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(1 Page, Page 1)
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Appendix 1
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METHOD OF OPERATION

Panel System - Inter-Office Incoming - From Key Indicator System -
From Full Mechanical - With 900 Ohm - 1300 Ohm Fundamentals or Full
Mechanical Tandem

In Item 2.1 of paragraph 2 change "the maximum external loop for
supervision to the called subscriber" from 900 ohms to 1500 ohms.

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W.T.K.
January 11, 1938
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This Method of Operation was Prepared from Issue 23 of Drawing ES-226886.

METHOD OF OPERATION

Panel System - Inter-Office Incoming - From Key Indicator System - From Full Mechanical - With 900 Ohm - 1300 Ohm Fundamentals - Or Full Mechanical Tandem.

DEVELOPMENT

1. PURPOSE OF CIRCUIT

- 1.1 This circuit is used to establish a connection from a manual office to a machine switching office, or from a machine switching office or sender tandem center to another machine switching office.

2. WORKING LIMITS

- 2.1 This circuit has an external pulsing loop resistance of 1488 ohms maximum. The maximum external loop for trunk supervision is 1200 ohms. The maximum external loop for supervision to the called subscriber is 900 ohms. Minimum trunk leak 30000 ohms minimum subscriber's line leak 10000 ohms.

OPERATION

3. PRINCIPAL FUNCTIONS

The functions of this circuit are as follows:

- 3.1 Selection of proper idle final selector.
- 3.2 Signalling the called subscriber.
- 3.3 Establishing the talking connection.
- 3.4 Returning to normal.

4. CONNECTING CIRCUITS

- 4.1 When used in conjunction with a manual office this circuit functions with key indicator circuits and final selectors. When used in conjunction with machine switching office, this circuit functions with district or office and final selectors.

(11 Pages, Page 2)
Issue 2 BT-226886
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DESCRIPTION OF OPERATION

5. TRUNK SELECTED

When this trunk is seized by a trunk selector in the manual office, or by a district or office selector in the machine switching office, or sender tandem center, the (L) relay operates, due to the closure of the fundamental circuit, as follows: Battery through inner winding of the (L) relay, lower outer contact of cam T, upper inner contact of cam S, (T) compensating resistance, over tip of line through the associated sender circuit, back over ring of the line, (R) compensating resistance, top inner and bottom outer contacts of cam R to ground. The (L) relay operated also locks up through its inner winding. The (L) relay operated causes the switch to advance to position #2.

6. BRUSH SELECTION

With the sequence switch in position 2, the UP magnet operates. The UP magnet is held operated under control of the (L) relay, and causes the selector brush rod to move upward, carrying the commutator brush over the A commutator segments. Ground is connected to each segment of the commutator, as the brush wipes over it, thus sending pulses over the fundamental circuit. The (L) relay is held operated and the (STP) relay in the sender circuit is successively short-circuited, causing it to release and reoperate, until a sufficient number of pulses to satisfy the counting relays in the sender circuit for incoming brush selection have been sent. The fundamental circuit is then opened in the sender circuit, releasing the (L) relay. The (L) relay released causes the switch to advance to position 3. With the sequence switch in position 3, the TM magnet is energized, rotating the trip rod in position to trip the proper multiple brush with the next upward movement of the brush rod. The (L) relay operates through the fundamental circuit as described in paragraph 5, advancing the switch to position 4.

7. GROUP SELECTION

The (L) relay is held operated and the UP magnet is energized in the same manner as described in paragraph 6. The selector brush rod again moves upward and the rotated trip finger of the trip rod engages with the trip finger of the multiple brush, tripping the brush, which allows its contacts to make with the bank terminals. As the selector moves upward, carrying the commutator brush over the B commutator segments, ground is intermittently connected to the tip side of the fundamental circuit, holding the (L) relay operated through the lower outer contact of cam S, and the lower inner contact of cam T, but successively short-circuiting the

sender STP relay, which releases and reoperates, "running down" the sender, counting relays. When sufficient pulses have been sent back to satisfy the sender, for incoming group selection, the fundamental circuit is opened in the sender circuit, releasing the (L) relay, which advances the sequence switch to position 5. With the sequence switch in position 5, the (L) relay operates, advancing the sequence switch to position 6. The selector group register operates for PEG count purposes when the sequence switch reaches position 5 1/2, during its advance.

