in the distant switching district.

7.16 Dialed Party Answers

When the handset at the dialed telephone is removed, the operation of the connector back-bridge relay reverses the current back to the central office trunk repeater, which, in turn, reverses the current back through the trunk loop of the switching selector repeater.

This reverses the current flow through the 100-ohm winding of relay J, with the result that the magnetic fields of the two windings aid each other, the relay operates and reverses the current to the calling telephone, to provide supervision if the call originated at a manual switchboard, or to operate a meter.

7.17 Releasing

When the handset, at the dialing telephone is replaced, the circuit to relay A is opened. Relay A, restoring, opens the trunk loop circuit to allow the switches in the central office and distant switching districts to release, and opens the circuit to relay B.

Relay B restores; removes the ground from the release trunk, to allow the switch behind to release and to make the switching selector repeater free; opens the circuit to the 900-ohm winding of J; opens the locking circuit of relay D; removes the ground from the hold lead to allow the associated outgoing lineswitch to release; and closes the circuit to the release magnet. The release magnet operates, allowing the shaft to return to normal. The off-normal springs, restoring; open the circuits to relay F and the release magnet.

SWITCHING SELECTOR REPEATER

7.2 Calls to the Associated Central Office

These calls have "3" as the first digit, since all numbers of the exchange including the sub-exchange, are in the 30,000 group. The E.C. control contact on the first rotary step at the third level has direct ground connected to it. This together with a second direct ground is connected by K to a winding of D causing the latter to remain inoperative until the wiper shaft has been returned to normal. Direct ground on the E.C. contact also serves to accomplish this return by operating the release magnet. The wiper shaft is, therefore, again free to rise. The operation of D just before the second digit is dialed serves to disconnect ground, whether direct or through 500-ohms, from E.C. contacts on bank levels belonging to the suboffice. But this call is not destined for the suboffice, because a second digit other than "3" or "4" is dialed, and so, the wiper shaft is driven to a level on which the E.C. contact is grounded through 500-ohms. The wiper rotates in one step and is stopped by the E.C. contact. The switch repeats subsequent pulses to the associated central office whose incoming first and second selectors have up to now been operating in tandem with the switching selector repeater.

The seizure of the switching selector repeater, the operation of the secondary lineswitch, and the vertical operation were the same as for a call to a distant switching district.

7.21 Rotary Operation

After the last impulse, the switch will cut in as has been described for a call to a distant office. As shown in Fig. 3, the dialed level (No. 3) has the E.C. contact connected through a break contact of D to ground on the control trunk.

The E.C. wiper, making contact with this direct ground, causes the operation of relay K which immediately connects (+) ground to both ends of the winding of relay D, preventing the operation of the latter at this time.

7.22 Automatically Releasing

Relay K also connects direct ground from the E.C. lead through a make contact of relay F, break contact of D, to the release magnet. The release magnet operates and closes its spring contacts, completing a locking circuit to relay K, so that the latter will not release when the wipers withdraw from the bank. The ground from the contact of the release magnet also maintains a shunt around D to prevent its operation.

When the shaft has restored to normal, the off-normal springs will open the circuit to relay F which, in turn, opens the shunt around relay D. Relay F also opens the locking circuit to the release magnet, but before the latter can restore

and open the circuit to K, relay D will operate from ground at a make contact of K and in series with the release magnet. Relay D closes its locking circuit and opens its operating circuit, at the same time opening the ground connection to the E.C. contacts on levels No. 3 and No. 4.

Relay D also closes a make contact to prepare the trunk-hunting circuit from the C wiper. Relay K restores, preparing the impulsing circuit to the vertical magnets. The operation of relay D in opening a connection to the E.C. contacts of levels No. 3 and No. 4 is incidental for a call to the central office but is essential for the operation on a local call, as explained later on.

7.23 Second Vertical Operation

As the second series of impulses comes in from the dial, this switch and a second selector in the main office raise their shafts to the dialed level (which will be any level except No. 3 or No. 4).

7.24 Second Rotary Operation

The E.C. wiper, cutting in on the dialed level, as described under "Rotary Operation" of the preceding section, will encounter ground through 500 ohms. This will operate relay K, opening the circuits to relay G and the vertical magnet, so that these circuits will not be disturbed during succeeding series of impulses.

