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COMMON SYSTEMS
CABLE INSULATION ALARM CIRCUIT
FOR CROSSBAR, STEP BY STEP OR PANEL OFFICE

CHANGES

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 In Note 105, option B is added, to replace option E, formerly not designated. This is to provide a minor alarm instead of a major alarm, since a major alarm in the alarm checking terminal cuts off the distinctive tone intended to indicate low cable insulation. The indication for a major alarm is no tone. A minor alarm is provided in No. 350A step by step offices and in No. 1 step by step offices using the pilot lamp and audible alarm circuits.

D.2 The multiple tap information for leads 1 and 2 is interchanged without record since it is lead 2 (per note 105) which connects to aisle pilot lamps.

D.3 Note 107 is revised for record of the change in note 105.

All other headings, no change.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 2313-OCH-RLL-AM

COMMON SYSTEMS
CABLE INSULATION ALARM CIRCUIT
FOR CROSSBAR, STEP BY STEP, OR PANEL OFFICE

CHANGES

B. CHANGES IN APPARATUS

B.1	Superseded	Superseded by
	314T Crossbar Sw. "M" Option KS-13546, L77 switch "H" Option	324T Crossbar Sw. "F" Option KS-13546, L90 switch "G" Option

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 The use of the KS-13546, L77, switch is rated Mfr. Disc. and is superseded by the KS-13546, L90, switch which has a longer shaft and thus makes it unnecessary to counter bore the mounting plate.

D.2 The use of the 314T Crossbar switch is rated Mfr. Disc. and is superseded by the 324T Crossbar switch, since the former is Mfr. Disc.

D.3 Options: "H", "G", "F", are added to the Options Used Table and to Note 107.

All other headings, no change

BELL TELEPHONE LABORATORIES, INC.

DEPT. 3440-MRG-EWO-MY

COMMON SYSTEMS
CABLE INSULATION ALARM CIRCUIT
FOR CROSSBAR, STEP-BY-STEP, OR PANEL OFFICE

CHANGES

D. DESCRIPTION OF CIRCUIT CHANGES

D.1 Note 105 is changed to remove all reference covering the use of this circuit in step-by-step No. 355A office.

D.2 The designation of the 479K key is changed from (CAL) to (TEST).

All other headings under Changes, no change.

1. PURPOSE OF CIRCUIT

1.1 To continuously and automatically test over a large number of groups of exchange vacant cable pairs to detect low cable insulation and give an alarm.

1.2 To provide the earliest indication of possible cable failure, particularly where the breakdown of the insulation occurs more or less gradually. Complete service interruption may thus be forestalled.

2. WORKING LIMITS

2.1 Optional arrangements provide for small, medium and large central office exchanges.

2.2 Provision is made for four optional conditions of cable insulation failure as shown on the circuit.

3. FUNCTIONS

3.01 To give an audible and visual alarm signal when the combined insulation of a group of vacant cable pairs on any given cable test terminal falls below a specified resistance value.

3.02 To indicate the particular cable test terminal on which a low insulation condition occurs.

3.03 Provides means for varying the current in the sensitrol relay to adapt it to any one of four cable insulation conditions.

3.04 Provides means for restoring the sensitrol relays to normal either by a local key or under control of an alarm checking circuit.

3.05 Provides means for checking the calibration of the circuit to insure correct determination of the cable insulation resistance.

3.06 Provides means for silencing the audible alarm.

3.07 Provides means for indicating the approximate total combined insulation of each group of cable pairs on a given cable test terminal.

3.08 To stop further testing and give the alarm when low insulation is detected on any cable test terminal.

3.09 Provision of means for starting and stopping the test at any time.

3.10 Provision for manual control of Cable Test Terminal Selection.

4. CONNECTING CIRCUITS

When this circuit is listed on a keysheet the connecting information thereon is to be followed.

4.01 Interrupter frame ckt. - SD-25062-01.

4.02 10 IPM, Int. & Imp. clock ckt. - SD-96343-01.