8. TRUNK HUNTING

If the tripped brush has made contact with an idle trunk, the (L) relay releases as the switch advances to position 6, and ground through the upper outer and lower outer contacts of cam K is connected to the sleeve of the trunk making the trunk test busy. If the tripped sleeve brush has made contact with the sleeve terminal of a busy trunk the (L) relay is held operated as the switch advances to position 6. The (L) relay operated with the sequence switch in position 6, energizes the UP magnet. The UP magnet energized, causes the selector brush rod to travel upward, wiping the springs of the tripped brush over the bank terminals of the group. When an idle trunk is found as indicated, by no ground connected to the S terminal of the trunk multiple, the holding circuit through the inner winding of the (L) relay is opened. The (L) relay, however, will not release immediately, since a circuit is closed from battery, through the outer winding, lower outer and upper inner contacts of cam Q, C commutator segments and brush to ground.

8.1 "C" Commutator Note

The adjustment of the C commutator brush with relation to the tripped brush, is such that it does not break contact with the C commutator segment until slightly after the holding circuit through the inner winding of the (L) relay is opened by the sleeve brush, leaving the busy terminal and making contact with the S terminal of an idle trunk. The UP magnet therefore, remains operated, and the selector rod travels upward, until the brushes are carried slightly above the center of the selected trunk terminals, allowing the locking pawl to enter a notch on the rack attached to the brush rod. At this time the holding circuit through the outer winding of the (L) relay is opened, at the C commutator, releasing the (L) relay. The (L) relay released, (a) disconnects ground from the commutator feed bar "G", (b) deenergizes the UP magnet, dropping the selector rod into place, centering the brush on the bank terminals, (c) immediately connects a temporary busy ground to the S terminal of the selected trunk, thus holding it busy to other hunting selectors

until the switch advances to position 6 3/4. This circuit is from ground, both outer contacts of cam K, break contact of the (L) relay, upper contacts of cam I to the S terminal of the trunk, (a) advances the switch to position 7, from battery, winding of the R magnet, lower outer contact of cam B, break contact of the (L) relay, to ground. When the switch reaches position 6 3/4, during its advance, a permanent busy ground is connected to the S terminal of the selected trunk, through the lower outer and upper inner contacts of cam I to the S terminal. During trunk hunting in position 6 only, commutator feed ground is supplied through one of the make contacts of, and under control of the (L) relay, through the upper outer and lower inner contacts of cam E, which prevents the reoperation of the (L) relay by the closing of a circuit between the C commutator brush and segment on an overflow of the selector, or as it drops into place.

8.2 The (L) relay operates with the switch in position 7, from battery through its inner winding lower contacts of cam T, outer contacts of cam I, to ground, and is held operated by battery through its inner winding, contacts of cam H, make contact of the (L) relay, inner contacts of cam G, over the ring side of trunk to ground in the final circuit. The (L) relay operated, advances the switch to position 8.

9. SELECTION BEYOND

When the switch reaches position 8, a circuit is closed through the final line relay, through the associated sender. The final circuit then satisfies the sender for final brush, final tens and final units selections, and then advances, opening the holding circuit through the inner winding of (L) relay, which releases. The release of the (L) relay advances the switch to position 9.

10. INCOMING ADVANCE

With the switch in position 9, the (L) relay awaits the closure of the fundamental circuit in the sender. When this is made the (L) relay operates. The (L) relay operated advances the switch to position 11. When position 9 3/4, is reached, during the advance of the switch, the outer and inner windings of the (L) relay are connected in parallel, increasing the current flow through the sender to insure the operation of the sender polarized relay over a long loop. For this purpose, position 10 is passed by to give increased time for this polarized relay to operate. As the switch advances out of position 10, the (L) relay releases.

11. TRUNK CLOSURE

11.1 Incoming from Key Indicator ("L" Wiring)

With the sequence switch in position 11, the incoming awaits trunk closure. The circuit is closed from an "A" operator's cord in the distant office, operating the (A) relay (B361) which in turn operates the (D) relay. The (D) relay operated, locks under control of cam V, during the time the sequence switch is in position 11, and also causes the (L) relay to operate. The (L) relay operated, advances the sequence switch to position 12.

11.2 Incoming from Machine Switching Office with 900-1300 Ohm Fundamental ("N" Wiring)

With the sequence switch in position 11, the incoming awaits trunk closure in the district circuit in the distant office. When the closure is made, the (A) relay, (B392 or B415) operates. The (A) relay operated, operates the (L) relay. The (L) relay operated, locks up to ground through the outer contacts of cam I. The (L) relay operated advances the switch to position 12.

