CIRCUIT EXPLANATION
OF
10-LINE ISOLATED P.A.X. CIRCUIT
24 VOLTS
CIRCUIT H-75159

INDEX

Miscellaneous Features
Condensers
Radio Suppressor
Charge Start
Executive Loud Speaker

GENERAL DESCRIPTION

1. PURPOSE

This circuit is designed to provide for completing connections between stations in a ten-line automatic telephone exchange.

2. ASSOCIATED CIRCUITS

2-a Executive Loud Speaker Circuit
2-b Station Telephone Circuits

3. OPERATION

3-a Call Initiated

When a call is initiated, relay A3 operates partially to mark the position of the calling line on the finder switch bank multiple, and relay T5 operates to provide for starting an idle finder.

3-b Finder Selection (Operated: Relays A3 partially and T5)

There are two finder switches with their associated selector relays in this exchange.

The selector relays are so arranged that when both finder switches are idle, the first finder is selected and the second finder switch cannot be started while the first switch is hunting.

While the finder switch is in use the circuit to the associated selector relay is held open so that the finder cannot be restored until after the completion of the call.

The selector relay E1 on operating starts the finder switch.

3-c Finding the Calling Line (Operated: Relays A3 partially, T5 and E1)

The finder switch (A2) is interrupted by relay A1 to cause it to hunt for the calling line. This hunting action stops when the wipers encounter the bank contact marked by relay A3 of the calling line.

Relay A1 then remains operated to stop the finder.

Relay A3 operates fully to disconnect itself and relay T5 from the line.

Relays B1 and D1 operate to cut the calling line thru to relay A1, to return dial tone thru condenser B to the calling party and to ground the CN lead via the C lead to make the calling line busy at the connector bank multiple.

Relays T5 and E1 restore to prepare for starting the second finder switch.

3-d Dialing (Operated: Relays A3, A1, B1 and D1)

On hearing dial tone, the subscriber dials the number of the line to be called causing relay A1 to pulse the connector switch A4 in multiple with relay C1.

Relay C1 Operates and remains operated during impulsing to keep the impulsing circuit closed when relay G1 operates if the connector switch wipers pass over a busy line.

The connector switch is stepped to the dialed line by its motor magnet A4.

Relay A1 remains operated and relay C1 restores after the last impulse of the dial.

3-e Testing the Dialed Line (Operated: Relays A3, A1, B1 and D1)

The busy test is made before relay C1 restores after the last impulse of the dialed digit.

If the dialed line is busy ground from the CN lead is encountered by the connector switch. Relay G1 will then operate to return busy tone to the calling party thru condenser B.

If the dialed line is free, battery from the CN lead is encountered by the connector switch. Relay G1 will not operate but relay H1 will operate after relay C1 restores. Relay H1, operating, starts the ringing equipment and extends interrupted generator to the called line when automatic ringing ("X" wiring) is provided or prepares to extend direct generator if dial controlled ringing ("Y" wiring) is provided.

3-f Ringing (Operated: Relays A3, A1, B1, D1 and H1)

When the ringing converter relay K5 is started, it closes direct current alternately and in opposite direction to the 8-7 and 2-1 windings of the ringing transformer primary which induces an alternating current in the secondary.

3-f1 Automatic Ringing - Interrupted Generator ("X" wiring)

When automatic ring is provided, the ringing interrupter relays N5, P5 and R5 are started at the same time as the ringing converter. These relays operate in a cycle and each time relay P5 operates, ringing current is connected over the INT. GEN. lead to the called line to operate the ringer at the called station.

3-f2 Dial Ringing-Direct Generator ("Y" wiring)

When dial controlled ring is provided, the ringing interrupter relays are not started and direct generator is maintained on the INT. GEN. lead.

Further dialing cannot step the connector switch but relay C1 operates and remains operated during impulsing extending ringing current to the called line to operate the ringer at the called station.

The digit 0 will produce a long ring and the digit 2 will produce a short ring so that codes may be rung as required.

3-g Ring-Back Tone (Operated: Relays A3, A1, B1, D1 and H1)

A small part of the ringing current is by-passed back to the calling party thru condenser B for ring-back tone.