4.03 Misc. ckt. for misc. int. fr. in bat. cut-off offices - SD-21666-01.

4.04 Misc. ckt. for misc, int. fr. grd. cut-off offices - SD-21667-01.

4.05 Audible & visual alarm ckt. - SD-96188-01.

4.06 Pilot lamp and power alm. lamp ckt. - SD-31573-01.

4.07 Misc. alarm ckt. for aisle pilot - SD-31970-01.

4.08 Misc. alarm ckt. for alarm control - SD-31980-01.

4.09 Pilot lamp ckt. - SD-31548-01.

4.10 Misc. alarm and register ckt. - SD-31798-01.

4.11 Alarm checking terminal ckt. - SD-31835-01.

4.12 Permanent signal alarm ckt. - SD-31912-01.

4.13 Misc. alarms - ES-226189.

4.14 Floor alm. bd. misc. & aux. alarm ckt. - SD-21203-01.

4.15 Crossbar system No. 1 aisle pilot circuit - SD-25087-01.

4.16 Crossbar system No. 5 alarm circuit - SD-25671-01.

DESCRIPTION OF OPERATION

5. GENERAL

5.1 The sensitrol relay (CI-) and test resistance network in Figs. 1 and 5 are connected from 48 volt battery to the ring conductors of various groups of vacant pairs of exchange tables and the tip conductors are grounded. Provision is made for changing the testing relay and its network from one cable test terminal to another at 6 or 7 sec. intervals. A total time of 11 or 13 min. will be required for testing 100 or 200 cable test terminals and a total time of 4 to 5 min. will be required for testing 40 cable test terminals or any number of terms. less than 40.

5.2 The application of alarms to exchange cables is greatly facilitated when a previous yearly record of the insulation resistance is available of the cable to be alarmed because the more accurately the yearly minimum insulation is known the easier it is to group several cable pairs together to equal the non-operate min. res. given under "Working Limits". A cable is protected by alarms by connecting as many spare cable pairs together as possible (max. of eight) without their combined yearly minimum insulation resistance falling below one of the four non-operating resistance values given in the "Working Limits" table shown on the circuit. The needle of the sensitrol relay (CI) connected to a particular group of cable pairs, under normal conditions, therefore does not swing over to the end of its indicating scale. If, however, the insulation drops below normal the needle will swing to the end of the 125 microamp scale where it locks magnetically and gives an alarm.

5.3 A start key (ST) is provided for placing the circuit in operation on an automatic basis and should be restored to normal when making adjustments on the apparatus or during certain manual tests. When normal this key prevents the operation of relay (H), the holding and selecting magnets, or any of the (HS) relays. Operation of start key (ST) closes a ground path for operating relay (H) to a 1/2 sec. closure of battery once every 6 or 7 sec. by an external interrupter over lead 6. The manner in which the (H) selector is operated and connection made to the (CI) relay and its associated network is described in a succeeding section 6.1. If the (ST) key is operated during the open interval of the interrupter, a false alarm may be brought in due to relay (CI) being connected to a cable test terminal without the necessary circuit preparation described in section 6.1. To avoid this operate both keys (MT) and (ST) simultaneously and then restore key (MT) to normal.

6. CABLE INSULATION NETWORKS

6.1 Due to possible high cable capacities and the sensitivity of the (CI) relay with its tendency to overthrow, it is necessary to connect to the test relay and its network in the following sequence. The (H) relay, operating for approx. 3/4 sec. once every 6 or 7 sec. to connect the network with the next cable test terminal, first replaces the network by battery thru a 600 ohm resistance. While slow operate relay (J) is operating magnet (H) energizes and then de-energizes as soon as (J) is completely operated thus causing connection to be made with the next cable test terminal. The low resistance battery then quickly charges the cable test terminal. When the (J) relay operates, a shunt path thru 150 ohm resistance (F) or (F1) was connected around the 50 ohm winding of the (CI) relay so that when relay (H) releases and while slow release relay (J) is releasing a shunt resistance of 150 ohms will be connected around the 50 ohm winding of relay (CI) in addition to the network resistances. This permits current in the winding to partially build up. Shortly thereafter relay (J) releases which opens the 150 ohm shunt path and allows the current to build up to the non-operate value, permitted by the network. In this way the effects of excessive charge current and needle overthrow are eliminated.

6.2 The networks of Figs. 1 and 5 comprise a series shunt wiring arrangement in which the 50 ohm winding of the sensitrol relay (CI) is connected in shunt with the battery path that supplies battery to the (R) conductors of the vacant cable pairs during the testing period, ground being connected to the tip conductors. Four different cable conditions are provided for as shown in "Working Limits" table, depending on whether or not ground is connected to the leads "E" and "F" and therefore upon whether relays (E) and (F) operate. The terminals on arcs 1 and 2 of selector switch (H) are brought out to a terminal block so that they may be permanently grounded in accordance with circuit note 103. When any given (HS) relay or holding magnet of the crossbar switch is energized any one of four insulation tests may be applied to the associated cable test terminals. It will, however, be evident that if condition 2 for example is applied to

terminal 0 then the same condition will necessarily be applied to even terminals 2, 4, etc. up to 18, viz. all first springs in the vertical units for the zero hold magnet. In the case of the relay unit the 1st and 3rd cable test terminals on any given relay would have the same test condition. The operation of the (E) or (F) relays in effect changes the value of the current flow in the sensitrol relay (CI1) or (CI2), due to changing the value of series and shunting resistances of the associated network. Four different insulation tests are thus obtainable as given in the "Working Limits" table.

