# Western Electric Co., Incorporated, Engineering Dept.. New York. 

## METHOD OF OPERATION TEJT CIRCUIT

Final Muitiple Test Line, for Testing Incoming selector Circuits - Having Four Party semi-selective A。C. Ringing - 95 to 110 Volts - Automatic Routine selector Test Frame - Power Driven Machine sivitching system.

## GENERAT DESCRIPTION

1. This circuit is used for making tests on machine switching incoming selector circuits. These incoming circuits are equipped with four party semi-selective ringing feature and use 24 volt talking battery. This circuit is used to test the ringing relays of the incoming selector circuit under test for premature tripping, false tripping, and timely tripping. The supervisory relay in the circuit under test is first given a soaking current, and then a releasing current, after which the rtiay is sperated and released alternately until disconnection takes place.
2. These test lines are assinged special numbers and are cross connected to the final muitiple, but not connected to either line switches, or line finders. Test calls are made by either a routine testing circuit, or a manual testing circuit at the originating end, which selects automatically a trunk for test.

## DJTAITBD DESCRIPTION

3. When the test number designated by the telephone company is sent either by an automatic test circuit fron the originating office, an inconing selector seizes a final selector, which in turn hunts for the first idle test line. When this cirm cuit is seized by the final selector, battery over the s lead operates the CO relay which locks through its nake contact, to battery on the $s$ lead, when the test switch R-1, advances to position 2. The Co relay operated performs no useful function at this time. When tho incming selector circuit under test has advanced to its fiuging position, the $R$ relay pperates on the first period of ringing current supplied by a two ring interrupter. The operation of the $R$ relay closes a circuit from ground through its make contact, to battery through the winding of the R-l relay, which oporates. The operation of the R-1 relay cioses circuits (a) from ground through tre PU interrupter brush \#1 (not shown) PU-1 lamp, cantacts of cam $I$, make contacts of the R-I relay, contacts of cam E, break contacts of the PU-1 and PU-2 relays, to battery through the winding of the PU-2 relay, and (b) from ground through the PU interrupter brush 42 , (not shown), PU-2 lamp, contacts of cam H, make contacts of the R-1 relay, break contacts of the PU-2 and PU-1 relays, to battery through the winding of the PU-l relay. If the ringing current operating the R relay is being received from the incoming circuit through ringing brush set fl, PU-2 relay operates, and locks through its make contact to ground on cam $D_{0}$. When the ringing current is connected to the test circuit through ringing brush set \#2, the PU-1 reiay operates and locks through its make contact to ground on cam D. The operation of either the PU-1 or PU-2 relays, poens the operating circuit to the other relay, preventing its subsequent operation. The operation of either the PU-1 or PUn releys closes a circuit from ground through its make contact, can B, to battory through the $\bar{k} 1$ ragnet, advancing the switch to position 2. should either set of intemupter brushes connect ground through the make or break contact of the PU-l relay before the R-I switch is moved out of position 3, the PU relay operates on its inner windins and locks on its outer winding and make contact to ground on can $C$, preventing
further operation of the test circuit until disconnection takes place. With the saitch in position 2, ringing current is disconnected from the test line circuit during the interval between the first and second rings, releasing the $R$ relay, which in turn releases the R-1 relay. The release of the R-1 relay closes a circuit from ground on cam $D$, through the make contact of the $C O$ relay, break contact of the $\mathrm{R}-1$ relay, lower contacts of can $F$, break contact of the PU relay to battery through the R-1 magnet, advancing the switch to position 3. When the next interval of two ring riaging current is connected to the test circuit, the R relay re-operates, in turn operating the R-1 relay. The operation of the R-1 relay connects ground through cam $D$, make contacts of the $C O$ and R-1 relays, contacts of cam $E$, break contact of the PU relay, to battery through the R-2 magnet, advancing the switch to position 4. In position 4, either the PU interrupter brush set $H 1$, or brush set ${ }^{4} 2$ connects ground through cass I and H respectively, and contacts of the PU-1 relay, to battery through the PU relay, operating the relay. The operation of the PU relay, closes a circuit from ground on cam $D$, through the make contact of the Co relay, break contact of the R-1 relay, which released, during the interval between rings, contacts of cam $F$, make contacts of PU relay to battery through the R-I inagnet, advancing the switch to position 5. As the switch leaves position 4, the PU relay releases.