3-h Ring Cut-Off and Switch Through (Operated: Relays A3, A1, B1, D1 and H1)

When the called party answers the call, relay F1 operates to stop the ringing and tone equipment, to remove ringing current from the line and to connect the calling line to the called line.

3-j Transmission (Operated: Relays A3, A1, B1, D1, H1 and F1)

Transmission battery is fed to both parties thru relay A1.

All other attachments are removed from the transmission lines.

3-k Restoring (Operated: Relays A3, A1, B1, D1 and H1 and F1 if completed connection)

This circuit will return to normal from any condition.

Since relay A1 feeds battery to both parties of a connection, both parties must disconnect before the circuit will restore from a completed connection.

If the connection has not been completed, relay A1 will be held by the calling party only.

Relay A1 restoring releases relay B1.

Relay B1 restoring releases relay D1, relay G1, relay H1 and relay F1 or various combinations of these relays depending on how far the call has progressed.

Relay D1 restoring releases A3.

Thus all of the relays of the circuit will have restored.

The connector switch restores to its normal position by the self-interrupted operation of its motor magnet A4 when relays B1 and H1 are at normal.

There is no particular normal position for the finder switch so that it remains where it is until started again when another call is initiated.

DETAILED DESCRIPTION

RELAY A1 (Finder Interrupter Impulsing and Bridging Relay)

Operates and Restores as the circuit to its #2 winding is closed and opened by the finder switch motor magnet A2 during the hunting action of the finder switch.

Remains Operated on its #1 winding in series with the #1 windings of relays D1 and A3 when the finder switch finds the calling line.

Holds operated on both of its windings over the calling line loop when relay D1 operates after the finder switch finds the calling line.

Restores and Reoperates as the dial at the calling station opens and closes the line loop thus generating ground pulses to the connector switch motor magnet A4.

Holds Operated on both of its windings over the called line loop in multiple with the calling line loop when relay F1 operates to cut off ringing after the called party answers.

Restores when both of its line loop circuits have been opened as the called and calling parties disconnect at the end of the conversation.

RELAY B1

Operates from the impulsing ground at relay A1 when relay D1 closes its preliminary make ("X") contacts after the finder switch finds the calling line.

Holds operated during impulsing of relay A1 to the connector switch motor magnet A4 because of its slow release characteristic.

Holds operated during the conversation to ground at relay A1.

Restores when its circuit is opened by relay A1 during the restoration of the circuit.

RELAY C1

Operates in multiple with the connector switch motor magnet A4 ("X" or "Y" wiring) from impulsing ground at relay A at the first impulse of a digit.

Holds operated during impulsing of relay A1 ("X" or "Y" wiring) to the connector switch motor magnet A4 because of its slow to release characteristic.

Operates and holds operated during additional digits ("Y" wiring only, not in multiple with the connector switch motor magnet A4) in order to ring the called line under control of the dial.

Restores when its circuit is held open by relay A1 ("X" or "Y" wiring) remaining operated after the last impulse of a digit.

RELAY D1 (Tone Start and Line Busying Relay)

Operates its "X" contacts only in its #1 winding in series with the #1 windings of relays A1 and A3 when the finder switch finds the calling line.

Operates completely and is held operated on its #2 winding from ground at relay B when relay B closes the circuit.

Restores when relay B restores during the restoration of the circuit.

RELAY E1 (Finder Selector and Start Relay)

Operates thru the LEV. A wipers of the connector switch in series with the connector switch motor magnet A4 when its circuit is closed by relay T5 after the call is initiated.

Restores when its circuit is opened by relay D1 after the finder switch finds the calling line.

RELAY F1 (Ring Cut-off Relay)

Carries ringing current in its #2 winding during ringing periods.

Does not operate on ringing current because of its slow operate characteristic.

Begins operating (closes its preliminary make ("X") contact) on its #2 winding when its circuit over the called line loop is closed at the called telephone. Its operating ground during silent periods is at the back contact (5-6) of relay C1 ("Y" wiring, dial controlled ringing) or the back contacts (1-2) of relay P5 ("X" wiring, automatic, interrupted ringing). Its operating ground during ringing periods is at the #5 terminal of the ringing transformer.