6.3 Whatever the condition, the 50 ohm winding of the (CI1) or (CI2) relay is always included in the shunt path so that if either relay (CI) operates in turn operating the (A) relay, only the shunt path is opened leaving battery always connected to the cable. This maintains the charge on the cable and minimizes the effect on the relay when the winding is again restored to the testing battery supply in case the reset key (RS) is subsequently operated.

6.4 Each (CI) relay being in effect an ammeter, may when desired be calibrated for each particular network and the indicating scale translated into ohms representing total cable insulation.

7. SWITCHING OF SENSITROL RELAY AND ITS NETWORK FROM ONE GROUP TO ANOTHER

7.1 Fig. 1 with Figures 2 and 3 For Small Offices

Figs. 2 and 3 of this arrangement makes use of a relay unit and provides for offices with an ultimate number of cable test terminals from 4 up to 40. Assuming the circuit has been placed in operation, ground thru the (MT) and (ST) keys will supply the brush of arc 3 of selector (H). This ground path is also carried thru the interrupter spring contact of the (H) selector in order to open this path whenever the selector brushes are moving from one terminal to another. Selector brush 3 thru its bank terminals operates the corresponding (HS) relays one at a time as the switch makes a complete revolution. During the first revolution, relay (TR) remains normal and therefore only the cable test terminals connected to the two top sets of contacts on the (HS) relays are tested. Each (HS) relay is operated twice by brush 3, the first time with relay (G) operated thru brush 4 and the second time with relay (G) normal. The (CI1) relay and its network are thus connected, first over lead A and then over lead B, thence thru normal contacts on relay (TR) and operated top contacts on one of the operated (HS) relays to the cable test terminals.

On the last step of the (H) selector, ground from brush 4 over lead 11 and top normal contact relay (RC) operates relay (TR) which locks for the duration of the second revolution of the selector (H). This relay transfers the "A" and "B" leads from the top to the bottom contacts on the (HS) relays and thus permits the corresponding cable test terminals to be tested.

The function of the (RC) relay is to prepare the circuit for releasing the (TR) relay at the end of the second revolution so that the above cycle may then repeat itself. This is accomplished by brush 4 at terminal 11 operating relay (RC) over lead 10 thru its primary winding. At its bottom contact the secondary winding is then connected in multiple with resistance (TR) which continues to hold it operated from ground at relay (TR). When terminal 22 is reached, ground is connected over lead 11 and the top front contact on relay (RC). This ground shunts out the ground path thru the winding of relay (TR) causing it to release but continues to hold (RC) relay operated over its secondary winding. When the selector (H) steps off terminal 22 the (RC) relay also releases thus restoring the circuit to its initial condition.

7.2 Fig. 1 with Fig. 4 for Larger Offices

Fig. 4 of this arrangement calls for a crossbar switch having 6 verticals with one of the verticals unused and provides for an ultimate capacity of 100 cable test terminals. With the (H) selector switch stepping as previously described, ground on brush 3 thru its respective bank terminals operate each hold magnet twice every half revolution of the switch, the first time with relay (G) operated from ground on brush 4 and the second time with relay (G) normal. The (CI1) relay and its network are thus connected, first over lead A and then over lead B, thence thru contact springs 0 and 1 corresponding to the hold and select magnets that are operated. The particular selecting magnet operated depends on the position of selector (S) which, at the (H) selector bank terminals 10 and 21 on arc 4, is made to take one step for each half revolution of the selector (H). The brush 1 of selector (S) is carried thru the interrupter spring on the (S) magnet, previously described for brushes 3 and 4 of selector (H), in order to save a contact protection network for each selecting magnet.

7.3 Fig. 1 with Figures 4 and 5 for Large Offices

The same crossbar switch unit is furnished in this arrangement as just described for the 100 test terminal unit, but the number of ultimate cable test terminals is doubled by adding the equipment shown in Fig. 5. This additional (CI2) relay with its own individual network is wired thru

independent contacts on the (E), (F), (G), (H) and (J) relays and therefore functions in the same manner as described for the (CI1) relay and its network.