PREWATURE TRIPRING TEST
4. With the R-1 switch in position 5, a circuit is closed from either ringing interruptur urusn set 籼, or brush set \#2, depending unon the gosition of the PU-2
 pperating the $R$ relay on the first ringing period of the two ring current. Ringing. current is also being supplied from the incoming under test, but this current performs no useful function in the test circuit. The R relay operated, in turn operates the $\mathrm{R}-1$ relay, which closes a circuit from ground on cam $D$, through the make contacts of the C0 and R-1 relays, inner contacts of can $\mathcal{Z}(\mathrm{R}-1)$, can B on $\mathrm{B}-2$, to battery through the R-Z magnet, advancing the timing switch from yosition I the $\Delta$ cam carrym ing it to position 9. As the $\mathrm{R}-2$ switch is advancing through position 2 to $7-3 / 4$. the $T$ and $R$ sides of the test circuit are closed through cala $\mathbb{E}$ on $R-2$, cam $J$, on $\mathrm{B}-1,2, D, C, B$ and A resistances for $1 / 2$ seoond, testing for premature tripping of the ringing relays in the incoaing selector circuit under test. At the end of the first ringing period, the R and $\mathrm{R}-1$ relays release, closing a circuit fron ground on cam $D$, through the make contact of the CO relay, break contact of the R-1 relay, cams $F$ and $G$ in position 5, upper inner contact of cam $B$ on $\mathbb{R}-2$, to battery through the R-2 magnet, advancing the switch to position 10. With the R-1 saitch in position 5, and the $\mathrm{R}-2$ switch in position 10 , the R and $\mathrm{R}-1$ relays re-pperate on a second period of ringing current closing a circuit froa ground on cain $D$ and. make contact of the CO relay, make contact of $\mathrm{R}-1$ relay cam E , can B on $\mathrm{B}-2$, to battery through the R-2 magnet, advancing the switch out of position 10 , the $A$ cam carrying it to position 18.
5. As the $\mathrm{R}-2$ switch is noving through position 11 to $16-3 / 4$, the ringing relays in the incoming selector circuit under test, are again tested for premature tripping, by connecting the $A, B, C, D$ and $E$ resistances across the tip and ring side of the test and through cams $J$, and. When the R relay releases at the end of the second ringing period the $\mathrm{R}-1$ relay releases, and cioses a circuit from ground througe its break contact, caas $F$ and upper suter contact of $G$ on $R-1$, cam $C$ on $R-2$, which is in position 18, to battery through the R-1 magnet, advancing the switch to position o. When the A relay releases a circuit is also closed through its break
contact，cans $F$ and $G$ on R－1，can $B$ on $R-2$ ，to battery through the R－2 magnet，ad－ vancing the timing switch to position $I$ ．On the next ringing interval the $R$ ans $R-1$ relays again operate and move the R－2 switch out of position 1 through cam B advanc－ ing the switch to position 9．As the Raz switch is cassing through positions 2 to $7-1 / 4$ on its second revolution，the premature tripping of the ringing relays is tested a third time．In the silent period between the two rings，the R relay re－ leases，in turn releasing the R－1 relay，which connects ground through its break con－ tact，cans $F$ and $G$ ，can $B$ ，to battery through the $R-2$ magnet，advancing the timing switcil to position 10．With the R－2 switch in position 10，the same ground through cam C on R－2，advances the R－1 switch to position 7．In position 7 of R－1．the R relay is connected across the $T$ and $R$ sides of the teat circuit awaiting the second interval of ringing current．

## TRIP ING TE．ST

6．If the ringing relays in the inconing selector circuit under test have not tripped prematurely，and the A relay operates on the second ringing intervai，in turn operating the R－1 relay，which cioses a circuit from ground through its make contact，uyper cuter contact of can E，break contact of the PU relay to battery trorough the R－I magnet，advancing the switch to position 8 ．However，should the ringing relays in the incoming selector circuit trip prenaturely，the a relay does not perate，and the test circuit is held $u_{v}$ until cieared from the originating end． In position 8 of $\mathrm{R}-1$ ，the silent interval between the two rings and ore ring periods occurs，releasing the R relay，which in turn releases the R－1 relay．The release of the R－l relay cioses ground through its break contact，and inner oontacts of cam F．to battery through the R－1 magnet，advancing the sequence switen to position 9 ． In positim 9 of $\mathrm{R}-1$ ，the R relay is connected in a circuit from generator ground on can N．winding of the R reiay，cam 0 ，contact of the PU－2 reiay to either brush set新 or brush set it2，of the ringing interrupter，operating the A relay．The R relay remperates the R－1 relay，which connects ground through its hake contact，and cara $E$ to can B on R－Z，advancing the R－2 switch out of position 10 of its second revolu－ tion．The R－2 switch is carried to position 18，by zeans of the A can，and as it passes through positions 11 to $16-3 / 4$ ，the ringing relays in the selector circuit are tested for timely tripping，by connecting the $A$ and $B$ resistances across the $T$ and． R side of the test line．During the silent period，after the second two ring interval，the $R$ and $R-1$ relays release wich advances the $R-2$ switch to position 1 in a circuit thrcugn the lower inner contacts of cams $F$ and $G$ ，and cam $B$ on $R-2$ ． With the R－2 s．vitch in position 1，the same ground through the break contact of the R－1 relay，cans F and G on R－1，can C on R－2，to battery thrcugh the R－1 magnet， advances the testing switch to position 10.