11.3 Used Directly or Indirectly on Sender Tandem Center ("M" Wiring)

The (A) relay operates in position 11, as described in paragraph 11.2. The (A) relay operated operates the (D) relay. The (D) relay operated locks up and operates the (L) relay. The (L) relay is held operated, advancing the switch to position 12.

11.4 As the switch moves out of position 11, during its advance the holding circuit for the (A) relay at cam P is transferred from the lower outer to the lower inner contacts of cam P. In case the fundamental circuit is momentarily opened while the apparatus at the sender tandem center is advancing from its selection beyond position, or in case the (A) relay "CHATTERS" on a long loop, the (A) relay which is slow in releasing, holds the (D) relay operated. In case the opening of the fundamental circuit is prolonged, and the (A) relay releases, the (D) relay, which is slow in releasing, maintains the circuit through its make contact, operating the (A) relay, as soon as the fundamental circuit closes.

12. RINGING

12.1 Groups 0 and 2

When the sequence switch advanced to position 12, with the selector brush in either group 0 or 2, or any one of the groups, not

Replacing all previous issues.

associated with the P commutator the (L) relay releases. The (L) relay released, operates the (PU) relay. The (PU) relay operated is held operated from battery through its winding thru the make contact of the (PU) relay, lower contacts of cam J, break contact of the (R) relay, make contact of the (D) relay, (L and M wiring) or, make contact of the (A) relay, (Bl44) (F and N wiring) to ground. The operation of the (PU) relay causes the sequence switch to advance to position 13. With the switch in position 13, ringing current for the "one bell" code is connected to the line, over the (R-1) ringing lead, to the called subscribers' loop and subset to ground. The (R) relay is marginal and does not operate until the receiver is removed from the switchhook.

12.2 Groups 1 and 3

When the sequence switch is advanced to position 12, with the selector brush in either group, 1 or 3, the (L) relay is held operated. With the sequence switch in position 12, and the selector brush in the 1 and 3 groups, the (PU) relay awaits ground through a pick-up interrupter. This interrupter is definitely timed to connect ground to the winding of the (PU) relay immediately, before the closure of the first ringing interval of the "two bell" code, over the (R-2) lead. This prevents the false ringing of a subscribers' station, where the ringing signal is "one bell" at one second intervals. The (PU) relay now operates through the pick-up interrupter to ground. The (PU) relay is now held operated under control of the J, M, and N cams and the sequence switch advances to position 13. With the sequence switch in position 13, the (L) relay is still held operated, continuing the advance of the sequence switch to position 14. As the switch passes out of position 13, the (L) relay is held operated from battery, inner winding, lower contacts of cam H, make contact of the (L) relay and both outer contacts of cam I to ground. As the switch advances out of position 13 1/2, the (L) relay is held operated from battery, inner winding, contacts of cam H, make contact of the (L) relay, upper contacts of cam L, make contacts of the (PU) relay, upper outer contact of cam K to ground. With the switch in position 14, the (PU) relay is held operated under control of the (R) relay and ringing current for the "two bell" code is connected to the line over the (R-2) ring lead.

13. AUDIBLE RINGING TONE

Ringing current passes through the .02 mf condenser, both outer contacts of cam C, winding of the (S) relay, 7-8 winding of the repeating coil to battery producing an audible ringing tone which is transmitted back to the calling subscriber.

14. CALLED SUBSCRIBER ANSWERS

With the sequence switch in position 13, the removal of the receiver from the switchhook will shunt the ringing, and 48 volt battery circuit through the transmitter, thereby increasing the current flow through the (R) relay, operating it. The (R) relay operated, releases the (PU) relay by opening circuit at the break contact of the (R) relay. The (PU) relay released, with the switch in position 13, operates the (L) relay. The (L) relay operated, advances the switch to position 14. As the switch advances out of position 13, the (L) relay releases. When position 14 is reached the switch continues its advance to position 15. The (PU) relay releases with the switch in position 14, operates the (S) relay. The (S) relay operates from battery through the winding of the relay, outer contacts of cam C, break contact of the (PU) relay, lower contacts of cam (G), ring side of the line, the called subscriber's loop and subset, tip of the line, lower contacts of cam F to generator ground. The (S) relay operated performs no useful function at this time. When position 14 1/2 is reached, the lower outer contact of cam F is opened, and the circuit is transferred through the upper outer contacts of cam F, through the 3-4 winding of the repeating coil to ground. The (L) relay operates from battery through its inner winding, upper inner and lower outer contacts of cam E to ground. The (L) relay operated, advances the switch to position 16.