Operates completely and holds operated on its #1 winding to ground at relay B1.

Restores when its circuit is opened by relay B1 during the restoration of the circuit.

RELAY G1 (Busy Relay)

Operates over the C1 lead from ground on the CN lead only when the LEV. B wipers of the connector switch encounter the CN lead of a busy line. If the wipers of the connector switch pass over a busy line on their way to the dialed

line, relay C1 will operate and restore but will not interfere with impulsing because of the multiple circuit to the connector switch motor magnet A4 held closed by relay C1.

Holds operated thru its 4-5 spring contact from ground at relay H1 as long as relay B1 remains operated.

Restores when its circuit is opened by relay B1 during the restoration of the circuit.

RELAY H1 (Ring Start Relay)

Begins operating (closes its preliminary make ("X") contact) on its #2 winding over the C1 and CN leads in series with the #1 winding of the A3 relay of the called line (See relay A3, Outgoing Call) and from ground at its own spring contact (5-6), when relay C1 restores after the first dialed digit.

Operates completely and holds operated on its #1 winding to ground at relay B1.

Restores when its circuit is opened by relay B1 during the restoration of the circuit.

FINDER SWITCH MOTOR MAGNET A2

Operates for the first time from ground at relay A1 when relay E1 operates after the call is initiated.

Restores and operates alternately as its circuit is interrupted by relay A1 and it in turn interrupts the circuit to relay A1.

Steps the wipers of the finder switch across the bank contacts.

Remains unoperated when relay A1 remains operated after the finder switch finds the calling line.

RELAY A3 (Line and Cut-off Relay)

One A3 relay is supplied for each line in the system.

Incoming Call

Operates its "X" contacts only on its #2 winding in series with relay T5, when its circuit over the line loop is closed at the subscriber's telephone.

Operates completely on its #1 winding over the C lead in series with the #1 windings of relays D1 and A1, when its circuit thru the LEV. B wipers of the finder switch is closed by the finder switch.

Holds operated on its #1 winding over the C lead to ground at relay D1.

Restores when ground is removed from the C lead by the restoration of relay D1 during the restoring of the circuit.

Outgoing Call

Operates on its #1 winding over the CN lead in series with the #2 winding of relay H1 when its circuit thru the LEV. B wipers of the connector switch is closed.

Holds Operated on its #1 winding over the CN lead to ground at relay H1 (springs 6 and 7).

Restores when ground is removed from the CN lead by the restoration of relay H1 during the restoring of the circuit.

CONNECTOR SWITCH MOTOR MAGNET A4

Will not operate in series with the 250ω resistance of relay E1 when the circuit is closed by relay T5 thru the LEV. A wipers of the connector switch at the time when the call is initiated.

Operates and restores in multiple with the circuit to relay C1, with the ground pulses from relay A1.

Its circuit is held closed in multiple thru contacts of relays C1 and G1 so that when relay G1 operates if the wipers pass over a busy line on their way to the dialed line, the impulsing will not be disturbed.

Its circuit is opened so that it cannot be operated further, when relay H1 operates after a free line has been dialed, or when relay C1 restores following the operation of relay G1 after a busy line has been dialed.

Operates and restores by self-interrupted operation when its circuit is closed thru the LEV. A wipers of the connector switch after relay H1 restores following relay B1 during the restoration of the circuit. This action continues until the LEV. A wipers of the connector switch reach the 11th bank contact.

Steps the wiper of the connector switch across the bank contacts.

RELAY J5 (Thump Start Relay)

This relay is provided with a slow operate characteristic in order to allow relay K5 to operate completely on a direct thump start circuit before the vibrating, short-circuit is closed.

Operates when its circuit over the GEN. ST. lead is closed by relay H1 after the connector switch has been dialed to a free line.

Restores when its circuit over the GEN. ST. lead is opened by relay F1 after the called party answers the call.

RELAY K5 (Ringing Converter Relay)

This relay has a vibrating reed armature.

Operates completely when its circuit over the GEN. ST. lead is closed by H1 after the connector switch has been dialed to a free line.

Its armature vibrates opening and closing its short circuit [illegible] when relay J5 operates to transfer the circuit from the thump start circuit to the short circuit.