7．With the switan in position 10，the R relay is again connected across the tip and ring sides of the test line．If the ringing relays in the selector circuit under test have not tripped，the R and．R－1 relays operate oin the first period of ringing current，and the R－1 relay iocis through eam J，and its own make contacts， make contact of the $C 0$ relay to ground on can $D$ ，preventing further operation of the testing circuit until disconnection takes place．If the ringing relays in the inm coning circuit are tripped，ringing current is not supplied to the test circuit，and the $R$ and R－1 relays consequently do not sperate．During the ringing interval，with the testing switch in position 10，ground is supplied wither through pick up interm rupter brush set 湖，or brush set 㕱 can I or cana $H$ ，make or break contact of the PU－1 relay，depending upon whother the PULZ or pUl relay is operated，to battery
through the inner winding of the PU relay, winich oyerates. With the PU relay operated, and the R-1 relay nonmperated, a circuit is closed fro:n ground on cam $D$, through the make contact of the CO relay, break contact of the R-1 relay, cam F, make contacts of the PU relay to battery through the R-1 magnet, advancing the sivitch to position 11. As the test switch leaves position 10, the holding circuits for the PU-1, or PU-Z relays, and the PU relay are open, releasing the relays. In position 11 of the R-1 switch, the R-1 relay is placed under control of the 149 interrupter. When the contacts of the interrupter make, a circuit is closed from ground on can $K$, through the contacts of the interrupter, upper contacts of can $J$, to battery through the winding of the R-1 relay, which operates. The operation of the R-i relay cioses a circuit froa ground on cam $D$, through the make contacts of the CO and Rol relay, break contact of the PU relay to battery through the R-1 :agnet, advancing the switch to position 12. With the switch in position 12, the R-1 relay releases, when the interrupter contacts break, and advances the testing switch to position 13, in a circuit from ground on can $D$, through :ake contact of the CO relay, break contact of the R-1 relay, contacts of cam $F$ to battery through the R-1 magnet. The testing switch remains in position 13, approximately $1 / 2$ second until the brushes on the 149 interrupter make. During this interval of time, the A resistance ( 20 onins) is -onnected across the tip and ring sides of the test line, through can $M$, to give a soaking current to the supervisory relay under test, in the incoaing selector circuit.

## SUPERVISORY RETAY TEST

8. Uoon the make of the contacts on the 149 interrupter, the R-1 relay reoperates and closes a circuit from ground through its make contact, contacts on cam $E$, break contacts of the PU relay to battery through the R-1 magnet, advancing the testing switch to position 14. When it leaves position 13 , the short arpund the Jo relay is open at cam $M$, allowing the Jo relay to operate over the tip and ring sides of the test line, in series with the testing resistances to battery and ground in the inconing selector circuit under test. The operation of the Lo relay connects ground through its make contact, and catn $C$, to battery through the outer winding of the PU relay, wich locks through its make contact, to the same ground. In position 14, of the k-1 switch, the contacts of the 149 interrupter make, perating the R-1 relay, which prevents the moving of the $\mathrm{k}-1$ switch out of position 14, through the break contact of the R-1 relay. During the interval the brusnes on the 149 interrupter make, the A. B, C, D, E, and F resistances and the JO relay, are connected across the tip and ring sides of the test line, to release the supervisory relay in the incoaing selector circuit. Upon the break of the interrupter brushes, the R-1 relay releases, connectiog ground through its break contact and cam $F$, to battery through the E-1 magnet, advancing the testing switch to position 15. In position 15, of the soitch, the $A, B$, and $C$, or the $A, B, C$ and $D$ resistances, depending upon the lengt: of subscriber's loop the supervisory relay is adjusted to operate over, are connected across the tip and ring sides of the test circuit through the contacts of the 149 intorrupter and the LO rolay, cam J. When the contacts of the 149 interrupter alternately mane and break, the supervisory relay in the inconing selector circuit under test, is alternately operated and released until the required number of puises are sent back to satisfy the routine test circuit (not shown).