15. SUPERVISION WHEN TRUNK IS USED AS INCOMING FROM KEY INDICATOR ("L" WIRING)

As the sequence switch advances out of position 15, (A) the (S) relay is held operated by the talking circuit to the subscriber's set. The (S) relay operated, shunts the 12000 ohm winding of the (A) relay (B361). This increases the flow of current through the supervisory relay in the distant operator's cord circuit, operating it and extinguishing the supervisory lamp. The (A) relay remains operated from battery and ground in the distant operator's cord circuit.

16. OVERFLOW SIGNAL

When the sequence switch advances to position 17, due to all trunks in the final being busy, a circuit is closed from the overflow interrupter, flashing the (S) relay. Flashing of the (S) relay causes the corresponding intermittent removal of the shunt around the 12000 ohm winding of the (A) relay, thereby decreasing and increasing the current flow, through the supervisory relay in the distant "A" operator's cord circuit, resulting in the flashing of the calling supervisory lamp, as a signal to the operator that all trunks are busy.

(11 Pages, Page 8)

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17. SUPERVISION WHEN THIS CIRCUIT IS USED AS AN INCOMING FROM A MACHINE SWITCHING OFFICE OR SENDER TANDEM CENTER ("M" AND "N" WIRING)

As the sequence switch advances out of position 15, (a) the (S) relay is held operated over the talking circuit, through the subscriber's set, (b) the (A) relay (B392 or B415) is held operated. With the (S) and (A) relays operated, and the sequence switch in position 16, the (PU) relay operates. The (PU) relay operated, transfers the circuit of the (A) relay, thus reversing the battery and ground over tip and ring of the trunk, causing the operation of the polarized relay in the district circuit, which in turn causes the operation of the charge relay in that circuit.

18. DISCONNECTION

18.1 Incoming from Key Indicator

When this circuit is used as an incoming circuit from a key indicator, and the receiver at the called station is replaced on the switchhook, the (S) relay releases. The (S) relay released, removed the shunt from the 12000 ohm winding of the (A) relay, causing a decrease in the current flow to the calling supervisory relay in the distant operator's cord circuit, causing it to release and a consequent relighting of the associated calling supervisory lamp as a disconnect signal to the operator. When the calling plug of the (A) operator's cord circuit is removed from the outgoing multiple jack at the distant office, the (A) relay releases. The (A) relay released, releases the (D) relay, in turn releasing the (L) relay. The (L) relay released, advances the switch to position 18. With the sequence switch in position 18, the D magnet energizes. The D magnet energized disengages the locking pawl from the selector rod rack, and causes the selector rod to be lowered to normal, resetting the trip brush. With the selector rod normal, the sequence switch advances to position 1.

18.2 Incoming from Machine Switching

When this circuit is used as an incoming from a machine switching office, or sender tandem center, the replacement of the receiver on the switchhook at the called station, releases the (S) relay. (The (S) relay released, releases the (PU) relay. No further functioning of the incoming circuit takes place until it is released by the advance of the associated circuit as a result of the replacement of the receiver on the switchhook at the calling station. When this circuit is released by the associated district circuit the (A) relay releases. The (A) relay released, releases the (D) relay. The (D) relay released, releases the (L) relay, returning the circuit to normal.

19. OVERFLOW

19.1 Incoming from Key Indicator

Should all final trunks in a group be busy at the time of trunk hunting, with sequence switch in position 6, as described in paragraph 8, the (L) relay will be held operated by ground from the busy sleeve terminals, thus causing the selector rod to continue upward until the multiple brush makes contact, with the overflow terminal at the top of the group. As the sleeve of the overflow terminal is open, the (L) relay releases, advancing the sequence switch in position 7 as described in paragraph 8. The (L) relay operates with the sequence switch in position 7 and advances the sequence switch to position 8 as described in paragraph 8. As the sequence switch advances out of position 7, the (L) relay releases, since the ring side of the circuit is open. The (L) relay released, advances the switch to position 9. In position 9, reversed battery and ground are connected to the tip and ring of the trunk, to advance the sender to the overflow position, through the inner winding of the (L) relay, which operates. The (L) relay operated, advances the switch to position 11. In position 11, the (A) relay operates over the fundamental circuit, in turn operating the (D) relay which locks through its make contact to ground through the lower contact of cam V. The (D) relay operated, closes a circuit, through the inner winding of the (L) relay, which operates, in turn advancing the switch to position 12. In position 12, ground through the Z commutator brush and segment, advances the switch to position 17. In position 17, a circuit is closed, through the (S) relay, operating and releasing the (S) relay through the make and break of the interrupter contacts. The operation and release of the (S) relay, short-circuits the 12,000 ohm winding of the (A) relay, causing the supervisory lamp in the cord circuit to flash as a busy signal. When the plug of the cord is removed from the trunk jack at the distant end, the (A) relay releases, in turn releasing the (D) relay. The (D) relay released, releases the (L) relay, advancing the switch to position 18. In position 18, the D magnet is operated, returning the selector to normal. When the selector reaches normal, ground through the Y commutator brush and segment, returning the switch to position 1 or normal.