8. ALARM OPERATION

8.1 Assuming the insulation of a cable pair terminal falls enough below its lowest allowable value to cause one of the sensitrol test relays to operate, it will lock magnetically due to a small bar magnet on a piece of iron connected to the pointer or moving contact. The contact closed operates relay (A) in turn operating relays (B) and (C). Relay (A) operated opens the circuit to the 50 ohm sensitrol operating windings to protect them against excessive current and prepares an operating path for the 900 ohm sensitrol restoring solenoid windings. Relay (C) operated lights red alarm lamp (MP) and connects ground to various leads for lighting aisle pilot lamps and giving an audible alarm. At its top contact, relay (C) opens the circuit of the (H) relay to stop the testing of other cable pair terminals.

8.2 When the alarm is transmitted to a distant office having alarm checking facilities the distant operator may dial the alarm checking terminal and cause ground to be connected to lead "5". This will energize the sensitrol restoring solenoids which break the magnetic pull on the moving contacts and allow them to return to normal thus releasing relay (A). Relay (A) released opens the circuit to relay (B) and recloses the sensitrol operating windings and operates relay (D). Relay (D) operated locks to ground on lead "5" and opens the circuit to the sensitrol restoring solenoids. Relay (A) is slow releasing so the (CI) relay contacts will be restored to normal before relay (D) operates and opens the restoring circuit. If the alarm condition still exists the (A) relay reoperates, in turn reenergizing relays (B) and (C). Relays (B) and (C) are slow releasing so when this condition occurs relay (C) will not be released before the circuit is reenergized and ground will stay on the various lamp signal and alarm leads. If it was a false alarm, relay (A) does not reoperate, thus releasing relay (B) and in turn releasing relay (C) which removes ground from the alarm leads and extinguishes lamp (MP). When the operator disconnects from the alarm checking terminal ground is removed from lead "5", releasing relay (D) and restoring the circuit to normal.

8.3 If the alarm signals are in the same office with the testing equipment the maintenance force will locate the alarm lamp (MP) and will then operate the (AL) key to cut off the alarm. After recording the number of the cable test terminal in trouble, the reset key (RS) should be operated to see if the (CI) relay reoperates. If it does then the (MT) key should be operated and the test terminal disconnected from the testing equipment. Automatic testing may then be resumed by restoring the (MT) key and operating the (RS) key to restore the (CI) relay.

9. MANUAL CONTROL OF TESTING EQUIPMENT

When it is desired to check a particular cable test terminal the following procedure should be followed.

9.1 Operate Manual Test Key (MT) to Stop Automatic Testing

This permits the (SEL) and (HLD) keys to be operated for selecting the cable test terminal to be tested.

9.2 Restore key (ST). This opens the circuit of the (H) relay but it is slow to release and during this period a circuit thru a normal contact on the key connects ground thru the brushes and bank terminals on arcs 3 and 4 of the (H) selector for operating one of the (HS) relays in Fig. 3 or one of the hold magnets in Fig. 4, thus permitting battery thru the (G) resistance and operated contact on relay (H) to charge the cable test terminal being tested. Then when relays (H) finally releases the (CI) relays and their test networks will replace the circuit thru the resistance (G).

9.3 Assuming one or both of the (CI) relays operate relay (A) will operate but relays (B) and (C) will not operate because the operating path for relay (B) is open at the (ST) key. To retest the cable test terminal operate reset key (RS) to reset one or both (CI) relays. To check another cable test terminal, reoperate the (ST) key and the (SEL) and (HLD) keys then restore the (ST) key as before to close the test path to the terminal selected. To resume automatic testing, reoperate the (ST) key then restore the Manual Test key (MT) to normal.

10. CALIBRATION

With Fig. B rotation of the (CAL) switch from the first position to pos. 2 to 5 disconnects the test terminals from the sensitrol relay networks and substitutes the proper non-operate values for test conditions 1 to 4. Further rotation to pos. 6 to 9 substitutes the operate values for test conditions 1 to 4. After each of pos. 6 to 9 is reached and the alarm operates, rotate the (CAL) switch to the next posion and operate the (RS) key to reset the sensitrol relay. Failure of the alarm to ring on any of positions 6 to 9 indicates trouble and should be investigated. On completion of the test, switch (CAL) must be returned to position 1 to permit the circuit to continue its testing operation. With Fig. C, (TEST) key is operated to

"Ckt. 1" and the procedure described above performed. On completion of the test the (TEST) key is then thrown to "Ckt. 2" and the calibrate procedure repeated. After completion of the test, (TEST) key is restored to normal and the (CAL) switch returned to pos. 1, to permit the circuit to continue its testing procedure.

BELL TELEPHONE LABORATORIES, INC.

DEPT. 3440-JPD-EWO-H1