Its armature stops vibrating when the ground on the GEN. ST. lead is removed by relay F1 after the called party answers the call.

RELAY L5 (Ringing Current Cut-in Relay)

The operation of this relay is retarded slightly by the short circuit on its #1 winding in order to allow time for relay K5 to settle down to its normal vibration frequency before the ringing current output is connected to the primary of the ringing transformer.

Operates when relay J5 closes its circuit from ground on the GEN. ST. lead.

Restores when its circuit over the GEN. ST. lead is opened by relay F1 after the called party answers the call.

RELAY M5 (Busy Tone Interrupter Relay)

Begins operation when its circuit is closed in multiple with relay S5 over the TONE ST. lead by relay D1 after the finder switch finds the calling line.

Operates and restores because of the short circuit to its #1 winding which it closes as it operates.

The operation of this relay is retarded by the slow operate slug and the restoration is retarded by the short circuit. Thus the relay is kept from buzzing but is made to operate and restore rapidly.

RELAY N5 (First Interrupter Relay)

Operates when the circuit to its #1 winding is closed ("X" wiring) over the GEN. ST. lead by relay H1 after the connector switch is dialed to a free line.

Restores and Reoperates as the circuit to its #1 winding is alternately opened and closed by relay P5.

The restoration of this relay is retarded by the short circuit which is closed to the #1 winding by relay P5.

Restores completely when its circuit over the GEN. ST. lead is opened by relay F1 after the called party answers.

RELAY P5 (Third Interrupter Relay)

The slow operate characteristic of this relay prevents it from operating until the weighted spring of relay R5 comes nearly to rest.

Operates from ground at relay R5 when the weighted spring of relay R5 comes nearly to rest.

Restores when its circuit is opened by relay R5 restoring.

RELAY R5 (Second Interrupter Relay)

The slow operate characteristic of this relay prevents it from operating until the weighted spring of relay N5 comes nearly to rest.

Operates from ground at relay N5 when the weighted spring of relay N5 comes nearly to rest.

Restores when its circuit is opened by relay N5 restoring.

RELAY S5 (Tone Generator Relay)

Begins operation when its circuit is closed in multiple with relay M5 over the TONE ST. lead by relay D1 after the finder switch finds the calling line.

When its contacts are closed, the field of the #1 winding opposes the field of the #2 winding so that the relay starts to restore.

The relay buzzes, opening and closing the circuit to its #1 winding.

The inductive "kick" of the #1 winding when its circuit is opened produces a tone current which is transmitted thru the inductive resistance RFC-2 to the BSY TONE and DIAL TONE leads. Relay M5 interrupts the busy tone.

Condensers F5 and G5 provide resonance in the circuit to increase the volume of the two tones.

RELAY T5 (Common Line Relay)

There is one T5 relay in the exchange which is operated while any one of the finders switch is hunting for a calling line.

Operates in series with the #2 winding of relay A3 when its circuit over the line loop is closed at the subscriber's telephone.

Restores when its circuit is opened by relay A3 after the finder switch finds the calling line.

MISCELLANEOUS FEATURES

Condensers S1 and S2 (Spark Suppressors)

Condensers S1 and S2 connected from ground in multiple with the operating circuits of the finder and connector motor magnets respectively thru 125ω resistors prevent excessive sparking at the contacts of relay A1 during impulsing when the circuits to the motor magnets are opened.

Condenser B (Tone Condenser)

Condenser B provides a path for dial, busy and ring-back tones.

Radio Suppressor

The network of inductive resistance and condensers connected in the output leads of the ringing converter relay prevents excessive radio frequency discharges from the ringing converter.

Condensers S5 and S6 (Loading Condensers)

Condensers S5 and S6 connected in series with 100ω resistance across the 8-7 and 2-1 windings respectively of the ringing transformer increase the efficiency of the transformer.

Charge Start

If intermittent charging is required, the charger may be started at the same time as the tone equipment when the finder finds the calling line.

The charger will then operate until relay F1 operates when the called party answers the call.

Executive Loudspeaker

An extra connector bank multiple is provided with each line for the control of loudspeaker equipment which may be installed in place of the usual telephone equipment.

(1) DWM:hz