The operation of the switch is the same from this point on as described under "Repeating Impulses" and succeeding headings in Section 7.1, "Calls to a Distant Office."

7.3 Calls Within the Suboffice

Suboffice calls are distinguished from calls to the associated central office by having "3" or "4" as second digits; i.e., 33,000 and 34,000. First digit (3) drives switching-selector-repeater wipers to the third level. As before the incoming selector in the associated central office operates in tandem. The E.C. wiper of the switching selector repeater has encountered direct ground on the first rotary contact causing the switch to release. The second digit, say "4", drives the switch wipers to the fourth level. Ground through a 500 ohm resistor has been removed, and the wiper is rotated automatically inward to find a free trunk to a local third selector. The switches in the central office which operates in tandem with the switching selector repeater are released as is the central office trunk. Note that the switching selector repeater takes the place of first and second selectors on local calls.

The seizure, vertical operation, first rotary step, and automatic release are the same as described for a call to the associated central

office. The second vertical operation is also the same except that a local level, either level "3" or "4", is dialed.

7.31 Second Rotary Operation

The E.C. wiper, cutting in on either the third or fourth level, will encounter an open contact, with the result that relay K does not operate. The action of this switch will now be similar to that of a selector.

If the first trunk is busy, ground will be encountered on the C lead, which will cause the operation of relay G from (-) battery, winding of relay G, break contact of relay K, make contact of F, cam springs, rotary magnet interrupter springs, make contact of D, break contact of H, break contact of K, to ground on the C contact. Relay G completes the circuit to the rotary magnet, which operates, rotating the shaft and breaking the circuit to G.

7.32 Switching Through

When a free trunk is found, the wipers come to rest, and the shunt is removed from relay H, which operates and switches the lines through to a local third selector. Relay H operates in series with relay G and is locked up by ground on the control lead from the switch ahead. Relay H also opens the circuit to relay A.

7.33 Release of Switches in the Central Office

Relay A, releasing, opens the trunk loop to the incoming selector in the central office, allowing the switches in the central office to release. Relay B releases and opens the circuit to hold trunk, allowing the outgoing lineswitch to release and free the trunk to the central office.

7.34 Release

When the receiver at the dialing telephone is replaced, a switch ahead removes the ground from the release trunk which makes the switching selector repeater free and opens the circuit to H. Relay H, restoring, closes the circuit to the release magnet.

8. CALLS TO AN OPERATOR

The operation of the switching selector repeater on a call extended to a toll recording operator in a central office is similar to the operation on a call to a central office subscriber.

The toll recording operator, on answering a call removes the battery from the trunk long enough to ascertain which "discriminating tone" (indicating the class of service to which the dialing party is entitled) is upon the trunk. Removal of battery from the trunk opens the circuit to E, allowing E to restore and remain at normal until battery is replaced upon the trunk.

Relay E, while at normal, removes the short-circuit from the 11-ohm winding of the induction coil and connects the 24-ohm winding of the induction coil in series with the 0.7 M.F. condenser across the trunk (the discriminating tone lead is connected to the (-) side of the trunk at the associated outgoing lineswitch).

The release trunk is now grounded through the 11-ohm winding of the induction coil, and any discriminating tone that has been connected to the release trunk at the lineswitch of the calling telephone is induced in the 24-ohm winding of the induction coil. The induced current completes a circuit to the operator over the trunk to inform her regarding the class of service to which the subscriber is entitled.

9. OPERATION OF SWITCH WHEN OTHER GROUPS OF NUMBERS ARE ASSIGNED

The notes on Fig. 3 explain the connections to the bank contacts for any desired group of numbers which may be assigned to the suboffice. It is not required that the second digit be the same as the first digit for one of the thousand groups assigned to the suboffice, as was the case in the example given.

Assume that it is desired to assign only the 37,000 group of lines to the satellite which has been previously used as an illustration. The wiring of the E.C. contacts is then as indicated in the supplementary diagram on Fig. 3.

Should a suboffice subscriber dial a 33,000 number (now a main office number) the E.C. wiper would encounter direct ground on the first digit, releasing the shaft. The opening of the off-normal springs would permit the operation of relay D which would open the circuit leading from the E.C. wiper to the release magnet. Hence, when the E.C. wiper encounters direct ground on the second digit, relay K but not the release magnet would be operated. The switch would then continue to function as a repeater, as explained under previous headings.