19.2 Incoming From Machine Switching

When the circuit is used as an incoming selector from a full mechanical office and goes to overflow, the switch advances to position 9 and reversed battery and ground are sent back over the trunk, advancing the associated sender and district circuits to

the overflow position, and operating the (L) relay which advances the switch to position 11. As the district circuit advances to its overflow position trunk closure is momentarily made, (operating the (A) relay, as described in paragraph 11.2), operating the (L) relay and advancing the switch to position 12 as described in paragraph 11.3. The (A) relay releases when the district reaches its overflow. As the switch advances out of position 11, the (L) relay releases, since the circuit through the P commutator is open. The (PU) relay operates with the switch in position 12 as described in paragraph 12 and is held operated, advancing the switch to position 13 as described in paragraph 12. The (PU) relay releases, when the switch advances from position 12. With the switch in position 13, no ringing current is connected to the ring, since the (PU) relay is normal. The (L) relay operates with the switch in position 13. The (L) relay operated, advances the switch to position 14. The (L) relay operates in position 15, advancing the switch to position 16. As the switch advances out of position 15, the (L) relay releases, continuing the advance of the switch out of position 16. In position 17 ground through the armature advances the switch to position 18, where it is restored to normal, as described in paragraph 16.2.

20. TELL TALE

During selections in position 2, 4 or 6, there are possibilities of the UP magnet failing to release. The brush rod then continues upwards until the X brush makes contact with the X commutator segment at the top of the bank. Such a condition could be caused by a grounded commutator, failure of the (L) relay to release, or failure of the fundamental to open in the sender, spring adjustment etc. When the X commutator brush makes contact with the X commutator segment, with the switch in position 2, 4, or 6 and the (L) relay fails to release, the switch advances to position 3, 5 or 7, releasing the (L) relay. During the time the selector rod is moving upward, in position 2 or 4 the A or B commutator sends pulses back to the sender, "running down" the sender counting relays, for incoming selections and possibly for final selections. If the (L) relay does not release when the switch advances out of position 2, 4 or 6, the switch continues its advance to position 12, under control of ground, through the make contact of the (L) relay, and also through the X commutator, through the outer contacts of cam B. As the switch passes through position 9, battery is connected through the fundamental ring, as described in paragraph 10, operating the sender overflow relay as described in paragraph 19.2. If the (L) relay releases when the switch advances out of position 2, or 4, it reoperates over the fundamental circuit, closed through the sender in one of its incoming or final selection positions, advancing the switch to position 4, or 6, the X commutator

continuing its advance to position 5 or 7. In position 5, the (L) relay reoperates over the fundamental circuit, advancing the switch to position 6, the X commutator continuing its advance to position 7. With the switch in position 7, the (L) relay operates as described in paragraph 6, advancing the sequence switch to position 8, the X commutator continuing its advance to position 9. In position 9, the (L) relay reoperates over the fundamental circuit, as described in paragraph 10, advancing the switch to position 11, operating the overflow relay, as described in paragraph 19.2. With the switch in position 11, the (A) relay finds a closure through the district, operating the relay, and advancing the switch to position 12, in turn operating the (PU) relay, advancing the switch to position 13. The (PU) relay releases in position 13, and the (L) relay reoperates and advances the switch to position 14, where the (L) relay releases, causing the switch to advance to position 15. In position 15, the (L) relay reoperates, advancing the switch to position 16, releasing the (L) relay, the X commutator continuing its advance to position 18, where the circuit is restored to normal by the Y commutator.

21. SELECTOR GROUP REGISTER

When the sequence switch advances thru position 17 1/2 ground is connected to the lead to the Selector Group Register thereby operating the register.

22. GROUP BUSY REGISTER

When the sequence switch is in position 1 ground is connected to the lead to the Group Busy Register to indicate that the circuit is idle. As soon as the switch advances from position 1 this ground is removed thereby indicating that the circuit is busy.

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