## DISCONNECTION

9. When the routine test circuit is satisfied, disconnection takes place, pening the tip and ring sides of the test circuit in the inco:ing selector circuit,
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releasing the $I 0$ relay. The release of the 3.0 relay opens the circuit of the $P U$ relay, which releases. The release of the PU relay closes a circuit of the PU relay, which releases. The release of the PU relay closes a circuit from ground on cam $D$, through the make contact of the CO relay, break contact of the R-1 relay, cam $F$, break contact of the PU relay, to battery through the R-1 magnet, advancing the switch to position 16, the A cam carrying it to position 18. The switch remains in position 18 until the release of the final selector circuit. When the final selector circuit releases, the S terminal of the test circuit opens and the CO relay releases, closing a circuit from battery through a resistance, break contaet of the CO relay, cam P, to the S terminal, holding this circuit busy to other hunting finals until restored to normal. The release of the co relay also closes a circuit from ground on cam $D$ to the break contact of the relay, to battery through the winding of the $M R$ register, which operates and records the number of tests made with this circuit. The operation of the $\mathcal{M R}$ register closes a circuit from ground through its make contact, cam $D$ or $R-2$ to battery through the R-2 magnet, advancing the switeh to pasition l provided it has not already advanced to position 1. With the R-Z switch in position 1, the same ground is connected through the lower contacts of cam $D$ on $\mathrm{R}-2$, cam $B$ or $\mathrm{R}-1$ to battery through the B-1 magnet advancing the test switch to position 1. In position 1 of $\mathrm{f}-1$, the MR register releases, restoring the circuit to normal.
10. In case of premature disconnection due to fault either in the incoming circuit under test or the test circuit itself, the test line circuit awaits in the position in which the trouble occurred until the release of the final. From this point the circuit is restored to normal as described above.

## CIRCUIT BRGUIRBMENTS

## THE GBADJUST RECUIRBMBNTS SHOUN BETOM ARS FOR WA INTENANCE USE ONTY

## OPERITE <br> NON-OPBRLITE <br> RETMASE

E672

E720
(OU)
Inner
W2.
(1500
onms)
Outer
Tag. (1500 oirms)

3888 (PUT] \& PU-2)

Dpecial requirements to insure fast operation. Readj. .0033 amp. Test . 0035 amp.习.c.C. . 0035 amp .

Readj. . 0008 amp Test .0007 amp.

Special requirements to insure A.C. control
Readj. . 012 amp Readj. . 007 ampe Test . 013 amp . Test .0065 amp . W.C.C. .021 amp.

Test requirement of outer winding is proportional to test requirement of inner winding: Readj. . 018 amp. Test .019 amp.

Readj. . 011 amp. Test . 010 amg.

$$
\text { W.C.c. . } 020 \text { amp. }
$$

Test . 021 amp. W. C.C. . 028 amp.

Readj. . 021 amp.
Readj. . 004 amp.
Test .023 amp . W.C.C. . 025 amp.

Test . 0038 amp .

NOT:- When necessary to readjust this relay adjust straight outside spring of make break combination to give a least 20 grams contact pressure against the bent sprins.

## E1328

Test requirement of inn
of wirdings in series.
aiding
Readje . 018 ampe
Reauj. . 012 amp .
Test . 033 amg .
Test . 011 amp.
$\begin{array}{ll}\text { Inner } & \text { Test } .088 \text { amp. } \\ \text { Was. } & \text { I.C.C. } .134 \text { amp. }\end{array}$
100
ohms

## IIRCUIT REU IREMENTS

THE READJU'T REGU IRENENTE DHONN BELOV ARE FOB MAINTENANCE USE ONTY OPBRATE

NON-OPERATE
RET,BASE
special requirements to insure $A$. $C$, pperation.
Armature air gap - ninimuan . 023 inch.
R
Contact follow - minimum . 003 inch.
Test in series with I M.F. condenser and 7300 oria resistance at exchange ringing voitage.

